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Part 103: Agriculture - Secondary

2013 Introduction to Agriscience

Mississippi Department of Education

Program CIP: 01.0001 – Introduction to Agriscience

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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.

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Acknowledgments

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Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the *Introduction to Agriscience Curriculum Framework and Supporting Materials* are based on the following:

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 2-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. A complete copy of the standards can be accessed at https://www.ffa.org/thecouncil/Documents/finalafnrstandardsv324609withisbn_000.pdf

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Reprinted from http://www.corestandards.org/.

National Educational Technology Standards for Students

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 No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

There are several resources for Mississippi teachers.

My PLC: An online registration for all professional-development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Blackboard/PACE site: An online resource

Preparation for Academic and Career Education (PACE) sites have been created for Mississippi career and technical educators to have one central location for obtaining information regarding their teaching practice and classrooms. Each of the 16 career clusters has an individual site. Within the appropriate PACE site, a career pathway that is currently taught in Mississippi schools will be located, along with information from the Mississippi Department of Education (MDE) state curriculum coordinator, the MDE student organization coordinator, and the Research and Curriculum Unit (RCU) curriculum specialist. As information that is relevant to an educator's particular course is available, this information will be posted to the PACE site.

To log in to Blackboard:

1. Visit http://rcu.blackboard.com.
2. Log in with your first initial, last name, and last four (4) digits of your social security number (e.g., ddorroh3456).
3. Input the password: rcu.
4. Should you need additional instructions, please call 662.325.2510.

Introduction to Agriscience
Executive Summary

Course Description

The Introduction to Agriscience course introduces students to the broad field of agriculture, biotechnology, 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 introduces agribusiness management practices and maintenance of facilities and equipment. Students in the course will participate in active learning exercises, including integral activities of the FFA organization and supervised experiences. Students who successfully complete the competencies in this course 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*, a publication 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. However, competencies and suggested performance indicators in the Introduction to Agriscience course have been correlated to the National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Student Prerequisites

In order for students to be able to experience success in the Introduction to Agriscience course, the following prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)
3. Instructor approval and a TABE Reading Score of eighth grade or higher

or

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

or

1. Instructor approval

Applied Academic Credit

Content of the Introduction to Agriscience course has been aligned to the *2010 Mississippi Science Curriculum Framework.* Students who successfully complete the Introduction to Agriscience curriculum will receive one Carnegie unit for science and an additional 0.5 Carnegie unit for completion of the Supervised Agricultural Experience (SAE).

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 and ask for a professional-learning specialist.

Course Outline

Course Name Introduction to Agriscience **Course Code: 029990**

Unit	Unit Name	Hours
1	Introduction to Agriscience Opportunities and Careers	5
2	Introduction to Agriscience Lab Safety and the Scientific Method	10
3	Human Relations and FFA Activities	8
4	Experiential Learning (SAE)	6
5	Mechanical Technologies in Agriscience	15
6	Introduction to Biotechnology	12
7	Principles of Animal Science	13
8	Principles of Plant Science	10
9	Principles of Entomology	9
10	Principles of Natural Resources	9
11	Alternative and Sustainable Technologies	12
Total		109

Introduction to Agriscience Research Synopsis

Agricultural science or agriscience refers to research and development concerned with agricultural productivity and production techniques, the prevention and correction of adverse agricultural phenomena, and the transformation of primary products into end-consumer products. 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. Despite an overall nationwide decline in agricultural employment, occupations within agrisciences will experience average to much faster than average growth. Job prospects will continue to grow and be readily available for most graduates of postsecondary, technical, and baccalaureate agricultural programs (United States Bureau of Labor Statistics, 2012). This growth is due largely to the expansion and emergence of biotechnological innovation, the green industry, and agricultural engineering. According to the U.S. Department of Labor, the growing interest in worldwide standardization of agricultural equipment should result in increased employment of agricultural engineers. Agricultural job opportunities should also increase due to the rising demand for agricultural products. For example, according to U.S. Department of Agriculture (USDA) statistics, the sales of food and fiber products amounted to $5.8 billion in the year 2005 alone. The continuing efforts for more efficient agricultural production and the increasing emphasis on the conservation of resources are also contributing to job growth in agricultural sectors. In fact, the Mississippi Department of Agriculture and Commerce estimates that 30% of the state's workforce is employed in jobs relating directly or indirectly to agriculture.

Biotechnology

According to the Convention on Biological Diversity, biotechnology is "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products for specific use" (Secretariat of the Convention on Biological Diversity, 1992). Therefore, biotechnology includes but is not limited to medical, agricultural, and industrial applications. It is predicted to be one of the United States' most prominent applied sciences of this century. Careers in biotechnology range from research and scientific careers directly related to biotechnology to health and agricultural careers dependent on biotechnological innovations and applications. And while other agricultural sectors continue to decline, agricultural biotechnology is among growing occupational sectors in this country. In fact, employment of agricultural scientists in the United States is projected to increase 10 percent from 2010 to 2020, and employment of agricultural engineers is projected to increase 9 percent in that same time frame (US Bureau of Labor Statistics, 2012).

Trends in Secondary Biotechnology Education

Biotechnology High School: Monmouth County Vocational School District.

http://www.bths.mcvsd.org/

Students take their introductory biotechnology course in tenth grade after taking Biology/Genetics as an elective. Students may then take electives such as Environmental Biotechnology, Forensic Analysis, Neuroscience and Biopsychology, and Biomedical Engineering. The full course sequence is available at http://www.bths.mcvsd.org/storage/Course%20Sequence.pdf.

Abraham Lincoln High School: San Francisco Unified School District

Students participate in a Biotechnology Academy which focuses on the use, ethical issues and current trends in Biotechnology. Academic class work also focuses around the Biotechnology Industry further enhancing Biotechnology centered learning.

https://alhs-sfusd-ca.schoolloop.com/academy/biotech/overview

Biotechnology, Health, and Public Administration at Olympic High School – North Carolina

Students take Exploring Agricultural Science and Exploring Biotechnology in Agriculture in middle school. Prior to taking cluster foundation courses based on their selected pathway, high school students take Agriscience Applications. Students enrolled in the plant and animal systems pathways then have the option to take the advanced biotechnology courses: Biotechnology and Agriscience Research I and II.

http://schools.cms.k12.nc.us/bhpaOHS/Pages/Default.aspx

Agricultural Robotics Engineering

Agricultural robotics is the use of automation in bio systems such as agriculture, forestry, and fisheries. Applying automation to agriculture has generated several advancements in the industry while helping farmers save money and time.

Agricultural robots are capable of collecting crop and soil samples because they are small in size, which allows them to be able to accumulate data close to the crops. They are also capable of mowing, spraying pesticides, finding diseases or parasites, and performing mechanical weeding. Agricultural robots come equipped with cameras and sensors that are used to detect weeds and other forms of stress. Their sensors are used to spray only the area affected by the parasite instead of the entire crop. These innovations have helped to protect our environment by reducing the amount of harmful chemicals released in the air.

Employment Projections for Agriscience Occupations in Mississippi[1]

Occupation	2008 Employment	2018 Projected Employment	Projected Growth	Percent Projected Growth	Total Projected Avg. Annual Job Openings
Life, Physical, and Social Science Occupations	9490	10830	1340	14.1%	400
Life Scientists	2350	2680	330	14.0%	80
Animal Scientists	50	50	0	0.0%	5
Food Scientists and Technologists	130	160	30	23.1%	10
Soil and Plant Scientists	270	300	30	11.1%	10
Biochemists and Biophysicists	30	40	10	33.3%	0

[1] Data compiled from Mississippi Department of Employment Security Report: Occupational Employment Projections (author, date for citation reference). Then make sure report is included in Works Cited section below.

