MISSISSIPPI DEPARTMENT OF EDUCATION

Ensuring a bright future for every child

2018 Agricultural and Natural Resources

Program CIP: 01.0003 – Agricultural and Natural Resources

Direct inquiries to

Instructional Design Specialist
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
662.325.2510

Program Coordinator
Office of Career and Technical Education
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
601.359.3461

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Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

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Melissa Luckett, Project Coordinator, Research and Curriculum Unit, Mississippi State University

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Agricultural and Natural Resources Curriculum Framework and supporting materials are based on the following:

National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards

The National Council for Agricultural Education (The Council) shapes and strengthens school-based agricultural education at all levels. The Council and the National AFNR Career Cluster Content Standards Committee have developed standards that provide state agricultural education leaders and teachers with a guide to cultivate well-planned curriculum in agriscience education for grades 9 through 14. The standards referenced in this curriculum are reprinted with permission from the National Council for Agricultural Education, 1410 King Street, Suite 400, Alexandria, VA 22314. (800) 772-0939. Copyright © 2015.
https://www.ffa.org/thecouncil/Documents/finalafnrstandardsv324609withisbn_000.pdf

College and Career-Ready Standards

The College and Career-Ready Standards emphasize critical thinking, teamwork and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College- and Career-Ready Standards (MCCRS) because they provide a consistent, clear understanding of what students are expected to learn so that teachers and parents know what they need to do to help them. Reprinted from http://www.mde.k12.ms.us/MCCRS

International Society for Technology in Education Standards (ISTE)

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21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

~~Preface~~

~~Secondary career and technical education programs in Mississippi face 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 IV, 2007; and Every Student Succeeds Act 2015.)~~

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

Agricultural and natural resources is a pathway to introduce the student to the broad field of agriculture and natural resources, including the production of plants and animals and the management of natural resources. The program includes instruction in the applied sciences related to plant and animal production and natural resource conservation and management, as well as introducing the student to agribusiness management practices and maintenance of facilities and equipment. Students in the pathway will participate in active learning exercises, including integral activities of the FFA organization and supervised experiences. Students who successfully complete the competencies in this pathway will possess fundamental knowledge and skills that can be used to secure entry-level employment or as a foundation for continuing their education. Industry standards are adapted from *Career Cluster Resources for Agriculture, Food, and Natural Resources*, developed by the National Association of State Directors of Career and Technical Education.

Industry Certification

No national, industry-recognized certifications are known to exist at this time in the field of agricultural and natural resources. Competencies and suggested performance indicators in the horticulture courses have been correlated, however, to the Agriculture, Food, and Natural Resources Career Cluster Content Standards that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx.

Student Prerequisites

In order for students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in science (the previous year)
2. C or higher in English (the previous year)
3. C or higher in mathematics (last course taken, or the instructor can specify the course needed)
4. Instructor approval

Applied Academic Credit

The latest academic credit information can be found at http://www.mde.k12.ms.us/ACCRED/AAS. Once there, click the Mississippi Public School Accountability Standards Year tab. Review the appendices for graduation options and superscript

information regarding specific programs receiving academic credit. Check this site often, as it is updated frequently.

Teacher Licensure

The latest teacher licensure information can be found at http://www.mde.k12.ms.us/educator-licensure.

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510.

Course Outlines

Option 1—Four One-Carnegie Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. Fundamentals of Agricultural and Natural Resources—Course Code: 991102
2. Agricultural and Natural Resources: Soils and Ag Lab Operations—Course Code: 991103
3. Agricultural and Natural Resources: Environmental Science—Course Code: 991104
4. Agricultural and Natural Resources: Equipment Operation and Business MGT—Course Code: 991105

Course Description: Fundamentals of Agricultural and Natural Resources is designed to introduce the student to fundamental concepts and principles of the modern agricultural and natural resources industry. Emphasis is placed on career and leadership skills and basic principles of plant, animal, and soil science.

Course Description: Agricultural and Natural Resources: Soils and Ag Lab Operations is designed to provide knowledge and skills concerning basic mechanical technologies in the field.

Course Description: Agricultural and Natural Resources: Environmental Science is designed to provide concepts and principles associated with agriculture and natural resources. Emphasis is placed on the conservation and management of natural resources; agricultural business management practices; and the environment as it relates to water quality, forestry, and wildlife.

Course Description: Agricultural and Natural Resources: Equipment Operation and Business MGT is designed to provide instruction on basic agriculture construction techniques and agriculture business management and processes.

Fundamentals of Agricultural and Natural Resources—Course Code: 991102

Unit	Unit Name	Hours
1	Introduction to ANR*	8
2	Agricultural Leadership and Career Development*	15
3	Introduction to Experiential Learning (SAE)*	12
4	Science of Animals	35
5	Science of Plants	30
Totals		100

Agricultural and Natural Resources: Soils and Ag Lab Operations—Course Code: 991103

Unit	Unit Name	Hours
6	Soil Science	30
7	Agricultural Lab Operations and Safety	40
8	Agricultural Small Engines	30
Totals		100

Agricultural and Natural Resources: Environmental Science—Course Code: 991104

Unit	Unit Name	Hours
9	Orientation/Careers/Leadership*	15
10	Science of the Agricultural Environment	20
11	Water Quality Management	20
12	Science of Forestry and the Environment	20
13	Wildlife and the Environment	20
14	Environmental Stewardship	20
Totals		115

Agricultural and Natural Resources: Equipment Operation and Business MGT—Course Code: 991105

Unit	Unit Name	Hours
15	Construction/Agricultural Equipment Operation and Maintenance	75
16	Agricultural Business Management and Processes*	30
Totals		105

*** Units not MS-CPAS3 tested.**

Option 2—Two Two-Carnegie Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. Agricultural and Natural Resources I—Course Code 991100
2. Agricultural and Natural Resources II—Course Code 991101

Course Description: Agricultural and Natural Resources I is designed to introduce the student to fundamental concepts and principles of the modern agricultural and natural resources industry. Emphasis is placed on career and leadership skills; basic principles of plant, animal, and soil science; and basic mechanical technologies in the field. (2–2.5 Carnegie units depending on time spent in course)

Course Description: Agricultural and Natural Resources II is designed to continue the exploration of fundamental concepts and principles associated with agriculture and natural resources. Emphasis is placed on the conservation and management of natural resources; agricultural business management practices; and the environment as it relates to water quality, forestry, and wildlife. Instruction is provided on basic agriculture construction techniques and agriculture business management and processes. (2–2.5 Carnegie units depending on time spent in course)

Agricultural and Natural Resources I—Course Code 991100

Unit	Unit Name	Hours
1	Introduction to ANR*	8
2	Agricultural Leadership and Career Development*	15
3	Introduction to Experiential Learning (SAE)*	12
4	Science of Animals	35
5	Science of Plants	30
6	Soil Science	30
7	Agricultural Lab Operations and Safety	40
8	Agricultural Small Engines	30
Total		200

Agricultural and Natural Resources II—Course Code: 991101

Unit	Unit Name	Hours
9	Orientation/Careers/Leadership*	15
10	Science of the Agricultural Environment	20
11	Water Quality Management	20
12	Science of Forestry and the Environment	20
13	Wildlife and the Environment	20
14	Environmental Stewardship	20
15	Construction/Agricultural Equipment Operation and Maintenance	75
16	Agricultural Business Management and Processes*	30
Total		220

Research Synopsis

Introduction

The agricultural and natural resources (ANR) cluster covers the broad field of occupations related to the production and use of plants and animals for food, fiber, aesthetic, and environmental purposes. According to the U.S. Department of Labor, the growing interest in worldwide standardization of agricultural equipment should result in increased employment in agriculture-related jobs. Job opportunities should also result from the increasing demand for agricultural products, continued efforts for more efficient agricultural production, and increasing emphasis on the conservation of resources. According to Farm Families of Mississippi, Mississippi's value of agricultural production estimates for 2015 amounted to $7.4 billion. Additionally, the Mississippi Department of Agriculture and Commerce estimates that 17% of the state's workforce is employed in jobs relating directly or indirectly to agriculture, for a total economic impact of $16.1 billion each year. Agriculture makes an impact in all 82 of Mississippi's counties, throughout the nation, and around the world.

The ANR career pathway will target careers at the professional and technical levels in agriculture. Students enrolled in these courses should be better prepared to pursue degrees at the community college and four-year college levels.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2017). Employment opportunities for each of the occupations are listed below:

Table 1.1: Current and Projected Occupation Report

Occupation	Employment		Projected Growth 2012-2022		Average Wage 2017	
	Current (2012)	Projected (2022)	Number	Percent	Hourly	Annual
Biological technicians	110	140	30	27.3%	$17.93	$37,500
Vocational education teachers, secondary school	1230	1450	220	17.9%	N/A	$45,750
First-line supervisors/managers of landscaping, lawn service, and grounds keeping workers	920	1120	200	21.7%	$17.81	$37,050
Agricultural inspectors	310	330	20	6.5%	$19.44	$40,430
Chemical technicians	330	350	20	6.1%	$21.74	$45,220
Environmental scientists and specialists, including health	30	40	10	33.3%	N/A	N/A
Soil and plant scientists	70	80	10	14.3%	$40.75	$84,750

Zoologists and wildlife biologists	320	340	20	6.3%	$31.72	$65,990
Forest and conservation technicians	110	120	10	9.1%	$20.59	$42,830
Forest and conservation workers	70	80	10	14.3%	N/A	N/A
Survey researchers	290	310	20	6.9%	$19.93	$41,450
Environmental science and protection technicians, including health	30	40	10	33.3%	$17.76	$36,930
Farm and home management advisors	150	170	20	13.3%	$23.15	$48,160
Animal scientists	130	140	10	7.7%	N/A	N/A
Geological and petroleum technicians	100	110	10	10.0%	$28.36	$58,990
Biological technicians	110	140	30	27.3%	$17.93	$37,300

Source: Mississippi Department of Employment Security, www.mdes.ms.gov.

Perkins IV Requirements

The secondary ANR curriculum meets Perkins IV requirements for high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations within the field of ANR. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will prepare them for occupations in these fields. Additionally, the secondary ANR technology curriculum is integrated with academic standards. Lastly, the secondary ANR curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards included in the secondary ANR curriculum are based on the Mississippi College- and Career-Ready State Standards Initiative, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter postsecondary education or the workforce.

Academic Infusion

The secondary ANR curriculum is aligned to the Mississippi College- and Career-Ready Standards. The curriculum provides multiple opportunities to enhance and reinforce these academic skills. Because students will be required to communicate effectively in the classroom and in the workforce, there is a considerable amount of writing in this curriculum. The academic content in the secondary ANR curriculum provides several opportunities for public speaking, personal finance, and money management as they relate to secondary ANR content. Overall, the secondary ANR content requires students to perform calculations using strategic and critical-thinking skills to solve real-world problems. Appendix E includes the Mississippi College- and Career-Ready Standards for each unit.

Transition to Postsecondary Education

The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website: http://www.mccb.edu/.

Best Practices

The premise of the success of all school-based, agricultural-education programs is the three-circle model, which depicts the three major components of the program interlocked and working together as one. The three components are classroom and laboratory instruction; experiential learning through SAE programs for individual students; and participation in the CTE student organization for agriculture education, the National FFA.

Classroom and Laboratory Instruction

The classroom and laboratory component of the school-based, agricultural-education, three-circle model is the foundation of the success of the other two components. Through contextual learning, students in agricultural education can learn the science, business, and technology of modern agriculture through innovative instructional technologies, differentiated instruction, and cooperative learning.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The ANR teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a set of smart tablets and one teacher laptop. To make use of the latest online communication tools, such as wikis, blogs, and podcasts, the teacher is encouraged to use a learning-management system that introduces students to teaching and learning strategies in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

All students are unique and possess an individualized learning style. Differentiated instruction is an approach to teaching that addresses the differences in learning styles by providing alternative teaching and assessment methods that reach across the spectrum of student needs in the classroom. By differentiating instruction in ANR, teachers can more effectively reach students and address their strengths and weaknesses, thereby increasing student success. The implementation of various forms of technology; use of alternative assessments, such as rubrics and problem-based assessment; and utilizing hands-on and work-based learning opportunities in the program of instruction truly enhance the quality of the curriculum presentation.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the ANR curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The ANR curriculum provides opportunities for students to work together and help each other complete complex tasks.

~~Experiential Learning (SAE)~~

~~The experiential-learning (SAE) component has long been an integral part of the school-based, agricultural-education, three-component model. Each student is encouraged to explore their career interests and plan an experiential, service, and/or work-based learning program to guide them to their career goals. This SAE program guides the student as they maintain a record-keeping system of the time and money invested, as well as the skills gained from their experiences. The SAE projects can be used in a variety of situations to reinforce and complement classroom theory and content. The SAE project consists of entrepreneurship, placement, research/experimentation, and exploratory discovery and spans the duration of program enrollment.~~

~~CTE Student Organizations~~

~~As the third part of the school-based, agricultural-education program, the FFA component is the showcase, or focal point, of leadership, growth, and development for students. The FFA is the student organization for the ANR curriculum. The FFA offers many opportunities for student success, such as leadership development, career development events, degrees of attainment, awards and scholarships, and community service. The FFA provides students with growth opportunities and competitive events. It also opens the doors to the world of agriculture and scholarship opportunities.~~

~~Conclusion~~

~~Secondary ANR is one of Mississippi's most contemporary and advanced agriculture curricula. Students that complete this program are well equipped for a variety of endeavors. Instructors are urged to encourage secondary ANR students to pursue educational opportunities at community colleges and universities in Mississippi.~~

Professional Organizations

Agricultural Education Division of the Association for Career and Technical Education. May be found online at http://www.acteonline.org/

American Association for Agricultural Education. May be found online at http://aaaeonline.org/

Mississippi ACTE. May be found online at http://www.mississippiacte.com/

Mississippi Association of Vocational Agriculture Teachers (MAVAT). May be found online at www.mississippiffa.org

National Association of Agricultural Educators. May be found online at http://www.naae.org/

National Association of Supervisors of Agricultural Education. May be found online at https://www.ffa.org/thecouncil/nasae/

National FFA Alumni Association. May be found online at https://www.ffa.org/getinvolved/alumni/

National FFA Foundation, Inc. May be found online at https://www.ffa.org/support/foundation/

National Farm and Ranch Business Management Education Association. May be found online at http://www.nfrbmea.org/

National Postsecondary Agricultural Student Organization. May be found online at http://www.nationalpas.org/

National Young Farmer Educational Association. May be found online at http://www.nyfea.org

Using This Document

Suggested Time on Task

This section indicates 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% 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.

AFNR National Standards, 21st Century Skills, *College and Career Ready Standards* and International Society for Technology in Education (ISTE) Standards

This section crosswalks the Agricultural and Natural Resources curriculum with the Agriculture, Forestry and Natural Resources National Standards, as well as identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877. The standards that are integrated into the content of the unit are aligned with the *College and Career Ready Standards* outlined in this document. Research-based teaching strategies also incorporate the 21st Century Skills and Information and Communication Technology Literacy skills.

Unit 1: Introduction to ANR

Competencies and Suggested Objectives
1. Examine the nature of the ANR industry. DOK1, ABS, AS, BS, CRP, CS, ES, FPP, NRS, PS, PST a. Investigate the scope of the ANR industry from a national and global perspective. b. Trace the development of agricultural sciences and technologies in the United States. c. Associate the major areas of ANR with their products and practices. d. Investigate career opportunities in ANR.
2. Examine the relationships between the pure sciences, agriculture, and agriscience. DOK1, NRS a. Associate the pure sciences with agriculture and agriscience areas. b. Develop a plan for conducting an experiment using the scientific method.
3. Apply standard ANR safety practices. DOK1, NRS a. Apply safety standards in the workplace. b. Apply safety standards in the agricultural classroom and laboratory. c. Interpret information on a material safety data sheet (MSDS). d. Describe the use of general safety hand equipment and indicators including, but not limited to, the following: • Safety color codes • Fire extinguishers • First aid kits • Emergency exits e. Apply safety precautions related to dress and personal protection devices and select procedures for dealing with the different classes of fires.

Unit 2: Agricultural Leadership and Career Development

Competencies and Suggested Objectives

1. Explore the integral relationship between the FFA and agricultural education. DOK 2, CRP, CS
   a. Examine historical events that shaped school-based agricultural education:
      - Smith-Hughes Act (1917)
      - Establishment of the National FFA Organization (1928)
      - Mississippi FFA Association chartered (1934)
      - Establishment of the New Farmers of America (1935)
      - Public Law 740 (1950)
      - Merger of the FFA and the NFA (1965)
      - Female membership (1969)
      - Organizational name change (1988)
   b. Identify types of FFA membership:
      - Active
      - Collegiate
      - Alumni
      - Honorary
   c. Distinguish among the degree levels of FFA membership and describe the requirements for each:
      - Discovery FFA degree
      - Greenhand FFA degree
      - Chapter FFA degree
      - State FFA degree
      - American FFA degree

2. Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st Century Skills Standards. DOK 2, CRP, CS
   a. Explain the role of effective leadership.
   b. Have students self-evaluate their personal leadership traits and develop a plan for improvement.
   c. Identify and put into practice FFA activities that promote personal and career development, teamwork, and leadership skills:
      - Public speaking and communication skills
      - Career development events
      - Proficiency awards
      - Community service activities
      - Conventions and leadership conferences

d. Demonstrate basic parliamentary procedures:
    - Conducting a meeting
    - Stating a main motion
    - Voting on a motion
    - Understanding the use of the gavel
    - Distinguish between types of motions: main, subsidiary, incidental, and privileged

3. Describe the role of 21st Century Skills, work ethic, and values in establishing and building a successful career. DOK 3, CRP, CS
    a. Define and describe universally accepted work ethics and values as applied to agricultural, food, and natural resources careers:
        - Trustworthiness
        - Respect
        - Responsibility
        - Fairness
        - Caring
        - Citizenship
    b. Identify career-related values and ethics promoted through FFA activities:
        - Attendance
        - Attitude
        - Achievement
        - Relationships
        - Vision
        - Character
        - Awareness
        - Continuous improvement
        - Personal growth
        - Time management
        - Communication
        - Decision-making
        - Flexibility/adaptability
    c. Practice work ethic and values in the ANR classroom and laboratory, student organization activities, and in experiential learning projects.

4. Investigate careers associated with the agricultural industry and write a report with details about a career, including: DOK1, CRP, CS
    - Description of the career
    - Educational/training requirements
    - Salary range

- ~~Job outlook~~

Unit 3: Introduction to Experiential Learning (SAE)

Competencies and Suggested Scenarios

1. Describe the purposes and requirements of the supervised agricultural experience (SAE) program. DOK 1, ABS, CRP, CS
   a. Establish objectives for the SAE program:
      - Personal growth
      - Career development
      - Responsible citizenship
      - Practical application of work experience and/or skill attainment
   b. Determine the benefits of participation in an SAE program:
      - Assist with career and personal choices.
      - Apply business practices, such as record keeping and money management.
      - Nurture individual talents and develop a cooperative attitude.
      - Build character and encourage citizenship and volunteerism.
      - Provide an environment for practical learning.
   c. Describe the types of SAE programs:
      - Exploratory
      - Research
        - Experimental
        - Analytical
        - Invention
      - Placement/internship
      - Entrepreneurship/ownership
      - School-based enterprise
      - Service learning
      - Improvement project
2. Develop a personal plan for the SAE program. DOK2, ABS, CRP, CS
   a. Determine the availability of time and money/resources to invest.
   b. Set short-range goals for the SAE program.
   c. Project long-range goals for the SAE program.
   d. Complete a training agreement for an SAE project.
   e. Establish requirements for student, parents, supervisor, and/or employer.
3. Develop a record-keeping system for an individual student's SAE program. DOK3, ABS, CRP, CS
   a. Determine types of records to keep:
      - Hours worked/spent on a project or enterprise
      - Inventory of assets

- ~~Expenses~~
- ~~Income~~
- ~~Skills attained during a project or enterprise~~
- ~~Leadership record~~
- ~~Community service record~~
- ~~Journal of experiences~~

b. ~~Maintain records using an electronic/computer-based system of record keeping for the SAE program.~~

Unit 4: Science of Animals

Competencies and Suggested Objectives
1. Explore the animal-agriculture industry and enterprises. DOK1, ABS, AS, BS a. Associate the different classes of domestic animals with ways that each benefits humanity: • Beef and dairy cattle • Horses • Swine • Poultry • Goats and sheep • Companion animals b. Compare and contrast common production and marketing practices for major animal enterprises. • Distinguish between small scale (niche markets) versus commercial production. c. Compare and contrast the concepts of animal rights and animal welfare as related to agricultural-animal enterprises.
2. Investigate the anatomy and physiology of animals. DOK2, AS, BS a. Diagram the major components of an animal cell and list their functions: • Cell membrane • Mitochondria • Nucleus • Nucleolus • Ribosomes • Rough ER • Smooth ER • Golgi body b. Explain animal growth and reproduction by cell mitosis and meiosis. c. Identify the basic anatomical and physiological features of cows, sheep, swine, goats, horses, and poultry: • Respiration (mammals versus avian) • Digestion (ruminant versus mono-gastric versus avian) • Reproduction (natural versus artificial insemination versus embryo transfer)
3. Describe important elements of animal nutrition. DOK2, AS, BS a. Associate each of the six major classes of nutrients with their roles and functions: • Water • Carbohydrates • Protein • Fats • Vitamins • Minerals

b. Classify and discuss the use of feedstuffs as roughages, concentrates, processed feeds, and by-products.
    - *Roughage examples:* Hay, cottonseed hulls, and silage
    - *Concentrate examples:* Corn, soybeans, and oats
    - *Processed feed examples:* Pelleted feed
    - *By-product examples:* Soybean meal, cotton-seed meal, distillers grains

4. Examine the role of genetics and breeding in animal production. DOK2, AS, BS
    a. Explain basic concepts of heredity and genetics:
        - Punnett squares
        - Homozygous
        - Heterozygous
        - Recessive
        - Dominant
        - Hybrid vigor/heterosis
    b. Describe the processes of selective breeding:
        - Hand mating versus pasture breeding

Unit 5: Science of Plants

Competencies and Suggested Objectives
1. Explore the anatomy and physiology of a plant. DOK1, ABS, BS, PS a. Draw a diagram of a flowering plant. Label and describe the functions of the major parts: • Roots • Stems • Leaves • Flowers b. Compare and contrast the processes of respiration, photosynthesis, and transpiration. c. Examine the process of plant growth to include cell division, cell elongation, and cell differentiation.
2. Investigate common methods of plant reproduction. DOK2, BS, PS a. Analyze the process of seed formation, to include pollination and fertilization. b. Identify the parts of a seed and associate each part with its function: • Seed coat • Endosperm • Cotyledon c. Describe and apply factors essential to seed germination: • Light or lack of light (photoperiod) • Temperature • Moisture • Viable seed • Oxygen d. Identify the five methods of asexual reproduction: • Layering • Budding/grafting • Separation/division • Tissue culture • Cuttings
3. Apply classification methods to plants. DOK2, PS a. Classify plants based on life cycle: • Annual • Perennial • Biennial b. Examine the use of the binomial nomenclature classification system in horticulture (i.e., genus, species, and variety).
4. Apply principles of plant nutrition. DOK2, PS a. Differentiate between the major plant nutrients (macronutrients) and the minor nutrients (micronutrients). b. Classify and explain the function of each of the nonmineral nutrients, primary and secondary macronutrients, and micronutrients in plant growth.

NonMineral Nutrients	Primary Macronutrients	Micronutrients
• Carbon (C) • Hydrogen (H) • Oxygen (O)	• Nitrogen (N) • Phosphorus (P) • Potassium (K) **Secondary Macronutrients** • Calcium (CA) • Magnesium (Mg) • Sulfur (S)	• Boron (B) • Chlorine (Cl) • Copper (Cu) • Iron (Fe) • Manganese (Mn) • Molybdenum (Mo) • Nickel (Ni) • Zinc (Zn)

5. Explore basic concepts of pest management, to include insect damage, weed damage, and diseases. DOK 1, PS
   a. Describe the categories of plant pests (i.e., insects, diseases, weeds, and wildlife), and describe how each type of pest affects production:
      - Insects
        - Siphoning mouthparts
        - Chewing mouthparts
        - Sucking mouthparts
        - Piercing mouthparts
      - Diseases
        - Fungus
        - Viruses
        - Bacteria
      - Weeds
        - Broadleaf
        - Grassy
      - Wildlife
        - Armadillo
        - Wild hog
        - Deer
        - Rabbit
        - Raccoon
   b. Compare and contrast the different components of integrated pest management (IPM) measures:
      - Chemical
      - Mechanical
      - Biological
      - Cultural

Unit 6: Soil Science

Competencies and Suggested Objectives
1. Demonstrate an understanding of the impact of soil as a natural resource. DOK1, NRS a. Define soil and discuss its importance. b. Describe the process of soil formation, including the effects of chemical and physical weathering. c. Classify the texture of a soil utilizing the soil textural triangle: • Sand • Silt • Clay d. Identify the different layers of a typical soil profile, and describe their importance: • O- organic • A- topsoil • B- subsoil • C- parent material • R- bedrock
2. Investigate the use of the land-capability classification system. DOK1, NRS a. Describe the concepts of land-capability classification (I-VIII). b. Identify and describe factors that contribute to land capability: • Slope • Texture • Runoff • Permeability • Erosion
3. Investigate the chemical properties of soils. DOK2, NRS a. Develop a written soil-testing plan for a given field or area. b. Take a soil sample for testing purposes. c. Define soil pH. d. Describe how soil pH affects the productivity of a soil. e. Test a soil for pH and nutritional content, and make recommendations on amendments and fertilizers to be applied.

Unit 7: Agricultural Labs Operations and Safety

Competencies and Suggested Objectives
1. Identify safety procedures and safety devices for the agricultural workplace. DOK1, PST a. Describe procedures for maintaining a clean and safe workplace environment and the use of all protective devices. b. Demonstrate rules for hand/power tools, including basic operation, danger point, observer safety, and electrical safety. c. Explain the relationship between volts, amps, and watts. d. Demonstrate use of the voltmeter, amp meter, pliers, screwdriver, wire cutters, and wire strippers. e. Discuss the causes of electrical accidents, including short circuits, overloads, improper insulation, and presence of moisture. f. Demonstrate procedures for preventing electrical accidents: • Proper tool maintenance • Disconnecting of power when working on circuits (lockout-tag out) • Proper operation of breakers, fuses, ground fault circuit interrupters (GFCI), grounding, and other appropriate safety devices
2. Identify common equipment, tools, and safety procedures, and perform the various welding processes. DOK2, PST a. Identify major types of welders: • Shield metal arc welding (SMAW) • Gas metal arc welding (GMAW) • Gas tungsten arc welding (GTAW) b. Describe and identify different welding supplies used in welding: • Low-hydrogen, mild steel, and alloy welding electrodes • Types of gases involved in the GMAW process: ○ Argon ○ CO_2 ○ Mixed gas (Argon/CO_2) c. Perform welding techniques utilizing the appropriate welding process: • Start, stop, and restart • Pad construction • Flat-butt construction • Beads, fillet (T), lap, corner, and edge (SMAW, GMAW)
3. Apply safety procedures, and perform tasks using oxyacetylene equipment (OAW). DOK2, PST a. Identify and demonstrate parts of the oxyacetylene cutting equipment (safety procedures will be addressed through the oxyacetylene content). b. Identify the different types of oxyacetylene flames and the applications of each, to include neutral, oxidizing, and carburizing. c. Assemble and operate oxyacetylene cutting equipment. Set up equipment for cutting operations, to include selecting the proper tip and setting regulator pressures. d. Discuss oxyacetylene welding (brazing).

Unit 8: Agricultural Small Engine

Competencies and Suggested Objectives
1. Examine the major parts and function of a small engine. DOK 1, PST a. Identify and discuss the fundamentals of the combustion engine, including the difference between two- and four-cycle engines: • Air intake/exhaust • Fuel • Compression • Ignition b. Identify the common systems of a small gasoline engine: • Ignition • Air intake • Lubrication • Power train • Cooling • Exhaust • Fuel systems c. Identify and demonstrate the use of hand tools and diagnostic instruments used in small-engine maintenance and repair.

Unit 9: Orientation/Careers/Leadership

Competencies and Suggested Objectives
1. Review safety rules and behavior. DOK1, CRP, CS a. Identify safety rules and behavior for the classroom. b. Identify safety rules and behavior for the shop and laboratory areas.
2. Investigate and develop skills necessary for pursuing a career in ANR. DOK2, ABS, AS, BS, CRP, CS, ES, FPP, NRS, PS, PST a. Compare the careers available in ANR. b. Build a personal résumé and cover letter for the purpose of applying for jobs. c. Perform a mock interview utilizing a personal resume and cover letter.
3. Develop an individual FFA activity plan. DOK2, ABS, CRP, CS a. Identify FFA activities and programs that contribute to career advancement and individual achievement. b. Select and document FFA activities and programs that contribute to personal development.
4. Develop and present a 3-5 minute multimedia presentation on an ANR topic. DOK2, CRP, CS a. Discuss guidelines for preparing a successful presentation, including preparation, resource development, writing skills, and presentation skills.
5. Maintain SAE records. DOK2, ABS, CRP, CS a. Maintain records as they relate to SAE activities.

Unit 10: Science of the Agricultural Environment

Competencies and Suggested Objectives
1. Examine the relationship of the atmosphere to the earth's environment. DOK1, ES, NRS a. Define *atmosphere*. b. Diagram and describe the layers of the atmosphere: • Troposphere • Stratosphere • Mesosphere • Thermosphere c. Identify the composition of the troposphere: • Nitrogen • Oxygen • Argon • Trace gases
2. Assess air quality and identify sources of agricultural air pollution. DOK1, ES, NRS a. Define air quality and air pollution. b. Describe the major kinds and sources of air pollution: • Equipment • Pesticides • Agricultural waste • Dust/Smoke • Odors c. Identify the effects of air pollution on the ANR industry: • Increased government regulation/restrictions • Reduced agricultural production • Compromised health of livestock and humans • Increased production costs

Unit 11: Water Quality Management

Competencies and Suggested Objectives
1. Explore concepts of water usage and quality. DOK1, ES, NRS a. Describe the nature and states of water: • Liquid • Solid • Gas b. Compare the classifications of water: • Fresh • Salt • Brackish c. Identify important uses of water: • Drinking • Irrigation • Manufacturing • Cooling • Power production d. Identify sources of water: • Rainfall • Ground (aquifers) • Surface (e.g., rivers, lakes, ponds) • Ocean
2. Describe important water-management practices. DOK2, ES, NRS a. Diagram and describe the water cycle. b. Compare natural water bodies of flowing and nonflowing sources: • Ground (aquifers) • Surface (e.g., rivers, lakes) • Ocean c. Identify common causes of water pollution, and distinguish between point and nonpoint sources of pollution: • *Point sources of pollution:* o Crop-field erosion o Confined feeding o Industry • *Nonpoint sources of pollution:* o Agricultural run-off (e.g., pesticides) o Trash o Suburban development d. Monitor the water quality in a selected body of flowing water. e. Describe and analyze the qualities of potable water.
3. Describe how wastewater is treated to maintain water quality. DOK2, ES, NRS a. Identify and describe the sources and types of wastewater:

- ~~Domestic (i.e., grey water and black water)~~
- ~~Industrial~~
- ~~Agricultural~~
- ~~Storm water run-off~~

b. ~~Identify and describe hazards that may be present in water:~~
   - ~~Fecal matter~~
   - ~~E. Coli~~
   - ~~Listeria~~
   - ~~Pesticides~~

c. ~~Describe methods and processes in wastewater treatment:~~
   - ~~Settling ponds~~
   - ~~Chemical treatment~~
   - ~~Aeration~~

Unit 12: Science of Forestry and the Environment

Competencies and Suggested Objectives

1. Examine basic principles of forest dendrology and mensuration. DOK2, ES, NRS, PS
   a. Examine the layered structure of forests and how these layers protect and enhance the ecosystem:
      - Emergent
      - Canopy
      - Understory/Shrub layer
      - Forest floor
   b. Identify locally important tree species by common name, type, physical characteristics, and use:
      - Yellow pine
      - White oak
      - Poplar
      - Sweet gum
      - Cedar
   c. Analyze the growth rate and age of trees by examining the annual rings and accounting for variations in growth rate due to environmental factors.
   d. Demonstrate proper procedures for planting trees.
2. Discuss the relationship of forestry to environmental quality and economic development. DOK2, ABS, ES, NRS, PS
   a. Identify consumer goods derived from forestry:
      - Paper products
      - Lumber and building products
      - Finished products (i.e., consumer goods)
   b. Define biodiversity and describe its relationship to forestry.
   c. Investigate methods for forest fire prevention.
      - Control burns
      - Fire lanes
      - Fire prevention marketing and education
   d. Discuss the different damages caused by forest fires:
      - Loss of habitat
      - Environmental degradation
      - Loss of revenue
      - Property damage and loss
   e. Discuss the methods of reforestation:
      - Natural reseeding
      - Hand or machine planting

Unit 13: Wildlife and the Environment

Competencies and Suggested Objectives
1. Examine the relationships of wildlife well-being and environmental quality. DOK1, ES, NRS a. Identify common wildlife species found in Mississippi, and classify each as terrestrial or aquatic: • Whitetail deer * *(terrestrial) • Raccoon * #(either) • Turkey * ^(aquatic) • Opossum * • Turtle # • Bass ^ • Crappie ^ b. Describe the importance of wildlife to the environment and human well-being. c. Recommend procedures for improving habitat for wildlife: • Food plots • Responsible hunting practices • Observe environmental regulations
2. Explore concepts and practices related to wildlife conservation and management. DOK1, ES, NRS a. Create a diagram illustrating the interrelationships among the soil, plants, animals, and humans (i.e., food web). b. Discuss the concept of a food web.
3. Investigate approaches in protecting and managing wildlife species. DOK2, ES, NRS a. Discuss the need for wildlife protection and conservation policies and how species are lost from the earth. b. Classify wildlife species based on threats to their continued existence: • Endangered • Threatened • Extinct c. Describe practices in conservation, protection, and management of wildlife: • Game laws and limits • Sustainability of the ecosystem • Establishment of wildlife refuges • Natural versus artificial population management d. Research a given species of wildlife to determine habitat and management practices.

Unit 14: Environmental Stewardship

Competencies and Suggested Objectives

1. Discuss concepts of sustainable agriculture. DOK1, ES, NRS
   a. Describe the nature and importance of sustainable agriculture:
      - Renewable resources
      - Nonrenewable resources
   b. Identify and select practices that promote sustainability in agriculture, forestry, and natural resources:

      Crop/Livestock production
      - No till
      - Grass waterways
      - Strip tilling
      - Terraces
      - Cover crops
      - Rotational grazing

      Forestry
      - Select cutting
      - Streamside management zones (SMZs)
      - Land management plan

      Natural resources
      - Water conservation
      - Wildlife conservation
      - Sustainable agriculture
      - Soil conservation

2. Explore the principles and applications of precision-farming operations. DOK2, ES, NRS
   a. Identify components of an agricultural GIS system:
      - Hardware
      - Software
      - Data
      - People
      - Methods
   b. Explore the principles and applications of precision-farming operations:
      - Variable rate/site-specific applications of fertilizer and chemicals

3. Explore the services of agencies and organizations that protect and maintain the environment. DOK1, ES, NRS
   a. Identify and describe the role of government and other agencies concerned with environmental quality and natural resource conservation:
      - Natural Resources Conservation Service (NRCS)
      - United States Department of Agriculture (USDA)
      - Bureau of Land Management
      - Farm Service Agency

4. Use appropriate procedures for management and disposal of solid waste. DOK2, ES, NRS

a. Identify sources of solid waste:
   - Residential
   - Industrial
   - Agricultural

b. Identify common hazards associated with improperly managed wastes:
   - Poor water quality
   - Soil degradation
   - Disease

c. Explain how solid-waste materials should be managed and disposed:
   - Landfills
   - Incineration
   - Recycling
   - Waste-management plan

d. Discuss recycling techniques.

e. Explain the use of residential, agricultural, and industrial composting.

5. Select appropriate procedures for managing hazardous-waste materials. DOK2, ES, NRS

a. Explore the meaning of hazardous waste.

b. Classify hazardous-waste materials:
   - Flammable gases/liquids/solids
   - Toxic
   - Radioactive
   - Corrosive

Unit 15: Construction/Agricultural Equipment Operation and Maintenance

Competencies and Suggested Objectives
1. Inspect, maintain, and repair agricultural equipment. DOK2, PST a. Describe procedures for inspecting the following: • Coolant • Engine oil • Tire pressure • Hydraulic fluid • Gear oil • Air filters b. Perform operation and maintenance checks on agricultural equipment according to manufacturer's specifications. c. Assess parts to repair or replace parts based on manufacturer's specifications and observation. d. Perform maintenance for required parts, reassemble, adjust, and test.
2. Perform reconditioning of agricultural machinery and equipment. DOK2, PST a. Recondition agricultural machinery and equipment.
3. Perform welds with shielded-metal arc welding (SMAW) equipment. DOK2, PST a. Fabricate a single v-groove butt weld in the horizontal position. b. Fabricate a single v-groove butt weld in the vertical up position.
4. Perform welds with gas-metal arc welding (GMAW) equipment. DOK2, PST a. Fabricate a single v-groove butt weld in the horizontal position. b. Fabricate a single v-groove butt weld in the vertical up position.
5. Cut metal with plasma arc cutter. DOK2, PST a. Identify safety rules and practices associated with a plasma arc cutter. b. Perform proper safe operation of plasma cutter.
6. Select and demonstrate proper equipment for a specific construction job, and develop a bill of materials for a specific job. DOK2, ABS, PST a. Estimate materials for a specific task.

