

Biological Applications in Agriculture

8086 36 weeks

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Course Description

Suggested Grade Level: 9 or 10

This course applies biological principles to agriculture, food, and natural resources. Competencies emphasize and reinforce standards of learning for biology with agricultural applications. This course gives students the foundational knowledge to be successful in Biotechnology Foundations in Agricultural and Environmental Science (8085).

Task Essentials Table

8086	Tasks/Competencies
+	Identify the role of supervised agricultural experiences (SAEs) in agricultural education.
+	Participate in an SAE.
+	Identify the benefits and responsibilities of FFA membership.
+	Describe leadership characteristics and opportunities as they relate to agriculture and FFA.
○	Apply for an FFA degree and/or an agricultural proficiency award.
+	Describe the relationship between agriculture and biology.
+	Explain the key steps of the scientific method.
+	Develop experimental procedures to solve a problem or answer a question.
+	Demonstrate safe laboratory practices.

+	Describe the relationship between atoms and molecules.
+	Describe how organisms are identified and classified.
+	Identify the role of federal, state, and local regulatory agencies in agriculture.
+	Describe the cell as the building block of life.
+	Analyze the differences between plant and animal cells.
+	Compare prokaryotic and eukaryotic cells.
+	Analyze cell components.
+	Explain how cell structure and function are used to improve agricultural practices.
+	Explain the cell's surface area to volume ratio.
+	Explain the process of diffusion.
+	Explain the process of osmosis.
+	Explain the concept of homeostasis.
+	Explain the processes of mitosis and meiosis.
+	Explain Mendelian principles of inheritance.
+	Analyze a Punnett square.
+	Describe the structures and components of DNA molecules.
+	Describe the function and replication of nucleic acids.
+	Discuss the process of DNA transfer.
+	Explain how genetic principles are used in animal and plant breeding.
+	Explain how hybrid plants and animals are developed.
+	Describe how genetic modification is used in animal and plant breeding programs.
+	Identify how technology is used in the selection of breeding animals and plants.
+	Explain the role of genetic mutations in animal and plant breeding.
+	Explain the principles of genetic engineering.
+	Describe how genetic engineering is used in agriculture.

<input checked="" type="radio"/>	Compare genetic engineering and genetic modification in agriculture, food, and natural resources (AFNR).
<input checked="" type="radio"/>	Identify emerging trends in genetic engineering.
<input checked="" type="radio"/>	Analyze ethical issues related to genetic engineering.
<input checked="" type="radio"/>	Summarize the laws affecting genetically altered organisms.
<input checked="" type="radio"/>	Explain safety procedures and policies related to genetic engineering and the laboratory.
<input checked="" type="radio"/>	Explain the life-sustaining processes by which all plants grow and develop.
<input checked="" type="radio"/>	Describe factors that affect plant growth.
<input checked="" type="radio"/>	Describe the movement of minerals, water, and nutrients in plants.
<input checked="" type="radio"/>	Describe the methods plants use to store food.
<input checked="" type="radio"/>	Explain how plants protect themselves from diseases, insects, and predators.
<input checked="" type="radio"/>	Compare the primary methods of asexual reproduction.
<input checked="" type="radio"/>	Explain the advantages and disadvantages of soilless plant production.
<input checked="" type="radio"/>	Describe the anatomy and physiology of domestic animals.
<input checked="" type="radio"/>	Explain the four major classes of macromolecules.
<input checked="" type="radio"/>	Explain nutrition requirements for animals.
<input checked="" type="radio"/>	Calculate the amount of feed needed based on energy requirements.
<input checked="" type="radio"/>	Describe the roles of non-nutritive factors in feed.
<input checked="" type="radio"/>	Identify toxic substances that can harm animals.
<input checked="" type="radio"/>	Calculate the feed conversion ratio (FCR).
<input type="radio"/>	Evaluate overall health or homeostasis for a domestic animal species.
<input checked="" type="radio"/>	Define terms associated with disease conditions.
<input checked="" type="radio"/>	Define terms associated with severity of disease or condition.
<input type="radio"/>	Compare treatment methods.
<input checked="" type="radio"/>	Explain disease resistance.
<input checked="" type="radio"/>	Outline best management practices (BMP) for preventing disease outbreaks in a domestic animal species.

+	Define terms related to water quality management.
+	Explain factors that affect dissolved oxygen concentrations in water.
+	Explain how turbidity affects water quality.
+	Identify BMP for water management.
+	Explain how water quality affects aquatic life.
+	Conduct a water analysis.
+	Analyze key issues related to water quality and agriculture.
+	Identify the components of a soil profile used in nutrient management.
+	Identify the particles that make up the structure of soil.
+	Explain the purpose of testing soil fertility.
+	Conduct a soil test.

Legend: + Essential ○ Non-essential ⊖ Omitted

Note: Competencies 39-43 have been added to ensure compliance with federal legislation: National FFA Organization's Federal Charter Amendments Act (Public Law 116-7, <https://www.congress.gov/116/plaws/publ7/PLAW-116publ7.pdf>). All inquiries may be sent to cte@doe.virginia.gov. Students are provided opportunities for leadership, personal growth, and career success. Instruction is delivered through three major components: classroom and laboratory instruction, supervised agricultural experience (SAE) program, and student leadership (FFA).

Curriculum Framework

Task Number 39

Identify the role of supervised agricultural experiences (SAEs) in agricultural education.

Definition

Identification should include

- defining an SAE program as *an opportunity for students to consider multiple careers and occupations in the agriculture, food, and natural resources (AFNR) industries, learn expected workplace behavior,*

develop specific skills within an industry, and apply academic and occupational skills in the workplace or a simulated workplace environment

- researching the Foundational SAE
 - career exploration and planning
 - personal financial planning and management
 - workplace safety
 - employability skills for college and career readiness
 - agricultural literacy
- researching the Immersion SAE
 - entrepreneurship/ownership
 - placement/internships
 - research (experimental, analytical, invention)
 - school business enterprises
 - service learning
- developing a plan to participate in an SAE, based on personal and career goals
- researching available awards and degrees, based on SAE participation.

Teacher resource: [SAE Resources](#), National Council for Agricultural Education

Process/Skill Questions

- What are examples of SAEs related to this course and in the AFNR industries?
- Where can a copy of the Virginia SAE Record Book be found?
- What is an Immersion SAE?
- How does a placement/internship SAE differ from an ownership/entrepreneurship SAE?
- How does an SAE provide relevant work experience and contribute to the development of critical thinking skills?
- How is the SAE an extended individualized instructional component of a student's Career Plan of Study?
- How can an SAE be used to provide evidence of student growth and participation in authentic, work-related tasks?
- What are the four types of SAEs?
- What are the advantages of participating in work-based learning experiences and projects?
- How does one choose an appropriate SAE in which to participate?

Task Number 40

Participate in an SAE.

