

Statewide Framework Document for: 261201

Agricultural Biotechnology

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments and leadership alignment may be developed at the local level. In order to earn state approval, performance assessments must be submitted within this framework. **This course is eligible for one life science or lab science.** The Washington State Science Standards performance expectations for high school blend core ideas (Disciplinary Core Ideas, or DCIs) with scientific and engineering practices (SEPs) and crosscutting concepts (CCCs) to support students in developing usable knowledge that can be applied across the science disciplines. These courses are to be taught in a [three-dimensional manner](#). The details about each performance expectation can be found at [Next Generation Science Standards](#).

School District Name	
Course Title: Agricultural Biotechnology	Total Framework Hours: 180
CIP Code: 261201 <input checked="" type="checkbox"/> Exploratory <input type="checkbox"/> Preparatory	Date Last Modified: December 30, 2020
Career Cluster: Agriculture, Food, and Natural Resources	Cluster Pathway: Biotechnology Systems
<p>Course Summary:</p> <p>Animal and Plant Biotechnology is a course that focuses on the application of the biological sciences, biochemistry, and genetics to the preparation of new and enhanced agricultural, environmental, clinical, and industrial products, including the commercial exploitation of microbes, plants, and animals. Includes instruction in bioinformatics, gene identification, phylogenetic and comparative genomics, bioinorganic chemistry, immunoassaying, DNA sequencing, xenotransplantation, genetic engineering, industrial microbiology, drug and biologic development enzyme-based production processes, patent law, biotechnology management and marketing, applicable regulations, and biotechnology ethics.</p> <p>The course will include areas of study such as laboratory protocols and safety, cells, DNA and protein, genetically modified organisms, micropropagation, polymerase chain reaction, and research in biotechnology.</p> <p>As with all agriculture courses, instruction and assessment in the Supervised Agriculture Experience (SAE) is a requirement. The Supervised Agriculture Experience includes placing a student in a position where he or she will learn the practices of entrepreneurship and the fundamentals of research and experimentation in the agricultural field. Participants in the SAE will conduct exploratory projects with the purpose of learning about and improving practices in their surroundings.</p> <p>SAE.01. This course will include instruction in and Student involvement in Supervised Agriculture Experience Projects (SAE)</p>	
Eligible for Equivalent Credit in: Science	Total Number of Units: 6

Unit 1: Foundations of Biotechnology**Total Learning Hours for Unit: 20****Unit Summary:**

This unit will include instruction in; Foundations of Biotechnology, Standard Operating Procedures, and the Basics of Cells and DNA.

Competencies include:

- 1.1 Modern biotechnology has foundations in historical technologies, such as fermentation and selective breeding, while utilizing newer fields, such as molecular biology, bioengineering, and bioinformatics.
- 1.2 Organization and record keeping are important to success in biotechnology.
- 1.3 Innovations in biotechnology have led to more efficient production of agricultural goods and may support sustainable agricultural practices in the future
- 1.4 Ethical questions surrounding applications of biotechnology, which generate discussions and varying opinions that drive policy and regulation, are based on personal beliefs.
- 1.5 Working in biotechnology laboratory requires diligence in following safety procedures and rules.
- 1.6 Knowledge of the location of safety equipment is essential when working in the laboratory
- 1.7 Safety Data Sheets (SDS) contain important information related to the proper use and cleanup of biological and chemical materials.
- 1.8 Proper and accurate measurement is important for laboratory investigation.
- 1.9 Good Laboratory Procedures (GLPs) ensure the quality and integrity of laboratory data used to support registration of a product.
- 1.10 Culturing research specimen in the laboratory requires the use of sterile techniques to limit contamination
- 1.11 Prokaryotic and eukaryotic cells, which are used for biotechnological applications, can be cultured and observed easily in the laboratory.
- 1.12 Understanding DNA structure is essential for bioengineering processes
- 1.13** DNA is studied in order to understand how living things work.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

- Complete a series of activities to explore the applications of biotechnology
- Write a definition of biotechnology
- Develop and maintain a Laboratory Notebook to record observations and protocols.
- Determine the date and significance of a biotechnological discovery.
- Work collaboratively to develop a timeline of biotechnology discoveries.
- Explore their personal beliefs and knowledge to gain perspective on practices in biotechnology.
- Review the Lab Safety Manual and determine safe practices for the biotechnology laboratory
- Diagram and describe where emergency equipment and safety hazards in the biotechnology laboratory are located.
- Explain appropriate uses of safety and emergency equipment.
- Use SDS forms to determine the proper use and clean-up of compounds used in the course.
- Mix diluted solutions based on the percentage of a substance desired.
- Prepare solutions based on the desired molar concentration.
- Use pipets to transfer accurate volumes of solutions.

