Mississippi Department of Education
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Office of Career Education and Workforce Development
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TO: District Superintendents and Secondary Vocational Directors/Contact Persons

FROM: Jean Massey, Associate State Superintendent
Office of Vocational Education and Workforce Development

DATE: February 18, 2011

RE: **Request for Comments Administrative Procedures Act Process**

The State Board of Education, on February 18, 2011, approved the Office of Vocational Education and Workforce Development to begin the Administrative Procedures Act Process for the following item:

To revise the Mississippi Secondary Curriculum Frameworks for the following secondary programs:

1. Construction: Carpentry
2. Diesel Service Technician
3. Early Childhood Education
4. Engineering
5. Health Sciences
6. Information Technology
7. Polymer Science

A copy of the secondary curriculum can be downloaded from the following site:

http://www.mde.k12.ms.us/vocational/OVTE/

Written comments must be received by **5:00 p.m. on Tuesday, March 15, 2011 and should be addressed to: Mrs. Jean Massey, Associate State Superintendent of Career and Technical Education, P.O. Box 771, Jackson MS 39205-0771.**

JM:cb

MEMORANDUM#11.009

OFFICE OF INSTRUCTIONAL ENHANCEMENT AND INTERNAL OPERATIONS
Summary of State Board of Education Agenda Items
February 17 – 18, 2011

OFFICE OF VOCATIONAL EDUCATION AND WORKFORCE DEVELOPMENT

Approval to begin the Administrative Procedures Act process: To revise the *Mississippi Secondary Curriculum Frameworks.*

EXECUTIVE SUMMARY

The following secondary curriculum frameworks are recommended for approval:

1. Construction: Carpentry
2. Diesel Service Technician
3. Early Childhood Education
4. Engineering
5. Health Sciences
6. Information Technology
7. Polymer Science

Each curriculum framework follows the established format established for secondary vocational and technical programs. Draft curricula for each program were revised and reviewed with input from local district personnel and business/industry collaborators. Approved secondary curricula will be disseminated for implementation in the Fall 2011.

The *Executive Summary-Secondary Curricula Frameworks* contains the following elements for each revised secondary curricula:

- Program Description
- CIP Code and CIP Name
- Course Outline and Codes
- Curriculum Framework
  - Student Competencies
  - Suggested Student Objectives

All curricula frameworks are designed to provide local programs with a foundation that can be used to develop localized instructional management plans and course syllabi. Contents of each framework are not designed to limit the content of a course, but to provide a minimum baseline of instruction, which all programs must meet.

Teachers, administrators, and instructional management personnel are encouraged to expand and enhance the statewide frameworks to better meet the needs of their students.

NOTE: The Office of Vocational Education and Workforce Development have provided printed, bound executive summaries for the curriculum frameworks. The completed documents are available upon request.

Recommendation: Approval

Back-up material attached

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Vocational and Technical Education
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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Construction: Carpentry Executive Summary

Program Description

Construction: Carpentry is a pathway that prepares students for employment or continued education in the occupations of carpentry. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

When developing this curriculum, writers recognized the importance of differentiating instruction and meeting the needs of the 21st century learner. Teaching strategies included a blend of online and face-to-face instruction. Teaching strategies are aligned with Contren Connect e-books, online lectures, video presentations, online quizzes, active figures, and Spanish content. Students will have access to this information to learn new content as well as review, reinforce, or revise work.

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **Contren Learning Series.** When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi construction instructors will be required to successfully complete the **Instructor Certification Training Program**. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi **NCCER Accredited Training and Education Facilities (ATEF)**. In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
10. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Assessment

Students will be assessed using the Construction: Carpentry MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://info.rcu.msstate.edu/services/pathway.asp. If there are questions regarding assessment of this program, please contact the construction instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Construction: Carpentry pathway, the following student prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)

   or
3. Instructor Approval and TABE Reading Score (eighth grade or higher)

   or
4. Instructor Approval

Proposed Applied Academic Credit

Applied Math content from the curriculum was aligned to the 2007 Mississippi Math Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Math credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

Teacher license 977 is required to teach Construction: Carpentry. The requirements for the 977 licensure endorsement are listed below:

1. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education.
2. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught. Applicant with a bachelor's or higher degree must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
4. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must validate occupational competency by earning a passing score on the Construction Technology assessment through NCCER National Craft Assessment and Certification Program.
6. Applicant must successfully complete the Contren Instructor Certification.
7. Applicant must successfully complete an MDE-approved computer literacy certification exam.
8. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
9. Applicant must successfully complete the Construction certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a **977** endorsement—a 5-year license. If the applicant does not meet **all** requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows options for local school districts to meet student needs and scheduling demands. One option groups units into four one-Carnegie-unit courses. The second option groups units into two two-Carnegie-unit courses. A discussion of each option is provided below.

Option 1

Upon completion of this option, the student will be trained to take the **Contren Level 1 Certification** exam. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. Safety and Orientation to Construction (Course Code: 993102)
2. Introduction to Construction (Course Code: 993103)
3. Theory and Application of Carpentry, Part A (Course Code: 993111)
4. Theory and Application of Carpentry, Part B (Course Code: 993112)

Course Description: Safety and Orientation to Construction includes an introduction to the field as well as fundamentals of construction safety, tools, math, and blueprint reading and basic carpentry, electrical, masonry, and plumbing skills.

Course Description: Introduction to Construction emphasizes an overview of other construction-related trades such as electrical writing, masonry, and plumbing. This course gives students real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Safety and Orientation to Construction.

Course Description: Theory and Application of Carpentry, Part A includes an in-depth study of materials used in the carpentry field, foundations, and floor framing. This course also reinforces safety related to the construction industry. This one-Carnegie-unit course should only be taken after students successfully pass Introduction to Construction.

Course Description: Theory and Application of Carpentry, Part B includes an in-depth study of wall and ceiling framing, roof framing, windows and doors, and stair layout. This course also reinforces safety related to the construction industry. This one-Carnegie-unit course should only be taken after students successfully pass Theory and Application of Carpentry, Part A.

Safety and Orientation to Construction (Course Code: 993102)

Unit		Title	Hours
1		Introduction and Orientation	15
2		Basic Safety	19
3		Basic Math	24
4		Hand and Power Tools	24
5		Introduction to Blueprints	24
6		Introduction to Carpentry	34
			140

Introduction to Construction (Course Code: 993103)

Unit		Title	Hours
7		Introduction to Electrical Wiring	48
8		Introduction to Masonry	48
9		Introduction to Plumbing	44

			140

Theory and Application of Carpentry, Part A (Course Code: 993111)

Unit		Title	Hours
10		Orientation (Review and Reinforcement)	5
11		Basic Safety (Review and Reinforcement)	10
12		Construction Math	30
13		Introduction to Materials Used in Construction	20
14		Footing, Foundation, and Floor Framing	75
			140

Theory and Application of Carpentry, Part B (Course Code: 993112)

Unit		Title	Hours
15		Wall, Ceiling, and Roof Framing	86
16		Windows, Doors, and Stairs	54
			140

Option 2

This option will prepare students for employment in the content area chosen and prepare students to complete the **Contren Level 1 Certification**. Students are encouraged to take this certification exam. This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. Construction I (Course Code: 993101)
2. Construction II: Carpentry (Course Code: 993110)

Course Description: The Construction I course introduces students to fundamentals of construction safety, tools, math, and blueprint reading and basic carpentry, electrical, masonry, and plumbing skills. Upon the completion of this course, students will have knowledge to complete the Contren Core Certification.

Course Description: The Construction II: Carpentry course consists of an in-depth study of foundations; wall and ceiling framing; room framing; windows and doors; and stair layout. Upon the completion of this course, students will have the knowledge to complete the Contren Level I Certification.

Construction I (Course Code: 993101)

Unit		Title	Hours
1		Introduction and Orientation	15
2		Basic Safety	19
3		Basic Math	24
4		Hand and Power Tools	24
5		Introduction to Blueprints	24
6		Introduction to Carpentry	34
7		Introduction to Electrical Wiring	48
8		Introduction to Masonry	48
9		Introduction to Plumbing	44
			280

Construction II: Carpentry (Course Code: 993110)

Unit		Title	Hours
10		Orientation (Review and Reinforcement)	5
11		Basic Safety (Review and Reinforcement)	10
12		Construction Math	30
13		Introduction to Materials Used in Construction	20
14		Footing, Foundation, and Floor Framing	75
15		Wall, Ceiling, and Roof Framing	86
16		Windows, Doors, and Stairs	54
			280

Construction: Carpentry Concentration Competencies and Objectives

Unit 1: Introduction and Orientation

1. Describe local program and vocational center expectations, policies, and procedures. (DOK 1)
   a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. (DOK 1)
   b. Give a brief overview of the course. Explain to students what Construction Technology is, why it is important, and how it will be delivered. (DOK 1)
   c. Compare and contrast local program and school policies to expectations of employers. (DOK 1)
   d. Preview course objectives, program policy, and the industry standards. (DOK 1)
2. Describe employment opportunities and responsibilities. (DOK1)
   a. Describe employment opportunities including potential earnings, employee benefits, job availability, working conditions, educational requirements, required technology skills, and continuing education/training. (DOK 1)
   b. Describe basic employee responsibilities and appropriate work ethics. (DOK 1)
   c. Compare and contrast employment responsibilities and expectations to local school and program policies and expectations. (DOK 1)
3. Research, design, and conduct a project that will integrate the knowledge and skills learned in the Construction Pathway Course in a real-world, unpredictable environment. (DOK4)
   a. Demonstrate effective team-building and leadership skills. (DOK4)
   b. Explore leadership skills and personal development opportunities provided to students by student organizations to include SkillsUSA. (DOK 1)
   c. Work as a team to design a community service project for which the knowledge and skills learned in the course can be used to improve the lives of others. (DOK4)
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2)
   a. Follow basic written and verbal instructions. (DOK 1)
   b. Effectively communicate in on-the-job situations. (DOK 2)

Unit 2: Basic Safety

1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry. (DOK 2)
   a. Describe how to avoid on-site accidents. (DOK 1)
   b. Explain the relationship between housekeeping and safety. (DOK 1)
   c. Explain the importance of following all safety rules and company safety policies. (DOK 1)
   d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. (DOK 2)
   e. Explain the need for evacuation policies and the importance of following them. (DOK 1)
   f. Explain the employer's substances abuse policy and how it relates to safety. (DOK 1)
   g. Compare and contrast shop/lab safety rules to industry safety rules. (DOK 2)
2. Identify and apply safety around welding operations. (DOK 1)
   a. Use proper safety practices when welding or working around welding operations. (DOK 1)
   b. Use proper safety practices when welding in or near trenches and excavations. (DOK 1)
   c. Explain the term "proximity work." (DOK 1)
3. Display appropriate safety precautions to take around common jobsite hazards. (DOK 1)
   a. Explain the safety requirements for working in confined areas. (DOK 1)

b. Explain and practice lock-out/tag-out procedures. (DOK 1)
c. Explain the different barriers and barricades and how they are used. (DOK 1)

4. Demonstrate the appropriate use and care of personal protective equipment. (DOK 1)
   a. Identify commonly used personal protective equipment (PPE) items. (DOK 1)
   b. Understand proper use of PPE. (DOK 1)
   c. Demonstrate appropriate care for PPE. (DOK 1)
5. Explain lifting and the use of ladders and scaffolds. (DOK 1)
   a. Identify and explain the procedures for lifting heavy objects. (DOK 1)
   b. Inspect and safely work with various ladders and scaffolds. (DOK 1)
6. Explain the material safety data sheet (MSDS). (DOK 2)
   a. Explain the function of the MSDS. (DOK 1)
   b. Interpret the requirements of the MSDS. (DOK 2)
7. Display appropriate safety procedures related to fires. (DOK 1)
   a. Explain the process by which fires start. (DOK 1)
   b. Explain fire prevention of various flammable liquids. (DOK 1)
   c. Explain the classes of fire and the types of extinguishers. (DOK 1)
   d. Illustrate the proper steps to follow when using a fire extinguisher. (DOK 1)
   e. Demonstrate the proper techniques of putting out a fire. (DOK 1)
8. Explain safety in and around electrical situations. (DOK 1)
   a. Explain injuries that can result when electrical contact occurs. (DOK 1)
   b. Explain safety around electrical hazards. (DOK 1)
   c. Explain action to take when an electrical shock occurs. (DOK 1)

Unit 3: Basic Math

1. Apply the four basic math skills with whole numbers, fractions, decimals, and percents. (DOK 2)
   a. Define terms related to construction math. (DOK 1)
   b. Add, subtract, multiply, and divide whole numbers, decimals, and fractions. (DOK 1)
   c. Convert whole numbers to fractions, and convert fractions to whole numbers. (DOK 2)
   d. Convert decimals to percents, and convert percents to decimals. (DOK 2)
   e. Convert fractions to decimals. (DOK 2)
   f. Convert fractions to percents. (DOK 2)
   g. Demonstrate reading a tape measure to the nearest 16th. (DOK 2)
2. Use the metric system. (DOK 2)
   a. Explain what the metric system is and its importance. (DOK 2)
   b. Use a standard and metric ruler to measure. (DOK 2)
   c. Recognize and use metric units of length, weight, volume, and temperature. (DOK 2)

Unit 4: Hand and Power Tools

1. Demonstrate the use and maintenance of hand and power tools. (DOK 2)
   a. Identify and discuss the use of common hand and power tools. (DOK 1)
   b. Discuss rules of safety. (DOK 1)
   c. Select and demonstrate the use of tools. (DOK 2)
   d. Explain the procedures for maintenance. (DOK 1)

Unit 5: Introduction to Blueprints

1. Read, analyze, and understand basic components of a blueprint. (DOK 3)
   a. Identify terms and symbols commonly used on blueprints. (DOK 1)
   b. Interpret various symbols to locate various elements. (DOK 1)

c. Interpret a plan to determine layout. (DOK 1)
d. Interpret electrical drawings, including site plans, floor plans, and detail drawings. (DOK 2)
e. Read an equipment schedule. (DOK 1)
f. Explain the basic layout of a blueprint. (DOK 1)
g. Describe the information in a title block. (DOK 1)
h. Identify the lines used on blueprints. (DOK 1)
i. Explain the architect's and engineer's scales. (DOK 2)
j. Sketch a project to scale. (DOK 3)
k. Construct a structure based on a sketch. (DOK 3)

Unit 6: Introduction to Carpentry

1. Explain the fundamentals of the carpentry trade. (DOK 1)
   a. Define terms related to the carpentry trade. (DOK 1)
   b. Discuss the history of the carpentry trade. (DOK 1)
   c. Describe modern carpentry. (DOK 1)
   d. Describe career ladders, stages of progress, and advancement possibilities in carpentry work. (DOK 1)
   e. Exhibit the skills, attitudes, abilities, personal responsibilities, and responsibilities a person needs to work as a successful carpenter. (DOK 1)
   f. Recognize materials used and the importance of safety in the carpentry industry. (DOK 1)
2. Demonstrate safety when working in carpentry and with carpentry tools. (DOK 2)
   a. Demonstrate safe working procedures related to carpentry. (DOK 1)
   b. Identify hazards related to carpentry and how to avoid or minimize them in the workplace. (DOK 1)

Unit 7: Introduction to Electrical Wiring

1. Demonstrate safety in and around electrical circuits and equipment. (DOK 2)
   a. Define terms related to electrical safety. (DOK 1)
   b. Demonstrate safe working procedures in a construction and shop/lab environment. (DOK 2)
   c. Explain the purpose of OSHA and how it promotes safety on the job. (DOK 1)
   d. Identify electrical hazards and how to avoid or minimize them in the workplace. (DOK 1)
   e. Explain safety issues concerning lock-out/tag-out procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems. (DOK 2)
2. Describe/identify basic electrical theory. (DOK 2)
   a. Define terms related to electrical theory. (DOK 1)
   b. State how electrical power is generated and distributed. (DOK 1)
   c. Identify voltage, and identify the ways in which it can be produced. (DOK 1)
   d. Compare the difference between conductors and insulators. (DOK 1)
   e. Describe how voltage, current, resistance, and power are related. (DOK 1)
   f. Explain the different types of meters used to measure voltage, current, and resistance. (DOK 1)
   g. Use Ohm's law to calculate the current, voltage, and resistance in a circuit. (DOK 2)
   h. Calculate how much power is consumed by a circuit using the power formula. (DOK 2)
   i. Describe the differences between series and parallel circuits. (DOK 1)
   j. Calculate the amount of power used by a circuit using the power formula. (DOK 2)

Unit 8: Introduction to Masonry

1. Explain the fundamentals of the masonry trade. (DOK 1)
    a. Review the history of masonry. (DOK 1)
    b. Explain modern masonry materials and methods. (DOK 1)
    c. Describe career ladders and advancement possibilities in masonry work. (DOK 1)
    d. Demonstrate the skills, attitudes, and abilities needed to work as a mason. (DOK 1)
2. Identify and discuss safety issues in and around the masonry work site. (DOK 1)
    a. Identify hazards related to masonry and how to avoid or minimize them in the workplace. (DOK 1)
    b. Identify and describe the safe use of tools and equipment used in performing masonry tasks. (DOK 1)
    c. Demonstrate safe working procedures related to masonry. (DOK 1)
    d. Demonstrate the correct procedure for assembling and disassembling scaffolding according to federal safety regulations. (DOK 1)
    e. Perform safety and mechanical checks on a mechanical mixer. (DOK 1)
3. Explain and define terms and materials associated with masonry. (DOK 1)
    a. Name the different types of brick, block, and stone. (DOK 1)
    b. Label parts of a brick, block, and stone. (DOK 1)
    c. Identify the positions as they appear in a wall. (DOK 1)
    d. Identify the materials used in the masonry trade. (DOK 1)
4. Perform procedures used in masonry trades. (DOK 2)
    a. Identify the positions of masonry units as they appear in a wall. (DOK 1)
    b. Measure, mark, and cut brick and block to specifications. (DOK 2)
    c. Lay out a brick and/or block wall using the dry bond method. (DOK 2)
    d. Mix a batch of mortar. (DOK 2)
    e. Lay a wall between established leads. (DOK 2)

Unit 9: Introduction to Plumbing

1. Recognize the fundamentals and use appropriate materials of the plumbing trade. (DOK 2)
    a. Identify terms related to the plumbing trade. (DOK 1)
    b. Describe the historical development of the plumbing trade. (DOK 1)
    c. Describe the importance of plumbers in modern society and career opportunities available. (DOK 1)
    d. Explore leadership skills and personal development opportunities related to plumbing. (DOK 1)
    e. Describe the functions of water supply and sewage treatment systems. (DOK 1)
    f. Explain how the water supply and sewage treatment facilities function. (DOK 1)
    g. Relate the development of plumbing to improvement in public health. (DOK 1)
    h. Identify materials of the plumbing trade. (DOK 1)
    i. Utilize materials of the plumbing trade. (DOK 2)
2. Identify tools and safety procedures used in plumbing trades, and perform basic plumbing operations using proper tools and safety procedures. (DOK 1)
    a. Identify and describe how to handle unsafe acts and conditions that cause accidents. (DOK 1)
    b. Use and care for personal protective equipment. (DOK 1)
    c. Identify jobsite hazards specific to the plumbing industry. (DOK 1)
    d. Identify basic hand and power tools used in the plumbing trade. (DOK 1)
    e. Demonstrate how to use and maintain power tools safely. (DOK 1)
    f. Demonstrate proper selection of tools for various plumbing tasks. (DOK 1)
    g. Demonstrate how to prepare a surface for tool use. (DOK 1)
    h. Describe the safety requirements for using plumbing tools. (DOK 1)

i. Explain how to work safely in and around a trench. (DOK 1)

Unit 10: Orientation (Review and Reinforcement)

1. Review local program and vocational center policies and procedures. (DOK 1)
   a. Review local program and vocational center policies and procedures including dress code, attendance, technology acceptable use policy, academic requirements, discipline, shop/lab rules and regulations, and transportation regulations. (DOK 1)
   b. Give a brief overview of the course, and explain to students what Construction Technology II is, why it is important for students to know the content of the course, and how it will be delivered. (DOK 1)
   c. Preview the school handbook, the technology acceptable use policy, and all other safety procedures for the classroom and building level. (DOK 1)
   d. Preview course objectives, program policy, and the industry standards. (DOK 1)
2. Describe employment opportunities and responsibilities. (DOK 1)
   a. Describe employment opportunities including potential earnings, employee benefits, job availability, working conditions, and educational requirements. (DOK 1)
   b. Describe basic employee responsibilities and appropriate work ethics of those working in the construction industry. (DOK 1)
   c. Classify stages of progress within the carpentry trade. (DOK 1)
3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA. (DOK 2)
   a. Demonstrate effective team-building and leadership skills. (DOK 1)
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2)
   a. Follow basic written and verbal instructions. (DOK 1)
   b. Effectively communicate in on-the-job situations. (DOK 2)

Unit 11: Basic Safety (Review and Reinforcement)

1. Describe general safety rules for working in a shop/lab and industry. (DOK 1)
   a. Describe how to avoid on-site accidents. (DOK 1)
   b. Compare and contrast the relationship between housekeeping and safety. (DOK 1)
   c. Carry out all safety rules and company safety policies. (DOK 1)
   d. Summarize the importance of reporting all on-the-job injuries, accidents, and near misses. (DOK 1)
   e. Review the need for evacuation policies and the importance of following them. (DOK 1)
   f. Research employer's substances abuse policy and how it relates to safety. (DOK 1)
2. Identify and apply safety around welding operations. (DOK 1)
   a. Use proper safety practices when welding or working around welding operations. (DOK 1)
   b. Use proper safety practices when welding in or near trenches and excavations. (DOK 1)
   c. Explain the term "proximity work." (DOK 1)
3. Explain the appropriate safety precautions to take around common jobsite hazards. (DOK 1)
   a. Perform safety requirements for working in confined areas. (DOK 1)
   b. Explain and practice lock-out/tag-out procedures. (DOK 1)
   c. Explain the different barriers and barricades and how they are used. (DOK 1)
4. Demonstrate the appropriate use and care of personal protective equipment (PPE). (DOK 2)
   Identify commonly used PPE items. (DOK 2)
   Understand proper use of PPE. (DOK 2)
   Demonstrate appropriate care for PPE. (DOK 2)
5. Explain lifting and the use of ladders and scaffolds. (DOK 1)

a. Identify and explain the procedures for lifting heavy objects. (DOK 1)
b. Inspect and safely work with various ladders and scaffolds. (DOK 1)

6. Explain the material safety data sheet (MSDS). (DOK 2)
   a. Explain the function of the MSDS. (DOK 1)
   b. Interpret the requirements of the MSDS. (DOK 2)
7. Explain fires and safety procedures related to fires. (DOK 1)
   a. Explain the process by which fires start. (DOK 1)
   b. Explain fire prevention of various flammable liquids. (DOK 1)
   c. Explain the classes of fires and the types of extinguishers. (DOK 1)
8. Explain safety in and around electrical situations. (DOK 1)
   a. Explain injuries that can result when electrical contact occurs. (DOK 1)
   b. Explain safety around electrical hazards. (DOK 1)
   c. Explain action to take when an electrical shock occurs. (DOK 1)

Unit 12: Construction Math

1. Apply basic mathematics for carpentry. (DOK 2)
   a. Solve basic algebraic equations. (DOK 2)
   b. Calculate area and volume of simple geometric figures. (DOK 2)
   c. Apply basic math to solve simple geometric figures and problems. (DOK 2)

Unit 13: Introduction to Materials Used in Construction

1. Identify, use, and select appropriate wood building materials used in the construction industry. (DOK 3)
   a. Identify the terms commonly used in discussing wood and lumber. (DOK 1)
   b. Review building materials discussed in Construction Technology I. (DOK 1)
   c. Explain how plywood is manufactured, graded, and used. (DOK 1)
   d. Identify various types of hardwoods and softwoods and the various types of imperfections that are found in the lumber. (DOK 1)
   e. Identify various types of building panels, and identify their uses. (DOK 1)
   f. Identify the uses and safety precautions associated with pressure-treated lumber. (DOK 1)
   g. Describe the proper method of caring for lumber and wood building materials at the jobsite. (DOK 1)
   h. State the uses of various types of engineered lumber. (DOK 1)
   i. Calculate the quantities of lumber and building materials using accepted standards. (See local building codes.) (DOK 3)
2. Describe, use, and select the appropriate wood building fasteners and adhesives used in the construction industry. (DOK 1)
   a. List the basic types of screws and their uses. (DOK 1)
   b. Identify the different types of anchors and their uses. (DOK 1)
   c. Describe the common types of adhesives used in construction work, and explain their uses. (DOK 1)
      - Resorcinol resin or waterproof glue
      - Contact cement

      <u>Construction Adhesives</u>
      - Construction adhesives
      - Neoprene adhesive
      - Contact cement
      - Drywall adhesive
      - Instant-bond glue
      - Epoxies

Unit 14: Footing, Foundation, and Floor Framing

1. Identify, plan, and construct types of footing and foundations used in carpentry. (DOK 3)
    a. Set up a level or transit for determining grade or elevation prior to digging a foundation. (DOK 2)
    b. Calculate the amount of materials needed for a given foundation, including forms, concrete, moisture barrier, and reinforcement materials. (DOK 2)
    c. Set up batter boards to proper elevation. (DOK 2)
    d. Explain how building lines are established using batter boards. (DOK 1)
    e. Identify different types of concrete structures that require the construction of edge forms (DOK1):
        - Slabs with or without a foundation
        - Parking lots
        - Driveways and streets
        - Sidewalks
        - Approaches
    f. Demonstrate the ability to construct and dissemble edge forms for the following (DOK3):
        - A slab-on-grade with the existing foundation
        - A slab-on-grade with an integral foundation
    g. Explain the purpose of a screed, and identify the different types of screeds. (DOK 1)
    h. Demonstrate the ability to set screeds on grade. (DOK 1)
2. Identify floor systems. (DOK 2)
    a. Identify the different types of framing systems. (DOK 1)
    b. Describe floor system requirements from drawings and specifications. (DOK 1)
    c. Identify floor and sill framing support members. (DOK 1)
    d. Describe the methods used to fasten sills and floor framing systems to the foundation. (DOK 1)
    e. Select the correct girder/beam size using specific floor load and span data. (DOK 1)
    f. Describe different types of floor joists. (DOK 1)
    g. Identify different types of bridging. (DOK 1)
    h. Describe and explain different types of sub-flooring materials. (DOK 1)
    i. Estimate the amount of material needed to frame a floor assembly. (DOK 2)
3. Plan and construct floor systems. (DOK 3)
    a. Plan a floor system for construction to include a comprehensive material list and detailed plan of a floor system to scale.
    b. Construct a floor system for a detailed plan.

Unit 15: Wall, Ceiling, and Roof Framing

1. Research, lay out, and construct wall framing. (DOK 3)
    a. Describe the different components of a wall layout. (DOK 1)
    b. Explain the procedures for layout and assembly of interior and exterior wall frames (laying out a wood frame wall, including plates, corner posts, door and window openings, partition T's, bracing, and firestops). (DOK 1)
    c. Perform the proper procedure for assembling and erecting an exterior wall. (DOK 1)
    d. Classify the appropriate materials and methods used for installing sheathing on walls. (DOK 1)
    e. Perform layout and assembly of a given size wall. (DOK 3)
    f. Calculate framing and sheathing materials needed for a wall assembly. (DOK 2)
2. Lay out and construct ceiling framing. (DOK 3)
    a. Identify and describe the components needed to estimate and assemble a ceiling layout. (DOK 1)
    b. Construct a ceiling frame according to specified instructions or plans. (DOK 3)
3. Describe principles of roof framing. (DOK 2)
    a. Define roof framing members and terms. (DOK 1)

b. Identify the basic roof styles. (DOK 1)
c. Discuss methods used to calculate the length of a rafter. (DOK 1)
d. Identify types of roof trusses. (DOK 1)
e. Calculate the length of a rafter for a given size roof. (DOK 2)
f. Identify various types of sheathing used in roof construction. (DOK 1)
g Estimate materials needed to frame and sheathe a given size roof. (DOK 3)
h. Frame a gable roof. (DOK 3)
i. Sheathe and apply roofing felt on a gable roof. (DOK 3)

Unit 16: Windows, Doors, and Stairs

1. Install windows and doors. (DOK 3)
   a. Describe the various types of windows commonly used in construction. (DOK 1)
   b. List the parts of a window. (DOK 1)
   c. State requirements for proper window installation. (DOK 1)
   d. Install a pre-hung window. (DOK 3)
   e. Identify various types of doors commonly used in construction. (DOK 1)
   f. Identify the parts of door construction. (DOK 1)
   g. Identify types of thresholds used with exterior doors. (DOK 1)
   h. Install pre-hung doors. (DOK 3)
   i. Identify and install various types of locksets used on doors. (DOK 3)
2. Identify the types and parts of stairs. (DOK 1)
   a. Classify stairs according to the type such as open, closed, winding, geometrical, and spiral. (DOK 1)
   b. Recognize common stair components such as tread, riser, stringer, skirt-board, and cleats. (DOK 1)
3. Measure and calculate the rise, run, and stairwell openings. (DOK 2)
   a. Explain rise and run in relation to a given platform height. (DOK 1)
   b. Define rules for determining the rise and run for a given set of stairs. (DOK 1)
   c. Determine the number of treads and risers for a given platform height. (DOK 2)
   d. Identify codes and standards for determining rise, run, and stairwell openings. (DOK 1)
4. Lay out and cut stair stringers. (DOK 3)
   a. Demonstrate ability in selecting appropriate material for stair stringers. (DOK 1)
   b. Understand and be familiar with the use of the framing square and stair gauges in marking stringer cuts. (DOK 2)
   c. Demonstrate ability in marking a stair stringer accurately. (DOK 3)
   d. Demonstrate ability to cut a stair stringer accurately. (DOK 3)

Construction: Carpentry Competency Profile
Program CIP: 51.0000

Unit 1: Introduction and Orientation

_____ 1. Describe local program and vocational center expectations, policies, and procedures.

_____ 2. Describe employment opportunities and responsibilities

_____ 3. Research, design, and conduct a project that will integrate the knowledge and skills learned in the Construction Pathway Course in a real-world, unpredictable environment.