~~Unit 16: Agricultural Business Management and Processes~~

~~Competencies and Suggested Objectives~~
~~1. Explore basic principles of agricultural economics and marketing.~~ ~~DOK2, PST~~ ~~a. Describe and contrast the types of business organizations:~~ ~~• Individual~~ ~~• Partnership~~ ~~• Cooperative~~ ~~• Corporation~~ ~~b. Describe the law of supply and demand.~~ ~~c. Differentiate between wholesale and retail marketing.~~
~~2. Discuss principles and practices of an agricultural business.~~ ~~DOK2, PST~~ ~~a. Compare sources of agricultural credit:~~ ~~• Commercial banks~~ ~~• Farm credit cooperatives~~ ~~• Federal government (e.g., Farm Service Agency)~~ ~~b. Discuss the importance of agricultural credit:~~ ~~• Availability~~ ~~• Credit score~~ ~~c. Discuss taxes and insurance as related to agriculture businesses:~~ ~~• Liability, life, medical, and property insurance~~ ~~• Personal income, property taxes, W-2, 1099, 1040EZ~~

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Introduction to ANR		
	1.	Examine the nature of the agriculture and natural resources industry.
	2.	Examine the relationships between the pure sciences, agriculture, and agriscience.
	3.	Apply standard agricultural and natural resources safety practices.
Unit 2: Agricultural Leadership and Career Development		
	1.	Explore the integral relationship between the FFA and agricultural education.
	2.	Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st Century Skills Standards.
	3.	Describe the role of 21st Century Skills, work ethic, and values in establishing and building a successful career.
	4.	Investigate careers associated with the agricultural industry and write a report with details about the career, including:
Unit 3: Introduction to Experiential Learning (SAE)		
	1.	Describe the purposes and requirements of the supervised agricultural experience (SAE) program.
	2.	Develop a personal plan for the SAE program.
	3.	Develop a record-keeping system for an individual student's SAE program.
Unit 4: Science of Animals		
	1.	Explore the animal agriculture industry and enterprises.
	2.	Investigate the anatomy and physiology of animals.
	3.	Describe important elements of animal nutrition.
	4.	Examine the role of genetics and breeding in animal production.
Unit 5: Science of Plants		
	1.	Explore the anatomy and physiology of a plant.
	2.	Investigate common methods of plant reproduction.
	3.	Apply classification methods to plants.
	4.	Apply principles of plant nutrition.

	5.	Explore basic concepts of pest management to include insect damage, weed damage, and diseases.
Unit 6: Soil Science		
	1.	Demonstrate an understanding of the impact of soil as a natural resource.
	2.	Investigate the use of the land capability classification system.
	3.	Investigate the chemical properties of soils.
Unit 7: Agricultural Lab Operations and Safety		
	1.	Identify safety procedures and safety devices for the agricultural workplace.
	2.	Identify common equipment, tools, and safety procedures and perform the various welding processes
	3.	Apply safety procedures and perform tasks using oxyacetylene equipment (OAW).
Unit 8: Agricultural Small Engines		
	1.	Examine the major parts and function of a small engine.
Unit 9: Orientation/Careers/Leadership		
	1.	Review safety rules and behavior.
	2.	Investigate and develop skills necessary for pursuing a career in agriculture and natural resources.
	3.	Develop an individual FFA activity plan.
	4.	Develop and present a 3-5 min multimedia presentation on an agriculture or natural resource topic.
	5.	Maintain Supervised Agricultural Experience records.
Unit 10: Science of the Agricultural Environment		
	1.	Examine the relationship of the atmosphere to the earth's environment.
	2.	Assess air quality and identify sources of agricultural air pollution.
Unit 11: Water Quality Management		
	1.	Explore concepts of water usage and quality.
	2.	Examine the importance of water management practices.
	3.	Describe how wastewater is treated to maintain water quality.
Unit 12: Science of Forestry and the Environment		
	1.	Examine basic principles of forest dendrology and mensuration.
	2	Discuss the relationship of forestry to environmental quality and economic development.
Unit 13: Wildlife and the Environment		
	1.	Examine basic principles of forest dendrology and mensuration.
	2.	Discuss the relationship of forestry to environmental quality and economic development.
	3.	Examine the relationships of wildlife well-being and environmental quality.

~~Unit 14: Environmental Stewardship~~		
	~~1.~~	~~Discuss concepts of sustainable agriculture.~~
	~~2.~~	~~Explore the principles and applications of precision-farming operations.~~
	~~3.~~	~~Explore the services of agencies and organizations that protect and maintain the environment.~~
	~~4.~~	~~Use appropriate procedures for management and disposal of solid waste.~~
	~~5.~~	~~Select appropriate procedures for managing hazardous waste materials.~~
~~Unit 15: Construction/Agricultural Equipment Operation and Maintenance~~		
	~~1.~~	~~Inspect, maintain, and repair agricultural equipment.~~
	~~2.~~	~~Perform reconditioning of agricultural machinery and equipment.~~
	~~3.~~	~~Perform welds with shielded metal arc welding (SMAW) equipment~~
	~~4.~~	~~Perform welds with gas metal arc welding (GMAW) equipment.~~
	~~5.~~	~~Cut metal with plasma arc cutter.~~
	~~6.~~	~~Select and demonstrate proper equipment for a specific construction job and develop a bill of materials for a specific job.~~
~~Unit 16: Agricultural Business Management and Processes~~		
	~~1.~~	~~Explore basic principles of agricultural economics and marketing.~~
	~~2.~~	~~Discuss principles and practices of an agricultural business.~~

Appendix A: Industry Standards

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

AFNR	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
ABS - AGRIBUSINESS SYSTEMS	X	X	X	X	X			
AS - ANIMAL SYSTEMS	X			X				
BS - BIOTECHNOLOGY	X			X	X			
CRP - CAREER READY PRACTICES	X	X	X					
CS – AGRICULTURE, FOOD AND NATURAL RESOURCES CLUSTER SKILL	X	X	X					
ES - ENVIRONMENTAL SERVICE SYSTEMS	X							
FPP - FOOD PRODUCTS AND PROCESSING SYSTEMS	X							
NRS - NATURAL RESOURCE SYSTEMS	X					X		
PS - PLANT SYSTEMS	X				X			
PST - POWER, STRUCTURAL, AND TECHNICAL SYSTEMS	X						X	X
AFNR	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16
ABS - AGRIBUSINESS SYSTEMS	X						X	X
AS - ANIMAL SYSTEMS	X							
BS - BIOTECHNOLOGY	X							
CRP - CAREER READY PRACTICES	X							
CS – AGRICULTURE, FOOD AND NATURAL RESOURCES CLUSTER SKILL	X							
ES - ENVIRONMENTAL SERVICE SYSTEMS	X	X	X	X	X	X		
FPP - FOOD PRODUCTS AND PROCESSING SYSTEMS	X							
NRS - NATURAL RESOURCE SYSTEMS	X	X	X	X	X	X		
PS - PLANT SYSTEMS	X			X				
PST - POWER, STRUCTURAL, AND TECHNICAL SYSTEMS	X						X	

ABS – AGRIBUSINESS SYSTEMS
AS – ANIMAL SYSTEMS
BS – BIOTECHNOLOGY
CRP – CAREER READY PRACTICES
CS – AGRICULTURE FOOD AND NATURAL RESOURCES CLUSTER SKILL
ES – ENVIRONMENTAL SERVICE SYSTEMS

FPP – FOOD PRODUCTS AND PROCESSING SYSTEMS
NRS – NATURAL RESOURCE SYSTEMS
PS – PLANT SYSTEMS
PST – POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

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Agribusiness Systems Career Pathway Content Standards

The Agribusiness Systems (ABS) Career Pathway encompasses the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), and business planning, and sales and marketing. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the planning, development, application and management of agribusiness systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Agribusiness Systems (AG-ABS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ABS.01. CCTC Standard: Apply management planning principles in AFNR businesses.

ABS.01.01. Performance Indicator: Apply micro- and macroeconomic principles to plan and manage inputs and outputs in an AFNR business.

ABS.01.02. Performance Indicator: Read, interpret, evaluate and write statements of purpose to guide business goals, objectives and resource allocation.

ABS.01.03. Performance Indicator: Devise and apply management skills to organize and run an AFNR business in an efficient, legal and ethical manner.

ABS.01.04. Performance Indicator: Evaluate, develop and implement procedures used to recruit, train and retain productive human resources for AFNR businesses.

ABS.02. CCTC Standard: Use record keeping to accomplish AFNR business objectives, manage budgets and comply with laws and regulations.

ABS.02.01. Performance Indicator: Apply fundamental accounting principles, systems, tools and applicable laws and regulations to record, track and audit AFNR business transactions (e.g., accounts, debits, credits, assets, liabilities, equity, etc.).

ABS.02.02. Performance Indicator: Assemble, interpret and analyze financial information and reports to monitor AFNR business performance and support decision-making (e.g., income statements, balance sheets, cash-flow analysis, inventory reports, break-even analysis, return on investment, taxes, etc.).

ABS.03. CCTC Standard: Manage cash budgets, credit budgets and credit for an AFNR business using generally accepted accounting principles.

ABS.03.01. Performance Indicator: Develop, assess and manage cash budgets to achieve AFNR business goals.

ABS.03.02. Performance Indicator: Analyze credit needs and manage credit budgets to achieve AFNR business goals.

ABS.04. CCTC Standard: Develop a business plan for an AFNR business.

ABS.04.01. Performance Indicator: Analyze characteristics and planning requirements associated with developing business plans for different types of AFNR businesses.

ABS.04.02. Performance Indicator: Develop production and operational plans for an AFNR business.

ABS.04.03. Performance Indicator: Identify and apply strategies to manage or mitigate risk.

ABS.05. CCTC Standard: Use sales and marketing principles to accomplish AFNR business objectives.

ABS.05.01. Performance Indicator: Analyze the role of markets, trade, competition and price in relation to an AFNR business sales and marketing plans.

ABS.05.02. Performance Indicator: Assess and apply sales principles and skills to accomplish AFNR business objectives.

ABS.05.03. Performance Indicator: Assess marketing principles and develop marketing plans to accomplish AFNR business objectives.

Animal Systems Career Pathway Content Standards

The Animal Systems (AS) Career Pathway encompasses the study of animal systems, including content areas such as life processes, health, nutrition, genetics, and management and processing, as applied to small animals, Agricultural and Natural Resources, exotic animals, livestock, dairy, horses and/or poultry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of animal systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Animal Systems (AG-AS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and

Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.

- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

AS.01. CCTC Standard: Analyze historic and current trends impacting the animal systems industry.

AS.01.01. Performance Indicator: Evaluate the development and implications of animal origin, domestication and distribution on production practices and the environment.

AS.01.02. Performance Indicator: Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts.

AS.01.03. Performance Indicator: Analyze and apply laws and sustainable practices to animal agriculture from a global perspective.

AS.02. CCTC Standard: Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.

AS.02.01. Performance Indicator: Demonstrate management techniques that ensure animal welfare.

AS.02.02. Performance Indicator: Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system, etc.).

AS.03. CCTC Standard: Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction and/or economic production.

AS.03.01. Performance Indicator: Analyze the nutritional needs of animals.

AS.03.02 Performance Indicator: Analyze feed rations and assess if they meet the nutritional needs of animals.

AS.03.03 Performance Indicator: Utilize industry tools to make animal nutrition decisions.

AS.04. CCTC Standard: Apply principles of animal reproduction to achieve desired outcomes for performance, development and/or economic production.

AS.04.01. Performance Indicator: Evaluate animals for breeding readiness and soundness.

AS.04.02. Performance Indicator: Apply scientific principles to select and care for breeding animals.

AS.04.03 Performance Indicator: Apply scientific principles to breed animals.

AS.05. CCTC Standard: Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.

AS.05.01. Performance Indicator: Design animal housing, equipment and handling facilities for the major systems of animal production.

AS.05.02. Performance Indicator: Comply with government regulations and safety standards for facilities used in animal production.

AS.06. CCTC Standard: Classify, evaluate and select animals based on anatomical and physiological characteristics.

AS.06.01. Performance Indicator: Classify animals according to taxonomic classification systems and use (e.g. agricultural, companion, etc.).

AS.06.02. Performance Indicator: Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.06.03. Performance Indicator: Select and train animals for specific purposes and maximum performance based on anatomy and physiology.

AS.07. CCTC Standard: Apply principles of effective animal health care.

AS.07.01. Performance Indicator: Design programs to prevent animal diseases, parasites and other disorders and ensure animal welfare.

AS.07.02. Performance Indicator: Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level.

AS.08. CCTC Standard: Analyze environmental factors associated with animal production.

AS.08.01. Performance Indicator: Design and implement methods to reduce the effects of animal production on the environment.

AS.08.02. Performance Indicator: Evaluate the effects of environmental conditions on animals and create plans to ensure favorable environments for animals.

Common Career Technical Core Career Ready Practices Content Standards

The CCTC CRPs encompass fundamental skills and practices that all students should acquire to be career ready such as: responsibility, productivity, healthy choices, maintaining personal finances, communication, decision-making, creativity and innovation, critical thinking, problem solving, integrity, ethical leadership, management, career planning, technology use and cultural/global competency. Students completing a program of study in any AFNR career pathway will demonstrate the knowledge, skills and behaviors that are important to career ready through experiences in a variety of settings (e.g., classroom, CTSO, work-based learning, community etc.).

DEFINITIONS: Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for CRPs from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance

indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a CTE program of study.

CRP.01. CCTC Standard: Act as a responsible and contributing citizen and employee.

CRP.01.01. Performance Indicator: Model personal responsibility in the workplace and community.

CRP.01.02 Performance Indicator: Evaluate and consider the near-term and long-term impacts of personal and professional decisions on employers and community before taking action.

CRP.01.03. Performance Indicator: Identify and act upon opportunities for professional and civic service at work and in the community.

CRP.02. CCTC Standard: Apply appropriate academic and technical skills.

CRP.02.01. Performance Indicator: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.

CRP.02.02. Performance Indicator: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.

CRP.03. CCTC Standard: Attend to personal health and financial well-being.

CRP.03.01. Performance Indicator: Design and implement a personal wellness plan.

CRP.03.02. Performance Indicator: Design and implement a personal financial management plan.

CRP.04. CCTC Standard: Communicate clearly, effectively and with reason.

CRP.04.01. Performance Indicator: Speak using strategies that ensure clarity, logic, purpose and professionalism in formal and informal settings.

CRP.04.02. Performance Indicator: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.

CRP.04.03. Performance Indicator: Model active listening strategies when interacting with others in formal and informal settings.

CRP.05. CCTC Standard: Consider the environmental, social and economic impacts of decisions.

CRP.05.01. Performance Indicator: Assess, identify and synthesize the information and resources needed to make decisions that positively impact the workplace and community.

CRP.05.02. Performance Indicator: Make, defend and evaluate decisions at work and in the community using information about the potential environmental, social and economic impacts.

CRP.06. CCTC Standard: Demonstrate creativity and innovation.

CRP.06.01. Performance Indicator: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.

CRP.06.02. Performance Indicator: Assess a variety of workplace and community situations to identify ways to add value and improve the efficiency of processes and procedures.

CRP.06.03. Performance Indicator: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.

CRP.07. CCTC Standard: Employ valid and reliable research strategies.

CRP.07.01. Performance Indicator: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.

CRP.07.02. Performance Indicator: Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community.

CRP.08. CCTC Standard: Utilize critical thinking to make sense of problems and persevere in solving them.

CRP.08.01. Performance Indicator: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.

CRP.08.02. Performance Indicator: Investigate, prioritize and select solutions to solve problems in the workplace and community.

CRP.08.03. Performance Indicator: Establish plans to solve workplace and community problems and execute them with resiliency.

CRP.09. CCTC Standard: Model integrity, ethical leadership and effective management.

CRP.09.01. Performance Indicator: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).

CRP.09.02. Performance Indicator: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).

CRP.09.03. Performance Indicator: Demonstrate behaviors that contribute to a positive morale and culture in the workplace and community (e.g., positively influencing others, effectively communicating, etc.).

CRP.10. CCTC Standard: Plan education and career path aligned to personal goals.

CRP.10.01. Performance Indicator: Identify career opportunities within a career cluster that match personal interests, talents, goals and preferences.

CRP.10.02. Performance Indicator: Examine career advancement requirements (e.g., education, certification, training, etc.) and create goals for continuous growth in a chosen career.

CRP.10.03. Performance Indicator: Develop relationships with and assimilate input and/or advice from experts (e.g., counselors, mentors, etc.) to plan career and personal goals in a chosen career area.

CRP.10.04. Performance Indicator: Identify, prepare, update and improve the tools and skills necessary to pursue a chosen career path.

CRP.11. CCTC Standard: Use technology to enhance productivity.

CRP.11.01. Performance Indicator: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

CRP.11.02. Performance Indicator: Evaluate personal and organizational risks of technology use and take actions to prevent or minimize risks in the workplace and community.

CRP.12. CCTC Standard: Work productively in teams while using cultural/global competence.

CRP.12.01. Performance Indicator: Contribute to team-oriented projects and builds consensus to accomplish results using cultural global competence in the workplace and community.

CRP.12.02. Performance Indicator: Create and implement strategies to engage team members to work toward team and organizational goals in a variety of workplace and community situations (e.g., meetings, presentations, etc.).

Agriculture, Food, and Natural Resources Cluster Skill Content Standards

The AFNR Cluster Skills (CS) encompasses the study of fundamental knowledge and skills related to all AFNR professions. Students completing a program of study in any AFNR career pathway will demonstrate fundamental knowledge of the nature, scope and relationships of AFNR systems and the skills necessary for analysis of current and historical issues and trends; application of technologies; safety, health and environmental practices; stewardship of natural resources; and exploration of career opportunities.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Agriculture, Food and Natural Resources Career Cluster® (AG) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

CS.01. CCTC Standard: Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster.

CS.01.01. Performance Indicator: Research, examine and discuss issues and trends that impact AFNR systems on local, state, national and global levels.

CS.01.02. Performance Indicator: Examine technologies and analyze their impact on AFNR systems.

CS.01.03. Performance Indicator: Identify public policies and examine their impact on AFNR systems.

CS.02. CCTC Standard: Evaluate the nature and scope of the Agriculture, Food & Natural Resources Career Cluster and the role of agriculture, food and natural resources (AFNR) in society and the economy.

- **CS.02.01. Performance Indicator:** Research and use geographic and economic data to solve problems in AFNR systems.
- **CS.02.02. Performance Indicator:** Examine the components of the AFNR systems and assess their impact on the local, state, national and global society and economy.

CS.03. CCTC Standard: Examine and summarize the importance of health, safety and environmental management systems in AFNR workplaces.

- **CS.03.01. Performance Indicator:** Identify and explain the implications of required regulations to maintain and improve safety, health and environmental management systems.
- **CS.03.02. Performance Indicator:** Develop and implement a plan to maintain and improve health, safety and environmental compliance and performance.
- **CS.03.03. Performance Indicator:** Apply health and safety practices to AFNR workplaces.
- **CS.03.04. Performance Indicator:** Use appropriate protective equipment and demonstrate safe and proper use of AFNR tools and equipment.

CS.04. CCTC Standard: Demonstrate stewardship of natural resources in AFNR activities.

- **CS.04.01. Performance Indicator:** Identify and implement practices to steward natural resources in different AFNR systems.
- **CS.04.02. Performance Indicator:** Assess and explain the natural resource related trends, technologies and policies that impact AFNR systems.

CS.05. CCTC Standard: Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources career pathways.

- **CS.05.01. Performance Indicator:** Evaluate and implement the steps and requirements to pursue a career opportunity in each of the AFNR career pathways (e.g., goals, degrees, certifications, resumes, cover letter, portfolios, interviews, etc.).

CS.06. CCTC Standard: Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.

- **CS.06.01. Performance Indicator:** Examine and explain foundational cycles and systems of AFNR.
- **CS.06.02. Performance Indicator:** Analyze and explain the connection and relationships between different AFNR systems on a national and global level.

Biotechnology Systems Career Pathway Content Standards

The Biotechnology Systems (BS) Career Pathway encompasses the study of using data and scientific techniques to solve problems concerning living organisms with an emphasis on applications to agriculture, food and natural resource systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of biotechnology in the context of AFNR.

Within each pathway, the standards are organized as follows:

- ***National Council for Agricultural Education (NCAE) Standard**** – These are the standards set forth by the National Council for Agricultural Education for Biotechnology Systems. They define what students should know and be able to do after completing instruction in a program of study focused on applying biotechnology to AFNR systems.
- ***Performance Indicators*** – These statements distill each performance element into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related performance element at the conclusion of a program of study in this area.

BS.01. NCAE Standard: Assess factors that have influenced the evolution of biotechnology in agriculture (e.g., historical events, societal trends, ethical and legal implications, etc.).

- **BS.01.01. Performance Indicator**: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).
- **BS.01.02. Performance Indicator:** Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).
- **BS.01.03. Performance Indicator:** Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

BS.02. NCAE Standard: Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).

- **BS.02.01. Performance Indicator**: Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.
- **BS.02.02. Performance Indicator:** Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.
- **BS.02.03. Performance Indicator:** Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.
- **BS.02.04. Performance Indicator:** Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

BS.02.05. Performance Indicator: Examine and perform scientific procedures using microbes, DNA, RNA and proteins in a laboratory.

BS.03. NCAE Standard: Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

- **BS.03.01. Performance Indicator:** Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.
- **BS.03.02. Performance Indicator:** Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.
- **BS.03.03. Performance Indicator:** Apply biotechnology principles, techniques and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).
- **BS.03.04. Performance Indicator:** Apply biotechnology principles, techniques and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).
- **BS.03.05. Performance Indicator:** Apply biotechnology principles, techniques and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).
- **BS.03.06. Performance Indicator:** Apply biotechnology principles, techniques and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.).

Environmental Service Systems Career Pathway Content Standards

The Environmental Service Systems (ESS) Career Pathway encompasses the study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of environmental service systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Environmental Service Systems (AG-ESS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ESS.01. CCTC Standard: Use analytical procedures and instruments to manage environmental service systems.

- **ESS.01.01. Performance Indicator:** Analyze and interpret laboratory and field samples in environmental service systems.
- **ESS.01.02. Performance Indicator:** Properly utilize scientific instruments in environmental monitoring situations (e.g., laboratory equipment, environmental monitoring instruments, etc.).

ESS.02. CCTC Standard: Evaluate the impact of public policies and regulations on environmental service system operations.

- **ESS.02.01. Performance Indicator:** Interpret and evaluate the impact of laws, agencies, policies and practices affecting environmental service systems.
- **ESS.02.02. Performance Indicator:** Compare and contrast the impact of current trends on regulation of environmental service systems (e.g., climate change, population growth, international trade, etc.).
- **ESS.02.03. Performance Indicator:** Examine and summarize the impact of public perceptions and social movements on the regulation of environmental service systems.

ESS.03. CCTC Standard: Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.

- **ESS.03.01. Performance Indicator:** Apply meteorology principles to environmental service systems.
- **ESS.03.02. Performance Indicator:** Apply soil science and hydrology principles to environmental service systems.
- **ESS.03.03. Performance Indicator:** Apply chemistry principles to environmental service systems.
- **ESS.03.04. Performance Indicator:** Apply microbiology principles to environmental service systems.
- **ESS.03.05. Performance Indicator:** Apply ecology principles to environmental service systems.

ESS.04. CCTC Standard: Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management and energy conservation).

- **ESS.04.01. Performance Indicator:** Use pollution control measures to maintain a safe facility and environment.
- **ESS.04.02. Performance Indicator:** Manage safe disposal of all categories of solid waste in environmental service systems.
- **ESS.04.03. Performance Indicator:** Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.
- **ESS.04.04. Performance Indicator:** Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

ESS.05. CCTC Standard: Use tools, equipment, machinery and technology common to tasks in environmental service systems.

ESS.05.01. Performance Indicator: Use technological and mathematical tools to map land, facilities and infrastructure for environmental service systems.

ESS.05.02. Performance Indicator: Perform assessments of environmental conditions using equipment, machinery and technology.

Food Products and Processing Systems Career Pathway Content Standards

The Food Products and Processing Systems (FPP) Career Pathway encompasses the study of food safety and sanitation; nutrition, biology, microbiology, chemistry and human behavior in local and global food systems; food selection and processing for storage, distribution and consumption; and the historical and current development of the food industry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of food products and processing systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Food Products and Processing Systems (AG-FPP) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

FPP.01. CCTC Standard: Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.

FPP.01.01. Performance Indicator: Analyze and manage operational and safety procedures in food products and processing facilities.

FPP.01.02. Performance Indicator: Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

FPP.01.03. Performance Indicator: Apply food safety procedures when storing food products to ensure food quality.

FPP.02. CCTC Standard: Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.

FPP.02.01. Performance Indicator: Apply principles of nutrition and biology to develop food products that provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.02.02. Performance Indicator: Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.02.03. Performance Indicator: Apply principles of human behavior to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.03. CCTC Standard: Select and process food products for storage, distribution and consumption.

FPP.03.01. Performance Indicator: Implement selection, evaluation and inspection techniques to ensure safe and quality food products.

FPP.03.02. Performance Indicator: Design and apply techniques of food processing, preservation, packaging and presentation for distribution and consumption of food products.

FPP.03.03. Performance Indicator: Create food distribution plans and procedures to ensure safe delivery of food products.

FPP.04. CCTC Standard: Explain the scope of the food industry and the historical and current developments of food product and processing.

FPP.04.01. Performance Indicator: Examine the scope of the food industry by evaluating local and global policies, trends and customs for food production.

FPP.04.02. Performance Indicator: Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

FPP.04.03. Performance Indicator: Identify and explain the purpose of industry organizations, groups and regulatory agencies that influence the local and global food systems.

Natural Resource Systems Career Pathway Content Standards

The Natural Resource Systems (NRS) Career Pathway encompasses the study of the management, protection, enhancement and improvement of soil, water, wildlife, forests and air as natural resources. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of natural resource systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Natural Resource Systems (AG-NRS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators

is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

NRS.01. CCTC Standard: Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

- **NRS.01.01. Performance Indicator:** Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.
- **NRS.01.02. Performance Indicator:** Classify different types of natural resources in order to enable protection, conservation, enhancement and management in a particular geographical region.
- **NRS.01.03. Performance Indicator:** Apply ecological concepts and principles to atmospheric natural resource systems.
- **NRS.01.04. Performance Indicator:** Apply ecological concepts and principles to aquatic natural resource systems.
- **NRS.01.05. Performance Indicator:** Apply ecological concepts and principles to terrestrial natural resource systems.
- **NRS.01.06. Performance Indicator:** Apply ecological concepts and principles to living organisms in natural resource systems.

NRS.02. CCTC Standard: Analyze the interrelationships between natural resources and humans.

- **NRS.02.01. Performance Indicator:** Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).
- **NRS.02.02. Performance Indicator:** Assess the impact of human activities on the availability of natural resources.
- **NRS.02.03. Performance Indicator**: Analyze how modern perceptions of natural resource management, protection, enhancement and improvement change and develop over time.
- **NRS.02.04. Performance Indicator:** Examine and explain how economics affects the use of natural resources.
- **NRS.02.05. Performance Indicator:** Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

NRS.03. CCTC Standard: Develop plans to ensure sustainable production and processing of natural resources.

- **NRS.03.01. Performance Indicator:** Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).
- **NRS.03.02. Performance Indicator:** Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.

NRS.04. CCTC Standard: Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

NRS.04.01. Performance Indicator: Demonstrate natural resource protection, maintenance, enhancement and improvement techniques.

NRS.04.02. Performance Indicator: Diagnose plant and wildlife diseases and follow protocols to prevent their spread.

NRS.04.03. Performance Indicator: Prevent or manage introduction of ecologically harmful species in a particular region.

NRS.04.04. Performance Indicator: Manage fires in natural resource systems.

Plant Science Systems Career Pathway Content Standards

The Plant Systems (PS) Career Pathway encompasses the study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as wells as growth and cultural practices through the study of crops, turf grass, trees, shrubs and/or ornamental plants. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of plant systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Plant Systems (AG-PS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PS.01. CCTC Standard: Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

PS.01.01. Performance Indicator: Determine the influence of environmental factors on plant growth.

PS.01.02. Performance Indicator: Prepare and manage growing media for use in plant systems.

PS.01.03. Performance Indicator: Develop and implement a fertilization plan for specific plants or crops.

PS.02. CCTC Standard: Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

PS.02.01. Performance Indicator: Classify plants according to taxonomic systems.

PS.02.02. Performance Indicator: Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.02.03. Performance Indicator: Apply knowledge of plant physiology and energy conversion to plant systems.

PS.03. CCTC Standard: Propagate, culture and harvest plants and plant products based on current industry standards.

PS.03.01. Performance Indicator: Demonstrate plant propagation techniques in plant system activities.

PS.03.02. Performance Indicator: Develop and implement a management plan for plant production.

PS.03.03. Performance Indicator: Develop and implement a plan for integrated pest management for plant production.

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

PS.03.05. Performance Indicator: Harvest, handle and store crops according to current industry standards.

PS.04. CCTC Standard: Apply principles of design in plant systems to enhance an environment (e.g. floral, forest landscape, and farm).

PS.04.01. Performance Indicator: Evaluating, identifying and preparing plants to enhance an environment.

PS.04.02. Performance Indicator: Create designs using plants.

Power, Structural and Technical Systems Career Pathway Content Standards

The Power, Structural and Technical Systems (PST) Career Pathway encompasses the study of agricultural equipment, power systems, alternative fuel sources and precision technology, as well as woodworking, metalworking, welding and project planning for agricultural structures. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of power, structural and technical systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Power, Structural and Technical Systems (AG-PST) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PST.01. CCTC Standard: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.

PST.01.01. Performance Indicator: Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural and technical systems.

PST.01.02. Performance Indicator: Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations.

PST.01.03. Performance Indicator: Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen and plasma arc torch, etc.).

PST.02. CCTC Standard: Operate and maintain AFNR mechanical equipment and power systems.

PST.02.01. Performance Indicator: Perform preventative maintenance and scheduled service to maintain equipment, machinery and power units used in AFNR settings.

PST.02.02. Performance Indicator: Operate machinery and equipment while observing all safety precautions in AFNR settings.

PST.03. CCTC Standard: Service and repair AFNR mechanical equipment and power systems.

PST.03.01. Performance Indicator: Troubleshoot, service and repair components of internal combustion engines using manufacturers' guidelines.

PST.03.02. Performance Indicator: Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and/or diagnostic methods.

PST.03.03. Performance Indicator: Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension, etc.).

PST.04. CCTC Standard: Plan, build and maintain AFNR structures.

PST.04.01. Performance Indicator: Create sketches and plans for AFNR structures.

PST.04.02. Performance Indicator: Determine structural requirements, specifications and estimate costs for AFNR structures

PST.04.03. Performance Indicator: Follow architectural and mechanical plans to construct, maintain and/or repair AFNR structures (e.g., material selection, site preparation and/or layout, plumbing, concrete/masonry, etc.).

PST.04.04. Performance Indicator: Apply electrical wiring principles in AFNR structures.

PST.05. CCTC Standard: Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.

PST.05.01. Performance Indicator: Apply computer and other technologies (e.g., robotics, CNC, UAS, etc.) to solve problems and increase the efficiency of AFNR systems.

PST.05.02. Performance Indicator: Prepare and/or use electrical drawings to design, install and troubleshoot electronic control systems in AFNR settings.

PST.05.03. Performance Indicator: Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.

Appendix B: 21st Century Skills[1]

21st Century Crosswalk for Agricultural and Natural Resources											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
21st Century Standards											
CS1			X							X	
CS2			X	X						X	
CS3			X	X						X	
CS4		X	X					X		X	
CS5		X			X	X	X				X
CS6		X	X	X	X	X	X	X	X	X	X
CS7		X	X	X	X	X	X	X	X	X	X
CS8		X	X	X	X	X	X	X	X	X	X
CS9		X	X	X	X	X	X	X	X	X	X
CS10		X	X	X	X	X	X	X	X	X	X
CS11		X	X	X	X	X	X	X	X	X	X
CS12		X	X	X	X	X	X	X	X	X	X
CS13		X	X	X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X	X	X
CS15			X	X	X	X	X	X	X	X	X
CS16		X	X	X	X	X	X	X	X	X	X
		Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16				
CS1											
CS2							X				
CS3											
CS4											
CS5		X	X	X	X						
CS6		X	X	X	X	X	X				
CS7		X	X	X	X	X	X				
CS8		X	X	X	X	X	X				
CS9		X	X	X	X	X	X				
CS10		X	X	X	X	X	X				
CS11		X	X	X	X	X	X				
CS12		X	X	X	X	X	X				
CS13		X	X	X	X	X	X				
CS14		X	X	X	X	X	X				
CS15		X	X	X	X	X	X				
CS16		X	X	X	X	X	X				

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

[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

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 toward 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 C: College and Career Ready Standards

English Standards											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
RL.9.1											
RL.9.2											
RL.9.3											
RL.9.4											
RL.9.5											
RL.9.6											
RL.9.7											
RL.9.8											
RL.9.9											
RL.9.10											
RL.9.10											
RI.9.3											
RI.9.5											
RI.9.6											
RI.9.7											
RI.9.8											
RI.9.9											
W.9.1		X	X		X	X	X	X	X	X	X
W.9.2		X	X		X	X	X	X	X	X	X
W.9.3											
W.9.4		X	X		X	X	X	X	X	X	X
W.9.5											
W.9.6		X	X		X	X	X	X	X	X	X
W.9.7											
W.9.8		X	X		X	X	X	X	X	X	X
W.9.9		X	X		X	X	X	X	X	X	X
W.9.10		X	X		X	X	X	X	X	X	X
SL.9.1		X	X		X	X	X	X	X	X	X
SL.9.2		X	X		X	X	X	X	X	X	X
SL.9.3		X	X		X	X	X	X	X	X	X
SL.9.4		X	X		X	X	X	X	X	X	X
SL.9.5		X	X		X	X	X	X	X	X	X
SL.9.6		X	X		X	X	X	X	X	X	X
L.9.1		X	X		X	X	X	X	X	X	X
L.9.2		X	X		X	X	X	X	X	X	X
L.9.3											
L.9.4		X	X		X	X	X	X	X	X	X
L.9.5											
L.9.6		X	X		X	X	X	X	X	X	X
RL.10.10											
RH.9-10.1											
RH.9-10.2											
RH.9-10.3											
RH.9-10.4											
RH.9-10.5											
RH.9-10.6											
RH.9-10.7		X	X		X	X	X	X	X	X	X
RH.9-10.8											
RH.9-10.9											
RH.9-10.10											
RST.9-10.1		X	X		X	X	X	X	X	X	X
RST.9-10.2		X	X		X	X	X	X	X	X	X
RST.9-10.3		X	X		X	X	X	X	X	X	X
RST.9-10.4		X	X		X	X	X	X	X	X	X

RST.9-10.5		X	X	X	X	X	X	X	X	X	X
RST.9-10.6		X	X	X	X	X	X	X	X	X	X
RST.9-10.7		X	X	X	X	X	X	X	X	X	X
RST.9-10.8		X	X	X	X	X	X	X	X	X	X
RST.9-10.9		X	X	X	X	X	X	X	X	X	X
RST.9-10.10		X	X	X	X	X	X	X	X	X	X
WHST.9-10.1		X	X	X	X	X	X	X	X	X	X
WHST.9-10.2		X	X	X	X	X	X	X	X	X	X
WHST.9-10.3		X	X	X	X	X	X	X	X	X	X
WHST.9-10.4		X	X	X	X	X	X	X	X	X	X
WHST.9-10.5		X	X	X	X	X	X	X	X	X	X
WHST.9-10.6		X	X	X	X	X	X	X	X	X	X
WHST.9-10.7		X	X	X	X	X	X	X	X	X	X
WHST.9-10.8		X	X	X	X	X	X	X	X	X	X
WHST.9-10.9		X	X	X	X	X	X	X	X	X	X
WHST.9-10.10		X	X	X	X	X	X	X	X	X	X
RL.11.1											
RL.11.2											
RL.11.3											
RL.11.4											
RL.11.5											
RL.11.6											
RL.11.7											
RL.11.8											
RL.11.9											
RL.11.10											
RI.11.3											
RI.11.4											
RI.11.5											
RI.11.6											
RI.11.7											
RI.11.8											
RI.11.9											
RI.11.10											
W.11.1											
W.11.2											
W.11.3											
W.11.4											
W.11.5											
W.11.6											
W.11.7											
W.11.8											
W.11.9											
W.11.10											
SL.11.1		X	X	X	X	X	X	X	X	X	X
SL.11.2		X	X	X	X	X	X	X	X	X	X
SL.11.3		X	X	X	X	X	X	X	X	X	X
SL.11.4		X	X	X	X	X	X	X	X	X	X
SL.11.5		X	X	X	X	X	X	X	X	X	X
SL.11.6		X	X	X	X	X	X	X	X	X	X
L.11.1											
L.11.2											
L.11.3											
L.11.4											
RL.12.10											
RH.11-12.1											
RH.11-12.2											
RH.11-12.3											
RH.11-12.4											
RH.11-12.5											
RH.11-12.6											
RH.11-12.7											
RH.11-12.8											
RH.11-12.9											
RH.11-12.10											

~~RST.11-12.1~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.2~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.3~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.4~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.5~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.6~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.7~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.8~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.9~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~RST.11-12.10~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~WHST.11-12.1~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~WHST.11-12.2~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~WHST.11-12.6~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~WHST.11-12.8~~		~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~

English Standards											
	Units	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16				
RL.9.1											
RL.9.2											
RL.9.3											
RL.9.4											
RL.9.5											
RL.9.6											
RL.9.7											
RL.9.8											
RL.9.9											
RL.9.10											
RL.9.10											
RI.9.3											
RI.9.5											
RI.9.6											
RI.9.7											
RI.9.8											
RI.9.9											
W.9.1		X	X		X	X	X				
W.9.2		X	X		X	X	X				
W.9.3											
W.9.4		X	X		X	X	X				
W.9.5											
W.9.6		X	X		X	X	X				
W.9.7											
W.9.8		X	X		X	X	X				
W.9.9		X	X		X	X	X				
W.9.10		X	X		X	X	X				
SL.9.1		X	X		X	X	X				
SL.9.2		X	X		X	X	X				
SL.9.3		X	X		X	X	X				
SL.9.4		X	X		X	X	X				
SL.9.5		X	X		X	X	X				
SL.9.6		X	X		X	X	X				
L.9.1		X	X		X	X	X				
L.9.2		X	X		X	X	X				
L.9.3											
L.9.4		X	X		X	X	X				
L.9.5											
L.9.6		X	X		X	X	X				
RL.10.10											
RH.9-10.1											
RH.9-10.2											
RH.9-10.3											
RH.9-10.4											
RH.9-10.5											
RH.9-10.6											
RH.9-10.7		X	X		X	X	X				
RH.9-10.8											
RH.9-10.9											
RH.9-10.10											
RST.9-10.1		X	X		X	X	X				
RST.9-10.2		X	X		X	X	X				
RST.9-10.3		X	X		X	X	X				
RST.9-10.4		X	X		X	X	X				

RST.9-10.5		X	X	X	X	X	X				
RST.9-10.6		X	X	X	X	X	X				
RST.9-10.7		X	X	X	X	X	X				
RST.9-10.8		X	X	X	X	X	X				
RST.9-10.9		X	X	X	X	X	X				
RST.9-10.10		X	X	X	X	X	X				
WHST.9-10.1		X	X	X	X	X	X				
WHST.9-10.2		X	X	X	X	X	X				
WHST.9-10.3		X	X	X	X	X	X				
WHST.9-10.4		X	X	X	X	X	X				
WHST.9-10.5		X	X	X	X	X	X				
WHST.9-10.6		X	X	X	X	X	X				
WHST.9-10.7		X	X	X	X	X	X				
WHST.9-10.8		X	X	X	X	X	X				
WHST.9-10.9		X	X	X	X	X	X				
WHST.9-10.10		X	X	X	X	X	X				
RL.11.1											
RL.11.2											
RL.11.3											
RL.11.4											
RL.11.5											
RL.11.6											
RL.11.7											
RL.11.8											
RL.11.9											
RL.11.10											
RI.11.3											
RI.11.4											
RI.11.5											
RI.11.6											
RI.11.7											
RI.11.8											
RI.11.9											
RI.11.10											
W.11.1											
W.11.2											
W.11.3											
W.11.4											
W.11.5											
W.11.6											
W.11.7											
W.11.8											
W.11.9											
W.11.10											
SL.11.1		X	X	X	X	X	X				
SL.11.2		X	X	X	X	X	X				
SL.11.3		X	X	X	X	X	X				
SL.11.4		X	X	X	X	X	X				
SL.11.5		X	X	X	X	X	X				
SL.11.6		X	X	X	X	X	X				
L.11.1											
L.11.2											
L.11.3											
L.11.4											
RL.12.10											
RH.11-12.1											
RH.11-12.2											
RH.11-12.3											
RH.11-12.4											
RH.11-12.5											
RH.11-12.6											
RH.11-12.7											
RH.11-12.8											
RH.11-12.9											
RH.11-12.10											

RST.11-12.1		X	X	X	X	X	X				
RST.11-12.2		X	X	X	X	X	X				
RST.11-12.3		X	X	X	X	X	X				
RST.11-12.4		X	X	X	X	X	X				
RST.11-12.5		X	X	X	X	X	X				
RST.11-12.6		X	X	X	X	X	X				
RST.11-12.7		X	X	X	X	X	X				
RST.11-12.8		X	X	X	X	X	X				
RST.11-12.9		X	X	X	X	X	X				
RST.11-12.10		X	X	X	X	X	X				
WHST.11-12.1		X	X	X	X	X	X				
WHST.11-12.2		X	X	X	X	X	X				
WHST.11-12.6		X	X	X	X	X	X				
WHST.11-12.8		X	X	X	X	X	X				

College and Career Ready English I

Reading Literature Key Ideas and Details

RL.9.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RL.9.2 Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.