Definition

Participation should include

- developing, completing, or continuing a plan to participate in an SAE as a work-based learning experience, based on personal and career goals
- documenting experience, connections, positions held, and competencies attained, using the *Virginia SAE Record Book*

- researching available awards and degrees, based on SAE participation.

Teacher resources:

[FFA SAE](#)

[The Agricultural Experience Tracker](#)

[Virginia SAE Record Book](#)

Process/Skill Questions

- What are the advantages of participating in work-based learning experiences and projects?
- How do SAEs help prepare students for the workforce?
- What are some examples of SAEs in AFNR?

Exploring Leadership Opportunities through FFA

Task Number 41

Identify the benefits and responsibilities of FFA membership.

Definition

Identification should include

- benefits
 - listing opportunities to participate in community improvement projects and career development events (CDEs) and leadership development events (LDEs)
 - exploring leadership development opportunities
- responsibilities
 - researching the responsibilities of FFA officers, committees, and members
 - locating resources that guide participation in FFA activities
 - explaining the FFA Creed, Motto, Salute, and mission statement
 - explaining the meaning of the FFA emblem, colors, and symbols
 - explaining significant events and the history of the organization.

Process/Skill Questions

- How does one become an FFA member?
- What is the FFA's mission and how does it accomplish its mission?
- What are the benefits and responsibilities of FFA membership?
- What five FFA activities are available through the local chapter?
- What are some significant events in FFA history? How have these events shaped membership over time?

- What is the FFA program of activities (POA), and how is it used?

Task Number 42

Describe leadership characteristics and opportunities as they relate to agriculture and FFA.

Definition

Description should include

- examples of successful leaders
- types of leadership
 - autocratic
 - participative
 - laissez-faire
 - servant
 - followership
- positive leadership qualities and traits of successful leaders
- opportunities for participating in leadership activities in FFA
- demonstrating methods for conducting an effective meeting.

Process/Skill Questions

- Who are some successful leaders in the agriculture industry?
- What qualities make a successful leader?
- What are leadership traits?
- What is the difference between positive and negative leadership?

Task Number 43

Apply for an FFA degree and/or an agricultural proficiency award.

Definition

Application should include

- identifying types of FFA degrees
 - Greenhand
 - Chapter
 - State
 - American
- identifying proficiency award areas
 - entrepreneurship
 - placement
 - combined
 - agriscience research

- exploring CDEs and LDEs related to this course
- identifying all SAE criteria to be eligible for the award
- identifying the type of award
- applying for an FFA award.

Teacher resource: [FFA Agricultural Proficiency Awards](#)

Process/Skill Questions

- Where are the awards and their application criteria located?
- What are the benefits of winning an FFA award?
- What are the benefits and requirements of an FFA degree?
- What FFA awards are available?
- How does the FFA degree program reward FFA members in all phases of leadership, skills, and occupational development?
- What is the highest degree that can be conferred upon an FFA member at the national level?
- What are the requirements for a Greenhand FFA degree?

Understanding the Study of Living Things

Task Number 44

Describe the relationship between agriculture and biology.

Definition

Description should include

- definitions of *agriculture* and *biology*
- the fundamental concepts that apply to both agriculture and biology
- how these concepts connect to real-world applications.

Process/Skill Questions

- What life processes are used in agriculture for the production of food, fiber, and other agricultural products?

Task Number 45

Explain the key steps of the scientific method.

Definition

Explanation should include the importance of scientific inquiry, acceptable methods, and the description and purpose of each step. Steps include

- identifying and stating the problem
- formulating the hypothesis
- designing the research methodology
- conducting experiments
- collecting the data
- analyzing the data
- drawing conclusions and implications
- making recommendations
- writing the research report.

Process/Skill Questions

- What steps are needed for scientific method evaluation?
- What input data are critical?
- How does the student identify the problem to be studied?
- What is the difference between inductive and deductive methods in science?

Task Number 46

Develop experimental procedures to solve a problem or answer a question.

Definition

Development should include

- basing the procedure on an experimental design diagram
- communicating findings in written form, using the scientific method or engineering design process as a guide.

Process/Skill Questions

- How might an experimental design diagram be used when planning an experiment on plant growth and development?
- How does one determine the type of data to be collected? What visuals might be used to display the data for analysis?
- What information should be included in a laboratory report?

Task Number 47

Demonstrate safe laboratory practices.

Definition

Demonstration should include identification of potential hazards and ways to promote safety through use of personal protective equipment (PPE) and proper safety procedures/practices. Laboratory skills involve working with power equipment, animals, water, and chemicals.

Teacher resources:

- [Safety in Science Teaching](#), Virginia Department of Education (VDOE)
- [Laboratory Safety](#), Occupational Safety and Health Administration (OSHA)
- [CTE Safety Best Practice Guide](#), VDOE

Process/Skill Questions

- What are safe practices for handling biological agents?
- What resources and skills are needed to establish a safe laboratory?
- What safety practices are associated with personal protection?
- What elements are included in a standard safety contract?

Task Number 48

Describe the relationship between atoms and molecules.

Definition

Description should include how atoms and molecules combine to form the basis for all living and non-living matter.

Process/Skill Questions

- What procedures are needed to identify differences in molecules?
- What are the most common molecules in biological systems?
- How are atoms combined to form molecules, compounds, mixtures, and macromolecules?
- What types of macromolecules are common in biological systems? What are examples of each?
- How can macromolecules be altered to improve the value of food, fiber, and agricultural products?

Task Number 49

Describe how organisms are identified and classified.

Definition

Description should include the characteristics used to identify and classify organisms from all three domains of life (i.e., Eukarya, Bacteria, Archaea) and how the process is used to give each organism a scientific name.

Process/Skill Questions

- Why is it necessary to identify and classify organisms?
- How can physical characteristics be used to classify and identify organisms?

- What is *binomial nomenclature*, and why is it necessary?

Task Number 50

Identify the role of federal, state, and local regulatory agencies in agriculture.

Definition

Identification should include the names of agencies, along with a brief written description of their purpose. Some agencies include

- U.S. Department of Agriculture
- U.S. Food and Drug Administration
- Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Virginia Department of Agriculture
- Virginia Department of Forestry
- Virginia Department of Game and Inland Fisheries
- Virginia Department of Environmental Quality
- Virginia Department of Conservation and Recreation
- soil and water conservation districts
- local cooperative extension offices.

Process/Skill Questions

- Who regulates the production of food at the state level?
- Why should all agricultural products be regulated and monitored? How do agencies work together to regulate and monitor agricultural products?
- What are some sources of funding for the implementation of sound agricultural practices and sustainability efforts?

Understanding Cell Structure and Functions

Task Number 51

Describe the cell as the building block of life.

Definition

Description should include the following concepts:

- Cells are the fundamental units of life for all living things.

- Cells form the structure of organisms and contain the hereditary information passed on to new cells as reproduction occurs.
- Cells among similar species are similar in chemical composition.