Microbiologists	40	50	10	25.0%	0
Zoologists and Wildlife Biologists	240	270	30	12.5%	10
Biological Scientists, All Other	220	270	50	22.7%	10
Conservation Scientists	840	940	100	11.9%	20
Foresters	410	450	40	9.8%	10
Hydrologists	30	40	10	33.3%	0
Life, Physical, and Social Science Technicians	1,990	2,260	270	13.60%	95
Agricultural and Food Science Technicians	280	320	40	14.30%	15
Biological Technicians	440	520	80	18.20%	25
Environmental Science and Protection Technicians, including Health	30	40	10	33.30%	0
Forensic Science Technicians	130	160	30	23.10%	10
Forest and Conservation Technicians	330	370	40	12.10%	20

2012 Wage Estimates for Agriscience Occupations in Mississippi[2]

Occupation	Avg. Hourly Wage	Avg. Annual Wage	Entry Level Hourly Wage	Entry Level Annual Wage	Experienced Hourly Wage	Experience Annual Wage
Hydrologists	$40.97	$85,220	$30.67	$63,800	$46.12	$95,930
Agricultural and Food Science Technicians	$15.32	$31,870	$10.27	$21,370	$17.85	$37,120
Biological Technicians	$17.43	$36,250	$10.43	$21,690	$20.92	$43,520
Chemical Technicians	$19.95	$41,500	$12.10	$25,160	$23.88	$49,670
Geological and Petroleum Technicians	$29.41	$61,170	$16.98	$35,320	$35.62	$74,090
Environmental Science and Protection Technicians, including Health	$17.33	$36,040	$13.64	$28,380	$19.17	$39,870
Forensic Science Technicians	$24.59	$51,150	$17.71	$36,830	$28.03	$58,310
Life, Physical, and Social Science Technicians, All Other	$20.77	$43,190	$13.32	$27,710	$24.49	$50,930
Food Scientists and Technologists	$23.40	$48,670	$13.55	$28,180	$28.33	$58,920
Soil and Plant Scientists	$35.99	$74,850	$19.33	$40,200	$44.32	$92,180
Microbiologists	$35.13	$73,070	$19.85	$41,280	$42.77	$88,970

[2] Data compiled from Mississippi Department of Employment Security Report: 2012 Occupations Employment and Wage Estimates (author date for citation reference). Then make sure report is in Works Cited section below.

Zoologists and Wildlife Biologists	$28.46	$59,200	$16.81	$34,960	$34.29	$71,330
Biological Scientists, All Other	$34.57	$71,900	$22.52	$46,840	$40.59	$84,430
Conservation Scientists	$25.62	$53,290	$17.02	$35,400	$29.92	$62,240
Foresters	$21.19	$44,080	$13.31	$27,680	$25.14	$52,280
Environmental Scientists and Specialists, including Health	$23.62	$49,120	$15.32	$31,870	$27.76	$57,750

Agriscience Education in Mississippi

All of Mississippi's institutions of higher learning (IHL) offer undergraduate and graduate education that would potentially lead to a career in agricultural science. Alcorn State University and Mississippi State University are the only two with departments explicitly dedicated to agricultural education.

Alcorn University offers instruction leading to the following Bachelor of Science degrees[3]:

- Bachelor of Science in Agricultural Economics
- International Agriculture Option
- Bachelor of Science in Agribusiness Management
- Bachelor of Science in Agricultural Sciences
- Plant and Soil Science Emphasis
- Animal Science Emphasis
- Forestry Emphasis
- General Agriculture Emphasis
- Agricultural Education Emphasis
- Veterinary Science Emphasis
- Environmental Science Emphasis

Graduate students admitted into the department can choose thesis or non-thesis tracks culminating in Master of Science degrees with options and endorsements as listed below:

[3] http://www.alcorn.edu/Academics/Schools/AREAS/Default.aspx?id=703

- Master of Science in Agriculture - Agronomy Option
- Master of Science in Agriculture - Animal Science Option (thesis track only)
- Master of Science in Agriculture – Agricultural Economics Option
- Master of Science in Secondary Education – Agricultural Education Endorsement

Mississippi State University undergraduate students have the option of choosing one of the following Bachelor of Science degrees[4]:

- Agribusiness
- Agricultural Engineering Technology and Business
- Agricultural Information Science
- Agricultural Science
- Agronomy
- Animal and Dairy Sciences
- Biochemistry
- Environmental Economics and Management
- Food Science and Nutrition
- Horticulture
- Human Sciences
- Landscape Architecture
- Landscape Contracting and Management
- Poultry Science

Masters degrees

- Agricultural Economics
  - Agricultural Economics
  - Agribusiness
- Animal and Dairy Sciences
  - Agriculture Major/Animal Nutrition Concentration (An Interdepartmental Curriculum)
  - Agriculture Major /Animal and Dairy Sciences Concentration
  - Agricultural Life Sciences Major/Animal Physiology Concentration (An Interdisciplinary Program)
- Biochemistry, Molecular Biology, Entomology and Plant Pathology
  - Agricultural Life Sciences Major/Biochemistry Concentration
- Food Science, Nutrition and Health Promotion
  - Food Science, Nutrition, Health Promotion Major/Food Science and Technology Concentration, Health Promotion Concentration, or Nutrition Concentration

[4] http://www.cals.msstate.edu/prospective/pick/undergrad/under_major.php

- School of Human Sciences
  - Agricultural and Extension Education
- Landscape Architecture
  - Landscape Architecture
- Plant and Soil Sciences
  - Agriculture Major/Agronomy Concentration
  - Agriculture Major/Horticulture Concentration
  - Agriculture Major/Weed Science Concentration
- Poultry Science
  - Agriculture Major/Poultry Science Concentration
- Interdisciplinary Programs
  - Agricultural Life Sciences Major/Genetics Concentration

Doctoral degrees

- Animal and Dairy Sciences
- Biochemistry
- Entomology and Plant Pathology
- Human Sciences Department
- Food Science and Nutrition
- Plant and Soil Sciences
- Poultry Science
- Interdisciplinary

Works Cited

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Hall, C. P., Hodges, A. W., & Haydu, J. J. (2005). *Economic Impacts of the Green Industry in the United States.* Knoxville: USDA-Forest Service, National Urban and Community Forestry Advisory Committee.

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State Workforce Investment Board. (n.d.). *Sector Report: State of Agriculture, Forestry, Fishing, and Hunting in Mississippi.* Retrieved October 10, 2012, from Mississippi eData Portal: http://swib.ms.gov/DataCenter/PublicReports/IndustryAnalysis/Summary.aspx

United States Bureau of Labor Statistics. (2012, March 29). *Agricultural Engineers.* Retrieved October 10, 2012, from Bureau of Labor Statistics: Occupational Outlook Handbook: http://www.bls.gov/ooh/architecture-and-engineering/agricultural-engineers.htm

United States Department of Labor. (2012, March 29). *Bureau of Labor Statistics: Occupational Outlook Handbook.* Retrieved October 10, 2012, from Agricultural and Food Scientists: http://www.bls.gov/ooh/life-physical-and-social-science/agricultural-and-food-scientists.htm

Perkins IV Requirements

The Introduction to Agriscience curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing and preparing students for occupations. It offers students an introductory program of study that may lead them to other secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Introduction to Agriscience curriculum is integrated with academic Common Core Standards. Last, the Introduction to Agriscience curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Introduction to Agriscience curriculum are the Common Core Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Mastery of these standards will result in highly skilled, well-rounded students who are prepared to enter a postsecondary academic or career and technical program of study. They will also be prepared to compete academically at a national level as the Common Core Standards are designed to prepare students for success in community colleges, IHLs, and careers.

Academic Infusion

The Introduction to Agriscience curriculum is aligned to the Mississippi Academic Science Standards. Content of the Introduction to Agriscience courses have been aligned to the Mississippi Science Curriculum Framework. Introduction to Agriscience is intended to be a one-year course of study. Students completing the course will receive one Carnegie unit for science and an additional 0.5 Carnegie unit for completion of the Supervised Agricultural Experience (SAE).

The Introduction to Agriscience curriculum is tied to the 2010 Mississippi Science Curriculum Framework Common Core Science and Mathematics standards. The curriculum provides multiple opportunities to enhance and reinforce these academic skills. Since students will be required to communicate effectively in the classroom as well as in the workforce, there is a considerable amount of writing in this curriculum. The academic content in the Introduction to Agriscience curriculum provides several opportunities for focus in science and mathematics as it directly relates to Introduction to Agriscience content. Overall the Introduction to Agriscience content requires students to preform calculations and use strategic and critical thinking skills to solve real world problems.

Best Practices

Experiential Learning (SAE)

Experiential Learning (SAE) has long been and continues to be the backbone of every agriculture program. SAE projects can be used in a variety of situations to reinforce and compliment classroom theory and content, and they may consist of entrepreneurship, placement, research/experimentation, and/or exploratory exercises.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach students in the way they need to learn. The Introduction to Agriscience teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop computers for students and one laptop for the teacher. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system, for example, the Agriculture Teacher Blackboard Content Management System, which introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add a student's background, emotional health, and circumstances, and a very unique learner emerges. To accommodate this, the Introduction to Agriscience curriculum is written to include several instructional methods by using the Understanding by Design (UbD) approach. This method of instructional design leads students to a deeper understanding of course material and provides multiple opportunities for students to succeed in different ways. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several available in Mississippi that will foster the types of learning expected from the Introduction to Agriscience curriculum. The FFA is the students' organization for Introduction to Agriscience. The FFA provides students with growth opportunities and competitive events. It also opens the doors to the world of agriculture and scholarships opportunities.

