CASE

# Principles of Agricultural Science – Plant
# Expanded Lesson Review

The following is a compiled listing of the concepts, performance objectives, standards alignment, and essential questions by lesson.

## Lesson 1.1 A World Without Enough Plants

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Organization and record keeping are important to the success of a plant business. | • Develop and keep an Agriscience Notebook to record and store information presented in classroom discussions and activities throughout the course. (Activity 1.1.1) |
| 2. Many people work in a variety of agricultural enterprises to produce food, fiber, and fuel, which are essential to daily life. | • Research plant industries and related careers. (Activity 1.1.2) |
| 3. Plants are used to sustain human existence by providing many essential products, such as food, fiber, fuel, and medicine. | • Survey their personal dependency upon plants. (Activity 1.1.3) |
| 4. The many different types of plant industries provide career opportunities in plant production and management. | • Begin an ongoing course project researching physical attributes and growth requirements for several species of plants. (Project 1.1.4) |

### National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy and plant physiology to the production and management of plants. |

### Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS4: Biological Evolution: Unity and Diversity** | |
| **LS4.D: Biodiversity and Humans** | • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and |

| | |
|---|---|
| | enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. |
| **Earth and Space Science** | |
| **ESS3: Earth and Human Activity** | |
| **ESS3.A: Natural Resources** | • Resource availability has guided the development of human society. |

| **Science and Engineering Practices** | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. |
| **Obtaining, Evaluating, and Communicating Information** | Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.<br>• Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.<br>• Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. |

| **Crosscutting Concepts** | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. |
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. |

## Common Core State Standards for English Language Arts

| **CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10** | |
|---|---|
| **Integration of Knowledge and Ideas** | • **RST.9-10.9 –** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |

## Essential Questions

1. What are the benefits of keeping an Agriscience Notebook?
2. What is meant by the phrase “crop production”?
3. What represents or makes up a plant business?
4. What career opportunities are available in a plant business?
5. How do botany and horticulture differ?
6. How common are plants in everyday life?
7. How are plants important for human survival?
8. What is biofuel?
9. Why are certain crops grown in specific regions in the country?
10. Why could there be a shortage of plant related products to meet future global demands?
11. What are the issues facing crop production?

12. What different growth factors must be considered when raising healthy productive plants?

# Lesson 2.1 Understanding Soil Properties

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. The proportion of sand, silt, and clay in a soil determine the texture and influence soil use decisions. | • Conduct tests to determine soil texture by feel. (Activity 2.1.1) |
| 2. Soil permeability is influenced by the texture and structure of soil horizons. | • Illustrate soil structure and determine how structure influences soil permeability. (Activity 2.1.2)<br>• Test soil permeability to understand the relationship between soil particle size and rate of water filtration. (Activity 2.1.5) |
| 3. Organisms found in soils improve soil quality. | • Collect and identify macroscopic and microscopic organisms found in a soil sample. (Activity 2.1.3) |
| 4. Soil structure and texture influence water holding capacity, drainage, and erosion. | • Measure the water holding capacity of various test substances and compare data. (Activity 2.1.4) |
| 5. Organic matter affects the porosity and water holding capacity of soils. | • Conduct an experiment to explore the relationship between organic matter and water holding capacity of the soil. (Activity 2.1.5) |
| 6. Internal drainage, evidenced by color, mottling and permeability, affects soil management decisions. | • Describe soil hue, value, and chroma and assess soils for drainage-related characteristics based on color. (Activity 2.1.6) |
| 7. The structure and color of the soil profile determine the effective depth of a soil. | • Conduct an inquiry lab making predictions of soil characteristics using knowledge of the properties of the whole system. (Project 2.1.7) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS2: Ecosystems: Interactions, Energy, and Dynamics** | |
| **LS2.A: Interdependent Relationships in Ecosystems** | • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. |
| **Earth and Space Science** | |
| **ESS3: Earth and Human Activity** | |
| **ESS3.C: Human Impacts on Earth Systems** | • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. |

| Science and Engineering Practices | |
|---|---|
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. |
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.<br>• Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. |
| | • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence. |

| Crosscutting Concepts | |
|---|---|
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. |
| **Understandings about the Nature of Science** | |
| **Scientific Investigations Use a Variety of Methods** | • Science investigations use diverse methods and do not always use the same set of procedures to obtain data. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Making Inferences and Justifying Conclusions** | • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies. |
| **Using Probability to Make Decisions** | • *Use probability to evaluate outcomes of decisions. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.<br>• **WHST.9-10.2.E –** Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.<br>• **WHST.9-10.2.F –** Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). |
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research. |
| **Range of Writing** | • **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. |

## Essential Questions

1. What are the size comparisons among the three soil particles?
2. What do sand, silt, and clay each contribute to soil characteristics?
3. How are sand, silt, and clay detected in a soil sample?
4. How do soil microorganisms contribute to soil quality?
5. What constitutes a loam soil?
6. What is permeability as it pertains to soils and why is it important?
7. What soil substances influence the water-holding capacity of soil?
8. How is porosity critical for plant production?
9. What effects does soil texture have on porosity, permeability, and water holding capacity?
10. How do soil color and mottles indicated the water-related properties of a soil?
11. Why are different horizons visible in a soil profile?
12. Why do certain types of soil structure formations indicate soil quality?
13. What is the role of organic matter in soil?

# Lesson 2.2 Soil Chemistry

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Soil pH determines the availability of nutrients required for plant growth and health. | • Conduct a soil sample test to determine pH. (Activity 2.2.1) |
| 2. The optimal pH and salinity level required for plant growth varies among plant species and the levels are adjusted with the use of chemical treatments. | • Correct for acidic soil conditions using lime. (Activity 2.2.2) |
| 3. Soil salinity concentration determines how well plants uptake water, and as a result the ability of plants to absorb the available necessary nutrients. | • Determine the salinity of soil by measuring the electrical conductivity. (Activity 2.2.3) |
| 4. Testing of soil samples detect imbalances related to soil chemistry factors. | • Measure soil salinity to determine the effects of chemical fertilizers on soil salinity levels. (Activity 2.2.3) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Earth and Space Science** | |
| **ESS3: Earth and Human Activity** | |
| **ESS3.C: Human Impacts on Earth Systems** | • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. |
| **Physical Science** | |
| **PS1: Matter and Its Interactions** | |
| **PS1.B: Chemical Reactions** | • In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.<br>• Changes in systems may have various causes that may not have equal effects. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on two categorical and quantitative variables. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |

## Essential Questions

1. What does the pH scale represent?
2. How do plants grow in a basic soil versus a neutral soil?
3. How do different kinds of plants tolerate high levels of salinity?
4. How is plant nutrient availability affected by plant growth?
5. Why does salinity affect plant growth?
6. How can a soil with a low pH be corrected for optimal plant growing conditions?
7. How does fertilization affect soil?
8. How does the testing of soil aid in understanding soil chemistry?
9. Why is fertilization of the soil necessary?
10. How is soil chemistry related to plant nutrients?

# Lesson 3.1 Mixing Media

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Potting media has specific qualities suited for container crops, such as using lightweight and inexpensive materials that provide the essential components needed for drainage and porosity. | • Identify components commonly used in potting media. (Activity 3.1.1) |
| 2. There are a variety of ingredients used in potting soil that provide permeability, porosity, and fertility needed for container crops. | • Test different potting media ingredients to determine the permeability and porosity qualities of the media. (Activity 3.1.1)<br>• Determine the percentage of ingredients found in a potting soil mixture. (Activity 3.1.1) |
| 3. Media is sold in cubic feet or cubic yard increments and calculation of usage is an important skill for greenhouse and nursery production. | • Calculate the volume of various containers using mathematics. (Activity 3.1.2) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Earth and Space Science** | |
| **ESS3: Earth and Human Activity** | |
| **ESS3.A: Natural Resources** | • Resource availability has guided the development of human society. |
| **ESS3.C: Human Impacts on Earth Systems** | • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. |

| Science and Engineering Practices | |
|---|---|
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>• Apply techniques of algebra and functions to represent and solve scientific and engineering problems.<br>• Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.). |

| Crosscutting Concepts | |
|---|---|
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.<br>• The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Reasoning with Equations and Inequalities** | • Understand solving equations as a process of reasoning and explain the reasoning.<br>• Solve equations and inequalities in one variable.<br>• Solve systems of equations. |

| CCSS: Conceptual Category – Geometry | |
|---|---|
| **Geometric Measurement and Dimension** | • *Explain volume formulas and use them to solve problems. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.<br>• **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.<br>• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |

## Essential Questions

1. Why is potting media critical for plants?
2. How is the density of an object measured?
3. What is the difference between potting media and mineral soil?
4. Why does potting media consist of a variety of components?
5. What is the function of potting media ingredients, such as perlite and vermiculite?
6. Why is garden soil not a good choice for container-grown plants?
7. How are potting media quantities handled and calculated?
8. What choices exist for purchasing potting media?
9. How is volume calculated for a round pot?

# Lesson 3.2 Hydroponics

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Growing crops with a hydroponic method relies on using water with or without potting media instead of mineral soil to provide the necessary growth requirements. | • Examine and discuss hydroponic system components. (Activity 3.2.1)<br>• Design a hydroponic system incorporating the design principles of a specific type of system, such as nutrient flow, aggregate, water culture, or aeroponics. (Project 3.2.3) |
| 2. There are many considerations to examine when choosing between hydroponic production and traditional crop production, such as the spread of disease and increased equipment costs. | • List the advantages and disadvantages of hydroponics and traditional crop production systems. (Activity 3.2.2) |
| 3. Hydroponic crop production has advantages over traditional cropping systems, such as efficient use of space and resources. | • Compare the use of fertilizers, water, and media in hydroponic and traditional plant production systems. (Activity 3.2.2)<br>• Recognize the different types of hydroponic systems available. (Project 3.2.3) |

| | |
|---|---|
| 4. Careful management and monitoring of water quality in a hydroponic system are necessary to ensure plant health. | • Monitor hydroponic system water quality for electrical conductivity, pH, dissolved oxygen, and nutrient levels. (Project 3.2.3) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.09.** | Technical Skills: Compare and contrast issues affecting the AFNR industry. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS2: Ecosystems: Interactions, Energy, and Dynamics** | |
| **LS2.A: Interdependent Relationships in Ecosystems** | • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. |
| **ESS3: Earth and Human Activity** | |
| **ESS3.C: Human Impacts on Earth Systems** | • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.<br>• Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. |
| **Engineering, Technology, and the Application of Science** | |
| **ETS1: Engineering Design** | |
| **ETS1.A: Defining and Delimiting Engineering Problems** | • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. |
| **ETS1.B: Developing Possible Solutions** | • When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural, and environmental impacts. |
| **ETS1.C: Optimizing the Design Solution** | • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. |

| Science and Engineering Practices | |
|---|---|
| **Developing and Using Models** | Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).<br>• Design a test of a model to ascertain its reliability.<br>• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.<br>• Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. |
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.<br>• Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. |
| **Engaging in Argument from Evidence** | Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.<br>• Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence. |
| **Obtaining, Evaluating, and Communicating Information** | Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.<br>• Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). |

| Crosscutting Concepts | |
|---|---|
| **Systems and System Models** | A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. |
| | • Systems can be designed to do specific tasks.<br>• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. |
| **Energy and Matter: Flows, Cycles, and Conservation** | Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. |
| | • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.<br>• Energy drives the cycling of matter within and between systems. |
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. |
| **Stability and Change** | For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand. |
| | • Systems can be designed for greater or lesser stability. |

| Understandings about the Nature of Science | |
|---|---|
| **Scientific Investigations Use a Variety of Methods** | • Science investigations use diverse methods and do not always use the same set of procedures to obtain data. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |
| **Making Inferences and Justifying Conclusions** | • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.<br>• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.<br>• **RST.9-10.8 –** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.<br>• **RST.9-10.9 –** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |

## Essential Questions

1. How do hydroponic systems compare to traditional cropping practices?
2. What equipment is needed to raise plants using hydroponic methods?
3. What are the management issues with the production of plants using hydroponics?
4. How do the different types of hydroponic systems differ?
5. How do hydroponic systems lessen the impact on the environment and natural resources?
6. What role will hydroponics play in the future of sustainable crop production?
7. Why is water quality important for plant growth in hydroponic systems?
8. How is water quality monitored in a hydroponic system?

# Lesson 4.1 Cells: Life's Smallest Units

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. There are different classifications of cells based on their utility. | • Develop a pictorial representation of cell function. (Project 4.1.1) |
| 2. Plant cells are comprised of many parts that have essential functions for the survival of plant tissue, such as respiration. (dependent relationship among organelles) | • Identify and label plant cell organelles. (Project 4.1.1)<br>• Represent relationships between organelles using a graphic organizer. (Activity 4.1.3) |

| | |
|---|---|
| 3. Plant cells contain microscopic organelles specific to plant functions.<br><br>4. Cells use water, oxygen, and glucose to produce energy and metabolic by-products of carbon dioxide and water. | • Correctly prepare slides of plant cells for viewing under a microscope. (Activity 4.1.2)<br><br>• Collect and analyze data to provide evidence of cell metabolism. (Activity 4.1.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Systems of specialized cells within organisms help them perform the essential functions of life.<br>• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.<br>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. |
| **LS1.C: Organization for Matter and Energy Flow in Organisms** | • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.<br>• As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature.<br>• Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. |
| **Physical Science** | |
| **PS1: Matter and Its Interactions** | |
| **PS1.B: Chemical Reactions** | • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.<br>• The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. |

| Crosscutting Concepts | |
|---|---|
| **Systems and System Models** | A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. |
| | • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Seeing Structure in Expressions** | • *Interpret the structure of expressions.<br>• *Write expressions in equivalent forms to solve problems. |
| **Creating Equations** | • *Create equations that describe numbers or relationships. |
| **Reasoning with Equations and Inequalities** | • *Represent and solve equations and inequalities graphically. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Production and Distribution of Writing** | • **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. |

## Essential Questions

1. What is a cell?
2. How are cells classified?
3. What is the function of cell organelles and how do they work together?
4. How do cells perform plant functions?
5. How do plant cells convert raw nutrients into energy?
6. How are cellular respiration and cellular metabolism related?
7. Why is understanding cells important to understanding plants and plant systems?

# Lesson 4.2 The Radicle Root

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. The four major parts of a plant are the root, stem, leaves, and flower; and their functions are vital for plant health and growth. | • Describe the function of the major plant parts. (Activity 4.2.1) |
| 2. The root has specific anatomical features responsible for anchoring the plant in the soil. | • Examine a root structure and sketch representations of the structural form of a root. (Activity 4.2.2) |
| 3. Plant roots use differentiated cells that perform specific functions in the root, such as the absorption of water and dissolved nutrients. | • Examine cell differentiation as it relates to root cells. (Activity 4.2.3) |
| 4. Plants use the process of osmosis, influenced by turgidity of plant tissues, for the uptake of water and dissolved nutrients required for plant growth. | • Conduct an experiment to simulate the osmosis process of plant root hairs. (Activity 4.2.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Systems of specialized cells within organisms help them perform the essential functions of life.<br>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. |

## Essential Questions

1. How do the four major parts of a plant function together?
2. How does the root system of a plant contribute to plant health?
3. How do roots grow?
4. What differences exist between the three kinds of root systems?
5. How does a root absorb water and nutrients from the soil?
6. What part of the root absorbs water from the soil?
7. What are differentiated cells?
8. What are turgid cells and why are they important to plant life?
9. How is knowledge about root anatomy and physiology important in the management of plants?

# Lesson 4.3 Stems, Stalks, and Trunks

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Stems of plants provide physical support, storage of nutrients, and necessary pathways for translocation of materials throughout the plant. | • Identify differences between internal structures of monocotyledon and dicotyledon features. (Activity 4.3.1) |
| 2. The majority of plant growth takes place in meristematic tissue. | • Compare plant survival and recovery from damage to meristematic tissue. (Activity 4.3.2) |
| 3. Environmental conditions, such as temperature and precipitation are reflected in the growth rates of plants and evidence of those conditions can be found in woody stems. | • Create a poster depicting the lifespan of a tree referencing environmental conditions, historical events, and stages of growth. (Project 4.3.3) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |

| Science and Engineering Practices | |
|---|---|
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. |

| Crosscutting Concepts | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. |
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.<br>• Changes in systems may have various causes that may not have equal effects. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |
| **Making Inferences and Justifying Conclusions** | • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.1 –** Write arguments focused on discipline-specific content.<br>• **WHST.9-10.1.A –** Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research. |

## Essential Questions

1. What provides the structure for plant stems needed to support the weight of leaves, flowers, and fruit?
2. How do nutrients flow within a stem?
3. Why are the xylem and phloem critical for a plant?
4. How do monocotyledon and dicotyledon plants differ in terms of stem structure?
5. How do tree trunks compare to herbaceous stems?
6. How can stem growth be altered to produce desired characteristics for end use of plant material?
7. How does a severe climate change affect plant growth?
8. How does damage to meristematic tissue affect plant growth?

# Lesson 4.4 Leave It to Leaves

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. The understanding of leaf characteristics assists agricultural scientists in identifying species or varieties of plants. | • Create a journal that includes sketches and identification information for 20 different species of local plants. (Project 4.4.1)<br>• Identify the characteristics of simple and compound leaves. (Project 4.4.1) |
| 2. Leaves are comprised of several parts that have differences in physical characteristics, such as shape and venation patterns. | • Investigate the pigments and food storage systems found in plant leaves. (Activity 4.4.2) |
| 3. Leaf cells contain a specialized pigment known as chlorophyll that is used by the plant to harvest radiant energy from the sun. | • Explain why leaves are important to plants. (Activity 4.4.2) |
| 4. Leaves produce food in the form of sugars that fuel the metabolic functions of a plant. | • Explain the process plants use to produce and store food. (Activity 4.4.2) |

| | |
|---|---|
| 5. Leaves produce and store food. | • Compare stored sugar content of leaves. (Activity 4.4.2) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy and plant physiology to the production and management of plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Systems of specialized cells within organisms help them perform the essential functions of life.<br>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |

| Crosscutting Concepts | |
|---|---|
| **Energy and Matter: Flows, Cycles, and Conservation** | Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. |
| | • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.<br>• Energy drives the cycling of matter within and between systems. |
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. |

| Understandings about the Nature of Science | |
|---|---|
| **Scientific Investigations Use a Variety of Methods** | • Science investigations use diverse methods and do not always use the same set of procedures to obtain data.<br>• Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.<br>• **WHST.9-10.2.A –** Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |

## Essential Questions

1. How do plant leaves contribute to plant processes?
2. How are the parts of the leaf used to distinguish among different plant species?
3. Why is chlorophyll important to a plant?
4. What type of energy do plants harvest from the sun?
5. How do simple leaves and compound leaves differ?
6. Why is photosynthesis important to plant function?
7. How do plants use transpiration to regulate their environment?
8. What is a plant's fuel source?
9. Where does a plant store food reserves?

# Lesson 4.5 Flower Power

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. The parts of the flower are the mechanisms for pollination and fertilization and are used by a plant to complete sexual reproduction. | • Identify the parts of a flower and explain the function for each part. (Activity 4.5.1) |
| 2. Concept maps assist in structuring ideas or concepts and illustrating the various connections between those ideas. | • Develop a concept map to illustrate understanding of related ideas and nomenclature necessary to discuss the parts and functions of a flower. (Activity 4.5.2) |
| 3. Flowers are classified as either complete or incomplete based on the inclusion of either male or female parts, or both. | • Classify flowers using a dichotomous key and predict type of pollination for each flower. (Activity 4.5.3) |
| 4. Flowering structures are precursors for seeds, seed pods, and fruit structures. | • Use knowledge of flower structure to predict the type of seed structure based on a flowering structure. (Project 4.5.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Systems of specialized cells within organisms help them perform the essential functions of life.<br>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |
| **LS4: Biological Evolution: Unity and Diversity** | |
| **LS4.B: Natural Selection** | • The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. |
| **LS4.C: Adaptation** | • Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. |

| Science and Engineering Practices | |
|---|---|
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.<br>• Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. |
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.<br>• The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |

| | |
|---|---|
| | • **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

## Essential Questions

1. What role(s) do the parts of a flower serve in reproduction?
2. How do flowers differ in form and function?
3. What is the difference between a flower and inflorescence?
4. How are flowers organized?
5. How is monocot inflorescence different from dicot inflorescence?
6. What are the mechanisms required for pollination and fertilization?
7. What constitutes a perfect flower?
8. What is the difference between a complete or incomplete flower?
9. What is the true purpose of showy petals of a flower?
10. How does the type of flower determine the type of seed structure produced by the plant?
11. What value do flowers have for humans?
12. Why are flowers valuable in an ecosystem?

# Lesson 5.1 Sorting Out Plants

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Physiological categories are used to identify and select plants. | • Develop a flowchart to classify 20 different species of plants. (Activity 5.1.1) |
| 2. Plant parts are used as visual clues for differentiating between plant species often referred to as plant identification. | • Prepare for the plant identification portions of the Agronomy, Floriculture, Forestry, or Nursery/Landscape Career Development Events. (Activity 5.1.1) |
| 3. Classification is based on morphology that uses plant forms, such as parts, size, color, and usefulness to sort and group into classes with similar features. | • Determine different ways to group plants. (Activity 5.1.1) |
| 4. Plants and animals are categorized using a hierarchical system to group organisms by anatomical or physiological similarities. | • Research the taxonomic classification for a plant species. (Activity 5.1.2) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |

## Next Generation Science Standards Alignment

| Science and Engineering Practices | |
|---|---|
| **Developing and Using Models** | Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).<br>• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. |

| Crosscutting Concepts | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. |

| Understandings about the Nature of Science | |
|---|---|
| **Scientific Knowledge is Based on Empirical Evidence** | • Science disciplines share common rules of evidence used to evaluate explanations about natural systems. |
| **Science is a Way of Knowing** | • Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge. |
| **Science is a Human Endeavor** | • Scientific knowledge is a result of human endeavor, imagination, and creativity. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |
| **Craft and Structure** | • **RST.9-10.4 –** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.9 –** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

## Essential Questions

1. How do you identify plants?
2. What is morphology?
3. How do you classify plants?
4. How can the same plant be in multiple classification categories?
5. Why do scientists use Latin terminology for the scientific classification of plants?
6. What are the hierarchical levels for taxonomic classification?

7. What is the difference between a genus and a species designation?
8. What is taxonomy?

# Lesson 5.2 Plant Names

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Plants are classified and named based upon distinguishing characteristics, such as their physical features. | • Categorize plants by using leaf characteristics. (Activity 5.2.1)<br>• Identify plants by using physical features. (Activity 5.2.1) |
| 2. The scientific names for plants consist of Latin words representing descriptive features associated with the plant. | • Research the meaning of scientific names for 10 species of trees. (Activity 5.2.1) |
| 3. All plants are named using a binomial system, which is a two-word system for naming plants with the first word being the generic name and the second word being the specific name. | • Create a fictitious plant describing the physical features and apply the principles of binomial nomenclature to create a common and scientific name for the plant. (Project 5.2.2) |
| 4. Plant species are often subdivided into varieties and cultivars that will include additional names after the genus and species. | • Create a cultivar name for a fictitious plant. (Project 5.2.2) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |

| Science and Engineering Practices | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that arise from careful observation of phenomena, or unexpected results<br>▪ to clarify and/or seek additional information. |

| | |
|---|---|
| | ▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships.<br>▪ to determine relationships, including quantitative relationships, between independent and dependent variables.<br>▪ to clarify and refine a model, an explanation, or an engineering problem.<br>• Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. |
| **Engaging in Argument from Evidence** | Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.<br>• Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. |

| **Crosscutting Concepts** | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.<br>• Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. |

| **Understandings about the Nature of Science** | |
|---|---|
| **Science is a Way of Knowing** | • Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge.<br>• Science knowledge has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time. |

## Common Core State Standards for English Language Arts

| **CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10** | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.<br>• **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.<br>• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |
| **Craft and Structure** | • **RST.9-10.4 –** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

## Essential Questions

1. What is meant by the phrase “distinguishing characteristics”?
2. How is taxonomy used by scientists?
3. Why is binomial nomenclature used?
4. What is the process for naming plants using binomial nomenclature?
5. How do varieties and cultivars differ?
6. Why is Latin used as the language for naming plants?

7. How can you determine if the scientific name of a plant includes a variety name?
8. What is the problem with using the common names of plants?

# Lesson 6.1 Plant Food

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Plants obtain required nutrients from the soil provided the soil has the available nutrients. | • Use testing equipment to detect the levels of nitrogen, phosphorus, and potassium in soil samples. (Activity 6.1.1) |
| 2. Nutrient deficiencies are detected in plants by the examination of anatomical features and chemical test of tissues. | • Identify the effects of nutrient deficiencies in plants by observing anatomical differences. (Activity 6.1.2)<br>• Conduct plant tissue testing to determine the potential nutrients that are lacking in growing plants. (Activity 6.1.2) |
| 3. Nutrients can be added to the soil in various ways, such as chemical fertilizers, animal wastes, and organic matter. | • Use mathematical formulas to solve problems regarding fertilizer analyses, rates, and cost comparisons. (Activity 6.1.3) |
| 4. Plants require sixteen nutrients for optimal growth and development. | • Define soil nutrient relationships using Mulder's Chart. (Activity 6.1.4)<br>• Read a sample soil analysis and compare to crop nutrient removal rates. (Activity 6.1.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |

| | |
|---|---|
| **LS1.C: Organization for Matter and Energy Flow in Organisms** | • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. |
| **LS2: Ecosystems: Interactions, Energy, and Dynamics** | |
| **LS2.A: Interdependent Relationships in Ecosystems** | • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. |
| **Earth and Space Science** | |
| **ESS3: Earth and Human Activity** | |
| **ESS3.A: Natural Resources** | • Resource availability has guided the development of human society. |
| **ESS3.C: Human Impacts on Earth Systems** | • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.<br>• Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. |

| **Science and Engineering Practices** | |
|---|---|
| **Developing and Using Models** | Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).<br>• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. |
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>• Apply techniques of algebra and functions to represent and solve scientific and engineering problems.<br>• Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.). |

| **Crosscutting Concepts** | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. |
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.<br>• Systems can be designed to cause a desired effect. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| **CCSS: Conceptual Category – Number and Quantity** | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Seeing Structure in Expressions** | • *Interpret the structure of expressions.<br>• *Write expressions in equivalent forms to solve problems. |

| CCSS: Conceptual Category – Geometry | |
|---|---|
| **Geometric Measurement and Dimension** | • *Explain volume formulas and use them to solve problems.<br>• Visualize relationships between two-dimensional and three-dimensional objects. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Research to Build and Present Knowledge** | • **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. |

## Essential Questions

1. What do specific plant nutrients do for plant growth and health?
2. How do plants obtain nutrients?
3. How can soil be modified to provide more nutrients for the plant?
4. What nutrients are needed for plant growth?
5. How do nutrients interact with one another in the soil?
6. What would happen to a plant if it was exposed to too much of a certain type of nutrient?
7. How do you know when a plant does not have enough of a certain type of nutrient?
8. How do you know how much fertilizer to apply to the soil for a certain crop?
9. What are the differences among fertilizer sources?
10. How are mathematics used in fertilizer analysis, rates of application, and cost benefit analysis?

# Lesson 6.2 All Wet

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Different substances that plant containers are made from will affect the rate of water loss by evaporation in potted plants. | • Conduct an experiment to determine the rate of transpiration and evaporation for different plant growing containers. (Activity 6.2.1) |
| 2. Water is used by plants for the translocation of materials within the vascular systems of plants and used to complete the photosynthesis process. | • Collect evidence of water movement through a stem detecting transpiration pull. (Activity 6.2.2) |

| | |
|---|---|
| 3. Water is used to help cool the plant during periods of above optimal temperature conditions through the process of transpiration. | • Examine how the rate of water loss is altered by environmental conditions. (Activity 6.2.2) |
| 4. Water requirements and tolerances vary among plant species. | • Compare wilting points among various species. (Activity 6.2.3) |
| 5. The wilting point is a critical physiological stage that if exceeded can cause permanent damage to the health and physical appearance of plants. | • Monitor soil moisture to determine the wilting point of different plant species. (Activity 6.2.3) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **Earth and Space Science** | |
| **ESS2: Earth's Systems** | |
| **ESS2.C: The Roles of Water in Earth's Surface Processes** | • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. |

| Science and Engineering Practices | |
|---|---|
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>• Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. |
| **Energy and Matter: Flows, Cycles, and Conservation** | Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. |
| | • The total amount of energy and matter in closed systems is conserved.<br>• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Seeing Structure in Expressions** | • *Interpret the structure of expressions.<br>• *Write expressions in equivalent forms to solve problems. |
| **Reasoning with Equations and Inequalities** | • Understand solving equations as a process of reasoning and explain the reasoning.<br>• Solve equations and inequalities in one variable.<br>• Solve systems of equations. |

| CCSS: Conceptual Category – Functions | |
|---|---|
| **Linear, Quadratic, and Exponential Models** | • *Construct and compare linear, quadratic, and exponential models and solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.<br>• **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.<br>• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |

## Essential Questions

1. How does the substance a pot is made from influence water loss?
2. How do stomata influence a plant? What is transpiration and why do plants transpire?
3. How do transpiration, evaporation, and runoff differ?
4. What affects the rate of transpiration in plants?
5. How is transpiration related to temperature?
6. What is translocation?
7. How are the xylem and phloem involved in the process of translocation?
8. Why should the wilting of a plant be prevented?

9. How can too much water be harmful to the growing environment of a plant?
10. What determines the water requirements of plants?
11. How is soil moisture monitored to prevent plant wilting?

# Lesson 6.3 Lighting It Up

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Light is absorbed by chlorophyll and used by plants to convert carbon dioxide and water into glucose and oxygen through the process of photosynthesis. | • Collect evidence of the dependence of photosynthesis with light. (Activity 6.3.1) |
| 2. Growth of plants is altered by light intensity and poor light exposure can create undesirable physical characteristics. | • Conduct an investigation determining the effects of light intensity on plant growth. (Project 6.3.2) |
| 3. Photosynthetic rate is affected by environmental factors, such as light exposure, availability of carbon dioxide, and temperature. | • Manipulate environmental factors to test their effects on plants. (Project 6.3.2) |
| 4. The level of red and blue-violet light emitted in a spectrum determines the quality of a light source intended for plant use. | • Examine the relationship between the rate of photosynthesis and light spectrum quality. (Activity 6.3.3) |
| 5. Plants respond to the length of daily dark periods to trigger physiological processes, such as flowering. | • Calculate target dates for marketing flowering plants based on the length of time that plants are exposed to light. (Activity 6.3.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **LS1.C: Organization for Matter and Energy Flow in Organisms** | • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) |

| Science and Engineering Practices | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that arise from careful observation of phenomena, or unexpected results<br>▪ to clarify and/or seek additional information.<br>▪ to determine relationships, including quantitative relationships, between independent and dependent variables. |
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.<br>• Systems can be designed to cause a desired effect. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Reasoning with Equations and Inequalities** | • Understand solving equations as a process of reasoning and explain the reasoning.<br>• Solve equations and inequalities in one variable.<br>• Solve systems of equations.<br>• *Represent and solve equations and inequalities graphically. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |
| **Making Inferences and Justifying Conclusions** | • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. |

## Essential Questions

1. How does altering light intensity affect plants?
2. What happens if plant leaves are not exposed to light?
3. How does light exposure affect the rate of photosynthesis?
4. How can photosynthesis be measured?
5. Which artificial light sources are adequate for plant growth?
6. What is a light spectrum and how can knowledge of the spectrum be used for plant production?
7. How do colors of the light spectrum influence photosynthesis in plants?
8. Why do plants appear green?
9. Why is phototropism important to understand when raising plants?
10. How can plants be programmed to flower for seasonal markets?
11. Why is day length important for the physiology of plants?
12. How do plants react to the length of light or dark periods?

# Lesson 6.4 Chilly Lilies

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Plant maturity is determined by the accumulation of thermal units during a growing season. | • Calculate estimated plant maturity dates using growing degree-days to compare two geographical locations. (Activity 6.4.1) |
| 2. Temperature affects the metabolism rate of plants including transpiration, respiration, and photosynthesis. | • Calculate a growing schedule for a crop started on the same date, but have three different maturity target dates. (Project 6.4.2) |
| 3. Temperature is a principle determinant for plant dormancy of some seeds, bulbs, specialized roots, and species of perennial plants. | • Plant bulbs and schedule flowering for those bulbs to meet a holiday delivery date. (Project 6.4.3) |
| 4. Plants are classified as cool season or warm season plants based on their temperature requirements. | • Explore hardiness zones and assign plants to appropriate zones according to temperature requirements. (Activity 6.4.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.04.** | Systems: Examine roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. |

| | |
|---|---|
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| **AFNR: Plant Systems Career Pathway Content Standards** | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| **Disciplinary Core Ideas** | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **Physical Science** | |
| **PS3: Energy** | |
| **PS3.A: Definitions of Energy** | • Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. |
| **PS3.B: Conservation of Energy and Energy Transfer** | • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.<br>• The availability of energy limits what can occur in any system. |

| **Science and Engineering Practices** | |
|---|---|
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.<br>• Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>• Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. |

| | |
|---|---|
| | • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. |

| Crosscutting Concepts | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Mathematical representations are needed to identify some patterns. |
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Systems can be designed to cause a desired effect. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |
| **CCSS: Conceptual Category – Algebra** | |
| **Reasoning with Equations and Inequalities** | • Understand solving equations as a process of reasoning and explain the reasoning. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Making Inferences and Justifying Conclusions** | • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.<br>• **RST.9-10.8 –** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.<br>• **RST.9-10.9 –** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Research to Build and Present Knowledge** | • **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |

## Essential Questions

1. What is a cool season plant?
2. What constitutes a warm season plant designation?
3. Why do plants transpire?
4. How does temperature affect transpiration, respiration, and photosynthetic rates?
5. What are growing degree days and how are they calculated?
6. How are growing degree day units used to estimate plant maturity?
7. What is vernalization and why is it important for plant production?

8. How does temperature influence plant dormancy?
9. How are plant environments altered to provide optimal temperature for plant growth?

# Lesson 7.1 Plant Genetics

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Mitosis has five distinct phases necessary for cell division. | • Identify the different stages of mitosis in plant root cells. (Activity 7.1.1) |
| 2. Plant egg cells require meiosis and mitosis for development. | • Describe the steps of gamete cell production. (Activity 7.1.2) |
| 3. Fertilization, a necessary step for seed development, occurs when pollen unites with an egg cell. | • Illustrate the processes of meiosis and fertilization of an egg. (Activity 7.1.2) |
| 4. Dominant and recessive genes determine the phenotypic characteristics of plants. | • Perform computer simulations related to genetic heritance in order to learn about the role genetics play in plant production. (Activity 7.1.3) |
| 5. Hybrid, or crossbred, plants are an important source of agronomic commodities. | • Perform a simulation predicting offspring from a hybrid cross. (Activity 7.1.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |
| **LS3: Heredity: Inheritance and Variation of Traits** | |

| | |
|---|---|
| **LS3.A: Inheritance of Traits** | • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. |
| **LS3.B: Variation of Traits** | • In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. |

| **Science and Engineering Practices** | |
|---|---|
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. |
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. |

| **Crosscutting Concepts** | |
|---|---|
| **Patterns** | Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. |
| | • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. |
| **Systems and System Models** | A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. |
| | • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.<br>• Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. |

# Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| **CCSS: Conceptual Category – Number and Quantity** | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| **CCSS: Conceptual Category – Statistics and Probability** | |
|---|---|
| **Conditional Probability and the Rules of Probability** | • *Understand independence and conditional probability and use them to interpret data.<br>• *Use the rules of probability to compute probabilities of compound events in a uniform probability model. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems.<br>• *Use probability to evaluate outcomes of decisions. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.1 –** Write arguments focused on discipline-specific content.<br>• **WHST.9-10.1.B –** Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. |

## Essential Questions

1. How does a plant transfer pollen from the anthers to the stigma?
2. What are the steps involved in fertilization of plant embryos?
3. How is meiosis involved in plant reproduction?
4. How do meiosis and mitosis differ?
5. How can specific traits in plants be predicted in offspring?
6. What are dominant genetic traits and why are they important to understanding genetic probability?
7. What is the Punnett Square and how is it used in plant genetics?
8. What are the stages (phases) of mitosis?
9. What is crossbreeding or cross-pollination?
10. Why are hybrid plants valuable?

# Lesson 7.2 Pollination and Dispersion

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Flower pollination often requires natural agents, such as wind, water, insects, and vertebrates. | • Use clues given to identify the type of pollination agent in a variety of scenarios. (Activity 7.2.1) |
| 2. Plants use seeds to multiply species exponentially over time. | • Calculate the reproductive biotic potential of plants. (Activity 7.2.2) |
| 3. Identification and classification of plant species often relies on special structures that protect and support seeds. | • Develop a dichotomous key to classify seed-bearing structures. (Activity 7.2.3)<br>• Use the dichotomous key and observations of seed-bearing structures to determine the classification of structure. (Activity 7.2.3) |
| 4. Plants require methods of seed dispersal to ensure their survival in nature. | • Analyze articles related to issues involving seed dispersal to develop prescriptive plans to resolve the issue of seed dispersal. (Project 7.2.4)<br>• Illustrate the steps involved with seed dispersal and the relationship between plants and animals in this process. (Project 7.2.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.09.** | Technical Skills: Compare and contrast issues affecting the AFNR industry. |

| | |
|---|---|
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| **AFNR: Natural Resources Systems Career Pathway Content Standards** | |
|---|---|
| **NRS.01.** | Explain interrelationships between natural resources and humans necessary to conduct management activities in natural environments. |

| **AFNR: Plant Systems Career Pathway Content Standards** | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| **Disciplinary Core Ideas** | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **LS1.C: Organization for Matter and Energy Flow in Organisms** | • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature. |
| **LS2: Ecosystems: Interactions, Energy, and Dynamics** | |
| **LS2.A: Interdependent Relationships in Ecosystems** | • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. |
| **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** | • Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. |
| **LS3: Heredity: Inheritance and Variation of Traits** | |
| **LS3.B: Variation of Traits** | • Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. |
| **LS4: Biological Evolution: Unity and Diversity** | |
| **LS4.D: Biodiversity and Humans** | • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. |

| **Science and Engineering Practices** | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that arise from careful observation of phenomena, or unexpected results<br>▪ to clarify and/or seek additional information.<br>▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. |

| | |
|---|---|
| | ▪ to determine relationships, including quantitative relationships, between independent and dependent variables.<br>▪ to clarify and refine a model, an explanation, or an engineering problem. |
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. |

| **Crosscutting Concepts** | |
|---|---|
| **Energy and Matter: Flows, Cycles, and Conservation** | Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. |
| | • Energy drives the cycling of matter within and between systems. |
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| **CCSS: Conceptual Category – Number and Quantity** | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| **CCSS: Conceptual Category – Algebra** | |
|---|---|
| **Seeing Structure in Expressions** | • *Interpret the structure of expressions.<br>• *Write expressions in equivalent forms to solve problems. |

| **CCSS: Conceptual Category – Statistics and Probability** | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems.<br>• *Use probability to evaluate outcomes of decisions. |

## Common Core State Standards for English Language Arts

| **CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10** | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

| **CCSS: English Language Arts Standards » Writing » Grade 9-10** | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.1 –** Write arguments focused on discipline-specific content.<br>• **WHST.9-10.1.B –** Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. |
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |

## Essential Questions

1. How does pollination occur in nature?
2. How is biotic potential determined?
3. How does the use of mathematics aid in understanding the biotic potential of plants?
4. What is the purpose of fruit on a plant?
5. How are fruits identified or classified based on anatomical features?
6. Why do some plants produce more seeds than other plants?
7. Why is it important for plants to have a method to disperse seeds?
8. How does seed dispersal have an effect on plant and animal interactions?

# Lesson 7.3 Kernels of Life

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. The germinating seed has visible anatomical parts and structures from embryo to seedling stages that are used to identify the plant as either a monocotyledon or a dicotyledon. | • Identify the structures of seeds and plant embryos. (Activity 7.3.1)<br>• Distinguish between monocotyledon and dicotyledon seedlings using anatomical features. (Activity 7.3.1) |
| 2. Plant seeds convert starch into glucose by the use of enzymes during the germination process. | • Provide evidence in the form of data related to starch conversion to sugar during a seed germination experiment. (Activity 7.3.2) |
| 3. Germination rate in seeds is largely determined by the proper balance of environmental conditions, such as temperature, oxygen, and water. | • Design and conduct an experiment to show evidence of the effects for different variations of treatments required for seed germination. (Project 7.3.3)<br>• Make a presentation to the class regarding research procedures and findings. (Project 7.3.3) |
| 4. Not all seeds are viable and therefore do not have the potential to germinate. | • Conduct an experiment to test for seed viability. (Activity 7.3.4) |
| 5. Dormancy is a strategy plants utilize to ensure some offspring will germinate at optimal times and plants rely on special treatments, such as light, cold temperatures, and scarification to break seed dormancy. | • Perform scarification to treat seeds for seed coat dormancy. (Activity 7.3.5) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.04.** | Systems: Examine roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. |
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |

| | |
|---|---|
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| **AFNR: Plant Systems Career Pathway Content Standards** | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| **Disciplinary Core Ideas** | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Systems of specialized cells within organisms help them perform the essential functions of life.<br>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.<br>• Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |
| **LS1.C: Organization for Matter and Energy Flow in Organisms** | • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature. Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. |
| **LS2: Ecosystems: Interactions, Energy, and Dynamics** | |
| **LS2.A: Interdependent Relationships in Ecosystems** | • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. |
| **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** | • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. |

| **LS4: Biological Evolution: Unity and Diversity** | |
|---|---|
| **LS4.C: Adaptation** | • Natural selection leads to adaptation, which is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. |
| **Physical Science** | |
| **PS1: Matter and Its Interactions** | |
| **PS1.B: Chemical Reactions** | • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. |

| Science and Engineering Practices | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that arise from careful observation of phenomena, or unexpected results<br>▪ to clarify and/or seek additional information.<br>▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships.<br>▪ to determine relationships, including quantitative relationships, between independent and dependent variables.<br>▪ to clarify and refine a model, an explanation, or an engineering problem.<br>• Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. |
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.<br>• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>• Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Systems can be designed to cause a desired effect. |
| **Scale, Proportion, and Quantity** | In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change. |
| | • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). |
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Reasoning with Equations and Inequalities** | • *Represent and solve equations and inequalities graphically. |

| CCSS: Conceptual Category – Functions | |
|---|---|
| **Linear, Quadratic, and Exponential Models** | • *Construct and compare linear, quadratic, and exponential models and solve problems. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Making Inferences and Justifying Conclusions** | • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.<br>• **RST.9-10.9 –** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.1 –** Write arguments focused on discipline-specific content.<br>• **WHST.9-10.1.A –** Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. |
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |

## Essential Questions

1. How does a seed germinate?
2. What environmental conditions are required for seeds to germinate?
3. How do we determine the germination rate for seeds?
4. What is the function of water in seed germination?
5. How does temperature influence seed germination?
6. Why do plant seeds require oxygen?
7. What specific anatomical features are used to distinguish a monocotyledon from a dicotyledon in plant seedlings?
8. What are the stages of seedling development?
9. How do plant seedlings have enough energy to go from seed to seedling without generating food by photosynthesis?
10. What physiological factors cause a seed not to be viable?
11. How does a plant use enzymes during the germination process?
12. What purpose does dormancy serve for plant seeds?

# Lesson 7.4 Plant Multiplication

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Some plant hybrids will produce seeds with genetic characteristics that are inconsistent with the parent plant genotype; therefore, asexual propagation methods are required for reproducing the desired traits. | • Demonstrate how to perform common asexual propagation methods, such as grafting, budding, layering, division, and cuttings properly. (Activities 7.4.1, 7.4.2, 7.4.3, 7.4.4, and 7.4.5) |
| 2. Using asexual propagation methods, such as grafting, division, budding, layering, or cuttings are efficient ways to produce new plants exhibiting desired characteristics of a parent plant. | • Compare and contrast different asexual propagation methods. (Activities 7.4.1, 7.4.2, 7.4.3, 7.4.4, and 7.4.5) |
| 3. Safe tool and equipment use is required to perform asexual propagation on plants to avoid personal injury. | • Identify hazards and safe practices for the plant laboratory. (Activities 7.4.1, 7.4.2, 7.4.3, 7.4.4, and 7.4.5) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.07.** | Safety, Health, and Environmental: Demonstrate appropriate health and safety procedures for AFNR occupations. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Systems of specialized cells within organisms help them perform the essential functions of life.<br>• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.<br>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.<br>• Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **LS1.B: Growth and Development of Organisms** | • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. |
| **LS3: Heredity: Inheritance and Variation of Traits** | |
| **LS3.A: Inheritance of Traits** | • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the |

| | |
|---|---|
| | genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. |
| **LS4: Biological Evolution: Unity and Diversity** | |
| **LS4.A: Evidence of Common Ancestry and Diversity** | • Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. |

| **Science and Engineering Practices** | |
|---|---|
| **Obtaining, Evaluating, and Communicating Information** | Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.<br>• Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.<br>• Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). |

## Common Core State Standards for English Language Arts

| **CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10** | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.<br>• **RST.9-10.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

| **CCSS: English Language Arts Standards » Writing » Grade 9-10** | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.<br>• **WHST.9-10.2.D –** Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.<br>• **WHST.9-10.2.F –** Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). |
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |

## Essential Questions

1. How does asexual propagation work?
2. Why do producers often prefer asexual propagation methods over sexual reproduction?
3. How does knowledge of plant growth help a person understand asexual propagation?
4. What are the advantages of one method of asexual propagation versus another?
5. How does a producer decide which method of asexual propagation to use for a specific plant?
6. Which attributes in plants determine the most suitable method of asexual propagation?
7. How does asexual propagation compare to sexual reproduction from a plant producer standpoint?

8. What efficiencies are gained by using asexual propagation versus sexual reproduction?
9. What safety precautions must be observed when using tools and equipment during asexual propagation work?
10. How do plant growth hormones and nutrient interactions affect asexual propagation?
11. How is asexual propagation used on the commercial scale for plant production?

# Lesson 8.1 Pesky Bugs and Plants

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Pests have negative effects on plant growth, such as yield and quality. | • Research and share symptoms and damage caused by pests. (Project 8.1.1) |
| 2. Plant pests include several organisms including insects, mollusks, nematodes, vertebrates, and weeds. | • Identify anatomical features of pests that help determine what types of pests are responsible for crop predation. (Project 8.1.1) |
| 3. Proper detection of symptoms can determine plant pest threats. | • Identify specific symptoms of damage caused by pests. (Problem 8.1.2) |
| 4. Biological, chemical, and mechanical methods as well as cultural practices are options for eradication or deterring pests. | • Compare and contrast pest eradication and pest control methods. (Problem 8.1.2) |
| 5. An Integrated Pest Management plan assures that the management of pests is economically and environmentally sound. | • Create an Integrated Pest Management plan and discuss ways to implement such a plan. (Problem 8.1.2)<br>• Determine pest populations based upon using a statistical estimation method. (Activity 8.1.3) |
| 6. Life cycles of plant pests must be considered prior to employing proper control measures. | • Create a pictorial model of the life cycle of pests. (Activity 8.1.4) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.06.** | Examine the importance of health, safety, and environmental management systems in organizations and their importance to performance and regulatory compliance. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.09.** | Technical Skills: Compare and contrast issues affecting the AFNR industry. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

# Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **LS4: Biological Evolution: Unity and Diversity** | |
| **LS4.D: Biodiversity and Humans** | • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. |

| Science and Engineering Practices | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that arise from careful observation of phenomena, or unexpected results<br>▪ to clarify and/or seek additional information.<br>▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships.<br>▪ to determine relationships, including quantitative relationships, between independent and dependent variables.<br>▪ to clarify and refine a model, an explanation, or an engineering problem. |
| **Analyzing and Interpreting Data** | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.<br>• Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in 9-12 builds on K-8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>• Apply techniques of algebra and functions to represent and solve scientific and engineering problems.<br>• Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.). |
| **Engaging in Argument from Evidence** | Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.<br>• Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.<br>• Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. |
| **Obtaining, Evaluating, and Communicating Information** | Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.<br>• Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.<br>• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.<br>• Systems can be designed to cause a desired effect.<br>• Changes in systems may have various causes that may not have equal effects. |
| **Stability and Change** | For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand. |
| | • Much of science deals with constructing explanations of how things change and how they remain stable.<br>• Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.<br>• Feedback (negative or positive) can stabilize or destabilize a system.<br>• Systems can be designed for greater or lesser stability. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **Quantities** | • *Reason quantitatively and use units to solve problems. |

| CCSS: Conceptual Category – Algebra | |
|---|---|
| **Seeing Structure in Expressions** | • *Write expressions in equivalent forms to solve problems. |
| **Reasoning with Equations and Inequalities** | • Understand solving equations as a process of reasoning and explain the reasoning.<br>• Solve equations and inequalities in one variable. |

| CCSS: Conceptual Category – Geometry | |
|---|---|
| **Circles** | • Understand and apply theorems about circles.<br>• Find arc lengths and areas of sectors of circles. |

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.<br>• **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when |

appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research.

## Essential Questions

1. What is a pest?
2. What types of pests exist?
3. How are plant pests managed?
4. How does Integrated Pest Management impact the agriculture industry?
5. Why is observation critical to detection of pests?
6. How can pest management affect the natural environment?
7. What are the considerations for a producer when choosing the best method(s) of pest control?
8. Why is knowledge about the lifecycle of a pest helpful in controlling a pest?
9. How does the type of pest influence the type of plant damage?
10. How do various pest control methods and practices compare?
11. How is the pest population determined for a large area?
12. Why is the use of sampling crucial in controlling plant pests?

# Lesson 8.2 Diving into Diseases

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Plant disease-causing agents, such as bacteria, fungi, and viruses cause detrimental health effects on plants. | • Read articles related to common plant diseases and summarize the similarities and the differences among disease-causing agents. (Project 8.2.1) |
| 2. Plant diseases cause visible symptoms in plant growth, such as defoliation, abscesses, growths, and decaying of plant tissue. | • Develop an understanding of plant disease, causes, and means of prevention and control. (Project 8.2.1) |
| 3. Knowledge of disease prevention and treatment is important to protect plants from infection. | • Develop a plant disease management plan. (Project 8.2.1) |
| 4. Plant disease-causing agents are microscopic and damage plants in various ways. | • Compare the size of bacteria and viruses with other common objects to gain perspective of scale. (Activity 8.2.2)<br>• Investigate bacteria cells under a microscope. (Activity 8.2.2) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.04.** | Systems: Examine roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. |
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |
| **CS.06.** | Examine the importance of health, safety, and environmental management systems in organizations and their importance to performance and regulatory compliance. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **AFNR: Plant Systems Career Pathway Content Standards** | |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Life Science** | |
| **LS1: From Molecules to Organisms: Structures and Processes** | |
| **LS1.A: Structure and Function** | • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. |
| **LS4: Biological Evolution: Unity and Diversity** | |
| **LS4.C: Adaptation** | • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. |

| Science and Engineering Practices | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. |
| **Obtaining, Evaluating, and Communicating Information** | Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.<br>• Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.<br>• Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). |

| Crosscutting Concepts | |
|---|---|
| **Cause and Effect: Mechanism and Prediction** | Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. |
| | • Systems can be designed to cause a desired effect.<br>• Changes in systems may have various causes that may not have equal effects. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Number and Quantity | |
|---|---|
| **The Real Number System** | • Extend the properties of exponents to rational exponents. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-10.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Production and Distribution of Writing** | • **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |

## Essential Questions

1. What types of damage are the results of plant diseases?
2. How does disease treatment differ from disease prevention?
3. Why are plant diseases a formidable foe to agricultural producers?
4. What are the methods of disease reproduction and infection of plant tissue?
5. How do weather and climate affect plant diseases?
6. How do you identify plant diseases?
7. How do diseases differ from other plant pests?
8. What are the two types of disease control?
9. What is the difference between an infection and an outbreak?
10. How do disease-causing agents differ?

# Lesson 9.1 Tools of Plant Production

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand* | *Students will learn concepts by doing* |
| 1. Specialized equipment is required for soil tillage and the planting, harvesting, and transporting of agronomic crops. | • Research machinery and equipment used to produce plants and create a study guide. (Activity 9.1.1)<br>• Categorize machinery used to produce plants according to use. (Activity 9.1.1) |
| 2. The growing environment for plants may be altered by structures, such as greenhouses, to provide optimal temperature requirements. | • Conduct an experiment to determine the effects of greenhouse coverings on temperature. (Activity 9.1.2) |
| 3. Methods of irrigation vary and each method has advantages and disadvantages related to the impact on the environment. | • Research irrigation methods and compare each method to understand function and purpose. (Activity 9.1.3) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.06.** | Examine the importance of health, safety, and environmental management systems in organizations and their importance to performance and regulatory compliance. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |
| **PS.03.** | Propagate, culture, and harvest plants. |

## Next Generation Science Standards Alignment

| Science and Engineering Practices | |
|---|---|
| **Planning and Carrying Out Investigations** | Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. |

| Crosscutting Concepts | |
|---|---|
| **Systems and System Models** | A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. |
| | • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. |
| **Structure and Function** | The way an object is shaped or structured determines many of its properties and functions. |
| | • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Interpreting Categorical and Quantitative Data** | • *Summarize, represent, and interpret data on a single count or measurement variable. |
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-9.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.<br>• **RST.9-10.2 –** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. |
| **Range of Reading and Level of Text Complexity** | • **RST.9-9.10 –** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.<br>• **WHST.9-10.2.A –** Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.<br>• **WHST.9-10.2.F –** Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). |
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. |

## Essential Questions

1. What kinds of equipment and machinery are needed for raising plants?
2. How does tillage impact plant growth?
3. How does the type of crop influence harvest methods used?
4. How do greenhouses maintain warmer temperatures than outside air?
5. What equipment does a greenhouse need to maintain optimal plant growth?
6. How do irrigation methods compare?
7. What role does irrigation play in producing more food?

# Lesson 9.2 Planting Seeds of Fortune

| Concepts | Performance Objectives |
|---|---|
| *Students will know and understand*<br>1. Agronomy, floriculture, forestry, and nursery and landscape are the four major classifications of plant-based industries. | *Students will learn concepts by doing*<br>• Create a slide show of different plant industries. (Project 9.2.1) |

| | |
|---|---|
| 2. Product, placement, price, and promotion are the four keys to marketing products.<br><br>3. There are many products produced within plant-based industries and all require careful planning to ensure the marketability of the product.<br><br>4. Basic steps, such as analyze the situation, decide on your objective, develop a plan, and measure the results are key components of a business plan. | • Develop a presentation illustrating the four P's of marketing for each of the plant-based industries. (Project 9.2.1)<br><br>• Select crop(s) for a specific situation based on land analysis, local markets, and budget potential. (Problem 9.2.2)<br><br>• Develop a business proposal to utilize 20 acres to raise plants. (Problem 9.2.2) |

## National AFNR Career Cluster Content Standards Alignment

| AFNR: LifeKnowledge® and Cluster Skills Content Standards | |
|---|---|
| **CS.01.** | Premier Leadership: Acquire the skills necessary to positively influence others. |
| **CS.02.** | Personal Growth: Develop a skill set to enhance the positive evolution of the whole person. |
| **CS.03.** | Career Success: Demonstrate those qualities, attributes, and skills necessary to succeed in, or further prepare for, a chosen career while effectively contributing to society. |
| **CS.04.** | Systems: Examine roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. |
| **CS.05.** | Systems: Identify how key organizational structures and processes affect organizational performance and the quality of products and services. |
| **CS.08.** | Technical Skills: Use tools, equipment, machinery, and technology appropriate to work within areas related to AFNR. |
| **CS.09.** | Technical Skills: Compare and contrast issues affecting the AFNR industry. |
| **CS.10.** | Technical Skills: Envision emerging technology and globalization to project its influence on widespread markets. |
| **CS.11.** | Scientific Inquiry: Utilize scientific inquiry as an investigative method. |

| AFNR: Agribusiness Systems Career Pathway Content Standards | |
|---|---|
| **ABS.01.** | Utilize economic principles to establish and manage an AFNR enterprise. |
| **ABS.02.** | Utilize appropriate management planning principles in AFNR business enterprises. |
| **ABS.07.** | Create a production system plan. |

| AFNR: Plant Systems Career Pathway Content Standards | |
|---|---|
| **PS.01.** | Apply knowledge of plant classification, plant anatomy, and plant physiology to the production and management of plants. |
| **PS.02.** | Prepare and implement a plant management plan that addresses the influence of environmental factors, nutrients, and soil on plant growth. |
| **PS.04.** | Employ elements of design to enhance an environment. |

## Next Generation Science Standards Alignment

| Disciplinary Core Ideas | |
|---|---|
| **Engineering, Technology, and the Application of Science** | |
| **ETS1: Engineering Design** | |
| **ETS1.A: Defining and Delimiting Engineering Problems** | • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. |
| **ETS1.B: Developing Possible Solutions** | • When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural and environmental impacts. |

| Science and Engineering Practices | |
|---|---|
| **Asking Questions and Defining Problems** | Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>• Ask questions that arise from careful observation of phenomena, or unexpected results<br>▪ to clarify and/or seek additional information.<br>▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships.<br>▪ to determine relationships, including quantitative relationships, between independent and dependent variables.<br>▪ to clarify and refine a model, an explanation, or an engineering problem.<br>• Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations. |
| **Constructing Explanations and Designing Solutions** | Constructing explanations and designing solutions in 9–12 builds on K– 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>• Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. |

## Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

| CCSS: Conceptual Category – Statistics and Probability | |
|---|---|
| **Using Probability to Make Decisions** | • *Calculate expected values and use them to solve problems.<br>• *Use probability to evaluate outcomes of decisions. |

## Common Core State Standards for English Language Arts

| CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 9-10 | |
|---|---|
| **Key Ideas and Details** | • **RST.9-10.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |
| **Integration of Knowledge and Ideas** | • **RST.9-10.7 –** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |

| CCSS: English Language Arts Standards » Writing » Grade 9-10 | |
|---|---|
| **Text Types and Purposes** | **WHST.9-10.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.<br>• **WHST.9-10.2.A –** Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.<br>• **WHST.9-10.2.B –** Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. |

| | |
|---|---|
| | • **WHST.9-10.2.D –** Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.<br>• **WHST.9-10.2.E –** Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.<br>• **WHST.9-10.2.F –** Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). |
| **Production and Distribution of Writing** | • **WHST.9-10.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.<br>• **WHST.9-10.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. |
| **Research to Build and Present Knowledge** | • **WHST.9-10.7 –** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.<br>• **WHST.9-10.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.<br>• **WHST.9-10.9 –** Draw evidence from informational texts to support analysis, reflection, and research. |
| **Range of Writing** | • **WHST.9-10.10 –** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. |

## Essential Questions

1. What are the four plant-based industries?
2. How are plants used differently by the four plant industries?
3. How are plants used in everyday life?
4. What are the four aspects of marketing?
5. What are the steps in developing a business management plan?
6. What are the components of a business proposal?
7. How are plant businesses organized?