Process/Skill Questions

- What are common cell structures?
- How does the structure of a cell contribute to life processes?
- What laboratory resources are needed to study cellular biology?

Task Number 52

Analyze the differences between plant and animal cells.

Definition

Analysis should include

- structural differences
- physiological processes that perform different functions.

Process/Skill Questions

- What laboratory procedures are needed to study plant and animal cells?
- What cell structures are identifiable with a compound microscope? A scanning electron microscope?
- How does cell structure change during the life processes?
- What are the differences between active and passive transport?

Task Number 53

Compare prokaryotic and eukaryotic cells.

Definition

Comparison should include

- cell size
- cell type (uni- or multi-cellular)
- true membrane-bound nucleus
- similarities and differences in organelles and their features.

Process/Skill Questions

- What are the differences between prokaryotic and eukaryotic cells?
- What microscope skills are needed to study cells?
- What laboratory procedures are needed to study cellular components?
- What are examples of prokaryotic and eukaryotic cells?

Task Number 54

Analyze cell components.

Definition

Analysis should include the composition and function of various components, including

- plasma membrane
- centrioles
- cytoplasm
- DNA
- nucleoid region
- nucleolus
- nucleus
- ribosomes
- cell wall
- mitochondria
- chloroplast
- vacuoles
- Golgi apparatus
- endoplasmic reticulum.

Process/Skill Questions

- What techniques are required to make and view microscope slides?
- What laboratory resources are needed for cellular study?
- What cells are most effectively studied in a laboratory environment?

Task Number 55

Explain how cell structure and function are used to improve agricultural practices.

Definition

Explanation should include the concepts that plants and animals are composed of many different types of cells with specialized structures and that biotechnology applies this to agricultural practices such as

- pest management
- nutrition management
- genetic engineering
 - plants
 - animals
- energy production
- waste management
- food and fiber production.

Process/Skill Questions

- What cell structures are used in plant and animal nutrition?
- How do environmental conditions affect cell structures?
- What cellular structures are altered in genetically modified products?
- How can biotechnology use knowledge about cell structure and function to produce nonfood crops? Biofuels?
- How can biotechnology improve pest management?
- How can cellular components be altered for agricultural purposes?
- How are cellular components naturally altered (mutation)?

Task Number 56

Explain the cell's surface area to volume ratio.

Definition

Explanation should include

- how to calculate surface area and volume
- how to determine the surface area to volume ratio
- the relationship between the surface area to volume ratio and the cell membrane's ability to transport materials and gases into and out of the cell.

Process/Skill Questions

- How do solute and solvent concentrations affect plant and animal cells differently?
- How can the shape of a cell alter the surface area to volume ratio?

Task Number 57

Explain the process of diffusion.

Definition

Explanation should include

- factors that affect active and passive transport
- practical applications of diffusion (e.g., the uptake of nutrients by the roots of a plant).

Process/Skill Questions

- How is diffusion used by cells?
- What is the function of membranes in diffusion?
- How does saturation affect diffusion?
- What are two types of passive transport?
- What substances (solid, liquid, or gas) are transported into and out of a cell?

- How do solute and solvent concentrations affect diffusion?

Task Number 58

Explain the process of osmosis.

Definition

Explanation should include

- movement of water through a semi-permeable membrane, from high to low area of concentration
- osmotic pressure
- the different levels of solute and solvent concentration (e.g., hypertonic, hypotonic, isotonic).

Process/Skill Questions

- How is osmosis used by cells?
- What is the function of membranes in osmosis?
- How do solute and solvent concentrations affect osmosis?
- How does saturation affect osmosis?
- What other factors affect osmosis? How?
- What is the difference between osmosis and diffusion?

Task Number 59

Explain the concept of homeostasis.

Definition

Explanation should include the following concepts:

- An organism or cell's internal environment remains stable as the external environment changes because of homeostasis.
- Cells use active and passive transport to maintain homeostasis on a cellular level.
- Multicellular organisms show cell specialization, contain levels of organization, and engage in cellular communication.

Process/Skill Questions

- How does a cell maintain homeostasis between its internal and external environments?
- What are some examples of cell specialization in an organism?
- What are some examples of levels of organization in an organism?
- How do cells communicate?
- What laboratory resources are needed for an effective study of homeostasis?

Task Number 60

Explain the processes of mitosis and meiosis.

Definition

Explanation should include

- the division of body (i.e., somatic) cells, including division of the nucleus and division of the cytoplasm (i.e., cytokinesis)
- production of gametes through meiosis
- phases of mitosis and of meiosis.

Process/Skill Questions

- What are the cellular differences in mitosis and meiosis?
- What organisms use mitosis and meiosis for multiplication?
- What are the phases of mitosis? Of meiosis?
- What is the end product of mitosis? Of meiosis?
- How is meiosis different in male and female gamete production?
- What is the difference between a haploid and diploid cell?

Understanding Basic Genetics

Task Number 61

Explain Mendelian principles of inheritance.

Definition

Explanation should include

- Mendel's selective breeding experiments with pea plants to establish genes as the units of heredity (trait, alleles, fertilization)
- law of dominance (dominant and recessive genes)
- law of independent assortment
- law of segregation (gametes).

Process/Skill Questions

- How have Mendel's three laws influenced modern genetics?
- What is the result of genetic hybridization?
- What is the difference between natural and artificial selection?
- What are some examples of artificial selection in agriculture?
- What life processes are used in Mendel's genetic law?
- How are organisms altered according to Mendel's genetic law?

- What limits exist in Mendelian genetics?

Task Number 62

Analyze a Punnett square.

Definition

Analysis should address the use of Punnett squares to predict Mendelian genetics through the concept of dominant and recessive alleles recombined through sexual reproduction. Analysis should include hybrid and dihybrid crosses.

Process/Skill Questions

- How is a Punnett square constructed?
- What traits can be predicted using the Punnett square?
- How can one predict the likelihood of inheriting a particular trait by using the Punnett Square?
- How do mutations influence genetic diversity?
- When would a recessive gene be expressed?
- What is the difference between genotype and phenotype?

Task Number 63

Describe the structures and components of DNA molecules.

Definition

Description of DNA should include

- the structure of the double helix
- the three parts of a nucleotide and how they are bonded
- the four nitrogen bases
- related DNA structures (e.g., chromosomes, genes, alleles).

Process/Skill Questions

- What laboratory procedures are needed to identify chromosome components?
- How do chromosome components differ among organisms?
- What role do amino acids play in chromosome components?

Task Number 64

Describe the function and replication of nucleic acids.

Definition

Description should include

- replication
- transcription
- translation
 - ribonucleic acid (RNA)
 - the role of the ribosome.

Process/Skill Questions

- How is genetic information transferred during cell division?
- What is the function of RNA?
- How do the ribosomes contribute to the transfer of genetic information during cell division?