Cooperative Learning

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

Conclusions

The Introduction to Agriscience is an integral part of Mississippi's comprehensive agriculture curricula. Students that complete these programs are well equipped for a variety of endeavors. Instructors are urged to encourage Introduction to Agriscience students to pursue educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

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

P.A.C.E - Mississippi Agriculture Education. May be found at http://rcu.blackboard.com

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

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

National FFA Organization
P.O. Box 68960, 6060 FFA Drive
Indianapolis, IN 46268
317-802-6060
http://www.ffa.org

National Association of Agricultural Educators
300 Garrigus Building
University of Kentucky
Lexington, KY 40546
800 - 509 - 0204
http://www.naae.org/

Using this Document and the Blackboard Site

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 Performance Indicators
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 performance indicators represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Suggested Teaching Strategies (Found on the Blackboard site)
This section of each unit indicates research-based strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies that reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.

Suggested Assessment Strategies (Found on the Blackboard site)
This section indicates research-based strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students
This section 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, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

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

Introduction to Agriscience
Unit 1: Introduction to Agriscience Opportunities and Careers

Competencies and Suggested Scenarios
1. Introduce terms, concepts and major areas of agriculture, science, and agriscience.[DOK1, AT, AP, AN, AF, AE, AO, AS, AB] a. Examine major areas of agriculture: agricultural processing, agricultural production, agricultural mechanics, agribusiness/supplies and services, forestry, natural resources, horticulture, entomology, aquaculture, animal science, biotechnology, alternative energies and plant science. b. Describe the importance of the areas in society. c. Examine the career opportunities available in the areas of agriculture. d. Discuss the economic impact of the areas in local, state, national, and global economies.
2. Connect major sciences supporting agriscience.[DOK1, AT, AP, AN, AF, AE, AO, AS, AB] a. Examine concepts of biology, chemistry, biochemistry, physical sciences, and biotechnology. b. Relate the use of concepts of pure science to the use of concepts of agriscience.
3. Investigate current trends occurring in agriscience.[DOK2, AT, AP, AN, AF, AE, AO, AS, AB] a. Investigate precision agriculture. b. Investigate niche farming, such as organic farming and alternative animal agriculture. c. Investigate animal tracking. d. Investigate country of origin labeling. e. Investigate the use of GPS/GIS in agriscience.

Scenario

Unit 1

Attachments for Performance Task

None

Unit 2: Introduction to Agriscience Lab Safety and the Scientific Method

Competencies and Suggested Scenarios
1. Analyze the basic rules of safety in the agriscience laboratory. DOK1, AT, AP, AN, AF, AE, AO, AS, AB a. Discuss safe and proper use of chemicals, heat and fire, laboratory equipment, specimens and animals, and electrical equipment. b. Utilize procedures for reporting an accident. c. Illustrate the use of a Materials Safety Data Sheet (MSDS).
2. Demonstrate all safety equipment in the agriscience laboratory. DOK2, AT, AP, AN, AF, AE, AO, AS, AB a. Identify the location of safety equipment and discuss procedures for dealing with accidents, injuries, and spills. b. Describe general safety techniques using hand equipment and indicators to include safety color codes, fire extinguishers, first aid kits, emergency exits, and so forth.
3. Practice safety concepts in laboratory activities. DOK2, AT, AP, AN, AF, AE, AO, AS, AB a. Use appropriate precautions when working with electrical applications, fire, poisons, and gas. b. Protect hands and eyes. c. Wear proper clothing for protection. d. Safely work with animals and plants. e. Take steps to prevent explosion danger.
4. Discuss terms and concepts associated with the scientific method. DOK1, AT, AP, AN, AF, AE, AO, AS, AB a. Identify the problem. INBIO1 b. Gather data. INBIO1 c. Formulate possible solutions. INBIO1 d. Implement the preferred solutions. INBIO1 e. Evaluate the results. INBIO1
5. Apply the scientific method. DOK2, AT, AP, AN, AF, AE, AO, AS, AB a. Identify the problem or question to be answered. INBIO1 b. Gather data related to the problem or question INBIO1 c. Formulate possible solutions. INBIO1 d. Implement one or a combination of several solutions. INBIO1 e. Evaluate the results and pursue further research as needed INBIO1

Scenario

Unit 2

Attachments for Performance Task

None

Unit 3: Human Relations, Leadership and FFA Activities

Competencies and Suggested Scenarios
1. Discuss concepts related to leadership. DOK1 a. Describe leadership. b. Describe traits of a good leader, such as integrity, knowledge, courage, tactfulness, enthusiasm, unselfishness, and loyalty. c. Practice acceptable manners in appropriate places, including introductions, greetings, table manners, and telephone manners.
2. Investigate the FFA organization. DOK1 a. Describe the history of FFA. b. Contrast degrees of membership. c. State the creed. d. Demonstrate official dress. e. Investigate the emblem and its symbols.
3. Explain opportunities for leadership development through the FFA. DOK1 a. Describe contests and awards programs, including proficiency awards and state and American degrees. b. Participate in leadership activities and/or leadership conferences and conventions. c. Determine opportunities for participation in personal and community development programs.
4. Participate in parliamentary procedure. DOK1 a. Define parliamentary terms. b. Introduce a motion. c. Debate amendments. d. Utilize different methods of voting. e. Discuss taps of the gavel.

Scenario

Unit 3

Attachments for Performance Task

None

Unit 4: Experiental Learning (SAE) in Agriscience

Competencies and Suggested Scenarios
1. Describe the purposes and requirements of the SAE. DOK1, AB a. Establish objectives for the SAE. b. Determine the availability of time and money to invest. c. Select a system of record keeping. d. Determine benefits of participation in an SAE. e. Determine types of SAE programs.
2. Develop a short-range personal plan. DOK2, AB a. Set short-range goals.
3. Develop a long-range personal plan for the SAE. DOK2, AB a. Set long-range goals.
4. Complete a training agreement for an SAE. DOK2, AB a. Establish requirements of student, parents, supervisor, and/or employer.
5. Describe agricultural record keeping for an SAE. DOK2, AB a. Determine types of records to keep. b. Describe how to maintain various systems of record keeping.
6. Maintain agricultural records for an SAE. DOK3, AB a. Prepare income and expense records. b. Prepare inventory records. c. Compute enterprise summaries. d. Maintain placement records. e. Summarize the SAE program. f. Maintain leadership activity records. g. Compute a net worth statement.

Scenario

Unit 4

Attachments for Performance Task

None

Unit 5: Mechanical Technologies in Agriscience

Competencies and Suggested Scenarios
1. Define terms associated with mechanical technologies in agriscience.[DOK2, AT] a. Discuss terms associated with construction, machinery, internal combustion, and other related topics.
2. Identify commonly used tools and measuring devices used in agriscience.[DOK2, AT] a. Identify basic hand and power tools used in agriscience per MS FFA Tool ID List. b. Discuss and demonstrate the proper use precision measuring devices to determine mass, weight, and volume. • a balance. • a scale. • a graduated cylinder. • standard measuring devices including rulers, tape measures, micrometers, dividers, and protractors.
3. Discuss Small Engine Applications in agriscience.[DOK2, AT] a. Explain the principles of operation of an internal combustion engine. b. Define terms associated with the two-stroke cycle engine. c. Identify basic components of a two-stroke cycle engine. d. Explain the principles of two-stroke cycle engine operation. e. Discuss the various applications for two-stroke cycle engines in agriscience. f. Define terms associated with the principles of operation of a four-stroke cycle engine. g. Identify basic components of a four-stroke cycle engine. h. Explain the principles of four-stroke cycle engine operation. i. Discuss the various applications for four-stroke cycle engines in agriscience.
4. Investigate principles of electricity.[DOK2, AT] a. Explain the differences between alternating current (AC) and direct current (DC). b. Explain the principles of series and parallel circuits. c. Explain the characteristics of insulators (rubber, plastic, and ceramic) and conductors (copper and aluminum).