- Transfer microliters of solutions using a micropipet.
- Prepare and pour nutrient agar plates using sterile procedures.
- Prepare culture plates using proper sterile and streaking techniques.
- Observe differences in growth patterns of prokaryote and eukaryote model organisms.
- Develop a model of a DNA strand as a class and using simulation materials.
- Research DNA replication and develop a visual representation of the replication process.
- Determine the location of a specific gene sequence in a DNA segment.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work creatively with others and collaborate with others to develop a timeline of biotechnology discoveries.
- Students use judgements and decisions when working in a biotechnology laboratory to follow safety procedures and rules.

Industry Standards and/or Competencies:

Agriculture, Food, and Natural Resources (AFNR) Standards –Cluster Skills, Career Ready Practices, and Biotechnology Systems

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

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

BS.01.01: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

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

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

BS.02.03: Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

BS.02.04: Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

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

Aligned Washington State Academic Standards

Science

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

	HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Obtaining, Evaluating, and Communicating Information Planning and Carrying Out Investigations Developing and Using Models	LS1. A: Structure and Function: LS3.A Inheritance of Traits	Patterns Cause and Effect: Mechanism and Prediction Scale, Proportion, and Quantity Systems and System Models: Structure and Function:

Unit 2: DNA Technologies	Total Learning Hours for Unit: 30
<p>Unit Summary: This unit will include instruction in Diving into DNA and Genetic Transformers.</p> <p>Competencies include:</p> <p>2.1 DNA is extracted from cellular matter to be studied.</p> <p>2.2 Restriction enzymes are used to cut DNA in order to compare organisms, isolate and transfer genes, and genetically modify organisms.</p> <p>2.3 DNA profiles are created using fragments produced through Restriction Fragment Length Polymorphism.</p> <p>2.4 Transformation is used to synthetically produce proteins for increased animal and plant production.</p> <p>2.5 Plasmids are used to insert the genes for desired traits into bacterial cells.</p> <p>2.6 Proteins of interest can be purified from bacterial cultures for further study.</p> <p>2.7 Conducting background research is important to identify what is already known about the research objective.</p>	
<p>Performance Assessments: (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <ul style="list-style-type: none"> • Write an experiment to extract DNA from kiwi fruit. • Extract DNA from kiwi fruit using procedures developed. • Mix solutions and pour gel trays to prepare agarose gels. • Conduct gel electrophoresis to observe the migration of dyes and extracted DNA. • Demonstrate the action of restriction enzymes using paper DNA strands. • Digest a DNA sample using restriction enzymes and conduct gel electrophoresis to analyze the results. • Solve a problem determining the culprit of a crime using restriction enzymes and gel electrophoresis. • Prepare agar plates and LB broth for experiments. • Transform bacterial cells to exhibit ampicillin resistance and bioluminescence. • Use the pGLO plasmid to transform bacterial cells to exhibit desired traits • Research how the Ti plasmid is used to transform a bacteria of interest for agricultural biotechnology applications • Culture transformed cells and purify a protein of interest from the bacteria • Research <i>Agrobacterium tumefaciens</i> to determine applications in the agricultural field. • Write a scientific research paper using valid resources and parenthetical citations. 	

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work creatively with others, and reason effectively to complete DNA extraction experiments.
- Students access and evaluate information and use and manage information to complete research on *Agrobacterium tumefaciens*.

Industry Standards and/or Competencies:

Agriculture, Food, and Natural Resources (AFNR) Standards – Biotechnology Systems Pathway

CRP 04: Communicate clearly, effectively and with reason.

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

CRP. 07:Employ valid and reliable research strategies.