Task Number 65

Discuss the process of DNA transfer.

Definition

Discussion should include the concept that DNA is passed from parent to offspring through the processes of meiosis and sexual reproduction.

Process/Skill Questions

- How do the processes of meiosis and sexual reproduction produce genetically unique offspring?
- How does meiosis ensure maintenance of chromosome number?
- What laboratory procedures are needed to induce genetic change in organisms?

Task Number 66

Explain how genetic principles are used in animal and plant breeding.

Definition

Explanation should include

- dominant and recessive genes
- application of genetic principles in breeding practices, including selective breeding
- use of naturally occurring genetic variation to pass desired traits to the next generation of organisms.

Process/Skill Questions

- What is *selective breeding*?
- How has the history of selective breeding changed food production in agriculture?
- What roles do hybridization and inbreeding play in selective breeding?

Task Number 67

Explain how hybrid plants and animals are developed.

Definition

Explanation should include the following concepts:

- A hybrid is the offspring of two plants or animals differing in one or more characteristics.
- A hybrid is developed by crossing two genetically different breeds, varieties, species, or genera.

Process/Skill Questions

- What processes are used to produce a hybrid plant? A hybrid animal?
- What contribution have hybrid plants and animals made to agriculture in the past twenty years?
- What is *heterosis* or *hybrid vigor*?

Task Number 68

Describe how genetic modification is used in animal and plant breeding programs.

Definition

Description should include

- an animal and plant breeding program's goal of producing the most desirable market product to meet the demands of the consumer
- genetic contribution toward the producer reaching this goal
- examples of breeding programs' results, such as
 - dwarf crop breeds
 - increased milk production in cows
 - increased body mass in livestock
 - creation of exotic pets and designer breeds
 - crop resistance to insects, diseases, bacteria, and viruses
 - herbicide tolerance
 - increased nutritional value of food crops
 - production of medicines.

Process/Skill Questions

- How has modern agriculture limited diversity in animal and plant breeding?
- What genetic traits are valued in animal breeding today? In plant breeding?
- What are some disadvantages of artificial selection/selective breeding?
- What are the advantages of dwarf crop breeds (e.g., corn, wheat)?

Task Number 69

Identify how technology is used in the selection of breeding animals and plants.

Definition

Identification should include the roles played by computers, software, and other electronic devices in animal and plant breeding programs, including

- record-keeping systems
- marketing
- research
- identification and selection of desired traits
 - annotated crop genomes
 - genome-based breeding
 - site-specific gene integration
- scoring of genetic traits.

Process/Skill Questions

- What role do computers play in genetic selection of animals and plants?
- What genomic technologies are used in breeding programs?
- How are genetic traits scored when used in computer modeling?
- How do computer records and modeling contribute to improved genetics?

Task Number 70

Explain the role of genetic mutations in animal and plant breeding.

Definition

Explanation should include

- what mutations are and how they occur
- types of mutations
- how mutations produce new genetic information that may result in new traits
- how mutations may produce desirable and harmful traits.

Process/Skill Questions

- How do genetic mutations occur?
- How do polyploidy plants benefit agriculture production?
- What are examples of beneficial and harmful mutations?

Exploring Principles of Genetic Engineering

Task Number 71

Explain the principles of genetic engineering.

Definition

Explanation may include the concept that genetic engineering is the manipulation of genes within a cell or organism to alter the make-up of that cell or organism. Specific examples to explore are gene mapping, recombinant DNA, and gene splicing.

Process/Skill Questions

- What role does DNA play in genetic engineering?
- What laboratory procedures are used to artificially induce genetic change?
- What organism components are altered in genetic engineering?
- What laboratory equipment is necessary to map genes and conduct genetic engineering?
- How is the information from gene mapping used in breeding programs?
- How can recombinant DNA be used to alter genetic profiles?
- How are restriction enzymes and other enzymes used in gene splicing?
- What are some benefits of gene splicing? What are some concerns about gene splicing?

Task Number 72

Describe how genetic engineering is used in agriculture.

Definition

Description should include

- enhancing disease resistance
- improving yields
- producing multi-use animals.

Process/Skill Questions

- Why is genetic engineering used in plant and animal engineering?
- How is genetic engineering used in the medical field?

Task Number 73

Compare genetic engineering and genetic modification in agriculture, food, and natural resources (AFNR).

Definition

Comparison should include

- traditional breeding methods
- production efficiency
- efficacy of techniques
- actual breeding and seasonal time
- advantages of genetic engineering
- role of transgenic organisms
- genetically modified organisms (GMOs).

Process/Skill Questions

- How is a transgenic organism created? Why are they created?
- What are the limitations and concerns in plant and animal reproduction?
- What methods can be used to improve plant performance?
- How can alteration of the genetic characteristics of a plant improve plant nutrient value?
- How can plant improvement affect quality of life for humans and animals?

Task Number 74

Identify emerging trends in genetic engineering.

Definition

Identification should include trends in areas such as

- agriculture
 - plant science
 - animal science
 - food science
- medicine
- the environment.

Process/Skill Questions

- What contributions will genetic engineering make to agriculture?
- What contributions will genetic engineering make to human and animal medicine?
- What contributions will genetic engineering make to environmental concerns?

Task Number 75

Analyze ethical issues related to genetic engineering.

Definition

Analysis should include the benefits and potential risks of genetic engineering, such as

- resistance to medicines
- appearance of new diseases
- loss of pure species.

Process/Skill Questions

- What negative effects has genetic engineering had on agriculture?
- What events in the last several years have been driven by genetic engineering?
- What factors contribute to popular perceptions of genetic engineering?

Task Number 76

Summarize the laws affecting genetically altered organisms.

Definition

Summary should include recent legislation with the goal of

- protecting and informing the general population regarding the uses of genetically altered organisms in their everyday lives
- maintaining the integrity of naturally occurring organisms
- protecting the trademark of the companies producing GMOs.

Process/Skill Questions

- What controls should be put in place for genetically altered organisms?
- Who should provide quality control assurance on genetically altered organisms?
- How should proprietary rights be protected?

Task Number 77

Explain safety procedures and policies related to genetic engineering and the laboratory.

Definition

Explanation should include policies and procedures related to

- maintenance of a controlled and sterile environment (e.g., physical containment and biological barriers)
- worker protection
- equipment used to ensure safety
- risk assessment stages
 - formation
 - release
 - proliferation

- establishment
- effect
- potential hazards of biological agents
 - infection hazards
 - toxic, allergenic or other biological effects of the non-viable organism or cell, its components, or its naturally occurring metabolic products
 - toxic, allergenic, or other biological effects of the product expressed by the organism
 - environmental effects.

Teacher resource: [Restrictions on Genetically Modified Organisms](#), Library of Congress

Process/Skill Questions

- Why is a safe laboratory needed for genetic engineering?
- Who should have access to research material for genetic alteration of organisms?
- What documentation is needed to record and verify the alteration of organisms?