Scenario

Unit 5

Attachments for Performance Task

None

Unit 6: Introduction to Biotechnology

Competencies and Suggested Scenarios
1. Discuss terms and concepts related to biotechnology. DOK1, AO a. Define terms related to biotechnology. INBIO2, INBIO4, INBIO5 b. Identify improvements of animals and plants made possible through biotechnology. INBIO5, INBIO6 c. Describe emerging issues associated with biotechnology. INBIO6 d. Investigate issues of bio-security which producers of plants and animals should be applying to protect their products from contamination or destruction. INBIO6
2. Explain historical events in biotechnology. DOK1, AO a. Describe early discoveries before 1800. b. Describe basic scientific discoveries 1800 to 1900. c. Describe discoveries in molecular biology. d. Describe the age of biotechnology (1977 to present).
3. Explain the basic principles of heredity. DOK1, AO a. Describe the role of genes and chromosomes in heredity. INBIO5 b. Explain the functions of DNA and RNA in heredity. INBIO5 c. Describe the process of cell division in reproduction. INBIO5 d. Discuss mutations, genetic disease, and birth defects in the process of inheritance. INBIO5, INBIO6 e. Calculate a simple problem demonstrating inheritance of dominant and recessive traits. INBIO5, INBIO6

Scenario

Unit 6

Attachments for Performance Task

None

Unit 7: Principles of Animal Science

Competencies and Suggested Scenarios
1. Define terms associated with animal science.[DOK2, AS] a. Discuss terms associated with beef and dairy cattle. b. Discuss terms associated with swine. c. Discuss terms associated with equines. d. Discuss terms associated with food production, other species of animals and related animal science topics.
2. Investigate major agricultural species of animals and their economic contributions.[DOK2, AS] a. Discuss production of beef and dairy cattle, sheep, goats, swine, poultry, horses, and aquatic species.[INBIO3, INBIO6] b. Examine their economic impact at the local, state, national, and global levels.
3. Examine the internal and external body parts of major agricultural species of animals.[DOK2, AS] a. Discuss and identify the internal and external parts of cattle. b. Discuss and identify the internal and external parts of swine. c. Discuss and identify the internal and external parts of equines. d. Discuss and identify the internal and external parts of other animals used in agriscience.
4. Investigate economic and practical considerations of livestock production.[DOK2, AS] a. Identify management systems of animal production used with cattle, swine, poultry, and aquacultural animals.[INBIO3] b. Describe types and breeds of livestock.[INBIO3] c. Describe feeds and feeding practices required for cattle, sheep, swine, horses, and poultry.[INBIO3] d. Describe the importance of animal health in livestock production.[INBIO3, INBIO5, INBIO6] e. Describe the importance of factors contributing to cost of production of livestock. f. Define terms associated with livestock production such as producer, processor, distributor, wholesaler, retailer, and consumer. g. Investigate the effect of various areas of the food industry on the local, state, national, and global economy.[INBIO6] h. Explain methods of processing, preserving, and storing foods. i. Identify the wholesale cuts of major agricultural species of animals.

Scenario

Unit 7

Attachments for Performance Task

None

Unit 8: Principles of Plant Science

Competencies and Suggested Scenarios
1. Examine concepts related to plant science.[DOK2, AP, AF] a. Define terms in plant science relating to producing, harvesting, processing, and distributing plant food and feed products.[INBIO3] b. Investigate the effect of various areas of the plant industry on the local, state, national, and global economy.
2. Investigate major structural parts of plants including roots, stems, and leaves. [DOK2, AP] a. Diagram the parts of plants.[INBIO3,] b. Explain the functions of various parts of plants.[INBIO3]
3. Explain the important plant growth and food production processes.[DOK2, AP] a. Describe photosynthesis.[INBIO2] b. Describe transpiration.[INBIO2] c. Describe respiration.[INBIO2] d. Investigate principles of photosynthesis, transpiration, respiration, and absence of plant nutrients.[INBIO2, INBIO3, INBIO4]
4. Describe various methods of plant reproduction.[DOK2, AP] a. Contrast annual, perennial, and biennial plant life cycles.[INBIO6] b. Describe the functions of complete and incomplete flowers.[INBIO6] c. Discuss means of sexual and asexual reproduction.[INBIO4, INBIO5, INBIO6] d. Describe principles of plant pollination.[INBIO5, INBIO6]

Scenario

Unit 8

Attachments for Performance Task

None

Unit 9: Principles of Entomology

Competencies and Suggested Scenarios
1. Define terms related to entomology including morphology, insect parts, and metamorphosis. DOK1, AN, AP, AE, AF, AS
2. Describe the importance of entomology to agriculture. DOK2, AB, AN, AP, AE, AF, AS a. Identify beneficial insects and their importance. INBIO3, INBIO6 b. Identify harmful insects and their effects. INBIO3, INBIO6
3. Classify insects scientifically based on their morphology. DOK2, AN, AP, AE, AF, AS a. Identify the parts of an insect including head, antenna, thorax, abdomen, wings, and legs. INBIO3, INBIO6 b. Use scientific classification to identify insects by their order. INBIO3, INBIO6
4. Explain the growth processes of insects. DOK2, AN, AP, AE, AF, AS a. Describe gradual (incomplete) metamorphosis. INBIO3, INBIO6 b. Describe complete metamorphosis. INBIO3, INBIO6
5. Discuss an integrated pest management plan. DOK2, AN, AP, AE, AF, AS

Scenario

Unit 9

Attachments for Performance Task

None

Unit 10: Principles of Natural Resources

Competencies and Suggested Scenarios
1. Define terms related to environmental and natural resources including air, water, and soil. DOK1, AE, AN
2. Discuss the composition of air, water, and soil. DOK1, AE, AN a. Discuss the composition and properties of air. INBIO3 b. Investigate the factors affecting air quality. INBIO3 c. Discuss the composition and properties of water. INBIO3 d. Investigate the factors affecting water quality. INBIO3 e. Discuss the composition and properties of soil including the different types of soils (sand, silt and clay). INBIO3 f. Investigate the factors affecting soil quality. INBIO3
3. Explore the basic concepts of natural resource conservation and management. DOK1, AE, AN a. Classify renewable and non-renewable natural resources. INBIO3 b. Discuss the concept of sustainability as related to natural resources and the environment. INBIO3

Scenario

Unit 10

Attachments for Performance Task

None

Unit 11: Alternative and Sustainable Technologies in Agriscience

Competencies and Suggested Scenarios
1. Define the terms associated with alternative and sustainable technologies in agriculture. DOK1, AT, AN, AE
2. Discuss the various sources of traditional and alternative energy used locally, statewide, nationally and globally. DOK1, AT, AN, AE a. Wind b. Water c. Solar d. Geothermal e. Fossil Fuels f. Nuclear g. Hydrogen h. Biomass i. Biofuels
3. Discuss the advantages and disadvantages of the various energy sources. DOK2, AT, AN, AE a. Investigate costs and sustainability of the various energy sources. b. Investigate the environmental effects of the various energy sources. INBIO3 c. Investigate the local, state, national and global impact of the of the various energy sources. INBIO3
4. Discuss conservation and preservation practices for traditional and alternative energy. DOK2, AT, AN, AE
5. Discuss future trends in traditional and alternative energy sources. DOK1, AT, AN, AE

Scenario

Unit 11

Attachments for Performance Task

None

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 Agriscience Opportunities and Careers		
	1.	Introduce terms, concepts and major areas of agriculture, science, and agriscience.
	2.	Connect major sciences supporting agriscience.
	3.	Investigate current trends occurring in agriscience.
Unit 2: Introduction to Agriscience Lab Safety and the Scientific Method		
	1.	Analyze the basic rules of safety in the agriscience laboratory.
	2.	Demonstrate all safety equipment in the agriscience laboratory.
	3.	Practice safety concepts in laboratory activities.
	4.	Discuss terms and concepts associated with the scientific method.
	5.	Apply the scientific method.
Unit 3: Human Relations, Leadership and FFA Activities		
	1.	Discuss concepts related to leadership.
	2.	Investigate the FFA organization.
	3.	Explain opportunities for leadership development through the FFA.
	4.	Participate in parliamentary procedure.
Unit 4: Experiental Learning (SAE) in Agriscience		
	1.	Describe the purposes and requirements of the SAE.
	2.	Develop a short-range personal plan.
	3.	Develop a long-range personal plan for the SAE.
	4.	Complete a training agreement for an SAE.
	5.	Describe agricultural record keeping for an SAE.
	6.	Maintain agricultural records for an SAE.
Unit 5: Mechanical Technologies in Agriscience		
	1.	Define terms associated with mechanical technologies in agriscience.
	2.	Identify commonly used tools and measuring devices used in agriscience.
	3.	Discuss Small Engine Applications in agriscience.