RL.9.3 Analyze how complex characters (e.g., those with multiple or conflicting motivations) develop over the course of a text, interact with other characters, and advance the plot or develop the theme.

Craft and Structure

RL.9.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).

RL.9.5 Analyze how an author's choices concerning how to structure a text, order events within it (e.g., parallel plots), and manipulate time (e.g., pacing, flashbacks) create such effects as mystery, tension, or surprise.

RL.9.6 Analyze a particular point of view or cultural experience reflected in a work of literature from outside the United States, drawing on a wide reading of world literature.

Integration of Knowledge and Ideas

RL.9.7 Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment (e.g., Auden's "Musée des Beaux Arts" and Breughel's Landscape with the Fall of Icarus).

RL.9.8 Not applicable to literature.

College and Career Ready English I

RL.9.9 Analyze how an author draws on and transforms source material in a specific work (e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare).

Range of Reading and Level of Text Complexity

RL.9.10 By the end of grade 9, read and comprehend literature, including stories, dramas, and poems, in the grades 9-10 text complexity band proficiently, with scaffolding as needed at the high end of the range.

College and Career Ready English I

Reading Informational Text Key Ideas and Details

RI.9.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.

~~Craft and Structure~~

~~RI.9.5 Analyze in detail how an author's ideas or claims are developed and refined by particular sentences, paragraphs, or larger portions of a text (e.g., a section or chapter).~~

~~RI.9.6 Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.~~

~~Integration of Knowledge and Ideas~~

~~RI.9.7 Analyze various accounts of a subject told in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.~~

~~RI.9.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.~~

~~RI.9.9 Analyze seminal U.S. documents of historical and literary significance (e.g., Washington's Farewell Address, the Gettysburg Address, Roosevelt's Four Freedoms speech, King's "Letter from Birmingham Jail"), including how they address related themes and concepts.~~

~~College and Career Ready English I~~

~~Writing Text Types and Purposes~~

~~W.9.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.~~

~~W.9.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.~~

~~W.9.1b Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.~~

~~W.9.1c Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.~~

~~W.9.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.~~

~~W.9.1e Provide a concluding statement or section that follows from and supports the argument presented.~~

~~W.9.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.~~

~~W.9.2a Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.~~

~~W.9.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.~~

~~W.9.2c Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.~~

~~College and Career Ready English I~~

~~W.9.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic.~~

~~W.9.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.~~

~~W.9.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).~~

~~W.9.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.~~

~~W.9.3a Engage and orient the reader by setting out a problem, situation, or observation, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.~~

~~W.9.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.~~

~~W.9.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole.~~

~~W.9.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.~~

W.9.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.9.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.9.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10.)

W.9.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

W.9.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

College and Career Ready English I

W.9.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

W.9.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

W.9.9a Apply grades 9–10 Reading standards to literature (e.g., "Analyze how an author draws on and transforms source material in a specific work [e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare]").

W.9.9b Apply grades 9–10 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning").

Range of Writing

W.9.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audience.

College and Career Ready English I

SL.9.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SL.9.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

SL.9.1b Work with peers to set rules for collegial discussions and decision making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.

SL.9.1c Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.

SL.9.1d Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

SL.9.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

SL.9.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.

Presentation of Knowledge and Ideas

SL.9.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

College and Career Ready English I

SL.9.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.9.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grades 9–10 Language standards 1 and 3 for specific expectations.)

College and Career Ready English I

Language

Conventions of Standard English

L.9.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

L.9.1a Use parallel structure.*

L.9.1b Use various types of phrases (noun, verb, adjectival, adverbial, participial, prepositional, absolute) and clauses (independent, dependent; noun, relative, adverbial) to convey specific meanings and add variety and interest to writing or presentations.

L.9.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

L.9.2a Use a semicolon (and perhaps a conjunctive adverb) to link two or more closely related independent clauses.

L.9.2b Use a colon to introduce a list or quotation.

L.9.2c Spell correctly

Knowledge of Language

L.9.3 Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening

L.9.3a Write and edit work so that it conforms to the guidelines in a style manual (e.g., MLA Handbook, Turabian's Manual for Writers) appropriate for the discipline and writing type.

Vocabulary Acquisition and Use

L.9.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies.

L.9.4a Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

L.9.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., analyze, analysis, analytical; advocate, advocacy).

College and Career Ready English I

L.9.4c Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology.

L.9.4d Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.9.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

L.9.5a Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.

L.9.5b Analyze nuances in the meaning of words with similar denotations.

L.9.6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

College and Career Ready English II

Range of Reading and Level of Text Complexity

RL.10.10 By the end of grade 10, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Literacy in History/SS

Reading in History/Social Studies Key Ideas and Details

RH.9-10.1 Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

RH.9-10.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.

RH.9-10.3 Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.

Craft and Structure

RH.9-10.4 Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

RH.9-10.5 Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.

RH.9-10.6 Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.

Integration of Knowledge and Ideas

RH.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.

RH.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claims.

RH.9-10.9 Compare and contrast treatments of the same topic in several primary and secondary sources.

Range of Reading and Level of Text Complexity

RH.9-10.10 By the end of grade 10, read and comprehend history/social studies texts in the grades 9-10 text complexity band independently and proficiently.

Grades 9-10: Literacy in Science and Technical Subjects

Reading in Science and Technical Subjects Key Ideas and Details

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

RST.9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts

Range of Reading and Level of Text Complexity

RST.9-10.10 By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Grades 9-10: Writing in History/SS, Science, and Technical Subjects

Writing Text Types and Purposes

WHST.9-10.1 Write arguments focused on discipline-specific content.

WHST.9-10.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

WHST.9-10.1c Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e Provide a concluding statement or section that follows from or supports the argument presented.

WHST.9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.9-10.2b Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects

WHST.9-10.2c Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST.9-10.3 Not Applicable

Production and Distribution of Writing

WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Grades 9-10

Writing in History/SS, Science, and Technical Subjects

Range of Writing

WHST.9-10.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

English III

Reading Literature Key Ideas and Details

RL.11.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2 Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3 Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4 Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5 Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6 Analyze a case in which grasping a point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7 Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8 Not applicable to literature.

RL.11.9 Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10 By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III

Reading Informational Text Key Ideas and Details

RI.11.3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RI.11.5 Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

RI.11.6 Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RI.11.8 Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

RI.11.9 Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including Them Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

English III

Writing

W.11.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.11.1a Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

W.11.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

W.11.1c Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

W.11.1d Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

W.11.1e Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

W.11.2a Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

English III

W.11.2b Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

W.11.2c Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

W.11.2d Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.
W.11.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
W.11.2f Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
W.11.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W.11.3a Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.
W.11.3b Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.
W.11.3c Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).
W.11.3d Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
W.11.3e Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

English III

W.11.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12.)
W.11.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
W.11.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
W.11.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
W.11.9a Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").
W.11.9b Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

English III
Speaking and Listening

Comprehension and Collaboration

SL.11.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SL11.1a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

SL.11.1b Work with peers to promote civil, democratic discussions and decision making, set clear goals and deadlines, and establish individual roles as needed.

SL.11.1c Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

SL.11.1d Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4 Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

English III

SL11.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 for specific expectations.)

English III

Language

Conventions of Standard English

L.11.1a Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

L.11.1b Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2a Observe hyphenation conventions.

L.11.3a Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

L.11.4b Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

English IV

Range of Reading and Level of Text Complexity

RL.12.10 By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in History/SS

Reading in History/Social Studies Key Ideas and Details

RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.

RH.11-12.3 Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain. Craft and Structure

RH.11-12.4 Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11-12.5 Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11-12.6 Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence. Integration of Knowledge and Ideas

Rh.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11-12.8 Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11-12.9 Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources. Range of Reading and Level of Text Complexity

RH.11-12.10 By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Grades 11-12: Literacy in Science and Technical Subjects

Reading in Science and Technical Subjects Key Ideas and Details

RST. 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11-12.10 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Grades 11-12: Writing I History/SS, Science and Technical Subjects

Writing

Text Types and Purposes

WHST.11-12.1a Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

WHST.11-12.1b Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

WHST.11-12.1c Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Grades 11-12: Writing I History/SS, Science and Technical Subjects

WHST.11-12.2d Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

Production and Distribution of Writing

WHST.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Appendix C: College and Career Ready Standards

Mathematics Standards											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
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~~Number and Quantity~~

~~Reason quantitatively and use unites to solve problems~~

~~N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*~~

~~N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*~~

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Analyze and solve linear equations and pairs of simultaneous linear equations

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)n$ as the product of P and a factor not depending on P.

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression $1.15t$ can be rewritten as $[1.151/12]\ 12t \approx 1.01212t$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Creating equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Define, evaluate, and compare functions

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 1

8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

8.F.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

Use functions to model relationships between quantities

8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* Analyze functions using different representations Supporting

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.* Interpret expressions for functions in terms of the situation they model Supporting

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Geometry

Understand and apply the Pythagorean Theorem

8.G.6 Explain a proof of the Pythagorean Theorem and its converse.

8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Statistics and Probability

Investigate patterns of association in bivariate data

8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Algebra I

Number and Quantity

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*
N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra

Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.
A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2 thus recognizing it as a difference of squares that can be factored as (x2 − y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
a. Factor a quadratic expression to reveal the zeros of the function it defines.
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra I

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Understand the relationship between zeros and factors of polynomials

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p) 2 = q that has the same solutions. Derive the quadratic formula from this form.
b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra I

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n–1) for n ≥ 1

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*
F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*
F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Algebra I

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. B

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Algebra I

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Statistics and Probability *

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*
S-ID.9 Distinguish between correlation and causation.*

Geometry Course
Geometry
Experiment with transformations in the plane
G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions
G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems
G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.
G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.
G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Geometry Course
Make geometric constructions
G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand similarity in terms of similarity transformations
G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:
a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.
G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar
G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.
G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section A

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.
G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.
G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Algebra II

Number and Quantity

Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.

N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.

N-CN.2 Use the relation i 2 = −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 − y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Algebra II

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x − a is p(a), so p(a) = 0 if and only if (x − a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 − y 2) 2 + (2xy) 2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable. b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Algebra II

Solve systems of equations

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x2 + y2 = 3.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Functions

Understand the concept of a function and use function notation

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Algebra II

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)t$, $y = (0.97)t$, $y = (1.01)12t$, $y = (1.2)t/10$, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.4 For exponential models, express as a logarithm the solution to $abct = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Algebra II

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity $\sin(\Theta)^2 + \cos(\Theta)^2 = 1$ and use it to find $\sin(\Theta)$, $\cos(\Theta)$, or $\tan(\Theta)$, given $\sin(\Theta)$, $\cos(\Theta)$, or $\tan(\Theta)$ and the quadrant of the angle.

Geometry

Translate between the geometric description and the equation for a conic section

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Statistics and Probability

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

Algebra II

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.*

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics
Number and Quantity
Reason quantitatively and use units to solve problems

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*
N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

Algebra
Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.*
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as [1.151/12] 12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Integrated Mathematics I
Solve equations and inequalities in one variable

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Understand the concept of a function and use function notation

F-IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

Integrated Mathematics I

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.* a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.*

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F-LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

Interpret expressions for functions in terms of the situation they model

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

Integrated Mathematics I

Geometry

Experiment with transformations in the plane

G-CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Integrated Mathematics I

Statistics and Probability

Summarize, represent, and interpret data on a single count or measurement variable

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.*

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*
S-ID.9 Distinguish between correlation and causation.*

Integrated Mathematics I
Number and Quantity
Extend the properties of exponents to rational exponents

N-RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [51/3] 3 = 5(1/3) 3 to hold, so [51/3] 3 must equal 5.
N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Use properties of rational and irrational numbers

N-RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Perform arithmetic operations with complex numbers

N-CN.1 Know there is a complex number i such that i 2 = −1, and every complex number has the form a + bi with a and b real.
N-CN.2 Use the relation i 2 = −1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Use complex numbers in polynomial identities and equations

N-CN.7 Solve quadratic equations with real coefficients that have complex solutions.

Algebra
Interpret the structure of expressions

A-SSE.1 Interpret expressions that represent a quantity in terms of its context.* b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

Integrated Mathematics II

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2, thus recognizing it as a difference of squares that can be factored as (x2 − y 2) (x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
a. Factor a quadratic expression to reveal the zeros of the function it defines.
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Perform arithmetic operations on polynomials

A-APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.*

Understand solving equations as a process of reasoning and explain the reasoning M

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

A-REI.4 Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x − p) 2 = q that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

Solve systems of equations

A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x2 + y2 = 3.

Functions

Interpret functions that arise in applications in terms of the context M

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t , y = (0.97)t , y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth and decay.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Integrated Mathematics II

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Geometry

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:

a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems using similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

Integrated Mathematics II

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Statistics and Probability*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand independence and conditional probability and use them to interpret data

S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").*

S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*

S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*

S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Integrated Mathematics II

Use the rules of probability to compute probabilities of compound events in a uniform probability model

S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.*

S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) − P(A and B), and interpret the answer in terms of the model.*

Integrated Mathematics III

Number and Quantity

Reason quantitatively and use units to solve problems

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

Algebra

Interpret the structure of expressions

A-SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see x4 − y 4 as (x2) 2 − (y2) 2 , thus recognizing it as a difference of squares that can be factored as (x2 − y 2)(x2 + y2).

Write expressions in equivalent forms to solve problems

A-SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.*

Understand the relationship between zeros and factors of polynomials

A-APR.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x − a is p(a), so p(a) = 0 if and only if (x − a) is a factor of p(x).

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Use polynomial identities to solve problems

A-APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 − y 2) 2 + (2xy)2 can be used to generate Pythagorean triples.

Rewrite rational expressions

A-APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

Integrated Mathematics III

Create equations that describe numbers or relationships

A-CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

Understand solving equations as a process of reasoning and explain the reasoning

A-REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*

Interpret functions that arise in applications in terms of the context

F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Build new functions from existing functions

F-BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4 Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2x3 or f(x) = (x+1)/(x-1) for $x \neq 1$.

Construct and compare linear, quadratic, and exponential models and solve problems

F-LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

Extend the domain of trigonometric functions using the unit circle

F-TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Model periodic phenomena with trigonometric functions

F-TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

Prove and apply trigonometric identities

F-TF.8 Prove the Pythagorean identity sin (Θ)2 + cos (Θ)2 = 1 and use it to find sin (Θ), cos (Θ), or tan (Θ), given sin (Θ), cos (Θ), or tan (Θ) and the quadrant of the angle.

Integrated Mathematics III

Geometry

Make geometric constructions

G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar.

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Translate between the geometric description and the equation for a conic section

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2 Derive the equation of a parabola given a focus and directrix.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

Integrated Mathematics III

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics and Probability*

Summarize, represent, and interpret data on a single count or measurement variable S

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

b. Informally assess the fit of a function by plotting and analyzing residuals.

Understand and evaluate random processes underlying statistical experiments

S-IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Integrated Mathematics III

S-IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

S-IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

S-IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.*

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*

S-IC.6 Evaluate reports based on data.*

Advanced Mathematics Plus

Number and Quantity

Perform arithmetic operations with complex numbers

N-CN.3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane

N-CN.4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1+\sqrt{3}\,i)^3 = 8$ because $(-1+\sqrt{3}\,i)$ has modulus 2 and argument 120°.

N-CN.6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations

N-CN.8 Extend polynomial identities to the complex numbers. For example, rewrite $x2 + 4$ as $(x + 2i)(x - 2i)$.

N-CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials

Represent and model with vector quantities

N-VM.1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).

N-VM.2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3 Solve problems involving velocity and other quantities that can be represented by vectors.

Advanced Mathematics Plus

Perform operations on vectors

N-VM.4 Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N-VM.5 Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(vx, vy) = (cvx, cvy)$.

b. Compute the magnitude of a scalar multiple cv using $||cv|| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

Perform operations on matrices and use matrices in applications

N-VM.6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8 Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.

N-VM.10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12 Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Use polynomial identities to solve problems

A-APR.5 Know and apply the Binomial Theorem for the expansion of (x + y) n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

Advanced Mathematics Plus

Rewrite rational expressions

A-APR.7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Solve systems of equations

A-REI.8 Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9 Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

Functions

Analyze functions using different representations

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Build a function that models a relationship between two quantities

F-BF.1 Write a function that describes a relationship between two quantities. *

c. Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

Build new functions from existing functions

F-BF.4 Find inverse functions.

b. Verify by composition that one function is the inverse of another.

c. Read values of an inverse function from a graph or a table, given that the function has an inverse.

d. Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Advanced Mathematics Plus

Extend the domain of trigonometric functions using the unit circle

F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π − x, π+x, and 2π − x in terms of their values for x, where x is any real number.

F-TF.4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions

F-TF.6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. *

Prove and apply trigonometric identities

F-TF.9 Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Apply trigonometry to general triangles

G-SRT.9 Derive the formula A = ½ ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
G-SRT.10 Prove the Laws of Sines and Cosines and use them to solve problems.
G-SRT.11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Understand and apply theorems about circles
G-C.4 Construct a tangent line from a point outside a given circle to the circle.

Translate between the geometric description and the equation for a conic section
Advanced Mathematics Plus
G-GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Explain volume formulas and use them to solve problems
G-GMD.2 Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

Statistics and Probability*
Use the rules of probability to compute probabilities of compound events in a uniform probability model
S-CP.8 Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.*
S-CP.9 Use permutations and combinations to compute probabilities of compound events and solve problems.*

Calculate expected values and use them to solve problems
S-MD.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.*
S-MD.2 Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.*
S-MD.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*
S-MD.4 Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*

Advanced Mathematics Plus
Use probability to evaluate outcomes of decisions
S-MD.5 Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. *
a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.
b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*
S-MD.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*
S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*

Appendix D: International Society for Technology in Education Standards (ISTE)

ISTE Crosswalk for Agricultural and Natural Resources											
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
ISTE Standards											
T1		X	X	X	X	X	X	X	X	X	X
T2		X	X	X	X	X	X	X	X	X	X
T3		X	X	X	X	X	X	X	X	X	X
T4		X	X	X	X	X	X	X	X	X	X
T5		X	X	X	X	X	X	X	X	X	X
T6		X	X	X	X	X	X	X	X	X	X
	Course	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16				
ISTE Standards											
T1		X	X	X	X	X	X				
T2		X	X	X	X	X	X				
T3		X	X	X	X	X	X				
T4		X	X	X	X	X	X				
T5		X	X	X	X	X	X				
T6		X	X	X	X	X	X				

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.

Appendix E: Academic Standards

2018 MS College and Career Readiness Standards for Science: Agricultural and Natural Resources											
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
MS CCR Standards for Science											
BIO.1					X	X					
BIO.2											
BIO.3					X	X					
BIO.4					X	X					X
BIO.5					X	X					X
BOT.1						X					
BOT.2						X					
BOT.3						X					
BOT.4						X					
BOT.5						X					
BOT.6						X					
CHE.1											
CHE.2											
CHE.3											
CHE.4											
CHE.5											
CHE.6											
CHE.7											
CHE.8											
CHE.9											
CHE.10											
CHE.11											
CHE.12											
ESS.1											X
ESS.2							X				X
ESS.3						X					X

ESS.4						X	X				X
ENV.1					X	X					X
ENV.2					X	X	X				X
ENV.3					X	X	X				X
ENV.4					X	X	X				X
FB.1					X						
FB.2					X	X					
FB.3					X						
FB.4					X						
FB.5					X						
FB.6					X	X	X				X
FSL.1		X			X	X					X
FSL.2		X			X	X					X
FSL.3		X			X	X					X
GEN.1					X	X					
GEN.2											
GEN.3					X						
GEN.4					X						
GEN.5											
HAP.1											
HAP.2											
HAP.3											
HAP.4											
HAP.5											
HAP.6											
HAP.7											
HAP.8											
HAP.9											
HAP.10											
HAP.11											
HAP.12											
HAP.13											
HAP.14											

~~MAQ.1~~											
~~MAQ.2~~											
~~MAQ.3~~											
~~MAQ.4~~											
~~MAQ.5~~											
~~MAQ.6~~											
~~MAQ.7~~											
~~PHS.1~~						~~X~~					
~~PHS.2~~											
~~PHS.3~~						~~X~~					
~~PHS.4~~											
~~PHS.5~~											
~~PHS.6~~											
~~PHS.7~~											
~~PHS.8~~											
~~PHS.9~~								~~X~~			
~~PHY.1~~											
~~PHY.2~~											
~~PHY.3~~											
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~~PHY.5~~								~~X~~			
~~PHY.6~~											
~~ZOO.1~~						~~X~~					
~~ZOO.2~~											
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~~ZOO.7~~											
~~ZOO.8~~											
~~ZOO.9~~						~~X~~					
~~ZOO.10~~						~~X~~					

2018 MS College and Career Readiness Standards for Science: Agricultural and Natural Resources											
	Course	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16				
MS-CCR Standards for Science											
BIO.1											
BIO.2											
BIO.3											
BIO.4				X							
BIO.5		X	X	X	X						
BOT.1			X								
BOT.2			X								
BOT.3											
BOT.4			X								
BOT.5			X								
BOT.6			X								
CHE.1											
CHE.2											
CHE.3											
CHE.4											
CHE.5											
CHE.6											
CHE.7											
CHE.8											
CHE.9											
CHE.10											
CHE.11											
CHE.12											
ESS.1											
ESS.2		X	X	X	X						
ESS.3		X	X	X	X						

~~ESS.4~~		~~X~~		~~X~~	~~X~~							
~~ENV.1~~		~~X~~		~~X~~	~~X~~							
~~ENV.2~~		~~X~~		~~X~~	~~X~~							
~~ENV.3~~		~~X~~		~~X~~	~~X~~							
~~ENV.4~~		~~X~~		~~X~~	~~X~~							
~~FB.1~~												
~~FB.2~~		~~X~~										
~~FB.3~~												
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~~FB.5~~				~~X~~								
~~FB.6~~		~~X~~		~~X~~	~~X~~							
~~ENV.1~~		~~X~~		~~X~~	~~X~~							
~~ENV.2~~		~~X~~		~~X~~	~~X~~							
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~~HAP.14~~												

~~MAQ.1~~		~~X~~		~~X~~							
~~MAQ.2~~											
~~MAQ.3~~		~~X~~									
~~MAQ.4~~		~~X~~		~~X~~							
~~MAQ.5~~				~~X~~							
~~MAQ.6~~				~~X~~							
~~MAQ.7~~				~~X~~							
~~PHS.1~~		~~X~~									
~~PHS.2~~											
~~PHS.3~~											
~~PHS.4~~											
~~PHS.5~~											
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~~PHS.7~~											
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~~PHS.9~~											
~~PHY.1~~											
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~~ZOO.8~~				~~X~~							
~~ZOO.9~~				~~X~~							
~~ZOO.10~~				~~X~~							

Overarching (start to finish) SEPs for Inquiry Extension of Labs

Ask questions to generate hypotheses for scientific investigations based on empirical evidence and observations and/or ask questions to **clarify or refine** models, explanations, or designs.

Plan and conduct controlled scientific investigations to produce data to answer questions, test hypotheses and predictions, and develop explanations or evaluate design solutions, which require the following:

- Identify dependent and independent variables and appropriate controls.
- Select and use appropriate tools or instruments to collect data, and represent data in an appropriate form.
- Analyze and interpret various types of data sets, using appropriate mathematics, in order to verify or refute the hypothesis or determine an optimal design solution.
- Construct an explanation of observed relationships between variables.
- Communicate scientific and/or technical information in various formats.

BIOLOGY

BIO.1 Cells as a System

Conceptual Understanding: Biologists have determined that organisms share unique characteristics that differentiate them from non-living things. Organisms range from very simple to extremely complex.

BIO.1A Students will demonstrate an understanding of the characteristics of life and biological organization.

BIO.1A.1 Develop criteria to differentiate between living and non-living things.

BIO.1A.2 Describe the tenets of cell theory and the contributions of Schwann, Hooke, Schleiden, and Virchow.

BIO.1A.3 Using specific examples, explain how cells can be organized into complex tissues, organs, and organ systems in multicellular organisms.

BIO.1A.4 Use evidence from current scientific literature to support whether a virus is living or non-living.

Conceptual Understanding: Organisms are composed of four primary macromolecules: carbohydrates, lipids, proteins, and nucleic acids. Metabolism is the sum of all chemical reactions between molecules within cells. Cells continuously utilize materials obtained from the environment and the breakdown of other macromolecules to synthesize their own large macromolecules for cellular structures and functions. These metabolic reactions require enzymes for catalysis.

BIO.1B Students will analyze the structure and function of the macromolecules that make up cells.

BIO.1B.1 Develop and use models to compare and contrast the structure and function of carbohydrates, lipids, proteins, and nucleic acids (DNA and RNA) in organisms.

BIO.1B.2 Design and conduct an experiment to determine how enzymes react given various environmental conditions (i.e., pH, temperature, and concentration). Analyze, interpret, graph, and present data to explain how those changing conditions affect the enzyme activity and the rate of the reactions that take place in biological organisms.

Conceptual Understanding: Cells are the basic units of all organisms, both prokaryotes and eukaryotes. Prokaryotic and eukaryotic cells differ in key structural features, but both can perform all functions necessary for life.

BIO.1C Students will relate the diversity of organelles to a variety of specialized cellular functions.

BIO.1C.1 Develop and use models to explore how specialized structures within cells (e.g., nucleus, cytoskeleton, endoplasmic reticulum, ribosomes, Golgi apparatus, lysosomes, mitochondria, chloroplast, centrosomes, and vacuoles) interact to carry out the functions necessary for organism survival.

BIO.1C.2 Investigate to compare and contrast prokaryotic cells and eukaryotic cells, and plant, animal, and fungal cells.

BIO.1C.3 Contrast the structure of viruses with that of cells, and explain why viruses must use living cells to reproduce.

Conceptual Understanding: The structure of the cell membrane allows it to be a selectively permeable barrier and maintain homeostasis. Substances that enter or exit the cell must do so via the cell membrane. This transport across the membrane may occur through a variety of mechanisms, including simple diffusion, facilitated diffusion, osmosis, and active transport.

BIO.1D Students will describe the structure of the cell membrane and analyze how the structure is related to its primary function of regulating transport in and out of cells to maintain homeostasis.

BIO.1D.1 Plan and conduct investigations to prove that the cell membrane is a semi-permeable, allowing it to maintain homeostasis with its environment through active and passive transport processes.

BIO.1D.2 Develop and use models to explain how the cell deals with imbalances of solute concentration across the cell membrane (i.e., hypertonic, hypotonic, and isotonic conditions, sodium/potassium pump).

Conceptual Understanding: Cells grow and reproduce through a regulated cell cycle. Within multicellular organisms, cells repeatedly divide for repair, replacement, and growth. Likewise, an embryo begins as a single cell that reproduces to form a complex, multicellular organism through the processes of cell division and differentiation.

BIO.1E Students will develop and use models to explain the role of the cell cycle during growth, development, and maintenance in multicellular organisms.

BIO.1E.1 Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.

BIO.1E.2 Identify and describe the changes that occur in a cell during replication. Explore problems that might occur if the cell does not progress through the cycle correctly (cancer).

BIO.1E.3 Relate the processes of cellular reproduction to asexual reproduction in simple organisms (i.e., budding, vegetative propagation, regeneration, binary fission). Explain why the DNA of the daughter cells is the same as the parent cell.

BIO.1E.4 Enrichment: Use an engineering design process to investigate the role of stem cells in regeneration and asexual reproduction, then develop applications of stem cell research to solve human medical conditions.*

BIO.2 Energy Transfer

Conceptual Understanding: Organisms require energy to perform life functions. Cells are transformers of energy, continuously utilizing a complex sequence of reactions in which energy is transferred from one form to another, for example, from light energy to chemical energy to kinetic energy. Emphasis is on illustrating the inputs and outputs of matter and the transfer and transformation of energy in photosynthesis and cellular respiration. Assessment is limited to identification of the phases (i.e., glycolysis, citric acid cycle, and electron transport chain) in cellular respiration as well as light and light-independent reactions of photosynthesis and does not include specific biochemical reactions within the phases.

BIO.2 Students will explain that cells transform energy through the processes of photosynthesis and cellular respiration to drive cellular functions.

BIO.2.1 Use models to demonstrate that ATP and ADP are cycled within a cell as a means to transfer energy.

BIO.2.2 Develop models of the major reactants and products of photosynthesis to demonstrate the transformation of light energy into stored chemical energy in cells. Emphasize the chemical processes in which bonds are broken and energy is released, and new bonds are formed and energy is stored.

BIO.2.3 Develop models of the major reactants and products of cellular respiration (aerobic and anaerobic) to demonstrate the transformation of the chemical energy stored in food to the available energy of ATP. Emphasize the chemical processes in which bonds are broken and energy is released, and new bonds are formed and energy is stored.

BIO.2.4 Conduct scientific investigations or computer simulations to compare aerobic and anaerobic cellular respiration in plants and animals, using real-world examples.

BIO.2.5 Enrichment: Investigate variables (e.g., nutrient availability, temperature) that affect anaerobic respiration and current real-world applications of fermentation.

BIO.2.6 Enrichment: Use an engineering design process to manipulate factors involved in fermentation to optimize energy production.*

BIO.3 Reproduction and Heredity

Conceptual Understanding: Somatic cells contain homologous pairs of chromosomes, one member of each pair obtained from each parent, that form a diploid set of chromosomes in each cell. These chromosomes are similar in genetic information but may contain different alleles of these genes. For sexual reproduction, an offspring must inherit a haploid set from each parent. Haploid gametes are formed by meiosis, a specialized cell division in which the chromosome number is reduced by half. During meiosis, members of a homologous pair may exchange information and then are randomly sorted into gametes resulting in genetic variation in sex cells.

BIO.3A Students will develop and use models to explain the role of meiosis in the production of haploid gametes required for sexual reproduction.

BIO.3A.1 Model sex cell formation (meiosis) and combination (fertilization) to demonstrate the maintenance of chromosome number through each generation in sexually reproducing populations. Explain why the DNA of the daughter cells is different from the DNA of the parent cell.

BIO.3A.2 Compare and contrast mitosis and meiosis in terms of reproduction.

BIO.3A.3 Investigate chromosomal abnormalities (e.g., Down syndrome, Turner's syndrome, and Klinefelter syndrome) that might arise from errors in meiosis (nondisjunction) and how these abnormalities are identified (karyotypes).

Conceptual Understanding: Offspring inherit DNA from their parents. The genes contained in the DNA (genotype) determine the traits expressed in the offspring's phenotype. Alleles of a gene may demonstrate various patterns of inheritance. These patterns of inheritance may be followed through multiple generations within families.

BIO.3B Students will analyze and interpret data collected from probability calculations to explain the variation of expressed traits within a population.

BIO.3B.1 Demonstrate Mendel's law of dominance and segregation using mathematics to predict phenotypic and genotypic ratios by constructing Punnett squares with both homozygous and heterozygous allele pairs.

BIO.3B.2 Illustrate Mendel's law of independent assortment using Punnett squares and/or the product rule of probability to analyze monohybrid crosses.

BIO.3B.3 Investigate traits that follow non-Mendelian inheritance patterns (e.g., incomplete dominance, codominance, multiple alleles in human blood types, and sex-linkage).

BIO.3B.4 Analyze and interpret data (e.g., pedigrees, family, and population studies) regarding Mendelian and complex genetic traits (e.g., sickle-cell anemia, cystic fibrosis, muscular dystrophy, color-blindness, and hemophilia) to determine patterns of inheritance and disease risk.

Conceptual Understanding: Gene expression results in the production of proteins and thus determines the phenotypes of the organism. Changes in the DNA occur throughout an organism's life. Mutations are a source of genetic variation that may have a positive, negative, or no effect on the organism.

BIO.3C Students will construct an explanation based on evidence to describe how the structure and nucleotide base sequence of DNA determines the structure of proteins or RNA that carry out essential functions of life.

BIO.3C.1 Develop and use models to explain the relationship between DNA, genes, and chromosomes in coding the instructions for the traits transferred from parent to offspring.

BIO.3C.2 Evaluate the mechanisms of transcription and translation in protein synthesis.

BIO.3C.3 Use models to predict how various changes in the nucleotide sequence (e.g., point mutations, deletions, and additions) will affect the resulting protein product and the subsequent inherited trait.