Understanding Basic Plant Structures, Functions, and Nutrition

Task Number 78

Explain the life-sustaining processes by which all plants grow and develop.

Definition

Explanation should include

- photosynthesis reactants and products
- respiration reactants and products
- transpiration.

Process/Skill Questions

- What organisms within plant structures are involved in photosynthesis? In respiration? In transpiration?
- How do plants store energy?
- What role does the vascular system play in food transport within the plant?

Task Number 79

Describe factors that affect plant growth.

Definition

Description should include

- roles of air, water, light, and media/substrate in plant growth
- methods of control to achieve optimal plant health and production.

Process/Skill Questions

- What effects does photoperiod have on plants?
- How does soil fertility and pH affect plant growth and development?
- How do environmental factors affect plant growth and development?
- What critical abiotic and biotic factors affect plant growth and development?

Task Number 80

Describe the movement of minerals, water, and nutrients in plants.

Definition

Description should include plant structures and their roles in transporting minerals, water, and nutrients through the roots and to various parts of the plant.

Process/Skill Questions

- What plant structures are involved in nutrient transport?
- What nutrients are most often found in a given plant structure?
- What environmental factors decrease or increase nutrient transport in the plant?
- What plant structures are involved in water transport? Mineral transport? Nutrient transport?

Task Number 81

Describe the methods plants use to store food.

Definition

Description should include methods and structures plants use to store food. Plant species determines the storage methods and structures, such as

- bulbs
- corms
- storage taproots
- tubers
- tuberous roots.

Process/Skill Questions

- What plant structures store food?
- What are water storage structures in plants?
- Why do plants need to store nutrients and water?

Task Number 82

Explain how plants protect themselves from diseases, insects, and predators.

Definition

Explanation should include the variety of physical and chemical mechanisms plants use to protect themselves.

Process/Skill Questions

- What leaf structures protect plants from insects?
- What physical and chemical mechanisms do plants use to protect themselves?

Task Number 83

Compare the primary methods of asexual reproduction.

Definition

Comparison should include

- division
- separation
- cuttings
- grafting
- layering
- tissue culture

and when each method is most effective.

Process/Skill Questions

- What cell structures are involved in asexual reproduction?
- What is the difference between asexual and sexual reproduction?
- How are genetic traits transmitted in asexual reproduction?
- What factors affect the speed of asexual reproduction?
- What laboratory equipment is used for different methods of asexual reproduction?

Task Number 84

Explain the advantages and disadvantages of soilless plant production.

Definition

Explanation should include

- types of hydroponic and aeroponic systems
- growing processes
- plants suitable for each type of production method, based on cell structures
- growing media
- nutrient requirements
- water quality and supply
- logistical and economic factors.

Process/Skill Questions

- What methods are used in traditional plant production?
- What methods are used in hydroponic plant production?
- Why do the structures of some plants make them better suited for hydroponic production? For traditional production?
- How do plants obtain minerals from soil vs. a hydroponic solution?

Understanding Fundamentals of Animal Nutrition

Task Number 85

Describe the anatomy and physiology of domestic animals.

Definition

Description should include

- overview of body systems (i.e., structures and functions of skeletal, nervous, muscular, circulatory, respiratory, reproductive, digestive, excretory, immune, endocrine, and integumentary systems) for domestic animals
- nutritional requirements to maximize health and growth of domestic animals
- examination of how the domestic animal has been bred for function and how it interacts with its environment.

Process/Skill Questions

- What are the major body systems and their roles?

- How do the digestive, circulatory, nervous, endocrine, skeletal, and respiratory systems work?
- How have domestic animals adapted to their roles and environments?

Task Number 86

Explain the four major classes of macromolecules.

Definition

Explanation should include how each macromolecule (i.e., carbohydrates, proteins, lipids, nucleic acids) affects animal nutrition and wellness.

Process/Skill Questions

- What laboratory procedures are used to study carbohydrates, proteins, lipids, and nucleic acids in life processes?
- How do carbohydrates, proteins, lipids, and nucleic acids differ in structure?
- How do carbohydrates, proteins, lipids, and nucleic acids impact animal growth and development?

Task Number 87

Explain nutrition requirements for animals.

Definition

Explanation should include

- nutrient requirements, such as protein, fat, fiber, vitamins, and minerals, for a particular species
- differences in nutrient requirements based on purpose, health, and environmental factors
 - lactation
 - pregnancy
 - physical activity
 - growth stage
- nutrition recommendations from feed manufacturers and government agencies.

Process/Skill Questions

- What are the percentage requirements for components in a feed ration?
- What physiological conditions can cause nutrition requirements to change?
- How are energy requirements met by feed ingredients?

Task Number 88

Calculate the amount of feed needed based on energy requirements.

Definition

Calculation should include

- consideration of animal condition, health, age, stage, lactation, or gestation requirements
- amount of feed required for maximum production and efficiency
- recommendations from feed manufacturers and government agencies.

Teacher resource: [Nutrition and Feeding of the Cow-Calf Herd](#), Virginia Cooperative Extension

Process/Skill Questions

- What informational resources can be used to gauge feeding programs?
- How are feed volumes calculated from National Research Council (NRC) tables or on the feed packaging instructions?
- How is stage of growth addressed by feed ingredients?
- What ingredients influence the amount of energy in the feed?
- How do physiological, dietary, and environmental factors affect feed intake?

Task Number 89

Describe the roles of non-nutritive factors in feed.

Definition

Description should include roles such as

- prophylactic antibiotics
- improving palatability
- increasing shelf life
- providing medication for bloat, parasites, and other conditions/diseases and disease prevention.

Process/Skill Questions

- What ingredients may be used to increase palatability?
- What ingredients are used to extend the shelf life of the feed?

Task Number 90

Identify toxic substances that can harm animals.

Definition

Identification may include

- poisonous plants (e.g., hemlock, wild cherry)
- fungal epiphytes
- herbicides
- insecticides

- lead
- moldy hay/feed.

Process/Skill Questions

- How are toxic substances ingested?
- How do toxic substances in nature adversely affect animal production?
- What are some symptoms of poisoning?
- What laboratory procedures are used to identify toxic substances?

Task Number 91

Calculate the feed conversion ratio (FCR).

Definition

Calculation should include

- average daily gain (i.e., final weight minus starting weight, divided by the animal's age in days)
- feed conversion ratio (i.e., feed intake divided by average daily gain).

Calculation of the FCR is critical to planning nutrition, marketing, and harvesting systems and is dependent upon the species, environment, and type of feed.

Process/Skill Questions

- What information about feed components is needed to calculate the FCR? What formula is used?
- How does component quality affect FCR?
- How do disease and health challenges affect FCR?

Understanding Principles of Animal Health

Task Number 92

Evaluate overall health or homeostasis for a domestic animal species.