_____ 4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.

Unit 2: Basic Safety

_____ 1. Describe, define, and illustrate general safety rules for working in a shop/lab and how they relate to the construction industry.

_____ 2. Identify and apply safety around welding operations.

_____ 3. Display appropriate safety precautions to take around common jobsite hazards.

_____ 4. Demonstrate the appropriate use and care of personal protective equipment.

_____ 5. Explain lifting and the use of ladders and scaffolds.

_____ 6. Explain the material safety data sheet (MSDS).

_____ 7. Display appropriate safety procedures related to fires.

_____ 8. Explain safety in and around electrical situations.

Unit 3: Basic Math

_____ 1. Apply the four basic math skills with whole numbers, fractions, decimals, and percents.

_____ 2. Use the metric system.

Unit 4: Hand and Power Tools

_____ 1. Demonstrate the use and maintenance of hand and power tools.

Unit 5: Introduction to Blueprints

_____ 1. Read, analyze, and understand basic components of a blueprint.

Unit 6: Introduction to Carpentry

_____ 1. Explain the fundamentals of the carpentry trade.

_____ 2. Demonstrate safety when working in carpentry and with carpentry tools.

Unit 7: Introduction to Electrical Wiring

_____ 1. Demonstrate safety in and around electrical circuits and equipment.

_____ 2. Describe/identify basic electrical theory.

Unit 8: Introduction to Masonry

_____ 1. Explain the fundamentals of the masonry trade.

_____ 2. Identify and discuss safety issues in and around the masonry work site.

_____ 3. Explain and define terms and materials associated with masonry.

4. Perform procedures used in masonry trades.

Unit 9: Introduction to Plumbing

1. Recognize the fundamentals and use appropriate materials of the plumbing trade.
2. Identify tools and safety procedures used in plumbing trades, and perform basic plumbing operations using proper tools and safety procedures.

Unit 10: Orientation (Review and Reinforcement)

1. Review local program and vocational center policies and procedures.
2. Describe employment opportunities and responsibilities.
3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA.
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.

Unit 11: Basic Safety (Review and Reinforcement)

1. Describe general safety rules for working in a shop/lab and industry.
2. Identify and apply safety around welding operations.
3. Explain the appropriate safety precautions to take around common jobsite hazards.
4. Demonstrate the appropriate use and care of personal protective equipment (PPE).
5. Explain lifting and the use of ladders and scaffolds.
6. Explain the material safety data sheet (MSDS).
7. Explain fires and safety procedures related to fires.
8. Explain safety in and around electrical situations.

Unit 12: Construction Math

1. Apply basic mathematics for carpentry.

Unit 13: Introduction to Materials Used in Construction

1. Identify, use, and select appropriate wood building materials used in the construction industry.
2. Describe, use, and select the appropriate wood building fasteners and adhesives used in the construction industry.

Unit 14: Footing, Foundation, and Floor Framing

1. Identify, plan, and construct types of footing and foundations used in carpentry.
2. Identify floor systems.
3. Plan and construct floor systems.

Unit 15: Wall, Ceiling, and Roof Framing

1. Research, lay out, and construct wall framing.
2. Lay out and construct ceiling framing.
3. Describe principles of roof framing.

Unit 16: Windows, Doors, and Stairs

_____ 1. Install windows and doors.
_____ 2. Identify the types and parts of stairs.
_____ 3. Measure and calculate the rise, run, and stairwell openings.
_____ 4. Lay out and cut stair stringers.

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
4. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions

4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

a. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
b. Explain the causes and characteristics of tides. (DOK 1)
c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
d. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
e. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
   - Barrier island, coral reef, tidal pool, and ocean
   - River, stream, lake, pond, and swamp
   - Bay, sound, estuary, and marsh

3. <u>Apply an understanding of the diverse organisms found in aquatic environments.</u>

a. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
   - Adaptations of representative organisms for their aquatic environments
   - Relationship of organisms in food chains/webs within aquatic environments

b. Research, calculate, and interpret population data. (DOK 2)
c. Research and compare reproductive processes in aquatic organisms. (DOK 2)
d. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
e. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
f. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. <u>Draw conclusions about the relationships between human activity and aquatic organisms.</u>

a. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
   - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
   - Effectiveness of a variety of methods of environmental management and stewardship
   - Effects of urbanization on aquatic ecosystems and the effects of continued expansion

b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
   - Careers related to aquatic science
   - Modern technology within aquatic science (e.g., mariculture and aquaculture)
   - Contributions of aquatic technology to industry and government

<u>Biology I</u>

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

d. Formulate questions that can be answered through research and experimental design. (DOK 3)
e. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
f. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
g. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
h. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
i. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. **Describe the biochemical basis of life, and explain how energy flows within and between the living systems.**
   a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
      - Subatomic particles and arrangement in atoms
      - Importance of ions in biological processes
   b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
   c. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
   d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
      - Basic chemical composition of each group
      - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
      - Basic functions (e.g., energy, storage, cellular, heredity) of each group
   e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
      - Enzyme structure
      - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
   f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
      - ATP structure
      - ATP function
   g. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
      - Photosynthesis and respiration (reactants and products)
      - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
      - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. **Investigate and evaluate the interaction between living organisms and their environment.**
   a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
      - Plant and animal species
      - Climate (temperature and rainfall)
      - Adaptations of organisms
   b. Provide examples to justify the interdependence among environmental elements. (DOK 2)
      - Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
      - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
      - Roles of beneficial bacteria
      - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
   - Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
   - Components of mobility (e.g., cilia, flagella, pseudopodia)

b. Differentiate between types of cellular reproduction. (DOK 1)
   - Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
   - Binary fission (e.g., budding, vegetative propagation, etc.)
   - Significance of meiosis in sexual reproduction
   - Significance of crossing over

c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
   - Structures of DNA and RNA
   - Processes of replication, transcription, and translation
   - Messenger RNA codon charts

b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
   - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
   - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
   - Characteristics of the six kingdoms
   - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
   - Body plans (symmetry)
   - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
c. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
   - The impact of enzymatic reactions on biochemical processes
   - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
d. Differentiate between photosynthesis and cellular respiration. (DOK 2)
   - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

a. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
b. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
c. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
   - Translation of a messenger RNA strand into a protein
   - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
   - Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
   - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
d. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
   - Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
e. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

a. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
   - Main periods of the geologic timetable of earth's history
     - Roles of catastrophic and gradualistic processes in shaping planet Earth
b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
d. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
g. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

h. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

a. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)
   - Bacteria, fungi, and protists
   - Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
   - Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
   - Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

a. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
b. Differentiate the characteristics found in various plant divisions. (DOK 2)
   - Differences and similarities of nonvascular plants
   - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
   - Major vegetative structures and their modifications in angiosperms and gymnosperms
c. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
d. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
   - Classification scheme used in botany
   - Classification of native Mississippi plants
e. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
   - Relationships among photosynthesis, cellular respiration, and translocation
   - Importance of soil type and soil profiles to plant survival
   - Mechanism of water movement in plants
   - Effects of environmental conditions for plant survival
   - Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

a. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
b. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
c. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
   - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
   - Functions of flower parts, seeds, cones
   - Spore production in bryophytes and ferns
d. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
e. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
f. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

a. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
b. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
c. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
d. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

a. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

b. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
c. Discuss the effects of genetic engineering of plants on society. (DOK 2)
d. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
   - Plant extracts, their function, and origin
   - Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.
a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
   - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
   - Substances and mixtures
   - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
   - Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
   - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
   - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

e. Compare the properties of compounds according to their type of bonding. (DOK 1)
   - Covalent, ionic, and metallic bonding
   - Polar and nonpolar covalent bonding
   - Valence electrons and bonding atoms

f. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

g. Develop a three-dimensional model of molecular structure. (DOK 2)
   - Lewis dot structures for simple molecules and ionic compounds
   - Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

a. Analyze and explain acid/base reactions. (DOK 2)
   - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
   - Formation of acidic and basic solutions
   - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
   - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
   - How a buffer works and examples of buffer solutions

b. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

c. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
   - Structures of hydrocarbon compounds
   - Isomerism in hydrocarbon compounds
b. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
c. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
   - Lewis structures for organic molecules
   - Bond angles
   - Hybridization (as it applies to organic molecules)
d. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
e. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
   - Structural formulas from functional group names and vice versa
   - Chemical and physical properties of compounds containing functional groups
   - Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

a. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
   - Common polymers
   - Synthesis of polymers from monomers by addition or condensation
   - Condensations of plastics according to their commercial types
   - Elasticity and other polymer properties
b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
   - Common uses of polymers and organic compounds in medicine, drugs, and personal care products
   - Compounds that have the property to dye materials
   - Petrochemical production
   - Biologically active compounds in terms of functional group substrate interaction
c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

a. Summarize the origin and evolution of the universe. (DOK 2)
   - Big bang theory
   - Microwave background radiation
   - The Hubble constant
   - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

d. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
   - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
   - How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

a. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
   - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
   - Modern and ancient geological features to each kind of plate tectonic boundary

- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

b. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
c. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
d. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
e. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
f. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
   - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
   - Geological timetable
g. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
h. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

a. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
   - Latitudinal variations in solar heating
   - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
b. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
c. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
e. Research and explain how external forces affect earth's topography. (DOK 2)
   - How surface water and groundwater act as the major agents of physical and chemical weathering
   - How soil results from weathering and biological processes
   - Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

a. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
   - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
   - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
   - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
c. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
d. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
b. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment
c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms

e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

a. Summarize the effects of human activities on resources in the local environments. (DOK 2)
   - Sources, uses, quality, and conservation of water
   - Renewable and nonrenewable resources
   - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
b. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
c. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
b. Describe how organic components are integral to biochemical processes. (DOK 2)
c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
   - Cell cycle and mitosis
   - Meiosis, spermatogenesis, and oogenesis
d. Explain the significance of the discovery of nucleic acids. (DOK 1)

e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

a. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
b. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
   - Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
   - Inheritance of autosomal and sex-linked traits
   - Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
   - Chromosomal theory of inheritance
c. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
   - Genetic variability
   - Hardy-Weinberg formula
   - Migration and genetic drift
   - Natural selection in humans
d. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
   - Steps in genetic engineering experiments
   - Use of restriction enzymes
   - Role of vectors in genetic research
   - Use of transformation techniques
e. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
f. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
g. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

a. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
b. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
c. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
   - Physical weathering (e.g., atmospheric, glacial, etc.)
   - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
d. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
   - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
   - Processes that create earthquakes and volcanoes
   - Asthenosphere
e. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
f. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
g. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
h. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
i. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
j. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
k. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

<u>Physical Science</u>

PS 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2	Describe and explain how forces affect motion.
PS 3	Demonstrate an understanding of general properties and characteristics of waves.
PS 4	Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. **<u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>**
   a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
      - Safety symbols and safety rules in all laboratory activities
      - Proper use and care of the compound light microscope
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Identify questions that can be answered through scientific investigations. (DOK 3)
   c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
      - Predicting, gathering data, drawing conclusions
      - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
      - Critically analyzing current investigations/problems using periodicals and scientific scenarios

   d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)
2. **<u>Describe and explain how forces affect motion.</u>**
   a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
      - Inertia and distance-time graphs to determine average speed
      - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
      - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
      - Simple harmonic motion (oscillation)
   b. Explain the connection between force, work, and energy. (DOK 2)
      - Force exerted over a distance (results in work done)
      - Force-distance graph (to determine work)
      - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
   c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
   d. Draw and assess conclusions about charges and electric current. (DOK 2)
      - Static/current electricity and direct current/alternating current
      - Elements in an electric circuit that are in series or parallel
      - Conductors and insulators
      - Relationship between current flowing through a resistor and voltage flowing across a resistor
   e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
3. **<u>Demonstrate an understanding of general properties and characteristics of waves.</u>**

a. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
b. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
c. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
   - The emission of light by electrons when moving from higher to lower levels
   - Energy (photons as quanta of light)
   - Additive and subtractive properties of colors
   - Relationship of visible light to the color spectrum
d. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. <u>Develop an understanding of the atom.</u>

a. Cite evidence to summarize the atomic theory. (DOK 1)
   - Models for atoms
   - Hund's rule and Aufbau process to specify the electron configuration of elements
   - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
   - Atomic orbitals (s, p, d, f) and their basic shapes
b. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
c. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
   - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
   - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
   - Experiments (e.g., gold-foil, cathode-ray, etc.)
d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
   - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
   - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
   - Average atomic mass from isotopic abundance
   - Solids, liquids, and gases
   - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

a. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
b. Balance chemical equations. (DOK 2)
c. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Develop an understanding of concepts related to forces and motion.**
   a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
      - Vector and scalar quantities
      - Vector problems (solved mathematically and graphically)
      - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
      - Relations among mass, inertia, and weight
   b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
   c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
   d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
      - Situations where g is constant (falling bodies)
      - Concept of centripetal acceleration undergoing uniform circular motion
      - Kepler's third law
      - Oscillatory motion and the mechanics of waves
3. **Develop an understanding of concepts related to work and energy.**
   a. Explain and apply the conservation of energy and momentum. (DOK 2)
      - Concept of work and applications
      - Concept of kinetic energy, using the elementary work-energy theorem
      - Concept of conservation of energy with simple examples
      - Concepts of energy, work, and power (qualitatively and quantitatively)
      - Principles of impulse in inelastic and elastic collisions

b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
c. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
d. Investigate and summarize the principles of thermodynamics. (DOK 2)
    - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
    - Temperature and thermal energy as related to molecular motion and states of matter
    - Problems involving specific heat and heat capacity
    - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
e. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
    - Simple harmonic motion
    - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
    - Energy of a wave in terms of amplitude and frequency.
    - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
c. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
    - Characteristics of static charge and how a static charge is generated
    - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
    - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
    - Coulomb's law
b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

a. Analyze and explain the principles of nuclear physics. (DOK 1)
    - The mass number and atomic number of the nucleus of an isotope of a given chemical element
    - The conservation of mass and the conservation of charge
    - Nuclear decay
b. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
    - Quantum energy and emission spectra
    - Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. **Demonstrate the basic concepts of global positioning systems (GPS). (E)**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Demonstrate the basic concepts of remote sensing. (E, P)**
   a. Describe the characteristics of the electromagnetic spectrum.
   b. Using images and graphs, interpret the absorption/reflection spectrum.
   c. Distinguish between passive vs. active sensor systems.
   d. Analyze the effects of changes in spatial, temporal, and spectral resolution.
   e. Analyze the effects on images due to changes in scale.
   f. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

a. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
   - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
   - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

b. Identify and describe characteristics of the major phyla. (DOK 1)
   - Symmetry and body plan
   - Germ layers and embryonic development
   - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
   - Locomotion and coordination

c. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
d. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
   - Phylogenic sequencing of the major phyla
   - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
   - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

a. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
b. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
   - Division of labor within a group of animals
   - Communication within animals groups
   - Degree of parental care given in animal groups

c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
d. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
   - Terrestrial and aquatic ecosystems
   - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
   - Symbiotic relationships such as mutualism, commensalisms, and parasitism

e. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
   - Relationship between natural selection and evolution
   - Mutations, crossing over, nondisjunction
   - Nonrandom mating, migration, etc.
   - Effects of genetic drift on evolution

b. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

- AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

- AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.
- AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.
- AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

- AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.
- AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

- AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.
- AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

- AS.05.01. Evaluate the male and female reproductive systems in selecting animals.
- AS.05.02. Evaluate animals for breeding readiness and soundness.
- AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

- AS.06.01. Demonstrate safe animal handling and management techniques.
- AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

- AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.
- AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

- AS.08.01. Reduce the effects of animal production on the environment.
- AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

- BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.
- BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.
- BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

- BS.02.01. Maintain and interpret biotechnology laboratory records.
- BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.
- BS.02.03. Demonstrate proper laboratory procedures using biological materials.
- BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.
- BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

- BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.
- BS.03.02. Perform biotechnology processes used in AFNR systems.
- BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.

PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.

PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.

PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.

PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.

PST.03.03. Service and repair hydraulic and pneumatic systems.

PST.03.04. Troubleshoot and service electrical systems.

PST.03.05. Service vehicle heating and air-conditioning systems.

PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.

PST.04.02. Apply structural plans, specifications, and building codes.

PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.

PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.

PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Diesel Service Technician Executive Summary

Pathway Description

Diesel Service Technician is a pathway for students in the Transportation career cluster. This pathway is designed for students who wish to diagnose and repair the systems and components related to diesel engines. The pathway emphasizes the techniques and tools used in servicing diesel systems and components. Both theoretical learning and activity-based learning are provided for students who wish to develop and enhance their competencies and skills. The courses focus on the basic areas of diesel engine components, electrical and electronic systems, and hydraulics. Exposure to state-of-the-art equipment is given through advice by experts from industry. The comprehensive project component provides practical experience toward developing a portfolio of work.

The pathway is aligned with the NATEF 2007 Medium/Heavy Truck program standards, which were retrieved August 1, 2009, from http://www.natef.org.

Industry Certification

The Diesel Service Technician pathway was written to incorporate the **National Automotive Technicians Education Foundation (NATEF)** learning objectives, content, and hours. Any student who successfully completes this pathway will be eligible to apply to obtain the ASE exams. ASE requires 2 years of employment before certificates are issued. Students receive 1 year of credit for completion of the secondary program. Students who take certifications before the 2-year requirement is met will be granted certifications after they complete 1 year of diesel service employment. NATEF is a national certification recognized throughout the transportation service industry. Each district should implement a maximum student number due to the size of each lab.

Assessment

Students will be assessed using the Diesel Service Technician MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://info.rcu.msstate.edu/services/pathway.asp. If there are questions regarding assessment of this program, please contact the transportation instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Diesel Service Technician program, the following student prerequisites are in place:

5. C or higher in English (the previous year)
6. C or higher in Math (last course taken or the instructor can specify the math)
7. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

1. TABE Reading Score (eighth grade or higher)
2. Instructor Approval

or

1. Instructor Approval

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn one Applied Mathematics Credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit,

please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A 968 educator license is required to teach the Diesel Service Technician pathway. The requirements for the 968 licensure endorsement are listed below:

1. Applicant must have earned a 2-year college degree (associate degree) or higher from an accredited institution of higher education.
2. Applicant must have 2 years of documented diesel service experience.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
4. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must hold ASE certificates in Medium Heavy Duty Truck (test Diesel T2), Electrical/Electronics (Test T6), and Preventative Maintenance (Test T8).
6. Applicant must successfully complete an approved computer literacy certification exam.
7. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the Mississippi Department of Education.
8. Applicant must successfully complete a Diesel Service Technician certification workshop, module, or course that is approved by the Mississippi Department of Education.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows multiple options for local school districts to implement based on the local needs of industry and students.

Option 1

This Diesel Service Technician Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF) learning objectives and content. The Diesel Service Technician Pathway (four Carnegie units total) is a program that will prepare students for the diesel service industry. The content is divided into four one-credit courses. These courses are to be taken sequentially. Safety is an integral part of every course and activity. A student must complete all four courses to be a completer and to receive the one mathematics credit.

- Safety will be reinforced and tested at the beginning of each year and throughout the content.
- Students are not to enroll into multiple courses at the same time.
- Courses cannot be taken out of the order unless the instructor approves. Foundation knowledge in each course must be mastered to move to the next unit.
- Students must complete diesel courses with a score of 80/C or higher in class work to advance to the next level.

Course Description: Fundamentals of Diesel Systems and Components (Course Code: 997202)
Fundamentals of Diesel Systems and Components contains information on safety, tool identification and use, employee information, estimating, service specification and service information, measurement, and personal and business finance.

Course Description: Electrical/Electronic Systems (Course Code: 997203)
The Electrical/Electronic Systems course contains electrical/electronic system theory, battery systems, starting systems, charging systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Diesel Engine Performance (Course Code: 997204)
The Diesel Engine Performance course contains information on safety, employability skills, advanced diesel service, diesel engine components and theory of operation, concepts of computerized engine control systems, and ignition systems.

Course Description: Auxiliary Components and Systems (Course Code: 997205)
The Auxiliary Components and Systems course contains information and skills relating to hydraulics, Introductory Truck Brake Systems, Introductory Agriculture/Construction Power Train and Components, and Introductory Welding and Cutting.

Fundamentals of Diesel Systems and Components (One Carnegie Unit) - Course Code: 997202

Unit		Title	Hours
1		Fundamentals of Diesel Systems and Components	25
2		Diesel Systems, Theories, and Components	115
			140

Electrical/Electronic Systems (One Carnegie Unit) - Course Code: 997203

Unit		Title	Hours
3		Electrical/Electronic Systems	140

			140

Diesel Engine Performance (One Carnegie Unit) - Course Code: 997204

Unit		Title	Hours
4		Preventive Maintenance and Inspection	70
5		Advanced Diesel Engine Performance	70
			140

Auxiliary Components and Systems (One Carnegie Unit) - Course Code: 997205

Unit		Title	Hours
6		Auxiliary Components	
		• Hydraulic Systems, Theories, and Components	70
		• Introductory Truck Brake Systems and S/S Components	15
		• Introductory Agriculture /Construction Power Train and Components	15
		• Introductory Welding and Cutting	40
			140

Option 2

This Diesel Service Technician Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF) learning objectives and content. The content is divided into two courses. Safety is an integral part of every course and activity. A student must complete both courses to be a completer and to receive the one mathematics credit.

Course Description: Diesel Service Technician I (Course Code: 997200) Fundamentals of Diesel Systems and Components contains information on safety, tool identification and use, employee information, estimating, service specification and service information, measurement, and personal and business finance. It also contains Electrical/Electronic Systems content: electrical/electronic system theory, battery systems, starting systems, charging systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Diesel Service Technician II (Course Code: 997201) The Diesel Engine Performance course contains information on safety, employability skills, advanced diesel service, diesel engine components and theory of operation, concepts of computerized engine control systems, and ignition systems. It also contains Auxiliary Components and Systems content: information and skills relating to hydraulics, Introductory Truck Brake Systems, Introductory Agriculture/Construction Power Train and Components, and Introductory Welding and Cutting.

Diesel Service Technician I (Two Carnegie Units) - Course Code: 997200

Unit		Title	Hours
1		Fundamentals of Diesel Systems and Components	25
2		Diesel Systems, Theories, and Components	115
3		Electrical/Electronic Systems	140
			280

Diesel Service Technician II (Two Carnegie Units) - Course Code: 997201

Unit		Title	Hours
6		Preventive Maintenance and Inspection	70
7		Advanced Diesel Engine Performance	70
8		Auxiliary Components	140
			280

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Students must complete the first year with a score of 80/C or higher in class work to advance to the next level.

Diesel Service Competencies and Objectives

Unit 1: Fundamentals of Diesel Service

1. Introduce, describe, and distinguish local program and vocational/career–technical center policies and procedures. (DOK1)
    a. Describe local program and vocational/career–technical center policies and procedures including dress code, attendance, academic requirements, discipline, and the school technology acceptable use policy and transportation regulations. (DOK 1)
    b. Compare and contrast local program policies, procedures, and expectations to industry policies, procedures, and expectations. (DOK 2)
2. Introduce, describe, and express employment opportunities and responsibilities of the diesel service industry. (DOK1)
    a. Introduce concepts associated with the diesel service industry; describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. (DOK 1)
    b. Describe basic employee responsibilities and how to communicate effectively in on-the-job situations. Identify and apply the practices that affect employer and employee decision making as it relates to identifying and applying appropriate algebraic formulas to personal finance situations, linear programming to business decisions, and algebraic formulas to personal and business investments. (DOK 2)
    c. Discuss the history of the diesel service industry to include materials, terminology, and techniques. (DOK 2)
    d. Research and report the computerized systems used by technicians in the diesel service industry. (DOK 3)
    e. Investigate and replicate leadership skills and personal development. (DOK1)
    f. Demonstrate effective team-building and leadership skills. (DOK 1)
    g. Model appropriate work ethics. (DOK 1)
    h. Describe basic employee responsibilities. (DOK 1)
    i. Design a resume and letter of application, and complete a job application. (DOK 1)
    j. Demonstrate an understanding of the impact of consumer credit (advantages and disadvantages of installment loans, applying algebraic formulas to consumer credit). (DOK 2)
    k. Design, collect, and apply information for planning a trip. (DOK 2)
3. Model general safety rules for working in a shop/lab and an industry setting. (DOK1)
    a. Explain the importance of following all safety rules and policies (report all on-the-job injuries and accidents), evacuation policy, substance abuse policy, and procedures when working near pressurized or high temperature, and explain electrical hazards and the action to take when an electrical shock occurs when performing diesel service operations (personal protective equipment, procedures for lifting heavy objects, and MSDS). (DOK 3)
    b. Explain the process by which fires start, fire prevention of various flammable liquids, the classes of fire, and the types of extinguishers. (DOK 1)
    c. Identify and demonstrate the safe and proper use of common hand tools. (DOK 2)
    d. Interpret and apply service specifications and information. (DOK1)

e. Locate and interpret service specifications and information, using both print and computerized service information references and vehicle and major component identification numbers (VIN, certification, and calibration labels). (DOK 1)
f. Interpret and apply information to a specific job on a specific vehicle. (DOK 3)
g. Demonstrate measurement practices used in the diesel service industry. (DOK 1)
h. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm. (DOK 1)
i. Identify the different types of bolts (grade, diameter, length, and thread pitch), nuts, and washers, and describe their appropriate uses. (DOK 1)

4. Manage personal and business finances to include aspects of employer–employee decision making and consumer credit. (DOK1)
   a. Design, analyze, and develop business finance concepts and skills. (DOK 3)

Unit 2: Diesel Systems, Theories, and Components

1. Inspect, analyze, and perform service to diesel engine systems and components. (DOK4)
   a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, and causes and corrections; determine needed repairs. (DOK 1)
   b. Identify and inspect diesel engine components and parts. (DOK 2)
   c. Analyze and diagnose engine noises according to manufacturer's specifications. (DOK 2)
2. Analyze, diagnose, and perform skills related to cylinder head and valve train. (DOK3)
   a. Diagnose cylinder head components. (DOK 3)
   b. Diagnose and perform procedures related to the valve trains. (DOK 3)
   c. Inspect and repair various diesel engine components. (DOK 1)
3. Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block. (DOK4)
   a. Diagnose various block components and the replacement/repair procedures. (DOK 4)
   b. Identify and discuss factors related to block component failure. (DOK 3)
   c. Identify and discuss factors related to block system failure. (DOK 2)

Unit 3: Electrical/Electronic Systems

1. Identify, analyze, and perform repair procedures to general electrical systems. DOK4 DST1 DST2 DST3 DST4
   a. Identify, analyze, and perform repair procedures to electrical/electronic systems and components. (DOK 3)
   b. Analyze, evaluate, recommend, and perform necessary repairs to the components and systems related to the battery. (DOK 4)
   c. Evaluate, recommend, and perform repair procedures as they relate to the starting system. (DOK 2)
   d. Diagnose and repair charging system. (DOK 3)
   e. Explore, analyze, and recommend proper repair procedures as they relate to lighting systems. (DOK 4)
   f. Test and evaluate gauges and warning devices. (DOK 4)
   g. Identify, evaluate, and recommend replacement or repair procedures of related electrical systems**.** **(**DOK 4)

Unit 4: Preventive Maintenance

1. Identify, evaluate, and repair engine systems and their components. DOK3 DST1 DST2 DST3 DST4
    a. Identify and inspect, determine necessary action, and perform the procedure as it relates to diagnostic and repair operations to engine components. (DOK 3)
    b. Identify, diagnose, recommend, and/or perform the necessary repair action as it relates to the fuel system. (DOK 3)
    c. Identify, practice, and evaluate air induction and exhaust systems. (DOK 3)
    d. Identify, practice, and evaluate cooling and lubrication systems. (DOK 3)
2. Inspect, diagnose, and recommend repair procedures for components and systems related to the cab and hood. (DOK1)
    a. Identify and inspect; determine necessary procedures as they relate to the cab and hood. (DOK 3)
    b. Identify, diagnose, and determine necessary procedures to electrical/electronic systems and components. (DOK 3)

Unit 5: Advanced Diesel Engine Performance

1. Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems, cooling systems, air induction, and exhaust systems. (DOK4)
    a. Safety precautions, regulations, and guidelines for diesel engines (DOK 2)
    b. Analyze and demonstrate information for lubrication and cooling systems. (DOK 3)
2. Determine failure cause(s), perform repair procedure, and evaluate procedure related to fuel systems and electronic fuel management systems. (DOK3)
    a. Diagnose, inspect, practice, and determine necessary procedures for fuel management system maintenance and repair procedures. (DOK 2)
    b. Inspect, analyze, and perform repairs related to engine brakes. (DOK 3)

Unit 6: Auxiliary Components and Systems

1. Explore and analyze hydraulic systems, theories, and components. (DOK3)
    a. Inspect, indentify, and evaluate general hydraulic system control valves; actuators; and hoses, fittings, connections, pumps and filtration/reservoirs (tanks). (DOK 3)
2. Identify and inspect truck brake systems and steering/suspension components. (DOK2)
    a. Indentify, inspect, and analyze truck brake systems and steering/suspension components. (DOK 2)
3. Identify and evaluate agriculture/construction power train and components. (DOK1)
    a. Inspect, identify, and diagnose agriculture/ construction power trains and components. (DOK 2)
4. Indentify, perform and analyze welding and cutting techniques. (DOK2)
    a. Identify, analyze, and perform operations pertaining to welding. (DOK 2)

Diesel Service Technician Competency Profile
Program CIP: 47.0605

Unit 1: Fundamentals of Diesel Service

_____ 1. Introduce, describe, and distinguish local program and vocational/career–technical center policies and procedures.
_____ 2. Introduce, describe, and express employment opportunities and responsibilities of the diesel service industry.
_____ 3. Investigate and replicate leadership skills and personal development.
_____ 4. Model general safety rules for working in a shop/lab and an industry setting
_____ 5. Interpret and apply service specifications and information.
_____ 6. Demonstrate measurement practices used in the diesel service industry.
_____ 7. Manage personal and business finances to include aspects of employer–employee decision making and consumer credit.