BIO.3C.4 Research and identify how DNA technology benefits society. Engage in scientific argument from evidence over the ethical issues surrounding the use of DNA technology (e.g., cloning, transgenic organisms, stem cell research, and the Human Genome Project, gel electrophoresis).

BIO.3C.5 Enrichment: Investigate current biotechnological applications in the study of the genome (e.g., transcriptome, proteome, individualized sequencing, and individualized gene therapy).

BIO.4 Adaptations and Evolution

Conceptual Understanding: Evolution is a key unifying principle in biology. Differentiating between organic and chemical evolution and the analysis of the gradual changes in populations over time, helps students understand common features and differences between species and thus the relatedness between species. There are several factors that affect how natural selection acts on populations within their environments leading to speciation, extinction, and the current diversity of life on earth.

BIO.4 Students will analyze and interpret evidence to explain the unity and diversity of life.

BIO.4.1 Use models to differentiate between organic and chemical evolution, illustrating the steps leading to aerobic heterotrophs and photosynthetic autotrophs.

BIO.4.2 Evaluate empirical evidence of common ancestry and biological evolution, including comparative anatomy (e.g., homologous structures and embryological similarities), fossil record, molecular/biochemical similarities (e.g., gene and protein homology), and biogeographic distribution.

BIO.4.3 Construct cladograms/phylogenetic trees to illustrate relatedness between species.

BIO.4.4 Design models and use simulations to investigate the interaction between changing environments and genetic variation in natural selection leading to adaptations in populations and differential success of populations.

BIO.4.5 Use Darwin's Theory to explain how genetic variation, competition, overproduction, and unequal reproductive success acts as driving forces of natural selection and evolution.

BIO.4.6 Construct explanations for the mechanisms of speciation (e.g., geographic and reproductive isolation).

BIO.4.7 Enrichment: Construct explanations for how various disease agents (bacteria, viruses, chemicals) can influence natural selection.

BIO.5 Interdependence of Organisms and Their Environments

Conceptual Understanding: Complex interactions within an ecosystem affect the numbers and types of organisms that survive. Fluctuations in conditions can affect the ecosystem's function, resources, and habitat availability. Ecosystems are subject to carrying capacities and can only support a limited number of organisms and populations. Factors that can affect the carrying capacities of populations are both biotic and abiotic.

BIO.5 Students will Investigate and evaluate the interdependence of living organisms and their environment.

BIO.5.1 Illustrate levels of ecological hierarchy, including organism, population, community, ecosystem, biome, and biosphere.

BIO.5.2 Analyze models of the cycling of matter (e.g., carbon, nitrogen, phosphorus, and water) between abiotic and biotic factors in an ecosystem and evaluate the ability of these cycles to maintain the health and sustainability of the ecosystem.

BIO.5.3 Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases on the carbon dioxide cycle and global climate.

BIO.5.4 Develop and use models to describe the flow of energy and amount of biomass through food chains, food webs, and food pyramids.

BIO.5.5 Evaluate symbiotic relationships (e.g., mutualism, parasitism, and commensalism) and other co- evolutionary (e.g., predator-prey, cooperation, competition, and mimicry) relationships within specific environments.

BIO.5.6 Analyze and interpret population data, both density-dependent and density-independent, to define limiting factors. Use graphical representations (growth curves) to illustrate the carrying capacity within ecosystems.

BIO.5.7 Investigate and evaluate factors involved in primary and secondary ecological succession using local, real-world examples.

BIO.5.8 Enrichment: Use an engineering design process to create a solution that addresses changing ecological conditions (e.g., climate change, invasive species, loss of biodiversity, human population growth, habitat destruction, biomagnification, or natural phenomena).*

BIO.5.9 Enrichment: Use an engineering design process to investigate and model current technological uses of biomimicry to address solutions to real-world problems.*

BOTANY

BOT.1 Plant Morphology, Cell Structure, and Function

Conceptual Understanding: Plants are a diverse and important part of the biosphere, providing oxygen, food, and shelter required for other organisms. The diversity of the plant kingdom is characterized by unique traits that are observed to identify the various plant divisions.

BOT.1 Students will investigate the morphology, anatomy, and physiology of plants.

BOT.1.1 Analyze models (3-D, paper, and/or computer-based) to distinguish the basic morphology of the plant kingdom, with attention to structures and their related functions. Use cladograms or phylogenetic trees to identify evolutionary features that distinguish the plant kingdom from other kingdoms.

BOT.1.2 Using microscopes, observe, identify, record, and analyze (e.g., see and draw) cells and cell structures unique to plants. Use data measurements obtained from microscopy to compare the plant cells and organelle sizes between various examples (e.g., elodea, onion, or algae).

BOT.1.3 Describe the relationship between the structure and purpose of plant organs (e.g., roots, stems, and leaves).

BOT.1.4 Evaluate and explain how bacteria and fungi work symbiotically to enhance plant root function.

BOT.1.5 Calculate surface area of leaves/roots, and compare surface areas of various plant specimens to explain adaptations of the various plant types.

BOT.1.6 Demonstrate through model development and manipulation an understanding of plant biochemistry.

BOT.1.7 Conduct investigations, collect and analyze data, and communicate results that explain the processes of photosynthesis and cellular respiration (e.g., light intensity, light color, light distance, temperature, altering pH, oxygen availability, and carbon dioxide concentration).

BOT.1.8 Enrichment: Use an engineering design process to manipulate a variable of choice to refine a protocol to optimize output of photosynthesis or cellular respiration.*

BOT.1.9 Communicate the importance of carbon, hydrogen, oxygen, phosphorus, and nitrogen cycles to plant physiology through graphics such as poster or computer presentations.

BOT.1.10 Identify and compare various live plant examples to explore plant morphological diversity, including leaf number, structure, and arrangement; root modifications; and flower structure and arrangement. Produce a visual product (e.g., an electronic presentation) to identify and communicate patterns of similarity and differences between the lab specimens.

BOT.1.11 Compare and contrast functions of the various characteristics found in plant divisions and utilize dichotomous keys to identify plant species.

BOT.2 Plant Evolution

Conceptual Understanding: Plants have been naturally selected to survive in a variety of habitats, from aquatic to arboreal. The development of these characteristics is used to construct cladograms that illustrate the evolution of plants.

BOT.2 Students will identify evolutionary modifications necessary for the terrestrial survival of plants.

BOT.2.1 Summarize and justify the characteristics of nonvascular algae (blue-green and green algae) and bryophytes that provide evidence of evolution within the plant kingdom.

BOT.2.2 Referencing the USDA plants database, identify, compare, and contrast seedless, naked seed, and enclosed-seed modifications for reproduction. Calculate the occurrence of seed types in given habitats.

BOT.2.3 Summarize and justify the characteristics of angiosperms and gymnosperms that lead to their success as terrestrial plants.

BOT.2.4 Research information to develop, produce, and communicate a scientifically justifiable argument for the rapid amplification and success of angiosperm compared to other plant divisions.

BOT.2.5 Enrichment: Referencing the National Center for Biotechnology Information's gene/protein databases, propose and design a scientifically supportable cladogram or phylogenetic tree that illustrates the evolutionary modifications of the plant kingdom using genetic (DNA) or protein sequence comparisons/alignments.

BOT.3 Plant Reproduction

Conceptual Understanding: Reproduction in plants occurs through different methods. Understanding the reproductive methods of plants allows humans to use these methods in agriculture and food development.

BOT.3 Students will characterize the reproductive strategies of plants.

BOT.3.1 Describe the various processes of asexual reproduction and vegetative propagation used by plants. Communicate the importance of these reproductive methods in regard to human food production.

BOT.3.2 Enrichment: Research and present an agronomically important crop (e.g., potato, sweet potato, pineapple, or strawberry) that is produced via vegetative propagation (non-GMOs) for human consumption. Include evidence-based arguments that identify the potential benefits and negative effects of this method of crop production.

BOT.3.3 Compare and contrast the consequences of the following reproductive methods: asexual reproduction, vegetative propagation, and sexual reproduction.

BOT.3.4 Plan and conduct comparative flower dissection to identify reproductive structures within the flower.

BOT.3.5 Compare the similarities between corresponding plant reproductive structures from a variety of species. Record via drawings of observed dissection specimens, and explain the similarities and differences observed.

BOT.3.6 Identify differences in flower structure and shape. Provide a rationale that explains the value of these differences in flower structure to reproductive success (e.g., pollinators, flower shape, smell, color, size, orientation).

BOT.3.7 Plan, conduct, and communicate the results of a comparative laboratory investigation of differing fruit types.

BOT.3.8 Using laboratory data, correctly categorize fruits, vegetables, nuts, modified stems, or other plant parts. Compare the scientific definitions of these terms to those used by the general public/society and the USDA to categorize food.

BOT.4 Society's Reliance on Plants

Conceptual Understanding: Human reliance on plants and plant products began with food and building materials. This use has expanded to include medicine, industrial clean-up (phytoremediation) of human- generated byproducts and toxic waste, and plant examples used in biomimicry for solving human problems.

BOT.4 Students will explore the global value of plants and the interaction between humans and plants.

BOT.4.1 Identify plants used in the bioremediation of an area due to natural processes (e.g., fire), industrial pollution, or wars, and develop and communicate a plan to remediate a habitat impacted by human interactions (e.g., carbon sinks, phytoremediation, or heavy metal detoxification).

BOT.4.2 Enrichment: Use an engineering design process to define a problem, design, construct, evaluate, and improve a habitat impacted by human interactions.*

BOT.4.3 Investigate historical and modern medicinal uses of plants.

BOT.4.4 Investigate the industrial use of plants.

BOT.4.5 Explore the impacts (both positive and negative) of plant biotechnology/GMOs on human society. Present findings using digital media or technology, and include evidence using graphs or charts.

BOT.4.6 Enrichment: Use an engineering design process to design and conduct an investigation that uses biomimicry to provide a plant-based solution to an environmental challenge.*

BOT.5 Plant Adaptations to Varying Habitats

Conceptual Understanding: Before animal life forms can survive within a habitat, there must be an existing plant population. Plants have specific adaptations that allow them to survive in habitats.

BOT.5 Students will explore adaptations that allow plants to survive in various habitats.

BOT.5.1 Research plants found in various habitats. Analyze how plants use adaptations for survival in these habitats including extreme habitats.

BOT.5.2 Relate atmospheric factors to biodiversity (e.g., climate as determined by temperature and precipitation).

BOT.5.3 Construct a model using technology that illustrates the levels of succession within a habitat (e.g., graveyard exploration, forest fire area, or reclamation sites).

BOT.5.4 Enrichment: Use an engineering design process to design and build a plant model based on extreme environment criteria to overcome the difficulties presented by this environment. Identify revisions to the proposed model over time.*

BOT.6 Local Plant Investigations

Conceptual Understanding: The plant diversity within the local environment impacts the health of the ecosystem. The ability to identify the plants within an ecosystem is a skill that will benefit students throughout life.

BOT.6 Students will ask questions, plan, and conduct field investigations on local plant communities.

BOT.6.1 Conduct transects/plot studies to determine species, biodiversity, or health of a plant community. (Plots may be linear or a quadrat (square or circular) depending on the habitat. (Typically, relative density, relative dominance, and relative frequency of each species are calculated to infer an importance value of the species in the plot.)

BOT.6.2 Compare and contrast genomes using plant genetic databases (e.g., BLAST or plant GDB).

BOT.6.3 Enrichment: Use an engineering design process to define a problem, design, construct, evaluate, and improve a societal concern with the aid of plants (e.g., irrigation, water conservation, urban shading, green-space development, food deserts, or other local needs or issues).*

CHEMISTRY

CHE.1 Mathematical and Computational Analysis

Conceptual Understanding: Mathematical and computational analysis is a key component of scientific investigation and prediction of outcomes. These components create a more student-centered classroom.

CHE.1 Students will use mathematical and computational analysis to evaluate problems.

CHE.1.1 Use dimensional analysis (factor/label) and significant figures to convert units and solve problems.
CHE.1.2 Design and conduct experiments using appropriate measurements, significant figures, graphical analysis to analyze data.

CHE.1.3 Enrichment: Research information from multiple appropriate sources and assess the credibility, accuracy, possible bias, and conclusions of each publication.

CHE.2 Atomic Theory

Conceptual Understanding: Atomic theory is the foundation of modern chemistry concepts. Students must be presented with a solid foundation of the atom and its components. These concepts lead to an understanding of the interactions of these components to explain macro-observations of the world.

CHE.2 Students will demonstrate an understanding of the atomic structure and the historical developments leading to modern atomic theory.

CHE.2.1 Investigate the historical progression leading to the modern atomic theory, including, but not limited to, work done by Dalton, Rutherford's gold foil experiment, Thomson's cathode ray experiment, Millikan's oil drop experiment, and Bohr's interpretation of bright line spectra.

CHE.2.2 Construct models (e.g., ball and stick, online simulations, mathematical computations) of atomic nuclei to explain the abundance weighted average (relative mass) of elements and isotopes on the published mass of elements.

CHE.2.3 Investigate absorption and emission spectra to interpret explanations of electrons at discrete energy levels using tools such as online simulations, spectrometers, prisms, flame tests, and discharge tubes. Explore both laboratory experiments and real-world examples.

CHE.2.4 Research appropriate sources to evaluate the way absorption and emission spectra are used to study astronomy and the formation of the universe.

CHE.3 Periodic Table

Conceptual Understanding: Modern chemistry is based on the predictability of atomic behavior. Periodic patterns in elements led to the development of the periodic table. Electron configuration is a direct result of this periodic behavior. The predictable behavior of electrons has led to the discovery of new compounds, elements, and atomic interactions. Predictability of atom behavior is a key to understanding ionic and covalent bonding and production of compounds or molecules.

CHE.3 Students will demonstrate an understanding of the periodic table as a systematic representation to predict properties of elements.

CHE.3.1 Explore and communicate the organization of the periodic table, including history, groups, families, family names, metals, nonmetals, metalloids, and transition metals.

CHE.3.2 Analyze properties of atoms and ions (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity and electron affinity, ionization energy, and atomic/ionic radii) using periodic trends of elements based on the periodic table.

CHE.3.3 Analyze the periodic table to identify quantum numbers (e.g., valence shell electrons, energy level, orbitals, sublevels, and oxidation numbers).

CHE.4 Bonding

Conceptual Understanding: A firm understanding of bonding is necessary to further development of the basic chemical concepts of compounds and chemical interactions.

CHE.4 Students will demonstrate an understanding of the types of bonds and resulting atomic structures for the classification of chemical compounds.

CHE.4.1 Develop and use models (e.g., Lewis dot, 3-D ball-stick, 3-D printing, or simulation programs such as PhET) to predict the type of bonding between atoms and the shape of simple compounds.

CHE.4.2 Use models such as Lewis structures and ball and stick models to depict the valence electrons and their role in the formation of ionic and covalent bonds.

CHE.4.3 Predict the ionic or covalent nature of different atoms based on electronegativity trends and/or position on the periodic table.

CHE.4.4 Use models and oxidation numbers to predict the type of bond, shape of the compound, and the polarity of the compound.

CHE.4.5 Use models of simple hydrocarbons to exemplify structural isomerism.

CHE.4.6 Use mathematical and computational analysis to determine the empirical formula and the percent composition of compounds.

CHE.4.7 Use scientific investigation to determine the percentage of composition for a substance (e.g., sugar in gum, water and/or unpopped kernels in popcorn, percent water in a hydrate). Compare results to justify conclusions based on experimental evidence.

CHE.4.8 Plan and conduct controlled scientific investigations to produce mathematical evidence of the empirical composition of a compound.

CHE.5 Naming Compounds

Conceptual Understanding: Polyatomic ions (radicals) and oxidation numbers are used to predict how metallic ions, nonmetals, and transition metals are used in naming compounds.

CHE.5 Students will investigate and understand the accepted nomenclature used to identify the name and chemical formulas of compounds.

CHE.5.1 Use the periodic table and a list of common polyatomic ions as a model to derive chemical compound formulas from compound names and compound names from chemical formulas.

CHE.5.2 Generate formulas of ionic and covalent compounds from compound names. Discuss compounds in everyday life and compile lists and uses of these chemicals.

CHE.5.3 Generate names of ionic and covalent compounds from their formulas. Name binary compounds, binary acids, stock compounds, ternary compounds, and ternary acids.

CHE.6 Chemical Reactions

Conceptual Understanding: Understanding chemical reactions and predicting products of these reactions is essential to student success.

CHE.6 Students will demonstrate an understanding of the types, causes, and effects of chemical reactions.

CHE.6.1 Develop and use models to predict the products of chemical reactions (e.g., synthesis reactions; single replacement; double displacement; and decomposition, including exceptions such as decomposition of hydroxides, chlorates, carbonates, and acids). Discuss and/or compile lists of reactions used in everyday life.

CHE.6.2 Plan, conduct, and communicate the results of investigations to demonstrate different types of simple chemical reactions.

CHE.6.3 Use mathematics and computational analysis to represent the ratio of reactants and products in terms of masses, molecules, and moles (stoichiometry).

CHE.6.4 Use mathematics and computational analysis to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Give real-world examples (e.g., burning wood).

CHE.6.5 Plan and conduct a controlled scientific investigation to produce mathematical evidence that mass is conserved. Use percent error to analyze the accuracy of results.

CHE.6.6 Use mathematics and computational analysis to support the concept of percent yield and limiting reagent.

CHE.6.7 Plan and conduct a controlled scientific investigation to produce mathematical evidence to predict and confirm the limiting reagent and percent yield in the reaction. Analyze quantitative data, draw conclusions, and communicate findings. Compare and analyze class data for validity.

CHE.7 Gas Laws

Conceptual Understanding: The comparison and development of the molecular states of matter are an integral part of understanding matter. Pressure, volume, and temperature are imperative to understanding the states of matter.

CHE.7 Students will demonstrate an understanding of the structure and behavior of gases.

CHE.7.1 Analyze the behavior of ideal and real gases in terms of pressure, volume, temperature, and number of particles.

CHE.7.2 Enrichment: Use an engineering design process to develop models (e.g., online simulations or student interactive activities) to explain and predict the behavior of each state of matter using the movement of particles and intermolecular forces to explain the behavior of matter.*

CHE.7.3 Analyze and interpret heating curve graphs to explain the energy relationship between states of matter (e.g., thermochemistry-water heating from -20oC to 120oC).

CHE.7.4 Use mathematical computations to describe the relationships comparing pressure, temperature, volume, and number of particles, including Boyle's law, Charles's law, Dalton's law, combined gas laws, and ideal gas laws.

CHE.7.5 Enrichment: Use an engineering design process and online simulations or lab investigations to design and model the results of controlled scientific investigations to produce mathematical evidence that confirms the gas-laws relationships.*

CHE.7.6 Use the ideal gas law to support the prediction of volume, mass, and number of particles produced in chemical reactions (i.e., gas stoichiometry).

CHE.7.7 Plan and conduct controlled scientific investigations to produce mathematical evidence that confirms that reactions involving gases conform to the law of conservation of mass.

CHE.7.8 Enrichment: Using gas stoichiometry, calculate the volume of carbon dioxide needed to inflate a balloon to occupy a specific volume. Use an engineering design process to design, construct, evaluate, and improve a simulated air bag.*

CHE.8 Solutions

Conceptual Understanding: Solutions exist as solids, liquids, or gases. Solution concentration is expressed by specifying relative amounts of solute to solvent.

CHE.8 Students will demonstrate an understanding of the nature of properties of various types of chemical solutions.

CHE.8.1 Use mathematical and computational analysis to quantitatively express the concentration of solutions using the concepts such as molarity, percent by mass, and dilution.

CHE.8.2 Develop and use models (e.g., online simulations, games, or video representations) to explain the dissolving process in solvents on the molecular level.

CHE.8.3 Analyze and interpret data to predict the effect of temperature and pressure on solids and gases dissolved in water.

CHE.8.4 Design, conduct, and communicate the results of experiments to test the conductivity of common ionic and covalent compounds in solution.

CHE.8.5 Use mathematical and computational analysis to analyze molarity, molality, dilution, and percentage dilution problems.

CHE.8.6 Design, conduct, and communicate the results of experiments to produce a specified volume of a solution of a specific molarity, and dilute a solution of a known molarity.

CHE.8.7 Use mathematical and computational analysis to predict the results of reactions using the concentration of solutions (i.e., solution stoichiometry).

CHE.8.8 Enrichment: Investigate parts per million and/or parts per billion as it applies to environmental concerns in your geographic region, and reference laws that govern these factors.

CHE.9 Acids and Bases (Enrichment)

CHE.9 Enrichment: Students will understand the nature and properties of acids, bases, and salt solutions.

CHE.9.1 Enrichment: Analyze and interpret data to describe the properties of acids, bases, and salts.

CHE.9.2 Enrichment: Analyze and interpret data to identify differences between strong and weak acids and bases (i.e., dissociation).

CHE.9.3 Enrichment: Plan and conduct investigations using the pH scale to classify acid and base solutions.

CHE.9.4 Enrichment: Analyze and evaluate the Arrhenius, Bronsted-Lowry, and Lewis acid-base definitions.

CHE.9.5 Enrichment: Use mathematical and computational thinking to calculate pH from the hydrogen-ion concentration.

CHE.9.6 Enrichment: Obtain, evaluate, and communicate information about how buffers stabilize pH in acid-base reactions.

CHE.10 Thermochemistry (Enrichment)

CHE.10 Enrichment: Students will understand that energy is exchanged or transformed in all chemical reactions.

CHE.10.1 Enrichment: Construct explanations to explain how temperature and heat flow in terms of the motion of molecules (or atoms).

CHE.10.2 Enrichment: Classify chemical reactions and phase changes as exothermic or endothermic based on enthalpy values. Use a graphical representation to illustrate the energy changes involved.

CHE.10.3 Enrichment: Analyze and interpret data from energy diagrams and investigations to support claims that the amount of energy released or absorbed during a chemical reaction depends on changes in total bond energy.

CHE.10.4 Enrichment: Use mathematical and computational thinking to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.

CHE.11 Equilibrium (Enrichment)

CHE.11 **Enrichment:** Students will understand that chemical equilibrium is a dynamic process at the molecular level.

CHE.11.1 **Enrichment:** Construct explanations to explain how to use Le Chatelier's principle to predict the effect of changes in concentration, temperature, and pressure.

CHE.11.2 **Enrichment:** Predict when equilibrium is established in a chemical reaction.

CHE.11.3 **Enrichment:** Use mathematical and computational thinking to calculate an equilibrium constant expression for a reaction.

CHE.12 Organic Nomenclature (Enrichment)

CHE.12 **Enrichment:** Students will understand that the bonding characteristics of carbon allow the formation of many different organic molecules with various sizes, shapes, and chemical properties.

CHE.12.1 **Enrichment:** Construct explanations to explain the bonding characteristics of carbon that result in the formation of basic organic molecules.

CHE.12.2 **Enrichment:** Obtain information to communicate the system used for naming the basic linear hydrocarbons and isomers that contain single bonds, simple hydrocarbons with double and triple bonds, and simple molecules that contain a benzene ring.

CHE.12.3 **Enrichment:** Develop and use models to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.

EARTH AND SPACE SCIENCE

ESS.1 Earth in the Universe

Conceptual Understanding: The planet Earth is a very small part of a very large universe that has developed over a huge expanse of time.

ESS.1.A Students will develop an understanding of the universe, its development, immense size, and composition.

ESS.1A.1 Describe the Big Bang theory and summarize observations (e.g., cosmic microwave background radiation, Hubble's law, and redshift caused by the Doppler effect) as evidence to support the formation and expansion of the universe.

ESS.1A.2 Interpret information from the Hertzsprung -Russell diagram to differentiate types of stars, including our sun, according to size, magnitude, and classification.

ESS.1A.3 Organize and interpret data sets for patterns and trends to compare and contrast stellar evolution in order to explain and communicate how a star changes during its life.

ESS.1A.4 Research and explain how nuclear fusion in stars and supernova lead to the formation of all other elements.

Conceptual Understanding: The sun, moon, and planets have predictable patterns that are explained by forces and laws. Patterns of motion in the solar system can be described and predicted based on observations and an understanding of gravity.

ESS.1.B Students will develop an understanding of Earth, the solar system, and the laws that predict the motion of celestial bodies.

ESS.1B.1 Read and evaluate scientific information for mechanisms/results (e.g., the solar nebular theory) to explain how the solar system was formed. Cite evidence and develop a logical argument.

ESS.1B.2 Compare and contrast celestial bodies (e.g., planets, natural satellites, comets, asteroids, and the Oort cloud) and their motion in our solar system (e.g., revolution and rotation). Build an Analemma calendar.

ESS.1B.3 Design a model (e.g., a gravity simulation using PVC and a neoprene screen) to demonstrate Kepler's laws and the relationships of the orbits of objects in our solar system. Relate them to Newton's law of universal gravitation and laws of motion.

ESS.2 Earth Structure and History

Conceptual Understanding: Earth's interior is divided into a solid inner core, a liquid outer core, a pliable mantle, and a solid crust. Even though the crust is solid, it is always in motion and is recycled through time.

ESS.2.A Students will develop an understanding of the structure and composition of Earth and its materials.

ESS.2A.1 Analyze and interpret data to explain and communicate the differentiation of Earth's internal chemical structure (e.g., core, mantle, and crust) using the production of internal heat from the radioactive decay of unstable isotopes and gravitational energy.

ESS.2A.2 Analyze and interpret data to explain and communicate the differentiation of Earth's physical divisions (e.g., lithosphere and asthenosphere) using data from seismic waves and Earth's magnetic field.

ESS.2A.3 Investigate the physical and/or chemical characteristics of mineral specimens to identify minerals and mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, and phosphates). Include the relationship between chemical bonds, chemical formulas, mineral use, and mineral properties.

ESS.2A.4 Investigate the physical and/or chemical characteristics of rock specimens to identify and categorize igneous, sedimentary, and metamorphic rocks. Include the processes that generate the transformation of rocks.

Conceptual Understanding: Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. Plate tectonics is the unifying theory that explains the movements of rocks on Earth's surface and provides a comprehensive account of its geological history. Physical and chemical weathering is a result of the interactions of Earth's geosphere, hydrosphere, atmosphere, and biosphere.

ESS.2.B Students will develop an understanding of the history and evolution of the earth.

ESS.2B.1 Research, analyze, and evaluate the contributions of William Smith, James Hutton, Nicolaus Steno, Charles Lyell, and others to physical geology.

ESS.2B.2 Apply different techniques (e.g., superposition, original horizontality, cross-cutting relationships, lateral continuity, principle of inclusions, fossil succession, and unconformities) to analyze and interpret the relative age of actual sequences, models, or photographs.

ESS.2B.3 Use mathematical concepts to calculate the absolute age of earth materials using actual or simulated isotope ratios.

ESS.2B.4 Research, analyze, and explain the origin of geologic features and processes that result from plate tectonics, including sea floor spreading, earthquake activity, volcanic activity, mountain building, and location of natural resources.

ESS.2B.5 Use mathematical representations to interpret seismic graphs to triangulate the location of an earthquake's epicenter and magnitude and to correlate the frequency and magnitude of an earthquake.

ESS.2B.6 Plan and conduct a scientific investigation to determine how factors (e.g., wind velocity, water velocity, ice, and temperature) may affect the rate of weathering.

ESS.2B.7 Enrichment: Use an engineering design process to design a model to simulate the formation of caves and karst topography by groundwater.*

ESS.3 Earth's Systems and Cycles

Conceptual Understanding: Earth's surface is comprised of the geosphere, hydrosphere, atmosphere, and biosphere, all of which are interconnected. The complex and dynamic interactions between these systems have shaped Earth, influenced climate, and shaped the evolution of life.

ESS.3 Students will develop an understanding of Earth's systems and cycles.

ESS.3.1 Use mathematical representations (e.g., latitude, longitude, and maps) to calculate the angle of noon solar incidence and relate the value to day length, distribution of sunlight, and seasonal change.

ESS.3.2 Enrichment: Use an engineering design process to explore the concepts of passive solar architecture to design a structure that best utilizes solar incidence.*

ESS.3.3 Explain how temperature and density of ocean water influence circulation.

ESS.3.4 Research and communicate information to explain the importance of the transfer of thermal energy among the hydrosphere, geosphere, and atmosphere. Include the unique physical and chemical properties of water, the water cycle, and energy transfer within the rock cycle.

ESS.3.5 Analyze and interpret weather data using maps and global weather systems to explain and communicate the relationships among air masses, pressure systems, and frontal boundaries.

ESS.3.6 Construct an explanation from data sets to obtain and evaluate scientific information to construct scientific arguments on changes in climate caused by various natural factors (e.g., plate tectonics and continent location and Milankovitch cycles) versus anthropogenic factors (e.g., fossil fuel use and agricultural factors).

ESS.3.7 Cite evidence and develop logical arguments to identify the cause and effect relationships of the evolutionary milestones (e.g., photosynthesis and the atmosphere, the evolution of multicellular animals, the development of shells, and the colonization of terrestrial environments by plants and animals) that most profoundly shaped Earth's systems.

ESS.3.8 Analyze and interpret the record of shared ancestry, evolution, and extinction as related to natural selection using fossils.

ESS.4 Earth's Resources and Human Activity

Conceptual Understanding: The dynamic Earth impacts human society. Natural hazards and other geologic events have shaped the course of human history. In addition, humans also impact the Earth through resource extraction and land use.

ESS.4 Students will develop an understanding of Earth's resources and the impact of human activities.

ESS.4.1 Research, evaluate, and communicate about how human life on Earth shapes Earth's systems and responds to the interaction of Earth's systems (e.g., geosphere, hydrosphere, atmosphere, and biosphere). Examine how geochemical and ecological processes interact through time to cycle matter and energy and how human activity alters the rates of these processes.

ESS.4.2 Research, assess, and communicate how Earth's systems influence the distribution of life, including how various natural hazards and geologic events (e.g., volcanic eruptions, earthquakes, landslides, tornadoes, and hurricanes) have shaped the course of human history.

ESS.4.3 Analyze earthquake and volcanic data to determine patterns that can lead to predicting such hazards and mitigating impact to humans.

ESS.4.4 Enrichment: Use an engineering design process to research, develop, and test models to aid in the responsible management of natural resources (e.g., recycling, composting, and energy usage).*

ESS.4.5 Enrichment: Research and communicate regarding geoscience career options (e.g., geologist, petroleum engineer, meteorologist, paleontologist, astronomer, and oceanographer.

ENVIRONMENTAL SCIENCE

ENV.1 Biosphere and Biodiversity

Conceptual Understanding: The biosphere is a system of biomes, each with unique characteristics. These characteristics are classified as biotic or abiotic. The environment in which humans live is dependent on a system of cycles. These biogeochemical cycles are the water, nitrogen, carbon, and phosphorus cycles. The flow of energy within the environment is critical for the success of life. The biodiversity within a biome is fragile and easily affected by human actions. Plant and animal populations are dynamic and are demonstrated through graphical analysis.

ENV.1 Students will investigate the interdependence of diverse living organisms and their interactions with the components of the biosphere.

ENV.1.1 Identify, investigate, and evaluate the interactions of the abiotic and biotic factors that determine the types of organisms that live in major biomes.

ENV.1.2 Evaluate evidence in nonfiction text to explain how biological or physical changes within biomes affect populations and communities and how changing conditions may result in altered ecosystems.

ENV.1.3 Use models to explain why the flow of energy through an ecosystem can be illustrated by a pyramid with less energy available at the higher trophic levels compared to lower levels.

ENV.1.4 Describe symbiotic relationships (e.g., mutualism, parasitism, and commensalism) and other co- evolutionary (e.g., predator-prey, cooperation, competition, and mimicry) relationships within specific environments.

ENV.1.5 Develop and use models to diagram the flow of nitrogen, carbon, and phosphorus through the environment.

ENV.1.6 Use mathematics, graphics, and informational text to determine how population density- dependent and density-independent limiting factors affect populations and diversity within ecosystems. Use technology to illustrate and compare a variety of population-growth curves.

ENV.1.7 Analyze and interpret quantitative data to construct explanations of how the carrying capacity of an ecosystem may change as the availability of resources changes.

ENV.1.8 Utilize data to communicate changes within a given population and the environmental factors that may have impacted these changes (e.g., weather patterns, natural disasters).

ENV.1.9 Evaluate and communicate data that explains how human activity may impact biodiversity (e.g., introduction, removal, and reintroduction of an organism within an ecosystem; land usage) and genetic variations of organisms, including endangered and threatened species.

ENV.1.10 Enrichment: Engage in scientific argument from evidence the benefits versus harm of genetically modified organisms.

ENV.2 Natural Resources Use and Conservation

Conceptual Understanding: The environment is affected by human demand for its resources. However, through conservation applications, a balance may be reached between human sustainability and the environment.

ENV.2 Students will relate the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

ENV.2.1 Differentiate between renewable and nonrenewable resources, and compare and contrast the pros and cons of using these resources.

ENV.2.2 Investigate and research the pros and cons of using traditional sources of energy (e.g., fossil fuels) and alternative sources of energy (e.g., water, wind, geothermal, biomass/biofuels, solar).

ENV.2.3 Compare and contrast biodegradable and non-biodegradable wastes and their significance in landfills.

ENV.2.4 Examine solutions for developing, conserving, managing, recycling, and reusing energy and mineral resources to minimize impacts in natural systems (e.g., agricultural soil use, mining for coal, construction sites, and exploration of petroleum and natural gas sources).

ENV.2.5 Research various resources related to water quality and pollution (e.g., nonfictional text, EPA's Surf Your Watershed, MDEQ publications) and communicate the possible effects on the environment and human health.

ENV.2.6 Enrichment: Obtain water from a local source (e.g., stream on campus, rainwater, ditch water) to monitor water quality over time, using a spreadsheet program to graphically represent collected data.

ENV.3 Human Activities and Climate Change

Conceptual Understanding: Humans are a part of their environment and may have a detrimental impact on the environment. Using evidence based on scientific research, efforts are underway to repair the environment. Historical and current regional and global models illustrate the changes in the environment.

ENV.3 Students will discuss the direct and indirect impacts of certain types of human activities on the Earth's climate.

ENV.3.1 Use a model to describe cycling of carbon through the ocean, atmosphere, soil, and biosphere and how increases in carbon dioxide concentrations have resulted in atmospheric and climate changes.

ENV.3.2 Interpret data and climate models to predict how global and regional climate change can affect Earth's systems (e.g., precipitation, temperature, impacts on sea level, global ice volumes, and atmosphere and ocean composition).

ENV.3.3 Use satellite imagery and other resources to analyze changes in biomes over time (e.g., glacial retreat, deforestation, desertification) and propose strategies to reduce the impact of human activities leading to these issues.

ENV.3.4 Enrichment: Determine mathematically an individual's impact on the environment (carbon footprint, water usage, landfill contribution) and develop a plan to reduce personal contribution.

ENV.4 Human Sustainability

Conceptual Understanding: Human health is dependent on the environment. Changes within an environment, whether natural or man-made, may lead to the spread of disease. Sudden environmental changes (e.g., tsunami or volcanic activity) lead to human migration into other areas of the environment. Case studies illustrate the need to intervene in environmental change, when possible, to improve health issues (e.g., smog's effect on asthma patients).

ENV.4 Students will demonstrate an understanding of the interdependence of human sustainability and the environment.

ENV.4.1 Identify human impact and develop a solution for protection of the atmosphere, considering pollutants (e.g., acid rain, air pollution, smog, ozone layer, or increased levels of greenhouse gases) and the impacts of pollutants on human health (e.g., asthma, COPD, emphysema, and cancer).

ENV.4.2 Evaluate data and other information to explain how key natural resources (e.g., water sources, fertile soils, concentrations of minerals, and fossil fuels), natural hazards, and climate changes influence human activity (e.g., mass migrations, human health).

ENV.4.3 Enrichment: Research and analyze case studies to determine the impact of human-related and natural environmental changes on human health and communicate possible solutions to reduce/resolve the dilemma.

ENV.4.4 Enrichment: Explore online resources related to air pollution to determine air quality in a geographic area and communicate the possible effects on the environment and human health.

ENV.4.5 Enrichment: Use an engineering design process to define a problem, design, construct, evaluate, and improve a device or method to reduce or prevent human impact on a natural resource (e.g., build a water filter, design an air purifier, develop a method to prevent parking lot pollution from entering a watershed).*

FOUNDATIONS OF BIOLOGY

FB.1 History of Biology and Impacts on Society

Conceptual Understanding: The history of science is a compilation of the works of many people. To understand science and its applications, the history of scientific experiments and developments must be understood. The needs of society have been the driving force behind numerous advances in science and technology. Advances in science and technology have forever changed, and will continue to change, society.

FB.1 Students will relate the importance of significant historical biological experiments and their impact of these on research, development, and society.

FB.1.1 Identify and communicate the contributions of famous scientists and their experiments that formed fundamental scientific principles (e.g., Robert Hooke, Schleiden/ Schwann/Virchow, Griffith, Avery/MacLeod/McCarty, Hershey/Chase, Rosalind Franklin, Gregor Mendel, Watson/Crick, Pasteur, and Charles Darwin).

FB.1.2 Trace and model the historical development of scientific ideas and theories (e.g., creation of the microscope, discovery of cells/cell theory, discovery of DNA/RNA, double helical shape of DNA, evolution/natural selection, endosymbiosis) through the development of a timeline.