Definition

Evaluation should include behavioral and physical signs of illness, as well as stressors and other environmental factors. Examples may include, but are not limited to

- optimum temperature
- access to feed and water

- companionship.

Process/Skill Questions

- What is the role of water quality in domestic animal health?
- How does animal nutrition affect animal health?
- What measures should be taken to prevent animals from becoming sick?
- How can behavioral and physical stressors be limited to ensure optimal health?

Task Number 93

Define terms associated with disease conditions.

Definition

Definition should include

- *bacteria*
- *fungus*
- *nutritional deficiency*
- *parasite*
- *pathogen*
- *vector*
- *virus*
- *zoonotic disease.*

Process/Skill Questions

- What terms describe animal disease conditions?
- Why is the use of appropriate terminology important when working with other animal healthcare professionals?

Task Number 94

Define terms associated with severity of disease or condition.

Definition

Definition should include

- *abnormality*
- *acute*
- *chronic*
- *contagion*
- *infection*
- *lesion*
- *mortality*

- *prognosis*
- *sign*
- *syndrome*
- *terminal*
- *ulceration*
- *zoonotic*.

Process/Skill Questions

- What terms are used to describe the severity of a disease or condition?
- What is a chronic condition? What is an acute condition?
- When is a disease considered terminal?

Task Number 95

Compare treatment methods.

Definition

Comparison should include treatment methods for

- specific illnesses or conditions in common species
- dehydration
- common pests, fungi, and parasites
- wounds.

Teacher resource: [American Veterinary Medical Association](#)

Process/Skill Questions

- What forms of treatment are available for sick and diseased animals?
- Why are there withdrawal periods for certain treatments in animals raised for food?
- What are the differences between traditional treatment methods and acceptable organic treatment methods?

Task Number 96

Explain disease resistance.

Definition

Explanation should include

- methods for achieving resistance to disease
- health management programs.

Process/Skill Questions

- How can disease resistance be achieved?
- What diseases are most common to specific species?

Task Number 97

Outline best management practices (BMP) for preventing disease outbreaks in a domestic animal species.

Definition

Outline should include

- diagnostics
- detection
- prevention
 - biosecurity
 - nutrition planning
 - cleanliness of housing
 - access to clean, fresh feed and water
 - vaccines
 - anthelmintics
- alternatives to antibiotics
- biotherapeutics
- disease management systems (e.g., preventive health care, such as limiting exposure to sick animals and implementing farm biosecurity measures).

Process/Skill Questions

- What daily maintenance checks aid in the prevention of disease?
- Why is nutrition planning vital to disease prevention?
- Why are vaccines and preventive health care plans important?

Understanding Principles of Water and Soil Quality

Task Number 98

Define terms related to water quality management.

Definition

Definition may include

- *aquifer*

- *biofilter*
- *bioindicator*
- *dissolved oxygen*
- *infiltration*
- *leaching*
- *microorganism*
- *nitrate*
- *non-point-source pollution*
- *nutrient influx*
- *pathogen*
- *point-source pollution*
- *pollutant*
- *pH*
- *pH scale*
- *runoff*
- *salinity*
- *stewardship*
- *turbidity*
- *wastewater*
- *water quality.*

Process/Skill Questions

- What instruments are used to identify turbidity?
- How can using BMP support better water quality?
- How does oxygen content in water support abiotic and biotic organisms?
- How does pH help determine overall water quality?

Task Number 99

Explain factors that affect dissolved oxygen concentrations in water.

Definition

Explanation should include the effects of

- pollution
- water temperature
- man-made aeration
- wind
- photosynthesis
- decomposition.

Process/Skill Questions

- How do dissolved oxygen levels affect water quality and aquatic life?
- What methods are used to measure dissolved oxygen?
- How do different organisms respond to lower or higher dissolved oxygen levels?

- What are signs of dissolved oxygen deficiency?
- How can dissolved oxygen deficiencies be corrected?

Task Number 100

Explain how turbidity affects water quality.

Definition

Explanation should include the degree to which the penetration of light into water is limited by the presence of suspended or dissolved matter caused by factors such as

- human activity
- erosion
- presence of other organisms
- other environmental disturbances.

Process/Skill Questions

- How does turbidity affect aquatic life?
- How is turbidity created by fish?
- What tools are used to determine turbidity?

Task Number 101

Identify BMP for water management.

Definition

Identification should include

- cropland runoff control
- animal waste disposal
- stream bank erosion control
- fertilizer and pesticide use
- water harvesting and conservation
- irrigation alternatives
- other pollutant reduction actions.

Process/Skill Questions

- How do riparian buffers, diversions, and grass filter strips help support water quality?
- How can rotational grazing and planting cover crops protect water quality?
- How can capping abandoned wells affect water quality?
- How do integrated pest management and nutrient management plans improve water quality?
- What practices can be adopted to mitigate point-source pollution? Non-point-source pollution?

Task Number 102

Explain how water quality affects aquatic life.

Definition

Explanation should include the effects of changes in

- water quality
- water temperature
- water composition.

Process/Skill Questions

- How can water composition changes be managed?
- How can water quality be improved?

Task Number 103

Conduct a water analysis.

Definition

Conducting a water analysis could include testing for

- pesticides
- herbicides
- pathogens
- pH
- nitrates
- dissolved oxygen
- turbidity.

Data should be organized and communicated to an audience.

Process/Skill Questions

- How do pathogens enter agricultural water supply systems?
- What effects do pesticides in the water supply have on the health of livestock?
- Who conducts water analyses in the local area?
- How can pH be adjusted in a water source?
- What tests are mandated for specific animals, plants, or aquaculture farms?
- How can a water source be purified from a given contaminant?
- What are the acceptable ranges of specific chemicals, pollutants, or pathogens in a water source used for animals?

Task Number 104

Analyze key issues related to water quality and agriculture.

Definition

Analysis should include the effects of water quality on the health and productivity of humans and animals and the effects from

- erosion
- run-off
- pollution.

Process/Skill Questions

- What are common water pollutants from agriculture systems?
- What are different issues faced by industrial feedlots and high-intensity farms?
- How can water pollution from runoff be prevented?
- What steps can be taken to recover a polluted water area?

Task Number 105

Identify the components of a soil profile used in nutrient management.

Definition

Identification should include

- soil horizons
- organic and inorganic components
- parent material.

Process/Skill Questions

- How do soil horizons affect plant growth?
- How does the parent material affect the makeup of soil?
- How can examination of the soil profile give insight into soil fertility?
- What is the *regolith*, and what are its two components?

Task Number 106

Identify the particles that make up the structure of soil.

Definition

Identification should include

- soil horizons

- soil triangle
- the soil particles
 - sand
 - silt
 - clay
 - organic matter
- air and water space
- organisms.