	4.	Investigate principles of electricity.
Unit 6: Introduction to Biotechnology		
	1.	Discuss terms and concepts related to biotechnology.
	2.	Explain historical events in biotechnology.
	3.	Explain the basic principles of heredity.
Unit 7: Principles of Animal Science		
	1.	Define terms associated with animal science.
	2.	Investigate major agricultural species of animals and their economic contributions.
	3.	Examine the internal and external body parts of major agricultural species of animals.
	4.	Investigate economic and practical considerations of livestock production.
Unit 8: Principles of Plant Science		
	1.	Examine concepts related to plant science.
	2.	Investigate major structural parts of plants including roots, stems, and leaves.
	3.	Explain the important plant growth and food production processes.
	4.	Describe various methods of plant reproduction.
Unit 9: Principles of Entomology		
	1.	Define terms related to entomology including morphology, insect parts, and metamorphosis.
	2.	Describe the importance of entomology to agriculture.
	3.	Classify insects scientifically based on their morphology.
	4.	Explain the growth processes of insects.
	5.	Discuss an integrated pest management plan.
Unit 10: Principles of Natural Resources		
	1.	Define terms related to environmental and natural resources including air, water, and soil.
	2.	Discuss the composition of air, water, and soil.
	3.	Explore the basic concepts of natural resource conservation and management.
Unit 11: Alternative and Sustainable Technologies in Agriscience		
	1.	Define the terms associated with alternative and sustainable technologies in agriculture.
	2.	Discuss the various sources of traditional and alternative energy used locally, statewide, nationally and globally.
	3.	Discuss the advantages and disadvantages of the various energy sources.
	4.	Discuss conservation and preservation practices for traditional and alternative energy.
	5.	Discuss future trends in traditional and alternative energy sources.

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Unit 11

Appendix B: Glossary

Unit 1
Basic Communication (00107-09)

(BOLD the First WORD)
Active listening: a process that involves respecting others, listening to wheat is being said, and understanding what is being said.
Appendix: A source of detailed or specific information placed at the end of a section, a chapter, or a book.
Body Language: A person's physical posture and gestures that reflect how that person is feeling.

Appendix C: Industry Standards

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

Crosswalk for Agriculture and Natural Resources

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
AFNR											
AB -AGRIBUSINESS SYSTEMS		X	X		X					X	
AS -ANIMAL SYSTEMS		X	X					X		X	
AO - BIOTECHNOLOGY		X	X				X				
AE - ENVIRONMENTAL SERVICE SYSTEMS		X	X							X	X
AF -FOOD PRODUCTS AND PROCESSING SYSTEMS		X	X					X	X	X	
AN -NATURAL RESOURCE SYSTEMS		X	X							X	X
AP -PLANT SYSTEMS		X	X						X	X	
AT -POWER, STRUCTURAL, AND TECHNICAL SYSTEMS		X	X			X					
		Unit 11									
AB -AGRIBUSINESS SYSTEMS											
AS -ANIMAL SYSTEMS											
AO - BIOTECHNOLOGY											
AE - ENVIRONMENTAL SERVICE SYSTEMS		X									
AF -FOOD PRODUCTS AND PROCESSING SYSTEMS											
AN -NATURAL RESOURCE		X									

SYSTEMS											
AP -PLANT SYSTEMS											
AT -POWER, STRUCTURAL, AND TECHNICAL SYSTEMS		X									

AT - POWER, STRUCTURAL, AND TECHNICAL SYSTEMS
AP - PLANT SYSTEMS
AN - NATURAL RESOURCE SYSTEMS
AF - FOOD PRODUCTS AND PROCESSING SYSTEMS
AE - ENVIRONMENTAL SERVICE SYSTEMS
AO - BIOTECHNOLOGY
AS - ANIMAL SYSTEMS
AB - AGRIBUSINESS SYSTEMS

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AB - AGRIBUSINESS SYSTEMS

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

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

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

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

ABS.04. Apply generally accepted accounting principles and skills to manage cash budgets, credit budgets, and credit for AFNR businesses.

ABS.04.01. Use accounting fundamentals to accomplish dependable bookkeeping and fiscal management.

ABS.05. Assess accomplishment of goals and objectives by an AFNR business.

ABS.05.01. Maintain and interpret financial information (income statements, balance sheets, inventory, purchase orders, accounts receivable, and cash-flow analyses) for businesses.

ABS.06. Use industry-accepted marketing practices to accomplish AFNR business objectives.

ABS.06.01. Conduct appropriate market and marketing research.
ABS.06.02. Develop a marketing plan.
ABS.06.03. Develop strategies for marketing plan implementation.
ABS.06.04. Develop specific tactics to market AFNR products and services.

ABS.07. Create a production system plan.

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

AS - ANIMAL SYSTEMS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

AO - BIOTECHNOLOGY

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

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

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

BS.02 Demonstrate laboratory skills as applied to biotechnology.

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

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

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

AE - ENVIRONMENTAL SERVICE SYSTEMS

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

ESS.01. Use analytical procedures to plan and evaluate environmental service systems.
- ESS.01.01. Analyze and interpret samples.

ESS.02. Assess the impact of policies and regulations on environmental service systems.
- ESS.02.01. Interpret laws affecting environmental service systems.

ESS.03. Apply scientific principles to environmental service systems.
- ESS.03.01. Apply meteorology principles to environmental service systems.
- ESS.03.02. Apply soil science principles to environmental service systems.
- ESS.03.03. Apply hydrology principles to environmental service systems.
- ESS.03.04. Apply best management techniques associated with the properties, classifications, and functions of wetlands.
- ESS.03.05. Apply chemistry principles to environmental service systems.
- ESS.03.06. Apply microbiology principles to environmental service systems.

ESS.04. Operate environmental service systems to manage a facility environment.
- ESS.04.01. Use pollution control measures to maintain a safe facility environment.
- ESS.04.02. Manage safe disposal of all categories of solid waste.
- ESS.04.03. Apply the principles of public drinking water treatment operations to ensure safe water at a facility.
- ESS.04.04. Apply principles of wastewater treatment to manage wastewater disposal in keeping with rules and regulations.
- ESS.04.05. Manage hazardous materials to assure a safe facility and to comply with applicable regulations.

ESS.05. Examine the relationships between energy sources and environmental service systems.
- ESS.05.01. Compare and contrast the impact of conventional and alternative energy sources on the environment.

ESS.06. Use tools, equipment, machinery, and technology to accomplish tasks in environmental service systems.
- ESS.06.01. Use technological and mathematical tools to map land, facilities, and infrastructure.
- ESS.06.02. Maintain tools, equipment, and machinery in safe working order for tasks in environmental service systems.

AF - FOOD PRODUCTS AND PROCESSING SYSTEMS

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

FPP.01. Examine components of the food industry and historical development of food products and processing.
- FPP.01.01. Evaluate the significance and implications of changes and trends in the food products and processing industry.

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

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

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

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

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

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

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

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

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

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

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

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

AN - NATURAL RESOURCE SYSTEMS

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

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

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

NRS01.02. Classify natural resources.

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

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

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

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

NRS.02.04. Demonstrate natural resource enhancement techniques.

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

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

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

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

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

NRS.04.01. Manage fires in natural resource systems.

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

NRS.04.03. Manage insect infestations of natural resources.

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

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

AP - PLANT SYSTEMS

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

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

PS.01.01. Classify agricultural plants according to taxonomy systems.
PS.01.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.
PS.01.03. Apply knowledge of plant physiology and energy conversion to plant systems.

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

PS.02.01. Determine the influence of environmental factors on plant growth.
PS.02.02. Prepare growing media for use in plant systems.
PS.02.03. Develop and implement a fertilization plan for specific plants or crops.

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

PS.03.01 Demonstrate plant propagation techniques.
PS.03.02. Develop and implement a plant management plan for crop production.
PS.03.03. Develop and implement a plan for integrated pest management.
PS.03.04. Apply principles and practices of sustainable agriculture to plant production.
PS.03.05 Harvest, handle, and store crops.

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

PS.04.01. Create designs using plants.

AT - POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

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

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

PST.01.01. Select energy sources in power generation appropriate to the situation.
PST.01.02. Apply physical science laws and principles to identify, classify, and use lubricants.
PST.01.03. Identify and use hand and power tools and equipment for service, construction, and fabrication.

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

PST.02.01. Perform service routines to maintain power units and equipment.
PST.02.02. Operate, service, and diagnose the condition of power units and equipment.

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

PST.03.01. Troubleshoot and repair internal combustion engines.
PST.03.02. Utilize manufacturers' guidelines to service and repair the power transmission systems of equipment.
PST.03.03. Service and repair hydraulic and pneumatic systems.
PST.03.04. Troubleshoot and service electrical systems.
PST.03.05. Service vehicle heating and air-conditioning systems.
PST.03.06. Service and repair steering, suspension, traction, and vehicle performance systems.