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

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

BS.02.02: Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

BS.02.03: Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

BS.02.04: Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

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

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

BS.03.01: Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.

Aligned Washington State Academic Standards

Science

Washington Science Standards (Next Generation Science Standards):

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Obtaining, Evaluating, and Communicating Information Constructing Explanations and Designing Solutions Asking Questions and Defining Problems Planning and Carrying Out Investigations	LS1.A Structure and Function LS3. A Inheritance of Traits LS4.A Evidence of Common Ancestry and Diversity ETS1. A Defining and Delimiting Engineering Problems ETS1.B Developing Possible Solutions	Patterns Cause and Effect: Mechanism and Prediction Scale, Proportion, and Quantity Systems and Systems Models

Unit 3: Proteins	Total Learning Hours for Unit: 30
<p>Unit Summary: Instruction will include Protein Processes.</p> <p>Competencies include:</p> <p>3.1 Transcription and translation are processes that produce proteins of which all living things are made.</p> <p>3.2 Colorimetric assays can be used to identify and determine the amount of protein in a biological sample extract.</p> <p>3.3 The presence of specific proteins in a biological sample can indicate the presence of disease, exposure to disease, or identify genetically modified product.</p>	
<p>Performance Assessments: (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <ul style="list-style-type: none"> • Research the processes of transcription and translation and complete a simulation of amino acid production. • Perform an experiment using a spectrophotometer to assess the protein content of milk and other high protein drinks. • Compare the results of Bradford assays to Biuret assays. • Complete an enzyme-linked immunosorbent assay to determine the presence of protein. • Write an outline of their research paper on <i>Agrobacterium tumefaciens</i>. 	
<p>Leadership Alignment: (Districts to complete for each unit)</p> <p><i>Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.</i></p> <p><i>Example:</i></p> <ul style="list-style-type: none"> • Students apply technology effectively when performing experiments using the spectrophotometer. • Students work independently to create their research paper outline. 	
<p>Industry Standards and/or Competencies:</p> <p>Agriculture, Food, and Natural Resources (AFNR) Standards – Biotechnology Systems Pathway:</p> <p>BS.02: Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).</p> <p>BS.02.05: Examine and perform scientific procedures using microbes, DNA, RNA and proteins in a laboratory.</p> <p>BS.03: Demonstrate the application of biotechnology to solve problems in AFNR systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).</p>	

BS.03.02: Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.

BS.03.04: Apply biotechnology principles, techniques and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).

Aligned Washington State Academic Standards

Science	Washington Science Standards (Next Generation Science Standards): HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Analyzing and Interpreting Data Using Mathematics and Computational Thinking Obtaining, Evaluating, and Communicating Information	LS1.A Structure and Function LS1.C Organization for Matter and Energy Flow in Organisms LS3.A Inheritance of Traits	Patterns Scale, Proportion, and Quantity

Unit 4: Agricultural Biotechnology

Total Learning Hours for Unit: 60

Unit Summary: This unit will include instruction in; Genetically Modified Organisms, Performance Enhanced Plants, Animal Applications, and Everyday Biotechnology.

Competencies include:

4.1 Ethical and moral questions arise from the science of genetically modifying organisms.

4.2 Genetic testing, such as polymerase chain reactions and lateral flow tests, is used to make production based decisions and identify genetically modified organisms.

4.3 Organisms are genetically modified to improve agricultural products by inserting genes into cells.

4.4 Plants are genetically modified to improve agricultural products by inserting genes into cells.

- 4.5 The totipotency of plants allows a minute portion of tissue to be cultured into a complete plant.
- 4.6 A sterile environment, including media, work area, equipment, and lab technician is required to produce viable plants by micropropagation.
- 4.7 Deoxyribonucleic acid (DNA) can be cut, replicated, and inserted into the genome of an organism for the improvement of agricultural production.
- 4.8 The immune response of mammals can be used to detect proteins of interest.
- 4.9 Animal reproductive technologies are used by producers in order to achieve management goals.
- 4.10 Markers are used to identify the successful insertion of genes.
- 4.11 Genetic testing and disease diagnosis are used to make production based decisions.
- 4.12 Biotechnological practices, such as bioremediation, use naturally occurring processes to provide industrial applications.
- 4.13 Biofuels are a source of renewable energy derived from organisms.
- 4.14 Fermentation and esterification are processes in which agricultural products are converted into biofuels.
- 4.14 The precautionary principle serves as a guiding statement for determining the ethical considerations of biotechnology and other scientific endeavors