Unit 2: Diesel Systems, Theories, and Components

_____ 1. Inspect, analyze, and perform service to diesel engine systems and components.
_____ 2. Analyze, diagnose, and perform skills related to cylinder head and valve train.
_____ 3. Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block.

Unit 3: Electrical/Electronic Systems

_____ 1. Identify, analyze, and perform repair procedures to general electrical systems.

Unit 4: Preventive Maintenance

_____ 1. Identify, evaluate, and repair engine systems and their components.
_____ 2. Inspect, diagnose, and recommend repair procedures for components and systems related to the cab and hood.

Unit 5: Advanced Diesel Engine Performance

_____ 1. Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems, cooling systems, air induction, and exhaust systems.
_____ 2. Determine failure cause(s), perform repair procedure, and evaluate procedure related to fuel systems and electronic fuel management systems.

Unit 6: Auxiliary Components and Systems

_____ 1. Explore and analyze hydraulic systems, theories, and components.
_____ 2. Identify and inspect truck brake systems and steering/suspension components.
_____ 3. Identify and evaluate agriculture/construction power train and components.
_____ 4. Identify, perform, and analyze welding and cutting techniques.

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

4. Using 21st century skills to understand and address global issues
5. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
6. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

4. Knowing how to make appropriate personal economic choices
5. Understanding the role of the economy in society
6. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

4. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
5. Exercising the rights and obligations of citizenship at local, state, national, and global levels
6. Understanding the local and global implications of civic decisions

CS4 Health Literacy

6. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
7. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
8. Using available information to make appropriate health-related decisions
9. Establishing and monitoring personal and family health goals
10. Understanding national and international public health and safety issues

CS5 Environmental Literacy

5. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
6. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
7. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
8. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

4. Think Creatively
5. Work Creatively with Others
6. Implement Innovations

CS7 Critical Thinking and Problem Solving

5. Reason Effectively
6. Use Systems Thinking
7. Make Judgments and Decisions

8. Solve Problems

CS8 Communication and Collaboration

3. Communicate Clearly
4. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

3. Access and Evaluate Information
4. Use and Manage Information

CS10 Media Literacy

3. Analyze Media
4. Create Media Products

CS11 ICT Literacy

2. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

3. Adapt to change
4. Be Flexible

CS13 Initiative and Self-Direction

4. Manage Goals and Time
5. Work Independently
6. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

3. Interact Effectively with others
4. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

3. Manage Projects
4. Produce Results

CS16 Leadership and Responsibility

3. Guide and Lead Others
4. Be Responsible to Others

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

2. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

h. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
i. Explain the causes and characteristics of tides. (DOK 1)
j. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
k. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
l. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
m. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

n. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
- River, stream, lake, pond, and swamp
- Bay, sound, estuary, and marsh

3. Apply an understanding of the diverse organisms found in aquatic environments.

g. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
- Relationship of organisms in food chains/webs within aquatic environments

h. Research, calculate, and interpret population data. (DOK 2)
i. Research and compare reproductive processes in aquatic organisms. (DOK 2)
j. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
k. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
l. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. Draw conclusions about the relationships between human activity and aquatic organisms.

j. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
- Effectiveness of a variety of methods of environmental management and stewardship
- Effects of urbanization on aquatic ecosystems and the effects of continued expansion

k. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
l. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
- Modern technology within aquatic science (e.g., mariculture and aquaculture)
- Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

b. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

m. Formulate questions that can be answered through research and experimental design. (DOK 3)
n. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
o. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
p. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
q. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
r. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

h. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
- Importance of ions in biological processes

i. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

j. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

k. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, heredity) of each group

l. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

m. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

n. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

d. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

e. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

f. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

e. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
- Components of mobility (e.g., cilia, flagella, pseudopodia)

f. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

g. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

h. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

e. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
- Processes of replication, transcription, and translation
- Messenger RNA codon charts

f. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

g. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

h. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
- Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

f. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
- Body plans (symmetry)
- Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

g. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

h. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

i. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)

j. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

h. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)

i. Clarify research questions and design laboratory investigations. (DOK 3)

j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

e. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)

f. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)

g. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)

- The impact of enzymatic reactions on biochemical processes
- Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

h. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

f. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)

g. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

h. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)

- Translation of a messenger RNA strand into a protein
- Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
- Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

i. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)

- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

j. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

j. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)

- Main periods of the geologic timetable of earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

k. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

l. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

m. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

n. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

o. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

p. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

q. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
r. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

c. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
d. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)
- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

i. Formulate questions that can be answered through research and experimental design. (DOK 3)
j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

f. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
g. Differentiate the characteristics found in various plant divisions. (DOK 2)
   - Differences and similarities of nonvascular plants
   - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
   - Major vegetative structures and their modifications in angiosperms and gymnosperms
h. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
i. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
   - Classification scheme used in botany
   - Classification of native Mississippi plants
j. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
   - Relationships among photosynthesis, cellular respiration, and translocation
   - Importance of soil type and soil profiles to plant survival
   - Mechanism of water movement in plants
   - Effects of environmental conditions for plant survival
   - Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

g. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
h. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
i. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
   - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
   - Functions of flower parts, seeds, cones
   - Spore production in bryophytes and ferns
j. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
k. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
l. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

e. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
f. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
g. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
h. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

e. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

f. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
g. Discuss the effects of genetic engineering of plants on society. (DOK 2)
h. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
   - Plant extracts, their function, and origin
   - Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.
h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
i. Clarify research questions and design laboratory investigations. (DOK 3)
j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
h. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
   - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
   - Substances and mixtures
   - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
i. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
j. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
   - Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

k. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
   - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
   - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

l. Compare the properties of compounds according to their type of bonding. (DOK 1)
   - Covalent, ionic, and metallic bonding
   - Polar and nonpolar covalent bonding
   - Valence electrons and bonding atoms

m. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

n. Develop a three-dimensional model of molecular structure. (DOK 2)
   - Lewis dot structures for simple molecules and ionic compounds
   - Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

e. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

f. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

g. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

h. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

e. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

f. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

g. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

h. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

d. Analyze and explain acid/base reactions. (DOK 2)
   - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
   - Formation of acidic and basic solutions
   - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
   - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
   - How a buffer works and examples of buffer solutions

e. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

f. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

i. Formulate questions that can be answered through research and experimental design. (DOK 3)
j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
m. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

g. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

h. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
i. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

j. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
k. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
l. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

d. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

e. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

f. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

i. Formulate questions that can be answered through research and experimental design. (DOK 3)

j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

e. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

f. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

g. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

h. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

i. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
- Modern and ancient geological features to each kind of plate tectonic boundary

- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

j. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)

k. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)

l. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

m. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)

n. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
   - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
   - Geological timetable

o. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)

p. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

f. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
   - Latitudinal variations in solar heating
   - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

g. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)

h. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

i. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

j. Research and explain how external forces affect earth's topography. (DOK 2)
   - How surface water and groundwater act as the major agents of physical and chemical weathering
   - How soil results from weathering and biological processes
   - Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

e. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
   - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
   - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
   - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

f. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
g. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
h. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
i. Formulate questions that can be answered through research and experimental design. (DOK 3)
j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

h. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
i. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment
j. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
k. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms

l. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
m. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
n. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

d. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

e. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
f. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
i. Clarify research questions and design laboratory investigations. (DOK 3)
j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

h. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
i. Describe how organic components are integral to biochemical processes. (DOK 2)
j. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
- Meiosis, spermatogenesis, and oogenesis

k. Explain the significance of the discovery of nucleic acids. (DOK 1)

l. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
m. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
n. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

h. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
i. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
- Chromosomal theory of inheritance

j. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

k. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

l. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
m. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
n. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

i. Formulate questions that can be answered through research and experimental design. (DOK 3)

j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

l. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
m. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
n. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
- Physical weathering (e.g., atmospheric, glacial, etc.)
- Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)

o. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
- Processes that create earthquakes and volcanoes
- Asthenosphere

p. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
q. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
r. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
s. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
t. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
u. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
v. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

<u>Physical Science</u>

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2 Describe and explain how forces affect motion.
PS 3 Demonstrate an understanding of general properties and characteristics of waves.
PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

h. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
- Proper use and care of the compound light microscope
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

i. Identify questions that can be answered through scientific investigations. (DOK 3)

j. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
- Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
- Critically analyzing current investigations/problems using periodicals and scientific scenarios

k. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

l. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)

m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

n. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. <u>Describe and explain how forces affect motion.</u>

f. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
- Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
- Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
- Simple harmonic motion (oscillation)

g. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
- Force-distance graph (to determine work)
- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

h. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)

i. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
- Elements in an electric circuit that are in series or parallel
- Conductors and insulators
- Relationship between current flowing through a resistor and voltage flowing across a resistor

j. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

3. <u>Demonstrate an understanding of general properties and characteristics of waves.</u>

e. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
f. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
g. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
   - The emission of light by electrons when moving from higher to lower levels
   - Energy (photons as quanta of light)
   - Additive and subtractive properties of colors
   - Relationship of visible light to the color spectrum
h. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. <u>Develop an understanding of the atom.</u>

e. Cite evidence to summarize the atomic theory. (DOK 1)
   - Models for atoms
   - Hund's rule and Aufbau process to specify the electron configuration of elements
   - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
   - Atomic orbitals (s, p, d, f) and their basic shapes
f. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
g. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
   - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
   - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
   - Experiments (e.g., gold-foil, cathode-ray, etc.)
h. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
   - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
   - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
   - Average atomic mass from isotopic abundance
   - Solids, liquids, and gases
   - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

d. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
e. Balance chemical equations. (DOK 2)
f. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
i. Clarify research questions, and design laboratory investigations. (DOK 3)
j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Develop an understanding of concepts related to forces and motion.</u>

e. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

f. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
g. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
h. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. <u>Develop an understanding of concepts related to work and energy.</u>

f. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)
- Principles of impulse in inelastic and elastic collisions

g. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
h. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
i. Investigate and summarize the principles of thermodynamics. (DOK 2)
   - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
   - Temperature and thermal energy as related to molecular motion and states of matter
   - Problems involving specific heat and heat capacity
   - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
j. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

f. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
   - Simple harmonic motion
   - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
   - Energy of a wave in terms of amplitude and frequency.
   - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
g. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
h. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
i. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
j. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

d. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
   - Characteristics of static charge and how a static charge is generated
   - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
   - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
   - Coulomb's law
e. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
f. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

c. Analyze and explain the principles of nuclear physics. (DOK 1)
   - The mass number and atomic number of the nucleus of an isotope of a given chemical element
   - The conservation of mass and the conservation of charge
   - Nuclear decay
d. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
   - Quantum energy and emission spectra
   - Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
i. Clarify research questions, and design laboratory investigations. (DOK 3)
j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

g. Describe the characteristics of the electromagnetic spectrum.
h. Using images and graphs, interpret the absorption/reflection spectrum.
i. Distinguish between passive vs. active sensor systems.
j. Analyze the effects of changes in spatial, temporal, and spectral resolution.
k. Analyze the effects on images due to changes in scale.
l. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

i. Formulate questions that can be answered through research and experimental design. (DOK 3)
j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

e. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
- Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

f. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
- Germ layers and embryonic development
- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

g. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
h. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
- Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
- Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

f. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
g. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
- Communication within animals groups
- Degree of parental care given in animal groups

h. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
i. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

j. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

c. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

d. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.

AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.

AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.

AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

AS.05.01. Evaluate the male and female reproductive systems in selecting animals.

AS.05.02. Evaluate animals for breeding readiness and soundness.

AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

AS.06.01. Demonstrate safe animal handling and management techniques.

AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.

AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

AS.08.01. Reduce the effects of animal production on the environment.

AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

- BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.
- BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.
- BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

- BS.02.01. Maintain and interpret biotechnology laboratory records.
- BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.
- BS.02.03. Demonstrate proper laboratory procedures using biological materials.
- BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.
- BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

- BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.
- BS.03.02. Perform biotechnology processes used in AFNR systems.
- BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.
NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.
NRS.02.03. Measure and survey natural resource status to obtain planning data.
NRS.02.04. Demonstrate natural resource enhancement techniques.
NRS.02.05. Interpret laws related to natural resource management and protection.
NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.
NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.
NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.
PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.
PS.02.02. Prepare growing media for use in plant systems.
PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.
PS.03.02. Develop and implement a plant management plan for crop production.
PS.03.03. Develop and implement a plan for integrated pest management.
PS.03.04. Apply principles and practices of sustainable agriculture to plant production.
PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.

PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.

PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.

PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.

PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.

PST.03.03. Service and repair hydraulic and pneumatic systems.

PST.03.04. Troubleshoot and service electrical systems.

PST.03.05. Service vehicle heating and air-conditioning systems.

PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.

PST.04.02. Apply structural plans, specifications, and building codes.

PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.

PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.

PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Early Childhood Education

Early Childhood Education Executive Summary

Program Description

Early Childhood Education is a pathway in the Human Science career cluster. This is a two year high school program (offering 4 Carnegie units of credit), which includes classroom and hands-on experiences that help to prepare students for employment or continuing education in the early childhood education field. In the course of study, emphasis is placed on students' personal and professional preparation for careers or education in the field, history and trends of early childhood education, children's health and safety, child development, and child guidance and observation. Emphasis is also placed on career and professional development, characteristics of high quality early childhood centers, management and administration in quality child care programs, and the learning environment. Membership is encouraged in the student organization, FCCLA (Family, Career, and Community Leaders of America), which provides activities for leadership and the application of competencies through participating in competitive events. Skills developed through the course of study assist students in meeting requirements for the CDA (Child Development Associate credential).

Industry Certification

This curriculum is based on state and national standards, CDA (Child Development Associate) standards, NAEYC (National Association for the Education of Young Children) standards, as well as 21st century workforce skills. The curriculum combines effective classroom instruction with hands-on training or internships in local child care sites. Due to the growing information-technology age in education, the National Educational Technology Standards for Students are incorporated into the curriculum.

Assessment

Students will be assessed using the Engineering MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://redesign.rcu.msstate.edu/curriculum/. If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

Year I-

1. "C" averages in Biology (if applicable) and English from the previous school year
2. Application and/or Interview process
3. Discipline Review (No more than three referrals from the previous school year: severity of infractions to be determined according to the Mississippi Discipline Codes)
4. 90% attendance rate

Year 2-

1. Early Childhood Education I ("C" or better grade in Year I)
2. Work ethic review
3. Discipline review
4. Attendance review

Proposed Applied Academic Credit

Applied Health content from the curriculum was aligned to the 2006 Mississippi Comprehensive Health Framework or the 2008 Family and Individual Health Framework (Family and Consumer Science course). It is proposed that upon the completion of this program, students will earn 1/2 comprehensive or family health credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit,

please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 970 licensure endorsement is required for instructors in the Early Childhood program. The requirements for the 970 licensure endorsement are the following:

1. Currently valid Mississippi Educator License with endorsement in #321-Vocational Home Economics/Family and Consumer Sciences or #322-Home Economics/Family and Consumer Sciences.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must possess and maintain American Red Cross Lay Responder First Aid, CPR, and AED Instructor certification.

5. Applicant must successfully complete an MDE-approved computer literacy certification exam.
6. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the MDE.
7. Applicant must successfully complete a Early Childhood certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a 970 endorsement-a 5-year license. If the applicant does not meet all requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outline

This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Early Childhood year 1. The last two courses are comprised of units from Early Childhood year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: Fundamentals and Stages of Child Development
This course is an introduction to personal and professional preparation and careers in the field of early childhood education. Other topics covered are the history and trends of education. The majority of hours in this course are spent on child development, ranging from birth throughout the adolescent years. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: Children's Health, Safety, and Guidance
Much of this course relates to topics which include protecting children's health and safety. Students are introduced to MSDH Guidelines and Regulations Governing Child Care Facilities. Other topics covered are related to the importance of observing and assessing children. Methods of child guidance techniques are also introduced in this course. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: The Learning Environment
This course is a continuation of year one in regards to students continuing to develop educational, career, and professional plans in the area of early childhood. The major topic of this course includes curriculum planning and scheduling in an early childhood program. Students will develop age appropriate activities and create lesson plans that encompass all areas of child development. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: Management of a Quality Child Care Program
This course includes topics related to state licensing requirements for child care facilities, management principles as a center director (including responsibilities regarding management of personnel, the facility's physical indoor and outdoor space, inventory, record-keeping, accreditation, parental involvement, marketing, budgeting, and maintaining a healthy, effective learning environment). Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Fundamentals and Stages of Child Development (One Carnegie Unit) - Course Code: 996202

Unit		Title	Hours
1		Orientation, Personal and Professional Preparation	20
2		Health and Safety	80
3		History and Trends of Early Childhood Education	20

			120

Children's Health, Safety, and Guidance (One Carnegie Unit) - Course Code: 996203

Unit		Title	Hours
4		Child Development: Infants-Middle Childhood Years	80
5		Observation, Assessment, and Guidance	40
			120

The Learning Environment (One Carnegie Unit) - Course Code: 996204

Unit		Title	Hours
6		Career Development and Professionalism	40
7		The Learning Environment	80
			120

Management of a Quality Child Care Program (One Carnegie Unit) - Course Code: 996205

Unit		Title	Hours
8		Characteristics of Quality Child Care Programs	40
9		Management and Administration	80
			120

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: Early Childhood I

This year long course begins with an introduction to personal and professional preparation for continued education, training, and careers in early childhood. Major topics of study in this course are stages of child development, ranging from birth through age twelve, and children's health and safety. Students are introduced to MSDH Guidelines and Regulations Governing Child Care Facilities. Other topics covered are related to the importance of observing and assessing children. Methods of child guidance techniques are also introduced in this course. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: Early Childhood II

This course focuses on curriculum planning and the development of age appropriate activities and lesson plans that encompass all areas of child development, and administration and management techniques needed in order to operate a successful, quality child care facility. Other major topics covered in this course are related to state licensing requirements for child care facilities, management principles as a center director (including responsibilities regarding management of personnel, the facility's physical indoor and outdoor space, inventory, record-keeping, accreditation, parental involvement, marketing, budgeting, and maintaining a healthy, effective learning environment). Students will continue to develop educational, career, and professional plans in the area of early childhood. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Early Childhood I (Two Carnegie Units) - Course Code: 996200

Unit		Title	Hours
1		Orientation, Personal and Professional Preparation	20
2		Health and Safety	80
3		History and Trends of Early Childhood Education	20

4		Child Development: Infants-Middle Childhood Years	80
5		Observation, Assessment, and Guidance	40
			240

Early Childhood II (Two Carnegie Units) - Course Code: 996201

Unit		Title	Hours
6		Career Development and Professionalism	40
7		The Learning Environment	80
8		Characteristics of Quality Child Care Programs	40
9		Management and Administration	80
			240

Unit 1: Orientation, Personal, and Professional Preparation

1. Examine and research educational, occupational, and leadership opportunities in Early Childhood. (DOK 3)
   a. Identify career trends, workplace options, and opportunities that are available in Early Childhood. (DOK1)
   b. Research education and training requirements for various career paths in Early Childhood. (DOK 3)
   c. Compile safety information regarding emergency information, evacuation procedure, lab equipment use and procedure, and other classroom procedures according to school and classroom policies. (DOK 4)
   d. Identify leadership opportunities in the school and community through membership in FCCLA. (DOK 1)
   e. Create Blackboard log- ins and passwords, and navigate throughout the site to become familiar with its use. (DOK 1)
2. Analyze knowledge, skills, and dispositions needed to work in the teaching profession. (DOK 3)
   a. Investigate the personal characteristics, roles, and functions of individuals as professionals working in the early childhood education field. (DOK 3)
   b. Locate information in the Mississippi State Department of Health publication, Regulations Governing Licensure of Child-Care Facilities, and understand requirements for students, volunteers, and caregiver assistants regarding fingerprinting and background checks.(DOK 1)

Unit 2: Health and Safety

1. Explain the responsibilities of caregivers for protecting children's health and safety. (DOK 3)
   a. Demonstrate proper sanitation practices of caregivers according to the MSDH regulation guidelines (with emphasis on hand washing, diapering, and feeding). (DOK 2)
   b. Demonstrate the procedures for proper cleaning and sanitizing of equipment and facilities according to the MSDH regulation guidelines. (DOK 2)
   c. Investigate responsibilities of caregivers for safety according to the MSDH regulation guidelines, including but not limited to topics such as adult to child ratio, food safety precautions, handling emergencies, universal precautions, safety hazards, equipment specifications, and so forth. (DOK 3)
   d. Demonstrate appropriate responses to emergency situations to include fire drills, hurricane drills/evacuation, tornado drills, lockdown emergencies, and natural disasters. (DOK 2)
   e. Complete and obtain the American Red Cross Certification in First Aid and Infant and Child CPR. (DOK 3)
2. Recognize factors contributing to children's physical health. (DOK 1)
   a. Research and identify childhood diseases, including signs and symptoms, incubation periods, and preventative measures. (DOK 1)
   b. Know types of immunizations that Mississippi requires for enrollment in a child-care facility and kindergarten. (DOK 1)

c. Cite the recommended time periods for indoor and outdoor play, exercise, and napping, according to the MSDH regulation guidelines throughout the early childhood years. (DOK 1)
d. Relate the importance of good nutrition and exercise for increased overall health in children and adults. (DOK 2)

3. Describe factors contributing to children's mental and emotional health. (DOK3)
   a. Examine the impact of stress and its relation to the emotional well-being of children to include divorce, separation, remarriage, blended families, illness, death, and natural disasters. (DOK 3)
   b. Create a list of children's literature that can be used as bibliotherapy tools. (DOK 3)
   c. Investigate types of child abuse, prevention, and the reporting process. (DOK 3)
   d. Identify methods and sources to help children and families cope with stress factors, such as handling negativism, thumb sucking, fear, biting, tattling, body exploration, and inappropriate behaviors. (DOK 1)
   e. Demonstrate ways to promote children's self-esteem, trust, and emotional well-being. (DOK 2)

Unit 3: History and Trends of Early Childhood Education

1. Understand the history and evolution of early childhood education. (DOK 2)
   a. Recognize the contributions of leaders and theorists throughout the history of early childhood education (suggested: Jean-Jacques Rousseau, Johann Pestalozzi, Friedrich Froebel, Sigmund Freud, John Dewey, Maria Montessori, Elizabeth Palmer Peabody, Patty Smith Hill, Erik Erikson, Jean Piaget, B.F. Skinner, Lev Vygotsky, and/or Howard Gardner). (DOK 1)
   b. Determine historical events that influenced early childhood programs and initiatives throughout history in America. (DOK 3)
2. Examine programs, initiatives, and accreditations that influenced early childhood education. (DOK 3)
   a. Summarize contributions of Head Start, Smart Start, and No Child Left Behind. (DOK 3)
   b. Probe factors of the National Association for the Education of Young Children (NAEYC) accreditation. (DOK 3)
   c. Outline requirements for obtaining the Child Development Associate (CDA) credential. (DOK 1)
   d. Cite goals of the Mississippi Child Care Quality Step Program. (DOK 1)
3. Recognize social and societal trends of early childhood education. (DOK 2)
   a. Describe types of child care, including but not limited to: parent cooperatives, lab schools, public and private center based programs, family child care, in home child care, nanny, au pair, Christian or church based child care, and so forth. (DOK 1)
   b. Determine trends in society that have led to a growing need for child-care services. (DOK 3)

Unit 4: Child Development: Infants - Middle Childhood

1. Examine the physical, cognitive, social, and emotional development of infants from birth to 1 year of age. (DOK 3)
   a. Explore brain development from birth to 1 year of age. (DOK 3)
   b. Describe characteristics of physical development during the first year of life. (DOK1)
   c. Identify activities to encourage physical development from birth to 1 year of age. (DOK 1)
   d. List cognitive skills that infants acquire from birth to 1year of age. (DOK 1)
   e. Examine social development during the first year of life. (DOK3)

f. Explore Erikson's Psychosocial Theory of Human Development as related to infancy. (DOK 3)
g. Determine activities to encourage social development from birth to 1 year of age. (DOK3)
h. Describe emotional development during the first year of life. (DOK 1)
i. Determine activities to encourage emotional development from birth to 1 year of age. (DOK 3)
j. Select activities, toys, and equipment to promote development from birth to one year of age. (DOK3)

2. Examine the physical, cognitive, social, and emotional characteristics of toddlers from 1 to 3 years of age. (DOK 3)
   a. Describe characteristics of physical development from 1 to 3 years of age. (DOK 1)
   b. List cognitive skills that toddlers acquire from 1 to 3 years of age. (DOK1)
   c. Research Piaget's Theory of Cognitive Development. (DOK1)
   d. Explore Erikson's Psychosocial Theory of Human Development as related to toddlers. (DOK3)
   e. Investigate social development from 1 to 3 years of age. (DOK3)
   f. Describe emotional development from 1 to 3 years of age. (DOK1)
   g. Identify specific behaviors exhibited by toddlers to include but not limited to the following: biting, temper tantrums, potty training, hitting, playing, eating, and sharing. (DOK 1)
   h. Select activities, toys, and equipment to promote all areas of development in children ages 1 to 3 years old. (DOK 3)
3. Summarize the physical, cognitive, social, and emotional characteristics of preschoolers from 3 to 5 years of age. (DOK 3)
   a. Describe characteristics of physical development from 3 to 5 years of age. (DOK 1)
   b. Develop activities to encourage physical development from 3 to 5 years of age. (DOK 4)
   c. List cognitive skills that preschoolers acquire from 3 to 5 years of age. (DOK1)
   d. Explore language acquisition/ development and the use of phonological awareness in teaching literacy to preschoolers. (DOK3)
   e. Compile activities to encourage language development in preschoolers. (DOK 4)
   f. Research the cognitive stage according to Piaget's Theory of Cognitive Development. (DOK 2)
   g. Explore Erikson's Psychosocial Theory of Human Development and Maslow's Hierarchy of Needs. (DOK 3)
   h. Examine social development from 3 to 5 years of age. (DOK 3)
   i. Develop activities to encourage social and emotional development from 3 to 5 years of age. (DOK 4)
   j. Investigate emotional development from 3 to 5 years of age. (DOK 3)
   k. Select toys and equipment to promote all areas of development from 3 to 5 years of age. (DOK 3)
4. Survey inclusion and techniques to meet the developmental needs of special needs and culturally diverse children. (DOK 1)
   a. Define the Individuals with Disabilities Education Act (IDEA). (DOK 1)
   b. Examine an Individualized Educational Plan (IEP). (DOK 3)
   c. Research types of physical, cognitive, and behavioral disabilities (including but not limited to hearing, speaking, speech, language, vision, and mental or emotional disorders). (DOK 1)

d. Describe how the Americans with Disabilities Act affects children, parents, and employees. (DOK 1)
e. Investigate accommodations for children with special needs. (DOK 3)