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

PST.04.01. Create sketches and plans of agricultural structures.
PST.04.02. Apply structural plans, specifications, and building codes.
PST.04.03. Examine structural requirements for materials and procedures, and estimate construction cost.
PST.04.05. Follow architectural and mechanical plans to construct and/or repair equipment, buildings, and facilities.

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

PST.05.01. Use instruments and meters to test and monitor electrical and electronic processes.
PST.05.02. Prepare and/or use electrical drawings to design, install, and troubleshoot control systems.
PST.05.03. Use geospatial technologies in agricultural applications.

Appendix D: 21st Century Skills[5]

21st Century Crosswalk for Agriculture 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	x	
CS2		X			x			x	x	x	
CS3		X		x							
CS4								x	x	x	
CS5		X					x	x	x	x	
CS6			X				x	x	x	x	
CS7			X	x	x		x	x	x	x	
CS8			X	x	x						
CS9					x	x					
CS10					x						
CS11		X			x						
CS12											
CS13				x	x						
CS14				x							
CS15			X		x						
CS16				x	x						
		Unit 11									
CS1		X									
CS2											
CS3											
CS4		X									
CS5		X									
CS6		X									
CS7		X									
CS8											
CS9		X									
CS10		X									
CS11		X									
CS12											
CS13											
CS14											
CS15											
CS16											

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

[5] *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 E: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)												
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**
Common Core Standards												
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.11.1.												
RI.11.2.												
RI.11.3.												
RI.11.4.		X										
RI.11.5.												
RI.11.6.												
RI.11.7.		X										
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.		X										
W.11.8.		X										
W.11.9.		X										
W.11.10.												
SL.11.1.		X		X								
SL.11.2.		X		X								
SL.11.3.				X								
SL.11.4.		X		X								
SL.11.5.		X		X								
SL.11.6.		X		X								
L.11.1.					X							
L.11.2.					X							
L.11.3.				X	X							
L.11.4.					X							
L.11.5.					X							
L.11.6.					X							
RH.11.1.												
RH.11.2.												
RH.11.3.												
RH.11.4.												
RH.11.5.												
RH.11.6.												
RH.11.7.												
RH.11.8.												
RH.11.9.												
RH.11.10.												
RST.11.1.			X				X	X	X	X	X	X
RST.11.2.			X				X	X	X	X	X	X
RST.11.3.			X			X	X	X	X	X	X	X

RST.11.4.			X			X	X	X	X	X	X	X
RST.11.5.			X				X	X	X	X	X	X
RST.11.6.			X									
RST.11.7.		X	X			X	X	X	X	X	X	X
RST.11.8.		X	X									
RST.11.9.		X	X			X	X	X	X	X	X	X
RST.11.10.												
WHST.11.1.					X							
WHST.11.2.					X							
WHST.11.3.					X							
WHST.11.4.					X							
WHST.11.5.					X							
WHST.11.6.					X							
WHST.11.7.			X		X							
WHST.11.8.			X		X							
WHST.11.9.			X		X							
WHST.11.10.					X							

Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *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 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.
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.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

Key Ideas and Details

RI.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.

RI.11.2. Determine two or more 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 provide a complex analysis; provide an objective summary of the text.

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 The 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.
By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

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

a. 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.

b. 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.

c. 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.

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

e. 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.

a. 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.

b. 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.

c. 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.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

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

f. 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.

a. 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.

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

c. 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).

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

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 on page 54.)

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.

a. 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").

b. 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.

College and Career Readiness Anchor Standards for *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.

a. 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.

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

c. 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.

d. 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.

SL.11.5. 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 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

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

b. 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.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

Knowledge of Language

L.11.3. 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.

a. 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.

a. 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.

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

c. 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, its etymology, or its standard usage.

d. 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.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.
b. Analyze nuances in the meaning of words with similar denotations.

L.11.6. 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.

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 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.11.2. 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.11.3. 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.11.4. 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.11.5. 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.11.6. 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.11.7. 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.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. 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.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. 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.11.2. 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.11.3. 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.11.4. 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.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. 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.

Integration of Knowledge and Ideas

RST.11.7. 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.11.8. 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.11.9. 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.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

a. 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.

b. 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.

c. 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.

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

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

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. 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.

b. 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.

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

d. 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.

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

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.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.

WHST.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

WHST.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.

WHST.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 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.

WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

WHST.11.10. 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.

Common Core Crosswalk for Mathematics (11-12)

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11
Common Core Standards												
N-RN.1.												
N-RN.2.												
N-RN.3.												
N-Q.1.												
N-Q.2.												
N-Q.3.												
N-CN.1.												
N-CN.2.												
N-CN.3.												
N-CN.4.												
N-CN.5.												
N-CN.6.												
N-CN.7.												
N-CN.8.												
N-CN.9.												
N-VM.1.												
N-VM.2.												
N-VM.3.												
N-VM.4.												
N-VM.5.												
N-VM.6.												
N-VM.7.												
N-VM.8.												
N-VM.9.												
N-VM.10.												
N-VM.11.												
N-VM.12.												
A-SSE.1.												
A-SSE.2.												
A-SSE.3.												
A-SSE.4.												
A-APR.1.												
A-APR.2.												
A-APR.3.												
A-APR.4.												
A-APR.5.												
A-APR.6.												
A-APR.7.												
A-CED.1.												
A-CED.2.												
A-CED.3.												
A-CED.4.												
A-REI.1.												
A-REI.2.												
A-REI.3.												
A-REI.4.												
A-REI.5												
A-REI.6.												
A-REI.7.												
A-REI.8.												
A-REI.9.												
A-REI.10.												
A-REI.11.												
A-REI.12.												
F-IF.1.												
F-IF.2.												
F-BF.3.												

F-BF.4.												
F-LE.1.												
F-LE.2.												
F-LE.3.												
F-LE.4.												
F-LE.5.												
F-TF.1.												
F-TF.2.												
F-TF.3.												
F-TF.4.												
F-TF.5.												
F-TF.6.												
F-TF.7.												
F-TF.8.												
F-TF.9.												
G-CO.1.												
G-CO.2.												
G-CO.3.												
G-CO.4.												
G-CO.5.												
G-CO.6.												
G-CO.7.												
G-CO.8.												
G-CO.9.												
G-CO.10.												
G-CO.11.												
G-CO.12.												
G-CO.13.												
G-SRT.1.												
G-SRT.2.												
G-SRT.3.												
G-SRT.4.												
G-SRT.5.												
G-SRT.6.												
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G-SRT.8.												
G-SRT.9.												
G-SRT.10.												
G-SRT.11.												
G-C.1.												
G-C.2.												
G-C.3.												
G-C.4.												
G-C.5.												
G-GPE.1.												
G-GPE.2.												
G-GPE.3.												
G-GPE.4.												
G-GPE.5.												
G-GPE.6.												
G-GPE.7.												
G-GMD.1.												
G-GMD.2.												
G-GMD.3.												
G-GMD.4.												
G-MG.1.												
G-MG.2.												
G-MG.3.												
S-ID.1.		X										
S-ID.2.		X										
S-ID.3.												
S-ID.4.		X										
S-ID.5.		X										
S-ID.6.												
S-ID.7.												

S-ID.8.												
S-ID.9.												
S-IC.1.		X										
S-IC.2.		X										
S-IC.3.		X										
S-IC.4.		X										
S-IC.5.		X										
S-IC.6.		X										
S-CP.1.							X					
S-CP.2							X					
S-CP.3.							X					
S-CP.4.							X					
S-CP.5.							X					
S-CP.6.							X					
S-CP.7.							X					
S-CP.8.							X					
S-CP.9.							X					
S-MD.1.							X					
S-MD.2.							X					
S-MD.3.							X					
S-MD.4.							X					
S-MD.5.							X					
S-MD.6.							X					
S-MD.7.							X					

Mathematics (High School)

Number and Quantity

The Real Number System

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.

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

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.

Quantities

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.

The Complex Number System

N-CN.1. Know there is a complex number i such that i2= –1, and every complex number has the form a + bi with a and b real.

N-CN.2. Use the relation i2= –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

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 + √3 i)3= 8 because (–1 + √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.

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

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.

Vector and Matrix Quantities

N-VM.1. (+) Recognize vector quantities as having both magnitude anddirection. Represent vector quantities by directed line segments, anduse 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.

N-VM.4. (+) Add and subtract vectors

N-VM.4.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.

N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

N-VM.4.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.

N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(vx, vy) = (cvx, cvy)$.

N-VM.5.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 $c < 0$).

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 realnumbers. 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

Seeing structure in expressions

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

A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.

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

A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

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-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.

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.

Arithmetic with Polynomials and Rational Expressions

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

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.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships.

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.

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.

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.

Creating Equations

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 nonviable 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.