Process/Skill Questions

- How can soil particle makeup be determined in a soil sample?
- What effect does air and water space have on the agricultural productivity of a soil?
- How can organisms affect soil quality?
- How does organic matter affect the nutrient- and water-holding capacity of soil?
- What does color indicate about soil?

Task Number 107

Explain the purpose of testing soil fertility.

Definition

Explanation should include

- determining current soil analysis
- describing lawn or pasture growth needs
- conservation of soil amendments
- legal requirements and environmental regulations.

Process/Skill Questions

- Why is soil testing needed before applying soil amendments?
- How can soil testing help determine land use?

Task Number 108

Conduct a soil test.

Definition

Conducting a soil test should include

- selecting sample sites
- handling soil samples
- describing soil collection methods
- conducting a specific test for nutrient content

- conducting a specific test for biological content
- conducting a pH test
- interpreting the results
- identifying soil amendments
- creating a nutrient management plan.

Process/Skill Questions

- How are the number and location of samples sites determined?
- What information is provided in a soil analysis report?
- How can a crop's nutrient needs be determined after reading the soil analysis report?
- How can soil test reports save input costs for farmers and landowners?
- How can soil pH be altered?
- How long does it take for lime or sulfur to neutralize soil pH?
- What are the effects of nitrogen, phosphorus, and potassium on plant growth?
- What are the essential micronutrients in soil, and how can they affect plant growth?
- What are the differences between organic (e.g., compost, manure) and inorganic (e.g., chemical fertilizer, lime, sulfur, sand) soil amendments?

SOL Correlation by Task

39	Identify the role of supervised agricultural experiences (SAEs) in agricultural education.	English: 9.3, 9.5, 10.3, 10.5, 11.3, 11.5, 12.3, 12.5
40	Participate in an SAE.	English: 9.5, 9.8, 10.5, 10.8, 11.5, 11.8, 12.5, 12.8
41	Identify the benefits and responsibilities of FFA membership.	English: 9.5, 9.6, 9.7, 9.8, 10.5, 10.6, 10.7, 10.8, 11.5, 11.6, 11.7, 11.8, 12.5, 12.6, 12.7, 12.8
42	Describe leadership characteristics and opportunities as they relate to agriculture and FFA.	English: 9.5, 10.5, 11.5, 12.5 History and Social Science: VUS.8, VUS.9, VUS.10, VUS.11, WHII.8, WHII.10, WHII.11
43	Apply for an FFA degree and/or an agricultural proficiency award.	English: 9.5, 10.5, 11.5, 12.5
44	Describe the relationship between agriculture and biology.	English: 9.3, 9.5, 10.3, 10.5 History and Social Science: WHI.2, WHI.3, WHI.4, WHI.5, WHI.6, WHI.10, WHI.14, WHII.4 Science: BIO.3, BIO.5
45	Explain the key steps of the scientific method.	English: 9.5, 9.6, 9.7, 10.5, 10.6, 10.7 Science: BIO.1, CH.1, ES.2, PH.1
46	Develop experimental procedures to solve a problem or answer a question.	English: 9.1, 9.5, 10.1, 10.5 History and Social Science: WHII.4 Science: BIO.1, CH.1, ES.2, PH.1

47	Demonstrate safe laboratory practices.	English: 9.8, 10.8 History and Social Science: GOVT.8 Science: CH.1
48	Describe the relationship between atoms and molecules.	English: 9.5, 10.5 Science: CH.2
49	Describe how organisms are identified and classified.	English: 9.5, 9.8, 10.5, 10.8 Science: BIO.4, BIO.6
50	Identify the role of federal, state, and local regulatory agencies in agriculture.	English: 9.5, 9.8, 10.5, 10.8 History and Social Science: GOVT.7, GOVT.8, GOVT.14, GOVT.15
51	Describe the cell as the building block of life.	English: 9.5, 10.5 History and Social Science: WHII.4 Science: BIO.3
52	Analyze the differences between plant and animal cells.	English: 9.5, 10.5 History and Social Science: WHII.4 Science: BIO.3
53	Compare prokaryotic and eukaryotic cells.	English: 9.5, 10.5 History and Social Science: WHII.4 Science: BIO.3
54	Analyze cell components.	History and Social Science: WHII.4 Science: BIO.3
55	Explain how cell structure and function are used to improve agricultural practices.	English: 9.5, 10.5 History and Social Science: WHII.4 Science: BIO.3
56	Explain the cell's surface area to volume ratio.	English: 9.5, 10.5 History and Social Science: WHII.4 Mathematics: G.13, G.14 Science: BIO.3
57	Explain the process of diffusion.	English: 9.5, 10.5 Science: BIO.3

58	Explain the process of osmosis.	English: 9.5, 10.5 Science: BIO.3
59	Explain the concept of homeostasis.	English: 9.5, 10.5 History and Social Science: WHII.4 Science: BIO.3
60	Explain the processes of mitosis and meiosis.	English: 9.5, 10.5 Science: BIO.5
61	Explain Mendelian principles of inheritance.	English: 9.5, 10.5 Science: BIO.5
62	Analyze a Punnett square.	English: 9.5, 10.5 Mathematics: PS.11*, PS.12* Science: BIO.5
63	Describe the structures and components of DNA molecules.	English: 9.5, 10.5 Science: BIO.5
64	Describe the function and replication of nucleic acids.	English: 9.5, 10.5 Science: BIO.5
65	Discuss the process of DNA transfer.	English: 9.1, 10.1 Science: BIO.5
66	Explain how genetic principles are used in animal and plant breeding.	English: 9.5, 10.5 Science: BIO.5
67	Explain how hybrid plants and animals are developed.	English: 9.5, 10.5 Science: BIO.5
68	Describe how genetic modification is used in animal and plant breeding programs.	English: 9.5, 10.5
69	Identify how technology is used in the selection of breeding animals and plants.	English: 9.5, 10.5
70	Explain the role of genetic mutations in animal and plant breeding.	English: 9.5, 10.5 Science: BIO.5
71	Explain the principles of genetic engineering.	English: 9.5, 10.5 Science: BIO.5
72	Describe how genetic engineering is used in agriculture.	English: 9.5, 10.5 History and Social Science: GOVT.12, VUS.14, WG.17, WHII.14