Unit 5: Observation, Assessment, and Guidance

1. Investigate the importance of observing and assessing children in a child-care setting. (DOK 4)
   a. Identify types of observation and assessment tools utilized in a child-care setting (including but not limited to checklists, anecdotal records, rating scales, participation charts, samples of children's work, portfolios, photographs, videotapes, etc.). (DOK 3)
   b. Determine the importance of assessments, both initial and ongoing assessments. (DOK 3)
   c. Explore the assessment tools found in the Mississippi Early Learning Guidelines publication. (DOK 3)
2. Identify goals of effective guidance. (DOK 1)
   a. Explore positive child guidance methods and positive classroom management techniques. (DOK 1)
   b. Describe principles of direct and indirect guidance. (DOK 1)
   c. Demonstrate positive classroom management and guidance skills (ex. Giving I-messages, praising, affirming, prompting, persuading, suggesting, redirecting, ignoring, modeling, listening, encouraging, warning, use of time-out, rules, and consequences). (DOK 3)

Unit 6: Career Development and Professionalism

1. Investigate occupational, educational, and leadership opportunities in the field of Early Childhood. (DOK 3)
   a. Update educational, career, and leadership plans and opportunities related to early childhood to include workforce opportunities, certifications, postsecondary educational options, and IHL educational options. (DOK 2)
   b. Research professional organizations (NAEYC, SECA, MECA, and area child-care director networks). (DOK 1)
   c. Prepare a professional portfolio to include your philosophy of early childhood education, resume, work samples, and other documentation ongoing (ex. CPAS test scores, photographs, lesson plans or activities, menus, daily schedules, observation records, etc.). (DOK 4)
   d. Demonstrate effective job-seeking skills needed for the interviewing process. (DOK 2)
   e. Practice appropriate behaviors in relation to individual, family, community, career, and workplace settings to include attitude, appearance, and work ethic. (DOK 2)
   f. Exemplify effective communication techniques to include clear and logical verbal and nonverbal communication, writing skills, listening skills, and speaking skills. (DOK 2)
   g. Apply leadership and team skills in the school, community, and workplace through membership and projects in FCCLA and other avenues of community service. (DOK 4)
   h. Determine the importance of demonstrating respect for individuals' differences, including sensitivity to gender, age, and cultural diversity. (DOK 3)

Unit 7: The Learning Environment

1. Describe daily routines for infants, toddlers, and preschool age children in a child-care setting. (DOK 1)
   a. Discuss the importance of a daily schedule. (DOK 1)

b. Develop a daily time schedule for each of the following age groups: infants, toddlers, and preschoolers, who are enrolled in a child-care setting, including time slots allocated for eating, napping, indoor and outdoor play, toileting, hand washing, center times, free play, transitions, and educational time. (DOK 4)
c. Demonstrate the use of effective transitions that could be used in a child- care setting. (DOK 2)

2. Plan a thematic unit of study. (DOK 4)
   a. Explore program goals and factors to consider when planning a curriculum. (DOK 3)
   b. Relate the importance of literature in the effective child-care curriculum. (DOK 3)
   c. Compile a list of developmentally appropriate themes for each of the following age groups: infants, toddlers, and preschool age children. (DOK 4)
   d. Develop and illustrate a web or flowchart connecting activities to a themed unit of lessons. (DOK 4)
   e. Plan and demonstrate theme based learning activities in each of the following areas: language (storytelling, writing, play, or puppetry), art, math, science, social studies, music or movement, food experiences, field trip experiences, and computer technology. (DOK 4)
   f. Write a "block" formatted lesson plan based on a theme. (DOK 4)
   g. Create a "daily lesson plan" to include goals, motivation or introduction, learning objectives, procedures, materials, closure/transition, and evaluation. (DOK 4)
   h. Explore how technology is used in preschool settings. (DOK 3)
3. Explore types of equipment and arrangement of physical space that help to promote learning. (DOK 3)
   a. Explore ways in which room arrangement, furniture, and equipment are utilized as teaching or learning tools in the environment. (DOK 3)
   b. Illustrate effective ways to use outdoor space and equipment to enhance learning and physical activity. (DOK 2)
   c. Compare and contrast area child- care centers in regards to facility design or layout including office, classrooms, restrooms, isolation room, rest areas, security, lighting, toys and equipment, flooring, wall and window treatments, and so forth. (DOK 3)

Unit 8: Characteristics of Quality Child-Care Programs

1. Explain components of quality child-care programs. (DOK 3)
   a. Investigate and outline requirements set forth by the MSDH regarding licensure of child-care facilities. (DOK 3)
   b. Review the NAEYC accreditation process. (DOK 1)
   c. Interpret goals of the Mississippi Child Care Quality Step System (a five star rating system) developed for licensed early childhood facilities in Mississippi. (DOK 2)
   d. Examine the ITERS and ECERS rating scale system. (DOK 3)

Unit 9: Management and Administration

1. Explain the purpose of licensing and other regulations affecting child-care services. (DOK 3)
   a. Explore aspects of child care that are subject to licensing requirements, including but not limited to indoor and outdoor square footage, training or education of employees, ratio of adults to children, maximum group size, equipment, facility structure and safety, zoning codes, criminal background checks and fingerprinting of staff, health exams, and immunization status of children and staff. (DOK 1)
2. Summarize sound business and operating procedures that are necessary for a successful, productive child-care center. (DOK 3)

a. Identify sources of income for a program. (DOK 1)
b. Explore types of expenses (fixed, variable, and optional expenditures) that may be involved in operating a program, including but not limited to mortgage or rent, salaries, utilities, insurance, food, maintenance, repairs, purchasing, indoor and outdoor equipment and supplies, field trip costs, transportation, and so forth. (DOK 3)
c. Investigate liability and legal concerns in operating a program such as local, state, and federal regulations. (DOK 3)
d. Explore ways to market and advertise a child- care program. (DOK 3)

3. Analyze the role of a director. (DOK 4)
   a. Identify skills and responsibilities needed in areas of communication, leadership, management, supervision, administrative tasks, such as record keeping, evaluation of staff, time management, inventory, use of technology, and networking. (DOK 1)
   b. Outline moral and ethical characteristics stated in the NAEYC Code of Ethical Conduct and Statement of Commitment. (DOK 1)
   c. Recognize the importance of developing written rules in handbooks for parents and staff/ personnel. (DOK 1)
   d. Formulate strategies to involve parents in the child-care program. (DOK 3)

Early Childhood Education Competency Profile
Program CIP: 19.0709

Unit 1: Orientation, Personal, and Professional Preparation

_____ 1. Examine and research educational, occupational, and leadership opportunities in Early Childhood. (DOK 3)

_____ 2. Analyze knowledge, skills, and dispositions needed to work in the teaching profession. (DOK 3)

Unit 2: Health and Safety

_____ 1. Explain the responsibilities of caregivers for protecting children's health and safety. (DOK 3)

_____ 2. Recognize factors contributing to children's physical health. (DOK 1)

_____ 3. Describe factors contributing to children's mental and emotional health.(DOK3)

Unit 3: History and Trends of Early Childhood Education

_____ 1. Understand the history and evolution of early childhood education. (DOK 2)

_____ 2. Examine programs, initiatives, and accreditations that influenced early childhood education. (DOK 3)

_____ 3. Recognize social and societal trends of early childhood education. (DOK 2)

Unit 4: Child Development Infants Middle Childhood

_____ 1. Examine the physical, cognitive, social, and emotional development of infants from birth to 1 year of age. (DOK 3)

_____ 2. Examine the physical, cognitive, social, and emotional characteristics of toddlers from 1 to 3 years of age. (DOK 3)

_____ 3. Summarize the physical, cognitive, social, and emotional characteristics of preschoolers from 3 to 5 years of age. (DOK 3)

_____ 4. Survey inclusion and techniques to meet the developmental needs of special needs and culturally diverse children. (DOK 1)

Unit 5: Observation, Assessment, and Guidance

_____ 1. Investigate the importance of observing and assessing children in a child-care setting. (DOK 4)

2. Identify goals of effective guidance. (DOK 1)

Unit 6: Career Development and Professionalism

_____ 1. Investigate occupational, educational, and leadership opportunities in the field of Early Childhood. (DOK 3)

Unit 7: The Learning Environment

_____ 1. Describe daily routines for infants, toddlers, and preschool age children in a child-care setting. (DOK 1)

_____ 2. Plan a thematic unit of study. (DOK 4)

_____ 3. Explore types of equipment and arrangement of physical space that help promote learning. (DOK 3)

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Unit 9: Management and Administration

1. Explain the purpose of licensing and other regulations affecting child-care services. (DOK 3)
2. Summarize sound business and operating procedures that are necessary for a successful, productive child-care center. (DOK 3)
3. Analyze the role of a director. (DOK 4)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

7. Using 21st century skills to understand and address global issues
8. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
9. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

7. Knowing how to make appropriate personal economic choices
8. Understanding the role of the economy in society
9. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

7. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
8. Exercising the rights and obligations of citizenship at local, state, national, and global levels
9. Understanding the local and global implications of civic decisions

CS4 Health Literacy

11. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
12. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
13. Using available information to make appropriate health-related decisions
14. Establishing and monitoring personal and family health goals
15. Understanding national and international public health and safety issues

CS5 Environmental Literacy

9. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
10. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
11. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
12. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

7. Think Creatively
8. Work Creatively with Others
9. Implement Innovations

CS7 Critical Thinking and Problem Solving

9. Reason Effectively
10. Use Systems Thinking
11. Make Judgments and Decisions

12. Solve Problems

CS8 Communication and Collaboration

5. Communicate Clearly
6. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

5. Access and Evaluate Information
6. Use and Manage Information

CS10 Media Literacy

5. Analyze Media
6. Create Media Products

CS11 ICT Literacy

3. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

5. Adapt to change
6. Be Flexible

CS13 Initiative and Self-Direction

7. Manage Goals and Time
8. Work Independently
9. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

5. Interact Effectively with others
6. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

5. Manage Projects
6. Produce Results

CS16 Leadership and Responsibility

5. Guide and Lead Others
6. Be Responsible to Others

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

3. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

o. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
p. Explain the causes and characteristics of tides. (DOK 1)
q. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
r. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
s. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
t. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

u. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
- River, stream, lake, pond, and swamp
- Bay, sound, estuary, and marsh

3. Apply an understanding of the diverse organisms found in aquatic environments.

m. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
- Relationship of organisms in food chains/webs within aquatic environments

n. Research, calculate, and interpret population data. (DOK 2)
o. Research and compare reproductive processes in aquatic organisms. (DOK 2)
p. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
q. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
r. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. Draw conclusions about the relationships between human activity and aquatic organisms.

s. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
- Effectiveness of a variety of methods of environmental management and stewardship
- Effects of urbanization on aquatic ecosystems and the effects of continued expansion

t. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
u. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
- Modern technology within aquatic science (e.g., mariculture and aquaculture)
- Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

c. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

v. Formulate questions that can be answered through research and experimental design. (DOK 3)
w. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
x. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
y. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
z. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
aa. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Describe the biochemical basis of life, and explain how energy flows within and between the living systems.</u>

o. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
- Importance of ions in biological processes

p. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

q. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

r. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, heredity) of each group

s. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

t. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

u. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

g. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

h. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

i. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

i. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
- Components of mobility (e.g., cilia, flagella, pseudopodia)

j. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

k. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

l. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

i. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
- Processes of replication, transcription, and translation
- Messenger RNA codon charts

j. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

k. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

l. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
- Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

k. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
- Body plans (symmetry)
- Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

l. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

m. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

n. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)

o. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

o. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)

p. Clarify research questions and design laboratory investigations. (DOK 3)

q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

i. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)

j. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)

k. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)

- The impact of enzymatic reactions on biochemical processes
- Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

l. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

k. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)

l. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

m. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
- Translation of a messenger RNA strand into a protein
- Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
- Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

n. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

o. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

s. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

t. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

u. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

v. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

w. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

x. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

y. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

z. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)

aa. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

e. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

f. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

p. Formulate questions that can be answered through research and experimental design. (DOK 3)

q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

k. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
l. Differentiate the characteristics found in various plant divisions. (DOK 2)
- Differences and similarities of nonvascular plants
- Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
- Major vegetative structures and their modifications in angiosperms and gymnosperms

m. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
n. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
- Classification scheme used in botany
- Classification of native Mississippi plants

o. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
- Relationships among photosynthesis, cellular respiration, and translocation
- Importance of soil type and soil profiles to plant survival
- Mechanism of water movement in plants
- Effects of environmental conditions for plant survival
- Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

m. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
n. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
o. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
- Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
- Functions of flower parts, seeds, cones
- Spore production in bryophytes and ferns

p. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
q. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
r. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

i. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
j. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
k. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
l. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

i. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

j. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
k. Discuss the effects of genetic engineering of plants on society. (DOK 2)
l. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
   - Plant extracts, their function, and origin
   - Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
p. Clarify research questions and design laboratory investigations. (DOK 3)
q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

o. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
   - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
   - Substances and mixtures
   - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
p. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
q. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
   - Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

r. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

s. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

t. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

u. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

i. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

j. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

k. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

l. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

i. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

j. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

k. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

l. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

g. Analyze and explain acid/base reactions. (DOK 2)
   - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
   - Formation of acidic and basic solutions
   - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
   - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
   - How a buffer works and examples of buffer solutions

h. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

i. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

p. Formulate questions that can be answered through research and experimental design. (DOK 3)
q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
t. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

m. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

n. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
o. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

p. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
q. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
r. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

g. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

h. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

i. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

p. Formulate questions that can be answered through research and experimental design. (DOK 3)

q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

i. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

j. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

k. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

l. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

q. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
- Modern and ancient geological features to each kind of plate tectonic boundary

- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

r. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
s. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
t. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
u. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
v. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
   - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
   - Geological timetable
w. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
x. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

k. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
   - Latitudinal variations in solar heating
   - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

l. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
m. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
n. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
o. Research and explain how external forces affect earth's topography. (DOK 2)
   - How surface water and groundwater act as the major agents of physical and chemical weathering
   - How soil results from weathering and biological processes
   - Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

i. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
   - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
   - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
   - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

j. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
k. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
l. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
p. Formulate questions that can be answered through research and experimental design. (DOK 3)
q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

o. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
p. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment
q. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
r. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms

s. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
t. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
u. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

g. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

h. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
i. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
p. Clarify research questions and design laboratory investigations. (DOK 3)
q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

o. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
p. Describe how organic components are integral to biochemical processes. (DOK 2)
q. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
- Meiosis, spermatogenesis, and oogenesis

r. Explain the significance of the discovery of nucleic acids. (DOK 1)

s. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
t. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
u. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

o. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
p. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
- Chromosomal theory of inheritance

q. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

r. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

s. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
t. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
u. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

p. Formulate questions that can be answered through research and experimental design. (DOK 3)

q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

w. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
x. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
y. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
- Physical weathering (e.g., atmospheric, glacial, etc.)
- Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)

z. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
- Processes that create earthquakes and volcanoes
- Asthenosphere

aa. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
bb. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
cc. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
dd. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
ee. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
ff. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
gg. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

<u>Physical Science</u>

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2 Describe and explain how forces affect motion.
PS 3 Demonstrate an understanding of general properties and characteristics of waves.
PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. **<u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>**
   o. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
      - Safety symbols and safety rules in all laboratory activities
      - Proper use and care of the compound light microscope
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   p. Identify questions that can be answered through scientific investigations. (DOK 3)
   q. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
      - Predicting, gathering data, drawing conclusions
      - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
      - Critically analyzing current investigations/problems using periodicals and scientific scenarios

   r. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   s. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
   t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   u. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)
2. **<u>Describe and explain how forces affect motion.</u>**
   k. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
      - Inertia and distance-time graphs to determine average speed
      - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
      - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
      - Simple harmonic motion (oscillation)

   l. Explain the connection between force, work, and energy. (DOK 2)
      - Force exerted over a distance (results in work done)
      - Force-distance graph (to determine work)
      - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

   m. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
   n. Draw and assess conclusions about charges and electric current. (DOK 2)
      - Static/current electricity and direct current/alternating current
      - Elements in an electric circuit that are in series or parallel
      - Conductors and insulators
      - Relationship between current flowing through a resistor and voltage flowing across a resistor

   o. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
3. **<u>Demonstrate an understanding of general properties and characteristics of waves.</u>**

i. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
j. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
k. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
- Energy (photons as quanta of light)
- Additive and subtractive properties of colors
- Relationship of visible light to the color spectrum

l. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. <u>Develop an understanding of the atom.</u>

i. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
- Hund's rule and Aufbau process to specify the electron configuration of elements
- Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
- Atomic orbitals (s, p, d, f) and their basic shapes

j. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
k. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
- Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
- Experiments (e.g., gold-foil, cathode-ray, etc.)

l. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
- Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
- Average atomic mass from isotopic abundance
- Solids, liquids, and gases
- Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

g. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
h. Balance chemical equations. (DOK 2)
i. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
p. Clarify research questions, and design laboratory investigations. (DOK 3)
q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Develop an understanding of concepts related to forces and motion.</u>

i. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

j. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
k. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
l. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. <u>Develop an understanding of concepts related to work and energy.</u>

k. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)
- Principles of impulse in inelastic and elastic collisions

l. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
m. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
n. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

o. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

k. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

l. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
m. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
n. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
o. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

g. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

h. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
i. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

e. Analyze and explain the principles of nuclear physics. (DOK 1)
- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

f. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. **Demonstrate the basic concepts of global positioning systems (GPS). (E)**
   o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   p. Clarify research questions, and design laboratory investigations. (DOK 3)
   q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
   s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Demonstrate the basic concepts of remote sensing. (E, P)**
   m. Describe the characteristics of the electromagnetic spectrum.
   n. Using images and graphs, interpret the absorption/reflection spectrum.
   o. Distinguish between passive vs. active sensor systems.
   p. Analyze the effects of changes in spatial, temporal, and spectral resolution.
   q. Analyze the effects on images due to changes in scale.
   r. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   p. Formulate questions that can be answered through research and experimental design. (DOK 3)
   q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

i. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
- Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

j. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
- Germ layers and embryonic development
- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

k. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
l. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
- Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
- Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

k. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
l. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
- Communication within animals groups
- Degree of parental care given in animal groups

m. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
n. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

o. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

e. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

f. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

- AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

- AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.
- AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.
- AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

- AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.
- AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

- AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.
- AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

- AS.05.01. Evaluate the male and female reproductive systems in selecting animals.
- AS.05.02. Evaluate animals for breeding readiness and soundness.
- AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

- AS.06.01. Demonstrate safe animal handling and management techniques.
- AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

- AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.
- AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

- AS.08.01. Reduce the effects of animal production on the environment.
- AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

- BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.
- BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.
- BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

- BS.02.01. Maintain and interpret biotechnology laboratory records.
- BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.
- BS.02.03. Demonstrate proper laboratory procedures using biological materials.
- BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.
- BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

- BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.
- BS.03.02. Perform biotechnology processes used in AFNR systems.
- BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.
PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.
PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.
PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.
PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.
PST.03.03. Service and repair hydraulic and pneumatic systems.
PST.03.04. Troubleshoot and service electrical systems.
PST.03.05. Service vehicle heating and air-conditioning systems.
PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.
PST.04.02. Apply structural plans, specifications, and building codes.
PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.
PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.
PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.
PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Engineering

Engineering Executive Summary

Program Description

Engineering is a pathway in pre-engineering for high school students. The purpose of the pathway is to provide students with expanded knowledge of the use of technological skills and to enable them to solve problems by applying knowledge in a technological context. The program is designed to provide students with hands-on experiences related to the application of engineering concepts in the workplace. Students will develop academic and technical skills, 21st century skills, and human relations competencies that accompany technical skills for job success and lifelong learning. Students who complete the program will be better prepared to enter and succeed in engineering programs offered by Mississippi community and junior colleges and institutions of higher education.

Industry Certification

Engineering: Most engineering programs involve a concentration of study in an engineering specialty along with courses in both mathematics and the physical and life sciences. Many programs also include courses in general engineering. A design course, sometimes accompanied by a computer or laboratory class or both, is part of the curriculum of most programs. General courses not directly related to engineering, such as those in the social sciences or humanities, are also often required.

In addition to the standard engineering degree, many colleges offer 2-year or 4-year degree programs in engineering technology. These programs, which usually include various hands-on laboratory classes that focus on current issues in the application of engineering principles, prepare students for practical design and production work, rather than for jobs that require more theoretical and scientific knowledge. Graduates of 4-year technology programs may get jobs similar to those obtained by graduates with a bachelor's degree in engineering. Engineering technology graduates, however, are not qualified to register as professional engineers under the same terms as graduates with degrees in engineering. Some employers regard technology program graduates as having skills between those of a technician and an engineer.

All states and the District of Columbia require licensure for engineers who offer their services directly to the public. Engineers who are licensed are called Professional Engineers (PEs). This licensure generally requires a degree from an ABET-accredited engineering program, 4 years of relevant work experience, and successful completion of a state examination. Recent graduates can start the licensing process by taking the examination in two stages. The initial Fundamentals of Engineering (FE) examination can be taken upon graduation. Engineers who pass this examination commonly are called Engineers in Training (EIT) or Engineer Interns (EIs). After acquiring suitable work experience, EITs can take the second examination, the Principles and Practice of Engineering exam.

Assessment

Students will be assessed using the Engineering MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://info.rcu.msstate.edu/services/pathway.asp If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to experience success in the Engineering program, the following prerequisites are recommended:

1. C or Higher in Pre-Algebra

   or
2. TABE Math Computation and TABE Math Applied Score (eighth grade or higher)

   or
3. Instructor Approval

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Mathematics credit that can be used for graduation requirements.

Applied Physics content from the curriculum was aligned to the 2010 Mississippi Science Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Physics credit that can be used for graduation requirements.

The applied academic credit has **not** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 985 licensure endorsement is needed to teach the Engineering program. The requirements for the 985 licensure endorsement are listed below:

1. Applicant must have earned a 4-year degree (bachelor's degree) or higher from an accredited institution of higher education. The degree must be in engineering, mathematics, or an appropriate field of science and must be approved by the MDE program coordinator.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must successfully complete an MDE-approved computer literacy certification exam.
5. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
6. Applicant must successfully complete an Engineering certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 985 endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant may be issued a 3-year endorsement (license), and all requirements must be satisfied prior to the ending date of that license.
Exception: LEAs converting to this pathway from existing programs in Technology Applications (with teachers currently licensed and endorsed #994 Technology Applications) may continue to employ those

teachers and seek 985 endorsement for them although they do not meet the above stated requirement for a 4-year degree in certain major fields of study. These teachers must satisfy all other requirements stated above. All other teachers must meet the requirements for this endorsement.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Program CIP Code: 14.1901
This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Engineering Year 1. The last two courses are comprised of units from Engineering Year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: Engineering Fundamentals teaches students the history of engineering and the careers associated with the field. The students will also learn the foundations and fundamentals of engineering and materials. This course also teaches technical writing, presenting, and project management.
Course Description: Engineering Design teaches students the engineering design process, the steps one follows for successful design planning. Students are also introduced to the advanced concepts of 3-D sketching and modeling with CAD software. This course also focuses on quality control and the benefits of engineering failure.
Course Description: Systems in Engineering is a comprehensive course that focuses on the following four systems: electrical, fluid, mechanical, and thermal. It also introduces students to Computer Integrated Manufacturing, or how robotics and drafting work together to create products.
Course Description: Applying Engineering Concepts teaches students the concepts of digital electronic control system technology, focusing on electronics, gates, and truth tables. Students will also learn valuable workforce readiness skills and participate in a self-directed project that focuses on concepts associated with engineering.

Engineering Fundamentals (One Carnegie Unit) - Course Code: 994002

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
			140

Engineering Design (One Carnegie Unit) - Course Code: 994003

Unit		Title	Hours
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			140

Systems in Engineering (One Carnegie Unit) - Course Code: 994004

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
			140

Applying Engineering Concepts (One Carnegie Unit) - Course Code: 994005

Unit		Title	Hours
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20

			140

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: Engineering I teaches students the history of engineering and the careers associated with the field. The students will also learn the foundations and fundamentals of engineering and materials. This course also teaches technical writing, presenting, and project management. It also teaches students the engineering design process, the steps one follows for successful design planning. Students are also introduced to the advanced concepts of 3-D sketching and modeling with CAD software. This course also focuses on quality control and the benefits of engineering failure.

Course Description: Engineering II is a comprehensive course that focuses on the four systems: electrical, fluid, mechanical, and thermal. It also introduces students to Computer Integrated Manufacturing, or how robotics and drafting work together to create products. This course teaches students the concepts of digital electronic control system technology, focusing on electronics, gates, and truth tables. Students will also learn valuable workforce readiness skills and participate advanced concepts of programming robotic equipment.