FB.1.3 Research, analyze, explain, and communicate how scientific enterprise relates to society and classic inventions (e.g., microscope, blood typing, gel electrophoresis equipment, DNA sequencing technology).

FB.1.5 Enrichment: Research, analyze, explain, and communicate the influence of society, including cultural components, on the direction and progress of science and technology (e.g., medical treatments, emerging viruses, antibiotic resistance, vaccinations and re-emergent diseases, alternative energy development, and/or biomimicry.

FB.2 The Chemistry of Life

Conceptual Understanding: Living and non-living things are composed of elements. Elements have the unique ability to form compounds and molecules based on their atomic structures. Water has unique properties that allow it to form solutions with a variety of compounds. Living organisms are composed of biological molecules that interact with water and through chemical reactions, help to maintain homeostasis.

FB.2 Students will demonstrate an understanding of the structure and interactions of matter and how the organization of matter supports living organisms.

FB.2.1 Develop and use simple atomic models to describe the components of elements (e.g., relative position, charges of protons, neutrons, and electrons).

FB.2.2 Obtain and use information about elements (e.g., chemical symbol, atomic number, atomic mass, and group or family) to describe the organization of the periodic table.

FB.2.3 Relate chemical reactivity to an element's position on the periodic table. Use this information to determine what type of bond will form between elements (ionic, covalent, hydrogen).

FB.2.4 Analyze and interpret data to classify common solutions as acids, bases, or neutral. Communicate the importance of pH in living systems.

FB.2.5 Investigate how the properties of water (e.g., cohesion, adhesion, heat capacity, solvent properties) contribute to the maintenance of living cells and organisms.

FB.2.6 Explain the role of the major biomolecules (carbohydrates, proteins -including enzymes, lipids, and nucleic acids) to the survival of living organisms.

FB.2.7 Enrichment: Explore the structure of biomolecules using molecular models. Relate the structure of biomolecules to their function in living things (discuss types bonding, importance of the strength and weakness of the bond in function, energy in bonds, enzyme function).

FB.3 Organization and Energy in Living Systems

Conceptual Understanding: Cells are the basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular). Living things use their cells to acquire energy from their environment to grow and reproduce, and then they respond and adapt to that environment for survival.

FB.3 Students will demonstrate an understanding of how the structure of living organisms supports the essential functions of life.

FB.3.1 Compare and contrast prokaryotic/eukaryotic and plant/animal/bacteria cells.

FB.3.2 Use models to investigate and explain structures within living cells that support life (e.g., cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, Golgi, vacuoles, ER, ribosomes, chromosomes, centrioles, cytoskeleton, nucleolus, nuclear membrane).

FB.3.3 Compare and contrast active and passive cellular transport. Analyze the movement of water across a cell membrane in hypotonic, isotonic, and hypertonic solutions.

FB.3.5 Analyze the relationship between photosynthesis and cellular respiration and explain that relationship in terms of the need for all living things to acquire energy from their environment.

FB 3.6 Use models to explain how ADP and ATP cycle to store and release chemical energy using inorganic phosphate.

FB.3.7 Compare and contrast the processes and results of mitosis and meiosis.

FB.3.8 Enrichment: Research and orally communicate the possible outcomes of a failure of mitosis (cancer) or meiosis (nondisjunction).

FB.4 Molecular Basis of Heredity

Conceptual Understanding: One strand of DNA creates a chromosome. Chromosomes have genes, which are simply segments of DNA. The information stored in DNA (in genes on chromosomes) determines the unique characteristics of an individual. DNA is the blueprint for RNA through transcription, which in turn, allows for the creation of a protein through translation. Modern technologies allow humans to manipulate DNA, RNA, and proteins to solve human dilemmas. Using technology to manipulate genetic information is controversial.

FB.4 Students will demonstrate an understanding of how genetic information is transferred from parent to offspring.

FB.4.1 Compare and contrast the basic structure and function of nucleic acids (e.g., DNA, RNA).

FB.4.2 Obtain and communicate information illustrating the relationships among DNA, genes, chromosomes, and proteins to the basis of life.

FB.4.3 Use models (e.g., Punnett squares) and mathematical reasoning to describe and predict patterns of inheritance of single genetic traits from parents to offspring (e.g., dominant, and recessive traits, incomplete dominance, codominance, multiple alleles, sex- linkage).

FB.4.4 Obtain and communicate information to describe how mutations may affect genetic expression and provide examples.

FB.4.5 Research and report genetic technologies that may improve the quality of life (e.g., genetic engineering, cloning, gene splicing, DNA testing).

FB.4.6 Enrichment: Debate the pros and cons of using biotechnology to manipulate genetic information for human purpose (society).

FB.5 Biological Evolution

Conceptual Understanding: The geologic time scale interpreted from rock strata and fossil evidence provides a way to organize major historical events in Earth's history. Rock strata can document the existence, diversity, extinction, and changes in many life forms. Adaptation by natural selection acting over generations is one important process by which species gradually change to respond to environmental pressures.

FB.5 Students will demonstrate an understanding of Earth's fossil record and its indication of the diversity of life over time.

FB.5.1 Investigate through research the contributions of scientists to the theory of evolution and evolutionary processes (e.g., Needham, Spallanzani, Redi, Pasteur, Lyell, Lamark, Malthus, Wallace, Darwin).

FB.5.2 Analyze and interpret data to support claims that different types of fossils provide evidence of the diversity of life that has existed on Earth and of the relationships between past and existing life on Earth.

FB.5.3 Obtain and communicate information to explain how DNA evidence and fossil records support Darwin's theory of evolution.

FB.5.4 Investigate how biological adaptations and genetic variations of traits in a population enhance the probability of survival in an environment (natural selection).

FB.5.5 **Enrichment:** Create and analyze models that illustrate the relatedness between all living things (cladograms/phylogenic trees).

FB.6 Ecological Principals

Conceptual Understanding: Ecosystems are dynamic in nature, full of complex interactions that affect the numbers and types of organisms that can survive. Biotic and abiotic factors affect ecosystems, allowing for them to sustain only a limited number of organisms and populations, known as a carrying capacity. There is a delicate balance that exists between the living and non-living things in an ecosystem. Humans can interrupt this balance, causing both local and global environmental issues.

FB.6 Students will understand the interdependence of living organisms and their environment.

FB 6.1 Compare and contrast biotic and abiotic factors.

FB 6.2 Use models to analyze the cycling of matter in an ecosystem (e.g., water, carbon dioxide/oxygen, nitrogen).

FB.6.3 Obtain, evaluate, and communicate information to explain relationships that exist between abiotic and biotic components of an ecosystem. Explain how changes in biotic and abiotic components affect the balance of an ecosystem over time.

FB 6.4 Develop and use models to discuss the climate, flora, and fauna of the terrestrial and aquatic biomes of the world.

FB 6.5 Use models to analyze the flow of energy through food chains, webs, and pyramids.

FB 6.6 Engage in scientific argument from evidence to distinguish organisms that exist in symbiotic (mutualism, parasitism, commensalism) or co-evolutionary (predator-prey, cooperation, competition, and mimicry) relationships within ecosystems.

FB 6.7 Enrichment: Design solutions to reduce the impact of human activity on the ecosystem.

FOUNDATIONS OF SCIENCE LITERACY

FSL.1 History of Science and Impacts on Society

Conceptual Understanding: The history of science is a compilation of the works of many people. To understand science and its applications, the history of scientific experiments and developments must be understood. The needs of society have been the driving force behind numerous advances in science and technology. Advances in science and technology have forever changed, and will continue to change, society.

FSL.1 Students will relate the importance of significant historical experiments and their impact on research and development.

FSL.1.1 Trace and model the historical development of scientific ideas and theories (e.g., atomic theory, plate tectonics, evolution, genetics, discovery of cells) through the development of a timeline.

FSL.1.2 Research, analyze, explain, and communicate how scientific enterprise relates to society and classic inventions (e.g., microscope, telescope, computer, and telephone).

FSL.1.3 Identify and communicate the impact of mathematics and technology in the development of scientific thought and the practice of science (e.g., space exploration, the human genome project, and ocean exploration).

FSL.1.4 **Enrichment:** Research, analyze, explain, and communicate the influence of society, including cultural components, on the direction and progress of science and technology (e.g., medical treatments, antibiotic resistance, alternative energy development, and biomimicry).

FSL.2 Nature of Technology and Engineering

Conceptual Understanding: Societal demands influence the need for engineering design and technology. The goal of engineering is to design and manufacture useful devices or materials (technologies) to meet societal demands. Global challenges such as climate change, medical treatments, space exploration, food supply, and clean water drive engineering design and technology development to solve societal needs and wants. Engineering practices are critical to undertaking the world's challenges. Exposure to engineering activities sparks interest in the study of science, technology, engineering, and mathematics careers.

FSL.2 Students will identify, research, and communicate the development of technology and engineering practices.

FSL.2.1 Research and present a technology that was developed through engineering design. Identify its purpose, how it has advanced through alterations in design (e.g., systems that provide homes and businesses with utilities, parking structures, park and recreational structures, and traffic flow), and careers related to its use).

FSL.2.2 Use an engineering design process to identify a problem within the local community, and propose and develop a possible solution for that problem.*

FSL.2.3 **Enrichment:** Use a computer simulation to model the impact of proposed solutions on a complex, real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.*

FSL.3 Nature of Science

Conceptual Understanding: Science is characterized by the systematic gathering of information through various forms of direct and indirect observations, and the testing of this information by methods including, but not limited to, experimentation. By formulating their own questions, planning, and conducting investigations, learners build new meaning, understanding, and knowledge of science. This helps develop their critical thinking, reasoning and decision-making skills that will serve a learner for a lifetime.

FSL.3A Students will apply science and engineering practices and skills to scientific investigations.

FSL.3A.1 Ask questions and conduct research to generate a hypothesis, determine independent/dependent variables, and appropriate controls for scientific investigations and experiments.

FSL.3A.2 Analyze data from simple experiments and construct organized models (e.g., data tables, graphs) detailing results from the experiments.

FSL.3A.3 Demonstrate the proper use of safety procedures and scientific laboratory equipment. Select and use appropriate tools and instruments to collect qualitative and quantitative data.

FSL.3A.4 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for investigations, and (3) compare or combine data from two or more simple data presentations (e.g., order or sum data from a table, categorize data from a table using a scale from another table).

FSL.3A.5 Analyze data sets from experiments for patterns and trends and identify any weaknesses in the experimental designs.

Conceptual Understanding: Scientists interpret tables, graphs, and diagrams to locate data, examine relationships in the data, and extend those relationships beyond the data. Students should analyze scientific investigations and data presented in passages like those found in the science section of the ACT (e.g., Data Representation, Research Summaries, and Conflicting Viewpoint passages).

FSL.3B Students will apply scientific literacy and thinking skills to analyze and interpret data found in various graphics including, but not limited to, those found in sample ACT science passages.

FSL.3B.1 Analyze select data from a simple and complex data presentation (e.g., charts, graphs, diagrams).

FSL.3B.2 Compare or combine data from two or more simple data presentations (e.g., order or sum data from a table, categorize data from a table using a scale from another table, relationships between data sets).

FSL.3B.3 Translate information into a table, graph, or diagram. Determine patterns, trends, and relationships as the values of variables change.

FSL.3B.4 Perform a simple interpolation or simple extrapolation using data in a table or graph.
Determine and/or use a simple (e.g., linear) mathematical relationship that exists between data.

FSL.3B.5 Analyze presented information when given new information (e.g., given a new scenario, how would a given scenario be changed).

Conceptual Understanding: Scientists understand experimental design and procedures, compare designs and procedures across experiments, and understand how changes in design and procedures affect experimental results. Students should analyze scientific investigations and data presented in passages like those found in the science section of the ACT (e.g., Data Representation, Research Summaries, and Conflicting Viewpoint passages) to understand experimental designs and procedures.

FSL.3C Students will apply scientific literacy and thinking skills to analyze scientific investigations found in various experimental designs including, but not limited to, those found in sample ACT science passages.

FSL.3C.1 Analyze the methods and choice of tools used in simple and complex experimental designs.

FSL.3C.2 Determine the validity of scientific questions (e.g., hypothesis) and variables for complex experimental designs.

FSL.3C.3 Select and describe an alternate method for testing a hypothesis.

FSL.3C.4 Predict how modifying the experimental design or adding another measurement in an experimental design will affect results of the experiment.

FSL.3C.5 Determine which additional trials could be performed in an investigation to enhance the results of an experimental design.

Conceptual Understanding: Scientists evaluate multiple explanations for the same phenomena to determine their differences, similarities, strengths, and weaknesses, and evaluating the validity of conclusions based on experimental results. They evaluate the validity of conclusions based on experimental results. Students should analyze scientific investigations and data presented in passages like those found in the science section of the ACT (e.g., Data Representation, Research Summaries, and Conflicting Viewpoint passages) to evaluate scientific explanations.

FSL.3D Students will apply scientific literacy and thinking skills to evaluate theoretical models, inferences, and experimental results found in various experimental designs including, but not limited to, those found in sample ACT science passages.

FSL.3D.1 Select the hypothesis, prediction, or conclusion that is, or is not, supported by data presentation or pieces of informational text.

FSL.3D.2 Determine whether given information supports or contradicts a hypothesis or conclusion, and provide support for the reasoning.

FSL.3D.3 Analyze and interpret data from informational texts and data to (1) reveal patterns and construct meaning (2) support or refute hypotheses, explanations, claims or designs, or (3) evaluate the strength of conclusions.

FSL.3D.4 Use new information to make a prediction based on a theoretical model.

FSL.3D.5 Select and explain why a hypothesis, prediction, or conclusion is, or is not, supported by two or more data presentations or theoretical models.

GENETICS

GEN.1 Structure and Function of DNA

Conceptual Understanding: Chromosomes, the carriers of genetic information, are composed of both DNA and proteins. A significant body of evidence generated through multiple experiments by many scientists led to the conclusion that DNA is the universal genetic material. Once this was established, efforts focused on deciphering the structure of DNA and the mechanism through which DNA is passed on to cells with little to no errors. These discoveries formed the foundation of modern molecular genetics.

GEN.1A Students will demonstrate that all cells contain genetic material in the form of DNA.

GEN.1A.1 Model the biochemical structure, either 3-D or computer-based, of DNA based on the experimental evidence available to Watson and Crick (Chargaff, 1950; Franklin, 1951).

GEN.1A.2 Explain the importance of the historical experiments that determined that DNA is the heritable material of the cell (Griffith, 1928; Avery, McCarty & MacLeod, 1944; Hershey & Chase, 1952).

GEN.1A.3 Relate the structure of DNA to its specific functions within the cell.

GEN.1A.4 Conduct a standard DNA extraction protocol using salt, detergent, and ethanol from various cell types (e.g., plant, animal, fungus). Compare and contrast the consistency and quantity of DNA extracted from various cell types.

GEN.1A.5 Enrichment: Use an engineering design process to refine the methodology to optimize the DNA-extraction process for various cell types.*

GEN.1A.6 Investigate the structural differences between the genomes (i.e., circular/linear chromosomes and plasmids) found in prokaryotes and eukaryotes.

Conceptual Understanding: Before a cell divides, the DNA sequence of its chromosomes is replicated, and each daughter cell receives a copy. In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow.

GEN.1B Students will analyze how the DNA sequence is copied and transmitted to new cells.

GEN.1B.1 Compare and contrast various proposed models of DNA replication (i.e., conservative, semi- conservative, and disruptive). Evaluate the evidence used to determine the mechanism of DNA replication.

GEN.1B.2 Develop and use models to illustrate the mechanics of DNA replication.

GEN.1B.3 Microscopically observe and analyze the stages of the cell cycle (G1-S-G2-M) to describe the phenomenon, and identify methods at different cell cycle checkpoints through which the integrity of the DNA code is maintained.

GEN.2 Transcription, Translation, and Mutations

Conceptual Understanding: The genetic information stored in the DNA molecule is expressed to produce a protein and result in the formation of an observable trait, or phenotype, in the organism. Gene expression leads to protein production through the processes of transcription in the nucleus and translation in the ribosome.

GEN.2A Students will analyze and explain the processes of transcription and translation in protein production.

GEN.2A.1. Compare and contrast the structure of RNA to DNA and relate this structure to the different function of each molecule.

GEN.2A.2 Describe and model how the process of transcription produces RNA from a DNA template in both prokaryotes and eukaryotes.

GEN.2A.3 Develop a model to show the relationship between the components involved in the mechanics of translation at the ribosome.

GEN.2A.4 Analyze the multiple roles of RNA in translation. Compare the structure and function of tRNA, rRNA, mRNA, and snRNA.

GEN.2A.5 Enrichment: Evaluate Beadle and Tatum's "One Gene-One Enzyme Hypothesis" (1941) in the development of the central dogma (DNA →RNA →Protein). Explain how new discoveries, such as alternate splicing of introns, have led to the revision of the central dogma.

Conceptual Understanding: Mutations may result in the formation of new gene alleles, alter protein structure, and produce new phenotypes.

GEN.2B Students will determine the causes and effects of mutations in DNA.

GEN.2B.1 Identify factors that cause mutations (e.g., environmental, errors in replication, and viral infections).

GEN.2B.2 Explain how these mutations may result in changes in protein structure and function.

GEN.2B.3 Describe cellular mechanisms that can help to minimize mutations (e.g., cell cycle checkpoints, DNA polymerase proofreading, and DNA repair enzymes).

GEN.2B.4 Investigate the role of mutations and the loss of cell cycle regulation in the development of cancers.

GEN.2B.5 Enrichment: Use an engineering design process to research the current status of genetic technology and personalized medicine, then propose and test targeted medical or forensic applications.*

GEN.3 Biotechnological Applications

Conceptual Understanding: The application of modern molecular genetics led to the development of recombinant DNA technology and the subsequent explosion of biotechnology applications. Biotechnology and the use of genetically modified organisms have altered many aspects of daily life, including forensics, agriculture, and medicine.

GEN.3 Students will investigate biotechnology applications and bioengineering practices.

GEN.3.1 Explain and demonstrate the use of various tools and techniques of DNA manipulation and their applications in forensics (e.g., paternity and victim/suspect identification), agriculture (e.g., pesticide or herbicide resistance, improved yields, and improved nutritional value), and personalized medicine (e.g., targeted therapies, cancer treatment, production of insulin and human growth hormone, and engineering insect vectors of human parasites).

GEN.3.2 Experimentally demonstrate genetic transformation, protein purification, and/or gel electrophoresis.

GEN.3.3 Enrichment: Use an engineering design process to refine methodology and optimize the process of genetic transformation, protein purification, and/or gel electrophoresis.*

GEN.3.4 Enrichment: Develop logical arguments based on scientific evidence for and against ethical concerns regarding biotechnology/bioengineering.

GEN.4 Classic Mendelian Genetics

Conceptual Understanding: Gregor Mendel is known as the "Father of Genetics" due to his work with pea plants, which established that traits are passed from parents to offspring in predictable ways. Mendel's findings formed the foundation from which geneticists can determine the mode of inheritance of various traits (e.g., dominant, recessive, and codominant).

GEN.4 Students will analyze and interpret data collected from probability calculations to explain the inheritance of traits within a population.

GEN.4.1 Demonstrate Mendel's law of dominance and segregation using mathematics to predict phenotypic and genotypic ratios.

GEN.4.2 Illustrate Mendel's law of independent assortment by analyzing multi-trait cross data sets for patterns and trends.

GEN.4.3 Investigate traits that follow non-Mendelian inheritance patterns (e.g., incomplete dominance, codominance, multiple alleles, autosomal linkage, sex-linkage, polygenic, and epistasis).

GEN.4.4 Construct pedigrees from observed phenotypes. Analyze and interpret data to determine patterns of inheritance and disease risk.

GEN.4.5 Enrichment: Construct maps of genes on a chromosome based on data obtained from 2- and/or 3-point crosses or from recombination frequencies.

GEN.5 Population Genetics

Conceptual Understanding: Most species display considerable amounts of genetic variation. The variation is represented as differences in allele frequencies within the gene pool of populations of a species. Variations in the structure of gene pools form the basis of evolutionary change.

GEN.5 Students will apply population genetic concepts to explain variability of organisms within a population.

GEN.5.1 Model the inheritance of chromosomes through meiotic cell division and demonstrate how meiosis and sexual reproduction lead to genetic variation in populations.

GEN.5.2 Explain how natural selection acts upon genetic variability within a population and may lead to changes in allelic frequencies over time and evolutionary changes in populations.

GEN.5.3 Describe processes that cause changes in allelic frequencies (e.g., nonrandom mating, small population size, immigration and emigration, genetic drift, and mutation).

GEN.5.4 Apply the Hardy-Weinberg formula to analyze changes in allelic frequencies due to natural selection in a population. Relate these changes to the environmental fitness of the phenotypes.

GEN.5.5 Enrichment: Analyze computer simulations of the effects of natural selection on allelic frequencies in a population.

GEN.5.6 Enrichment: Apply the concept of natural selection to analyze differences in human populations (e.g., skin color, lactose persistence, sickle cell anemia, and malaria).

GEN.5.7 Enrichment: Use genomic databases for sequence analysis and apply the information to species comparisons, evolutionary relationships, and/or determine the molecular basis of inherited disorders.

HUMAN ANATOMY AND PHYSIOLOGY

HAP.1 Physiological Functions/Anatomical Structure

Conceptual Understanding: Anatomists have developed a universal set of reference terms that aid in the identification of body structures with a high degree of specificity. Body organization from simple to complex levels and an introduction to the organ systems forming the body lead to a higher understanding of anatomical structures in the human body.

HAP.1 Students will demonstrate an understanding of how anatomical structures and physiological functions are organized and described using anatomical position.

HAP.1.1 Apply appropriate anatomical terminology when explaining the orientation of regions, directions, and body planes or sections.

HAP.1.2 Locate organs and their applicable body cavities and systems.

HAP.1.3 Investigate the interdependence of the various body systems to each other and to the body as a whole.

HAP.2 Cells and Tissues

Conceptual Understanding: The smallest structural and functional unit of the human body is the cell. The cell is composed of organelles that perform varied but specific functions. Cells within the human body can metabolize, digest foods, dispose of waste, reproduce, grow, move, and respond to stimuli. Groups of cells that are similar in structure and function form the four types of tissues (epithelial, connective, nervous, and muscle) found in the human body.

HAP.2 Students will demonstrate an understanding of the relationship of cells and tissues that form complex structures of the body.

HAP.2.1 Analyze the characteristics of the four main tissue types: epithelial, connective, muscle, and nervous. Examine tissues using microscopes and other various technologies.

HAP.2.2 Construct a model to demonstrate how the structural organization of cells in a tissue relates to the specialized function of that tissue.

HAP.2.3 Enrichment: Use an engineering design process to research and develop medications (i.e., targeted cancer therapy drugs) that target uncontrolled cancer cell reproduction.*

HAP.3 Integumentary System

Conceptual Understanding: The integumentary system is composed of epithelial membranes (i.e., skin epidermis, mucosae, and serosae). The connective-tissue synovial membranes cover, insulate, protect, and cushion body organs as well as the entire body. The integumentary system is critical to maintaining homeostasis using internal and external regulators.

HAP.3 Students will investigate the structures and functions of the integumentary system, including the cause and effect of diseases and disorders.

HAP.3.1 Identify structures and explain the functions of the integumentary system, including layers of skin, accessory structures, and types of membranes.

HAP.3.2 Investigate specific mechanisms (e.g., feedback and temperature regulation) through which the skin maintains homeostasis.

HAP.3.3 Research and analyze the causes and effects of various pathological conditions (e.g., burns, skin cancer, bacterial/viral infections, and chemical dermatitis).

HAP.3.4 Enrichment: Use an engineering design process to design and model/simulate effective treatments for skin disorders (e.g., tissue grafts).*

HAP.4 Skeletal System

Conceptual Understanding: The skeletal system is composed of cartilage and bone. Together these supportive tissues form the framework for the body. The skeletal system encloses organs, attaches skeletal muscles, and connects bone, forming joints to aid in movement.

HAP.4 Students will investigate the structures and functions of the skeletal system including the cause and effect of diseases and disorders.

HAP.4.1 Use models to compare the structure and function of the skeletal system.

HAP.4.2 Develop and use models to identify and classify major bones as part of the appendicular or axial skeleton.

HAP.4.3 Identify and classify types of joints and their movement.

HAP.4.4 Demonstrate an understanding of the growth and development of the skeletal system, differentiating between endochondral and intramembranous ossification.

HAP.4.5 Construct explanations detailing how mechanisms (e.g., Ca2+ regulation) are used by the skeletal system to maintain homeostasis.

HAP.4.6 Research and analyze various pathological conditions (e.g., bone fractures, osteoporosis, bone cancers, various types of arthritis, and carpal tunnel syndrome).

HAP.4.7 Enrichment: Use an engineering design process to develop, model, and test effective treatments for bone disorders (i.e., prosthetics).*

HAP.5 Muscular System

Conceptual Understanding: The muscular system, with the aid of three types of muscle tissue (skeletal, cardiac, and smooth), provides movement, contour and shape, joint stability, heat generation, and the transportation of materials throughout the body.

HAP.5 Students will investigate the structures and functions of the muscular system, including the cause and effect of diseases and disorders.

HAP.5.1 Develop and use models to illustrate muscle structure, muscle locations and groups, actions, origins, and insertions.

HAP.5.2 Describe the structure and function of the skeletal muscle fiber and the motor unit.

HAP.5.3 Explain the molecular mechanism of muscle contraction and relaxation.

HAP.5.4 Use models to locate the major muscles and investigate the movements controlled by each muscle.

HAP.5.5 Compare and contrast the anatomy and physiology of the three types of muscle tissue.

HAP.5.6 Use technology to plan and conduct an investigation that demonstrates the physiology of muscle contraction, muscle fatigue, or muscle tone. Collect and analyze data to interpret results, then explain and communicate conclusions.

HAP.5.7 Research and analyze the causes and effects of various pathological conditions, (e.g., fibromyalgia, muscular dystrophy, cerebral palsy, muscle cramps/strains, and tendonitis).

HAP.5.8 Enrichment: Use an engineering design process to develop effective ergonomic devices to prevent muscle fatigue and strain (e.g., carpal tunnel, exoskeletons for paralysis, or training plans to prevent strains/sprains/cramps).*

HAP.6 Nervous System

Conceptual Understanding: The nervous system is composed of the central nervous system and the peripheral nervous system. These divisions work together to create every thought, action, and sensation that occurs within the body. The exploration of the special senses will provide an understanding of sight, hearing, smell, and taste.

HAP. 6 Students will investigate the structures and functions of the nervous system, including the cause and effect of diseases and disorders.

HAP.6.1 Describe and evaluate how the nervous system functions and interconnects with all other body systems.

HAP.6.2 Analyze the structure and function of neurons and their supporting neuroglia cells (e.g. astrocytes, oligodendrocytes, Schwann cells, microglial).

HAP.6.3 Discuss the structure and function of the brain and spinal cord.

HAP.6.4 Compare and contrast the structures and functions of the central and peripheral nervous systems. Investigate how the systems interact to maintain homeostasis (e.g., reflex responses, sensory responses).

HAP.6.5 Enrichment: Plan and conduct an experiment to test reflex response rates under varying conditions. Using technology, construct graphs in order to analyze and interpret data to explain and communicate conclusions.

HAP.6.6 Describe the major characteristics of the autonomic nervous system. Contrast the roles of the sympathetic and parasympathetic nervous systems in maintaining homeostasis.

HAP.6.7 Describe the structure and function of the special senses (i.e., vision, hearing, taste, and olfaction).

HAP.6.8 Research and analyze the causes and effects of various pathological conditions (e.g., addiction, depression, schizophrenia, Alzheimer's, sports-related chronic traumatic encephalopathy [CTE], dementia, chronic migraine, stroke, and epilepsy).

HAP.6.9 Enrichment: Use an engineering design process to develop, model, and test preventative devices for neurological injuries and/or disorders (e.g., concussion-proof helmets or possible medications for addiction and depression).*

HAP.7 Endocrine System

Conceptual Understanding: The endocrine system, using hormones, gives instructions that control growth and development, reproductive capabilities, and the physiological homeostasis of the body systems.

HAP.7 Students will demonstrate an understanding of the major organs of the endocrine system and the associated hormonal production and regulation.

HAP.7.1 Obtain, evaluate, and communicate information to illustrate that the endocrine glands secrete hormones that help the body maintain homeostasis through feedback mechanisms.

HAP.7.2 Discuss the function of each endocrine gland and the various hormones secreted.

HAP.7.3 Model specific mechanisms through which the endocrine system maintains homeostasis (e.g., insulin/glucagon and glucose regulation; T3 / T4 and metabolic rates; calcitonin/parathyroid and calcium regulation; antidiuretic hormone and water balance; growth hormone; and cortisol and stress).

HAP.7.4 Research and analyze the effects of various pathological conditions (e.g., diabetes mellitus, pituitary dwarfism, Graves' disease, Cushing's syndrome, hypothyroidism, and obesity).

HAP.7.5 Enrichment: Use an engineering design process to develop effective treatments for endocrine disorders (e.g., methods to regulate hormonal imbalance).*

HAP.8 Male and Female Reproductive Systems

Conceptual Understanding: The reproductive system's biological function is to generate offspring for the roles in the production of an offspring. Proper embryonic development directly depends on the health of the reproductive system.

HAP. 8 Students will investigate the structures and functions of the male and female reproductive system, including the cause and effect of diseases and disorders.

HAP.8.1 Compare and contrast the structure and function of the male and female reproductive systems.

HAP.8.2 Describe the male reproductive anatomy and relate structure to sperm production and release.

HAP.8.3 Describe the female reproductive anatomy and relate structure to egg production and release.

HAP.8.4 Construct explanations detailing the role of hormones in the regulation of sperm and egg development. Analyze the role of negative feedback in regulation of the female menstrual cycle and pregnancy.

HAP.8.5 Evaluate and communicate information about various contraceptive methods to prevent fertilization and/or implantation.

HAP.8.6 Describe the changes that occur during embryonic/fetal development, birth, and the growth and development from infancy, childhood, and adolescence to adult.

HAP.8.7 Research and analyze the causes and effects of various pathological conditions (e.g., infertility, ovarian cysts, endometriosis, sexually transmitted diseases, and ectopic pregnancy). Research current treatments for infertility.

HAP.9 Blood

Conceptual Understanding: Blood is the necessary fluid that transports oxygen and other elements throughout the body and removes waste products. Blood's unique composition allows for grouping into four major blood type groups (A, B, AB, and O). Blood types are based on the presence or absence of inherited antigens on the surface of the red blood cells.

HAP.9 Students will analyze the structure and functions of blood and its role in maintaining homeostasis.

HAP.9.1 Describe the structure, function, and origin of the cellular components and plasma components of blood.

HAP.9.2 Distinguish the cellular difference between the ABO blood groups and investigate blood type differences utilizing antibodies to determine compatible donors and recipients.

HAP.9.3 Research and analyze the causes and effects of various pathological conditions (e.g., anemia, malaria, leukemia, hemophilia, and blood doping).

HAP.9.4 Enrichment: Use an engineering design process to develop effective treatments for blood disorders (e.g., methods to regulate blood cell counts or blood doping tests).*

HAP.10 Cardiovascular System

Conceptual Understanding: The cardiovascular system is composed of the heart and blood vessels. The heart is the mechanism that cycles the blood throughout the body via the blood vessels. Using blood as a carrier, the system transports nutrients, gases, wastes, antibodies, electrolytes, and many other substances to and from the cells of the body. The location, size, and orientation of the heart, blood vessels, veins, arteries, and capillaries are essential in maintaining cardiovascular health. Maintenance of this system is

HAP.10 Students will investigate the structures and functions of the cardiovascular system, including the cause and effect of diseases and disorders.

HAP.10.1 Design and use models to investigate the functions of the organs of the cardiovascular system.

HAP.10.2 Describe the flow of blood through the pulmonary system and systemic circulation.

HAP.10.3 Investigate the structure and function of different types of blood vessels (e.g., arteries, capillaries, veins). Identify the role each plays in the transport and exchange of materials.

HAP.10.4 Demonstrate the role of valves in regulating blood flow.

HAP.10.5 Plan and conduct an investigation to test the effects of various stimuli on heart rate and/or blood pressure. Construct graphs to analyze data and communicate conclusions.

HAP.10.6 Research and analyze the effects of various pathological conditions (e.g., hypertension, myocardial infarction, mitral valve prolapse, varicose veins, and arrhythmia).

HAP.10.7 Enrichment: Use an engineering design process to develop, model, and test effective treatments for cardiovascular diseases (e.g., methods to regulate heart rate, artificial replacement valves, open blood vessels, or strengthening leaky valves).*

HAP.11 Lymphatic System

Conceptual Understanding: The lymphatic system is composed of lymphoid vessels and organs. These vessels assist the cardiovascular system by maintaining blood volume. The lymphoid organs defend the body from pathogens by providing sites for development and maturation of immune system cells. There are multiple disorders of the immune system affecting the human population.

HAP. 11 Students will investigate the structures and functions of the lymphatic system, including the cause and effect of diseases and disorders.

HAP.11.1 Analyze the functions of leukocytes, lymph, and lymphatic organs in the immune system.

HAP.11.2 Compare the primary functions of the lymphatic system and its relationship to the cardiovascular system.

HAP.11.3 Compare and contrast the body's non-specific and specific lines of defense, including an analysis of the roles of various leukocytes: basophils, eosinophils, neutrophils, monocytes, and lymphocytes.

HAP.11.4 Correlate the functions of the spleen, thymus, lymph nodes, and lymphocytes to the development of immunity.

HAP.11.5 Differentiate the role of B-lymphocytes and T-lymphocytes in the development of humoral and cell-mediated immunity and primary and secondary immune responses.

HAP.11.6 Investigate various forms of acquired and passive immunity (e.g., fetal immunity, breastfed babies, vaccinations, and plasma donations).

HAP.11.7 Research and analyze the causes and effects of various pathological conditions (e.g., viral infections, auto-immune disorders, immunodeficiency disorders, and lymphomas).

HAP.12 Respiratory System

Conceptual Understanding: The respiratory system provides the body with an abundant and continuous supply of oxygen and removes carbon dioxide from the body. The organs of this system include the nose, pharynx, larynx, trachea, bronchi and their smaller branches, and the lungs. The interaction of these organs with the cardiovascular system transports respiratory gases to the tissue cells throughout the body. Interruptions in the mechanics of this system will lead to respiratory distress.

HAP. 12 Students will investigate the structures and functions of the respiratory system, including the cause and effect of diseases and disorders.

HAP.12.1 Design and use models to illustrate the functions of the organs of the respiratory system.

HAP.12.2 Describe structural adaptations of the respiratory tract and relate these structural features to the function of preparing incoming air for gas exchange at the alveolus.

HAP.12.3 Identify the five mechanics of gas exchange: pulmonary ventilation, external respiration, transport gases, internal respiration, and cellular respiration.

HAP.12.4 Enrichment: Use an engineering design process to develop a model of the mechanisms that support breathing, and illustrate the inverse relationship between volume and pressure in the thoracic cavity.*

HAP.12.5 Research and analyze the causes and effects of various pathological conditions (e.g., asthma, bronchitis, pneumonia, and COPD).

HAP.12.6 Research and discuss new environmental causes of respiratory distress (e.g., e-cigarettes, environmental pollutants, and changes in inhaled gas composition).

HAP.13 Digestive System

Conceptual Understanding: The digestive system processes food so that it can be absorbed and used by the body's cells. The organs of the system are responsible for food ingestion, digestion, absorption, and elimination of the undigested remains from the body.

HAP.13 Students will investigate the structures and functions of the digestive system, including the cause and effect of diseases and disorders.

HAP.13.1 Analyze the structure-function relationship in organs of the digestive system.

HAP.13.2 Use models to describe structural adaptations present in each organ of the tract and correlate the structures to specific processing of food at each stage (e.g., types of teeth; muscular, elastic wall and mucous lining of the stomach; villi and microvilli of the small intestine; and sphincters along the digestive tract).

HAP.13.3 Identify the accessory organs (i.e., salivary glands, liver, gallbladder, and pancreas) for digestion and describe their function.

HAP.13.4 Plan and conduct an experiment to illustrate the necessity of mechanical digestion for efficient chemical digestion.

HAP.13.5 Research and analyze the activity of digestive enzymes within different organs of the digestive tract, connecting enzyme function to environmental factors such as pH.

HAP.13.6 Evaluate the role of hormones (i.e., gastrin, leptin, and insulin) in the regulation of hunger and satiety/fullness.

HAP.13.7 Research and analyze the causes and effects of various pathological conditions (e.g., GERD/acid reflux, stomach ulcers, lactose intolerance, irritable bowel syndrome, gallstones, appendicitis, and hormonal imbalances and obesity).

HAP.13.8 Enrichment: Use an engineering design process to develop effective treatments for gastrointestinal diseases (e.g., methods to regulate stomach acids or soothe ulcers, treat food intolerance, and dietary requirements/modifications).*

HAP.14 Urinary System

Conceptual Understanding: The urinary system regulates the body's homeostasis by removing nitrogenous wastes while maintaining water balance, electrolytes, and the blood's acid/base balance within the body. The kidney is the primary filtration and reabsorption organ of the urinary system, controlling the composition of urine and, in turn, regulating blood composition. Improper function of the kidneys could lead to death if not corrected.