Reasoning with Equations and Inequalities

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.

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-REI.4.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.

A-REI.4.b. Solve quadratic equations by inspection (e.g., for x2= 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.

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.

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.

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).

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

Interpreting Functions

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 $n \geq 1$.

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.

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.

F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

F-IF.7.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.

F-IF.8.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.8.b. Use the properties of exponents to interpret expressions for exponential functions.

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.

Building Functions

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

F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.1.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.1.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.

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.

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.

F-BF.4.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.

F-BF.4.b. (+) Verify by composition that one function is the inverse of another.

F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

F-BF.4.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.

Linear, Quadratic, and Exponential Models

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

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.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.

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

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

Trigonometric Functions

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.

F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ 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.

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

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.

F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ 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.

F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Congruence

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.

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.

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.

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.

Similarity, Right Triangles, and Trigonometry

G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

G-SRT.1.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.

G-SRT.1.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.

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.

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.

G-SRT.9. (+) Derive the formula $A = 1/2\ ab\ \sin(C)$ 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).

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.

G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.

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.

Expressing Geometric Properties with Equations

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.

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.

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.

Geometric Measurement and Dimension

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.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

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.

Modeling with Geometry

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

Interpreting Categorical and Quantitative Data

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).

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.

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.

S-ID.6.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.

S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.

S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.

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.

Making Inferences and Justifying Conclusions

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?

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.

Conditional Probability and the Rules of Probability

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.

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.

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.

Using Probability to Make Decisions

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?

S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

> S-MD.5.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.
>
> S-MD.5.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 F: National Educational Technology Standards for Students (NETS-S)

NETS Crosswalk for Introduction to Agriscience											
	Course	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
NETS Standards											
T1		X									
T2		X			X						
T3		X			X	X	X	X	X	X	X
T4			X		X						
T5		X			X						
T6		X			X	X	X	X	X	X	X
		Unit 11									
T1											
T2											
T3		X									
T4		X									
T5											
T6		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 G: Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

MS Science Standards for Introduction to Agriscience												
	Course	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**
MS Science Standards												
AQ 1												
AQ 2												
AQ 3												
AQ 4												
INBIO1			X									
INBIO2							X		X	X		
INBIO3								X	X	X	X	X
INBIO4							X		X			
INBIO5							X	X	X			
INBIO6							X	X	X	X		
BIOI 1												
BIOI 2												
BIOI 3												
BIOI 4												
BIOI 5												
BIOI 6												
BIOII 1												
BIOII 2												
BIOII 3												
BIOII 4												
BIOII 5												
BO 1												
BO 2												
BO 3												
BO 4												
BO 5												
CHI 1												
CHI 2												
CHI 3												
CHI 4												
CHI 5												
ORGC 1												
ORGC 2												
ORGC 3												
E1												
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E4												
E5												
ES 1												
ES 2												
ES 3												
G 1												
G 2												
G 3												
GE1												
GE2												
PS 1												
PS 2												
PS 3												

PS 4												
PS 5												
PHYI 1												
PHYI 2												
PHYI 3												
PHYI 4												
PHYI 5												
PHYI 6												
SP 1												
SP 2												
ZO 1												
ZO 2												
ZO 3												
ZO 4												

Marine and Aquatic Science

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

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

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

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

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, and so forth
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

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

2. **Develop an understanding of physical and chemical properties of water and aquatic environments.**
    a. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
    b. Explain the causes and characteristics of tides. (DOK 1)
    c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
    d. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
    e. Investigate the causes and effects of erosion, and discuss conclusions. (DOK 2)
    f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
        - Plate tectonics
        - Rise, slope, elevation, and depth
        - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
        - Watershed formation as it relates to bodies of freshwater
    g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
        - Barrier island, coral reef, tidal pool, and ocean
        - River, stream, lake, pond, and swamp
        - Bay, sound, estuary, and marsh
3. **Apply an understanding of the diverse organisms found in aquatic environments.**
    a. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
        - Adaptations of representative organisms for their aquatic environments
        - Relationship of organisms in food chains/webs within aquatic environments
    b. Research, calculate, and interpret population data. (DOK 2)
    c. Research and compare reproductive processes in aquatic organisms. (DOK 2)
    d. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
    e. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
    f. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
    a. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
        - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
        - Effectiveness of a variety of methods of environmental management and stewardship
        - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
    b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)

c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
   - Careers related to aquatic science
   - Modern technology within aquatic science (e.g., mariculture and aquaculture)
   - Contributions of aquatic technology to industry and government

Introduction to Biology

INBIO 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
INBIO 2	Investigate and summarize the chemical basis of life.
INBIO 3	Investigate and explain how organisms interact with their environment.
INBIO 4	Investigate, compare, and contrast cell structures, functions, and methods of reproduction.
INBIO	Analyze the roles DNA and RNA play on the mechanism of inheritance.
INBIO 6	Apply the concept of evolution to the diversity of organisms.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment.
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
   b. Identify questions that can be answered through scientific investigations.
   c. Identify and apply components of scientific methods in classroom investigations.
      - Predicting, gathering data, drawing conclusions
      - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
      - Critically analyzing current investigations/problems using periodicals and scientific scenarios.
   d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs.
   e. Analyze procedures and data to draw conclusions about the validity of research.
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis).
   g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics.
2. **Investigate and summarize the chemical basis of life.**
   a. Compare and contrast atoms, ions, elements, molecules, and compounds in terms of the relationship of the bond types (e.g., ionic, covalent, and hydrogen bonds) to chemical activity and explain how this is relevant to biological activity.
   b. Classify pH solutions (e.g., acids, bases, neutrals) and explain the importance of pH in living systems.
   c. Compare the composition and primary properties of carbohydrates, proteins, lipids, and nucleic acids and relate these to their functions in living organisms.

d. Compare and contrast the basic processes of photosynthesis and cellular respiration.

3. Investigate and explain how organisms interact with their environment.

a. Describe the criteria that must be present to distinguish between living and nonliving Homeostasis, adaptation, and response to stimuli Growth, development, reproduction, energy use Levels of organization
b. Analyze and explain the interactions among organisms for each level of biological organization. Biotic and abiotic Predation, competition, symbiosis, mutualism, commensalism, parasitism, etc. Food chains, food webs, and food pyramids
c. Analyze energy flow through an ecosystem by assessing the roles of carnivores, omnivores, herbivores, producers, and decomposers and determine their effects on an ecosystem.
d. Predict the impact of human activities (e.g., recycling, pollution, overpopulation) on the environment.

4. Investigate, compare, and contrast cell structures, functions, and methods of reproduction.

a. Compare and contrast cell structures, functions, and methods of reproduction to analyze the similarities and differences among cell types. Prokaryotic/eukaryotic Unicellular/multicellular Plant/animal/bacterial/protist/fungal
b. Describe and explain the relationships between structures and functions of major eukaryotic organelles (e.g., cell wall, cell membrane, chromosomes, mitochondrion, nucleus, chloroplast, vacuole, endoplasmic reticulum, ribosomes, centrioles, cytoplasm/cytosol, Golgi apparatus, vesicles, lysosomes, microtubules, microfilaments, cytoskeleton, nucleolus, nuclear membrane.)
c. Describe how active, passive, and facilitated transports relate to the maintenance of homeostasis.
d. Compare and contrast the processes and results of mitosis and meiosis.

5. Analyze the roles DNA and RNA play on the mechanism of inheritance.

a. Utilize genetic terminology and principles to solve monohybrid crosses involving dominant and recessive traits.
b. Identify inheritance patterns using pedigrees and karyotypes.
c. Explain and distinguish among the roles of DNA and RNA in replication, transcription, and translation.

6. Apply the concept of evolution to the diversity of organisms.

a. Classify organisms into groups based on their unique characteristics (e.g., cell type, nutrition, reproductive methods, organism examples, etc.) and trace the evolutionary relationships among the groups.
b. Describe how natural selection relates to adaptation, survival, and speciation.

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.

BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. **<u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, and so forth
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
   d. Construct and analyze graphs (e.g., plotting points, labeling *x*- and *y*-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **<u>Describe the biochemical basis of life, and explain how energy flows within and between the living systems.</u>**
   a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
      - Subatomic particles and arrangement in atoms
      - Importance of ions in biological processes
   b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
   c. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
   d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
      - Basic chemical composition of each group
      - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)

- Basic functions (e.g., energy, storage, cellular, and heredity) of each group

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

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

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

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

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

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

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

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

a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
   - Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus,

chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], and cytosol)
- Components of mobility (e.g., cilia, flagella, and pseudopodia)

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

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

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

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

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

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

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

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

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

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

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

c. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, and geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

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

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling *x*- and *y*-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Describe and contrast the structures, functions, and chemical processes of the cell.**
   a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
   b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
   c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
      - The impact of enzymatic reactions on biochemical processes
      - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
   d. Differentiate between photosynthesis and cellular respiration. (DOK 2)

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

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

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

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

a. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
   - Main periods of the geologic timetable of earth's history
   - Roles of catastrophic and gradualistic processes in shaping planet Earth
b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
d. Formulate a scientific explanation based on fossil records of ancient life forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
g. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
h. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution and molecular biology). (DOK 3)
i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. Develop an understanding of organism classification.