Engineering I (Two Carnegie Units) - Course Code: 994000

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			280

Engineering II (Two Carnegie Units) - Course Code: 994001

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20
			280

Engineering Competencies and Objectives

Unit 1: Orientation and Safety

1. Identify course expectations, school policies, and program policies related to this course. (DOK 1)
    a. Identify school rules, policy and procedures. (DOK 1)
    b. Identify and establish classroom guidelines and procedures. (DOK 1)
    c. Review course standards and affiliated national standards. (DOK 1)
    d. Review the comparison of self- and classroom expectations. (DOK 1)
2. Demonstrate proper use and care for laboratory equipment. (DOK 2)
    a. Identify, describe, and demonstrate the importance of safety and the proper use of lab equipment. (DOK 1)
    b. Describe the operating procedures for the equipment utilized in the course. (DOK 1)
    c. Compare and contrast safety issues in the classroom to safety issues in industry. (DOK 2)

Unit 2: Engineering History, Ethics, and Careers

1. Explore the history of engineering, its major achievements, and key figures. (DOK 1)
    a. Identify the characteristics of engineers. (DOK 1)
    b. Identify the key contributors in the field of engineering. (DOK 1)
    c. Identify historical engineering designs, and tell what effects it has on today's society. (DOK 1)
2. Recognize the importance of ethical teamwork in the field of engineering. (DOK 1)
    a. Identify successful team attributes. (DOK 1)
    b. Practice teamwork collaboration to construct an engineering device. (DOK 1)
    c. Define ethics, etiquette, and morality as they are related to the workplace. (DOK 1)
    d. Compare and contrast engineering ethics in the United States to engineering ethics in other countries. (DOK 2)
    e. Examine the effects of discrimination and stereotyping within a team. (DOK 1)
3. Investigate careers within the field of engineering. (DOK 1)
    a. Investigate the different fields of engineering and careers within each. (DOK 1)
    b. Investigate the career you are most interested in, and plan for further study (beginning of electronic portfolio.) (DOK 1)

Unit 3: Writing, Presenting, and Project Management

1. Create a technical report. (DOK 4)
    a. Examine the importance of correct grammar in a technical document. (DOK 1)
    b. Compose an outline and a technical paper on a career in engineering from Unit 2. (DOK 4)
2. Know and be able to use the correct forms for presenting reports. (DOK 4)
    a. Develop and deliver a presentation based on the research conducted in the chosen engineering field from Unit 2, demonstrating appropriate communication techniques such as voice quality, posture, attire, eye contact, preparation, and confidence. (DOK 4)
3. Recognize and demonstrate the importance of project planning and documentation. (DOK 4)
    a. Examine the aspects of teamwork and project management in the workforce. (DOK 1)
    b. Compose technical directions to construct a useful product from provided materials. (DOK 3)

c. Prepare e-portfolio for potential employers. (DOK 4)

Unit 4: Introduction to Robotics

1. Explore and evaluate concepts associated with physical principles of engineering. (DOK 3)
   a. Define and illustrate principles of force, motion, and torque. (DOK 2)
   b. Describe Newton's laws of motion. (DOK 1)
   c. Test structures against various environmental factors. (DOK 3)
2. Explore mechanisms and simple machines to create working robots. (DOK 4)
   a. Distinguish between machines and mechanisms. (DOK 3)
   b. Define, calculate, and demonstrate gear ratios, AMA (actual mechanical advantage), and IMA (ideal mechanical advantage). (DOK 3)
   c. Students will design and build a device to use to show force, motion, and/or torque using simple machines (trebuchet, catapults, backhoe, pulley system, etc.). (DOK 4)
   d. Define and construct robots. (DOK 4)

Unit 5: Engineering Design Process

1. Recognize the need for a design process. (DOK 1)
   a. Define the design process. (DOK 1)
   b. Identify items designed by engineers and those not designed by engineers. (DOK 1)
2. Examine how the design process is used to create and modify products and inventions, then apply it to your own invention. (DOK 4)
   a. Follow the design process to modify a product or invention. (DOK 1)
   b. Apply concepts of planning, design, building, testing, quality assurance, and customer needs.(DOK 4)

Unit 6: Sketching and Modeling

1. Create 2-D and 3-D models with CAD software. (DOK 4)
   a. Trace the history of drafting and design. (DOK 1)
   b. Identify drafting and design applications in business and industry. (DOK 1)
   c. Identify terms and concepts related to drafting and design. (DOK 1)
   d. Demonstrate the proper use of scales, including engineering and metric scales. (DOK 2)
   e. Distinguish between the types of drawing views: Orthographic, isometric, and perspective. (DOK 2)
   f. Identify and design 2-D and 3-D engineering drawings. (DOK 2)
   g. Construct and print a 3-D engineering assembly drawing. (DOK 4)
   h. Animate a 3-D engineering drawing. (DOK 2)

Unit 7: Production, Quality Control, and Engineering Failure

1. Explore the processes of manufacturing and production. (DOK 1)
   a. Define terms associated with manufacturing. (DOK1)
   b. Identify the major commands and components of CAD/CAM software. (DOK 1)
   c. Design a part to be produced on a milling machine. (DOK 4)
2. Explore the methods of quality control. (DOK 1)
   a. Describe basic concepts of quality control technology. (DOK 1)

b. Perform applications of quality control technology. (DOK 4)

3. Explore the causes and effects of engineering failure. (DOK 1)
   a. Examine the effects of engineering failures on structures. (DOK 1)

Unit 8: The Four Systems

1. Examine electrical systems in engineering. (DOK 1)
   a. Identify and define terms associated with energy. (DOK 1)
   b. Calculate total energy usage for the student's own house. (DOK 2)
2. Examine fluid systems in engineering. (DOK 1)
   a. Identify and define terms associated with fluid systems in engineering. (DOK 1)
   b. Construct a small hovercraft. (DOK 4)
3. Examine mechanical systems in engineering. (DOK 1)
   a. Identify and define terms associated with mechanical systems in engineering. (DOK 1)
   b. Assemble mousetrap-powered cars. (DOK 2)
4. Examine thermal systems in engineering. (DOK 1)
   a. Identify and define terms associated with thermal systems in engineering. (DOK 1)
   b. Construct a model house that uses solar power. (DOK 4)

Unit 9: CIM—Computer Integrated Manufacturing

1. Design and write a program for controlling a robot. (DOK 4)
   a. Identify the terms associated with CIM and the components of a work envelope and a robot. (DOK 1)
   b. Manually control a robot. (DOK 2)
   c. Compose and execute a simple program to control the robot. (DOK 4)
   d. Compose and execute a complex program to control the robot. (DOK 4)
2. Design and create an object using NC code. (DOK 4)
   a. Label a diagram of the CNC machine to show its components and safety features. (DOK 1)
   b. Create and execute an NC program to create a design specified by the teacher. (DOK 3)
   c. Create and execute an original NC program to create a three-dimensional object. (DOK 4)
3. Set up the CIM cell using the robot and CNC machine. (DOK 4)
   a. Create and post warning signs for the CIM cell, and mark the work envelope with tape on the work surface. (DOK 2)
   b. Write and synchronize an NC program and a robot program. (DOK 4)

Unit 10: Advanced Robotics

1. Design, construct, program, and reprogram robotic equipment to work properly. (DOK 4)
   a. Design a functional robot using provided software and hardware. (DOK 4)
   b. Construct a functional robot using provided software and hardware. (DOK 4)
   c. Create a blog outlining the successes and failures associated with designing the robot. (DOK 2)
   d. Reprogram a functional robot using provided software and hardware. (DOK 3)
   e. Program a functional robot using provided software and hardware (DOK 4)

Unit 11: Digital Electronic Control System Technology

1. Describe applications of electronic control systems technology. (DOK 2)
    a. Use electronics vocabulary to lead and conduct group discussions. (DOK 2)
    b. Identify and use the tools used in designing a digital device. (DOK 1)
    c. Compare past and modern electronics as well as the notable electrical engineers who created them. (DOK 2)
2. Apply concepts of electronic control systems technology. (DOK 2)
    a. Conduct practical exercise to identify components of electronic control system technology. (DOK 2)
    b. Construct truth tables associated with the AND, NAND, NOT, NOR, and OR gates. (DOK 3)
    c. Engage in a practical exercise to construct and demonstrate projects that will utilize breadboards, wires, sensors, infrared sensors, touch sensors, speed controls and relays. (DOK 3)

Unit 12: Workforce Readiness

1. Develop employability skills that will prepare students for the world of work. (DOK 4)
    a. Examine examples of correctly formatted job applications, resumes, and job interviews, then create your own. (DOK 4)
    b. Recognize diversity in the workplace. (DOK 1)

Engineering Competency Profile (Course 1)
Program CIP: 14.1901

Unit 1: Orientation and Safety

_____ 1. Identify course expectations, school policies, and program policies related to this course.

_____ 2. Demonstrate proper use and care for laboratory equipment.

Unit 2: Engineering History, Ethics, and Careers

_____ 1. Explore the history of engineering, its major achievements, and key figures.

_____ 2. Recognize the importance of ethical teamwork in the field of engineering.

_____ 3. Investigate careers within the field of engineering.

Unit 3: Writing, Presenting, and Project Management

_____ 1. Create a technical report.

_____ 2. Know and be able to use the correct forms for presenting reports.

_____ 3. Recognize the importance of project planning and documentation.

Unit 4: Introduction to Robotics

_____ 1. Explore concepts associated with physical principles of engineering.

_____ 2. Explore mechanisms and simple machines.

Engineering Competency Profile (Course 2)

Unit 5: Engineering Design Process

_____ 1. Recognize the need for a design process.

_____ 2. Examine how the design process is used to create and modify products and inventions.

Unit 6: Sketching and Modeling

_____ 1. Create 2-D and 3-D models with CAD software.

Unit 7: Production, Quality Control, and Engineering Failure

_____ 1. Explore the processes of manufacturing and production.

_____ 2. Explore the methods of quality control.

_____ 3. Explore the causes and effects of engineering failure.

Engineering Competency Profile (Course 3)

Unit 8: The Four Systems

_____ 1. Examine electrical systems in engineering.

_____ 2. Examine fluid systems in engineering.

_____ 3. Examine mechanical systems in engineering.

_____ 4. Examine thermal systems in engineering.

Unit 9: CIM—Computer Integrated Manufacturing

1. Design and write a program for controlling a robot.
2. Design and create an object using NC code.

_____ 3. Set up the CIM cell using the robot and CNC machine.

Engineering Competency Profile (Course 4)

Unit 10: Advanced Robotics

_____ 1. Design, construct, program, and reprogram robotic equipment to work properly.

Unit 11: Digital Electronic Control System Technology

_____ 1. Describe applications of electronic control systems technology.

_____ 2. Apply concepts of electronic control systems technology.

Unit 12: Workforce Readiness

_____ 1. Develop employability skills that will prepare students for the world of work.

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

10. Using 21st century skills to understand and address global issues
11. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
12. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

10. Knowing how to make appropriate personal economic choices
11. Understanding the role of the economy in society
12. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

10. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
11. Exercising the rights and obligations of citizenship at local, state, national, and global levels
12. Understanding the local and global implications of civic decisions

CS4 Health Literacy

16. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
17. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
18. Using available information to make appropriate health-related decisions
19. Establishing and monitoring personal and family health goals
20. Understanding national and international public health and safety issues

CS5 Environmental Literacy

13. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
14. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
15. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
16. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

10. Think Creatively
11. Work Creatively with Others
12. Implement Innovations

CS7 Critical Thinking and Problem Solving

13. Reason Effectively
14. Use Systems Thinking
15. Make Judgments and Decisions

16. Solve Problems

CS8 Communication and Collaboration

7. Communicate Clearly
8. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

7. Access and Evaluate Information
8. Use and Manage Information

CS10 Media Literacy

7. Analyze Media
8. Create Media Products

CS11 ICT Literacy

4. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

7. Adapt to change
8. Be Flexible

CS13 Initiative and Self-Direction

10. Manage Goals and Time
11. Work Independently
12. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

7. Interact Effectively with others
8. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

7. Manage Projects
8. Produce Results

CS16 Leadership and Responsibility

7. Guide and Lead Others
8. Be Responsible to Others

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

4. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

v. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
w. Explain the causes and characteristics of tides. (DOK 1)
x. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
y. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
z. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
aa. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

bb. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
- River, stream, lake, pond, and swamp
- Bay, sound, estuary, and marsh

3. <u>Apply an understanding of the diverse organisms found in aquatic environments.</u>

s. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
- Relationship of organisms in food chains/webs within aquatic environments

t. Research, calculate, and interpret population data. (DOK 2)

u. Research and compare reproductive processes in aquatic organisms. (DOK 2)

v. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)

w. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)

x. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. <u>Draw conclusions about the relationships between human activity and aquatic organisms.</u>

bb. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
- Effectiveness of a variety of methods of environmental management and stewardship
- Effects of urbanization on aquatic ecosystems and the effects of continued expansion

cc. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)

dd. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
- Modern technology within aquatic science (e.g., mariculture and aquaculture)
- Contributions of aquatic technology to industry and government

<u>Biology I</u>

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

d. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

ee. Formulate questions that can be answered through research and experimental design. (DOK 3)
ff. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
gg. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
hh. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
ii. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
jj. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Describe the biochemical basis of life, and explain how energy flows within and between the living systems.</u>

v. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
- Importance of ions in biological processes

w. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

x. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

y. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, heredity) of each group

z. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

aa. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

bb. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

j. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

k. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

l. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

m. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
- Components of mobility (e.g., cilia, flagella, pseudopodia)

n. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

o. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

p. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

m. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
- Processes of replication, transcription, and translation
- Messenger RNA codon charts

n. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

o. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

p. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
- Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

p. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
- Body plans (symmetry)
- Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

q. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

r. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

s. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)

t. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

v. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)

w. Clarify research questions and design laboratory investigations. (DOK 3)

x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

m. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)

n. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)

o. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)

- The impact of enzymatic reactions on biochemical processes
- Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

p. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

p. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)

q. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

r. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
- Translation of a messenger RNA strand into a protein
- Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
- Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

s. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

t. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

bb. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

cc. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

dd. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

ee. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

ff. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

gg. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

hh. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

ii. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)

jj. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

g. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

h. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

w. Formulate questions that can be answered through research and experimental design. (DOK 3)

x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

p. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
q. Differentiate the characteristics found in various plant divisions. (DOK 2)
- Differences and similarities of nonvascular plants
- Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
- Major vegetative structures and their modifications in angiosperms and gymnosperms

r. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
s. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
- Classification scheme used in botany
- Classification of native Mississippi plants

t. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
- Relationships among photosynthesis, cellular respiration, and translocation
- Importance of soil type and soil profiles to plant survival
- Mechanism of water movement in plants
- Effects of environmental conditions for plant survival
- Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>
s. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
t. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
u. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
- Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
- Functions of flower parts, seeds, cones
- Spore production in bryophytes and ferns

v. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
w. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
x. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>
m. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
n. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
o. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
p. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>
m. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

n. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
o. Discuss the effects of genetic engineering of plants on society. (DOK 2)
p. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
    - Plant extracts, their function, and origin
    - Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
w. Clarify research questions and design laboratory investigations. (DOK 3)
x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

v. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
    - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
    - Substances and mixtures
    - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
w. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
x. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
    - Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

y. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

z. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

aa. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

bb. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

m. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

n. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

o. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

p. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

m. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

n. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

o. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

p. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

j. Analyze and explain acid/base reactions. (DOK 2)
   - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
   - Formation of acidic and basic solutions
   - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
   - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
   - How a buffer works and examples of buffer solutions

k. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

l. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

w. Formulate questions that can be answered through research and experimental design. (DOK 3)
x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
aa. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

s. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

t. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
u. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

v. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
w. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
x. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

j. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

k. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

l. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

w. Formulate questions that can be answered through research and experimental design. (DOK 3)

x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

m. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

n. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

o. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in "ordinary" stars and supernovae lead to the formation of all other elements. (DOK 2)

p. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

y. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
- Modern and ancient geological features to each kind of plate tectonic boundary

- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

z. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)

aa. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)

bb. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

cc. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)

dd. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
- Geological timetable

ee. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)

ff. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

p. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
- The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

q. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)

r. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

s. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

t. Research and explain how external forces affect earth's topography. (DOK 2)
- How surface water and groundwater act as the major agents of physical and chemical weathering
- How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

m. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
- Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

n. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
o. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
p. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
w. Formulate questions that can be answered through research and experimental design. (DOK 3)
x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

v. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
w. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment
x. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
y. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms

z. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
aa. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
bb. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

j. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

k. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
l. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
w. Clarify research questions and design laboratory investigations. (DOK 3)
x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

v. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
w. Describe how organic components are integral to biochemical processes. (DOK 2)
x. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
- Meiosis, spermatogenesis, and oogenesis

y. Explain the significance of the discovery of nucleic acids. (DOK 1)

z. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
aa. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
bb. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

v. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
w. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
- Chromosomal theory of inheritance

x. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

y. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

z. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
aa. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
bb. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

w. Formulate questions that can be answered through research and experimental design. (DOK 3)

x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

hh. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
ii. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
jj. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
- Physical weathering (e.g., atmospheric, glacial, etc.)
- Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)

kk. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
- Processes that create earthquakes and volcanoes
- Asthenosphere

ll. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
mm. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
nn. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
oo. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
pp. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
qq. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
rr. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

<u>Physical Science</u>

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2 Describe and explain how forces affect motion.
PS 3 Demonstrate an understanding of general properties and characteristics of waves.
PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

v. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
- Proper use and care of the compound light microscope
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

w. Identify questions that can be answered through scientific investigations. (DOK 3)

x. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
- Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
- Critically analyzing current investigations/problems using periodicals and scientific scenarios

y. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

z. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)

aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

bb. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. <u>Describe and explain how forces affect motion.</u>

p. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
- Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
- Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
- Simple harmonic motion (oscillation)

q. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
- Force-distance graph (to determine work)
- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

r. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)

s. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
- Elements in an electric circuit that are in series or parallel
- Conductors and insulators
- Relationship between current flowing through a resistor and voltage flowing across a resistor

t. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

3. <u>Demonstrate an understanding of general properties and characteristics of waves.</u>

m. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
n. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
o. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
    - The emission of light by electrons when moving from higher to lower levels
    - Energy (photons as quanta of light)
    - Additive and subtractive properties of colors
    - Relationship of visible light to the color spectrum
p. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. <u>Develop an understanding of the atom.</u>

m. Cite evidence to summarize the atomic theory. (DOK 1)
    - Models for atoms
    - Hund's rule and Aufbau process to specify the electron configuration of elements
    - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
    - Atomic orbitals (s, p, d, f) and their basic shapes
n. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
o. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
    - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
    - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
    - Experiments (e.g., gold-foil, cathode-ray, etc.)
p. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
    - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
    - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
    - Average atomic mass from isotopic abundance
    - Solids, liquids, and gases
    - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

j. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
k. Balance chemical equations. (DOK 2)
l. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
w. Clarify research questions, and design laboratory investigations. (DOK 3)
x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Develop an understanding of concepts related to forces and motion.</u>

m. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

n. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
o. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
p. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. <u>Develop an understanding of concepts related to work and energy.</u>

p. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)
- Principles of impulse in inelastic and elastic collisions

q. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
r. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
s. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

t. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

p. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

q. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
r. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
s. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
t. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

j. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

k. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
l. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

g. Analyze and explain the principles of nuclear physics. (DOK 1)
- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

h. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
w. Clarify research questions, and design laboratory investigations. (DOK 3)
x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

s. Describe the characteristics of the electromagnetic spectrum.
t. Using images and graphs, interpret the absorption/reflection spectrum.
u. Distinguish between passive vs. active sensor systems.
v. Analyze the effects of changes in spatial, temporal, and spectral resolution.
w. Analyze the effects on images due to changes in scale.
x. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

w. Formulate questions that can be answered through research and experimental design. (DOK 3)
x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

m. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
- Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

n. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
- Germ layers and embryonic development
- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

o. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
p. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
- Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
- Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

p. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
q. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
- Communication within animals groups
- Degree of parental care given in animal groups

r. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
s. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

t. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

g. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

h. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.

AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.

AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.

AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

AS.05.01. Evaluate the male and female reproductive systems in selecting animals.

AS.05.02. Evaluate animals for breeding readiness and soundness.

AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

AS.06.01. Demonstrate safe animal handling and management techniques.

AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.

AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

AS.08.01. Reduce the effects of animal production on the environment.

AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

- BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.
- BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.
- BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

- BS.02.01. Maintain and interpret biotechnology laboratory records.
- BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.
- BS.02.03. Demonstrate proper laboratory procedures using biological materials.
- BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.
- BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

- BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.
- BS.03.02. Perform biotechnology processes used in AFNR systems.
- BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.
PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.
PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.
PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.
PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.
PST.03.03. Service and repair hydraulic and pneumatic systems.
PST.03.04. Troubleshoot and service electrical systems.
PST.03.05. Service vehicle heating and air-conditioning systems.
PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.
PST.04.02. Apply structural plans, specifications, and building codes.
PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.
PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.
PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.
PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Vocational and Technical Education
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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Engineering

Engineering Executive Summary

Program Description

Engineering is a pathway in pre-engineering for high school students. The purpose of the pathway is to provide students with expanded knowledge of the use of technological skills and to enable them to solve problems by applying knowledge in a technological context. The program is designed to provide students with hands-on experiences related to the application of engineering concepts in the workplace. Students will develop academic and technical skills, 21st century skills, and human relations competencies that accompany technical skills for job success and lifelong learning. Students who complete the program will be better prepared to enter and succeed in engineering programs offered by Mississippi community and junior colleges and institutions of higher education.

Industry Certification

Engineering: Most engineering programs involve a concentration of study in an engineering specialty along with courses in both mathematics and the physical and life sciences. Many programs also include courses in general engineering. A design course, sometimes accompanied by a computer or laboratory class or both, is part of the curriculum of most programs. General courses not directly related to engineering, such as those in the social sciences or humanities, are also often required.

In addition to the standard engineering degree, many colleges offer 2-year or 4-year degree programs in engineering technology. These programs, which usually include various hands-on laboratory classes that focus on current issues in the application of engineering principles, prepare students for practical design and production work, rather than for jobs that require more theoretical and scientific knowledge. Graduates of 4-year technology programs may get jobs similar to those obtained by graduates with a bachelor's degree in engineering. Engineering technology graduates, however, are not qualified to register as professional engineers under the same terms as graduates with degrees in engineering. Some employers regard technology program graduates as having skills between those of a technician and an engineer.

All states and the District of Columbia require licensure for engineers who offer their services directly to the public. Engineers who are licensed are called Professional Engineers (PEs). This licensure generally requires a degree from an ABET-accredited engineering program, 4 years of relevant work experience, and successful completion of a state examination. Recent graduates can start the licensing process by taking the examination in two stages. The initial Fundamentals of Engineering (FE) examination can be taken upon graduation. Engineers who pass this examination commonly are called Engineers in Training (EIT) or Engineer Interns (EIs). After acquiring suitable work experience, EITs can take the second examination, the Principles and Practice of Engineering exam.

Assessment

Students will be assessed using the Engineering MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://info.rcu.msstate.edu/services/pathway.asp If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to experience success in the Engineering program, the following prerequisites are recommended:

4. C or Higher in Pre-Algebra

   or

5. TABE Math Computation and TABE Math Applied Score (eighth grade or higher)

   or

6. Instructor Approval

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Mathematics credit that can be used for graduation requirements.

Applied Physics content from the curriculum was aligned to the 2010 Mississippi Science Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Physics credit that can be used for graduation requirements.

The applied academic credit has **not** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 985 licensure endorsement is needed to teach the Engineering program. The requirements for the 985 licensure endorsement are listed below:

7. Applicant must have earned a 4-year degree (bachelor's degree) or higher from an accredited institution of higher education. The degree must be in engineering, mathematics, or an appropriate field of science and must be approved by the MDE program coordinator.
8. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
9. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
10. Applicant must successfully complete an MDE-approved computer literacy certification exam.
11. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
12. Applicant must successfully complete an Engineering certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 985 endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant may be issued a 3-year endorsement (license), and all requirements must be satisfied prior to the ending date of that license.
Exception: LEAs converting to this pathway from existing programs in Technology Applications (with teachers currently licensed and endorsed #994 Technology Applications) may continue to employ those

teachers and seek 985 endorsement for them although they do not meet the above stated requirement for a 4-year degree in certain major fields of study. These teachers must satisfy all other requirements stated above. All other teachers must meet the requirements for this endorsement.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Program CIP Code: 14.1901
This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Engineering Year 1. The last two courses are comprised of units from Engineering Year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: Engineering Fundamentals teaches students the history of engineering and the careers associated with the field. The students will also learn the foundations and fundamentals of engineering and materials. This course also teaches technical writing, presenting, and project management.
Course Description: Engineering Design teaches students the engineering design process, the steps one follows for successful design planning. Students are also introduced to the advanced concepts of 3-D sketching and modeling with CAD software. This course also focuses on quality control and the benefits of engineering failure.
Course Description: Systems in Engineering is a comprehensive course that focuses on the following four systems: electrical, fluid, mechanical, and thermal. It also introduces students to Computer Integrated Manufacturing, or how robotics and drafting work together to create products.
Course Description: Applying Engineering Concepts teaches students the concepts of digital electronic control system technology, focusing on electronics, gates, and truth tables. Students will also learn valuable workforce readiness skills and participate in a self-directed project that focuses on concepts associated with engineering.

Engineering Fundamentals (One Carnegie Unit) - Course Code: 994002

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
			140

Engineering Design (One Carnegie Unit) - Course Code: 994003

Unit		Title	Hours
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			140

Systems in Engineering (One Carnegie Unit) - Course Code: 994004

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
			140

Applying Engineering Concepts (One Carnegie Unit) - Course Code: 994005

Unit		Title	Hours
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20

			140

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: Engineering I teaches students the history of engineering and the careers associated with the field. The students will also learn the foundations and fundamentals of engineering and materials. This course also teaches technical writing, presenting, and project management. It also teaches students the engineering design process, the steps one follows for successful design planning. Students are also introduced to the advanced concepts of 3-D sketching and modeling with CAD software. This course also focuses on quality control and the benefits of engineering failure.

Course Description: Engineering II is a comprehensive course that focuses on the four systems: electrical, fluid, mechanical, and thermal. It also introduces students to Computer Integrated Manufacturing, or how robotics and drafting work together to create products. This course teaches students the concepts of digital electronic control system technology, focusing on electronics, gates, and truth tables. Students will also learn valuable workforce readiness skills and participate advanced concepts of programming robotic equipment.

Engineering I (Two Carnegie Units) - Course Code: 994000

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			280

Engineering II (Two Carnegie Units) - Course Code: 994001

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20
			280

Engineering Competencies and Objectives

Unit 1: Orientation and Safety

3. Identify course expectations, school policies, and program policies related to this course. (DOK 1)
   a. Identify school rules, policy and procedures. (DOK 1)
   b. Identify and establish classroom guidelines and procedures. (DOK 1)
   c. Review course standards and affiliated national standards. (DOK 1)
   d. Review the comparison of self- and classroom expectations. (DOK 1)
4. Demonstrate proper use and care for laboratory equipment. (DOK 2)
   a. Identify, describe, and demonstrate the importance of safety and the proper use of lab equipment. (DOK 1)
   b. Describe the operating procedures for the equipment utilized in the course. (DOK 1)
   c. Compare and contrast safety issues in the classroom to safety issues in industry. (DOK 2)

Unit 2: Engineering History, Ethics, and Careers

4. Explore the history of engineering, its major achievements, and key figures. (DOK 1)
   d. Identify the characteristics of engineers. (DOK 1)
   e. Identify the key contributors in the field of engineering. (DOK 1)
   f. Identify historical engineering designs, and tell what effects it has on today's society. (DOK 1)
5. Recognize the importance of ethical teamwork in the field of engineering. (DOK 1)
   f. Identify successful team attributes. (DOK 1)
   g. Practice teamwork collaboration to construct an engineering device. (DOK 1)
   h. Define ethics, etiquette, and morality as they are related to the workplace. (DOK 1)
   i. Compare and contrast engineering ethics in the United States to engineering ethics in other countries. (DOK 2)
   j. Examine the effects of discrimination and stereotyping within a team. (DOK 1)
6. Investigate careers within the field of engineering. (DOK 1)
   c. Investigate the different fields of engineering and careers within each. (DOK 1)
   d. Investigate the career you are most interested in, and plan for further study (beginning of electronic portfolio.) (DOK 1)

Unit 3: Writing, Presenting, and Project Management

4. Create a technical report. (DOK 4)
   c. Examine the importance of correct grammar in a technical document. (DOK 1)
   d. Compose an outline and a technical paper on a career in engineering from Unit 2. (DOK 4)
5. Know and be able to use the correct forms for presenting reports. (DOK 4)
   b. Develop and deliver a presentation based on the research conducted in the chosen engineering field from Unit 2, demonstrating appropriate communication techniques such as voice quality, posture, attire, eye contact, preparation, and confidence. (DOK 4)
6. Recognize and demonstrate the importance of project planning and documentation. (DOK 4)
   d. Examine the aspects of teamwork and project management in the workforce. (DOK 1)
   e. Compose technical directions to construct a useful product from provided materials. (DOK 3)

f. Prepare e-portfolio for potential employers. (DOK 4)

Unit 4: Introduction to Robotics

3. Explore and evaluate concepts associated with physical principles of engineering. (DOK 3)
   d. Define and illustrate principles of force, motion, and torque. (DOK 2)
   e. Describe Newton's laws of motion. (DOK 1)
   f. Test structures against various environmental factors. (DOK 3)
4. Explore mechanisms and simple machines to create working robots. (DOK 4)
   e. Distinguish between machines and mechanisms. (DOK 3)
   f. Define, calculate, and demonstrate gear ratios, AMA (actual mechanical advantage), and IMA (ideal mechanical advantage). (DOK 3)
   g. Students will design and build a device to use to show force, motion, and/or torque using simple machines (trebuchet, catapults, backhoe, pulley system, etc.). (DOK 4)
   h. Define and construct robots. (DOK 4)

Unit 5: Engineering Design Process

3. Recognize the need for a design process. (DOK 1)
   c. Define the design process. (DOK 1)
   d. Identify items designed by engineers and those not designed by engineers. (DOK 1)
4. Examine how the design process is used to create and modify products and inventions, then apply it to your own invention. (DOK 4)
   c. Follow the design process to modify a product or invention. (DOK 1)
   d. Apply concepts of planning, design, building, testing, quality assurance, and customer needs.(DOK 4)

Unit 6: Sketching and Modeling

2. Create 2-D and 3-D models with CAD software. (DOK 4)
   i. Trace the history of drafting and design. (DOK 1)
   j. Identify drafting and design applications in business and industry. (DOK 1)
   k. Identify terms and concepts related to drafting and design. (DOK 1)
   l. Demonstrate the proper use of scales, including engineering and metric scales. (DOK 2)
   m. Distinguish between the types of drawing views: Orthographic, isometric, and perspective. (DOK 2)
   n. Identify and design 2-D and 3-D engineering drawings. (DOK 2)
   o. Construct and print a 3-D engineering assembly drawing. (DOK 4)
   p. Animate a 3-D engineering drawing. (DOK 2)

Unit 7: Production, Quality Control, and Engineering Failure

4. Explore the processes of manufacturing and production. (DOK 1)
   d. Define terms associated with manufacturing. (DOK1)
   e. Identify the major commands and components of CAD/CAM software. (DOK 1)
   f. Design a part to be produced on a milling machine. (DOK 4)
5. Explore the methods of quality control. (DOK 1)
   c. Describe basic concepts of quality control technology. (DOK 1)

d. Perform applications of quality control technology. (DOK 4)

6. Explore the causes and effects of engineering failure. (DOK 1)
   b. Examine the effects of engineering failures on structures. (DOK 1)

Unit 8: The Four Systems

5. Examine electrical systems in engineering. (DOK 1)
   c. Identify and define terms associated with energy. (DOK 1)
   d. Calculate total energy usage for the student's own house. (DOK 2)
6. Examine fluid systems in engineering. (DOK 1)
   c. Identify and define terms associated with fluid systems in engineering. (DOK 1)
   d. Construct a small hovercraft. (DOK 4)
7. Examine mechanical systems in engineering. (DOK 1)
   c. Identify and define terms associated with mechanical systems in engineering. (DOK 1)
   d. Assemble mousetrap-powered cars. (DOK 2)
8. Examine thermal systems in engineering. (DOK 1)
   c. Identify and define terms associated with thermal systems in engineering. (DOK 1)
   d. Construct a model house that uses solar power. (DOK 4)