HAP.14 Students will investigate the structures and functions of the urinary system, including the cause and effect of diseases and disorders.

HAP.14.1 Understand the structure and function of the urinary system in relation to maintenance of homeostasis.

HAP.14.2 Describe the processes of filtration and selective reabsorption within the nephrons as it relates to the formation of urine and excretion of excess materials in the blood.

HAP.14.3 Investigate relationship between urine composition and the maintenance of blood sugar, blood pressure, and blood volume.

HAP.14.4 Enrichment: Conduct a urinalysis to compare the composition of urine from various "patients."

HAP.14.5 Develop and use models to illustrate the path of urine through the urinary tract.

HAP.14.6 Research and analyze the causes and effects of various pathological conditions and other kidney abnormalities (e.g., kidney stones, urinary tract infections, gout, dialysis, and incontinence).

MARINE AND AQUATIC SCIENCE I

MAQ.1 Water Properties and Quality

Conceptual Understanding: Water is essential to all life on earth. The chemical and physical properties of water allow for all essential processes with biota. Analysis of water quality indicates ecosystem health and balance. Recycling of water throughout the biosphere allows for replenishment of fresh water, but contamination by human activities are hindering the total amount of potable fresh water.

MAQ.1 Students will develop an understanding of the unique physical and chemical properties of water and how those properties shape life on earth.

MAQ.1.1 Characterize the physical and chemical properties of water, including specific heat, surface temperature, universal solvent, and hydrogen bonding between water molecules (i.e., cohesion/adhesion/capillary action).

MAQ.1.2 Describe the role of water within biological systems (e.g., provides the medium necessary to allow for life processes such as protein synthesis, enzymatic reactions, and passive transport).

MAQ.1.3 Diagram, utilizing digital or physical models, the water cycle and how it relates to the total amount of fresh water available to living things at any given time.

MAQ.1.4 Collect, analyze, and communicate quantitative data that includes dissolved oxygen, pH, temperature, salinity, mineral content, nitrogen compounds, and turbidity from an aquatic environment (i.e., hydrometer, refractometer, Secchi disk, and chemical test kits).

MAQ.1.5 Research, analyze, and communicate current technology and career opportunities available to collect this data on a global scale using CTD, buoy data, or satellites.

MAQ.1.6 Enrichment: Use an engineering design process to reduce the effects of pollution in aquatic ecosystems (e.g., microplastics, garbage patches, oil spills, and eutrophication). Students will design a proposed solution based on current research and/or observations, and develop a model in order to test their design. Data from experimentation will be analyzed, organized graphically, and communicated to classmates to determine the effectiveness of the proposed solution.*

MAQ.2 Fluid Dynamics

Conceptual Understanding: Fluid dynamics include properties and features of waves, currents, and tides. Each of these is vital for uniformity of temperature and chemical balance within ecosystems. Physical changes can be attributed to the movement of water, including shoreline development, erosion, and island formation. Climate change is influencing changes in our present fluid dynamic models.

MAQ.2 Students will develop an understanding of the principles of fluid dynamics as it relates to both salt and freshwater systems.

MAQ.2.1 Characterize wave features and wave properties, including wavelength, period, wave speed, breakers, and constructive waves and their effects on shoreline communities (e.g., headlands, embayments, shoreline erosion, and deposition).

MAQ.2.2 Survey predictable patterns of tides (i.e., tidal period and range, diurnal, semidiurnal, mixed, spring, and neap tides) to correlate with moon phases in graphical form.

MAQ.2.3 Summarize principles related to currents (e.g., global wind patterns, Coriolis effect, Ekman spiral, surface, thermohaline, upwelling, downwelling, El Niño, La Niña, hurricanes, Barrier Island movement).

MAQ.2.4 Research, analyze, and communicate scientific arguments to support climate models that predict how global and regional climate change can affect Earth's systems (e.g., precipitation and temperature and their associated impacts on sea level, global ice volumes, and atmosphere and ocean composition).

MAQ.2.5 Distinguish among lentic and lotic water systems, including water flow, seasonal overturn, and watershed mapping.

MAQ.3 Geological Features

Conceptual Understanding: Plate tectonics explain present geological features that can be described in different aquatic ecosystems. Natural phenomena, such as sea floor spreading, are caused by plate tectonic action. The distance from shoreline and availability of light classifies different areas of the ocean.

MAQ.3 Students will understand the principles of plate tectonics, sea floor spreading, and physical features of oceanic zones.

MAQ.3.1 Use geospatial data to analyze, explain, and communicate differences among the major geological features of specific aquatic ecosystems (e.g., plate tectonics, continental rise, continental slope, abyssal plain, trenches, sea mounts, island formation, and watersheds).

MAQ.3.2 Develop an understanding of plate tectonics to predict certain geological features (e.g., sea floor spreading, paleomagnetic measurements, and orogenesis).

MAQ.3.3 Classify zones of the ocean based on distance from shorelines (i.e., intertidal, neritic, oceanic, and benthic zones), temperature, and light availability (i.e., epipelagic, mesopelagic, bathypelagic, abyssopelagic, and hadopelagic).

MAQ.3.4 Classify zones of freshwater sources based on the velocity of current, depth, and temperature.

MAQ.4 Flora and Fauna

Conceptual Understanding: Unique flora and fauna can be found in different aquatic ecosystems. Their features and unique biochemistry may serve to further the human quality of life. However, human impacts and natural events have altered many of these ecosystems in different ways.

MAQ.4 Students will examine characteristics of specific aquatic ecosystems and the effects of human and natural phenomena on those ecosystems.

MAQ.4.1 Compare and contrast the unique biotic and abiotic characteristics of the following selected aquatic ecosystems: intertidal zone, wetlands/estuaries, coral reef, barrier islands, continental slope/shelf, abyss, rivers/streams/watersheds, and lakes/ponds.

MAQ.4.2 Recognize representative examples of plants and animals that would be specifically adapted to the aquatic ecosystems, and identify adaptations necessary to survive.

MAQ.4.3 Determine the niches within trophic levels in the aquatic ecosystems by creating food webs and researching the symbiotic relationships that exist.

MAQ.4.4 Research, analyze, and communicate the effects of urbanization and continued expansion by humans on the aquatic ecosystems' biodiversity (e.g., land use changes, erosion and sedimentation, over-fishing, invasive/exotic species, and pollution).

MAQ.4.5 Explore the importance of species diversity to the biological resources needed by human populations, including food (e.g., aquaculture and mariculture), medicine, and natural aesthetics.

MAQ.4.6 Research, analyze, and communicate the effects of natural phenomena (e.g., hurricanes, floods, drought, and sea-level rise) on the aquatic ecosystems.

MAQ.4.7 Research, analyze, and communicate which and in what capacity local, state, and federal regulatory agencies are involved in different aquatic ecosystems, including current environmental policies already in place (e.g., the Clean Water Act and the Endangered Species Act). Research should include, but is not limited to, how humans can preserve animal diversity through the use of habitat creation and conservation, research, legislation, medical and breeding programs, and management of genetic diversity at local and global levels.

MAQ.4.8 Enrichment: Choose an environmental issue that currently exists in one of the aquatic ecosystems and use an engineering design process to propose and develop a possible solution using scientific knowledge and best management practices (BMPs). Create an environmental action plan to include moral, legal, societal, political, and economic decisions that impact animal diversity in both the short and long term. Results from developed plans will be communicated with classmates.*

Marine and Aquatic Science II

MAQ.5 Primary Producers

Conceptual Understanding: Primary producers are the basis of every food web in aquatic ecosystems. While many producers are photosynthetic autotrophs, chemosynthesis is also a common form of energy conversion. Surveying shared and derived characteristics of producers demonstrates evolutionary development. Various methods are currently utilized to measure primary productivity in various ecosystems.

MAQ.5 Students will explore the biodiversity and interactions among aquatic life.

MAQ.5.1 Survey common primary producers and their roles in primary production in relation to geographical distribution within various aquatic ecosystems.

MAQ.5.2 List and describe common autotrophs that may be found in particular aquatic ecosystems, including prokaryotes (e.g., Cyanobacteria and Archaebacteria), protists (e.g., diatoms, dinoflagellates, green algae, kelp, sargassum, and red algae), and plants (e.g., cord grasses, reeds, seagrasses, and mangroves).

MAQ.5.3 Recognize characteristics that are shared and derived using graphical representations of primary-producer evolution and develop cladograms/phylogenetic trees.

MAQ.5.4 Use dichotomous keys to identify sample producers within an aquatic ecosystem.

MAQ.5.5 Paraphrase energy conversion processes (e.g., photosynthesis and chemosynthesis).

MAQ.5.6 Enrichment: Research, analyze, and communicate historical and current methodologies for measuring primary productivity. Use an engineering design process to design and develop improvements to measure primary productivity (e.g., the light and dark bottle method and satellite data).*

MAQ.6 Invertebrate Consumers

Conceptual Understanding: Many consumers found within aquatic ecosystems range from single-celled protozoa to multicellular invertebrates. While many of these consumers share basic morphological characteristics, derived characters demonstrate evolutionary relationships. Varied adaptations are found among these organisms for successful niches within selected ecosystems.

MAQ.6 Students will investigate characteristics of aquatic invertebrates.

MAQ.6.1 Characterize aquatic representatives of the following taxa: Protozoa (e.g., foraminiferians, radiolarians, amoeba, and paramecium), Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Rotifera, Mollusca, Arthropoda, Bryozoa, Brachiopoda, and Echinodermata.

MAQ.6.2 Identify characteristics that are shared and derived using graphical representations of animal evolution (i.e., cladograms and phylogenetic trees) and develop cladograms and phylogenetic trees.

MAQ.6.3 Develop a dichotomous classification key to be used in the identification of sample aquatic invertebrates.

MAQ.6.4 Compare and contrast major body plans (e.g., asymmetry, radial, bilateral symmetry, acoelomate, pseudocoelomate, and eucoelomate).

MAQ.6.5 Explain various life cycles found among animals (e.g., polyp and medusa in cnidarians, multiple hosts and stages in the platyhelminthic life cycle, and arthropod metamorphosis).

MAQ.6.6 Dissect representative taxa (e.g., clam and squid), collect data, compare their internal and external anatomy, analyze, explain, and communicate results.

MAQ.6.7 Using key morphological and physiological adaptations found within animal taxa, assess how animals interact with their environment to determine their ecological roles.

MAQ.6.8 Enrichment: Given a niche in a specific environment, use an engineering design process to design an animal, listing characteristics based on your knowledge of shared and derived characters, internal and external anatomy, and how the animal would adapt morphologically and physiologically relative to its ecological role and specific environment.*

MAQ.7 Vertebrate Consumers

Conceptual Understanding: Other consumers that inhabit aquatic ecosystems are found within Phylum Chordata. While many of these consumers share basic morphological characteristics, derived characteristics demonstrate evolutionary relationships. Various adaptations are found among these organisms for successful niches within selected ecosystems.

MAQ.7 Students will investigate characteristics of aquatic invertebrates.

MAQ.7.1 Characterize aquatic representatives of the following taxa: Hemichordata, Urochordata, Cephalochordata, and Vertebrata (including Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia).

MAQ.7.2 Identify characteristics that are shared and derived using graphical representation of animal evolution, and develop cladograms/phylogenetic trees.

MAQ.7.3 Utilize a dichotomous key to identify select aquatic vertebrates.

MAQ.7.4 Differentiate various life cycles found among animals (e.g., egg, tadpole, and adult stages of the amphibian life cycle; leathery eggs on land in reptiles; hard-shelled eggs in Aves; placental, marsupial, or monotremes in mammals; viviparous, ovoviviparous, and oviparous animals).

MAQ.7.5 Dissect representative taxa (e.g., shark, fish); collect data; compare their internal and external anatomy; and analyze, explain, and communicate results.

MAQ.7.6 Using key morphological and physiological adaptations found within aquatic vertebrate taxa, assess how animals interact with their environment to determine their ecological roles.

MAQ.7.7 Enrichment: Given a niche in a specific environment, use an engineering design process to design an animal, listing characteristics based on your knowledge of shared and derived characteristics, internal and external anatomy, and how the animal would adapt morphologically and physiologically relative to its ecological role and specific environment.*

PHYSICAL SCIENCE

PHS.1 Nature of Matter

Conceptual Understanding: To actively develop scientific investigation, reasoning, and logic skills, this standard develops basic ideas about the characteristics and structure of matter. Matter is anything that has mass and occupies space. All matter is made up of small particles called atoms. Matter can exist as a solid, liquid, gas, or plasma.

PHS.1 Students will demonstrate an understanding of the nature of matter.

PHS.1.1 Use contextual evidence to describe particle theory of matter. Examine the particle properties of solids, liquids, and gases.

PHS.1.2 Use scientific research to generate models to compare physical and chemical properties of elements, compounds, and mixtures.

PHS.1.3 Conduct an investigation to determine the identity of unknown substances by comparing properties to known substances.

PHS.1.4 Design and conduct investigations to explore techniques in measurements of mass, volume, length, and temperature.

PHS.1.5 Design and conduct an investigation using graphical analysis (e.g., line graph) to determine the density of liquids and/or solids.

PHS.1.6 Use mathematical and computational analysis to solve density problems. Manipulate the density formula to determine density, volume, or mass or use dimensional analysis to solve problems.

PHS.2 Atomic Theory

Conceptual Understanding: Many scientists have contributed to our understanding of atomic structure. The atom is the basic building block of matter and consists of subatomic particles (proton, neutron, electron, and quark) that differ in their location, charge, and relative mass.

PHS.2 Students will demonstrate an understanding of both modern and historical theories of atomic structure.

PHS.2.1 Research and develop models (e.g., 3-D models, online simulations, or ball and stick) to investigate both modern and historical theories of atomic structure. Compare models and contributions of Dalton, Thomson, Rutherford, Bohr, and of modern atomic theory.

PHS.3 Periodic Table

Conceptual Understanding: The organization of the periodic table allows scientists to obtain information and develop an understanding of concepts of atomic interactions. Developing scientific investigations increases logical reasoning and deduction skills to present the nature of science in the context of key scientific concepts.

PHS.3 Students will analyze the organization of the periodic table of elements to predict atomic interactions.

PHS.3.1 Use contextual evidence to determine the organization of the periodic table, including metals, metalloids, and nonmetals; symbols; atomic number; atomic mass; chemical families/groups; and periods/series.

PHS.3.2 Using the periodic table and scientific methods, investigate the formation of compounds through ionic and covalent bonding.

PHS.3.3 Using naming conventions for binary compounds, write the compound name from the formula, and write balanced formulas from the name (e.g., carbon dioxide - CO_2, sodium chloride - NaCl, iron III oxide- Fe_2O_3, and calcium bromide - $CaBr_2$).

PHS.3.4 Use naming conventions to name common acids and common compounds used in classroom labs (e.g., sodium bicarbonate (baking soda), $NaHCO_3$; hydrochloric acid, HCl; sulfuric acid, H_2SO_4 ; acetic acid (vinegar), $HC_2H_3O_2$; and nitric acid, HNO_3).

PHS.3.5 Use mathematical and computational analysis to determine the atomic mass of binary compounds.

PHS.4 The Law of Conservation of Matter and Energy

Conceptual Understanding: The law of conservation of matter and energy states that matter and energy can be transformed in different ways, but the total amount of mass and energy will be conserved. These concepts should be investigated and further developed in the classroom.

PHS.4 Students will analyze changes in matter and the relationship of these changes to the law of conservation of matter and energy.

PHS.4.1 Design and conduct experiments to investigate physical and chemical changes of various household products (e.g., rusting, sour milk, crushing, grinding, tearing, boiling, and freezing) and reactions of common chemicals that produce color changes or gases.

PHS.4.2 Design and conduct investigations to produce evidence that mass is conserved in chemical reactions (e.g., vinegar and baking soda in a Ziploc© bag).

PHS.4.3 Apply the concept of conservation of matter to balancing simple chemical equations.

PHS.4.4 Use mathematical and computational analysis to examine evidence that mass is conserved in chemical reactions using simple stoichiometry problems (1:1 mole ratio) or atomic masses to demonstrate the conservation of mass with a balanced equation.

PHS.4.5 Research nuclear reactions and their uses in the modern world, exploring concepts such as fusion, fission, stars as reactors, nuclear energy, and chain reactions.

PHS.4.6 Analyze and debate the advantages and disadvantages of nuclear reactions as energy sources.

PHS.5 Newton's Laws of Motion

Conceptual Understanding: Kinematics (contact forces) describe the motion of objects using words, diagrams, numbers, graphs, and equations. The goal of any study of kinematics is to develop scientific models to describe and explain the motion of real-world objects. Newton's laws of motion are an example of a tool that can aid in the explanation of motion.

PHS.5 Students will analyze the scientific principles of motion, force, and work.

PHS.5.1 Research the scientific contributions of Newton, and use models to communicate Newton's principles.

PHS.5.2 Design and conduct an investigation to study the motion of an object using properties such as displacement, time of motion, velocity, and acceleration.

PHS.5.3 Collect, organize, and interpret graphical data using correct metric units to determine the average speed of an object.

PHS.5.4 Use mathematical and computational analyses to show the relationships among force, mass, and acceleration (i.e., Newton's second law).

PHS.5.5 Design and construct an investigation using probe systems and/or online simulations to observe relationships between force, mass, and acceleration (F=ma).

PHS.5.6 Use an engineering design process and mathematical analysis to design and construct models to demonstrate the law of conservation of momentum (e.g., roller coasters, bicycle helmets, bumper systems).

PHS.5.7 Use mathematical and computational representations to create graphs and formulas that describe the relationships between force, work, and energy (i.e., W=Fd, KE=½ mv2, PE=mgh, W=KE).

PHS.5.8 Research the efficiency of everyday machines, and debate ways to improve their economic impact on society (e.g., electrical appliances, transportation vehicles).

PHS.6 Waves

Conceptual Understanding: Waves are everywhere in nature. Understanding of the physical world is not complete until we understand the nature, properties, and behaviors of waves. Students have experienced transverse and horizontal waves in their everyday lives. The exploration of waves in greater depth will allow students to conceptualize these waves. The goal is to develop various models of waves and apply those models to understanding wave interactions.

PHS.6 Students will explore the characteristics of waves.

PHS.6.1 Use models to analyze and describe examples of mechanical waves' properties (e.g., wavelength, frequency, speed, amplitude, rarefaction, and compression).

PHS.6.2 Analyze examples and evidence of transverse and longitudinal waves found in nature (e.g., earthquakes, ocean waves, and sound waves).

PHS.6.3 Generate wave models to explore energy transference.

PHS.6.4 Enrichment: Use an engineering design process to design and build a musical instrument to demonstrate the influence of resonance on music.*

PHS.6.5 Design and conduct experiments to investigate technological applications of sound (e.g., medical uses, music, acoustics, Doppler effects, and influences of mathematical theory on music).

PHS.6.6 Research real-world applications to create models or visible representations of the electromagnetic spectrum, including visible light, infrared radiation, and ultraviolet radiation.

PHS.6.7 Enrichment: Use an engineering design process to design and construct an apparatus that forms images to project on screen or magnify images using lenses and/or mirrors.*

PHS.6.8 Enrichment: Debate the particle/wave behavior of light.

PHS.7 Energy

Conceptual Understanding: Concepts about different energy forms and energy transformations continue to be expanded and explored in greater depth, leading to the development of more mathematical applications. Focus should be on students actively developing scientific investigations, reasoning, and logic skills.

PHS.7 Students will examine different forms of energy and energy transformations.

PHS.7.1 Using digital resources, explore forms of energy (e.g., potential and kinetic energy, mechanical, chemical, electrical, thermal, radiant, and nuclear energy).

PHS.7.2 Use scientific investigations to explore the transformation of energy from one type to another (e.g., potential to kinetic energy, and mechanical, chemical, electrical, thermal, radiant, and nuclear energy interactions).

PHS.7.3 Using mathematical and computational analysis, calculate potential and kinetic energy based on given data. Use equations such as PE=mgh and KE=½ mv2.

PHS.7.4 Conduct investigations to provide evidence of the conservation of energy as energy is converted from one form of energy to another (e.g., wind to electric, chemical to thermal, mechanical to thermal, and potential to kinetic).

PHS.8 Thermal Energy

Conceptual Understanding: Thermal energy is transferred in the form of heat. Heat is always transferred from an area of high heat to low heat. More complex concepts and terminology related to phase changes are developed, including the distinction between heat and temperature.

PHS. Students will demonstrate an understanding of temperature scales, heat, and thermal energy transfer.

PHS.8.1 Compare and contrast temperature scales by converting between Celsius, Fahrenheit, and Kelvin.

PHS.8.2 Apply particle theory to phase change and analyze freezing point, melting point, boiling point, vaporization, and condensation of different substances.

PHS.8.3 Relate thermal energy transfer to real-world applications of conduction (e.g., quenching metals), convection (e.g., movement of air masses/weather/plate tectonics), and radiation (e.g., electromagnetic).

PHS.8.4 Enrichment: Use an engineering design process to construct a simulation of heat energy transfer between systems. Calculate the calories/joules of energy generated by burning food products. Communicate conclusions based evidence from the simulation.*

PHS.9 Electricity

Conceptual Understanding: Electrical energy (both battery and circuit energy) is transformed into other forms of energy. Charged particles and magnetic fields are similar because they both store energy. Magnetic fields exert forces on moving charged particles. Students investigate practical uses of these concepts and develop a working understanding of the basic concepts of magnetism and electricity.

PHS.9 Students will explore basic principles of magnetism and electricity (e.g., static electricity, current electricity, and circuits).

PHS.9.1 Use digital resources and online simulations to investigate the basic principles of electricity, including static electricity, current electricity, and circuits. Use digital resources (e.g., online simulations) to build a model showing the relationship between magnetic fields and electric currents.

PHS.9.2 Distinguish between magnets, motors, and generators, and evaluate modern industrial uses of each.

PHS.9.3 Enrichment: Use an engineering design process to construct a working electric motor to perform a task. Communicate design process and comparisons of task performance efficiencies.*

PHS.9.4 Use an engineering design process to construct and test conductors, semiconductors, and insulators using various materials to optimize efficiency.*

PHYSICS

PHY.1 One-Dimensional Motion

Conceptual Understanding: Linear motion of objects is described by displacement, velocity, and acceleration. These concepts should be introduced as computational and investigative phenomena.

PHY.1 Students will investigate and understand how to analyze and interpret data.

PHY.1.1 Investigate and analyze evidence gained through observation or experimental design regarding the one-dimensional (1-D) motion of objects. Design and conduct experiments to generate and interpret graphical evidence of distance, velocity, and acceleration through motion.

PHY.1.2 Interpret and predict 1-D motion based on displacement vs. time, velocity vs. time, or acceleration vs. time graphs (e.g., free-falling objects).

PHY.1.3 Use mathematical and computational analysis to solve problems using kinematic equations.

PHY.1.4 Use graphical analysis to derive kinematic equations.

PHY.1.5 Differentiate and give examples of motion concepts such as distance-displacement, speed-velocity, and acceleration.

PHY.1.6 Design and mathematically/graphically analyze quantitative data to explore displacement, velocity, and acceleration of various objects. Use probe systems, video analysis, graphical analysis software, digital spreadsheets, and/or online simulations.

PHY.1.7 Design different scenarios, and predict graph shapes for distance/time, velocity/time, and acceleration/time graphs.

PHY.1.8 Given a 1D motion graph students should replicate the motion predicted by the graph.

PHY.2 Newton's Laws

Conceptual Understanding: Motion and acceleration can be explained by analyzing the contact interaction of objects. This motion and acceleration can be predicted by analyzing the forces (i.e., normal, tension, gravitational, applied, and frictional) acting on the object and applying Newton's laws of motion.

PHY.2 Students will develop an understanding of concepts related to Newtonian dynamics.

PHY.2.1 Identify forces acting on a system by applying Newton's laws mathematically and graphically (e.g., vector and scalar quantities).

PHY.2.2 Use models such as free-body diagrams to explain and predict the motion of an object according to Newton's law of motion, including circular motion.

PHY.2.3 Use mathematical and graphical techniques to solve vector problems and find net forces acting on a body using free-body diagrams and/or online simulations.

PHY.2.4 Use vectors and mathematical analysis to explore the 2D motion of objects. (i.e. projectile and circular motion).

PHY.2.5 Use mathematical and computational analysis to derive simple equations of motion for various systems using Newton's second law (e.g. net force equations).

PHY.2.6 Use mathematical and computational analysis to explore forces (e.g., friction, force applied, normal, and tension).

PHY.2.7 Analyze real-world applications to draw conclusions about Newton's three laws of motion using online simulations, probe systems, and/or laboratory experiences.

PHY.2.8 Design an experiment to determine the forces acting on a stationary object on an inclined plane. Test your conclusions.

PHY.2.9 Draw diagrams of forces applied to an object, and predict the angle of incline that will result in unbalanced forces acting on the object.

PHY.2.10 Apply the effects of the universal gravitation law to generate a digital/physical graph, and interpret the forces between two masses, acceleration due to gravity, and planetary motion (e.g., situations where g is constant, as in falling bodies).

PHY.2.11 Explain centripetal acceleration while undergoing uniform circular motion to explore Kepler's third law using online simulations, models, and/or probe systems.

PHY.3 Work and Energy

Conceptual Understanding: Work and energy are synonymous. When investigating mechanical energy, energy is the ability to do work. The rate at which work is done is called power. Efficiency is the ratio of power input to the output of the system. In closed systems, energy is conserved.

PHY.3 Students will develop an understanding of concepts related to work and energy.

PHY.3.1 Use mathematical and computational analysis to qualitatively and quantitatively analyze the concept of work, energy, and power to explain and apply the conservation of energy.

PHY.3.2 Use mathematical and computational analysis to explore conservation of momentum and impulse.

PHY.3.3 Through real-world applications, draw conclusions about mechanical potential energy and kinetic energy using online simulations and/or laboratory experiences.

PHY.3.4 Design and conduct investigations to compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions using probe systems, online simulations, and/or laboratory experiences.

PHY.3.5 Investigate, collect data, and summarize the principles of thermodynamics by exploring how heat energy is transferred from higher temperature to lower temperature until equilibrium is reached.

PHY.3.6 Enrichment: Design, conduct, and communicate investigations that explore how temperature and thermal energy relate to molecular motion and states of matter.

PHY.3.7 Enrichment: Use mathematical and computational analysis to analyze problems involving specific heat and heat capacity.

PHY.3.8 Enrichment: Research to compare the first and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency.

PHY.3.9 Explore the kinetic theory in terms of kinetic energy of ideal gases using digital resources.

PHY.3.10 Enrichment: Research the efficiency of everyday machines (e.g., automobiles, hair dryers, refrigerators, and washing machines).

PHY.3.11 Enrichment: Use an engineering design process to design and build a themed Rube Goldberg- type machine that has six or more steps and complete a desired task (e.g., pop a balloon, fill a bottle, shoot a projectile, or raise an object 35 cm) within an allotted time. Include a poster that demonstrates the calculations of the energy transformation or efficiency of the machine.*

PHY.4 Waves

Conceptual Understanding: Wave properties are the transfer of energy from one place to another. The investigation of these interactions must include simple harmonic motion, sound, and electromagnetic radiation.

PHY.4 Students will investigate and explore wave properties.

PHY.4.1 Analyze the characteristics and properties of simple harmonic motions, sound, and light.

PHY.4.2 Describe and model through digital or physical means the characteristics and properties of mechanical waves by simulating and investigating properties of simple harmonic motion.

PHY.4.3 Use mathematical and computational analysis to explore wave characteristics (e.g., velocity, period, frequency, amplitude, phase, and wavelength).

PHY.4.4 Investigate and communicate the relationship between the energy of a wave in terms of amplitude and frequency using probe systems, online simulations, and/or laboratory experiences.

PHY.4.5 Design, investigate, and collect data on standing waves and waves in specific media (e.g., stretched string, water surface, and air) using online simulations, probe systems, and/or laboratory experiences.

PHY.4.6 Explore and explain the Doppler effect as it relates to a moving source and to a moving observer using online simulations, probe systems, and/or real-world experiences.

PHY.4.7 Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction.

PHY.4.8 Use ray diagrams and the thin lens equations to solve real-world problems involving object distance from lenses, using a lens bench, online simulations, and/or laboratory experiences.

PHY.4.9 Research the different bands of electromagnetic radiation, including characteristics, properties, and similarities/differences.

PHY.4.10 Enrichment: Research the ways absorption and emission spectra are used to study astronomy and the formation of the universe.

PHY.4.11 Enrichment: Research digital nonfictional text to defend the wave-particle duality of light (i.e., wave model of light and particle model of light).

PHY.4.12 Enrichment: Research uses of the electromagnetic spectrum or photoelectric effect.

PHY.5 Electricity and Magnetism

Conceptual Understanding: In electrical interactions, electrical energy (whether battery or circuit energy) is transformed into other forms of energy. Charged particles and magnetic fields are similar in that they store energy. Magnetic fields exert forces on moving charged particles. Changing magnetic fields cause electrons in wires to move and thus create a current.

PHY.5 Students will investigate the key components of electricity and magnetism.

PHY.5.1 Analyze and explain electricity and the relationship between electricity and magnetism.

PHY.5.2 Explore the characteristics of static charge and how a static charge is generated using simulations.

PHY.5.3 Use mathematical and computational analysis to analyze problems dealing with electric field, electric potential, current, voltage, and resistance as related to Ohm's law.

PHY.5.4 Develop and use models (e.g., circuit drawing and mathematical representation) to explain how electric circuits work by tracing the path of electrons, including concepts of energy transformation, transfer, conservation of energy, electric charge, and resistance using online simulations, probe systems, and/or laboratory experiences.

PHY.5.5 Design and conduct an investigation of magnetic poles, magnetic flux and magnetic field using online simulations, probe systems, and/or laboratory experiences.

PHY.5.6 Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential.

PHY.5.7 Analyze and communicate the relationship between magnetic fields and electrical current by induction, generators, and electric motors (e.g., microphones, speakers, generators, and motors) using Ampere's and Faraday's laws.

PHY.5.8 Enrichment: Design and construct a simple motor to develop an explanation of how the motor transforms electrical energy into mechanical energy and work.

PHY.5.9 Enrichment: Design and draw a schematic of a circuit that will turn on/off a light from two locations in a room like those found in most homes.

PHY.6 Nuclear Energy

Conceptual Understanding: Nuclear energy is energy stored in the nucleus of the atom. The energy holding atoms together is called binding energy. The binding energy is a huge amount of energy. So, at the subatomic scale, the conservation of energy becomes the conservation of mass-energy.

PHY.6 Students will demonstrate an understanding of the basic principles of nuclear energy.

PHY.6.1 Analyze and explain the concepts of nuclear physics.

PHY.6.2 Explore the mass number and atomic number of the nucleus of an isotope of a given chemical element.

PHY.6.3 Investigate the conservation of mass and the conservation of charge by writing and balancing nuclear decay equations for alpha and beta decay.

PHY.6.4 Simulate the process of nuclear decay using online simulations and/or laboratory experiences and using mathematical computations determine the half-life of radioactive isotopes.

Zoology I

ZOO.1 Evolution

Conceptual Understanding: Evolution results from the interaction of four factors: (1) the potential for a species to increase in number, (2) genetic variation occurring within a species due to mutations and sexual reproduction, (3) limited supply of resources needed for survival resulting in competition, and (4) those organisms that are better adapted for an environment survive and reproduce. Genetic information provides evidence of evolution. DNA sequences vary among species, but some similarities remain. By comparing the DNA sequences of different organisms, multiple lines of descent may be inferred. The ongoing branching into multiple lines of descent may also be derived by comparing the amino acid sequences and by examining the anatomical and embryological evidence.

ZOO.1 Students will develop a model of evolutionary change over time.

ZOO.1.1 Develop and use dichotomous keys to distinguish animals from protists, plants, and fungi.

ZOO.1.2 Describe how the fossil record documents the history of life on earth.

ZOO.1.3 Recognize that the classification of living organisms is based on their evolutionary history and/or similarities in fossils and living organisms.

ZOO.1.4 Construct cladograms or phylogenetic trees to show the evolutionary branches of an ancestral species and its descendants.

ZOO.1.5 Design models to illustrate the interaction between changing environments and genetic variation in natural selection leading to adaptations in populations and differential success of populations.

ZOO.1.6 Enrichment: Use an engineering design process to develop an artificial habitat to meet the requirements of a population that has been impacted by human activity.*

ZOO.2 Phyla Porifera and Cnidaria

Conceptual Understanding: Phyla Porifera and Cnidaria are two of the most primitive of animal phyla. They distinguish themselves from other metazoans by their lack of bilateral symmetry. Each phylum has its own anatomy, physiology, and unique role in aquatic ecosystems.

ZOO.2 Students will understand the structure and function of phylum Porifera and phylum Cnidaria and how each adapts to their environments.

ZOO.2.1 Differentiate among asymmetry, radial symmetry, and bilateral symmetry in an animal's body plan.

ZOO.2.2 Identify the anatomy and physiology of a sponge, including how specialized cells within sponges work cooperatively without forming tissues to capture and digest food.

ZOO.2.3 Describe the importance of phylum Porifera in aquatic habitats.

ZOO.2.4 Create a model, either physical or digital, illustrating the anatomy of a sponge, tracing the flow of water.

ZOO.2.5 Enrichment: Use an engineering design process to determine the quantity of water that may be absorbed per unit in a natural sponge versus a synthetic sponge.*

ZOO.2.6 Contrast the polyp lifestyle of most Cnidarians with the medusa lifestyle of jellyfish, including how both utilize a single body opening.

ZOO.2.7 Describe how nematocysts (stinging cells) of Cnidarians are used for capturing food and for defense.

ZOO.2.8 Enrichment: Utilize an engineering design process to create a simulated nematocyst, including possible biomimicry use.*

ZOO.2.9 Describe the ecological importance of and human impacts on coral reefs.

ZOO.2.10 Create a digital or physical model illustrating the anatomy of a cnidarian, citing similarities and differences between polyps and medusas.

ZOO.3 Phylum Mollusca

Conceptual Understanding: Phylum Mollusca is one of the most diverse phyla on earth, occupying almost every type of ecosystem. Despite its diversity, mollusks share a basic body plan and are well adapted to their niches within environments.

ZOO.3 Students will understand the structure and function of phylum Mollusca, and how they adapt to their environments.

ZOO.3.1 Considering the diversity of mollusks, explain how they all share a common body plan (i.e., mantle, visceral mass, and foot).

ZOO.3.2 Describe why mollusks are classified as eucoelomates.

ZOO.3.3 Explain how the mantle is used in forming the shell.

ZOO.3.4 Describe how the radula is used in feeding.

ZOO.3.5 Develop a dichotomous key to contrast characteristics of gastropods, bivalves, and cephalopods.

ZOO.3.6 Examine how the unique characteristics of cephalopods lead to survival.

ZOO.3.7 Create a model comparing the anatomy of gastropods, bivalves, and cephalopods.

ZOO.3.8 Enrichment: Use an engineering design process to model the jet propulsion utilized by cephalopods in mechanical design of fluid systems (e.g., improving hydraulic systems).*

ZOO.4 Phyla Platyhelminthes, Nematoda, and Annelida

Conceptual Understanding: Although the term "worms" may refer to an organism with a long, slender, soft body with bilateral symmetry, worms may be subdivided into phyla based on their unique body plan. These include phyla Platyhelminthes, Nematoda, and Annelida.

ZOO.4 Students will describe the evolution of structure and function of phylum Platyhelminthes, phylum Nematoda, and phylum Annelida.

ZOO.4.1 Define and describe the closed circulatory system of an annelid.

ZOO.4.2 Differentiate between parasitic and free living.

ZOO.4.3 Compare and contrast the characteristics and lifestyles of flatworms, roundworms, and segmented worms.

ZOO.4.4 Create a model comparing acoelomate, pseudocoelomate, and eucoelomate body plans of Platyhelminthes, Nematoda, and Annelida.

ZOO.4.5 Describe the evolutionary importance of the segmented body plans of annelids.

ZOO.4.6 Dissect representative taxa, and compare their internal and external anatomy and complexity.

ZOO.4.7 Enrichment: Design, conduct, and communicate results of an experiment demonstrating the importance of flatworms, roundworms, and annelids for human use (e.g., the earthworm in agriculture and the leech in medicine).

ZOO.4.8 Enrichment: Use an engineering design process to design and construct a system to utilize flatworms, roundworms, or annelids to meet a human need.*

ZOO.5 Phylum Arthropoda

Conceptual Understanding: Arthropods are the most successful of animal phyla, inhabiting land, sea, and air. Despite their differences, all arthropods share some characteristics enabling them to be united as one phylum.

ZOO.5 Students will understand the basic structure and function of phylum Arthropoda, and how they demonstrate the characteristics of living things.

ZOO.5.1 Describe the evolutionary advantages of segmented bodies, hard exoskeletons, and jointed appendages to arthropods and how they contribute to arthropods being the largest phyla in species diversity and the most geographically diverse.

ZOO.5.2 Explain how the exoskeleton is used in locomotion, protection, and development.