73	Compare genetic engineering and genetic modification in agriculture, food, and natural resources (AFNR).	English: 9.5, 10.5 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14
74	Identify emerging trends in genetic engineering.	English: 9.5, 10.5 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14 Science: BIO.5
75	Analyze ethical issues related to genetic engineering.	English: 9.5, 10.5 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14 Science: BIO.5
76	Summarize the laws affecting genetically altered organisms.	English: 9.5, 10.5 History and Social Science: GOVT.7, GOVT.8, GOVT.12, GOVT.14, GOVT.15, VUS.14, WG.17, WHIL.14
77	Explain safety procedures and policies related to genetic engineering and the laboratory.	English: 9.5, 9.8, 10.5, 10.8 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14
78	Explain the life-sustaining processes by which all plants grow and develop.	English: 9.5, 10.5 Science: BIO.2
79	Describe factors that affect plant growth.	English: 9.5, 10.5 Science: BIO.2
80	Describe the movement of minerals, water, and nutrients in plants.	English: 9.5, 10.5 Science: BIO.2
81	Describe the methods plants use to store food.	English: 9.5, 10.5
82	Explain how plants protect themselves from diseases, insects, and predators.	English: 9.5, 10.5
83	Compare the primary methods of asexual reproduction.	English: 9.5, 10.5
84	Explain the advantages and disadvantages of soilless plant production.	English: 9.5, 10.5
85	Describe the anatomy and physiology of domestic animals.	English: 9.5, 10.5 Science: BIO.4
86	Explain the four major classes of macromolecules.	English: 9.5, 10.5 Science: BIO.2
87	Explain nutrition requirements for animals.	English: 9.5, 10.5

88	Calculate the amount of feed needed based on energy requirements.	History and Social Science: GOVT.7, GOVT.8, GOVT.14, GOVT.15 Mathematics: A.1, A.4
89	Describe the roles of non-nutritive factors in feed.	English: 9.5, 10.5
90	Identify toxic substances that can harm animals.	English: 9.5, 10.5
91	Calculate the feed conversion ratio (FCR).	Mathematics: A.1, A.4
92	Evaluate overall health or homeostasis for a domestic animal species.	English: 9.5, 10.5
93	Define terms associated with disease conditions.	English: 9.3, 9.5, 10.3, 10.5 Science: BIO.4
94	Define terms associated with severity of disease or condition.	English: 9.3, 9.5, 10.3, 10.5
95	Compare treatment methods.	English: 9.5, 10.5
96	Explain disease resistance.	English: 9.5, 10.5 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14
97	Outline best management practices (BMP) for preventing disease outbreaks in a domestic animal species.	English: 9.6, 9.7, 10.6, 10.7 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14
98	Define terms related to water quality management.	English: 9.3, 9.5, 10.3, 10.5
99	Explain factors that affect dissolved oxygen concentrations in water.	English: 9.5, 10.5
100	Explain how turbidity affects water quality.	English: 9.5, 10.5
101	Identify BMP for water management.	English: 9.5, 9.8, 10.5, 10.8
102	Explain how water quality affects aquatic life.	English: 9.5, 10.5
103	Conduct a water analysis.	English: 9.6, 9.7, 10.6, 10.7 Mathematics: A.8, A.9, AFDA.8, PS.1*, PS.2*, PS.3*, PS.4*
104	Analyze key issues related to water quality and agriculture.	English: 9.5, 10.5 History and Social Science: GOVT.12, VUS.14, WG.17, WHIL.14
105	Identify the components of a soil profile used in nutrient management.	English: 9.5, 10.5 Science: ES.8
106	Identify the particles that make up the structure of soil.	English: 9.5, 10.5 Science: ES.8
107	Explain the purpose of testing soil fertility.	English: 9.5, 10.5
108	Conduct a soil test.	English: 9.1, 9.5, 10.1, 10.5

FFA Information

The National FFA is an organization dedicated to preparing members for leadership and careers in the science, business, and technology of agriculture. Local, state, and national activities and award programs provide opportunities to apply knowledge and skills acquired through agriculture education.

For additional information about the student organization, see the [National FFA website](#) and the [Virginia FFA Association website](#).

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Agricultural Biotechnology Assessment
- Animal Systems Assessment
- Biotechnology Assessment
- College and Work Readiness Assessment (CWRA+)
- Customer Service Specialist (CSS) Examination
- National Career Readiness Certificate Assessment
- Natural Resources Systems Assessment
- Production Agriculture Assessment
- Small Animal Science and Technology Assessment
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Applied Agricultural Concepts (8072/18 weeks)
- Applied Agricultural Concepts (8073/36 weeks)
- Biotechnology Applications in Agriculture (8087/36 weeks)
- Biotechnology Foundations in Agricultural and Environmental Science (8085/36 weeks)
- Biotechnology Foundations in Health and Medical Sciences (8344/36 weeks)
- Biotechnology Foundations in Technology Education (8468/36 weeks)
- Ecology and Environmental Management (8046/36 weeks)
- Ecology and Environmental Management (8045/18 weeks)
- Equine Science (8015/18 weeks)
- Equine Science (8080/36 weeks)
- Equine Science, Advanced (8094/36 weeks)
- Fisheries and Wildlife Management (8041/36 weeks)
- Floriculture (8038/36 weeks)
- Food Science and Dietetics (8239/36 weeks)
- Forestry Management (8042/36 weeks)
- Forestry Management, Advanced (8044/36 weeks)
- Greenhouse Plant Production and Management (8035/36 weeks)
- Horticulture Sciences (8034/36 weeks)
- Introduction to Animal Systems (8008/36 weeks)
- Introduction to Natural Resources and Ecology Systems (8040/36 weeks)
- Introduction to Plant Systems (8007/36 weeks)
- Small Animal Care I (8081/18 weeks)
- Small Animal Care I (8083/36 weeks)
- Small Animal Care II (8084/36 weeks)
- Veterinary Science I (8088/36 weeks, 140 hours)
- Veterinary Science II (8089/36 weeks, 140 hours)

Career Cluster: Agriculture, Food and Natural Resources	
Pathway	Occupations
Animal Systems	Animal Breeder, Husbandry Animal Geneticist Animal Nutritionist Animal Scientist Aquacultural Manager Poultry Manager Veterinarian Veterinary Technician
Environmental Service Systems	Environmental Compliance Inspector Environmental Sampling and Analysis Technician Hazardous Materials Handler Recycling Coordinator Secondary School Teacher Toxicologist Turf Farmer Water Conservationist
Food Products and Processing Systems	Biochemist Food Scientist
Natural Resources Systems	Ecologist Fish and Game Officer Fisheries Technician Forest Manager, Forester Forest Technician Geological Technician Microbiologist
Plant Systems	Botanist Certified Crop Advisor Crop Grower Forest Geneticist Nursery and Greenhouse Manager Ornamental Horticulturist Plant Breeder/ Geneticist Secondary School Teacher Soil and Plant Scientist Tree Surgeon Turf Farmer
Power, Structural, and Technical Systems	Agricultural Engineer

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	Occupations
Engineering and Technology	Agricultural Engineer
Science and Mathematics	Animal Nutritionist Animal Scientist Biologist Botanist Chemist Ecologist Environmental Scientist Materials Scientist Microbiologists

Career Cluster: Science, Technology, Engineering and Mathematics

Pathway	Occupations
	Oceanographer Plant Breeder and Geneticist Plant Pathologist Research Chemist Secondary School Teacher Technical Writer Toxicologist Veterinarian Veterinary Assistant