Unit 9: CIM—Computer Integrated Manufacturing

4. Design and write a program for controlling a robot. (DOK 4)
   a. Identify the terms associated with CIM and the components of a work envelope and a robot. (DOK 1)
   b. Manually control a robot. (DOK 2)
   c. Compose and execute a simple program to control the robot. (DOK 4)
   d. Compose and execute a complex program to control the robot. (DOK 4)
5. Design and create an object using NC code. (DOK 4)
   a. Label a diagram of the CNC machine to show its components and safety features. (DOK 1)
   b. Create and execute an NC program to create a design specified by the teacher. (DOK 3)
   c. Create and execute an original NC program to create a three-dimensional object. (DOK 4)
6. Set up the CIM cell using the robot and CNC machine. (DOK 4)
   a. Create and post warning signs for the CIM cell, and mark the work envelope with tape on the work surface. (DOK 2)
   b. Write and synchronize an NC program and a robot program. (DOK 4)

Unit 10: Advanced Robotics

2. Design, construct, program, and reprogram robotic equipment to work properly. (DOK 4)
   a. Design a functional robot using provided software and hardware. (DOK 4)
   b. Construct a functional robot using provided software and hardware. (DOK 4)
   c. Create a blog outlining the successes and failures associated with designing the robot. (DOK 2)
   d. Reprogram a functional robot using provided software and hardware. (DOK 3)
   e. Program a functional robot using provided software and hardware (DOK 4)

Unit 11: Digital Electronic Control System Technology

3. Describe applications of electronic control systems technology. (DOK 2)
    a. Use electronics vocabulary to lead and conduct group discussions. (DOK 2)
    b. Identify and use the tools used in designing a digital device. (DOK 1)
    c. Compare past and modern electronics as well as the notable electrical engineers who created them. (DOK 2)
4. Apply concepts of electronic control systems technology. (DOK 2)
    a. Conduct practical exercise to identify components of electronic control system technology. (DOK 2)
    b. Construct truth tables associated with the AND, NAND, NOT, NOR, and OR gates. (DOK 3)
    c. Engage in a practical exercise to construct and demonstrate projects that will utilize breadboards, wires, sensors, infrared sensors, touch sensors, speed controls and relays. (DOK 3)

Unit 12: Workforce Readiness

2. Develop employability skills that will prepare students for the world of work. (DOK 4)
    a. Examine examples of correctly formatted job applications, resumes, and job interviews, then create your own. (DOK 4)
    b. Recognize diversity in the workplace. (DOK 1)

Engineering Competency Profile (Course 1)
Program CIP: 14.1901

Unit 1: Orientation and Safety

_____ 1. Identify course expectations, school policies, and program policies related to this course.

_____ 2. Demonstrate proper use and care for laboratory equipment.

Unit 2: Engineering History, Ethics, and Careers

_____ 1. Explore the history of engineering, its major achievements, and key figures.

_____ 2. Recognize the importance of ethical teamwork in the field of engineering.

_____ 3. Investigate careers within the field of engineering.

Unit 3: Writing, Presenting, and Project Management

_____ 1. Create a technical report.

_____ 2. Know and be able to use the correct forms for presenting reports.

_____ 3. Recognize the importance of project planning and documentation.

Unit 4: Introduction to Robotics

_____ 1. Explore concepts associated with physical principles of engineering.

_____ 2. Explore mechanisms and simple machines.

Engineering Competency Profile (Course 2)

Unit 5: Engineering Design Process

_____ 1. Recognize the need for a design process.

_____ 2. Examine how the design process is used to create and modify products and inventions.

Unit 6: Sketching and Modeling

_____ 1. Create 2-D and 3-D models with CAD software.

Unit 7: Production, Quality Control, and Engineering Failure

_____ 1. Explore the processes of manufacturing and production.

_____ 2. Explore the methods of quality control.

_____ 3. Explore the causes and effects of engineering failure.

Engineering Competency Profile (Course 3)

Unit 8: The Four Systems

_____ 1. Examine electrical systems in engineering.

_____ 2. Examine fluid systems in engineering.

_____ 3. Examine mechanical systems in engineering.

_____ 4. Examine thermal systems in engineering.

Unit 9: CIM—Computer Integrated Manufacturing

1. Design and write a program for controlling a robot.
2. Design and create an object using NC code.

_____ 3. Set up the CIM cell using the robot and CNC machine.

Engineering Competency Profile (Course 4)

Unit 10: Advanced Robotics

_____ 1. Design, construct, program, and reprogram robotic equipment to work properly.

Unit 11: Digital Electronic Control System Technology

_____ 1. Describe applications of electronic control systems technology.

_____ 2. Apply concepts of electronic control systems technology.

Unit 12: Workforce Readiness

_____ 1. Develop employability skills that will prepare students for the world of work.

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

13. Using 21st century skills to understand and address global issues
14. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
15. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

13. Knowing how to make appropriate personal economic choices
14. Understanding the role of the economy in society
15. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

13. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
14. Exercising the rights and obligations of citizenship at local, state, national, and global levels
15. Understanding the local and global implications of civic decisions

CS4 Health Literacy

21. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
22. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
23. Using available information to make appropriate health-related decisions
24. Establishing and monitoring personal and family health goals
25. Understanding national and international public health and safety issues

CS5 Environmental Literacy

17. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
18. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
19. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
20. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

13. Think Creatively
14. Work Creatively with Others
15. Implement Innovations

CS7 Critical Thinking and Problem Solving

17. Reason Effectively
18. Use Systems Thinking
19. Make Judgments and Decisions

20. Solve Problems

CS8 Communication and Collaboration

9. Communicate Clearly
10. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

9. Access and Evaluate Information
10. Use and Manage Information

CS10 Media Literacy

9. Analyze Media
10. Create Media Products

CS11 ICT Literacy

5. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

9. Adapt to change
10. Be Flexible

CS13 Initiative and Self-Direction

13. Manage Goals and Time
14. Work Independently
15. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

9. Interact Effectively with others
10. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

9. Manage Projects
10. Produce Results

CS16 Leadership and Responsibility

9. Guide and Lead Others
10. Be Responsible to Others

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

5. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

cc. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
dd. Explain the causes and characteristics of tides. (DOK 1)
ee. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
ff. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
gg. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
hh. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

ii. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
- River, stream, lake, pond, and swamp
- Bay, sound, estuary, and marsh

3. Apply an understanding of the diverse organisms found in aquatic environments.

y. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
- Relationship of organisms in food chains/webs within aquatic environments

z. Research, calculate, and interpret population data. (DOK 2)

aa. Research and compare reproductive processes in aquatic organisms. (DOK 2)

bb. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)

cc. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)

dd. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. Draw conclusions about the relationships between human activity and aquatic organisms.

kk. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
- Effectiveness of a variety of methods of environmental management and stewardship
- Effects of urbanization on aquatic ecosystems and the effects of continued expansion

ll. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)

mm. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
- Modern technology within aquatic science (e.g., mariculture and aquaculture)
- Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

e. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

nn. Formulate questions that can be answered through research and experimental design. (DOK 3)
oo. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
pp. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
qq. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
rr. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
ss. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Describe the biochemical basis of life, and explain how energy flows within and between the living systems.</u>

cc. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
- Importance of ions in biological processes

dd. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

ee. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

ff. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, heredity) of each group

gg. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

hh. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

ii. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

m. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

n. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

o. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

q. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
- Components of mobility (e.g., cilia, flagella, pseudopodia)

r. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

s. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

t. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

q. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
- Processes of replication, transcription, and translation
- Messenger RNA codon charts

r. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

s. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

t. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
- Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

u. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
- Body plans (symmetry)
- Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

v. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

w. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

x. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)

y. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

cc. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)

dd. Clarify research questions and design laboratory investigations. (DOK 3)

ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

q. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)

r. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)

s. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)

- The impact of enzymatic reactions on biochemical processes
- Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

t. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

u. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)

v. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

w. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)

- Translation of a messenger RNA strand into a protein
- Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
- Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

x. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)

- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

y. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

kk. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)

- Main periods of the geologic timetable of earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

ll. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

mm. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

nn. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

oo. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

pp. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

qq. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

rr. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)

ss. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

i. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

j. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

dd. Formulate questions that can be answered through research and experimental design. (DOK 3)

ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

u. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
v. Differentiate the characteristics found in various plant divisions. (DOK 2)
- Differences and similarities of nonvascular plants
- Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
- Major vegetative structures and their modifications in angiosperms and gymnosperms

w. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
x. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
- Classification scheme used in botany
- Classification of native Mississippi plants

y. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
- Relationships among photosynthesis, cellular respiration, and translocation
- Importance of soil type and soil profiles to plant survival
- Mechanism of water movement in plants
- Effects of environmental conditions for plant survival
- Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

y. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
z. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
aa. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
- Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
- Functions of flower parts, seeds, cones
- Spore production in bryophytes and ferns

bb. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
cc. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
dd. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

q. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
r. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
s. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
t. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

q. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

r. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
s. Discuss the effects of genetic engineering of plants on society. (DOK 2)
t. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
- Plant extracts, their function, and origin
- Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
dd. Clarify research questions and design laboratory investigations. (DOK 3)
ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

cc. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

dd. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
ee. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
- Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

ff. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

gg. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

hh. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

ii. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

q. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

r. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

s. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

t. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

q. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

r. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

s. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

t. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

m. Analyze and explain acid/base reactions. (DOK 2)
   - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
   - Formation of acidic and basic solutions
   - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
   - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
   - How a buffer works and examples of buffer solutions

n. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

o. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
hh. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

y. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

z. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
aa. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

bb. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
cc. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
dd. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

m. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

n. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

o. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

dd. Formulate questions that can be answered through research and experimental design. (DOK 3)

ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

q. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

r. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

s. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

t. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

gg. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
- Modern and ancient geological features to each kind of plate tectonic boundary

- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

hh. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)

ii. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)

jj. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

kk. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)

ll. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
- Geological timetable

mm. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)

nn. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

u. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
- The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

v. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)

w. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

x. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

y. Research and explain how external forces affect earth's topography. (DOK 2)
- How surface water and groundwater act as the major agents of physical and chemical weathering
- How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

q. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
- Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

r. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
s. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
t. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

cc. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
dd. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment

ee. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
ff. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms

gg. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
hh. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
ii. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

m. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

n. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
o. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
dd. Clarify research questions and design laboratory investigations. (DOK 3)
ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

cc. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
dd. Describe how organic components are integral to biochemical processes. (DOK 2)
ee. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
- Meiosis, spermatogenesis, and oogenesis

ff. Explain the significance of the discovery of nucleic acids. (DOK 1)

gg. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
hh. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
ii. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

cc. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
dd. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
- Chromosomal theory of inheritance

ee. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

ff. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

gg. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
hh. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
ii. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

dd. Formulate questions that can be answered through research and experimental design. (DOK 3)

ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

ss. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)

tt. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)

uu. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)

- Physical weathering (e.g., atmospheric, glacial, etc.)
- Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)

vv. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)

- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
- Processes that create earthquakes and volcanoes
- Asthenosphere

ww. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)

xx. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)

yy. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)

zz. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)

aaa. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)

bbb. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)

ccc. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

<u>Physical Science</u>

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PS 2 Describe and explain how forces affect motion.

PS 3 Demonstrate an understanding of general properties and characteristics of waves.

PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

cc. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
- Proper use and care of the compound light microscope
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

dd. Identify questions that can be answered through scientific investigations. (DOK 3)

ee. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
- Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
- Critically analyzing current investigations/problems using periodicals and scientific scenarios

ff. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

gg. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)

hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

ii. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. <u>Describe and explain how forces affect motion.</u>

u. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
- Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
- Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
- Simple harmonic motion (oscillation)

v. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
- Force-distance graph (to determine work)
- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

w. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)

x. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
- Elements in an electric circuit that are in series or parallel
- Conductors and insulators
- Relationship between current flowing through a resistor and voltage flowing across a resistor

y. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

3. <u>Demonstrate an understanding of general properties and characteristics of waves.</u>

q. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
r. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
s. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
- Energy (photons as quanta of light)
- Additive and subtractive properties of colors
- Relationship of visible light to the color spectrum

t. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. <u>Develop an understanding of the atom.</u>

q. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
- Hund's rule and Aufbau process to specify the electron configuration of elements
- Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
- Atomic orbitals (s, p, d, f) and their basic shapes

r. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
s. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
- Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
- Experiments (e.g., gold-foil, cathode-ray, etc.)

t. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
- Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
- Average atomic mass from isotopic abundance
- Solids, liquids, and gases
- Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

m. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
n. Balance chemical equations. (DOK 2)
o. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
dd. Clarify research questions, and design laboratory investigations. (DOK 3)
ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Develop an understanding of concepts related to forces and motion.</u>

q. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

r. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
s. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
t. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. <u>Develop an understanding of concepts related to work and energy.</u>

u. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)
- Principles of impulse in inelastic and elastic collisions

v. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
w. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
x. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

y. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

u. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

v. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
w. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
x. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
y. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

m. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

n. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
o. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

i. Analyze and explain the principles of nuclear physics. (DOK 1)
- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

j. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. **Demonstrate the basic concepts of global positioning systems (GPS). (E)**
   - cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   - dd. Clarify research questions, and design laboratory investigations. (DOK 3)
   - ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   - ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
   - gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   - hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   - ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Demonstrate the basic concepts of remote sensing. (E, P)**
   - y. Describe the characteristics of the electromagnetic spectrum.
   - z. Using images and graphs, interpret the absorption/reflection spectrum.
   - aa. Distinguish between passive vs. active sensor systems.
   - bb. Analyze the effects of changes in spatial, temporal, and spectral resolution.
   - cc. Analyze the effects on images due to changes in scale.
   - dd. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   - cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
     - Safety rules and symbols
     - Proper use and care of the compound light microscope, slides, chemicals, etc.
     - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   - dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
   - ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   - ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   - gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

q. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
- Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

r. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
- Germ layers and embryonic development
- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

s. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
t. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
- Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
- Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

u. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
v. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
- Communication within animals groups
- Degree of parental care given in animal groups

w. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
x. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

y. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

i. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

j. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.

AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.

AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.

AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

AS.05.01. Evaluate the male and female reproductive systems in selecting animals.

AS.05.02. Evaluate animals for breeding readiness and soundness.

AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

AS.06.01. Demonstrate safe animal handling and management techniques.

AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.

AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

AS.08.01. Reduce the effects of animal production on the environment.

AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

- BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.
- BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.
- BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

- BS.02.01. Maintain and interpret biotechnology laboratory records.
- BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.
- BS.02.03. Demonstrate proper laboratory procedures using biological materials.
- BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.
- BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

- BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.
- BS.03.02. Perform biotechnology processes used in AFNR systems.
- BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.

PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.

PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.

PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.

PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.

PST.03.03. Service and repair hydraulic and pneumatic systems.

PST.03.04. Troubleshoot and service electrical systems.

PST.03.05. Service vehicle heating and air-conditioning systems.

PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.

PST.04.02. Apply structural plans, specifications, and building codes.

PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.

PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.

PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Information Technology

Information Technology Executive Summary

Program Description

The Information Technology pathway is designed to provide the basic foundation, skills, and knowledge for computer networking, applications, and support, along with an introduction to programming. Students will develop the skills necessary to prepare for certification exams and will learn how to develop, support, and integrate computing systems. They will acquire network planning and management skills and the ability to provide technical support. The program will provide hands-on experience in computer systems support and skill in network setup and maintenance.

Industry standards referenced are from the *Skill Standards for Information Technology* published by the National Workforce Center for Emerging Technologies. Program competencies are designed to prepare students for A+ certification. Additional research data used in the development of this publication were collected from a review of related literature and from surveys of local experts in business, industry, and education.

Industry Certification

Program competencies are designed to prepare students for A+ certification by integrating certification skills throughout the curriculum. *Skill Standards for Information Technology* is also referenced to assist in student preparation for IT careers.

Assessment

Students will be assessed using the Information Technology MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://info.rcu.msstate.edu/services/pathway.asp. If there are questions regarding assessment of this program, please contact the Business instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Information Technology program, the following student prerequisites are in place:

8. C or higher in Pre-Algebra
   or
9. TABE Math Computation and TABE Math Applied Score (eighth grade or higher)
   or
10. Instructor Approval

Proposed Applied Academic Credit

The academic credit is still pending for this curriculum.

Licensure Requirements

The 954 license is needed to teach the Information Technology pathway. The requirements for the 954 license endorsement are listed below:

1. Applicant must have an associate's or higher degree and must have at least 2 years for an AA and 1 year for BS or higher of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must possess and maintain A+ certification.
5. Applicant must successfully complete an MDE-approved computer literacy certification exam.
6. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
7. Applicant must successfully complete an information technology certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 954 endorsement—a 5-year license. If an applicant does not meet all requirements, the applicant will be issued a 3-year endorsement license, and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for the Professional Learning Specialist.

Program CIP Code: 11.0101

The Information Technology pathway is offered in two options as outlined below.

Option 1—Four One-Carnegie-Unit Courses

Course Description: Introduction to Information Technology includes the foundation skills required for building computer systems. Program competencies are designed to prepare students for A+ certification by integrating certification skills throughout the course.

Course Description: Computer Fundamentals provides an introduction to computer networking concepts. Program competencies are designed to prepare students for A+ certification by integrating certification skills throughout the course.

Course Description: Network Fundamentals includes advanced computer networking concepts including planning, design, and security. Program competencies are designed to prepare students for A+ certification by integrating certification skills throughout the course.

Course Description: Programming and Web Design provides instruction in Web page design, programming concepts, IT career opportunities, and emerging technologies in the field. Program competencies are designed to prepare students for A+ certification by integrating certification skills throughout the course.

Introduction to Information Technology (One Carnegie Unit) - Course Code: 992202

Unit		Title	Hours
1		Introduction to Information Technology	40
2		Introduction to Computer Hardware and Operating Systems	70
			110

Computer Fundamentals (One Carnegie Unit) - Course Code: 992203

Unit		Title	Hours
3		Basic Electricity and Data Communications	45
4		Computer Assembly, Configuration, and Diagnostics	60
			105

Network Fundamentals (One Carnegie Unit) - Course Code: 992204

Unit		Title	Hours
5		Network Concepts	40
6		Network Planning and Design	60
7		Network Security	40
			140

Programming and Web Design (One Carnegie Unit) - Course Code: 992205

Unit		Title	Hours
8		Web Design	45
9		Visual Basic	30
10		Career Development	30
			105

Option 2—Two Two-Carnegie-Unit Courses

Course Description: Information and Technology I provides the foundation skills necessary for IT professionals including an introduction to computer hardware and operation systems; data communications; and computer assembly, configuration, and diagnostics. The program also provides an introduction to computer programming.

Course Description: Information and Technology II provides opportunities for students to develop advanced networking skills, Web design skills, and employability skills. This course should be taken only upon successful completion of Information Technology I.

Information Technology I (Two Carnegie Units) - Course Code: 992200

Unit		Title	Hours
1		Introduction to Information Technology	40
2		Introduction to Computer Hardware and Operating Systems	70
3		Basic Electricity and Data Communications	45
4		Computer Assembly, Configuration, and Diagnostics	60
			215

Information Technology II (Two Carnegie Units) - Course Code: 992201

Unit		Title	Hours
5		Network Concepts	40
6		Network Planning and Design	60
7		Network Security	40
8		Web Design	45
9		Visual Basic	30
10		Career Development	30
			245

Information Technology Competencies and Objectives

Unit 1: Introduction to Information Technology

1. Research educational, occupational, and leadership opportunities in information technology. (DOK 1)
   a. Review student rules and regulations for the local school. (DOK 1)
   b. Compare and contrast local program policies, procedures, and expectations to industry policies, procedures, and expectations. (DOK 2)
   c. Preview the school technology acceptable use policy. (DOK 1)
   d. dentify and describe leadership opportunities available from student youth organizations in the school and community. (DOK 1)
2. Identify, discuss, and apply safety procedures in the computer classroom and lab. (DOK 1)
   a. Handle DVDs and CDs correctly. (DOK 1)
   b. Care for and use computer hardware correctly. (DOK 2)
   c. Identify potential health hazards when working on computer equipment. (DOK 2)
   d. Discuss the proper classroom and personal safety procedures to include fire extinguishers, electrical, clothing, jewelry, eye protection, and so forth. (DOK 1)
3. Publish and communicate with peers, experts, and other audiences using technology. (DOK 2)
   a. Research safety issues related to telecommunications and the Internet. (DOK 1)
   b. Develop personal safety guidelines that will be used when using telecommunications and the Internet. (DOK 2)
   c. Describe legal implications related to the computer industry to include software copyright issues, software licensing, and Internet ethics and policies. (DOK 1)
   d. Join and participate in appropriate, supervised Listservs. (DOK 2)
   e. Use an appropriate, supervised chat room to communicate with peers, experts, and other approved audiences. (DOK 2)
   f. Evaluate Web page design techniques. (DOK 2)
   g. Research, create, and present a presentation/ project on emerging technologies, practices, trends, and issues associated with information technology. (DOK 4)
   h. Post information to discussion boards, blogs, wikis, and so forth. (DOK 2)
   i. Use browsers, search engines and e-mail. (DOK 2)

Unit 2: Introduction to Computer Hardware and Operating Systems

1. Evaluate and resolve computer hardware and software issues. (DOK 3)
   a. Identify and describe computer types, purposes, and functions. (DOK 1)
   b. Differentiate between hardware and software in a computer environment. (DOK 1)
   c. Identify and describe the various peripheral components of a computer. (DOK 1)
   d. Identify and describe the internal components of a computer. (DOK 1)
   e. Identify and describe system resources to include I/O, processing, memory and storage. (DOK 1)
   f. Identify various pieces of hardware and the function(s) performed by each. (DOK 1)
2. Install, configure, and troubleshoot an operating system. (DOK 3)

a. Identify and describe the components of an operating system (input, processing, storage, and output). (DOK 1)
b. Discuss the difference between network operating systems and individual PC operating systems. (DOK 2)
c. Perform OS configuration and troubleshooting procedures. (DOK 3)
d. Demonstrate OS installation using various methods including CD installation and downloading. (DOK 2)
e. Compare and contrast operating systems. (DOK 2)

3. Investigate operating systems, programming languages, and application software. (DOK 1)
   a. Research programming languages. (DOK 2)
   b. Compare and contrast various programming languages. (DOK 2)
   c. Compare and contrast various software applications. (DOK 1)
   d. Research application software. (DOK 1)

Unit 3: Basic Electricity and Data Communications

1. Discuss voltage and current, explain UPS requirements, and troubleshoot transmission media. (DOK 2)
   a. Implement electrical safety procedures. (DOK 2)
   b. Discuss Ohm's law and the power formula. (DOK 2)
   c. Examine alternating and direct current. (DOK 2)
   d. Determine power requirements for the UPS. (DOK 2)
   e. Describe the functions of the surge protector. (DOK 1)
   f. Explore transmission media to include optics, copper wire, wireless/remote access, connectors, and circuits. (DOK 2)
2. Apply basic networking concepts. (DOK 2)
   a. Identify basic networking terminology. (DOK 1)
   b. Use networking capabilities of an operating system. (DOK 3)
   c. Apply Internet concepts and capabilities. (DOK 3)

Unit 4: Computer Assembly, Configuration, and Diagnostics

1. Assemble a computer, install components and diagnose hardware problems and install and configure operating system, application, web browser and virus protection software. (DOK 4)
   a. Build a computer, install additional components, and diagnose hardware problems. (DOK 4)
   b. Install and configure application, Web browser, and virus protection software. (DOK 3)
   c. Install, configure, and upgrade operating system and diagnose OS software issues. (DOK 4)
   d. Perform preventive maintenance procedures for a hard drive. (DOK 2)
   e. Examine causes, treatment, and prevention of viruses, and implement appropriate virus solutions. (DOK 1)

Unit 5: Network Concepts

1. Examine network hardware and software. (DOK 1)
   a. Define terminology related to networks. (DOK 1)

b. Identify hardware components needed to network two or more computers, such as a network interface card, various cables, hubs, switches, and server. (DOK 1)
c. Identify the various operating systems for networks such as Novell, Windows NT, Windows XP, Windows Vista, UNIX, Linux, and Mac OS. (DOK 1)

2. Relate characteristics, theories, and components of networks. (DOK 1)
   a. Discuss examples of recognized network topologies. (DOK 1)
   b. Discuss protocols. (DOK 1)
   c. Compare network topologies. (DOK 1)
   d. Discuss network models (OSI vs. protocol-specific, i.e. TCP/IP, IPX/SPX). (DOK 1)
3. Examine transmission media, and establish connections to transmit information. (DOK 2)
   a. Compare transmission media to include coax, twisted pair, fiber optics, and wireless. (DOK 1)
   b. Demonstrate cabling termination techniques. (DOK 2)
   c. Test and troubleshoot wired and wireless connections. (DOK 3)

Unit 6: Network Planning and Design

1. Outline the physical and logical aspects of a local area network (LAN), and then plan and construct a LAN. (DOK 4)
   a. Investigate appropriate topology and protocols for a local area network. (DOK 1)
   b. Identify hardware components of a LAN. (DOK 1)
   c. Identify software components of a LAN. (DOK 1)
   d. Examine network models. (DOK 1)
   e. Define classes of network addresses and subnetworks. (DOK 3)
   f. Examine routing tables. (DOK 1)
   g. Plan, design, construct, and test a LAN. (DOK 4)
2. Discuss the physical and logical components and protocols used in a wide area network (WAN), and then plan and design a WAN. (DOK 4)
   a. Examine domains and service providers. (DOK 1)
   b. Identify hardware components of a WAN. (DOK 1)
   c. Discuss the logical components of and various protocols used in a WAN. (DOK 1)
   d. Plan and design a WAN, and present a proposal. (DOK 4)

Unit 7: Network Security

1. Investigate and implement fundamental security principles. (DOK 3)
   a. Identify, describe, and discuss hardware and software security to include hardware deconstruction, smart cards/biometrics, authentication technologies, malicious software protection, software firewalls, and file system security. (DOK 2)
   b. Investigate security software and common security breaches and vulnerabilities. (DOK 2)
   c. Identify, describe, and discuss data and physical security to include wireless encryption, client configuration, and access points. (DOK 1)
   d. Create user accounts and edit user properties according to best practices for assigning and modifying rights, password creation and expiration, and security groups. (DOK 2)
   e. Explain the importance and process of incidence reporting. (DOK 1)

f. Recognize and determine appropriate responses to social engineering situations. (DOK 3)
g. Install, configure, upgrade, and optimize hardware, software, and data security. (DOK 2)
h. Identify, describe, and discuss data and physical security to include data access, encryption, backups, data migration, data removal, password management, and locking the workstation. (DOK 2)

Unit 8: Web Design

1. Use Web page design technologies, evaluate existing designs, and design and maintain a Web page. (DOK 4)
   a. Investigate trends and markup languages related to advanced Web page design. (DOK 2)
   b. Evaluate Web page designs. (DOK 3)
   c. Develop a Web page using Web-authoring software. (DOK 4)
   d. Create a basic Web page using commonly used HTML tags. (DOK 4)

Unit 9: Visual Basic

1. Discuss voltage and current, explain UPS requirements, and troubleshoot transmission media. (DOK 3)
   a. Describe the program development cycle to include input/output, processing, and storage. (DOK 1)
   b. Create, run, and debug an original program to input data, process data, and print a report. (DOK 3)
   c. Create programs that use array/table structures. (DOK 3)
   d. Create programs that include decision, selection, and iteration statements to include IF/THEN statements, Case statements, Do loops and For/Next loops. (DOK 3)
   e. Create programs that perform calculations using arithmetic operations to include addition, subtraction, multiplication, division, and exponentiation. (DOK 3)

Unit 10: Career Development

1. Investigate and implement fundamental security principles. (DOK 3)
   a. Investigate career opportunities and emerging technologies in information technology. (DOK 1)
   b. Search resources for a job opening in an IT career field. (DOK 2)
   c. Demonstrate appropriate job interview skills, including completing a job application. (DOK 3)
   d. Prepare, in an acceptable format, a cover letter, a resume, and a follow-up letter using word processing software. (DOK 3)
2. Use appropriate communication skills and professional behavior when communicating with clients and co-workers. (DOK 3)
   a. Practice appropriate communication skills including speaking clearly and concisely, using tact and discretion, avoiding jargon, asking pertinent questions, and exercising listening skills. (DOK 3)
   b. Practice appropriate professional behavior including maintaining a positive attitude and tone of voice, avoiding arguments or defensiveness, and respecting clients' privacy and property. (DOK 2)
3. Research opportunities related to information technology, and participate in field experiences or simulations. (DOK 2)
   a. Investigate educational opportunities related to information technology. (DOK 2)
   b. Describe national standards and certification/licensing procedures related to information technology. (DOK 2)

c. Describe the role of trade organizations, associations, and unions related to information technology. (DOK 2)
d. Participate in a school-to-careers activity (shadowing, mentoring, simulations, career fair, etc.). (DOK 2)
e. Visit an industry/computer center, and analyze the hardware/ software usage and needs, the educational training for personnel, the tasks performed by personnel, and the future outlook for those jobs. (DOK 3)

Information Technology Competency Profile
Program CIP: 11.0101

Unit 1: Introduction to Information Technology

_____ 1. Research educational, occupational, and leadership opportunities in information technology.

_____ 2. Identify, discuss, and apply safety procedures in the computer classroom and lab.

_____ 3. Publish and communicate with peers, experts, and other audiences using technology.

Unit 2: Introduction to Computer Hardware and Operating Systems

_____ 1. Evaluate and resolve computer hardware and software issues.

_____ 2. Install, configure, and troubleshoot an operating system.

_____ 3. Investigate operating systems, programming languages, and application software.

Unit 3: Basic Electricity and Data Communications

_____ 1. Discuss voltage and current, explain UPS requirements, and troubleshoot transmission media.

_____ 2. Apply basic networking concepts.

Unit 4: Computer Assembly, Configuration, and Diagnostics

_____ 1. Assemble a computer, install components and diagnose hardware problems and install and configure operating system, application, web browser and virus protection software.