ZOO.5.3 Enrichment: Use an engineering design process to develop a biomimicry of an arthropod's exoskeleton to meet a human need.*

ZOO.5.4 Identify organisms and characteristics of chelicerates, crustaceans, and insects.

ZOO.5.5 Describe the importance of toxins for arachnids, such as spiders and scorpions.

ZOO.5.6 Describe the importance of chela for decapods, such as lobsters and crabs.

ZOO.5.7 Differentiate between complete and incomplete metamorphosis in insects' life cycles.

ZOO.5.8 Explain the importance of eusociality in insects, such as ants, bees, and termites.

ZOO.5.9 Dissect representative taxa, and compare their internal and external anatomy and complexity.

ZOO.6 Phylum Echinodermata

Conceptual Understanding: Phylum Echinodermata contains complex organisms exhibiting pentaradial symmetry and a sophisticated water vascular system.

ZOO.6 Students will understand the structure and function of phylum Echinodermata, and how they demonstrate the characteristics of living things.

ZOO.6.1 Recognize that the echinoderms have spines on their skin that are extensions of plates that form from the endoskeleton.

ZOO.6.2 Explain how the starfish inverts its stomach for external digestion of food. ZOO.6.2 Describe sea urchins' and sea cucumbers' defense structures and behaviors.

ZOO.6.3 Describe the sexual and asexual reproduction of starfish.

ZOO.6.4 Describe how the water vascular system is used for locomotion, feeding, and gas exchange.

ZOO.6.5 Research, analyze, and communicate implications of applying the regeneration of starfish to human medicine.

ZOO.6.6 Dissect representative taxa and compare their internal and external anatomy and complexity.

ZOO.6.7 Enrichment: Use an engineering design process to model the water vascular system in hydraulic systems to meet a societal need.*

Zoology II

ZOO.1 Evolution * This standard does not have to be repeated if students have taken Zoology I during the first term.

Conceptual Understanding: Evolution results from the interaction of four factors: (1) the potential for a species to increase in number, (2) genetic variation occurring within a species due to mutations and sexual reproduction, (3) limited supply of resources needed for survival resulting in competition, and (4) those organisms that are better adapted for an environment survive and reproduce. Genetic information provides evidence of evolution. DNA sequences vary among species, but some similarities remain. By comparing the DNA sequences of different organisms, multiple lines of descent may be inferred. The ongoing branching into multiple lines of descent may also be derived by comparing the amino acid sequences and by
examining the anatomical and embryological evidence.

ZOO.1 Students will develop a model of evolutionary change over time.

ZOO.1.1 Develop and use dichotomous keys to distinguish animals from protists, plants, and fungi.

ZOO.1.2 Describe how the fossil record documents the history of life on earth.

ZOO.1.3 Recognize that the classification of living organisms is based on their evolutionary history and/or similarities in fossils and living organisms.

ZOO.1.4 Construct cladograms or phylogenetic trees to show the evolutionary branches of an ancestral species and its descendants.

ZOO.1.5 Design models to illustrate the interaction between changing environments and genetic variation in natural selection leading to adaptations in populations and differential success of populations.

ZOO.1.6 Enrichment: Use an engineering design process to develop an artificial habitat to meet the requirements of a population that has been impacted by human activity.*

ZOO.7 Phylum Chordata, Classes Chondrichthyes and Osteichthyes

Conceptual Understanding: Of the members of phylum Chordata, fish species are most numerous. These aquatic vertebrates have gills throughout their lives and either have or are descended from ancestors with scales or armor.

ZOO.7 Students will understand the structure and function of phylum Chordata, classes Chondrichthyes and Osteichthyes, and how they demonstrate the characteristics of living things.

ZOO.7.1 Students will understand why evolutionary changes lead to the diversity of fish and how they have adapted to the different aquatic environments.

ZOO.7.2 Compare and contrast the characteristics of class Chondrichthyes and Osteichthyes.

ZOO.7.3 Identify specific fish species and characteristics that differentiate class Chondrichthyes (e.g., sharks, skates, and rays).

ZOO.7.4 Describe how the body and jaw design of sharks make them adept predators.

ZOO.7.5 Label and describe functions of the anatomical features of the bony fish, including internal organs, lateral line system, operculum, swim bladder, and external fins.

ZOO.7.6 Research, analyze, and communicate the effects of urbanization and continued expansion by humans on the biodiversity of fish species (e.g., overfishing and invasive species).

ZOO.7.7 Dissect representative taxa and compare their internal and external anatomy and complexity.

ZOO.7.8 Enrichment: Use an engineering design process to design a "balloon fish" that has neutral buoyancy (i.e., does not sink or float). Report which materials were used to create the "fish," and predict which materials should be added to make the "fish" sink and which materials would make the "fish" float.*

ZOO.8 Phylum Chordata, Classes Amphibia and Reptilia

Conceptual Understanding: The two groups of ectothermic tetrapods—amphibians and reptiles—are similar in appearance, but differ drastically in development and body structure.

ZOO.8 Students will understand the structure and function of phylum Chordata, classes Amphibia and Reptilia, and how they demonstrate the characteristics of living things.

ZOO.8.1 Understand the evolution of tetrapods and the development of the structure and function of body systems and life cycles.

ZOO.8.2 Describe the constraints that require amphibians to spend part of their lives in water and part on land, including the morphological and physiological changes as they pass from one stage of their life cycle to the next.

ZOO.8.3 Describe adaptations that have led to reptiles living on land successfully.

ZOO.8.4 Define what it means to be ectothermic, and identify ways in which reptiles regulate their body temperature.

ZOO.8.5 Describe how snakes use chemosensory to locate and track prey.

ZOO.8.6 Enrichment: Use an engineering design process to model biomimicry of ectothermic temperature regulation or chemosensory detection to meet a societal need.*

ZOO.8.7 Compare and contrast living and extinct reptiles.

ZOO.8.8 Explain the importance of tetrapod evolution.

ZOO.8.9 Identify the amniotic egg as the major derived characteristic of reptiles.

ZOO.8.10 Dissect representative taxa and compare their internal and external anatomy and complexity.

ZOO.9 Phylum Chordata, Class Aves

Conceptual Understanding: Class Aves, including birds, are endothermic, egg-laying vertebrates with bodies covered in feathers. Although they are descendants of dinosaurs, they have evolved a unique physiology, making most capable of flight.

ZOO.9 Students will understand the structure and function of phylum Chordata, class Aves, and how they demonstrate the characteristics of living things.

ZOO. 9.1 Trace the evolutionary history of modern birds beginning with the theropods. Relate how today's birds have adapted to changing environments.

ZOO. 9.2 Describe the fossil evidence that indicates that birds evolved from two-legged dinosaurs called theropods.

ZOO. 9.3 Define the term endothermic, and describe how birds regulate body temperature in extreme environments.

ZOO. 9.4 Enrichment: Use an engineering design process to model biomimicry of endothermic temperature regulation to meet a sustainable need.*

ZOO. 9.5 Explain how birds of prey use their keen sense of sight to locate and attack prey.

ZOO. 9.6 Describe how corvids use their intellect for problem solving and locating food storage.

ZOO. 9.7 Explain the importance of the evolution of flight and feathers, including the morphological and physiological adaptations needed to sustain flight.

ZOO. 9.8 Enrichment: Use an engineering design process to utilize a bird's flight adaptations in the development of a flying aircraft (e.g., glider, plane).*

ZOO. 9.9 Demonstrate how different adaptations of the bird beak and feet allow them to feed and survive in different environments.

ZOO. 9.10 Enrichment: Based on an understanding of biomimicry, use an engineering design process to develop a tool based on a bird's beak/feet to meet a human need. *

ZOO. 9.11 Describe the parenting behavior of different birds in order to incubate their eggs and care for hatchlings.

ZOO. 9.12 Enrichment: Use an engineering design process to design and construct an incubator for hatching abandoned eggs.*

ZOO. 9.13 Explain the reasons for bird migration and the innate behavior of migratory birds.

ZOO. 9.14 Dissect representative taxa and compare their internal and external anatomy and complexity.

ZOO.10 Phylum Chordata, Class Mammalia

Conceptual Understanding: Class Mammalia consists of endothermic organisms with hair, a four- chambered heart, a diaphragm, and mammary glands. As inhabitants of every continent, they are successful in a great variety of ecosystems.

ZOO.10 Students will understand the structure and function of phylum Chordata, class Mammalia, and how they demonstrate the characteristics of living things.

ZOO 10.1 Understand the characteristics and behaviors that distinguish mammals from other phyla, and use characteristics and behaviors to distinguish the major orders, including primates. Explain how human impact has changed the environments of other organisms.

ZOO 10.2 Describe the characteristics of the first true mammal.

ZOO 10.3 Distinguish among monotremes, marsupials, and eutherians, and describe the importance and differences in the placenta in marsupials and eutherians.

ZOO 10.4 Describe characteristics that make primates unique, including investigating how the center of gravity relates to the evolution of bipedalism.

ZOO 10.5 Dissect representative taxa and compare their internal and external anatomy and complexity.

ZOO 10.6 Explain how human impacts have changed the environment of aquatic and terrestrial organisms (e.g., habitat destruction, urbanization, and climate change).

ZOO 10.7 Enrichment: Use an engineering design process to develop a possible solution to an environmental issue that currently exists in an ecosystem.*

2023 Agricultural and Natural Resources

Program CIP: 01.0003 – Agricultural and Natural Resources

Direct inquiries to:

Instructional Design Specialist
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
662.325.2510
helpdesk@rcu.msstate.edu

Program Supervisor
Office of Career and Technical Education
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
601.359.3974

Published by:

Office of Career and Technical Education
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances the intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

Acknowledgments

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Ms. Rosemary G. Aultman, chair
Mr. Glen East, vice-chair
Dr. Karen Elam
Mrs. Mary Werner
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Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE Agricultural and Natural Resources is aligned to the following standards:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards
The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in Grades 9-12 and two-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. The National AFNR Career Cluster Content Standards are copyrighted by the National Council for Agricultural Education and used with permission.
thecouncil.ffa.org/afnr

International Society for Technology in Education Standards (ISTE)
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College- and Career-Readiness Standards
College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities demanded by the workforce of today and the future. Mississippi adopted Mississippi College- and Career-Readiness Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn and so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning
In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, and technology skills; and life and career skills.
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied 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. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

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; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning
: Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource
: Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, contact the RCU at 662.325.2510 or helpdesk@rcu.msstate.edu.

Executive Summary

Pathway Description
Agricultural and Natural Resources (ANR) is a pathway to introduce the student to the broad field of agriculture and natural resources management, including the production of plants and animals and managing the sustainability of our natural resources. The program includes instruction in the applied sciences related to plant and animal production and natural resource conservation and management, as well as introducing the student to agribusiness management practices and maintenance of facilities and equipment. Students in the pathway will participate in active learning exercises, including integral activities of the National FFA organization and supervised agricultural experiences. Students who successfully complete the competencies in this pathway will possess fundamental knowledge and skills that can be used to secure entry-level employment or as a foundation for continuing their education.

College, Career, and Certifications
No national industry-recognized certifications are known to exist at this time in the field of agriculture and natural resources. Competencies and suggested objectives in this course have been correlated, however, to the National AFNR Career Cluster Content Standards that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as 10th-12th graders. Exceptions to this are a district-level decision based on class size, enrollment numbers, student maturity, and CTE delivery method. This is a hands-on, lab- or shop-based course. Therefore, a maximum of 15 students is recommended per class with only one class with the teacher at a time.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and Test of Adult Basic Education (TABE) reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning
If you have specific questions about the content of any training sessions provided, please contact the RCU at 662.325.2510 or helpdesk@rcu.msstate.edu.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses that should be completed in the following sequence:

1. **Fundamentals of Agricultural and Natural Resources—Course Code: 991102**
2. **Agricultural and Natural Resources: Soils and Ag Lab Operations—Course Code: 991103**
3. **Agricultural and Natural Resources: Environmental Science—Course Code: 991104**
4. **Agricultural and Natural Resources: Equipment Operation and Business MGT—Course Code: 991105**

Course Description: Fundamentals of Agricultural and Natural Resources
This course is designed to introduce the student to fundamental concepts and principles of the modern agricultural and natural resources industry. Emphasis is placed on career and leadership skills and basic principles of plant, animal, and soil science.

Course Description: Agricultural and Natural Resources: Soils and Ag Lab Operations
This course is designed to provide knowledge and skills concerning basic mechanical technologies in the field.

Course Description: Agricultural and Natural Resources: Environmental Science
This course is designed to provide concepts and principles associated with agriculture and natural resources. Emphasis is placed on the conservation and management of natural resources; agricultural business-management practices; and the environment as it relates to water quality, forestry, and wildlife.

Course Description: Agricultural and Natural Resources: Equipment Operation and Business MGT
This course is designed to provide instruction on basic agriculture-construction techniques and agriculture business-management and processes.

Fundamentals of Agricultural and Natural Resources—Course Code: 991102

Unit	Unit Title	Hours
1	Introduction to Agricultural and Natural Resources	15
2	The National FFA Organization and Career Development	15
3	Supervised Agricultural Experience (SAE) for All and Embedded Work-Based Learning	30
4	Science of Animals	40
5	Science of Plants	40
Total		**140**

Agricultural and Natural Resources: Soils and Ag Lab Operations—Course Code: 991103

Unit	Unit Title	Hours
6	Soil Science	35
7	Hand and Power Tools in Agriculture	35
8	Welding and Cutting Processes	35
9	Agricultural Small Engines	35
Total		**140**

Agricultural and Natural Resources: Environmental Science—Course Code: 991104

Unit	Unit Title	Hours
10	ANR Careers and FFA Leadership	20
11	Conservation and Management of Natural Resources	40
12	Science of Forestry and the Environment	40
13	Wildlife and the Environment	40
Total		**140**

Agricultural and Natural Resources: Equipment Operation and Business MGT—Course Code: 991105

Unit	Unit Title	Hours
14	Agricultural Equipment Operation and Maintenance	50
15	Agricultural Construction and Fabrication	50
16	Agricultural Business Management and Processes	40
Total		**140**

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses that should be completed in the following sequence:

1. **Agricultural and Natural Resources I—Course Code 991100**
2. **Agricultural and Natural Resources II—Course Code 991101**

Course Description: Agricultural and Natural Resources I
This course is designed to introduce the student to fundamental concepts and principles of the modern agricultural and natural resources industry. Emphasis is placed on career and leadership skills; basic principles of plant, animal, and soil science; and basic mechanical technologies in the field.

Course Description: Agricultural and Natural Resources II
This course is designed to continue the exploration of fundamental concepts and principles associated with agriculture and natural resources. Emphasis is placed on the conservation and management of natural resources; agricultural business-management practices; and the environment as it relates to water quality, forestry, and wildlife. Instruction is provided on basic agriculture-construction techniques and agriculture business management and processes.

Agricultural and Natural Resources I—Course Code: 991100

Unit	Unit Title	Hours
1	Introduction to Agricultural and Natural Resources	15
2	The National FFA Organization and Career Development	15
3	Supervised Agricultural Experience (SAE) for All and Embedded Work-Based Learning	30
4	Science of Animals	40
5	Science of Plants	40
6	Soil Science	35
7	Hand and Power Tools in Agriculture	35
8	Welding and Cutting Processes	35
9	Agricultural Small Engines	35
Total		**280**

Agricultural and Natural Resources II—Course Code: 991101

Unit	Unit Title	Hours
10	ANR Careers and FFA Leadership	20
11	Conservation and Management of Natural Resources	40
12	Science of Forestry and the Environment	40
13	Wildlife and the Environment	40
14	Agricultural Equipment Operation and Maintenance	50
15	Agricultural Construction and Fabrication	50
16	Agricultural Business Management and Processes	40
Total		**280**

Career Pathway Outlook

Overview

The agricultural sciences career cluster covers the broad field of occupations related to the production and use of plants and animals for food, fiber, aesthetic, and environmental purposes. According to the U.S. Department of Agriculture, during the next five years (2020-2025) 59,400 jobs are expected to open in food, agriculture, renewable natural resources, or the environment for graduates with bachelor's or higher degrees in those areas. Almost half of those jobs will be in management and business at 42%; 31% in science, technology, engineering, and math in agriculture; 13% in sustainable food and biomaterials production; and 14% in education, communication, and government services. According to the USDA, agriculture, food, and related industries contributed $1.109 trillion to the U.S. gross domestic product (GDP) in 2019. The Mississippi Department of Agriculture and Commerce reports that agriculture is Mississippi's number one industry at $7.35 billion and employs approximately 17.4% of the state's workforce.

Exploration of Agriscience will target careers at the professional and technical levels in agriculture. Students enrolled in these courses should be better prepared to pursue degrees at the community college and four-year college levels.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2022). Employment opportunities for each of the occupations are listed below:

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2018	Projected Jobs, 2028	Change (Number)	Change (Percent)	Average Yearly Earnings, 2022
Agricultural and Food Science Technicians	260	270	10	3.9%	$39,270
Agricultural Sciences Teachers, Postsecondary	150	160	10	6.7%	$93,260
Animal Trainers	100	110	10	10%	$23,120
Career/Technical Education Teachers, Middle School	320	350	30	9.4%	$47,270
Career/Technical Education Teachers, Secondary School	1220	1310	90	7.4%	$50,370
Conservation Scientists	700	730	30	4.3%	$54,950
Environmental Engineers	410	420	10	2.4%	$75,940
Environmental Engineering Technicians	160	170	10	6.3%	$46,790

Environmental Scientists and Specialists, Including Health	620	670	50	8.1%	$64,460
Environmental Science and Protection Technicians, Including Health	420	460	40	9.5%	$38,780
Farm and Home Management Advisors	290	300	10	3.2%	$38,650
Logging Equipment Operators	1,680	1,740	60	3.6%	$41,840
Landscaping and Groundskeeping Workers	6,000	6,620	620	10.3%	$25,630
Nonfarm Animal Caretakers	1,520	1,780	260	17.1%	$24,030
Soil and Plant Scientists	110	110	0	0%	$92,250
Farmers, Ranchers, and Other Agricultural Managers	1,790	1,840	20	2.8%	$55,830
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	980	1,090	110	11.2%	$40,270
First-Line Supervisors/Managers of Farming, Fishing, and Forestry Workers	940	990	50	5.3%	$54,550
Fish and Game Wardens	40	40	0	0%	$46,610
Foresters	190	200	10	5.3%	$52,660
Surveyors	450	470	20	4.4%	$48,600
Surveying and Mapping Technicians	530	550	20	3.8%	$39,840
Tree Trimmers and Pruners	270	300	30	11.1%	$44,920
Veterinarians	490	540	50	10.2%	$81,950
Veterinary Assistants and Laboratory Animal Caretakers	970	1,090	120	12.4%	$26,150
Veterinary Technologists and Technicians	570	630	60	10.5%	$35,890
Zoologists and Wildlife Biologists	260	270	10	3.9%	$70,200

Source: Mississippi Department of Employment Security; mdes.ms.gov (2022).

Perkins V Requirements and Academic Infusion
The Agricultural and Natural Resources curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in agricultural science fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses that will further prepare them for agricultural industry careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, it focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Transition to Postsecondary Education
The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The ANR educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances, for example—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunities to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. The National FFA Organization is the student organization for this pathway and will foster the types of learning expected from the ANR curriculum. FFA provides students with growth opportunities and competitive events and opens the doors to the world of agriculture and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the ANR curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The ANR curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the ANR curriculum that will allow and encourage collaboration with professionals currently in the agricultural field.

Work-Based Learning

Work-based learning (WBL) is an extension of understanding competencies taught in the ANR classroom. The ANR program requires students to obtain a minimum of 35 hours, which may include but are not limited to clinicals or worksite field experiences, entrepreneurships, internships, pre-apprenticeships, school-based enterprises, job placements, and simulated worksites. These real-world connections and applications provide a link to all types of students regarding knowledge, skills, and professional dispositions. Thus, supervised collaboration and immersion into the agricultural industry are keys to students' success, knowledge, and skills development. For more information on embedded WBL, visit the Mississippi Work-Based Learning Manual on the RCU website, rcu.msstate.edu.

Professional Organizations

American Association for Agricultural Education (AAAE)
aaaeonline.org

Association for Career and Technical Education (ACTE)
acteonline.org

Mississippi Association of Agricultural Educators (MSAAE)
mississippiffa.org

Mississippi ACTE (MS ACTE)
mississippiacte.com

National Association of Agricultural Educators (NAAE)
naae.org

National FFA Organization
ffa.org

Using This Document

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.

Teacher Resources
All teachers should request to be added to the Canvas Resource Guide for their course. For questions or to be added to the guide, send a Help Desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Some of the units may include an enrichment section at the end. This material will greatly enhance the learning experiences of students. If the ANR program is using a national certification, work-based learning, or another measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be tested on that quality indicator. It is the responsibility of the teacher to ensure all competencies for the selected quality indicator are covered throughout the year.

Unit 1: Introduction to Agricultural and Natural Resources

Competencies and Suggested Objectives
1. Examine the nature of the Agricultural and Natural Resources (ANR) industry. DOK1 a. Investigate the scope of the ANR industry from a national and global perspective. b. Trace the development of agricultural sciences and technologies in the United States. c. Associate the major areas of ANR with their products and practices. d. Investigate career opportunities in ANR.
2. Examine the relationships between the pure sciences, agriculture, and agriscience. DOK1 a. Associate the pure sciences with agriculture and agriscience areas. b. Identify a problem in agriculture and follow the steps of the scientific method to investigate a possible solution to the problem.
3. Apply standard ANR safety practices. DOK2 a. Apply safety standards in the workplace. b. Apply safety standards in the agricultural classroom and laboratory. c. Interpret information on a safety data sheet (SDS). d. Describe the use of general-safety hand equipment and indicators including, but not limited to, the following: safety color codes, fire extinguishers, first aid kits, emergency exits, etc. e. Apply safety precautions related to dress and personal protective equipment (PPE). f. Select procedures for dealing with different classes of fires.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 2: The National FFA Organization and Career Development

Competencies and Suggested Objectives
1. Explore the integral relationship between the FFA and agricultural education. DOK 2 a. Examine historical events that shaped school-based agricultural education. • Smith-Hughes Act (1917) • Establishment of the Future Farmers of America (FFA) (1928) • Mississippi FFA Association chartered (1934) • Establishment of New Farmers of America (NFA) (1935) • Public Law 740 (1950) • Merger of the FFA and NFA (1965) • Female membership (1969) • FFA changes its name to the National FFA Organization (1988) b. Identify types of FFA membership. • Active • Collegiate • Alumni • Honorary c. Distinguish among the degree levels of FFA membership and describe the requirements for each: • Discovery FFA degree • Greenhand FFA degree • Chapter FFA degree • State FFA degree • American FFA degree
2. Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st century skills standards. DOK2 a. Explain the role of effective leadership. b. Self-evaluate personal leadership traits and develop a plan for improvement. c. Identify and put into practice FFA activities that promote personal and career development, teamwork, and leadership skills. • Public speaking and communication skills • Career development events (CDEs) and leadership development events (LDEs) • Proficiency awards • Community service activities • Conventions and leadership conferences d. Demonstrate basic parliamentary procedure. • Conducting a meeting • Stating a main motion • Discussing the main motion • Voting on a motion • Understanding the use of the gavel

e. Distinguish between types of motions:
   - Main
   - Subsidiary
   - Incidental
   - Privileged

3. Describe the role of 21st-century skills, work ethic, and values in establishing and building a successful career. DOK3
   a. Define and describe universally accepted work ethics and values as applied to agricultural, food, and natural resources careers.
      - Trustworthiness
      - Respect
      - Responsibility
      - Fairness
      - Citizenship
   b. Identify career-related values and ethics promoted through FFA activities.
      - Attendance
      - Attitude
      - Achievement
      - Relationship building
      - Vision
      - Character
      - Awareness
      - Continuous improvement
      - Personal growth
      - Time management
      - Communication
      - Decision-making
      - Flexibility and adaptability
   c. Practice work ethic and values in the ANR classroom and laboratory, student organization activities, and experiential and work-based learning.

4. Investigate careers associated with the agricultural industry and complete a project with details about a career. DOK2
   a. Description of the career
   b. Educational and training requirements
   c. Salary range
   d. Job outlook

Unit 3: Supervised Agricultural Experience (SAE) for All and Embedded Work-Based Learning

Competencies and Suggested Objectives

1. Describe the purposes and requirements of the Supervised Agricultural Experience (SAE) for All program. DOK1
   a. Establish objectives for the SAE program.
      - Personal growth
      - Career development
      - Responsible citizenship
      - Practical application of work experience and/or skill attainment
   b. Determine the benefits of participation in an SAE program.
      - Assist with career and personal choices
      - Apply business practices, such as record-keeping and money management
      - Nurture individual talents and develop a cooperative attitude
      - Build character and encourage citizenship and volunteerism
      - Provide an environment for practical learning
   c. Describe the types of programs under SAE For All.
      - Foundational SAE
        - Career exploration and planning
        - Employability skills for college and career readiness
        - Personal financial management and planning
        - Workplace safety
        - Agricultural literacy
      - Immersion SAE
        - Placement/internship
        - Ownership/entrepreneurship
        - Research
          - Experimental
          - Analytical
          - Invention
        - School-based enterprise
        - Service learning
   d. Explore the Mississippi Work-Based Learning (WBL) Manual as a companion to Immersion SAE.

2. Launch a Foundational SAE plan. DOK2
   a. Identify potential career interests.
   b. Determine the availability of time and money/resources to invest.
   c. Set short-range goals for the SAE program.
   d. Project long-range goals for the SAE program.
   e. Complete a training agreement for an SAE project.
   f. Establish requirements for the student, parents, supervisor, and/or employer.

3. Develop a record-keeping system for an individual student's SAE program. DOK3
   a. Determine types of records to keep.
      - Hours worked/spent on a project or enterprise
      - Inventory of assets
      - Expenses
      - Income
      - Skills attained during a project or enterprise
      - Leadership record
      - Community service record
      - Journal of experiences
      - Pictures and/or videos
   b. Use an electronic/computer-based record-keeping system to maintain records for the SAE program.

Unit 4: Science of Animals

Competencies and Suggested Objectives

1. Explore the animal-agriculture industry and enterprises. DOK1
   a. Associate the different classes and breeds of domestic animals with ways that each benefits humanity.
      - Aquatic animals
      - Beef and dairy cattle
      - Equine
      - Swine
      - Poultry
      - Goats and sheep
      - Companion animals
   b. Compare and contrast common production and marketing practices for major animal enterprises.
   c. Distinguish between small-scale (niche markets) versus commercial production.
   d. Compare and contrast the concepts of animal rights and animal welfare as related to agricultural-animal enterprises.
2. Compare and contrast animal systems for mammals, avian, and aquatic animals including, but not limited to, respiratory, skeletal, and circulatory. DOK1
3. Examine the role of reproduction and genetics in agricultural animals. DOK2
   a. Explain procedures for managing livestock production.
   b. Define terms associated with livestock production.
   c. Describe periods of estrus and gestation in livestock.
   d. Describe the process of livestock mating.
      - Inbreeding
      - Closed breeding
      - Crossbreeding
      - Linebreeding
      - Outcrossing
   e. Explain basic concepts of heredity and genetics.
      - Punnett squares
      - Homozygous
      - Heterozygous
      - Recessive
      - Dominant
      - Hybrid vigor
      - Heterosis
      - Estimated Progeny Difference (EPD)
   f. Explore technologies in livestock reproduction.
      - Artificial insemination
      - Embryo transfer
      - Cloning

- Gender selection
- Genetic engineering

4. Describe important elements of animal nutrition and digestion. DOK2
   a. Compare and contrast the following digestive systems:
      - Ruminant
      - Monogastric
      - Avian
      - Pseudo-ruminant (hind gut fermenter)
   b. Associate each of the six major classes of nutrients with their roles and functions.
      - Water
      - Carbohydrates
      - Protein
      - Fats
      - Vitamins
      - Minerals
   c. Classify and discuss the use of feedstuffs as roughages, concentrates, processed feeds, and by-products.
      - Roughage examples: hay, cottonseed hulls, and silage
      - Concentrate examples: corn, soybeans, and oats
      - Processed feed examples: pelleted feed
      - By-product examples: soybean meal, cotton-seed meal, distillers' grains

5. Explain management practices for maintaining health in beef, dairy, swine, poultry, equine, aquaculture, and other species of local interest. DOK2
   a. Examine management practices for maintaining animal health.
   b. Examine causes and preventions of disease and parasites.
   c. Investigate the economic impact of sound herd health management practices.
   d. Investigate biosecurity practices related to animal health.

Unit 5: Science of Plants

Competencies and Suggested Objectives

1. Examine basic plant classifications. DOK2
   a. Identify and discuss vascular and nonvascular plants.
   b. Identify and discuss vascular plants that reproduce with the help of seeds and those that reproduce with the help of spores (seedless).
   c. Compare and contrast the two groups of vascular seed producing plants.
      - Angiosperms
      - Gymnosperms
   d. Investigate the life cycles of angiosperm plants.
      - Annual
      - Perennial
      - Biennial
   e. Examine the binomial nomenclature system used by scientists around the world to give plants scientific names.
   f. Demonstrate how scientists name plants using the genus and species.
   g. Research common names of plants and determine the scientific name (i.e., Loblolly Pine Tree = *Pinus taeda)*
   h. Identify and describe plants that are categorized as cereal crops, oil crops, forage crops, fiber crops, horticultural crops, and specialty crops.

2. Explore the anatomy and physiology of a plant. DOK1
   a. Draw a diagram of a flowering plant, label, and describe the functions of the major parts.
      - Roots
      - Stems
      - Leaves
      - Flowers
   b. Compare and contrast the processes of photosynthesis and cell respiration within a plant.
   c. Illustrate and label the process of plant transpiration. Show how water flows through the following plant parts within the illustration:
      - Roots (osmosis)
      - Stem (xylem)
      - Leaves (stomata)
   d. Examine the process of plant growth to include cell division, cell elongation, and cell differentiation.

3. Investigate common methods of plant reproduction. DOK2
   a. Investigate methods of pollination and fertilization within angiosperms (flowering plants).
   b. Draw and label a simple flower. Include the following parts:
      - Stamen: anther and filament
      - Pistil: stigma, style, ovary, ovule
   c. Investigate methods of pollination and fertilization within gymnosperms (non-flowering plants).
   d. Identify the parts of a seed and associate each part with its function.
      - Seed coat
      - Stored food (endosperm/cotyledon)
      - Embryo (epicotyl)
   e. Identify and discuss seed dispersal methods.
      - Wind (dandelion seeds)
      - Water (mangrove seeds)
      - Animals (seeds in fruits and burdock seeds)
      - Fire (eucalypts seeds and some seeds in conifer trees)
      - Explosions (pea seeds in a pod)
   f. Describe and apply factors essential to seed germination.
      - Light or lack of light (photoperiod)
      - Temperature
      - Moisture
      - Viable seed
      - Oxygen
   g. Identify the five methods of asexual propagation.
      - Layering
      - Budding/grafting
      - Separation/division
      - Tissue culture
      - Cuttings

4. Apply principles of plant nutrition. DOK4
   a. Differentiate between the major plant nutrients (macronutrients) and the minor nutrients (micronutrients).
   b. Classify and explain the function of each of the nonmineral nutrients, primary and secondary macronutrients, and micronutrients in plant growth.

Nonmineral Nutrients	**Primary Macronutrients**	**Micronutrients**
• Carbon (C) • Hydrogen (H) • Oxygen (O)	• Nitrogen (N) • Phosphorus (P) • Potassium (K)	• Boron (B) • Chlorine (Cl) • Copper (Cu) • Iron (Fe) • Manganese (Mn) • Molybdenum (Mo) • Nickel (Ni) • Zinc (Zn)
Secondary Macronutrients • Calcium (CA) • Magnesium (Mg) • Sulfur (S)		

5.

5. Compare and contrast the different components of integrated pest management (IPM) measures. DOK3
   a. Research the effects of each IPM component.
      - Chemical
      - Mechanical
      - Biological
      - Cultural

Unit 6: Soil Science

Competencies and Suggested Objectives
1. Demonstrate an understanding of the impact of soil as a natural resource. DOK1 a. Define soil and discuss its importance. b. Describe the process of soil formation, including the effects of chemical and physical weathering. c. Classify and determine the texture of a soil sample utilizing the United States Department of Agriculture (USDA) soil texture triangle. • Sand • Silt • Clay d. Identify the different layers of a typical soil profile and describe their importance. • O — organic • A — topsoil • B — subsoil • C — parent material • R — bedrock
2. Investigate the chemical properties of soils. DOK3 a. Develop a written soil-testing plan for a given field or area. b. Collect a soil sample for testing purposes. c. Define soil pH. d. Describe how soil pH affects the productivity of a soil. e. Test a soil for pH level and nutritional content and make recommendations on amendments and fertilizers to be applied.

Unit 7: Hand and Power Tools in Agriculture

Competencies and Suggested Objectives
1. Identify and demonstrate the proper use of hand and power tools. DOK1 a. Identify hand and power tools listed in the Mississippi Tool Identification contest and the National FFA Agricultural Technology and Mechanical Systems CDE. b. Demonstrate safety procedures when dealing with hand and power tools, including basic operation, danger point, observer safety, and electrical safety. c. Demonstrate the use of tools specific to the local program.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 8: Welding and Cutting Processes

Competencies and Suggested Objectives
1. Identify common equipment, tools, and safety procedures, and perform the various welding processes. DOK1 a. Identify major types of welders. • Shield metal arc welding (SMAW) • Gas metal arc welding (GMAW) • Gas tungsten arc welding (GTAW) b. Describe and identify different supplies used in welding. • Electrodes o Low-hydrogen, mild steel, and alloy welding • Gases in the GMAW process o Argon o CO_2 o Mixed gas (argon/CO_2) c. Perform welding techniques utilizing the appropriate welding process. • Start, stop, and restart • Pad construction • Flat-butt construction • Beads, fillet (T), lap, corner, and edge (SMAW, GMAW)
2. Apply safety procedures and perform tasks using oxyacetylene equipment (OAW). DOK2 a. Identify and demonstrate parts of the oxyacetylene cutting equipment utilizing all safety protocols. b. Identify the different types of oxyacetylene flames and the applications of each, including neutral, oxidizing, and carburizing. c. Assemble and operate oxyacetylene cutting equipment. Set up equipment for cutting operations, to include selecting the proper tip and setting regulator pressures. d. Discuss oxyacetylene welding (brazing).

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 9: Agricultural Small Engines

Competencies and Suggested Objectives
1. Apply safety procedures and examine the major parts and function of a small engine. DOK1 a. Identify and demonstrate the use of specific hand tools and diagnostic instruments used in small-engine maintenance and repair. b. Identify and discuss the fundamentals of the combustion engine, including the difference between two- and four-cycle engines. • Air intake and exhaust • Fuel • Compression • Ignition c. Identify the common systems of a small gasoline engine. • Ignition • Air intake • Lubrication • Power train • Cooling • Exhaust • Fuel systems d. Determine which basic tools are essential for engine repair. • One set of each socket, open-end, and box wrenches ¼ in. to 1 in. • Hex wrench set • 6-in. and 10-in. adjustable wrenches • Torque wrench • Slip-joint pliers • Long-nose pliers • Ball peen hammer • Chisels • Punches • Standard and Phillips-head screwdrivers

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 10: ANR Careers and FFA Leadership

Competencies and Suggested Objectives
1. Review safety rules and behavior. DOK1 a. Identify safety rules and behavior for the classroom. b. Identify safety rules and behavior for the shop and laboratory areas.
2. Investigate and develop skills necessary for pursuing a career in ANR. DOK2 a. Discover the careers available in ANR. b. Build a personal résumé and cover letter for the purpose of applying for jobs. c. Perform a mock interview utilizing the personal résumé and cover letter.
3. Develop an individual FFA activity plan. DOK2 a. Identify and participate in FFA activities and programs that contribute to career advancement and individual achievement. b. Select and document FFA activities and programs that contribute to personal development.
4. Develop and present a 3 to 5-minute presentation on an ANR topic. DOK2 a. Discuss guidelines for preparing a successful presentation, including preparation, resource development, writing skills, and presentation skills.
5. Develop an Immersion SAE and maintain records in an electronic record-keeping system. DOK3

Unit 11: Conservation and Management of Natural Resources

Competencies and Suggested Objectives

1. Explore basic concepts of natural resources and conservation management. DOK1
   a. Describe the nature and importance of sustainable agriculture.
      - Renewable resources
      - Nonrenewable resources
   b. Explore the services of agencies and organizations that protect and maintain the environment.
      - Natural Resources Conservation Service (NRCS)
      - United States Department of Agriculture (USDA)
      - Bureau of Land Management (BLM)
      - Farm Service Agency (FSA)
   c. Identify and select practices that promote sustainability in agriculture.
      - No-till
      - Grass waterways
      - Strip tilling
      - Terraces
      - Cover crops
      - Rotational grazing

2. Explore the principles and applications of precision-farming operations. DOK2
   a. Discover how Geographic Information System (GIS) mapping and Global Positioning System (GPS) technology are creating a shift from traditional agricultural practices.
   b. Recognize and discuss how GIS maps can assist a farmer with various tasks.
      - Crop management
      - Site suitability
      - Drainage planning
      - Flood prevention/management
      - Drought prevention/management
      - Erosion prevention/management
      - Disease control
   c. Discuss ways that GPS technology is used in precision-farming operations.
      - Farm planning
      - Field mapping
      - Soil sampling
      - Tractor guidance
      - Crop scouting
      - Variable rate applications
      - Yield mapping
      - Working during low-visibility field conditions

d. Compare and contrast variable-rate versus site-specific application of fertilizers and chemicals.