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

Botany

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

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

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

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

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

2. <u>Distinguish among the characteristics of botanical organization, structure, and function.</u>

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

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

a. Compare and contrast reproductive structures (e.g., cones and flowers). (DOK 2)
b. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
c. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)

- Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
- Functions of flower parts, seeds, and cones
- Spore production in bryophytes and ferns

d. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
e. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
f. Research and compare various methods of plant propagation. (DOK 2)

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

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

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

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

Chemistry I

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

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

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions, and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Organize data to construct graphs (e.g., plotting points, labeling *x*- and *y*-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. <u>Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.</u>

a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
   - Physical properties (e.g., melting points, densities, and boiling points) of a variety of substances
   - Substances and mixtures
   - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
   - Properties and interactions of the three fundamental particles of the atom
   - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
   - Three major types of radioactive decay (e.g., alpha, beta, and gamma) and the properties of the emissions (e.g., composition, mass, charge, and penetrating power)
   - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
e. Compare the properties of compounds according to their type of bonding. (DOK 1)
   - Covalent, ionic, and metallic bonding
   - Polar and nonpolar covalent bonding
   - Valence electrons and bonding atoms
f. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
g. Develop a three-dimensional model of molecular structure. (DOK 2)
   - Lewis dot structures for simple molecules and ionic compounds
   - Valence shell electron pair repulsion theory (VSEPR)

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

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

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)

- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, and atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)

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

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)

- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

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

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

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)

- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, and atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)

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

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

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

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

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

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

Organic Chemistry

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

ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.

ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

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

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

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

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

d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

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

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

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

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

Earth and Space Science

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

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, and so forth
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Develop an understanding of the history and evolution of the universe and earth.**
   a. Summarize the origin and evolution of the universe. (DOK 2)
      - Big bang theory
      - Microwave background radiation
      - The Hubble constant
      - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
   b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
   c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

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

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

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

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

a. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
    - Latitudinal variations in solar heating
    - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
b. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, and global warming). (DOK 2)
c. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
e. Research and explain how external forces affect earth's topography. (DOK 2)
   - How surface water and groundwater act as the major agents of physical and chemical weathering
   - How soil results from weathering and biological processes
   - Processes and hazards associated with both sudden and gradual mass wasting

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

a. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
   - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
   - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
   - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, and nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion; damming and channeling of rivers)
b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
c. Identify the cause-and-effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
d. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

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

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

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

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

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. <u>Develop an understanding of the relationship of ecological factors that affect an ecosystem.</u>

a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
b. Explain the flow of matter and energy in ecosystems. (DOK 2)
   - Interactions between biotic and abiotic factors
   - Indigenous plants and animals and their roles in various ecosystems
   - Biogeochemical cycles within the environment
c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
   - How a species adapts to its niche
   - Process of primary and secondary succession and its effects on a population
   - How changes in the environment might affect organisms
e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, and predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations, and diversity. (DOK 1)

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

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

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

Genetics

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

1. **Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Review the structure and function of the cell as it applies to genetics. (L)**
   a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
   b. Describe how organic components are integral to biochemical processes. (DOK 2)
   c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
      - Cell cycle and mitosis
      - Meiosis, spermatogenesis, and oogenesis
   d. Explain the significance of the discovery of nucleic acids. (DOK 1)
   e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation, and DNA repair. (DOK 2)
   f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
   g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

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

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

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

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

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

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

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

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

Physical Science

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2 Describe and explain how forces affect motion.
PS 3 Demonstrate an understanding of general properties and characteristics of waves.
PS 4 Develop an understanding of the atom.
PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
      - Safety symbols and safety rules in all laboratory activities
      - Proper use and care of the compound light microscope
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Identify questions that can be answered through scientific investigations. (DOK 3)
   c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
      - Predicting, gathering data, and drawing conclusions
      - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
      - Critically analyzing current investigations/problems using periodicals and scientific scenarios
   d. Interpret and generate graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)
2. **Describe and explain how forces affect motion.**
   a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
      - Inertia and distance–time graphs to determine average speed
      - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
      - Effects of the gravitational force on objects on earth and effects on planetary and lunar motion
      - Simple harmonic motion (oscillation)
   b. Explain the connection between force, work, and energy. (DOK 2)
      - Force exerted over a distance (results in work done)
      - Force–distance graph (to determine work)
      - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
d. Draw and assess conclusions about charges and electric current. (DOK 2)
   - Static/current electricity and direct current/alternating current
   - Elements in an electric circuit that are in series or parallel
   - Conductors and insulators
   - Relationship between current flowing through a resistor and voltage flowing across a resistor
e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

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

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

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

a. Cite evidence to summarize the atomic theory. (DOK 1)
   - Models for atoms
   - Hund's rule and Aufbau process to specify the electron configuration of elements
   - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
   - Atomic orbitals (s, p, d, f) and their basic shapes
b. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
c. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
   - Contributions of scientists (e.g., John Dalton, J. J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
   - Technology (e.g., X-rays, cathode-ray tubes, and spectroscopes)
   - Experiments (e.g., gold-foil, cathode-ray, etc.)
d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)

- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
- Periodic trends using the periodic table (e.g., valence, reactivity, and atomic radius)
- Average atomic mass from isotopic abundance
- Solids, liquids, and gases
- Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, and atomic/covalent/ionic radius) and how they relate to position in the periodic table

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

Physics I

PHYI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2	Develop an understanding of concepts related to forces and motion.
PHYI 3	Develop an understanding of concepts related to work and energy.
PHYI 4	Discuss the characteristics and properties of light and sound.
PHYI 5	Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6	Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
2. **Develop an understanding of concepts related to forces and motion.**
   a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)

- Vector and scalar quantities
- Vector problems (solved mathematically and graphically)
- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, and the special case of freefall). (DOK 2)

c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)

d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

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

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

b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)

c. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)

d. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

e. Develop the kinetic theory of ideal gases, and explain the concept of Carnot efficiency. (DOK 2)

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

a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
c. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. Apply an understanding of magnetism, electric fields, and electricity.

a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law, and Faraday's law
- Coulomb's law

b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. Analyze and explain concepts of nuclear physics.

a. Analyze and explain the principles of nuclear physics. (DOK 1)
- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

b. Defend the wave–particle duality model of light, using observational evidence. (DOK 3)
- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

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

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

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions, and design laboratory investigations. (DOK 3)
c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x- and y-axis, and creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)

e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. <u>Demonstrate the basic concepts of remote sensing. (E, P)</u>

a. Describe the characteristics of the electromagnetic spectrum.
b. Using images and graphs, interpret the absorption/reflection spectrum.
c. Distinguish between passive and active sensor systems.
d. Analyze the effects of changes in spatial, temporal, and spectral resolution.
e. Analyze the effects on images due to changes in scale.
f. Identify the types of sensor platforms.

Zoology

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

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

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

2. **Develop an understanding of levels of organization and animal classification.**
    a. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
        - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
        - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
    b. Identify and describe characteristics of the major phyla. (DOK 1)
        - Symmetry and body plan
        - Germ layers and embryonic development
        - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
        - Locomotion and coordination
    c. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
    d. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
        - Phylogenic sequencing of the major phyla
        - Invertebrate characteristics (e.g., habitat, reproduction, body plan, and locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
        - Vertebrate characteristics (e.g., habitat, reproduction, body plan, and locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
3. **Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
    a. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
    b. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
        - Division of labor within a group of animals
        - Communication within animals groups
        - Degree of parental care given in animal groups
    c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
    d. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
        - Terrestrial and aquatic ecosystems
        - Herbivores, carnivores, omnivores, decomposers, and other feeding relationships
        - Symbiotic relationships such as mutualism, commensalisms, and parasitism
    e. Contrast food chains and food webs. (DOK 2)
4. **Demonstrate an understanding of the principles of animal genetic diversity and evolution.**
    a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
        - Relationship between natural selection and evolution

- Mutations, crossing over, non-disjunction
- Nonrandom mating, migration, and so forth
- Effects of genetic drift on evolution

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