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

- Reflect upon the term genetically modified and develop personal perceptions and beliefs pertaining to the term.
- Research published perceptions of genetically modified organisms of different groups and organizations and discuss in class.
- Perform a lateral flow test to determine the presence of Round-Up Ready® genes in corn.
- Conduct a polymerase chain reaction to determine the presence of genetic modifications in a common food item.
- Conduct a public perception survey of genetically modified foods.
- Complete the annotated bibliography, the rough draft, and a peer review of the *A. tumefaciens* research paper.
- Research and compare methods of inserting genes into plants and discuss the advantages and disadvantages of each.
- Propagate African violets using tissue culture.
- Sanitize, sterilize, and maintain an aseptic environment to promote success during tissue culture.
- Complete a simulation of the process for developing transgenic plants.
- Develop and write a protocol to insert a gene of interest in plants.
- Perform enzyme-linked immunosorbent assays to detect the immunological response of animals.
- Research and present their findings on reproductive technologies used in animal agriculture.
- Perform PCR and electrophoresis to use marker assisted selection to determine ideal genotypes for specific situations.
- Complete a WebQuest to study the diagnostic tools available for detection of diseases and genetic abnormalities.
- Design and conduct an experiment determining the effectiveness of oil-eating microbes in various environmental conditions.
- Research a type of biofuel and determine a method of producing the fuel in a laboratory.
- Review a case study and interpret the application of the precautionary principle by interest groups.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students interact effectively with others while propagating African violets.

- Students work effectively in diverse teams while completing a WebQuest for detection of diseases and genetic abnormalities.
- Students produce results and be responsible to others while performing enzyme linked immunosorbent assays.

Industry Standards and/or Competencies:

Agriculture, Food, and Natural Resources (AFNR) Standards – Biotechnology Systems Pathway

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

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

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

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

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

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

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

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

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

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

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

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

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

BS.01.01: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

BS.01.02: Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).

BS.01.03: Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

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

BS.02.01: Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.

BS.02.02: Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

BS.02.04: Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

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

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

BS.03.01: Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.

BS.03.03: Apply biotechnology principles, techniques and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).

BS.03.04: Apply biotechnology principles, techniques and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).

BS.03.05: Apply biotechnology principles, techniques and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).

BS.03.06: Apply biotechnology principles, techniques and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.).

Aligned Washington State Academic Standards

Science

Washington Science Standards (Next Generation Science Standards):

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

	<p>HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.</p> <p>HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.</p> <p>HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.</p> <p>HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.</p> <p>HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.</p> <p>HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems</p> <p>HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information Developing and Using Models Planning and Carrying Out Investigations	LS1.A Structure and Function LS4.C Adaptation LS1.B Growth and Development of Organisms LS1.C Organization for Matter and Energy Flow in Organisms LS4.D Biodiversity and Humans ESS3.A Natural Resources ESS3.C Human Impacts on Earth Systems ETS 1A ETS 1B	Structure and Function Stability and Change Cause and Effect: Mechanism and Prediction Systems and System Models

Unit 5: Research Methods

Total Learning Hours for Unit: 30

Unit Summary: This unit will include instruction in Independent Researchers and From Lab to Production.

Competencies include:

- 5.1 Research is driven by questions and backed by literature reviews, experimentation, and communication of results.
- 5.2 Conducting background research is important to identify what is known about the research question.
- 5.3 Experiments are designed in such a way that the control is apparent and the researcher can conduct multiple trials.
- 5.4 Results of research experiments include interpretation of data in the form of posters, papers, or oral presentations.
- 5.5 The genome of multiple organisms can be analyzed in order to understand genetic variations.
- 5.6 Regulatory agencies monitor research and development, production, and use of biotech products in order to ensure safety for consumers and the environment.
- 5.7 Results of research undergo multiple steps and trials before researching consumers.
- 5.8 Ethical questions surrounding applications of biotechnology, which generate discussions and varying opinions, are based on personal feelings and beliefs.
- 5.9 Biotechnology is a fast growing industry with many emerging technologies and future career opportunities.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