3. Explore air and water quality. DOK2
   a. Discuss the sources of water and potential threats to each source.
      - Water cycle
      - Water uses
      - Water pollution
   b. Discuss the sources of air pollution and precautions that can be taken to reduce or prevent pollution.
      - Equipment
      - Pesticides
      - Agricultural waste
      - Dust, smoke, and odors

4. Investigate the use of the land-capability classification system. DOK1
   a. Describe the concepts of land-capability classification (I-VIII).
   b. Identify and describe factors that contribute to land capability.
      - Slope
      - Texture
      - Runoff
      - Permeability
      - Erosion
   c. Contrast types of soil erosion and controls.
      - Identify the different types of soil erosion.
      - Identify different practices that can be used to control erosion.
      - Apply erosion control practices to different agricultural scenarios.
   d. Evaluate a given location for home site suitability.
      - Identify factors that should be evaluated in selecting a home site.
      - Classify a given location using home site selection criteria.

Enrichment

1. Refer to the Land Judging in Oklahoma manual published by Oklahoma State University Extension as a guide to the Land Evaluation CDE. https://landjudging.com

Unit 12: Science of Forestry and the Environment

Competencies and Suggested Objectives
1. Examine basic principles of forest dendrology and mensuration. DOK2 a. Examine the layered structure of forests and how these layers protect and enhance the ecosystem. • Emergent • Canopy • Understory/shrub layer • Forest floor b. Identify locally important trees by type, physical characteristics, and use. • Softwoods (e.g., loblolly pine, long leaf pine, cedars, etc.) • Hardwoods (e.g., oak, sweet gum, hickory, etc.) c. Analyze the growth rate and age of trees by examining the annual rings and accounting for variations in growth rate due to environmental factors.
2. Discuss the relationship of forestry to environmental quality and economic development. DOK2 a. Identify consumer goods derived from forestry. • Paper products • Lumber and building products • Finished products (i.e., consumer goods) b. Define biodiversity and describe its relationship to forestry. c. Investigate methods for forest fire prevention. • Control burns • Fire lanes • Fire prevention marketing and education d. Discuss the different damages caused by forest fires. • Loss of habitat • Environmental degradation • Loss of revenue • Property damage and loss e. Discuss the methods of reforestation. • Natural reseeding • Hand or machine planting

Unit 13: Wildlife and the Environment

Competencies and Suggested Objectives
1. Examine the relationships of wildlife well-being and environmental quality. DOK1 a. Identify common wildlife species found in Mississippi, and classify each as terrestrial or aquatic (e.g., whitetail deer, raccoons, turkeys, opossums, turtles, bass, crappie, wild hogs, etc.). b. Describe the importance of wildlife to the environment and human well-being. c. Recommend procedures for improving wildlife habitats. • Constructing food plots • Following responsible hunting practices • Observing environmental regulations
2. Explore concepts and practices related to wildlife conservation and management. DOK1 a. Create a diagram illustrating the interrelationships among the soil, plants, animals, and humans (i.e., a food web). b. Discuss the concept of a food web.
3. Investigate approaches to protecting and managing wildlife species. DOK2 a. Discuss the need for wildlife protection and conservation policies and how species are lost from the earth. b. Classify wildlife species based on threats to their continued existence. • Endangered • Threatened • Extinct c. Describe practices in conservation, protection, and management of wildlife. • Game laws and limits • Sustainability of the ecosystem • Establishment of wildlife refuges • Natural versus artificial population management

Unit 14: Agricultural Equipment Operation and Maintenance

Competencies and Suggested Objectives
1. Inspect, maintain, and repair agricultural equipment. DOK4 a. Describe procedures for completing an inspection of agricultural equipment. • Coolant • Engine oil • Tire pressure • Hydraulic fluid • Gear oil • Air filters b. Perform operation and maintenance checks on agricultural equipment according to manufacturer's specifications. c. Assess parts to repair or replace based on manufacturer's specifications and observations. d. Perform maintenance for required parts, reassemble, adjust, and test.
2. Perform reconditioning of agricultural machinery and equipment. DOK4 a. Recondition agricultural machinery and equipment based on local availability. b. Select and demonstrate proper equipment for a specific job and develop a bill of materials for that job. c. Estimate materials for a specific task.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.
Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 15: Agricultural Construction and Fabrication

Competencies and Suggested Objectives
1. Select and demonstrate proper equipment for a specific construction job. DOK2 a. Identify tools and equipment for a specific job. b. Select and use hand and power tools safely and properly. c. Demonstrate mathematical concepts in measurement.
2. Develop a bill of materials for a specific job. DOK2 a. Compare dimensions, kind, and amounts of materials needed. b. Explain the use of wood, metal, fasteners, wire, concrete, and roofing materials. c. Design and build a structure. • Foundation • Wall construction • Roof construction
3. Identify and demonstrate electrical procedures and proper use of hand and power tools. DOK2 a. Apply rules for hand and power tools, including basic operation, danger point, observer safety, and electrical safety. b. Explain the relationship between volts, amps, and watts. c. Demonstrate use of a voltmeter, amp meter, pliers, screwdrivers, wire cutters, and wire strippers in electrical work. d. Discuss the causes of electrical accidents, including short circuits, overloads, improper insulation, and the presence of moisture. e. Demonstrate procedures for preventing electrical accidents. • Proper tool maintenance • Disconnecting of power when working on circuits (lockout-tag out) • Proper operation of breakers, fuses, ground fault circuit interrupters (GFCI), grounding, and other appropriate safety devices
4. Perform welds with SMAW equipment. DOK4 a. Fabricate a single v-groove butt weld in the horizontal position. b. Fabricate a single v-groove butt weld in the vertical up position.
5. Perform welds with GMAW equipment. DOK4 a. Fabricate a single v-groove butt weld in the horizontal position. b. Fabricate a single v-groove butt weld in the vertical up position.
6. Cut metal with a plasma arc cutter. DOK4 a. Identify safety rules and practices associated with a plasma arc cutter. b. Perform safe and proper operation of a plasma arc cutter.

Note: Safety is to be taught as an ongoing part of the program. Students are required to complete a written safety test with 100% accuracy before entering the shop for lab simulations and projects. This test should be documented in each student's file.

Note: This unit will be ongoing throughout the year. Time allotted for this unit will be distributed over the entire year.

Unit 16: Agricultural Business Management and Processes

Competencies and Suggested Objectives
1. Explore banking services for personal and business accounts. DOK2 a. Identify common types of personal savings and checking options. b. Create and maintain a transaction register. c. Demonstrate how to write a check. d. Demonstrate how to write a deposit slip. e. Reconcile a bank statement. f. Investigate online banking services, including online security, identity theft, and fraud-prevention procedures.
2. Explore concepts of credit. DOK2 a. Identify and compare sources of credit (e.g., credit card, bank, finance company, credit union, government agency, etc.) b. Describe factors that indicate a good credit rating (e.g., returns, repayment capacity, risk, etc.) c. Discuss guidelines for wise use of credit. d. Describe procedures for obtaining credit. e. Explain how credit is used in the decision-making process.
3. Compare loan options. DOK2 a. Discuss the different uses of loan funds (e.g., business and personal loans). b. Describe procedures for obtaining agribusiness loans. c. Identify types of collateral that can be used to obtain a loan. d. Calculate the cost of a loan. e. Explain the process of filling out a loan application.
4. Explore basic principles of agricultural economics and marketing. DOK2 a. Compare and contrast the types of business organizations. • Individual • Partnership • Cooperative • Corporation b. Describe the law of supply and demand. c. Differentiate between wholesale and retail marketing.
5. Discuss the principles and practices of an agricultural business. DOK2 a. Discuss taxes and insurance as related to agricultural businesses. • Liability, life, medical, and property insurance • Personal income, property taxes, W-2, 1099, and 1040EZ forms b. Develop a business plan.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Introduction to Agricultural and Natural Resources		
	1.	Examine the nature of the Agricultural and Natural Resources (ANR) industry.
	2.	Examine the relationships between the pure sciences, agriculture, and agriscience.
	3.	Apply standard ANR safety practices.
Unit 2: The National FFA Organization and Career Development		
	1.	Explore the integral relationship between the FFA and agricultural education.
	2.	Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st century skills standards.
	3.	Describe the role of 21st-century skills, work ethic, and values in establishing and building a successful career.
	4.	Investigate careers associated with the agricultural industry and complete a project with details about a career.
Unit 3: Supervised Agricultural Experience (SAE) for All and Embedded Work-Based Learning		
	1.	Describe the purposes and requirements of the Supervised Agricultural Experience (SAE) for All program.
	2.	Launch a Foundational SAE plan.
	3.	Develop a record-keeping system for an individual student's SAE program.
Unit 4: Science of Animals		
	1.	Explore the animal-agriculture industry and enterprises.
	2.	Compare and contrast animal systems for mammals, avian, and aquatic animals including, but not limited to, respiratory, skeletal, and circulatory.
	3.	Examine the role of reproduction and genetics in agricultural animals.
	4.	Describe important elements of animal nutrition and digestion.
	5.	Explain management practices for maintaining health in beef, dairy, swine, poultry, equine, aquaculture, and other species of local interest.

Unit 5: Science of Plants		
	1.	Examine basic plant classifications.
	2.	Explore the anatomy and physiology of a plant.
	3.	Investigate common methods of plant reproduction.
	4.	Apply principles of plant nutrition.
	5.	Compare and contrast the different components of integrated pest management (IPM) measures.
Unit 6: Soil Science		
	1.	Demonstrate an understanding of the impact of soil as a natural resource.
	2.	Investigate the chemical properties of soils.
Unit 7: Hand and Power Tools in Agriculture		
	1.	Identify and demonstrate the proper use of hand and power tools.
Unit 8: Welding and Cutting Processes		
	1.	Identify common equipment, tools, and safety procedures, and perform the various welding processes.
	2.	Apply safety procedures and perform tasks using oxyacetylene equipment (OAW).
Unit 9: Agricultural Small Engines		
	1.	Apply safety procedures and examine the major parts and function of a small engine.
Unit 10: ANR Careers and FFA Leadership		
	1.	Review safety rules and behavior.
	2.	Investigate and develop skills necessary for pursuing a career in ANR.
	3.	Develop an individual FFA activity plan.
	4.	Develop and present a 3 to 5-minute presentation on an ANR topic.
	5.	Develop an Immersion SAE and maintain records in an electronic record-keeping system.
Unit 11: Conservation and Management of Natural Resources		
	1.	Explore basic concepts of natural resources and conservation management.
	2.	Explore the principles and applications of precision farming operations.
	3.	Explore air and water quality.
	4.	Investigate the use of the land-capability classification system.
Unit 12: Science of Forestry and the Environment		
	1.	Examine basic principles of forest dendrology and mensuration.
	2.	Discuss the relationship of forestry to environmental quality and economic development.

Unit 13: Wildlife and the Environment		
	1.	Examine the relationships of wildlife well-being and environmental quality.
	2.	Explore concepts and practices related to wildlife conservation and management.
	3.	Investigate approaches to protecting and managing wildlife species.
Unit 14: Agricultural Equipment Operation and Maintenance		
	1.	Inspect, maintain, and repair agricultural equipment.
	2.	Perform reconditioning of agricultural machinery and equipment.
Unit 15: Agricultural Construction and Fabrication		
	1.	Select and demonstrate proper equipment for a specific construction job.
	2.	Develop a bill of materials for a specific job.
	3.	Identify and demonstrate electrical procedures and proper use of hand and power tools.
	4.	Perform welds with SMAW equipment.
	5.	Perform welds with GMAW equipment.
	6.	Cut metal with a plasma arc cutter.
Unit 16: Agricultural Business Management and Processes		
	1.	Explore banking services for personal and business accounts.
	2.	Explore concepts of credit.
	3.	Compare loan options.
	4.	Explore basic principles of agricultural economics and marketing.
	5.	Discuss the principles and practices of an agricultural business.

Appendix: Industry Standards

Framework for AFNR Content Standards and Performance Elements Crosswalk for Agricultural and Natural Resources

	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
AFNR																	
ABS- Agribusiness Systems		X		X												X	X
AS- Animal Systems		X			X									X			
BS- Biotechnology		X			X	X											
CRP- Career Ready Practices		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CS- AFNR Cluster Skill		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ES- Environmental Service Systems		X					X					X	X	X			
FPP- Food Products and Processing Systems		X			X												
NRS- Natural Resource Systems		X					X					X	X	X			
PS- Plant Systems		X			X	X	X					X	X				
PST- Power, Structural, and Technical Systems		X						X	X	X		X	X		X	X	

AFNR Pathway
Content Standards and Performance Elements

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ABS AGRIBUSINESS SYSTEMS
AS ANIMAL SYSTEMS
BS BIOTECHNOLOGY
CRP CAREER READY PRACTICES
CS AGRICULTURE FOOD AND NATURAL RESOURCES CLUSTER SKILL
ES ENVIRONMENTAL SERVICE SYSTEMS
FPP FOOD PRODUCTS AND PROCESSING SYSTEMS
NRS NATURAL RESOURCE SYSTEMS
PS PLANT SYSTEMS
PST POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

Agribusiness Systems Career Pathway Content Standards

The Agribusiness Systems (ABS) Career Pathway encompasses the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), and business planning, and sales and marketing. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the planning, development, application and management of agribusiness systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Agribusiness Systems (AG-ABS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ABS.01. CCTC Standard: Apply management planning principles in AFNR businesses.

ABS.01.01. Performance Indicator: Apply micro- and macroeconomic principles to plan and manage inputs and outputs in an AFNR business.

ABS.01.02. Performance Indicator: Read, interpret, evaluate and write statements of purpose to guide business goals, objectives and resource allocation.

ABS.01.03. Performance Indicator: Devise and apply management skills to organize and run an AFNR business in an efficient, legal and ethical manner.

ABS.01.04. Performance Indicator: Evaluate, develop and implement procedures used to recruit, train and retain productive human resources for AFNR businesses.

ABS.02. CCTC Standard: Use record keeping to accomplish AFNR business objectives, manage budgets and comply with laws and regulations.

ABS.02.01. Performance Indicator: Apply fundamental accounting principles, systems, tools and applicable laws and regulations to record, track and audit AFNR business transactions (e.g., accounts, debits, credits, assets, liabilities, equity, etc.).

ABS.02.02. Performance Indicator: Assemble, interpret and analyze financial information and reports to monitor AFNR business performance and support decision-making (e.g., income statements, balance sheets, cash-flow analysis, inventory reports, break-even analysis, return on investment, taxes, etc.).

ABS.03. CCTC Standard: Manage cash budgets, credit budgets and credit for an AFNR business using generally accepted accounting principles.

ABS.03.01. Performance Indicator: Develop, assess and manage cash budgets to achieve AFNR business goals.

ABS.03.02. Performance Indicator: Analyze credit needs and manage credit budgets to achieve AFNR business goals.

ABS.04. CCTC Standard: Develop a business plan for an AFNR business.

ABS.04.01. Performance Indicator: Analyze characteristics and planning requirements associated with developing business plans for different types of AFNR businesses.

ABS.04.02. Performance Indicator: Develop production and operational plans for an AFNR business.

ABS.04.03. Performance Indicator: Identify and apply strategies to manage or mitigate risk.

ABS.05. CCTC Standard: Use sales and marketing principles to accomplish AFNR business objectives.

ABS.05.01. Performance Indicator: Analyze the role of markets, trade, competition and price in relation to an AFNR business sales and marketing plans.

ABS.05.02. Performance Indicator: Assess and apply sales principles and skills to accomplish AFNR business objectives.

ABS.05.03. Performance Indicator: Assess marketing principles and develop marketing plans to accomplish AFNR business objectives.

Animal Systems Career Pathway Content Standards

The Animal Systems (AS) Career Pathway encompasses the study of animal systems, including content areas such as life processes, health, nutrition, genetics, and management and processing, as applied to small animals, aquaculture, exotic animals, livestock, dairy, horses and/or poultry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of animal systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Animal Systems (AG-AS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

AS.01. CCTC Standard: Analyze historic and current trends impacting the animal systems industry.

AS.01.01. Performance Indicator: Evaluate the development and implications of animal origin, domestication and distribution on production practices and the environment.

AS.01.02. Performance Indicator: Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts.

AS.01.03. Performance Indicator: Analyze and apply laws and sustainable practices to animal agriculture from a global perspective.

AS.02. CCTC Standard: Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.

AS.02.01. Performance Indicator: Demonstrate management techniques that ensure animal welfare.

AS.02.02. Performance Indicator: Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system, etc.).

AS.03. CCTC Standard: Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction and/or economic production.

AS.03.01. Performance Indicator: Analyze the nutritional needs of animals.

AS.03.02 Performance Indicator: Analyze feed rations and assess if they meet the nutritional needs of animals.

AS.03.03 Performance Indicator: Utilize industry tools to make animal nutrition decisions.

AS.04. CCTC Standard: Apply principles of animal reproduction to achieve desired outcomes for performance, development and/or economic production.

AS.04.01. Performance Indicator: Evaluate animals for breeding readiness and soundness.

AS.04.02. Performance Indicator: Apply scientific principles to select and care for breeding animals.

AS.04.03 Performance Indicator: Apply scientific principles to breed animals.

AS.05. CCTC Standard: Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.

AS.05.01. Performance Indicator: Design animal housing, equipment and handling facilities for the major systems of animal production.

AS.05.02. Performance Indicator: Comply with government regulations and safety standards for facilities used in animal production.

AS.06. CCTC Standard: Classify, evaluate and select animals based on anatomical and physiological characteristics.

AS.06.01. Performance Indicator: Classify animals according to taxonomic classification systems and use (e.g. agricultural, companion, etc.).

AS.06.02. Performance Indicator: Apply principles of comparative anatomy and physiology to uses within various animal systems.

AS.06.03. Performance Indicator: Select and train animals for specific purposes and maximum performance based on anatomy and physiology.

AS.07. CCTC Standard: Apply principles of effective animal health care.

AS.07.01. Performance Indicator: Design programs to prevent animal diseases, parasites and other disorders and ensure animal welfare.

AS.07.02. Performance Indicator: Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level.

AS.08. CCTC Standard: Analyze environmental factors associated with animal production.

AS.08.01. Performance Indicator: Design and implement methods to reduce the effects of animal production on the environment.

AS.08.02. Performance Indicator: Evaluate the effects of environmental conditions on animals and create plans to ensure favorable environments for animals.

Common Career Technical Core Career Ready Practices Content Standards

The CCTC CRPs encompass fundamental skills and practices that all students should acquire to be career ready such as: responsibility, productivity, healthy choices, maintaining personal finances, communication, decision-making, creativity and innovation, critical-thinking, problem solving, integrity, ethical leadership, management, career planning, technology use and cultural/global competency. Students completing a program of study in any AFNR career pathway will demonstrate the knowledge, skills and behaviors that are important to career ready through experiences in a variety of settings (e.g., classroom, CTSO, work-based learning, community etc.).

DEFINITIONS: Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for CRPs from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** –These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a CTE program of study.

CRP.01. CCTC Standard: Act as a responsible and contributing citizen and employee.

CRP.01.01. Performance Indicator: Model personal responsibility in the workplace and community.

CRP.01.02 Performance Indicator: Evaluate and consider the near-term and long-term impacts of personal and professional decisions on employers and community before taking action.

CRP.01.03. Performance Indicator: Identify and act upon opportunities for professional and civic service at work and in the community.

CRP.02. CCTC Standard: Apply appropriate academic and technical skills.

CRP.02.01. Performance Indicator: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.

CRP.02.02. Performance Indicator: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.

CRP.03. CCTC Standard: Attend to personal health and financial well-being.

CRP.03.01. Performance Indicator: Design and implement a personal wellness plan.

CRP.03.02. Performance Indicator: Design and implement a personal financial management plan.

CRP.04. CCTC Standard: Communicate clearly, effectively and with reason.

CRP.04.01. Performance Indicator: Speak using strategies that ensure clarity, logic, purpose and professionalism in formal and informal settings.

CRP.04.02. Performance Indicator: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.

CRP.04.03. Performance Indicator: Model active listening strategies when interacting with others in formal and informal settings.

CRP.05. CCTC Standard: Consider the environmental, social and economic impacts of decisions.

CRP.05.01. Performance Indicator: Assess, identify and synthesize the information and resources needed to make decisions that positively impact the workplace and community.

CRP.05.02. Performance Indicator: Make, defend and evaluate decisions at work and in the community using information about the potential environmental, social and economic impacts.

CRP.06. CCTC Standard: Demonstrate creativity and innovation.

CRP.06.01. Performance Indicator: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.

CRP.06.02. Performance Indicator: Assess a variety of workplace and community situations to identify ways to add value and improve the efficiency of processes and procedures.

CRP.06.03. Performance Indicator: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.

CRP.07. CCTC Standard: Employ valid and reliable research strategies.

CRP.07.01. Performance Indicator: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.

CRP.07.02. Performance Indicator: Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community.

CRP.08. CCTC Standard: Utilize critical thinking to make sense of problems and persevere in solving them.

CRP.08.01. Performance Indicator: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.

CRP.08.02. Performance Indicator: Investigate, prioritize and select solutions to solve problems in the workplace and community.

CRP.08.03. Performance Indicator: Establish plans to solve workplace and community problems and execute them with resiliency.

CRP.09. CCTC Standard: Model integrity, ethical leadership and effective management.

CRP.09.01. Performance Indicator: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).

CRP.09.02. Performance Indicator: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).

CRP.09.03. Performance Indicator: Demonstrate behaviors that contribute to a positive morale and culture in the workplace and community (e.g., positively influencing others, effectively communicating, etc.).

CRP.10. CCTC Standard: Plan education and career path aligned to personal goals.

CRP.10.01. Performance Indicator: Identify career opportunities within a career cluster that match personal interests, talents, goals and preferences.

CRP.10.02. Performance Indicator: Examine career advancement requirements (e.g., education, certification, training, etc.) and create goals for continuous growth in a chosen career.

CRP.10.03. Performance Indicator: Develop relationships with and assimilate input and/or advice from experts (e.g., counselors, mentors, etc.) to plan career and personal goals in a chosen career area.

CRP.10.04. Performance Indicator: Identify, prepare, update and improve the tools and skills necessary to pursue a chosen career path.

CRP.11. CCTC Standard: Use technology to enhance productivity.

CRP.11.01. Performance Indicator: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

CRP.11.02. Performance Indicator: Evaluate personal and organizational risks of technology use and take actions to prevent or minimize risks in the workplace and community.

CRP.12. CCTC Standard: Work productively in teams while using cultural/global competence.

CRP.12.01. Performance Indicator: Contribute to team-oriented projects and builds consensus to accomplish results using cultural global competence in the workplace and community.

CRP.12.02. Performance Indicator: Create and implement strategies to engage team members to work toward team and organizational goals in a variety of workplace and community situations (e.g., meetings, presentations, etc.).

Agriculture, Food, and Natural Resources Cluster Skill Content Standards

The AFNR Cluster Skills (CS) encompasses the study of fundamental knowledge and skills related to all AFNR professions. Students completing a program of study in any AFNR career

pathway will demonstrate fundamental knowledge of the nature, scope and relationships of AFNR systems and the skills necessary for analysis of current and historical issues and trends; application of technologies; safety, health and environmental practices; stewardship of natural resources; and exploration of career opportunities.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Agriculture, Food and Natural Resources Career Cluster® (AG) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** –These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

CS.01. CCTC Standard: Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster.

- **CS.01.01. Performance Indicator:** Research, examine and discuss issues and trends that impact AFNR systems on local, state, national and global levels.
- **CS.01.02. Performance Indicator:** Examine technologies and analyze their impact on AFNR systems.
- **CS.01.03. Performance Indicator:** Identify public policies and examine their impact on AFNR systems.

CS.02. CCTC Standard: Evaluate the nature and scope of the Agriculture, Food & Natural Resources Career Cluster and the role of agriculture, food and natural resources (AFNR) in society and the economy.

- **CS.02.01. Performance Indicator:** Research and use geographic and economic data to solve problems in AFNR systems.
- **CS.02.02. Performance Indicator:** Examine the components of the AFNR systems and assess their impact on the local, state, national and global society and economy.

CS.03. CCTC Standard: Examine and summarize the importance of health, safety and environmental management systems in AFNR workplaces.

- **CS.03.01. Performance Indicator:** Identify and explain the implications of required regulations to maintain and improve safety, health and environmental management systems.
- **CS.03.02. Performance Indicator:** Develop and implement a plan to maintain and improve health, safety and environmental compliance and performance.
- **CS.03.03. Performance Indicator:** Apply health and safety practices to AFNR workplaces.
- **CS.03.04. Performance Indicator:** Use appropriate protective equipment and demonstrate safe and proper use of AFNR tools and equipment.

CS.04. CCTC Standard: Demonstrate stewardship of natural resources in AFNR activities.
- **CS.04.01. Performance Indicator:** Identify and implement practices to steward natural resources in different AFNR systems.
- **CS.04.02. Performance Indicator:** Assess and explain the natural resource related trends, technologies and policies that impact AFNR systems.

CS.05. CCTC Standard: Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources career pathways.
- **CS.05.01. Performance Indicator:** Evaluate and implement the steps and requirements to pursue a career opportunity in each of the AFNR career pathways (e.g., goals, degrees, certifications, resumes, cover letter, portfolios, interviews, etc.).

CS.06. CCTC Standard: Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.
- **CS.06.01. Performance Indicator:** Examine and explain foundational cycles and systems of AFNR.
- **CS.06.02. Performance Indicator:** Analyze and explain the connection and relationships between different AFNR systems on a national and global level.

Biotechnology Systems Career Pathway Content Standards

The Biotechnology Systems (BS) Career Pathway encompasses the study of using data and scientific techniques to solve problems concerning living organisms with an emphasis on applications to agriculture, food and natural resource systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of biotechnology in the context of AFNR.

Within each pathway, the standards are organized as follows:

- ***National Council for Agricultural Education (NCAE) Standard**** – These are the standards set forth by the National Council for Agricultural Education for Biotechnology Systems. They define what students should know and be able to do after completing instruction in a program of study focused on applying biotechnology to AFNR systems.
- ***Performance Indicators*** – These statements distill each performance element into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related performance element at the conclusion of a program of study in this area.

BS.01. NCAE Standard: Assess factors that have influenced the evolution of biotechnology in agriculture (e.g., historical events, societal trends, ethical and legal implications, etc.).
- **BS.01.01**. **Performance Indicator**: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

BS.01.02. Performance Indicator: Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).

BS.01.03. Performance Indicator: Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

BS.02. NCAE Standard: Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).

BS.02.01. **Performance Indicator**: Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.

BS.02.02. Performance Indicator: Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

BS.02.03. Performance Indicator: Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

BS.02.04. Performance Indicator: Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

BS.02.05. Performance Indicator: Examine and perform scientific procedures using microbes, DNA, RNA and proteins in a laboratory.

BS.03. NCAE Standard: Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

BS.03.01. Performance Indicator: Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.

BS.03.02. Performance Indicator: Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.

BS.03.03. Performance Indicator: Apply biotechnology principles, techniques and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).

BS.03.04. Performance Indicator: Apply biotechnology principles, techniques and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).

BS.03.05. Performance Indicator: Apply biotechnology principles, techniques and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).

BS.03.06. Performance Indicator: Apply biotechnology principles, techniques and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.).

Environmental Service Systems Career Pathway Content Standards

The Environmental Service Systems (ESS) Career Pathway encompasses the study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of environmental service systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Environmental Service Systems (AG-ESS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ESS.01. CCTC Standard: Use analytical procedures and instruments to manage environmental service systems.

ESS.01.01. Performance Indicator: Analyze and interpret laboratory and field samples in environmental service systems.

ESS.01.02. Performance Indicator: Properly utilize scientific instruments in environmental monitoring situations (e.g., laboratory equipment, environmental monitoring instruments, etc.).

ESS.02. CCTC Standard: Evaluate the impact of public policies and regulations on environmental service system operations.

ESS.02.01. Performance Indicator: Interpret and evaluate the impact of laws, agencies, policies and practices affecting environmental service systems.

ESS.02.02. Performance Indicator: Compare and contrast the impact of current trends on regulation of environmental service systems (e.g., climate change, population growth, international trade, etc.).

ESS.02.03. Performance Indicator: Examine and summarize the impact of public perceptions and social movements on the regulation of environmental service systems.

ESS.03. CCTC Standard: Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.

ESS.03.01. Performance Indicator: Apply meteorology principles to environmental service systems.

ESS.03.02. Performance Indicator: Apply soil science and hydrology principles to environmental service systems.

ESS.03.03. Performance Indicator: Apply chemistry principles to environmental service systems.

ESS.03.04. Performance Indicator: Apply microbiology principles to environmental service systems.

ESS.03.05. Performance Indicator: Apply ecology principles to environmental service systems.

ESS.04. CCTC Standard: Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management and energy conservation).

ESS.04.01. Performance Indicator: Use pollution control measures to maintain a safe facility and environment.

ESS.04.02. Performance Indicator: Manage safe disposal of all categories of solid waste in environmental service systems.

ESS.04.03. Performance Indicator: Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.

ESS.04.04. Performance Indicator: Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

ESS.05. CCTC Standard: Use tools, equipment, machinery and technology common to tasks in environmental service systems.

ESS.05.01. Performance Indicator: Use technological and mathematical tools to map land, facilities and infrastructure for environmental service systems.

ESS.05.02. Performance Indicator: Perform assessments of environmental conditions using equipment, machinery and technology.

Food Products and Processing Systems Career Pathway Content Standards

The Food Products and Processing Systems (FPP) Career Pathway encompasses the study of food safety and sanitation; nutrition, biology, microbiology, chemistry and human behavior in local and global food systems; food selection and processing for storage, distribution and consumption; and the historical and current development of the food industry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of food products and processing systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Food Products and Processing Systems (AG-FPP) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to

demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

FPP.01. CCTC Standard: Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.

FPP.01.01. Performance Indicator: Analyze and manage operational and safety procedures in food products and processing facilities.

FPP.01.02. Performance Indicator: Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

FPP.01.03. Performance Indicator: Apply food safety procedures when storing food products to ensure food quality.

FPP.02. CCTC Standard: Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.

FPP.02.01. Performance Indicator: Apply principles of nutrition and biology to develop food products that provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.02.02. Performance Indicator: Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.02.03. Performance Indicator: Apply principles of human behavior to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.03. CCTC Standard: Select and process food products for storage, distribution and consumption.

FPP.03.01. Performance Indicator: Implement selection, evaluation and inspection techniques to ensure safe and quality food products.

FPP.03.02. Performance Indicator: Design and apply techniques of food processing, preservation, packaging and presentation for distribution and consumption of food products.

FPP.03.03. Performance Indicator: Create food distribution plans and procedures to ensure safe delivery of food products.

FPP.04. CCTC Standard: Explain the scope of the food industry and the historical and current developments of food product and processing.

FPP.04.01. Performance Indicator: Examine the scope of the food industry by evaluating local and global policies, trends and customs for food production.

FPP.04.02. Performance Indicator: Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

FPP.04.03. Performance Indicator: Identify and explain the purpose of industry organizations, groups and regulatory agencies that influence the local and global food systems.

Natural Resource Systems Career Pathway Content Standards

The Natural Resource Systems (NRS) Career Pathway encompasses the study of the management, protection, enhancement and improvement of soil, water, wildlife, forests and air as natural resources. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of natural resource systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Natural Resource Systems (AG-NRS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

NRS.01. CCTC Standard: Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

NRS.01.01. Performance Indicator: Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.

NRS.01.02. Performance Indicator: Classify different types of natural resources in order to enable protection, conservation, enhancement and management in a particular geographical region.

NRS.01.03. Performance Indicator: Apply ecological concepts and principles to atmospheric natural resource systems.

NRS.01.04. Performance Indicator: Apply ecological concepts and principles to aquatic natural resource systems.

NRS.01.05. Performance Indicator: Apply ecological concepts and principles to terrestrial natural resource systems.

NRS.01.06. Performance Indicator: Apply ecological concepts and principles to living organisms in natural resource systems.

NRS.02. CCTC Standard: Analyze the interrelationships between natural resources and humans.

NRS.02.01. Performance Indicator: Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).

NRS.02.02. Performance Indicator: Assess the impact of human activities on the availability of natural resources.

NRS.02.03. Performance Indicator: Analyze how modern perceptions of natural resource management, protection, enhancement and improvement change and develop over time.

NRS.02.04. Performance Indicator: Examine and explain how economics affects the use of natural resources.

NRS.02.05. Performance Indicator: Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

NRS.03. CCTC Standard: Develop plans to ensure sustainable production and processing of natural resources.

NRS.03.01. Performance Indicator: Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).

NRS.03.02. Performance Indicator: Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.

NRS.04. CCTC Standard: Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

NRS.04.01. Performance Indicator: Demonstrate natural resource protection, maintenance, enhancement and improvement techniques.

NRS.04.02. Performance Indicator: Diagnose plant and wildlife diseases and follow protocols to prevent their spread.

NRS.04.03. Performance Indicator: Prevent or manage introduction of ecologically harmful species in a particular region.

NRS.04.04. Performance Indicator: Manage fires in natural resource systems.

Plant Science Systems Career Pathway Content Standards

The Plant Systems (PS) Career Pathway encompasses the study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as wells as growth and cultural practices through the study of crops, turf grass, trees, shrubs and/or ornamental plants. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of plant systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Plant Systems (AG-PS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PS.01. CCTC Standard: Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

- **PS.01.01. Performance Indicator:** Determine the influence of environmental factors on plant growth.
- **PS.01.02. Performance Indicator:** Prepare and manage growing media for use in plant systems.
- **PS.01.03. Performance Indicator:** Develop and implement a fertilization plan for specific plants or crops.

PS.02. CCTC Standard: Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

- **PS.02.01. Performance Indicator:** Classify plants according to taxonomic systems.
- **PS.02.02. Performance Indicator:** Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
- **PS.02.03. Performance Indicator:** Apply knowledge of plant physiology and energy conversion to plant systems.

PS.03. CCTC Standard: Propagate, culture and harvest plants and plant products based on current industry standards.

- **PS.03.01. Performance Indicator:** Demonstrate plant propagation techniques in plant system activities.
- **PS.03.02. Performance Indicator:** Develop and implement a management plan for plant production.
- **PS.03.03. Performance Indicator:** Develop and implement a plan for integrated pest management for plant production.
- **PS.03.04. Performance Indicator:** Apply principles and practices of sustainable agriculture to plant production.
- **PS.03.05. Performance Indicator:** Harvest, handle and store crops according to current industry standards.

PS.04. CCTC Standard: Apply principles of design in plant systems to enhance an environment (e.g. floral, forest landscape, and farm).

- **PS.04.01. Performance Indicator:** Evaluating, identifying and preparing plants to enhance an environment.
- **PS.04.02. Performance Indicator:** Create designs using plants.

Power, Structural and Technical Systems Career Pathway Content Standards

The Power, Structural and Technical Systems (PST) Career Pathway encompasses the study of agricultural equipment, power systems, alternative fuel sources and precision technology, as well as woodworking, metalworking, welding and project planning for agricultural structures. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of power, structural and technical systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Power, Structural and Technical Systems (AG-PST) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PST.01. CCTC Standard: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.

PST.01.01. Performance Indicator: Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural and technical systems.

PST.01.02. Performance Indicator: Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations.

PST.01.03. Performance Indicator: Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen and plasma arc torch, etc.).

PST.02. CCTC Standard: Operate and maintain AFNR mechanical equipment and power systems.

PST.02.01. Performance Indicator: Perform preventative maintenance and scheduled service to maintain equipment, machinery and power units used in AFNR settings.

PST.02.02. Performance Indicator: Operate machinery and equipment while observing all safety precautions in AFNR settings.

PST.03. CCTC Standard: Service and repair AFNR mechanical equipment and power systems.

PST.03.01. Performance Indicator: Troubleshoot, service and repair components of internal combustion engines using manufacturers' guidelines.

PST.03.02. Performance Indicator: Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and/or diagnostic methods.

PST.03.03. Performance Indicator: Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension, etc.).

PST.04. CCTC Standard: Plan, build and maintain AFNR structures.

PST.04.01. Performance Indicator: Create sketches and plans for AFNR structures.

PST.04.02. Performance Indicator: Determine structural requirements, specifications and estimate costs for AFNR structures

PST.04.03. Performance Indicator: Follow architectural and mechanical plans to construct, maintain and/or repair AFNR structures (e.g., material selection, site preparation and/or layout, plumbing, concrete/masonry, etc.).

PST.04.04. Performance Indicator: Apply electrical wiring principles in AFNR structures.

PST.05. CCTC Standard: Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.

PST.05.01. Performance Indicator: Apply computer and other technologies (e.g., robotics, CNC, UAS, etc.) to solve problems and increase the efficiency of AFNR systems.

PST.05.02. Performance Indicator: Prepare and/or use electrical drawings to design, install and troubleshoot electronic control systems in AFNR settings.

PST.05.03. Performance Indicator: Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.