Unit 5: Network Concepts

_____ 1. Examine network hardware and software.

_____ 2. Relate characteristics, theories, and components of networks.

3. Examine transmission media, and establish connections to transmit information.

Unit 6: Network Planning and Design

_____ 1. Outline the physical and logical aspects of a local area network (LAN), and then plan and construct a LAN.

_____ 2. Discuss the physical and logical components and protocols used in a wide area network (WAN), and then plan and design a WAN.

Unit 7: Network Security

_____ 1. Investigate and implement fundamental security principles.

Unit 8: Web Design

1. Use Web page design technologies, evaluate existing designs, and design and maintain a Web page.

Unit 9: Visual Basic

_____ 1. Discuss voltage and current, explain UPS requirements, and troubleshoot transmission media.

Unit 10: Career Development

_____ 1. Investigate and implement fundamental security principles.

_____ 2. Use appropriate communication skills and professional behavior when communicating with clients and co-workers.

3. Research opportunities related to information technology, and participate in field experiences or simulations.

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

16. Using 21st century skills to understand and address global issues
17. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
18. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

16. Knowing how to make appropriate personal economic choices
17. Understanding the role of the economy in society
18. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

16. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
17. Exercising the rights and obligations of citizenship at local, state, national, and global levels
18. Understanding the local and global implications of civic decisions

CS4 Health Literacy

26. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
27. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
28. Using available information to make appropriate health-related decisions
29. Establishing and monitoring personal and family health goals
30. Understanding national and international public health and safety issues

CS5 Environmental Literacy

21. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
22. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
23. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
24. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

16. Think Creatively
17. Work Creatively with Others
18. Implement Innovations

CS7 Critical Thinking and Problem Solving

21. Reason Effectively
22. Use Systems Thinking
23. Make Judgments and Decisions

24. Solve Problems

CS8 Communication and Collaboration

11. Communicate Clearly
12. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

11. Access and Evaluate Information
12. Use and Manage Information

CS10 Media Literacy

11. Analyze Media
12. Create Media Products

CS11 ICT Literacy

6. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

11. Adapt to change
12. Be Flexible

CS13 Initiative and Self-Direction

16. Manage Goals and Time
17. Work Independently
18. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

11. Interact Effectively with others
12. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

11. Manage Projects
12. Produce Results

CS16 Leadership and Responsibility

11. Guide and Lead Others
12. Be Responsible to Others

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

6. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

jj. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
kk. Explain the causes and characteristics of tides. (DOK 1)
ll. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
mm. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
nn. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
oo. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

pp. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
- River, stream, lake, pond, and swamp
- Bay, sound, estuary, and marsh

3. <u>Apply an understanding of the diverse organisms found in aquatic environments.</u>

ee. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
- Relationship of organisms in food chains/webs within aquatic environments

ff. Research, calculate, and interpret population data. (DOK 2)

gg. Research and compare reproductive processes in aquatic organisms. (DOK 2)

hh. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)

ii. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)

jj. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. <u>Draw conclusions about the relationships between human activity and aquatic organisms.</u>

tt. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
- Effectiveness of a variety of methods of environmental management and stewardship
- Effects of urbanization on aquatic ecosystems and the effects of continued expansion

uu. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)

vv. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
- Modern technology within aquatic science (e.g., mariculture and aquaculture)
- Contributions of aquatic technology to industry and government

<u>Biology I</u>

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

f. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

ww. Formulate questions that can be answered through research and experimental design. (DOK 3)

xx. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)

yy. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

zz. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

aaa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

bbb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Describe the biochemical basis of life, and explain how energy flows within and between the living systems.</u>

jj. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
- Importance of ions in biological processes

kk. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

ll. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

mm. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, heredity) of each group

nn. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

oo. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

pp. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

p. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

q. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

r. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

u. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
- Components of mobility (e.g., cilia, flagella, pseudopodia)

v. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

w. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

x. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

u. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
- Processes of replication, transcription, and translation
- Messenger RNA codon charts

v. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

w. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

x. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
- Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

z. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
- Body plans (symmetry)
- Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

aa. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

bb. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

cc. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)

dd. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

jj. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)

kk. Clarify research questions and design laboratory investigations. (DOK 3)

ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

u. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)

v. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)

w. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)

- The impact of enzymatic reactions on biochemical processes
- Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

x. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

z. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)

aa. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

bb. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)

- Translation of a messenger RNA strand into a protein
- Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
- Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

cc. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)

- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

dd. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

tt. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)

- Main periods of the geologic timetable of earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

uu. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

vv. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

ww. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

xx. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

yy. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

zz. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

aaa. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)

bbb. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

k. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

l. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

kk. Formulate questions that can be answered through research and experimental design. (DOK 3)

ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

z. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)

aa. Differentiate the characteristics found in various plant divisions. (DOK 2)
- Differences and similarities of nonvascular plants
- Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
- Major vegetative structures and their modifications in angiosperms and gymnosperms

bb. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)

cc. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
- Classification scheme used in botany
- Classification of native Mississippi plants

dd. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
- Relationships among photosynthesis, cellular respiration, and translocation
- Importance of soil type and soil profiles to plant survival
- Mechanism of water movement in plants
- Effects of environmental conditions for plant survival
- Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

ee. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)

ff. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)

gg. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
- Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
- Functions of flower parts, seeds, cones
- Spore production in bryophytes and ferns

hh. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)

ii. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)

jj. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

u. List and assess several adaptations of plants to survive in a given biome. (DOK 2)

v. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

w. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)

x. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

u. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

v. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
w. Discuss the effects of genetic engineering of plants on society. (DOK 2)
x. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
- Plant extracts, their function, and origin
- Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
kk. Clarify research questions and design laboratory investigations. (DOK 3)
ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

jj. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

kk. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
ll. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
- Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

mm. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

nn. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

oo. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

pp. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

u. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

v. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

w. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

x. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

u. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

v. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

w. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

x. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements
   - Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

p. Analyze and explain acid/base reactions. (DOK 2)
   - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
   - Formation of acidic and basic solutions
   - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
   - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
   - How a buffer works and examples of buffer solutions

q. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

r. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
oo. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

ee. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

ff. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
gg. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

hh. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
ii. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
jj. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

p. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

q. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

r. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

kk. Formulate questions that can be answered through research and experimental design. (DOK 3)

ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

u. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

v. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

w. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in "ordinary" stars and supernovae lead to the formation of all other elements. (DOK 2)

x. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

oo. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)

- Modern and ancient geological features to each kind of plate tectonic boundary
- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

pp. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)

qq. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)

rr. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

ss. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)

tt. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
- Geological timetable

uu. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)

vv. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

z. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
- The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

aa. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)

bb. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

cc. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

dd. Research and explain how external forces affect earth's topography. (DOK 2)
- How surface water and groundwater act as the major agents of physical and chemical weathering
- How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

u. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
- Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

v. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
w. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
- Photosynthesis and the atmosphere
- Multicellular animals and marine environments
- Land plants and terrestrial environments

x. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

jj. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
kk. Explain the flow of matter and energy in ecosystems. (DOK 2)
- Interactions between biotic and abiotic factors
- Indigenous plants and animals and their roles in various ecosystems
- Biogeochemical cycles within the environment

ll. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
mm. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
- How a species adapts to its niche
- Process of primary and secondary succession and its effects on a population

- How changes in the environment might affect organisms

nn. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)

oo. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)

pp. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

p. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

q. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

r. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)

kk. Clarify research questions and design laboratory investigations. (DOK 3)

ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)

nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

jj. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)

kk. Describe how organic components are integral to biochemical processes. (DOK 2)

ll. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis

- Meiosis, spermatogenesis, and oogenesis

mm. Explain the significance of the discovery of nucleic acids. (DOK 1)

nn. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)

oo. Cite examples to compare the consequences of the different types of mutations. (DOK 1)

pp. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

jj. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)

kk. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
- Chromosomal theory of inheritance

ll. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)

- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

mm. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)

- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

nn. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)

oo. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)

pp. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

kk. Formulate questions that can be answered through research and experimental design. (DOK 3)

ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

ddd. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)

eee. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)

fff. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)

- Physical weathering (e.g., atmospheric, glacial, etc.)
- Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)

ggg. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)

- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
- Processes that create earthquakes and volcanoes
- Asthenosphere

hhh. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)

iii. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)

jjj. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)

kkk. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)

lll. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)

mmm. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)

nnn. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PS 2 Describe and explain how forces affect motion.

PS 3 Demonstrate an understanding of general properties and characteristics of waves.

PS 4 Develop an understanding of the atom.
PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

jj. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
- Proper use and care of the compound light microscope
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

kk. Identify questions that can be answered through scientific investigations. (DOK 3)

ll. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
- Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
- Critically analyzing current investigations/problems using periodicals and scientific scenarios

mm. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

nn. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)

oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

pp. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. <u>Describe and explain how forces affect motion.</u>

z. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
- Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
- Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
- Simple harmonic motion (oscillation)

aa. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
- Force-distance graph (to determine work)
- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

bb. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)

cc. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
- Elements in an electric circuit that are in series or parallel
- Conductors and insulators
- Relationship between current flowing through a resistor and voltage flowing across a resistor

dd. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

3. Demonstrate an understanding of general properties and characteristics of waves.

u. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)

v. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)

w. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)

- The emission of light by electrons when moving from higher to lower levels
- Energy (photons as quanta of light)
- Additive and subtractive properties of colors
- Relationship of visible light to the color spectrum

x. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. Develop an understanding of the atom.

u. Cite evidence to summarize the atomic theory. (DOK 1)

- Models for atoms
- Hund's rule and Aufbau process to specify the electron configuration of elements
- Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
- Atomic orbitals (s, p, d, f) and their basic shapes

v. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)

w. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)

- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
- Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
- Experiments (e.g., gold-foil, cathode-ray, etc.)

x. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)

- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
- Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
- Average atomic mass from isotopic abundance
- Solids, liquids, and gases
- Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. Investigate and apply principles of physical and chemical changes in matter.

p. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)

q. Balance chemical equations. (DOK 2)

r. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PHYI 2 Develop an understanding of concepts related to forces and motion.
PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
kk. Clarify research questions, and design laboratory investigations. (DOK 3)
ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Develop an understanding of concepts related to forces and motion.</u>

u. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

v. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
w. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
x. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. <u>Develop an understanding of concepts related to work and energy.</u>

z. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)

- Principles of impulse in inelastic and elastic collisions

aa. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)

bb. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)

cc. Investigate and summarize the principles of thermodynamics. (DOK 2)

- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

dd. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

z. Describe and model the characteristics and properties of mechanical waves. (DOK 2)

- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

aa. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)

bb. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)

cc. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)

dd. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

p. Analyze and explain the relationship between electricity and magnetism. (DOK 2)

- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

q. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)

r. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

k. Analyze and explain the principles of nuclear physics. (DOK 1)

- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

l. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)

- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. **Demonstrate the basic concepts of global positioning systems (GPS). (E)**
   jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   kk. Clarify research questions, and design laboratory investigations. (DOK 3)
   ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
   nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Demonstrate the basic concepts of remote sensing. (E, P)**
   ee. Describe the characteristics of the electromagnetic spectrum.
   ff. Using images and graphs, interpret the absorption/reflection spectrum.
   gg. Distinguish between passive vs. active sensor systems.
   hh. Analyze the effects of changes in spatial, temporal, and spectral resolution.
   ii. Analyze the effects on images due to changes in scale.
   jj. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
   ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

u. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
- Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

v. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
- Germ layers and embryonic development
- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

w. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)

x. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
- Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
- Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

z. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)

aa. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
- Communication within animals groups
- Degree of parental care given in animal groups

bb. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)

cc. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

dd. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

k. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

l. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

The AFNR Pathway Content Standards and Performance Elements are adapted from *National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards.* Reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2009. A complete copy of the National Standards can be downloaded from the Team Ag Ed Learning Center at https://aged.learn.com.

AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

- AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

- AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.
- AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.
- AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

- AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.
- AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

- AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.
- AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

- AS.05.01. Evaluate the male and female reproductive systems in selecting animals.
- AS.05.02. Evaluate animals for breeding readiness and soundness.
- AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

- AS.06.01. Demonstrate safe animal handling and management techniques.
- AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

- AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.
- AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

- AS.08.01. Reduce the effects of animal production on the environment.
- AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.

BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.

BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

BS.02.01. Maintain and interpret biotechnology laboratory records.

BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.

BS.02.03. Demonstrate proper laboratory procedures using biological materials.

BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.

BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.

BS.03.02. Perform biotechnology processes used in AFNR systems.

BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

ESS.03.01. Apply meteorology principles to environmental service systems.

ESS.03.02. Apply soil science principles to environmental service systems.

ESS.03.03. Apply hydrology principles to environmental service systems.

ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.

ESS.03.05. Apply chemistry principles to environmental service systems.

ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

ESS.04.01. Use pollution control measures to maintain a safe facility environment.

ESS.04.02. Manage safe disposal of all categories of solid waste.

ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.

ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.

ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.

NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.

NRS.02.03. Measure and survey natural resource status to obtain planning data.

NRS.02.04. Demonstrate natural resource enhancement techniques.

NRS.02.05. Interpret laws related to natural resource management and protection.

NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.

NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.

NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.

PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.

PS.02.02. Prepare growing media for use in plant systems.

PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.

PS.03.02. Develop and implement a plant management plan for crop production.

PS.03.03. Develop and implement a plan for integrated pest management.

PS.03.04. Apply principles and practices of sustainable agriculture to plant production.

PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.

PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.

PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.

PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.

PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.

PST.03.03. Service and repair hydraulic and pneumatic systems.

PST.03.04. Troubleshoot and service electrical systems.

PST.03.05. Service vehicle heating and air-conditioning systems.

PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.

PST.04.02. Apply structural plans, specifications, and building codes.

PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.

PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.

PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.

PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2011

SECONDARY EXECUTIVE SUMMARY 2011

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in

Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Polymer Science

Polymer Science Executive Summary

Pathway Description

Polymer Science is an instructional pathway that introduces an individual to the field of plastics and polymer materials manufacturing. The pathway allows an individual to prepare for employment or continued education in the occupations of plastics and polymer materials manufacturing. The pathway is designed to provide students with hands-on experiences related to the application of polymer science concepts in the workplace. Students will develop academic and technical skills, 21st century skills, and human relations competencies that accompany technical skills for job success and lifelong learning. Students who complete the pathway will be better prepared to enter and succeed in related programs offered by Mississippi community and junior colleges and institutions of higher education.

Industry Certification

Two national certifications are associated with the polymer science industry. They are the **Certified Composites Technician (CCT)** and **the National Certification in Plastics (NCP).**

Assessment

Students will be assessed using the Polymer Science MS-CPAS2 test. The MS-CPAS2 blueprint can be found http://info.rcu.msstate.edu/services/pathway.asp. If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to experience success in the Polymer Science program, the following prerequisites are recommended:

7. C or Higher in a Physical Science or Biology

   or

8. Instructor Approval

Applied Academic Credit

The Polymer Science curriculum is aligned and correlated with the competencies in the Organic Chemistry course found in the 2010 Mississippi Science Framework. The student must complete the 2-course sequence (4 Carnegie units) of Polymer Science.

Licensure Requirements

The 989 licensure endorsement is needed to teach the Polymer Science pathway. The requirements for the 989 licensure endorsement are listed below:

13. Applicant must have earned a 4-year degree (bachelor's degree) or higher from an accredited institution of higher education. The degree must be in polymer science, chemistry, or an appropriate field of science and must be approved by the MDE program coordinator.
14. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the *Redesign* Education Program (REP).
15. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
16. Applicant must successfully complete an MDE-approved computer literacy certification exam.
17. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
18. Applicant must successfully complete a Polymer Science certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 989 endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant may be issued a 3-year endorsement (license), and all requirements must be satisfied prior to the ending date of that license.
Exception: LEAs converting to this pathway from existing programs in Plastics and Polymer Science Applications (with teachers currently licensed and endorsed #379 Plastics and Polymer Science Applications) may continue to employ those teachers and seek 989 endorsement for them although they do not meet the above stated requirement for a 4-year degree in certain major fields of study. These teachers must satisfy all other requirements stated above. All other teachers must meet the requirements for this endorsement.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Polymer Science Year 1. The last two courses are comprised of units from Polymer Science Year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: Introduction to Polymer Science I orients the students to the course and lab. During this course, students learn computer applications relevant to polymer science. They are also introduced to chemistry concepts and the structures and properties of polymers.

Course Description: Introduction to Polymer Science II teaches students the processing techniques associated with polymers as well as the methods and benefits of plastics recycling.

Course Description: Advanced Topics in Polymer Science is a comprehensive course that focuses on polymer synthesis, surface coatings, and composite materials.

Course Description: Careers in Polymer Science explores the job opportunities that are available for individuals in this area. The course also teaches job application and workplace skills as well as offers a potential for job shadowing.

Introduction to Polymer Science I (One Carnegie Unit) - Course Code: 994502

Unit		Title	Hours
1		Orientation and Safety	40
2		Information, Media, and Computer Applications	40
3		Introduction to Chemistry	30
4		Structure and Properties of Polymers	30
			140

Introduction to Polymer Science II (One Carnegie Unit) - Course Code: 994503

Unit		Title	Hours
5		Polymer Processing	60
6		Recycling	60
			120

Advanced Topics in Polymer Science (One Carnegie Unit) - Course Code: 994504

Unit		Title	Hours
7		Orientation and Safety Review	10
8		Polymer Synthesis	60
9		Surface Coatings	20
10		Composite Materials, Processing, and Applications	30
			120

Careers in Polymer Science (One Carnegie Unit) - Course Code: 994505

Unit		Title	Hours
11		School to Work	110
			110

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: Polymer Science I orients the students to the course and lab. During this course, students learn computer applications relevant to polymer science. They are also introduced to chemistry concepts and the structures and properties of polymers. This course also teaches students the processing techniques associated with polymers as well as the methods and benefits of plastics recycling.

Course Description: Polymer Science II is a comprehensive course that focuses on polymer synthesis, surface coatings, and composite materials. This course explores the job opportunities that are available for individuals in this area. It also teaches job application and workplace skills as well as offers a potential for job shadowing.

Polymer Science I (Two Carnegie Units) - Course Code: 994500

Unit		Title	Hours
1		Orientation and Safety	40
2		Information, Media, and Computer Applications	40
3		Introduction to Chemistry	30
4		Structure and Properties of Polymers	30
5		Polymer Processing	60
6		Recycling	60
			260

Polymer Science II (Two Carnegie Units) - Course Code: 994501

Unit		Title	Hours
7		Orientation and Safety Review	10
8		Polymer Synthesis	60
9		Surface Coatings	20
10		Composite Materials, Processing, and Applications	30
11		School to Work	110
			230

Polymer Science Competencies and Objectives

Unit 1: Orientation and Safety

1. Evaluate the local program, and explore how personality traits and learning styles can impact success in the classroom and workplace. SPI-I, SPI-VI, MPC1, MPC4, MPC6, MPC14, MPC16, MPC18, MPC25-MPC28, MPC33-MPC35 (DOK 1)
   a. Describe SkillsUSA activities and participate in a polymer skills competition. (DOK 1)
   b. Examine how understanding personality and learning styles can impact learning and workplace performance. (DOK 1)
   c. Examine the local student handbook and program, establishing rules and guidelines. (DOK 1)
2. Examine the history and development of the polymer industry/profession, to include career opportunities, earnings, and educational requirements. SPI-I, MPC1, MPC4, MPC14, MPC16, MPC21, MPC26,-MPC28, MPC31 (DOK 1)
   a. Trace the development of polymer technologies/ industries from beginning through present day. (DOK 1) OC3
   b. Describe career opportunities, including educational requirements, earning potential, and so forth for polymer-related fields. (DOK 1)
3. Describe and demonstrate safe laboratory practices and environmental responsibility working with laboratory equipment, chemicals, and processing equipment commonly encountered in polymer-related industries. SPI-I , SPI-IV, SPI-VI, MPC1, MPC4, MPC14, MPC8, MPC16, MPC18, MPC21, MPC26,-MPC28, MPC31, MPC33-MPC35 (DOK 2)
   a. Determine how to apply safety rules/guidelines for the lab and workplace and to use safety equipment properly. (DOK 2)
   b. Investigate how industrial, governmental, and environment organizations impact safe operations in polymer-related industries. (DOK 1)
   c. Evaluate resources available for safe handling and disposal of chemicals. (DOK 1) OC3
   d. Detail safe practices particular to operation of equipment in polymer-related laboratories and manufacturing facilities. (DOK 1)
   e. Identify basic laboratory equipment and functions while correctly and safely using selected pieces of equipment. (DOK 2)

Unit 2: Information, Media, and Computer Applications

1. Demonstrate the ability to manage a computer operating system in relation to plastics and polymer applications. SPI-I, MPC1, MPC34 (DOK 3)
   a. Create files and transfer them between directories and subdirectories. (DOK 2) (ongoing
   b. Create an e-portfolio to include all relevant materials. (DOK 4) (ongoing)
   c. Produce quality word processing documents related to polymer science topics. (DOK 2) (ongoing)
   d. Produce and utilize graphics in relation to research for plastics design and production. (DOK 2) (ongoing)
2. Demonstrate the ability to read and interpret a basic blueprint. SPI-I, MPC1, MPC7, MPC34 (DOK 3)
   a. Demonstrate the ability to interpret the different views of a blueprint. (DOK 2) OC1
   b. Demonstrate the ability to read the various parts of a blueprint. (DOK 2)
3. Apply the principles of computer assisted design and drafting (CADD) as applied to the plastics and polymer manufacturing industry. SPI-I, MPC1, MPC8, MPC34 (DOK 4)

a. Interpret and use basic CADD symbols and terms. (DOK 1)
b. Apply basic CADD skills to create, edit, and print/plot 2D and 3D. (DOK 2)

4. Apply geometry and incorporate CADD and CAM (computer-aided machining) processes into the prototype production phase of plastics and polymer manufacturing. SPI-I, MPC1, MPC8, MPC34 (DOK 4)
   a. Design a part with appropriate draft angle. (DOK 2) OC1
   b. Produce a rapid prototyped part according to specifications. (DOK 3)
   c. Demonstrate the importance of ribs in relation to wall thickness. (DOK 2)
   d. Demonstrate the importance of fillets and rounds. (DOK 2)
   e. Calculate and measure wall thickness. (DOK 2)

Unit 3: Introduction to Chemistry

1. Illustrate atomic contributions to chemical structures. SPI-I, MPC4, MPC14, MPC26, MPC27, MPC31, MPC33, MPC34 (DOK 2)
   a. Describe atomic structures to include protons, neutrons, and electrons. (DOK 1) OC2
   b. Demonstrate ionic and covalent bonding, including multiple bonds (double and triple). (DOK 2) OC2
2. Identify common organic molecules, and relate their structures to chemical and physical properties. SPI-I, MPC19, MPC26-28, MPC31, MPC33 (DOK 3)
   a. Apply IUPAC nomenclature and illustrate structures for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 2)OC2
   b. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 3)OC2
   c. Describe functional groups to include structures, nomenclature, and properties. (DOK 1) OC2
3. Investigate compositions and properties of various mixtures and conditions that impact mixture formation and stability. SPI-I, MPC4, MPC7, MPC14, MPC18, MPC21, MPC26, MPC27 (DOK 2)
   a. Define and demonstrate various solution saturations. (DOK 1) OC1
   b. Define and demonstrate homogeneous and heterogeneous mixtures. (DOK 1) OC1

Unit 4: Structure and Properties of Polymers

1. Relate small molecule chemistry to the production of polymers. SPI-I, SPI-IV, MPC3-4, MPC14, MPC18-19 (DOK 3)
   a. Differentiate between properties of natural and synthetic polymers. (DOK 2) OC3
   b. Describe synthetic polymers (plastics, thermoplastics, thermosets, fibers, films, elastomers, and adhesives). (DOK 1) OC3
   c. Describe natural polymers (cellulose, DNA/RNA, natural rubber, starches, and proteins). (DOK 1) OC3
2. Recognize and define natural and synthetic polymers.
   a. Using models, demonstrate the structure of monomers. (DOK 2)OC1, OC2, OC3
   b. Using models, demonstrate the structure and synthesis of homopolymers. (DOK 2) OC1, OC2, OC3
   c. Using models, demonstrate the structure and synthesis of copolymers. (DOK 2) OC1, OC2, OC3
3. Relate rheology and viscosity to polymer properties. SPI-I, SPI-II, SPI-IV, MPC4, MPC28, MPC30-31, MPC35 (DOK 2)
   a. Research the history of rheology/viscosity. (DOK 1) OC3
   b. Demonstrate polymer melt rheology. (DOK 2) OC3
   c. Explain the importance of rheology/viscosity. (DOK 1) OC3

4. Explain how additives affect the properties of a polymeric material. SPI-I, SPI-II, SPI-IV, MPC4-5, MPC7,MPC14, MPC27-29, MPC34 (DOK 2)
    a. Explain how compounding and formulation changes the properties of polymers by using additives or modifiers. (DOK 2) OC3

Unit 5: Polymer Processing and Applications

1. Explain how each manufacturing processing technique is used to convert polymer feedstock into plastic end products, participate in manufacturing plastic parts using each processing technique, and identify parts made from each thermoplastic and thermoset processes. SPI-I, SPI-II, MPC5, MPC11, MPC25 (DOK 4)
    a. Describe and demonstrate extrusion processes. (DOK 2) OC2
    b. Describe and demonstrate injection molding. (DOK 2) OC2
    c. Describe and demonstrate blow molding. (DOK 2) OC2
    d. Describe and demonstrate thermoforming/vacuum forming. (DOK 2) OC2
    e. Describe and demonstrate rotational molding. (DOK 2) OC2
    f. Describe and demonstrate casting. (DOK 2) OC2
    g. Describe and demonstrate expanded bead molding. (DOK 2) OC2
    h. Describe and demonstrate foam processing. (DOK 2) OC2
    i. Describe and demonstrate coatings and adhesives principles. (DOK 2) OC2
    j. Describe and demonstrate compression molding. OC2
    k. Describe and demonstrate fiber formation. OC2
2. Explain the major types of resins or materials. SPI-I, SPI-II, MPC29 (DOK 1)
    a. Identify the major types of resins: thermoplastics, thermosets, and recycled plastics. (DOK 1) OC3

Unit 6: Plastics Recycling and Conservation

1. Relate plastics recycling/conservation principles and their effects on the environment. SPI-I, SPI-IV, SPI-V, MPC1, MPC24 (DOK 2)
    a. Examine issues and post-recycling uses for the different types of plastics. (DOK 1) OC2
    b. Debate the cost of using recycled polymers versus virgin polymers in manufacturing. (DOK 3) OC2
    c. Classify the different types of plastics and their recycle codes including PETE, HDPE, V, LDPE, PP, PS, and others. (DOK 1)

Unit 7: Orientation and Safety (Review)

1. Evaluate the local program and explore how personality traits and learning styles can impact success in the classroom and workplace. SPI-I, SPI-VI, MPC1, MPC4, MPC6, MPC14, MPC16, MPC18, MPC25-MPC28, MPC33-MPC35 (DOK 1)
    a. Examine the local student handbook and program, establishing rules and guidelines. (DOK 1)
    b. Examine how understanding personality and learning styles can impact learning and workplace performance. (DOK 3)
2. Describe and demonstrate safe laboratory practices and environmental responsibility working with laboratory equipment, chemicals, and processing equipment commonly encountered in polymer-related industries. SPI-I , SPI-IV, SPI-VI, MPC1, MPC4, MPC8, MPC14, MPC16, MPC18, MPC21, MPC26,MPC28, MPC31, MPC33-MPC35 (DOK 1)

a. Determine how to apply safety rules/guidelines for the lab and workplace and to use safety equipment properly. (DOK 1)
b. Investigate how industrial, governmental, and environment watchdog organizations impact safe operations in polymer-related industries. (DOK 2)
c. Identify basic laboratory equipment and functions while correctly and safely using selected pieces of equipment. (DOK 1)
d. Detail safe practices particular to operation of equipment in polymer-related laboratories and manufacturing facilities. (DOK 1)
e. Evaluate resources available for safe handling and disposal of chemicals. (DOK 3) OC3