- Brainstorm ideas for research projects and define a problem to solve in order to frame research.
- Collect and summarize similar research conclusions.
- Write a research proposal outlining the background and need for their research as well as a plan for conducting the research.
- Conduct a self-designed research project and collect data for results and analysis.
- Write a research paper summarizing the findings of their research.
- Prepare a research poster to present to the class and at local science fairs.
- Use web-based resources to find information on the genetic sequence of a protein.
- Determine the influence of governmental regulatory agencies.
- Write a case study pertaining to a biotechnological application and the role of governmental agencies in determining the safety of the application.
- Develop a model depicting the steps from laboratory research through production to end use of a biotechnology.
- Review their ethical perspectives of biotechnological practices and reflect on how their opinions have developed over the length of the course.
- Write a letter outlining their vision for future biotechnological innovations and practices.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students manage projects, produce results, and manage goals and time while self-monitoring completion of their research projects.
- Students work independently on self-designed research project.
- Students communicate clearly to complete project presentations.

Industry Standards and/or Competencies:

Agriculture, Food, and Natural Resources (AFNR) Standards – Biotechnology Systems Pathway:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

BS.01.01: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

BS.01.02: Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).

BS.01.03: Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

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

BS.02.01: Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.

BS.02.02: Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

BS.02.03: Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

BS.02.04: Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

Aligned Washington State Academic Standards	
Science	Washington Science Standards (Next Generation Science Standards): HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

	<p>HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Obtaining, Evaluating, and Communicating Information Engaging in Argument from Evidence Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Developing and Using Models Asking Questions and Defining Problems Planning and Carrying Out Investigations	ETS1.B Developing Possible Solutions ETS1. A Defining and Delimiting Engineering Problems	Systems and System Models

Unit 6: Career Leadership, Communication, and Documents	Total Learning Hours for Unit: 10
Unit Summary: Competencies include: <ul style="list-style-type: none"> • Participate in a job interview. • Produce a well-written cover letter, job application, and follow-up letter. • Follow oral and written directions with understanding; form questions that clarify directions as needed. • Communicate effectively in oral, written, visual and nonverbal modes. • Recognize and demonstrate reflective listening skills and assertive communications skills in the workplace. • Identify acceptable work habits and personal characteristics. • Demonstrate knowledge of the opportunities for leadership development available through an appropriate student organization. 	
Performance Assessments: (Districts to complete for each unit) <i>Example assessments for this unit include:</i> <ul style="list-style-type: none"> • Students explore the role of leadership in agricultural careers through research and discussions. Identify what is good communication in both written and verbal form within agricultural careers and develop documentation that allows them to most effectively reach specific audiences for particular purposes. 	
Leadership Alignment: (Districts to complete for each unit) <i>Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.</i> <i>Example:</i>	

- Students are self-directed learners, work independently, and communicate clearly by participating in a job interview.
- Students make judgments and decisions to recognize and demonstrate reflective listening skills and assertive communications skills and will be responsible to others and reason effectively to identify work habits.
- Students create media products and communicate clearly by producing a well-written cover letter, job application, and follow-up letter.

Industry Standards and/or Competencies:

Agriculture, Food, and Natural Resources (AFNR) Standards - Life Knowledge and Career Cluster Skills:

CS.01.03. Performance Indicator: Vision: Establish a clear image of what the future should look like.

CS.01.05. Performance Indicator: Awareness: Desire purposeful understanding related to professional and personal activities.

CS.02.03. Performance Indicator: Professional Growth: Develop awareness and apply skills necessary for achieving career success.

CS.03.01. Performance Indicator: Communication: Demonstrate oral, written and verbal skills.

Level II: CS.03.01.01.b. Select the appropriate form of technical and business writing or communication for a specific situation.

Level II: CS.03.01.02.b. Prepare a resume.

Level II: CS.03.01.03.b. Deliver a business presentation for a peer group (e.g., class presentation).

Aligned Washington State Academic Standards

Science	Washington Science Standards (Next Generation Science Standards): HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept