



Park Hill School District

Building Successful Futures • Each Student • Every Day

High School Science of Natural Resources Curriculum

Course Description: Applied Science of Natural Resources is a laboratory-based science course that integrates chemistry, biology, earth science, physical science and engineering to explore how natural and human systems interact. Students investigate the flow of energy and matter through Earth's systems, the factors that shape climate and biodiversity, and the impacts of human activity on environmental stability. Through hands-on labs, modeling, and design challenges, students apply scientific and engineering practices to real-world issues such as food systems, resource management, and sustainability. The course culminates with a student-designed project in which learners identify a problem, develop and test a solution, and communicate their findings using evidence and data.

Course Standards: Missouri DESE Science Standards

Scope and Sequence:

Timeframe	Unit	Instructional Topics
2 weeks	Chemistry of Food	The Role of Macromolecules Energy Transformations in Chemical Reactions Carbon Cycling. Solution Trade-Offs and Impacts - Food Quality and Availability
2 weeks	Physical & Chemical Environment	Geographical Influences on Climate Flow of Energy in Earth's Systems Water Property Influence on Climate Factors Developing and Limiting Biomes
3 weeks	Biodiversity	Primary Productivity

		Factors of Biodiversity Ecosystem Stability and Dynamics Species Stability in Ecosystems
2 weeks	Biotechnology & Engineering	Energy Transformations Real-World Dynamics and Impacts - Resource Availability Engineering Solutions - Resource Availability Influencing Genetic Diversity with Biotechnology
3 weeks	Human Activity	Management of Natural Resources Reducing Human Impact on Biodiversity Solution Trade-Offs and Impacts - Urban Planning Factors of Carrying Capacity
3 weeks	Sustainability Design	Global Agricultural Challenges Engineering Agricultural Solutions Solution Trade-Offs and Impacts - Agricultural Issues Herbicides, Pesticides, and Fertilizers
3 weeks throughout course	Culminating Student Design Project	Student-choice

Curriculum Revision Tracking

Fall 2025

- Curriculum Written

Unit 1: Chemistry of Food

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Unit: Chemistry of Food

Length of Unit: 2 weeks

Overview of Unit: In this unit, students will explore how matter and energy move through living systems and the environment. They will investigate the structure of organic macromolecules, including the elements that make them up and how they form large carbon-based molecules. Students will develop models to understand how energy is absorbed or released in chemical reactions and how thermal energy distributes in a system. They will examine the cycling of carbon through photosynthesis, cellular respiration, decomposition, and combustion across the biosphere, atmosphere, hydrosphere, and geosphere. Using evidence and data, students will evaluate real-world solutions to environmental challenges, considering trade-offs such as cost, safety, reliability, aesthetics, and social or environmental impacts. They will also design and revise models to understand energy flow, matter cycling, and ways to mitigate the effects of human activity on biodiversity.

Priority Standards for unit:

- LS1. C.3 - Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine nitrogen, sulfur, and phosphorus to form large carbon-based molecules.
- PS1. A.5 - Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
- LS2. B.3 - Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
- ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Supporting Standards for unit:

- PS3. B.1 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- LS2. B.2 - Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- LS4. C.3 - Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity.

Essential Questions

1. How do the elements that make up organic macromolecules determine their structure and function in living systems?
2. How is energy stored, released, and transformed during chemical reactions and biological processes?
3. How does carbon move through Earth's systems, and why is this cycle essential to life?
4. How can models and evidence help us evaluate solutions to environmental and food-system challenges?
5. What trade-offs must be considered when designing sustainable solutions that meet human needs while protecting ecosystems?

Enduring Understandings

1. **Structure Determines Function:** The composition and arrangement of atoms in macromolecules determine their chemical behavior and biological roles.
2. **Energy Drives Systems:** Chemical reactions and biological processes rely on energy transformations that sustain life and influence environmental systems.
3. **Interconnected Cycles:** Carbon and other elements cycle continuously through living and nonliving systems, maintaining balance within Earth's biosphere.
4. **Modeling and Evidence:** Scientific models and data analysis allow us to understand energy flow, matter cycling, and to evaluate the impacts of human activity on natural systems.
5. **Sustainability and Trade-Offs:** Addressing food and environmental challenges requires balancing efficiency, equity, and ecological health through informed, evidence-based decisions.

Unit Vocabulary:

- Micronutrients
- Macronutrients
- Nutrition Label
- Carbohydrates
- Proteins
- Lipids
- Saturated Fats
- Unsaturated Fats
- Enzymes
- Preservatives
- pH scale
- Organic Food Production
- Pesticides
- Herbicides
- Insecticides
- Food Additives
- Calorie
- Carbon cycle
- Digestion

Priority Standard: LS1.C.3 - Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the macronutrients (i.e. carbohydrates, lipids, and proteins) that serve as a biological source of energy.	1
	Understanding

Priority Standard: PS1.A.5 - Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how breaking and forming chemical bonds in food molecules leads to energy release or storage.	2
	Analyzing
Students will describe how calories on a nutrition label represent stored chemical energy in food molecules.	1
	Understanding

Priority Standard: LS2.B.3 - Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will develop a scenario (real-world case study, infographic, or written analysis) that predicts how changes in one process (e.g., increased combustion) impact the entire carbon cycle.	4
	Creating
Students will design a model (diagram, simulation, or physical representation) showing the pathways of carbon through Earth's spheres (e.g. hydro-, geo-, atmosphere).	3
	Analyzing
Students will identify the flow of carbon atoms through photosynthesis, cellular respiration, decomposition, and combustion in a model.	2
	Applying

Priority Standard: ETS1.B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will make a claim that compares competing design solutions about food quality and availability.	3
	Analyze
Students will evaluate competing design solutions about food quality and availability based on empirical evidence and scientific reasoning or analysis.	3
	Evaluate

Engaging Scenario

Engaging Scenario Students will create a poster (physical or digital) that illustrates the farm (productivity) to table (consumption) food chain for four ingredients of a meal of their choice.

Rubric for Engaging Scenario:

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
Food Chain Content	Accurately and clearly explains the complete farm-to-table process (production, processing, distribution, consumption, and waste) for all four ingredients; shows deep understanding of agricultural productivity and food systems.	Explains the farm-to-table process for all four ingredients with mostly accurate details; demonstrates understanding of food systems.	Explains the process for some ingredients, but details are incomplete, vague, or partly inaccurate; limited understanding shown.	Provides minimal or inaccurate explanation; fewer than four ingredients are represented.
Connections and Analysis	Demonstrates strong connections between productivity (farm stage) and consumption (table stage), with clear explanations of how each stage impacts the final food product.	Makes connections between production and consumption for each ingredient, though some explanations lack depth.	Makes limited or general connections between production and consumption; may not address each ingredient fully.	Few or no connections between production and consumption are made.
Visual Presentation	Poster is highly organized, visually engaging, and easy to follow; images, graphics, or symbols are accurate, creative, and enhance understanding.	Poster is organized and clear; visuals are relevant and support understanding.	Poster is somewhat organized; visuals are basic, limited, or not clearly connected to the content.	Poster lacks organization; visuals are missing, confusing, or irrelevant.

Accuracy and Use of Terminology	All terminology (e.g., productivity, distribution, consumption, sustainability) is accurate and used appropriately; explanations are scientifically sound.	Most terminology is accurate and used appropriately; explanations are mostly sound.	Some terminology is inaccurate or missing; explanations are vague or contain errors.	Little to no use of correct terminology; explanations are inaccurate or missing.
Creativity and Effort	Poster reflects exceptional effort and creativity; demonstrates originality in design and presentation.	Poster reflects solid effort and some creativity.	Poster reflects minimal effort and limited creativity.	Poster shows little effort; rushed or incomplete.

Topic 1: The Role of Macromolecules

Engaging Experience 1

Title: Macromolecules in Dairy

Suggested Length of Time: 120 minutes

Standards Addressed

Priority: LS1.C.3 - Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.

Detailed Description/Instructions: Students will compare the relative amounts of protein, lipids, sugar, and starch in different samples of milk (whole milk, skim milk, 2% milk, heavy cream, and half and half). Detailed lesson plans can be found at the following link:

<https://nourishthefuture.org/curriculum/animal-science/hs#macromolecules-dairy>

Bloom's Levels: Understand

Webb's DOK: 1

Topic 2: Energy Transformations in Chemical Reactions

Engaging Experience 1

Title: Counting Calories

Suggested Length of Time: 90 minutes

Standards Addressed

Priority: PS1.A.5 - Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Detailed Description/Instructions: Students will explore how much energy is contained in a single peanut by burning it and using the heat released to warm a measured amount of water. This demonstrates how food energy (Calories) can be measured and how it relates to chemical energy in food. Detailed lesson plans can be found at the following link:

<http://www.exo.net/~pauld/activities/food/burnapeanut.html>

Due to peanut allergies, modify the food item being used.

Bloom's Levels: Analyze

Webb's DOK: 2

Topic 3: Carbon Cycling

Engaging Experience 1

Title: The Carbon Cycle Game

Suggested Length of Time: 2 days

Standards Addressed

Priority: LS2.B.3 - Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Detailed Description/Instructions: Students will describe the movement of carbon within the carbon cycle and evaluate the relative timing of movement through various locations in the carbon cycle. Detailed lesson plans can be found at the following link: [The Carbon Cycle Game](#)

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 4: Solution Trade-Offs and Impacts - Food Quality and Availability

Engaging Experience 1

Title: Human Footprint: Shelf Life (Episode 1, Season 2)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority: ETS1.B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Detailed Description/Instructions: Students will explore how the supermarket food system shapes the environment, society, and culture, gaining insight into the impacts of food production, global supply chains, and consumer choices on sustainability and human well-being.

Bloom's Levels: Evaluate

Webb's DOK: 3

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
	Macromolecules in Dairy	Students test a variety of dairy and non-dairy products for the presence of carbohydrates, proteins, and lipids using chemical indicators. They analyze results to connect molecular composition with nutritional function and food energy content.	120 minutes
	Counting Calories	Students investigate the energy content of different foods by constructing simple calorimeters and measuring the temperature change caused by combustion. They calculate energy transfer and connect chemical bond energy to caloric values on nutrition labels.	90 minutes
	The Carbon Cycle Game	Students model the movement of carbon through Earth's spheres by taking on the roles of carbon atoms and tracking their pathways through photosynthesis, respiration, decomposition, and combustion. The game helps them visualize how human actions influence the balance of the carbon cycle.	2 blocks
	Human Footprint: Shelf Life	After viewing and analyzing the documentary Human Footprint: Shelf Life, students examine food production, preservation, and waste through a systems lens. They evaluate design trade-offs that influence food quality, availability, and sustainability.	60 minutes

Unit 2: Physical & Chemical Environment

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Unit: Physical & Chemical Environment

Length of Unit: 2 weeks

Overview of Unit: In this unit, students explore the interconnected systems that drive Earth's climate by engaging in an interactive climate modeling simulation. They begin by identifying global climate drivers such as solar radiation, atmospheric circulation, ocean currents, and greenhouse gases, making connections to how these forces shape regional climates. Students then construct a baseline model of an unperturbed climate, developing an understanding of how these drivers work together as a system. Building on this foundation, they experiment by manipulating key variables—including CO₂ levels, albedo, and ocean circulation—to observe and predict how such changes impact the climate system. Through guided discussion and reflection, students explain interactions between environments and climate, focusing on both positive and negative feedback mechanisms that amplify or stabilize change. Throughout the unit, students work collaboratively, contributing ideas, communicating their reasoning, and using evidence from their models to support their conclusions. By the end of the unit, students will have developed both a systems-level understanding of Earth's climate and the skills to analyze human and natural influences on climate change.

Priority Standards for unit:

- ESS2.A.2 - Analyze geoscientific data to make the claim that one change to Earth's surface can create changes in other Earth Systems.
- ESS2.A.4 - Use a model to describe how variations in the flow of energy into and out of Earth's System result in changes in climate.
- ESS2.C.1 - Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Supporting Standards for unit:

- ESS1.C.1 - Evaluate evidence of the past and current movements of continental and oceanic crust, the theory of plate tectonics, and relative densities of oceanic and continental rocks to explain why continental rocks are generally much older than rocks of the ocean floor.
- ESS1.C.2 - Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
- ESS2.E.1 - Construct an argument based on evidence about the simultaneous co evolution of Earth's System and life on Earth.
- PS1.B.1 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

- PS1.B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.
- ESS2.D.1 - Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- PS4.A.1 - Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
- PS1.A.3 - Plan and conduct an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles.

Essential Questions:

1. How do changes in one part of Earth's system, such as CO₂ levels or ocean circulation, affect other parts of the system and the global climate?
2. How can models help us understand the flow of energy into and out of Earth's system and predict changes in climate?
3. How do interactions between the atmosphere, oceans, land, and ice create feedback loops that either amplify or stabilize climate change?
4. How can we use evidence from Earth's materials, plate tectonics, and past climates to explain current climate patterns and changes?
5. How can human and natural activities alter climate, and what evidence helps us predict the consequences of these changes?

Enduring Understanding/Big Ideas:

1. Changes in one part of Earth's system—such as increases in atmospheric CO₂ or shifts in ocean circulation—can create ripple effects that influence other systems and ultimately alter global climate.
2. Scientific models help us represent the flow of energy into and out of Earth's system, identify relationships among variables, and predict how changes in climate might unfold.
3. Interactions between the atmosphere, oceans, land, and ice can create feedback mechanisms in the water and carbon cycles that either amplify climate change (positive feedback) or help stabilize it (negative feedback).
4. Data from rocks, fossils, ice cores, and plate tectonic activity allow us to reconstruct past climates, offering evidence to explain and predict current and future climate patterns.
5. Both natural processes (like volcanic eruptions) and human actions (like burning fossil fuels) can drive climate change, and evidence from multiple scientific disciplines allows us to predict the consequences of these changes.

Unit Vocabulary:

- Evaporation
- Condensation
- Transpiration
- Precipitation
- Primary succession
- Secondary succession
- Ocean circulation
- Air circulation
- Greenhouse Effect
- Feedback Loops
- Climate
- Weather
- Polar
- Percolation
- Erosion
- CEC (cation exchange capacity)
- Plate Tectonics
- Tropic
- Temperate
- Wavelength (light)
- Radiation
- Watershed
- Water Vapor

Priority Standard: ESS2.A.2 - Analyze geoscientific data to make the claim that one change to Earth's surface can create changes in other Earth Systems.	
Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how the factors of geographic location and amount of solar radiation determine climate.	3
	Analyzing
Students will describe the temperature and precipitation patterns in desert, tropical rainforest, grassland/savanna, temperate seasonal forest, and taiga biomes.	2
	Applying
Students will identify the processes of primary and secondary succession.	2
	Applying

Priority Standard: ESS2.A.4 - Use a model to describe how variations in the flow of energy into and out of Earth's System result in changes in climate.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will analyze data to determine patterns of climate change.	3
	Analyzing
Students will model the greenhouse effect.	3
	Analyzing

Priority Standard: ESS2.C.1 - Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how the specific heat capacity of water and ocean currents affect Earth's distribution of solar energy and nutrients.	3
	Analyzing
Students will observe the movement of water through soil and how it affects its properties.	2
	Applying

Engaging Scenario

Engaging Scenario

Lesson 3: Modeling the Climate using a Board Game

Resource: https://www.oce.global/sites/default/files/2025-03/OCE_ClimateModels.pdf

After having identified the global drivers of regional climate, students explore and understand how they are connected to form the Earth's climate system by modeling climate changes with a board game. During game time of the simulation, students build a model of an unperturbed climate, then use the model to run an experiment by manipulating variables that affect climate change. Finally, students offer explanations for the interactions between environments and climate change using climate feedback.

Rubric for Engaging Scenario:

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
Identifying Global Climate Drivers	Accurately identifies all major global drivers (e.g., solar radiation, ocean currents, atmospheric circulation, greenhouse gases) and clearly connects them to regional climate patterns.	Identifies most global climate drivers with minor gaps; explains their role in regional climate with some accuracy.	Identifies a few drivers but explanations are vague or partially inaccurate.	Has difficulty naming or explaining drivers; shows little understanding of their role in climate.
Model Construction (Unperturbed Climate)	Constructs a complete and accurate baseline climate model showing clear relationships among climate drivers.	Constructs a mostly accurate baseline model with some minor omissions or errors.	Constructs a partial model with limited relationships among drivers.	Struggles to construct a working model; relationships between elements are unclear or missing.

Experimentation (Manipulating Variables)	Skillfully manipulates multiple climate variables (e.g., CO ₂ levels, albedo, ocean circulation) and predicts outcomes with clear reasoning.	Manipulates at least one variable correctly and predicts outcomes with reasonable accuracy.	Attempts variable manipulation but predictions lack clarity or scientific accuracy.	Does not manipulate variables effectively or is unable to predict outcomes.
Explanation of Interactions & Feedbacks	Provides a thorough explanation of how environments and climate interact; clearly describes positive and negative feedback loops with accurate examples.	Provides a clear explanation of interactions; identifies at least one type of feedback (positive or negative) with a relevant example.	Provides a limited explanation of interactions; feedback examples are vague or partially incorrect.	Provides little or no explanation of interactions; feedback not addressed.
Collaboration & Communication	Consistently contributes ideas, listens to peers, and communicates findings clearly with evidence from the model.	Usually contributes ideas and communicates findings with some supporting evidence.	Occasionally contributes but explanations lack evidence or clarity.	Rarely contributes, struggles to communicate ideas, or provides no evidence.

Topic 1: Geographical Influences on Climate

Engaging Experience 1

Title: The Components of the Climate System

Suggested Length of Time: 2 hours

Standards Addressed

Priority:

- ESS2.A.2 - Analyze geoscientific data to make the claim that one change to Earth's surface can create changes to other Earth Systems.

Supporting:

- ESS1.C.1 - Evaluate evidence of the past and current movements of continental and oceanic crust, the theory of plate tectonics, and relative densities of oceanic and continental rocks to explain why continental rocks are generally much older than rocks of the ocean floor.
- ESS1.C.2 - Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
- ESS2.E.1 - Construct an argument based on evidence about the simultaneous co evolution of Earth's System and life on Earth.

Detailed Description/Instructions: Students review the difference between climate and weather and then analyze data on physical parameters (e.g. H₂O, CO₂, temperature, albedo, greenhouse gases, etc.) that affect climate. They complete summary cards and present to peers their findings. Detailed lesson plans can be found in the document located at the following link:

https://www.oce.global/sites/default/files/2025-03/OCE_ClimateModels.pdf.

Bloom's Levels: Applying

Webb's DOK: 3

Topic 2: Flow of Energy in Earth's Systems

Engaging Experience 1

Title: The Laws of Physics

Suggested Length of Time: 1 hour 40 minutes

Standards Addressed

Priority:

- ESS2.A.4 - Use a model to describe how variations in the flow of energy into and out of Earth's System result in changes in climate.

Supporting:

- PS1.B.1 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- PS1.B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.
- ESS2.D.1 - Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Detailed Description/Instructions: Students engage in document study or conduct experiments to explore the physical parameters that affect climate change, with solar radiation as the main focus. Detailed lesson plans can be found in the document located at the following link:

https://www.oce.global/sites/default/files/2025-03/OCE_ClimateModels.pdf.

Bloom's Levels: Analyzing

Webb's DOK: 3

Topic 3: Water Property Influence on Climate

Engaging Experience 1

Title: How do Plate Tectonics and Ocean Currents Affect Global Climate?

Suggested Length of Time: 1 hour, 30 minutes

Standards Addressed

Priority:

- ESS2.C.1 - Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Supporting:

- PS1.A.3 - Plan and conduct an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles.

Detailed Description/Instructions: Students model ancient land masses and oceans to determine current flow. They then use this model to explain how ocean currents affect regional and global climate. Detailed lesson plans can be found in the document located at the following link:

<https://www.everettsd.org/cms/lib07/WA01920133/Centricity/Domain/660/CS%2012.4.pdf>.

Bloom's Levels: Analyzing

Webb's DOK: 3

Topic 4: Factors Developing and Limiting Biomes

Engaging Experience 1

Title: Watersheds and Soil Profiles

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- ESS2.A.2 - Analyze geoscientific data to make the claim that one change to Earth's surface can create changes in other Earth Systems.

Supporting:

- ESS1.C.1 - Evaluate evidence of the past and current movements of continental and oceanic crust, the theory of plate tectonics, and relative densities of oceanic and continental rocks to explain why continental rocks are generally much older than rocks of the ocean floor.
- ESS2.E.1 - Construct an argument based on evidence about the simultaneous co evolution of Earth's System and life on Earth.

Detailed Description/Instructions: Students develop an understanding of what soil types/profiles are most susceptible to erosion by creating various soil profiles and collecting data about water movement through these profiles. Detailed lesson plans can be found in the document located at the following link: <https://nourishthefuture.org/curriculum/water-quality/ms#watersheds-and-soil-profiles>.

Bloom's Levels: Analyzing

Webb's DOK: 3

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
1	The Components of the Climate System	Students review the difference between climate and weather and then analyze data on physical parameters (e.g. H ₂ O, CO ₂ , temperature, albedo, greenhouse gases, etc.) that affect climate. They complete summary cards and present to peers their findings. Detailed lesson plans can be found in the document located at the following link: https://www.oce.global/sites/default/files/2025-03/OCE_ClimateModels.pdf .	2 hours
2	The Laws of Physics	Students engage in document study or conduct experiments to explore the physical parameters that affect climate change, with solar radiation as the main focus. Detailed lesson plans can be found in the document located at the following link: https://www.oce.global/sites/default/files/2025-03/OCE_ClimateModels.pdf .	1 hour 40 minutes
3	How do Plate Tectonics and Ocean Currents Affect Global Climate?	Students model ancient land masses and oceans to determine current flow. They then use this model to explain how ocean currents affect regional and global climate. Detailed lesson plans can be found in the document located at the following link: https://www.everettsd.org/cms/lib07/WA01920133/Centricity/Domain/660/CS%2012.4.pdf .	1 hour, 30 minutes
4	Watersheds and Soil Profiles	Students develop an understanding of what soil types/profiles are most susceptible to erosion by creating various soil profiles and collecting data about water movement through these profiles. Detailed lesson plans can be found in the document located at the following link: https://nourishthefuture.org/curriculum/water-quality/ms#watersheds-and-soil-profiles .	90 minutes

Unit 3: Biodiversity

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Unit: Biodiversity

Length of Unit: 3 weeks

Overview of Unit: In this unit, students explore how chemical reactions, biological interactions, and environmental factors shape biodiversity and ecosystem stability. They investigate how changes in temperature, concentration, and other conditions affect reaction rates and equilibrium, then analyze how biotic and abiotic factors influence carrying capacity and population dynamics. Through models and data, students examine how natural selection and genetic variation drive adaptation and change in species over time. Finally, students design and evaluate solutions that mitigate human impacts and support ecosystem health, applying engineering principles to balance scientific, societal, and environmental considerations.

Priority Standards for unit:

- PS1.B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.
- LS2.C.2 - Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.
- LS2.A.1 - Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.
- LS2.C.1 - Evaluate the claims, evidence, and reasoning that the interactions in Ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Supporting Standards for unit:

- LS4.C.1 - Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- LS4.C.3 - Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity.
- LS3.B.4 - Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- LS4.C.2 - Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- PS1.B.1 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- LS1.C.1 - Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.

- LS2.B.2 - Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- ETS1.A.1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- ETS1.B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- LS3.B.1 - Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring
- PS4.B.2 - Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

Essential Questions:

1. How can energy be transformed from one form to another, and what design choices make these transformations more efficient or practical?
2. In what ways do asexual and sexual reproduction impact the transfer of genetic information and the variation we see in living things?
3. How does the structure of DNA determine the functions of proteins, and why is this relationship essential to life?
4. How does matter cycle and energy flow through ecosystems, and what happens when those cycles are disrupted?
5. How are energy systems, genetic variation, and ecosystem balance connected to addressing global challenges for a sustainable future?

Enduring Understanding/Big Ideas:

1. Energy can change from one form to another, and the efficiency and practicality of these transformations depend on the design choices we make.
2. Asexual and sexual reproduction both transfer genetic information, but they affect variation differently, influencing the traits and adaptability of living things.
3. The structure of DNA determines the proteins it codes for, and this relationship underlies the functions essential for survival and diversity of life.
4. Matter cycles and energy flows through ecosystems in interconnected ways, and disruptions to these cycles can destabilize communities and affect biodiversity.
5. The way energy systems function, how genetic variation supports resilience, and how ecosystems maintain balance are all linked, and understanding these connections is key to building a sustainable future.

Unit Vocabulary:

- Monoculture / Monocropping
- GMOs (genetically modified organisms)
- Biotic factors
- Abiotic factors
- Phenotype
- Genotype
- Artificial selection
- Sexual reproduction
- Asexual reproduction
- Genes
- Alleles
- Carrying Capacity
- Density dependent
- Density independent
- Logistic growth
- Exponential growth
- Homeostasis
- Primary productivity
- Trophic level

Priority Standard: PS1.B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.	
Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how photosynthesis and nutrient availability impact primary productivity.	3
	Analyzing
Students will predict evolutionary changes in a population given alteration in biotic and abiotic conditions.	2
	Applying
Students will evaluate how monocropping, GMOs, and selective breeding affect the genetic diversity of populations.	4
	Evaluating

Priority Standard: LS2. C.2 - Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will create solutions for increasing biodiversity through mitigating practices.	4
	Evaluating
Students will evaluate peer-generated solution proposals and provide constructive feedback.	3
	Analyzing

Priority Standard: LS2. A.1 - Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify density-dependent and density-independent factors that illustrate human impacts.	1
	Understanding
Students will generate and analyze a graph demonstrating population growth (e.g. logistic and exponential patterns).	3
	Analyzing

Priority Standard: LS2. C.1 - Evaluate the claims, evidence, and reasoning that the interactions in Ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how positive and negative feedback loops regulate ecological processes.	3
	Analyzing
Students will evaluate factors that affect the homeostasis of ecosystems.	3
	Analyzing

Engaging Scenario

Engaging Scenario

After students have studied the components that affect biodiversity in various environments across the globe, students will do a comparison study of the biodiversity between managed preserve areas vs. wild habitats. In each location, students will conduct quadrat plant surveys and analyze soil/water samples. Then, they will use this data to make comparisons and identify contrasts between the two locations to explain how human activity impacts a physical environment and its biodiversity.

Rubric for Engaging Scenario:

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
Explanation of Human Impact	Provides a clear, detailed, and accurate explanation of specific human activities (e.g., agriculture, deforestation, pollution, urbanization) and directly connects them to changes in biodiversity and soil/water quality.	Explains human activities and makes general connections to biodiversity and soil/water quality with mostly accurate details.	Mentions human activities but explanations are vague, overly general, or partially inaccurate in relation to biodiversity or soil/water.	Limited or inaccurate mention of human activities; little or no connection to biodiversity or soil/water properties.
Understanding of Biodiversity Effects	Thoroughly explains how biodiversity is affected (e.g., species loss, invasive species introduction, changes to food webs or habitats) with relevant examples.	Explains how biodiversity is affected with some detail and examples.	Provides a minimal explanation of how biodiversity is affected; lacks examples or clarity.	Shows little or no understanding of how biodiversity is affected.
Understanding of Soil/Water Effects	Accurately explains how soil and/or water properties are altered (e.g., nutrient depletion, erosion, contamination, eutrophication) with clear examples.	Explains soil/water changes with mostly accurate details and at least one example.	Mentions soil/water changes but explanation is incomplete or contains errors.	Shows little or no understanding of soil/water property changes.

Clarity and Use of Evidence	Presents ideas logically and clearly, using scientific vocabulary and evidence (data, examples, case studies) to support claims.	Presents ideas clearly with some use of scientific vocabulary and examples as evidence.	Ideas are somewhat unclear or unorganized; limited use of scientific vocabulary and minimal evidence.	Ideas are unclear or disorganized; lacks scientific vocabulary and evidence.
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Topic 1: Primary Productivity

Engaging Experience 1

Title: Primary Productivity Lab

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- PS1. B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.

Detailed Description/Instructions: Students conduct an experiment investigating how light intensity affects primary productivity. Detailed lesson plans can be found in the following link:
https://cdn.pasco.com/lab_experiment/1_321/11_Photosynthesis_and_Primary_Productivity_S.pdf

Bloom's Levels: Evaluate

Webb's DOK: 4

Topic 2: Factors of Biodiversity

Engaging Experience 1

Title: Evaluating Perspectives About GMOs

Suggested Length of Time: 2-3 hours

Standards Addressed

Priority:

- LS2. C.2 - Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.

Detailed Description/Instructions: Students will participate in a 5E lesson that gives a brief overview of technology used to produce GMOs, equipping them with the ability to evaluate the social, environmental, and economic arguments for and against bioengineered crops (GMOs).

Detailed lesson plans can be found at the following link: [Evaluating Perspectives About GMOs – Curriculum Matrix | National Agriculture in the Classroom](#).

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 3: Ecosystem Stability and Dynamics

Engaging Experience 1

Title: Limiting Factors and Carrying Capacity

Suggested Length of Time: 30 minutes

Standards Addressed

Priority: LS2. A.1 - Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Detailed Description/Instructions: Students explore how limiting factors affect population growth. Students will apply the concept of limiting factors to several scenarios and analyze the effects on the systems. The activity can be accessed through the following link:

https://docs.google.com/document/d/1TksOq9tRkPzwRbvW5NONUwb1ha3Rr3RbNf2qHSuM_cc/edit?tab=t.0.

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 4: Species Stability in Ecosystems

Engaging Experience 1

Title: Dam Dilemma

Suggested Length of Time: 180 minutes

Standards Addressed

Priority:

- LS2. C.1 - Evaluate the claims, evidence, and reasoning that the interactions in Ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: Students investigate how changes in an ecosystem affect the stability of populations. Specifically, they explore how dams affect the abiotic factors of an ecosystem, which in turn affects native fish populations. They then act as water managers and examine a group of dams. Based on a budget and information about each dam, they then propose a plan detailing which dams to rehabilitate, which to remove, and which to maintain.

Detailed lesson plans can be found in the document located at the following link:

<https://drive.google.com/file/d/14kraNNzXLsJcjZK-pwq2GU2BA5df7WsS/view?usp=sharing>.

Bloom's Levels: Analyze

Webb's DOK: 3

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
1	Primary Productivity Lab	Students conduct an experiment to investigate how light intensity affects primary productivity in aquatic systems. They measure dissolved oxygen levels to infer photosynthetic rates, connecting energy flow to nutrient availability and ecosystem productivity.	90 minutes
2	Evaluating Perspectives About GMOs	Students engage in a structured 5E lesson to analyze the science, technology, and ethics behind genetically modified organisms. They evaluate evidence from multiple perspectives—environmental, social, and economic—to understand how biotechnology affects biodiversity and sustainability.	2-3 hours
3	Limiting Factors and Carrying Capacity	Through guided scenarios and data analysis, students explore how density-dependent and density-independent factors influence population growth. They model logistic and exponential growth patterns and connect limiting factors to ecosystem stability.	30 minutes
4	Dam Dilemma	Students investigate the impact of dams on aquatic ecosystems by analyzing data on water flow, temperature, and species populations. Acting as water resource managers, they make evidence-based recommendations about which dams to maintain, rehabilitate, or remove to balance human and ecological needs.	180 minutes

Unit 4: Biotechnology & Engineering

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Unit: Biotechnology & Engineering

Length of Unit: 2 weeks

Overview of Unit: In this unit, students connect concepts from physical science, life science, and engineering to explore how energy, genetics, and design intersect in solving real-world challenges. They investigate energy transformations and design devices that convert energy within given constraints, applying engineering practices to analyze and refine solutions. Students compare asexual and sexual reproduction to explain genetic variation, model how DNA structure determines protein function, and examine how matter cycles and energy flows through ecosystems. Finally, they evaluate and design strategies that support biodiversity and sustainability, demonstrating how scientific and engineering principles work together to create innovative, evidence-based solutions.

Priority Standards for unit:

- PS3. A.3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- LS3. B.1 - Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring

Supporting Standards for unit:

- ETS1. A.1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- LS2. B.2 - Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- LS2. C.2 - Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.
- LS1. A.1 - Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through a system of specialized cells.

Essential Questions

1. How do energy transformations occur in physical and biological systems, and how can we design devices that use these transformations efficiently?
2. How does genetic information determine traits and drive variation among organisms?
3. How can biotechnology be used to understand, modify, or improve living systems?
4. How can scientific and engineering principles be applied to design solutions that address environmental and societal challenges?
5. What trade-offs must be considered when developing and evaluating technologies that impact ecosystems and biodiversity?

Enduring Understandings

- **Energy Transformation:** Energy can be converted from one form to another in both biological and engineered systems; understanding these processes allows us to design more efficient and sustainable technologies.
- **Genetics and Variation:** The structure of DNA determines protein function and drives the inheritance and variation of traits through asexual and sexual reproduction.
- **Biotechnology Applications:** Biotechnology provides tools to analyze and influence genetic and ecological systems, offering solutions to improve sustainability and productivity.
- **Engineering Design:** Complex real-world problems can be solved by breaking them into smaller, manageable parts, evaluating constraints, and optimizing solutions through iterative design.
- **Systems Thinking and Impact:** Scientific data and models help us assess how technological and biological systems interact, ensuring that solutions balance environmental, economic, and social impacts.

Unit Vocabulary:

- | | |
|----------------------|------------------------|
| ● Electrophoresis | ● Solar Energy |
| ● Buffer | ● Hydroelectric Energy |
| ● Bioengineering | ● Wind Energy |
| ● Energy Transfer | ● kwh (kilowatt hour) |
| ● Recombinant DNA | ● Power |
| ● Micropipette | ● Electrical grid |
| ● Geothermal Energy | ● Sustainability |
| ● Photovoltaic cells | |

Priority Standard: PS3. A.3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain the processes of energy transformations in both biological and physical systems.	1
	Understanding
Students will design a model to show energy transformations.	3
	Analyzing

Priority Standard: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe current engineering practices that address resource availability (e.g. water, solar, and wind).	1
	Understand
Students will make a claim that compares competing design solutions about resource availability based on empirical evidence and scientific reasoning or analysis.	3
	Analyze
Students will evaluate competing design solutions about resource availability based on empirical evidence and scientific reasoning or analysis.	3
	Evaluate

Priority Standard: ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will design a framework for managing an environmental issue (e.g. water shortage, soil quality, resource limitation).	4
	Creating
Students will propose a solution to address a local environmental issue.	3
	Evaluating

Priority Standard: LS3. B.1 - Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will compare how asexual and sexual reproduction contributes to genetic diversity.	2
	Applying
Students will explain how genetically modified organisms (GMOs) are produced.	3
	Analyzing
Students will apply principles of biotechnology (i.e. Gel electrophoresis, recombinant DNA) to understand the benefits and limitations of GMOs.	2
	Applying

Engaging Scenario

Engaging Scenario Students will write an argument that justifies the selection of a particular bull to be mated with a group of cattle to meet the criteria set forth by the producer. First, students will identify trait heritability and make connections between trait heritability and making cattle produce beef more efficiently. Then, students review basic probability of outcomes for calf traits based on the expected differences from two different bulls. Students are introduced to a concept called Expected Progeny Difference. Next, students are asked to focus on a production trait of growth and make comparisons of the genetic difference between two calves on several economically and environmentally important traits. Last, students justify a decision to select a particular bull to be used in a selective breeding program to get a desired outcome.

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Applied Science of Natural Resources Project Rubric

Asking Questions - Developing focused, answerable inquiry and research questions.			
1 - Questions are relevant to a specific topic but are missing components to be testable.	2 - Questions are relevant to a specific topic, are testable or researchable, and build on prior knowledge about the topic. More research is needed along with pattern identifications.	4 - Questions are valid, testable or researchable, and based on observed patterns and/or research. More precision based on models or theory is needed.	5 - Questions are valid, precise, testable or researchable, based on patterns/ observations, specific evidence from current research and/or a specific model or theory, and push standard thinking on a given topic or in a particular discipline.
Defining a Problem - Defining the criteria and constraints for addressing a real-world problem through engineering design.			
1 -Begins to define a simple design problem with incomplete description of criteria or constraints. Student is not able to describe much information about the topic or components.	2 - Definition of a simple design problem is mostly complete. Representation of criteria for success and constraints is general. Student can describe topics and components but may be missing some details.	4 - Definition of the problem or design statement is complete. Identifies relevant criteria and constraints. Student can give information about the topics and details enough to address the question without revision.	5 - Definition of the problem or design statement is complete and includes rationale. Addresses multiple criteria and constraints relevant to the problem. Student can give a thorough and specific description of topics and details of components including WHY it needs to be addressed.
Designing a Solution - Designing a solution (e.g., an object, tool, process or system) that is supported by scientific ideas and meets criteria and constraints; evaluating and refining the solution through analysis of empirical evidence.			
1 - Designs a solution to address a problem with little or no connection to criteria or constraints.	2 - Designs a solution that meets one or more criteria and constrains the problem. Evaluation of the solution and the refined solution reflect minimal attention to empirical evidence.	4 -Designs a solution that refers to and applies to a relevant scientific idea and meets core and additional specific criteria and constraints. Evaluation of the solution and the refined solution refer to and are consistent with empirical evidence.	5 - Designs a solution that refers to and accurately applies relevant scientific idea(s) and makes trade-offs to satisfy prioritized criteria and meet constraints. Evaluation of the solution and the refined solution reflect analysis of empirical evidence.

Evaluating & Revising Design Solutions - Design solutions for a relevant problem, accounting for criteria and constraints, and drawing on empirical evidence, including the student's own generated evidence.

1 - Makes a claim about the merit of a solution to a problem by discussing generally how it meets the criteria or constraints of the problem, with minimal reference to evidence. Testing and improvements to the process are lacking and are needed.

2 - Makes a claim about the merit of a solution to a problem by discussing how it meets specific criteria and constraints of the problem, with some reference to evidence. More information is needed for the process.

4 - Makes a claim that compares and evaluates competing design solutions to a real-world problem based on empirical evidence and scientific reasoning or analysis. Feedback was gathered for revision and improvement of the process.

5 - Project is based on real-world problem based on empirical evidence and scientific reasoning or analysis. For the selected design solution, explains whether empirical evidence satisfies design criteria and constraints. Experimental design is detailed, logical, and controls variables effectively.

Conducting the Experimental Process - Conducting the process using scientific method, variables, data collection, and safety guidelines.

1 - Does not follow procedures or disregards safety; experiment not completed. No data collected or data irrelevant to the investigation.

2 - Attempts to follow procedures but inconsistently or with some confusion. Data are partially complete or lack clear organization. Significant data is missing key measurements or lacking analysis. Major procedural errors or unsafe practices interfere with validity.

4 - Follows most procedures accurately and safely. Minor errors do not affect results. Data are mostly complete and organized with analysis; minor inconsistencies in recording or analysis. All safety procedures are still followed.

5 - Follows all steps accurately and safely; procedures are well-organized and replicable. Shows initiative in problem-solving. Data is thorough, precise, and systematically recorded using appropriate tables, graphs, or digital tools.

Communicating Accurately & Precisely - Expressing, integrating, and applying specific content and/or conventions with accuracy and precision.

1 - Not yet meeting expectations. Information lacks supporting detail or is inaccurate or missing entirely.

2 - Partially meeting expectations. Needs development of details in the procedure as well as revisions.

4 - Mostly meeting expectations. There are some revisions needed to fit time and supply limitations or more supporting details are needed.

5 - Fully meeting expectations. All required components are included and meet time requirements as well as limitations of supply dynamics.

Topic 1: Energy Transformations

Engaging Experience 1

Title: Building Solar & Wind Systems

Suggested Length of Time: 130 minutes

Standards Addressed

Priority:

- PS3. A.3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Detailed Description/Instructions: Students learn about the benefits of renewable energy sources in contrast to the dangers of non-renewable energy sources. They will learn how to build their own solar-powered and wind-powered turbine prototype while trying to keep their costs as low as possible. Detailed lesson plans can be found at the following link:

<https://engineeringtomorrow.org/labs/renewable-energy>.

Bloom's Levels: Understand

Webb's DOK: 1

Topic 2: Real-World Dynamics and Impacts - Resource Availability

Engaging Experience 1

Title: The Ups and Downs of Populations

Suggested Length of Time: 2-3 days

Standards Addressed

Priority: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Supporting:

Detailed Description/Instructions:

Students will analyze population graphs, collect data to generate their own population graph, and experience limiting factors and their impact on carrying capacity in a small deer population. Students will be able to identify, explain, and evaluate the impact that different limiting factors have on the population of organisms including food, water, shelter, predation, human interference, changes in birth and death rate, changes in immigration and emigration, disease, and reproduction.

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[extension://efaidnbmnnnibpcajpcgltclefindmkaj/https://science4inquiry.com/LessonPlans/LifeScience/Populations_MS/UpsDownsPopulationsMSFinal.pdf](https://efaidnbmnnnibpcajpcgltclefindmkaj/https://science4inquiry.com/LessonPlans/LifeScience/Populations_MS/UpsDownsPopulationsMSFinal.pdf)

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 3: Engineering Solutions - Resource Availability

Engaging Experience 1

Title: Improving Crop Yield

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Detailed Description/Instructions: Students use graphical comparisons of multiple sets of data to describe how nutrient application affects production. Detailed lesson plans can be found at the following link: <https://nourishthefuture.org/curriculum/growing-america/hs#improving-crop-yield>.

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 4: Influencing Genetic Diversity with Biotechnology

Engaging Experience 1

Title: Determining the Genetics of a Ca\$h Cow MiniLab

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- LS3. B.1 - Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring.

Detailed Description/Instructions: Students use gel electrophoresis to determine which cows and bull to purchase to breed to increase milk protein production in offspring to bring the farmer a higher return on his/ her investment. Detailed lesson plans can be found at the following link:

<https://theminione.com/wp-content/uploads/2019/08/M3011-DeterminingtheGeneticsofaCaShCow-Students-Guide-081519-EMAIL-WEB.pdf>.

Bloom's Levels: Analyze

Webb's DOK: 3

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
	Building Solar & Wind Systems	Students explore renewable energy technologies by designing and constructing small-scale solar and wind turbine models. Working within cost and material constraints, they test and refine their devices to maximize energy output, connecting energy transformation principles to sustainable design.	130 minutes
	The Ups and Downs of Populations	Students simulate population dynamics using data sets and physical models to analyze how limiting factors—such as food, water, disease, and human interference—affect carrying capacity. They compare different population trends and evaluate the ecological and engineering implications for resource management.	2-3 days
	Improving Crop Yield	Students analyze agricultural data to determine how nutrient application affects plant productivity. Using graphical comparisons, they identify trends, discuss design constraints, and propose evidence-based solutions to optimize crop yield while minimizing environmental impact.	60 minutes
	Determining the Genetics of a Ca\$h Cow MiniLab	Students perform a biotechnology investigation using gel electrophoresis to identify genetic traits in cattle related to milk protein production. They analyze DNA banding patterns to make breeding recommendations, applying principles of heredity, biotechnology, and data interpretation to real-world agricultural decisions.	90 minutes

Unit 5: Human Activity

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Unit: Human Activity

Length of Unit: 3 weeks

Overview of Unit: In this unit, students will explore how human activity interacts with Earth's systems and affects biodiversity and sustainability. They will use computational and mathematical models to understand how biotic and abiotic factors influence the carrying capacity of ecosystems and how natural resources are managed to support human populations. Students will investigate real-world problems, evaluating technological and environmental solutions based on criteria such as cost, safety, reliability, aesthetics, and social or environmental impacts. They will analyze evidence from climate models and geoscientific data to forecast changes in Earth systems and examine both the positive and negative effects of human actions. Throughout the unit, students will design, refine, and evaluate solutions that aim to restore ecological stability, protect biodiversity, and promote sustainable interactions between humans and the environment.

Priority Standards for unit:

- ESS3. C.1 - Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- ESS3. C.2 - Evaluate or refine a technological solution that reduces impacts of human activities on the natural system in order to restore stability and or biodiversity of the ecosystem as well as prevent their recurrence.
- ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- LS2. A.1 - Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Supporting Standards for unit:

- ESS3. A.1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- ESS3. D.1 - Analyze geoscientific data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth System.
- ESS3. D.2 - Predict how human activity affects the relationships between Earth System in both positive and negative ways.
- LS2. C.2 - Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.

Essential Questions

1. How do human activities impact ecosystems, biodiversity, and the sustainability of natural resources?
2. How can mathematical and computational models help us predict and manage changes in Earth's systems?
3. What criteria and constraints should guide the design of technological solutions that reduce environmental impacts?
4. How can natural resource management balance human needs with the protection of ecosystems and biodiversity?
5. How can individuals and communities make informed decisions that promote environmental stability and sustainability?

Enduring Understandings

1. **Interconnected Systems:** Human and natural systems are deeply interconnected; changes in one affect the stability and health of the other.
2. **Modeling for Understanding:** Data, models, and simulations allow us to analyze how human activities, and environmental factors influence ecosystems and resource availability.
3. **Sustainable Design:** Effective solutions to environmental challenges require balancing social, economic, and ecological considerations.
4. **Science-Informed Decision-Making:** Evidence from geoscience, ecology, and climate models informs responsible decisions that support biodiversity and sustainability.
5. **Human Responsibility:** Humans have the capacity to both degrade and restore ecosystems, and sustainable futures depend on intentional, informed actions.

Unit Vocabulary:

- | | |
|-------------------------|------------------------|
| ● IPCC | ● Carbon footprint |
| ● Bidirectional Effects | ● Biodegradable |
| ● Aesthetics | ● Greenwashing |
| ● Parameters | ● Sequestration |
| ● Variables | ● Irrigation |
| ● Mitigation | ● Urbanization |
| ● Climate change | ● Energy Cascades |
| ● Anthropogenic | ● Reduce-Reuse-Recycle |

Priority Standard: ESS3. C.1 - Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will collect and analyze data on climate change.	3
	Analyzing
Students will describe how climate change affects natural resource availability and sustainability.	3
	Analyzing

Priority Standard: ESS3. C.2 - Evaluate or refine a technological solution that reduces impacts of human activities on natural Systems to restore stability and or biodiversity of the ecosystem as well as prevent their reoccurrences.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe technological advances in improving crop yield (e.g., drones, irrigation systems, GPS guidance, etc.).	2
	Apply
Students will assess how advances in technology address human effects on natural systems. (e.g. crop yield techniques, drones, GPS guidance, etc.)	3
	Analyzing

Priority Standard: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will make a claim that compares competing urban planning design solutions based on empirical evidence and scientific reasoning or analysis.	3
	Analyze
Students will evaluate competing urban planning design solutions based on empirical evidence and scientific reasoning or analysis.	3
	Evaluate

Priority Standard: LS2. A.1 - Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify density-dependent and density-independent factors that illustrate human impacts.	1
	Understanding
Students will generate and analyze a graph demonstrating population growth (e.g. logistic and exponential patterns).	3
	Analyzing

Engaging Scenario

Engaging Scenario

Analyzing Data to Minimize Land Use Impacts

Resource: <https://nourishthefuture.org/curriculum/growing-america/ms#analyzing-data-to-minimize-land-use-impacts>

Students analyze and interpret data to assess soil, water, and land use systems. They also construct an explanation for the data and design a solution to minimize the human impact that has led to the data they receive.

Applied Science of Natural Resources Project Rubric

Asking Questions - Developing focused, answerable inquiry and research questions.			
1 - Questions are relevant to a specific topic but are missing components to be testable.	2 - Questions are relevant to a specific topic, are testable or researchable, and build on prior knowledge about the topic. More research is needed along with pattern identifications.	4 - Questions are valid, testable or researchable, and based on observed patterns and/or research. More precision based on model or theory is needed.	5 - Questions are valid, precise, testable or researchable, based on patterns/ observations, specific evidence from current research and/or a specific model or theory, and push standard thinking on a given topic or in a particular discipline.
Defining a Problem - Defining the criteria and constraints for addressing a real-world problem through engineering design.			
1 -Begins to define a simple design problem with incomplete description of criteria or constraints. Student is not able to describe much information about the topic or components.	2 - Definition of a simple design problem is mostly complete. Representation of criteria for success and constraints is general. Student can describe topics and components but may be missing some details.	4 - Definition of the problem or design statement is complete. Identifies relevant criteria and constraints. Student can give information about the topics and details enough to address the question without revision.	5 - Definition of the problem or design statement is complete and includes rationale. Addresses multiple criteria and constraints relevant to the problem. Student can give a thorough and specific description of topics and details of components including WHY it needs to be addressed.
Designing a Solution - Designing a solution (e.g., an object, tool, process or system) that is supported by scientific ideas and meets criteria and constraints; evaluating and refining the solution through analysis of empirical evidence.			
1 - Designs a solution to address a problem with little or no connection to criteria or constraints.	2 - Designs a solution that meets one or more criteria and constrains the problem. Evaluation of the solution and the refined solution reflect minimal attention to empirical evidence.	4 -Designs a solution that refers to and applies to a relevant scientific idea and meets core and additional specific criteria and constraints. Evaluation of the solution and the refined solution refer to and are consistent with empirical evidence.	5 - Designs a solution that refers to and accurately applies relevant scientific idea(s) and makes trade-offs to satisfy prioritized criteria and meet constraints. Evaluation of the solution and the refined solution reflect analysis of empirical evidence.

Evaluating & Revising Design Solutions - Design solutions for a relevant problem, accounting for criteria and constraints, and drawing on empirical evidence, including the student's own generated evidence.			
1 - Makes a claim about the merit of a solution to a problem by discussing generally how it meets the criteria or constraints of the problem, with minimal reference to evidence. Testing and improvements to the process are lacking and are needed.	2 - Makes a claim about the merit of a solution to a problem by discussing how it meets specific criteria and constraints of the problem, with some reference to evidence. More information is needed for the process.	4 - Makes a claim that compares and evaluates competing design solutions to a real-world problem based on empirical evidence and scientific reasoning or analysis. Feedback was gathered for revision and improvement of the process.	5 - Project is based on real-world problems based on empirical evidence and scientific reasoning or analysis. For the selected design solution, it explains whether empirical evidence satisfies design criteria and constraints. Experimental design is detailed, logical, and controls variables effectively.
Conducting the Experimental Process - Conducting the process using scientific method, variables, data collection, and safety guidelines.			
1 - Does not follow procedures or disregards safety; experiment not completed. No data collected or data irrelevant to the investigation.	2 - Attempts to follow procedures but inconsistently or with some confusion. Data is partially complete or lacks clear organization. Significant data is missing key measurements or lacking analysis. Major procedural errors or unsafe practices interfere with validity.	4 - Follows most procedures accurately and safely. Minor errors do not affect results. Data are mostly complete and organized with analysis; minor inconsistencies in recording or analysis. All safety procedures are still followed.	5 - Follows all steps accurately and safely; procedures are well-organized and replicable. Shows initiative in problem-solving. Data is thorough, precise, and systematically recorded using appropriate tables, graphs, or digital tools.
Communicating Accurately & Precisely - Expressing, integrating, and applying specific content and/or conventions with accuracy and precision.			
1 - Not yet meeting expectations. Information lacks supporting detail or is inaccurate or missing entirely.	2 - Partially meeting expectations. Needs development of details in the procedure as well as revisions.	4 - Mostly meeting expectations. There are some revisions needed to fit time and supply limitations or more supporting details are needed.	5 - Fully meeting expectations. All required components are included and meet time requirements as well as limitations of supply dynamics.

Topic 1: Management of Natural Resources

Engaging Experience 1

Title: Cornucopia

Suggested Length of Time: 2 days

Standards Addressed

Priority: ESS3. C.1 - Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Supporting:

Detailed Description/Instructions:

1. Evaluate and compare the water and land resource needs of various crops and animal food sources.
2. Identify how changing weather and climate conditions such as drought affect water availability and food production.
3. Investigate how agricultural technologies impact water use.

From the California Academy of Science, Cornucopia is a game about food systems, water, and sustainability. Through simulated farming scenarios, students take on the role of a farmer and are challenged to effectively balance land and water resources in order to produce crops and fulfill food demands.

[Cornucopia Simulation Game](#)

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 2: Reducing Human Impact on Biodiversity

Engaging Experience 1

Title: Designing Solutions to Preserve Biodiversity

Suggested Length of Time: 120 minutes

Standards Addressed

Priority:

- ESS3. C.2 - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems in order to restore stability and or biodiversity of the ecosystem as well as prevent their reoccurrences.

Detailed Description/Instructions: Students explore major biodiversity threats and design, present, and refine solutions for preserving biodiversity. They also consider the roles of local partners and potential constraints in developing and implementing their solutions. Detailed lesson plans can be found in the document located at the following link:

<https://www.biointeractive.org/classroom-resources/designing-solutions-preserve-biodiversity>.

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 3: Solution Trade-Offs and Impacts - Urban Planning

Engaging Experience 1

Title: The Urban Game

Suggested Length of Time: 4 days

Standards Addressed

Priority: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Detailed Description/Instructions:

This activity involves an educational mapping activity that simulates the process of urbanization and industrialization, typically of an English village from 1700 to the late 1800s. Participants listen to a narrated script and, in timed rounds, add features like houses, factories, roads, and later, more complex elements like railroads and pollution to their maps, experiencing the dramatic societal and environmental changes of the era firsthand and connecting to the stresses of the Industrial Revolution.

[The Urban Game](#)

[Student Sheet for Activity on Urban Game](#)

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 4: Factors of Carrying Capacity

Engaging Experience 1

Title: Exponential Versus Linear Growth

Suggested Length of Time: 120 minutes

Standards Addressed

Priority:

- LS2. A.1 - Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Detailed Description/Instructions: Students compare the type of growth in human population and corn and soybean yields over time (linear or exponential) using software to create a mathematical equation. They also compare population dynamics characteristics to crop and human populations. Detailed lesson plans can be found at the following link:

<https://nourishthefuture.org/curriculum/food-security/hs#exponential-versus-linear-growth>.

Bloom's Levels: Understand

Webb's DOK: 1

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
	Cornucopia	Students take on the role of farmers in a simulation that models the relationships among land, water, food production, and sustainability. By managing crops under changing climate and resource conditions, they analyze trade-offs in agricultural decision-making and resource allocation.	2 days
	Designing Solutions to Preserve Biodiversity	Students investigate major threats to biodiversity and apply the engineering design process to create solutions that mitigate human impacts. They present and refine their proposals based on feedback, considering ecological, economic, and social constraints.	120 minutes
	The Urban Game	Through an interactive mapping simulation, students model the rapid urbanization of a town over time. As they add features such as housing, industry, and infrastructure, they observe how urban development affects ecosystems, resource use, and human quality of life.	4 days
	Exponential Versus Linear Growth	Students use real-world agricultural and population data to model and compare exponential and linear growth trends. They analyze how human population growth and crop yields interact, exploring the implications for sustainability and resource management.	120 minutes

Unit 6: Sustainability Design

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Unit: Sustainability Design

Length of Unit: 3 weeks

Overview of Unit: In this unit, students will explore how engineering and scientific principles can be applied to solve complex, real-world problems. They will analyze major global challenges and identify both qualitative and quantitative criteria, as well as constraints, to guide the design of solutions that meet societal needs and wants. Students will learn to break complex problems into smaller, manageable parts, design and refine solutions, and evaluate trade-offs such as cost, safety, reliability, aesthetics, and social or environmental impacts. They will apply chemistry and physics concepts, including chemical equilibrium, energy transfer, and the interactions of electromagnetic radiation with matter, to improve designs and devices. Throughout the unit, students will create and refine models and build devices that convert energy between forms while considering real-world constraints and practical applications.

Priority Standards for unit:

- ETS1. A.1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- PS2. B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.

Supporting Standards for unit:

- PS3. A.2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
- PS3. A.3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- PS4. B.1 - Communicate technical information about how electromagnetic radiation interacts with matter.

Essential Questions

1. How can engineers and scientists break down complex global challenges into smaller, solvable problems?
2. What criteria and constraints should guide the design of solutions that meet societal needs while protecting the environment?
3. How can changes in chemical or physical conditions affect system equilibrium and influence design outcomes?
4. How can energy be converted and optimized within a system to improve performance and sustainability?
5. How do models and evidence help us evaluate and refine solutions for real-world environmental and agricultural challenges?

Enduring Understandings

1. **Engineering Solves Real Problems:** Applying scientific and engineering principles allows us to design solutions that address global challenges in food, energy, and resource sustainability.
2. **Criteria, Constraints, and Trade-Offs:** Effective solutions balance technical performance with cost, safety, reliability, aesthetics, and social or environmental impacts.
3. **Science Informs Design:** Understanding energy transfer, chemical equilibrium, and matter interactions improves how we design and refine technologies.
4. **Energy Conversion and Optimization:** Energy can be transformed between forms, and optimizing these transformations increases system efficiency and sustainability.
5. **Modeling for Innovation:** Models and simulations help predict outcomes, communicate ideas, and guide continuous improvement of engineered systems.

Unit Vocabulary:

- Sustainability agriculture
- Food security
- Soil erosion
- Water scarcity
- Fertilizer runoff
- Pesticide resistance
- Greenhouse gas emissions
- Food waste
- Organic farming
- Regenerative agriculture
- Hydroponics
- Aquaponics
- Vertical farming
- No-till farming
- Crop rotation
- Integrated Pest Management (IPM)
- Polyculture

Priority Standard: ETS1. A.1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify current agricultural challenges related to food production.	3
	Analyze
Students will describe and compare alternative farming methods.	2
	Apply

Priority Standard: ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	
Learning Targets	Webb's DOK Level
	Bloom's Level
Students will utilize engineering methods to construct a solution to a current agricultural issue related to food production. (e.g. vertical, hydroponics, etc.)	4
	Create

Students will present their selected engineering method that proposes a solution to a current agricultural issue.	4
	Create

Priority Standard: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will evaluate a real-world agricultural problem and identify constraints.	3
	Evaluate
Students will describe the social, cultural, and environmental impacts of a real-world agricultural problem.	2
	Apply

Priority Standard: PS2. B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe the environmental and biological impacts of herbicides, pesticides, and fertilizers on productivity.	2
	Apply

Engaging Scenario

Engaging Scenario

Design a Farm (APES PBL Curriculum Activity)

Students take the role of farmers in Project 3, Food Systems, designing and redesigning a farm to meet an evolving set of economic, environmental, and social/cultural constraints. Students begin by designing a farm plan and are given basic information on soil and climate. They refine or revise the farm plan when they are asked to also consider how to manage potential pests for the crops they've chosen. To increase complexity, they are assigned to a client to whom they must sell their crops. Each client has their own set of requirements for the produce or meat they buy, so students may have to revise their farm to ensure they can meet their clients' needs. They negotiate with their neighbors over any issues brought about by different farming techniques being used and their regional impacts. They are then asked to think about irrigation and water rights issues when a drought threatens access to water. By the end of the project, students should have a working farm that meets a complex set of real-world constraints. The final task asks them to reflect on the implications of what they have learned for their own lives.

Applied Science of Natural Resources Project Rubric

Asking Questions - Developing focused, answerable inquiry and research questions.			
1 - Questions are relevant to a specific topic but are missing components to be testable.	2 - Questions are relevant to a specific topic, are testable or researchable, and build on prior knowledge about the topic. More research is needed along with pattern identifications.	4 - Questions are valid, testable or researchable, and based on observed patterns and/or research. More precision based on models or theory is needed.	5 - Questions are valid, precise, testable or researchable, based on patterns/ observations, specific evidence from current research and/or a specific model or theory, and push standard thinking on a given topic or in a particular discipline.
Defining a Problem - Defining the criteria and constraints for addressing a real-world problem through engineering design.			
1 -Begins to define a simple design problem with incomplete description of criteria or constraints. Student is not able to describe much information about the topic or components.	2 - Definition of a simple design problem is mostly complete. Representation of criteria for success and constraints is general. Student can describe topics and components but may be missing some details.	4 - Definition of the problem or design statement is complete. Identifies relevant criteria and constraints. Student can give information about the topics and details enough to address the question without revision.	5 - Definition of the problem or design statement is complete and includes rationale. Addresses multiple criteria and constraints relevant to the problem. Student can give a thorough and specific description of topics and details of components including WHY it needs to be addressed.
Designing a Solution - Designing a solution (e.g., an object, tool, process or system) that is supported by scientific ideas and meets criteria and constraints; evaluating and refining the solution through analysis of empirical evidence.			
1 - Designs a solution to address a problem with little or no connection to criteria or constraints.	2 - Designs a solution that meets one or more criteria and constrains the problem. Evaluation of the solution and the refined solution reflect minimal attention to empirical evidence.	4 -Designs a solution that refers to and applies to a relevant scientific idea and meets core and additional specific criteria and constraints. Evaluation of the solution and the refined solution refer to and are consistent with empirical evidence.	5 - Designs a solution that refers to and accurately applies relevant scientific idea(s) and makes trade-offs to satisfy prioritized criteria and meet constraints. Evaluation of the solution and the refined solution reflect analysis of empirical evidence.

Evaluating & Revising Design Solutions - Design solutions for a relevant problem, accounting for criteria and constraints, and drawing on empirical evidence, including the student's own generated evidence.			
1 - Makes a claim about the merit of a solution to a problem by discussing generally how it meets the criteria or constraints of the problem, with minimal reference to evidence. Testing and improvements to the process are lacking and are needed.	2 - Makes a claim about the merit of a solution to a problem by discussing how it meets specific criteria and constraints of the problem, with some reference to evidence. More information is needed for the process.	4 - Makes a claim that compares and evaluates competing design solutions to a real-world problem based on empirical evidence and scientific reasoning or analysis. Feedback was gathered for revision and improvement of the process.	5 - Project is based on real-world problem based on empirical evidence and scientific reasoning or analysis. For the selected design solution, explains whether empirical evidence satisfies design criteria and constraints. Experimental design is detailed, logical, and controls variables effectively.
Conducting the Experimental Process - Conducting the process using scientific method, variables, data collection, and safety guidelines.			
1 - Does not follow procedures or disregards safety; experiment not completed. No data collected or data irrelevant to the investigation.	2 - Attempts to follow procedures but inconsistently or with some confusion. Data are partially complete or lack clear organization. Significant data is missing key measurements or lacking analysis. Major procedural errors or unsafe practices interfere with validity.	4 - Follows most procedures accurately and safely. Minor errors do not affect results. Data are mostly complete and organized with analysis; minor inconsistencies in recording or analysis. All safety procedures are still followed.	5 - Follows all steps accurately and safely; procedures are well-organized and replicable. Shows initiative in problem-solving. Data are thorough, precise, and systematically recorded using appropriate tables, graphs, or digital tools.
Communicating Accurately & Precisely - Expressing, integrating, and applying specific content and/or conventions with accuracy and precision.			
1 - Not yet meeting expectations. Information lacks supporting detail or is inaccurate or missing entirely.	2 - Partially meeting expectations. Needs development of details in the procedure as well as revisions.	4 - Mostly meeting expectations. There are some revisions needed to fit time and supply limitations or more supporting details are needed.	5 - Fully meeting expectations. All required components are included and meet time requirements as well as limitations of supply dynamics.

Topic 1: Global Agricultural Challenges

Engaging Experience 1

Title: Filling the Global Grocery Bag

Suggested Length of Time: 90 minutes

Standards Addressed

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

Detailed Description/Instructions: Students learn what factors affect a country's ability to produce their own food and how food expenses differ throughout the world. Detailed lesson plans can be found at the following link: <https://agclassroom.org/matrix/lessons/29/>

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 2: Engineering Agricultural Solutions

Engaging Experience 1

Title: Aeroponic Engineering and Vertical Farming

Suggested Length of Time: 2-3 blocks

Standards Addressed

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

Detailed Description/Instructions: Students will use the *Engineering Design Process* to develop and construct an aeroponic garden to grow a food crop. Students will develop and apply an understanding of plant anatomy and physiology related to plant growth and ultimately discuss the possibilities and limitations of using vertical farming to produce our food. Detailed lesson plans can be found at the following link: <https://agclassroom.org/matrix/lessons/720/>

Bloom's Levels: Create

Webb's DOK: 4

Topic 3: Solution Trade-Offs and Impacts - Agricultural Issues

Engaging Experience 1

Title: The Challenge of Modern Farming

Suggested Length of Time: 1 block

Standards Addressed

Priority: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Detailed Description/Instructions: Students engage in a modern farming simulation, making decisions based on budget and modern practices in order to successfully grow a crop. Detailed lesson plans can be found at the following link: <https://nourishthefuture.org/curriculum/food-security/hs#challenge-modern-farming>

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 4: Herbicides, Pesticides, and Fertilizers

Engaging Experience 1

Title: From Farms to Phytoplankton - Using Models to Predict Nutrient Pollution

Suggested Length of Time: 3 blocks

Standards Addressed

Priority: PS2. B.2 - Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium.

Detailed Description/Instructions: Students will describe how scientists use models to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flow within systems. They will also recognize and describe the limitations of representing larger complex systems with models and illustrate how increased nutrient concentrations in rivers and streams from agricultural runoff can lead to algal blooms and dead zones at the mouths of drainage basins. Detailed lesson plans can be found at the following link:

[Lesson Plan | From Farms to Phytoplankton](#)

Bloom's Levels: Apply

Webb's DOK: 2

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
	Filling the Global Grocery Bag	Students learn what factors affect a country's ability to produce their own food and how food expenses differ throughout the world.	90 minutes
	Aeroponic Engineering and Vertical Farming	Students will use the <i>Engineering Design Process</i> to develop and construct an aeroponic garden to grow a food crop. Students will develop and apply an understanding of plant anatomy and physiology related to plant growth and ultimately discuss the possibilities and limitations of using vertical farming to produce our food.	2-3 blocks
	The Challenge of Modern Farming	Students engage in modern farming simulation, making decisions based on budget and modern practices to successfully grow a crop.	1 block
	From Farms to Phytoplankton - Using Models to Predict Nutrient Pollution	Students will describe how scientists use models to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flow within systems. They will also recognize and describe the limitations of representing larger complex systems with models and illustrate how increased nutrient concentrations in rivers and streams from agricultural runoff can lead to algal blooms and dead zones at the mouths of drainage basins.	3 blocks

What You're Working On (Standard)	4 – Exceeds	3 – Proficient	2 – Developing	1 – Beginning
Figuring out the problem: Analyze a global challenge and set clear rules/needs for your design (ETS1.A.1)	I clearly explain the big problem and list detailed rules/needs (both numbers and descriptions) that fully match what people want and need	I explain the big problem and list clear rules/needs that connect to what people want and need	I name the big problem but only list a few rules/needs, or they are vague	I don't clearly explain the big problem or give rules/needs that connect to what people want
Breaking it down: Design a solution by turning it into smaller, doable parts (ETS1.A.2)	I create a detailed solution with smaller steps that make sense, are realistic, and build toward the big goal	I design a solution and show smaller steps that mostly make sense and connect	I suggest a solution but the steps are unclear, incomplete, or don't connect well	I don't give a full solution or don't break it into smaller parts
Judging solutions: Evaluate ideas based on trade-offs like cost, safety, looks, and impact (ETS1.B.1)	I carefully compare solutions, explain trade-offs, and give strong reasons for my choice, considering cost, safety, looks, and impact on people and the planet	I compare solutions and explain trade-offs with reasons, touching on most of the important factors	I give limited comparisons or only talk about one or two factors	I don't compare solutions or use clear reasons
Making improvements: Change system conditions to adjust outcomes at equilibrium (PS2.B.2)	I clearly explain how changing specific conditions will change the amount of products, and connect it to improving the design	I explain how changing conditions will affect the amount of products	I suggest changes but don't explain them clearly or mix up how equilibrium works	I don't suggest changes, or my ideas don't connect to equilibrium

Culminating Student Design Project

Subject: Applied Science of Natural Resources

Grade: 9-12

Name of Project: Student Choice Ongoing Project

Length of Project: 3 weeks (interspersed days within the other 6 units finishing with a solid week for student design and presentation)

Overview of Project: In this unit, students will explore how engineers approach complex, real-world problems. They will analyze major global challenges and identify both qualitative and quantitative criteria, as well as constraints, to design solutions that address societal needs and wants. Students will learn how to break complex problems into smaller, manageable parts, develop creative and practical solutions, and evaluate their effectiveness. They will consider trade-offs such as cost, safety, reliability, aesthetics, and social, cultural, or environmental impacts when assessing solutions. Students will also design and conduct their own investigations based on these main concepts, collecting and analyzing data to support their conclusions. Their findings will be shared through a performance or presentation, demonstrating their ability to apply engineering thinking to solve real-world problems.

Priority Standards for project:

- ETS1. A.1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Essential Questions:

1. How can I use the engineering design process to develop and communicate an evidence-based solution to a real-world problem?

Enduring Understanding/Big Ideas:

1. Effective problem solving requires defining clear criteria and constraints, using data to guide design decisions, and communicating solutions that balance innovation, feasibility, and impact.

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

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify current agricultural challenges related to food production.	3
	Analyze
Students will describe and compare alternative farming methods.	2
	Apply

Priority Standard: ETS1. A.2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will utilize engineering methods to construct a solution to a current agricultural issue related to food production. (e.g. vertical, hydroponics, etc.)	4
	Create
Students will present their selected engineering method that proposes a solution to a current agricultural issue.	4
	Create

Priority Standard: ETS1. B.1 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will evaluate a real-world agricultural problem and identify constraints.	3
	Evaluate
Students will describe the social, cultural, and environmental impacts of a real-world agricultural problem.	2
	Apply

Engaging Scenario

Engaging Scenario Students will present a sustainable meal plan during a class food expo. The presentation will incorporate the following stages completed throughout the units:

- Stage 1 - Analyzing a Balanced Meal Using Nutrition Labels: Students will select a balanced meal that has a main dish that incorporates the five major food groups; appetizers, dessert, and optional drinks. Students will analyze the nutritional value of their meals using nutrition labels.
- Stage 2 - Physical and Chemical Influences and Limitations: Students will select three primary ingredients from their balanced meal and research the physical and chemical environmental factors that affect their production.
- Stage 3 - Food Production and Biodiversity: Students will research the impact the production of their three selected ingredients have on ecological and genetic diversity.
- Stage 4 - Biotechnology and Engineering: Students will describe how biotechnology and engineering practices are used to produce their three selected ingredients.
- Stage 5 - Food Security of Human Population: Students will explain how human population growth is affecting the demand for food production and associated practices.
- Stage 6 - Sustainable Meal Plan: Students will design a sustainable agriculture plan to produce their meal, focusing on their chosen three ingredients; the plan must address the environmental, biodiversity, biotechnology and engineering issues revealed in prior research. Students must also indicate how their sustainable agriculture plan relates to human population growth.

- Stage 7 - Presentation of Sustainable Meal: Students will create a visual display in a format of their choosing in a Sustainable Food Expo.

Stage 1: Analyzing a Balanced Meal Using Nutrition Labels

Criteria	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Nutrient Identification	Accurately identifies and explains all key nutrients (macronutrients & micronutrients) for each food item; includes calories, fat, protein, carbohydrates, fiber, vitamins/minerals, and added sugars.	Correctly identifies most key nutrients for each food item; minor mistakes or missing 1–2 items.	Identifies only basic nutrients or several errors; missing key parts of the label.	Incorrect or minimal nutrient identification; little use of label information.
Balanced Meal Evaluation	Clearly evaluates whether the meal is balanced using evidence (nutrition guidelines, food groups, % Daily Values). Shows strong understanding of nutritional needs.	Evaluates meal balance with some evidence and mostly accurate reasoning.	Attempts evaluation but uses limited evidence or demonstrates partial understanding.	Little or no attempt to evaluate balance; reasoning is inaccurate or unsupported.
Use of Nutrition Label Data	Uses nutrition label data accurately, including %DV and serving sizes. Compares values effectively across foods.	Uses label data correctly with minor errors. Uses %DV and serving size for most items.	Attempts to use label data but misinterprets values or misses serving size relevance.	Does not use nutrition label data correctly or relies on assumptions without labels.

Communication & Organization	Information is well-organized, clear, and visually appealing (charts, tables, etc.). Terminology is used correctly.	Mostly organized and clear; some minor errors or formatting issues.	Organization is inconsistent; hard to follow at times; vocabulary inconsistent.	Disorganized, unclear, and lacking nutrition vocabulary.
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Stage 2: Physical and Chemical Influences and Limitations

Criteria	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Identification of Ingredients & Background Information	Clearly identifies three ingredients (plants and/or livestock) and provides accurate, detailed background for each (species, origin, common uses).	Identifies three ingredients with mostly accurate background information.	Identifies three ingredients but background information is limited or partially inaccurate.	Fewer than three ingredients identified OR background information mostly inaccurate or missing.
Research on Growing / Raising Conditions	Accurately identifies and explains all major requirements for each ingredient: - Plants: climate, soil, water, sunlight, season, spacing, nutrient needs - Livestock: climate, housing, feed, water, space, health care, breeding needs	Identifies most requirements for each ingredient; minor details missing.	Provides only basic conditions (e.g., sun/water for plants, feed/water for livestock) OR conditions are incomplete/inaccurate.	Growing/raising conditions are mostly incorrect or missing.

Comparison & Explanation	Thoroughly compares conditions across ingredients and explains differences based on biological or ecological needs.	Compares conditions with some explanation of differences.	Attempts comparison but explanations are unclear or minimal.	No comparison or incorrect comparisons.
Application / Real-World Relevance	Applies knowledge to suggest where and how these ingredients could be successfully grown or raised regionally or globally; considers environmental, economic, or sustainability factors.	Suggests realistic locations or methods with some justification.	Provides location/method suggestions but little/no reasoning.	No real-world application or conclusions are incorrect.
Presentation & Organization	Information is well-organized, clear, and visually engaging (tables, charts, diagrams encouraged). Scientific terminology is accurate.	Organization and clarity are strong with minor issues.	Organization is inconsistent; information may be incomplete or confusing at times.	Disorganized, unclear, or lacking scientific vocabulary.
Use of Sources & Scientific Accuracy	Uses multiple credible sources, cites correctly, and presents highly accurate information.	Uses at least two credible sources with few errors.	Uses limited sources OR some inaccuracies present.	Uses unreliable/no sources OR information mostly inaccurate.

Stage 3: Food Production and Biodiversity

Criteria	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Analysis of Ecological Impacts	Thoroughly explains how production of each ingredient affects ecosystems (habitat loss, water use, pollution, deforestation, soil health, etc.) using evidence from credible sources.	Explains ecological impacts with mostly accurate information; minor omissions.	Provides limited analysis of ecological impacts; some inaccuracies or missing evidence.	Little or no explanation of ecological impacts; mostly inaccurate.
Analysis of Genetic Diversity Impacts	Clearly identifies and explains how ingredient production affects genetic diversity (monoculture, selective breeding, loss of heirloom varieties, livestock breeds) with strong supporting evidence.	Identifies most effects on genetic diversity; generally accurate.	Limited or partially inaccurate discussion of genetic diversity impacts.	Minimal or incorrect discussion of genetic diversity.
Use of Evidence & Sources	Uses multiple credible sources (scientific articles, databases, reputable organizations) and cites them correctly. Evidence strongly supports conclusions.	Uses at least two credible sources; minor citation errors; evidence mostly supports conclusions.	Limited sources or inconsistent credibility; evidence partially supports conclusions.	Uses unreliable/no sources; evidence does not support conclusions.

Comparison & Critical Thinking	Thoughtfully compares ecological and genetic impacts across ingredients; discusses trade-offs, long-term consequences, and sustainability.	Makes some comparisons and discusses basic trade-offs.	Limited comparisons; discussion of consequences is minimal or unclear.	No comparison or critical analysis present.
Presentation & Organization	Information is clear, well-organized, visually engaging (tables, diagrams, charts). Scientific terminology is used accurately.	Mostly clear and organized; minor issues with clarity or terminology.	Organization is inconsistent; information may be confusing; terminology limited.	Disorganized, unclear, and lacks proper terminology.

Stage 4: Biotechnology and Engineering in Food Production

Criteria	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Research on Biotechnology & Engineering Practices	Thoroughly explains biotechnological or engineering methods used for each ingredient (e.g., GMOs, CRISPR, selective breeding, hydroponics, precision agriculture, fermentation, synthetic biology). Uses accurate, detailed examples.	Explains most methods with generally accurate examples; minor details missing.	Provides only basic or partial explanation of methods; examples are limited or somewhat inaccurate.	Little or no explanation; methods are mostly incorrect or missing.

Impact Analysis	Clearly explain the effects of these practices on productivity, sustainability, environment, and/or human health. Provides strong evidence from credible sources.	Explains impacts with mostly accurate information; minor omissions.	Provides limited analysis of impacts; some inaccuracies or missing evidence.	Minimal or incorrect explanation of impacts; evidence missing.
Use of Evidence & Sources	Uses multiple credible sources (scientific articles, databases, reputable organizations) and cites them correctly; evidence strongly supports conclusions.	Uses at least two credible sources; minor citation errors; evidence mostly supports conclusions.	Limited sources or inconsistent credibility; evidence partially supports conclusions.	Uses unreliable/no sources; evidence does not support conclusions.
Comparison & Critical Thinking	Thoughtfully compares the biotechnological and engineering practices across ingredients; discusses trade-offs, benefits, risks, and ethical considerations.	Compares practices with some discussion of benefits/risks; limited ethical considerations.	Minimal comparison; discussion of benefits/risks is superficial or unclear.	No comparison or critical analysis present.
Presentation & Organization	Information is clear, well-organized, visually engaging (tables, diagrams, charts encouraged). Scientific terminology is accurate.	Mostly clear and organized; minor issues with clarity or terminology.	Organization is inconsistent; information may be confusing; terminology limited.	Disorganized, unclear, and lacks proper terminology.

Stage 5: Food Security of Human Population

Criteria	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Analysis of Food Security Challenges	Thoroughly identifies and explains multiple challenges to food security for a growing population (population growth, climate change, water scarcity, land degradation, conflict, supply chain issues) with evidence.	Identifies most challenges with generally accurate explanations; minor details missing.	Provides limited or partially inaccurate analysis of challenges.	Little or no identification of challenges; explanations mostly inaccurate or missing.
Use of Data & Evidence	Integrates multiple credible sources (scientific articles, UN/FAO data, reputable organizations) with accurate citations; data strongly supports conclusions.	Uses at least two credible sources; minor citation errors; evidence mostly supports conclusions.	Limited sources or inconsistent credibility; evidence partially supports conclusions.	Uses unreliable/no sources; evidence does not support conclusions.
Comparison & Global Perspective	Clearly compares food security issues across regions, countries, or populations; considers socio-economic and environmental contexts.	Makes some comparisons; perspective is somewhat global but limited.	Limited comparison; mostly local or superficial perspective.	No comparison or global perspective.
Presentation & Organization	Information is well-organized, clear, and visually engaging (tables, graphs, charts encouraged). Scientific terminology used correctly.	Mostly clear and organized; minor clarity or terminology issues.	Organization is inconsistent; information may be confusing; terminology limited.	Disorganized, unclear, or lacks proper terminology.

Stage 6: Sustainable Meal Plan

Criteria	5 – Exemplary	4 – Proficient	3 – Developing	2 – Emerging	1 – Beginning
Understanding of Climate Change Impacts on Ingredients	Provides an insightful, well-researched explanation of how climate change specifically affects each of the 3 key ingredients (e.g., drought, pests, temperature shifts). Demonstrates clear cause-and-effect reasoning.	Explains relevant climate impacts for each ingredient with good accuracy and supporting detail.	Identifies some relevant climate impacts, but explanations may be general or uneven across ingredients.	Mentions limited or unclear connections between climate change and ingredients; lacks supporting detail.	Shows little or no understanding of how climate change impacts ingredients.
Application of Biotechnology and Engineering Solutions	Clearly explains and justifies innovative biotechnology and engineering solutions (e.g., gene editing, bioengineering, precision agriculture) that directly address each ingredient's climate challenges.	Describes reasonable biotechnology and engineering approaches that relate to the identified challenges.	Suggests basic or partially relevant biotechnology and engineering ideas; some lack feasibility or direct connection.	Mentions biotechnology and engineering vaguely without connecting it to specific climate issues.	Does not demonstrate understanding of biotechnology and engineering or associated applications.

Sustainability and Societal Impact	Thoughtfully evaluates how the proposed biotech solutions promote sustainability (environmental, economic, and social) and considers ethical implications.	Discusses sustainability benefits with some reference to ethical or societal dimensions.	Mentions sustainability generally but without deep consideration of trade-offs or broader impact.	Limited mention of sustainability; may overlook important ethical or social aspects.	No consideration of sustainability or societal impact.
Creativity and Integration in Meal Design	Meal design is creative, cohesive, and integrates all three modified ingredients seamlessly; presentation shows originality and practicality.	Meal design is well thought out with logical integration of the ingredients and moderate creativity.	Meal concept is clear but lacks full integration of ingredients or originality.	Meal design is incomplete or disjointed; unclear link to ingredients or biotech solutions.	No meaningful meal concept or connection to ingredients.
Communication and Presentation	Presentation is clear, engaging, and uses strong visuals, organization, and language to effectively communicate scientific and design ideas.	Presentation is clear and organized; visuals and explanations support understanding.	Presentation is understandable but lacks polish, clarity, or strong organization.		

Stage 7 - Presentation at Food Expo

Asking Questions - Developing focused, answerable inquiry and research questions.			
1 - Questions are relevant to a specific topic, but are missing components to be testable.	2 - Questions are relevant to a specific topic, are testable or researchable, and build on prior knowledge about the topic. More research is needed along with pattern identifications.	4 - Questions are valid, testable or researchable, and based on observed patterns and/or research. More precision based on model or theory is needed.	5 - Questions are valid, precise, testable or researchable, based on patterns/ observations, specific evidence from current research and/or a specific model or theory, and push standard thinking on a given topic or in a particular discipline.
Defining a Problem - Defining the criteria and constraints for addressing a real-world problem through engineering design.			
1 -Begins to define a simple design problem with incomplete description of criteria or constraints. Student is not able to describe much information about the topic or components.	2 - Definition of a simple design problem is mostly complete. Representation of criteria for success and constraints is general. Student can describe topics and components, but may be missing some details.	4 - Definition of the problem or design statement is complete. Identifies relevant criteria and constraints. Student can give information about the topics and details enough to address the question without revision.	5 - Definition of the problem or design statement is complete and includes rationale. Addresses multiple criteria and constraints relevant to the problem. Student can give a thorough and specific description of topics and details of components including WHY it needs to be addressed.
Designing a Solution - Designing a solution (e.g., an object, tool, process or system) that is supported by scientific ideas and meets criteria and constraints; evaluating and refining the solution through analysis of empirical evidence.			
1 - Designs a solution to address a problem with little or no connection to criteria or constraints.	2 - Designs a solution that meets one or more criteria and constraints of the problem. Evaluation of the solution and the refined solution reflect minimal attention to empirical evidence.	4 -Designs a solution that refers to and applies a relevant scientific idea and meets core and additional specific criteria and constraints. Evaluation of the solution and the refined solution refer to and are consistent with empirical evidence.	5 - Designs a solution that refers to and accurately applies relevant scientific idea(s) and makes trade-offs to satisfy prioritized criteria and meet constraints. Evaluation of the solution and the refined solution reflect analysis of empirical evidence.

Evaluating & Revising Design Solutions - Design solutions for a relevant problem, accounting for criteria and constraints, and drawing on empirical evidence, including the student's own generated evidence.			
1 - Makes a claim about the merit of a solution to a problem by discussing generally how it meets the criteria or constraints of the problem, with minimal reference to evidence. Testing and improvements to the process are lacking and are needed.	2 - Makes a claim about the merit of a solution to a problem by discussing how it meets specific criteria and constraints of the problem, with some reference to evidence. More information is needed for the process.	4 - Makes a claim that compares and evaluates competing design solutions to a real-world problem based on empirical evidence and scientific reasoning or analysis. Feedback was gathered for revision and improvement of the process.	5 - Project is based on real-world problem based on empirical evidence and scientific reasoning or analysis. For the selected design solution, explains whether empirical evidence satisfies design criteria and constraints. Experimental design is detailed, logical, and controls variables effectively.
Conducting the Experimental Process - Conducting the process using scientific method, variables, data collection, and safety guidelines.			
1 - Does not follow procedures or disregards safety; experiment not completed. No data collected or data irrelevant to the investigation.	2 - Attempts to follow procedures but inconsistently or with some confusion. Data are partially complete or lack clear organization. Significant data is missing key measurements or lacking analysis. Major procedural errors or unsafe practices interfere with validity.	4 - Follows most procedures accurately and safely. Minor errors do not affect results. Data are mostly complete and organized with analysis; minor inconsistencies in recording or analysis. All safety procedures are still followed.	5 - Follows all steps accurately and safely; procedures are well-organized and replicable. Shows initiative in problem-solving. Data are thorough, precise, and systematically recorded using appropriate tables, graphs, or digital tools.
Communicating Accurately & Precisely - Expressing, integrating, and applying specific content and/or conventions with accuracy and precision.			
1 - Not yet meeting expectations. Information lacks supporting detail or is inaccurate or missing entirely.	2 - Partially meeting expectations. Needs development of details in the procedure as well as revisions.	4 - Mostly meeting expectations. There are some revisions needed to fit time and supply limitations or more supporting details are needed.	5 - Fully meeting expectations. All required components are included and meet time requirements as well as limitations of supply dynamics.

Unit of Study Terminology

Appendices: All Appendices and supporting material can be found in this course's shell course in the District's Learning Management System.

Assessment Leveling Guide: A tool to use when writing assessments in order to maintain the appropriate level of rigor that matches the standard.

Big Ideas/Enduring Understandings: Foundational understandings teachers want students to be able to discover and state in their own words by the end of the unit of study. These are answers to the essential questions.

Engaging Experience: Each topic is broken into a list of engaging experiences for students. These experiences are aligned to priority and supporting standards, thus stating what students should be able to do. An example of an engaging experience is provided in the description, but a teacher has the autonomy to substitute one of their own that aligns to the level of rigor stated in the standards.

Engaging Scenario: This is a culminating activity in which students are given a role, situation, challenge, audience, and a product or performance is specified. Each unit contains an example of an engaging scenario, but a teacher has the ability to substitute with the same intent in mind.

Essential Questions: Engaging, open-ended questions that teachers can use to engage students in learning.

Priority Standards: What every student should know and be able to do. These were chosen because of their necessity for success in the next course, the state assessment, and life.

Supporting Standards: Additional standards that support the learning within the unit.

Topic: These are the main teaching points for the unit. Units can have anywhere from one topic to many, depending on the depth of the unit.

Unit of Study: Series of learning experiences/related assessments based on designated priority standards and related supporting standards.

Unit Vocabulary: Words students will encounter within the unit that are essential to understanding. Academic Cross-Curricular words (also called Tier 2 words) are those that can be found in multiple content areas, not just this one. Content/Domain Specific vocabulary words are those found specifically within the content.