Unit 8: Polymer Synthesis

1. Explore how the chemistry of polymer preparation affects performance properties. SPI-I, SPI-IV, SPI-VI , MPC3, MPC7, MPC17, MPC21, MPC25, MPC28-29, MPC34-36 (DOK 1)
   a. Describe and demonstrate different types of polymer synthesis to include condensation and addition polymerization. (DOK 2) OC1, OC2, OC3
   b. Explore the effects of molecular weight and cross-linking on polymer properties. (DOK 2) OC3

Unit 9: Surface Coatings

1. Describe the production of various types of surface coatings. SPI-I, SPI-IV, SPI-V, MPC4-6, MPC12-13, MPC17, MPC24, MPC28-30, MPC33-36 (DOK 1)
   a. Describe the types of coatings, to include architectural (DIY), OEM, and specialty purpose coatings and their uses in industry. (DOK 1) OC3
   b. Illustrate the synthesis of surface coatings. (DOK 1) OC2, OC3
   c. Identify legislation that influences the push for no VOC coatings. (DOK 1) OC3
2. Demonstrate the properties of coatings. SPI-I, SPI-IV, SPI-V, MPC4, MPC12-13, MPC24, MPC34-36 (DOK 3)
   a. Demonstrate the various properties of surface coatings in relation to physical testing (i.e., blocking, scrub resistance, etc.). (DOK 3) OC2, OC3

Unit 10: Composite Materials, Processing, and Applications

1. Examine composite materials to determine how such materials affect the finish properties of a composite structure. SPI-I, MPC16, MPC17, MPC24, MPC26, MPC28, MPC29, MPC33 (DOK 2)
   a. Demonstrate composite materials and how they are utilized in composite structures. (DOK 2) OC3
2. Demonstrate different composite processing methods and composite applications. SPI-I, MPC16, MPC17, MPC24, MPC26, MPC28, MPC29, MPC33 (DOK4)
   a. Demonstrate composite processes and applications and how they are utilized in composite structures. (DOK 2) OC3

Unit 11: School to Work

1. Explain and demonstrate the role human relations, teamwork, and leadership play in plastics and polymer manufacturing. SPI-I, MPC1, MPC4, MPC18, MPC33 (DOK 3)

a. Research and/or participate in personal development seminars, leadership conferences, and national/international exchange programs. (DOK 4)
b. Prepare a project management methodology, and use it consistently. (DOK 4)
c. Describe and practice the qualities of an effective leader including positive attitude, image, decisiveness, communication skills, and being knowledgeable. (DOK 3)

2. Explain and demonstrate employability skills over the course of the program. SPI-I, MC1, MPC4, MPC18, MPC33 (DOK 4)
   a. Describe traits of a quality employee, including integrity, loyalty, responsibility, and so forth. (DOK 1)
   b. Prepare a resume containing essential information. (DOK 2)
   c. Complete a job application. (DOK 1)
   d. Describe and demonstrate the procedures for a job interview. (DOK 2)
   e. Explain personnel law, requirements of Title IX Law, and employment procedures as related to plastics and polymer materials manufacturing industry. (DOK 1)
3. Apply skills needed to be a viable member of the workforce. SPI-I, MPC1, MPC4, MPC18, MPC33 (DOK 4)
   a. Demonstrate human relationship skills in the supervised work experience program. (DOK 4)
   b. Prepare a description of and demonstrate technical skills to be developed in the supervised work experience program. (DOK 4) OC3
4. Work with instructor and/or employer to develop, assess, and document performance of written occupational objectives to be accomplished during a polymer-related internship and/or simulated polymer industry. SPI-I, MPC1, MPC4, MPC18, MPC33 (DOK 4)
   a. Develop and follow a set of written guidelines for the supervised work experience program. (DOK 4)
   b. Perform written occupational objectives in the supervised work experience program. (DOK 3)
   c. Prepare daily written assessment of accomplishment of objectives. (DOK 3)
   d. Present weekly written reports to instructor of activities performed and objectives accomplished. (DOK 3)
   e. Prepare and finalize electronic portfolio to include all relevant materials. (DOK 4)

Polymer Science Competency Profile (Course 1)
Program CIP: 15.0607

Unit 1: Orientation and Safety

_____ 1. Evaluate the local program, and explore how personality traits and learning styles can impact success in the classroom and workplace.

_____ 2. Examine the history and development of the polymer industry/profession, to include career opportunities, earnings, and educational requirements.

_____ 3. Describe and demonstrate safe laboratory practices and environmental responsibility working with laboratory equipment, chemicals, and processing equipment commonly encountered in polymer-related industries.

Unit 2: Information, Media, and Computer Applications

_____ 1. Demonstrate the ability to manage a computer operating system in relation to plastics and polymer applications.

_____ 2. Demonstrate the ability to read and interpret a basic blueprint.

_____ 3. Apply the principles of computer assisted design and drafting (CADD) as applied to the plastics and polymer manufacturing industry.

_____ 4. Apply geometry and incorporate CADD and CAM (computer-aided machining) processes into the prototype production phase of plastics and polymer manufacturing.

Unit 3: Introduction to Chemistry

_____ 1. Illustrate atomic contributions to chemical structures.

_____ 2. Identify common organic molecules, and relate their structures to chemical and physical properties.

_____ 3. Investigate compositions and properties of various mixtures and conditions that impact mixture formation and stability.

Unit 4: Structure and Properties of Polymers

_____ 1. Relate small molecule chemistry to the production of polymers.

_____ 2. Recognize and define natural and synthetic polymers.

_____ 3. Relate rheology and viscosity to polymer properties.

_____ 4. Explain how additives affect the properties of a polymeric material.

Polymer Science Competency Profile (Course 2)

Unit 5: Polymer Processing and Applications

_____ 1. Explain how each manufacturing processing technique is used to convert polymer feedstock into plastic end products, participate in manufacturing plastic parts using each processing technique, and identify parts made from each thermoplastic and thermoset processes.

_____ 2. Explain the major types of resins or materials.

Unit 6: Plastics Recycling and Conservation

_____ 1. Relate plastics recycling/conservation principles and their effects on the environment.

Unit 7: Orientation and Safety (Review)

_____ 1. Evaluate local program and explore how personality traits and learning styles can impact success in the classroom and workplace.

_____ 2. Describe and demonstrate safe laboratory practices and environmental responsibility working with laboratory equipment, chemicals, and processing equipment commonly encountered in polymer-related industries.

Unit 8: Polymer Synthesis

_____ 1. Explore how the chemistry of polymer preparation affects performance properties.

Unit 9: Surface Coatings

_____ 1. Describe the production of various types of surface coatings.

_____ 2. Demonstrate the properties of coatings.

Unit 10: Composite Materials, Processing, and Applications

_____ 1. Examine composite materials to determine how such materials affect the finish properties of a composite structure.

_____ 2. Demonstrate different composite processing methods and composite applications.

Polymer Science Competency Profile (Course 3)

Unit 11: School to Work

_____ 1. Explain and demonstrate the role human relations, teamwork, and leadership play in plastics and polymer manufacturing.

_____ 2. Explain and demonstrate employability skills over the course of the program.

_____ 3. Apply skills needed to be a viable member of the workforce.

_____ 4. Work with instructor and/or employer to develop, assess, and document performance of written occupational objectives to be accomplished during a polymer-related internship and/or simulated polymer industry.

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

19. Using 21st century skills to understand and address global issues
20. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
21. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

19. Knowing how to make appropriate personal economic choices
20. Understanding the role of the economy in society
21. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

19. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
20. Exercising the rights and obligations of citizenship at local, state, national, and global levels
21. Understanding the local and global implications of civic decisions

CS4 Health Literacy

31. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
32. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
33. Using available information to make appropriate health-related decisions
34. Establishing and monitoring personal and family health goals
35. Understanding national and international public health and safety issues

CS5 Environmental Literacy

25. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
26. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
27. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
28. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

19. Think Creatively
20. Work Creatively with Others
21. Implement Innovations

CS7 Critical Thinking and Problem Solving

25. Reason Effectively
26. Use Systems Thinking
27. Make Judgments and Decisions

28. Solve Problems

CS8 Communication and Collaboration

13. Communicate Clearly
14. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

13. Access and Evaluate Information
14. Use and Manage Information

CS10 Media Literacy

13. Analyze Media
14. Create Media Products

CS11 ICT Literacy

7. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

13. Adapt to change
14. Be Flexible

CS13 Initiative and Self-Direction

19. Manage Goals and Time
20. Work Independently
21. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

13. Interact Effectively with others
14. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

13. Manage Projects
14. Produce Results

CS16 Leadership and Responsibility

13. Guide and Lead Others
14. Be Responsible to Others

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

7. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

qq. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
rr. Explain the causes and characteristics of tides. (DOK 1)
ss. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
tt. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
uu. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
vv. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater

ww. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)

- Barrier island, coral reef, tidal pool, and ocean
- River, stream, lake, pond, and swamp
- Bay, sound, estuary, and marsh

3. Apply an understanding of the diverse organisms found in aquatic environments.

kk. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)

- Adaptations of representative organisms for their aquatic environments
- Relationship of organisms in food chains/webs within aquatic environments

ll. Research, calculate, and interpret population data. (DOK 2)

mm. Research and compare reproductive processes in aquatic organisms. (DOK 2)

nn. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)

oo. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)

pp. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. Draw conclusions about the relationships between human activity and aquatic organisms.

ccc. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)

- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
- Effectiveness of a variety of methods of environmental management and stewardship
- Effects of urbanization on aquatic ecosystems and the effects of continued expansion

ddd. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)

eee. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)

- Careers related to aquatic science
- Modern technology within aquatic science (e.g., mariculture and aquaculture)
- Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

g. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

fff. Formulate questions that can be answered through research and experimental design. (DOK 3)

ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)

hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Describe the biochemical basis of life, and explain how energy flows within and between the living systems.</u>

qq. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
- Importance of ions in biological processes

rr. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

ss. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)

tt. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
- Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
- Basic functions (e.g., energy, storage, cellular, heredity) of each group

uu. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
- Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)

vv. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
- ATP function

ww. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
- Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
- Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

s. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
- Climate (temperature and rainfall)
- Adaptations of organisms

t. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
- Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
- Roles of beneficial bacteria
- Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

u. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

y. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
- Components of mobility (e.g., cilia, flagella, pseudopodia)

z. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
- Binary fission (e.g., budding, vegetative propagation, etc.)
- Significance of meiosis in sexual reproduction
- Significance of crossing over

aa. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

bb. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

y. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
- Processes of replication, transcription, and translation
- Messenger RNA codon charts

z. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

aa. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

bb. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
- Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

ee. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
- Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
- Body plans (symmetry)
- Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)

- Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)

ff. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

gg. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)

hh. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)

ii. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

qq. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)

rr. Clarify research questions and design laboratory investigations. (DOK 3)

ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>

y. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)

z. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)

aa. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)

- The impact of enzymatic reactions on biochemical processes
- Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)

bb. Differentiate between photosynthesis and cellular respiration. (DOK 2)

- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)

- Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
- Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
- Oxidation and reduction reactions

3. <u>Investigate and discuss the molecular basis of heredity.</u>

ee. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)

ff. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

gg. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)

- Translation of a messenger RNA strand into a protein
- Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
- Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

hh. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)

- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

ii. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. <u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>

ccc. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)

- Main periods of the geologic timetable of earth's history
  - Roles of catastrophic and gradualistic processes in shaping planet Earth

ddd. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

eee. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

fff. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

ggg. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

hhh. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

iii. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

jjj. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)

kkk. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

m. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

n. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

rr. Formulate questions that can be answered through research and experimental design. (DOK 3)

ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

ee. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)

ff. Differentiate the characteristics found in various plant divisions. (DOK 2)

- Differences and similarities of nonvascular plants
- Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
- Major vegetative structures and their modifications in angiosperms and gymnosperms

gg. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)

hh. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)

- Classification scheme used in botany
- Classification of native Mississippi plants

ii. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)

- Relationships among photosynthesis, cellular respiration, and translocation
- Importance of soil type and soil profiles to plant survival
- Mechanism of water movement in plants
- Effects of environmental conditions for plant survival
- Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

kk. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)

ll. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)

mm. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)

- Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
- Functions of flower parts, seeds, cones
- Spore production in bryophytes and ferns

nn. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)

oo. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)

pp. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

y. List and assess several adaptations of plants to survive in a given biome. (DOK 2)

z. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

aa. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)

bb. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

y. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)

z. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)

aa. Discuss the effects of genetic engineering of plants on society. (DOK 2)

bb. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)

- Plant extracts, their function, and origin
- Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

CHI 3 Develop an understanding of the periodic table.

CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.

CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)

rr. Clarify research questions and design laboratory investigations. (DOK 3)

ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

qq. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)

- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

rr. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)

ss. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)

- Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

tt. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

uu. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

vv. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

ww. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

y. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

z. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

aa. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

bb. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. <u>Analyze the relationship between microscopic and macroscopic models of matter.</u>

y. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

z. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

aa. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

bb. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

5. <u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>

s. Analyze and explain acid/base reactions. (DOK 2)
- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
- Formation of acidic and basic solutions
- Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
- The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
- How a buffer works and examples of buffer solutions

t. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

u. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
vv. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Demonstrate an understanding of the properties, structure, and function of organic compounds.</u>

kk. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

ll. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
mm. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

nn. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
oo. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
pp. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

s. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

t. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

u. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.

rr. Formulate questions that can be answered through research and experimental design. (DOK 3)

ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

y. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
- Microwave background radiation
- The Hubble constant
- Evidence of the existence of dark matter and dark energy in the universe and the history of the universe

z. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)

aa. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in "ordinary" stars and supernovae lead to the formation of all other elements. (DOK 2)

bb. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

ww. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
- Modern and ancient geological features to each kind of plate tectonic boundary

- Production of particular groups of igneous and metamorphic rocks and mineral resources
- Sedimentary basins created and destroyed through time

xx. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)

yy. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)

zz. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

aaa. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)

bbb. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)

- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
- Geological timetable

ccc. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)

ddd. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

ee. Explain the interaction of earth systems that affect weather and climate. (DOK 1)

- Latitudinal variations in solar heating
- The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).

ff. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)

gg. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

hh. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

ii. Research and explain how external forces affect earth's topography. (DOK 2)

- How surface water and groundwater act as the major agents of physical and chemical weathering
- How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

y. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)

- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
- Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

z. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)

aa. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
- Photosynthesis and the atmosphere
- Multicellular animals and marine environments
- Land plants and terrestrial environments

bb. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.

ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

rr. Formulate questions that can be answered through research and experimental design. (DOK 3)

ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

qq. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)

rr. Explain the flow of matter and energy in ecosystems. (DOK 2)
- Interactions between biotic and abiotic factors
- Indigenous plants and animals and their roles in various ecosystems
- Biogeochemical cycles within the environment

ss. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)

tt. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
- How a species adapts to its niche
- Process of primary and secondary succession and its effects on a population
- How changes in the environment might affect organisms

uu. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
vv. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
ww. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

s. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

t. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
u. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
rr. Clarify research questions and design laboratory investigations. (DOK 3)
ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

qq. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
rr. Describe how organic components are integral to biochemical processes. (DOK 2)
ss. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
- Meiosis, spermatogenesis, and oogenesis

tt. Explain the significance of the discovery of nucleic acids. (DOK 1)

uu. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)

vv. Cite examples to compare the consequences of the different types of mutations. (DOK 1)

ww. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

qq. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)

rr. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
- Chromosomal theory of inheritance

ss. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)

- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

tt. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)

- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

uu. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)

vv. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)

ww. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

rr. Formulate questions that can be answered through research and experimental design. (DOK 3)

ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.</u>

ooo. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)

ppp. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)

qqq. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)

- Physical weathering (e.g., atmospheric, glacial, etc.)
- Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)

rrr. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)

- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
- Processes that create earthquakes and volcanoes
- Asthenosphere

sss. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)

ttt. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)

uuu. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)

vvv. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)

www. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)

xxx. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)

yyy. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

<u>Physical Science</u>

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PS 2 Describe and explain how forces affect motion.

PS 3 Demonstrate an understanding of general properties and characteristics of waves.

PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. **<u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>**
   qq. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
   - Safety symbols and safety rules in all laboratory activities
   - Proper use and care of the compound light microscope
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   rr. Identify questions that can be answered through scientific investigations. (DOK 3)
   ss. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
   - Predicting, gathering data, drawing conclusions
   - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
   - Critically analyzing current investigations/problems using periodicals and scientific scenarios

   tt. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   uu. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
   vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   ww. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)
2. **<u>Describe and explain how forces affect motion.</u>**
   ee. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
   - Inertia and distance-time graphs to determine average speed
   - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
   - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
   - Simple harmonic motion (oscillation)

   ff. Explain the connection between force, work, and energy. (DOK 2)
   - Force exerted over a distance (results in work done)
   - Force-distance graph (to determine work)
   - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

   gg. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
   hh. Draw and assess conclusions about charges and electric current. (DOK 2)
   - Static/current electricity and direct current/alternating current
   - Elements in an electric circuit that are in series or parallel
   - Conductors and insulators
   - Relationship between current flowing through a resistor and voltage flowing across a resistor

   ii. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
3. **<u>Demonstrate an understanding of general properties and characteristics of waves.</u>**

y. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
z. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
aa. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
- Energy (photons as quanta of light)
- Additive and subtractive properties of colors
- Relationship of visible light to the color spectrum

bb. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. <u>Develop an understanding of the atom.</u>

y. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
- Hund's rule and Aufbau process to specify the electron configuration of elements
- Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
- Atomic orbitals (s, p, d, f) and their basic shapes

z. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
aa. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
- Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
- Experiments (e.g., gold-foil, cathode-ray, etc.)

bb. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
- Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
- Average atomic mass from isotopic abundance
- Solids, liquids, and gases
- Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

s. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
t. Balance chemical equations. (DOK 2)
u. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.

PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. <u>Investigate and apply principles of physical and chemical changes in matter.</u>

qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
rr. Clarify research questions, and design laboratory investigations. (DOK 3)
ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Develop an understanding of concepts related to forces and motion.</u>

y. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

z. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
aa. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
bb. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. <u>Develop an understanding of concepts related to work and energy.</u>

ee. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)
- Principles of impulse in inelastic and elastic collisions

ff. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)

gg. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)

hh. Investigate and summarize the principles of thermodynamics. (DOK 2)

- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

ii. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. <u>Discuss the characteristics and properties of light and sound.</u>

ee. Describe and model the characteristics and properties of mechanical waves. (DOK 2)

- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

ff. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)

gg. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)

hh. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)

ii. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. <u>Apply an understanding of magnetism, electric fields, and electricity.</u>

s. Analyze and explain the relationship between electricity and magnetism. (DOK 2)

- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

t. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)

u. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

m. Analyze and explain the principles of nuclear physics. (DOK 1)

- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

n. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)

- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. **Demonstrate the basic concepts of global positioning systems (GPS). (E)**
   qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   rr. Clarify research questions, and design laboratory investigations. (DOK 3)
   ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
   uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Demonstrate the basic concepts of remote sensing. (E, P)**
   kk. Describe the characteristics of the electromagnetic spectrum.
   ll. Using images and graphs, interpret the absorption/reflection spectrum.
   mm. Distinguish between passive vs. active sensor systems.
   nn. Analyze the effects of changes in spatial, temporal, and spectral resolution.
   oo. Analyze the effects on images due to changes in scale.
   pp. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
   ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

y. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
- Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)

z. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
- Germ layers and embryonic development
- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

aa. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)

bb. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
- Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
- Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

ee. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)

ff. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
- Communication within animals groups
- Degree of parental care given in animal groups

gg. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)

hh. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

ii. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

m. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

n. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.

- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.

- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit’s place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.

- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.

- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.

- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.

- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure

- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) PATHWAY CONTENT STANDARDs AND PERFORMANCE ELEMENTS

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AGRIBUSINESS SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of agribusiness systems.

ABS.01. Utilize economic principles to establish and manage an AFNR enterprise.
- ABS.01.01. Apply principles of capitalism in the business environment.
- ABS.01.02. Apply principles of entrepreneurship in businesses.

ABS.02. Utilize appropriate management planning principles in AFNR business enterprises.
- ABS.02.01. Compose and analyze a business plan for an enterprise.
- ABS.02.02. Read, interpret, evaluate, and write a mission statement to guide business goals, objectives, and resource allocation.
- ABS.02.03. Apply appropriate management skills to organize a business.
- ABS.02.04. Recruit, train, and retain appropriate and productive human resources for business.

ABS.03. Utilize record keeping to accomplish AFNR business objectives while complying with laws and regulations.
- ABS.03.01. Prepare and maintain all files needed to accomplish effective record keeping.
- ABS.03.02 Implement appropriate inventory management practices.

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.
- ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.
- ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.
- ABS.06.01. Conduct appropriate market and marketing research.
- ABS.06.02. Develop a marketing plan.
- ABS.06.03. Develop strategies for marketing plan implementation.
- ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.
- ABS.07.01. Prepare a step-by-step production plan that identifies needed resources.
- ABS.07.02. Develop a production and operational plan.
- ABS.07.03. Utilize appropriate techniques to determine the most likely strengths, weaknesses, and inconsistencies in a business plan, and relate these to risk management strategies.
- ABS.07.04. Manage risk and uncertainty.

ANIMAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and practices to the production and management of animals.

AS.01. Examine the components, historical development, global implications, and future trends of the animal systems industry.

AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution.

AS.02. Classify, evaluate, select, and manage animals based on anatomical and physiological characteristics.

AS.02.01. Classify animals according to hierarchical taxonomy and agricultural use.

AS.02.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.02.03. Select animals for specific purposes and maximum performance based on anatomy and physiology.

AS.03. Provide for the proper health care of animals.

AS.03.01. Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.

AS.03.02. Provide for the biosecurity of agricultural animals and production facilities.

AS.04. Apply principles of animal nutrition to ensure the proper growth, development, reproduction, and economic production of animals.

AS.04.01. Formulate feed rations to provide for the nutritional needs of animals.

AS.04.02. Prescribe and administer animal feed additives and growth promotants in animal production.

AS.05. Evaluate and select animals based on scientific principles of animal production.

AS.05.01. Evaluate the male and female reproductive systems in selecting animals.

AS.05.02. Evaluate animals for breeding readiness and soundness.

AS.05.03. Apply scientific principles in the selection and breeding of animals.

AS.06. Prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products.

AS.06.01. Demonstrate safe animal handling and management techniques.

AS.06.02. Implement procedures to ensure that animal products are safe.

AS.07. Select animal facilities and equipment that provide for the safe and efficient production, housing, and handling of animals.

AS.07.01. Design animal housing, equipment, and handling facilities for the major systems of animal production.

AS.07.02. Comply with government regulations and safety standards for facilities used in animal production.

AS.08. Analyze environmental factors associated with animal production.

AS.08.01. Reduce the effects of animal production on the environment.

AS.08.02. Evaluate the effects of environmental conditions on animals.

BIOTECHNOLOGY

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to biotechnology in agriculture.

BS.01. Recognize the historical, social, cultural, and potential applications of biotechnology.

- BS.01.01. Distinguish major innovators, historical developments, and potential applications of biotechnology in agriculture.
- BS.01.02. Determine regulatory issues, and identify agencies associated with biotechnology.
- BS.01.03. Analyze the ethical, legal, social, and cultural issues relating to biotechnology.

BS.02 Demonstrate laboratory skills as applied to biotechnology.

- BS.02.01. Maintain and interpret biotechnology laboratory records.
- BS.02.02. Operate biotechnology laboratory equipment according to standard procedures.
- BS.02.03. Demonstrate proper laboratory procedures using biological materials.
- BS.02.04. Safely manage biological materials, chemicals, and wastes used in the laboratory.
- BS.02.05. Perform microbiology, molecular biology, enzymology, and immunology procedures.

BS.03. Demonstrate the application of biotechnology to Agriculture, Food, and Natural Resources (AFNR).

- BS.03.01. Evaluate the application of genetic engineering to improve products of AFNR systems.
- BS.03.02. Perform biotechnology processes used in AFNR systems.
- BS.03.03. Use biotechnology to monitor and evaluate procedures performed in AFNR systems.

ENVIRONMENTAL SERVICE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of environmental service systems.

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.

- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.

- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.

- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.

- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.

ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.

ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.

ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

FOOD PRODUCTS AND PROCESSING SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles, practices, and techniques in the processing, storage, and development of food products.

FPP.01. Examine components of the food industry and historical development of food products and processing.

FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

FPP.01.02. Work effectively with industry organizations, groups, and regulatory agencies affecting the food products and processing industry.

FPP.02. Apply safety principles, recommended equipment, and facility management techniques to the food products and processing industry.

FPP.02.01. Manage operational procedures, and create equipment and facility maintenance plans.

FPP.02.02. Implement Hazard Analysis and Critical Control Point (HACCP) procedures to establish operating parameters.

FPP.02.03. Apply safety and sanitation procedures in the handling, processing, and storing of food products.

FPP.02.04. Demonstrate worker safety procedures with food product and processing equipment and facilities.

FPP.03. Apply principles of science to the food products and processing industry.

FPP.03.01. Apply principles of science to food processing to provide a safe, wholesome, and nutritious food supply.

FPP.04. Select and process food products for storage, distribution, and consumption.

FPP.04.01. Utilize harvesting, selection, and inspection techniques to obtain quality food products for processing.

FPP.04.02. Evaluate, grade, and classify processed food products.

FPP.04.03. Process, preserve, package, and present food and food products for sale and distribution.

NATURAL RESOURCE SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the management of natural resources.

NRS.01. Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments.

NRS.01.01. Apply knowledge of natural resource components to the management of natural resource systems.

NRS01.02. Classify natural resources.

NRS.02. Apply scientific principles to natural resource management activities.

NRS.02.01. Develop a safety plan for work with natural resources.
NRS.02.02. Demonstrate cartographic skills to aid in developing, implementing, and evaluating natural resource management plans.
NRS.02.03. Measure and survey natural resource status to obtain planning data.
NRS.02.04. Demonstrate natural resource enhancement techniques.
NRS.02.05. Interpret laws related to natural resource management and protection.
NRS.02.06. Apply ecological concepts and principles to natural resource systems.

NRS.03. Apply knowledge of natural resources to production and processing industries.

NRS.03.01. Produce, harvest, process, and use natural resource products.

NRS.04. Demonstrate techniques used to protect natural resources.

NRS.04.01. Manage fires in natural resource systems.
NRS.04.02. Diagnose plant and wildlife diseases, and follow protocol to prevent their spread.
NRS.04.03. Manage insect infestations of natural resources.

NRS.05. Use effective methods and venues to communicate natural resource processes to the public.

NRS.05.01. Communicate natural resource information to the public.

PLANT SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of scientific principles and techniques to the production and management of plants.

PS.01. Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants.

PS.01.01. Classify agricultural plants according to taxonomy systems.
PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

PS.02. Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth.

PS.02.01. Determine the influence of environmental factors on plant growth.
PS.02.02. Prepare growing media for use in plant systems.
PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

PS.03. Propagate, culture, and harvest plants.

PS.03.01 Demonstrate plant propagation techniques.
PS.03.02. Develop and implement a plant management plan for crop production.
PS.03.03. Develop and implement a plan for integrated pest management.
PS.03.04. Apply principles and practices of sustainable agriculture to plant production.
PS.03.05 Harvest, handle, and store crops.

PS.04. Employ elements of design to enhance an environment.

PS.04.01. Create designs using plants.

POWER, STRUCTURAL AND TECHNICAL SYSTEMS

Pathway Content Standard: The student will demonstrate competence in the application of principles and techniques for the development and management of power, structural, and technical systems.

PST.01. Use physical science principles and engineering applications with power, structural, and technical systems to solve problems and improve performance.

PST.01.01. Select energy sources in power generation appropriate to the situation.
PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.
PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

PST.02. Design, operate, and maintain mechanical equipment, structures, biological systems, land treatment, power, and technology.

PST.02.01. Perform service routines to maintain power units and equipment.
PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

PST.03. Service and repair mechanical equipment and power systems.

PST.03.01. Troubleshoot and repair internal combustion engines.
PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.
PST.03.03. Service and repair hydraulic and pneumatic systems.
PST.03.04. Troubleshoot and service electrical systems.
PST.03.05. Service vehicle heating and air-conditioning systems.
PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

PST.04. Plan, build and maintain agricultural structures.

PST.04.01. Create sketches and plans of agricultural structures.
PST.04.02. Apply structural plans, specifications, and building codes.
PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.
PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

PST.05. Apply technology principles in the use of agricultural technical systems.

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.
PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.
PST.05.03. Use geospatial technologies in agricultural applications.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.