NGSS OVERVIEW

SUSTAINABILITY: CHANGING HUMAN IMPACT

Note: This four-activity introductory sequence is constructed around two NGSS science and engineering practices and addresses two relevant disciplinary core ideas and two crosscutting concepts. While the sequence introduces many foundational concepts, it does not address a Performance Expectation in its entirety. For this reason, no Performance Expectation is listed for this initial sequence.

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1	**Changing Landscapes** Students analyze and interpret data that reveals global environmental changes induced by human activity. They focus on tree cover loss and its primary causes in four different regions and generate questions about observed changes. The crosscutting concept of *stability and change* is introduced as students consider connections to sustainability.	LS2.C ETS1.B	Asking Questions and Defining Problems	Stability and Change	Mathematics: MP.2 ELA/Literacy: RST.11-12.7
2	**Measuring Human Impact** Students conduct a laboratory experiment to test soil samples for organic matter, using an experimental control as a basis of comparison. They analyze and interpret the data to determine the effect of human land use on the quality of soil. The class learns about the crosscutting concept of *cause and effect* as they discuss the economic, social, and environmental impacts of different kinds of land use.	LS2.C ETS1.B	Asking Questions and Defining Problems	Cause and Effect Stability and Change	Mathematics: MP.2 ELA/Literacy: RST.11-12.7
3	**Our Global Community** Students analyze and interpret patterns in indicator data pertaining to the three pillars of sustainability, including indicators of human activity and impacts on the environment and biodiversity. They evaluate the impacts of human activity on sustainability and consider social, economic, and environmental impacts.	LS-2.C ETS1.B	Asking Questions and Defining Problems	Cause and Effect	Mathematics: MP.2 MP.4 ELA/Literacy: RST.11-12.7

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
4	**Sustaining the Commons** Students use a physical model of a commercial fishery to explore the impact of human choices and actions on a shared resource and how changes in human activity affect that resource. Students test the effects of different fishing limits on the fish populations in the fishery, in terms of both population size and the diversity of species. Students investigate the trade-offs involved with setting different limits on the use of the resources. They use the model to design and test the effects of a variation on the limits of resource use.	LS-2.C ETS1.B	Asking Questions and Defining Problems Developing and Using Models	Cause and Effect Stability and Change	Mathematics: MP.2 MP.4 ELA/Literacy: 6.SP.B.5 RST.11-12.7

NGSS OVERVIEW

ECOLOGY: LIVING ON EARTH

Performance Expectations

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

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

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1	**Establishing a Baseline** In this activity, students examine two commonly used methods to quantify population size in a variety of organisms and determine how best to estimate the size of a population. Students work through the two methods using the science and engineering practice of *using mathematics and computational thinking* in order to compute or estimate population size. Students brainstorm causal relationships for the changes in population growth for four example populations exhibiting different growth patterns. This requires students to activate their prior middle school learning about interdependent relationships in ecosystems. *Working Toward* HS-LS2-1	LS2.A	Using Mathematics and Computational Thinking Asking Questions and Defining Problems Developing and Using Models	Scale, Proportion, and Quantity	Mathematics: MP.2 MP.4 HSN.Q.A.1 HSN.Q.A.2 HSS-IC.A.1

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
2	**Population Growth Models** Building on their understanding of how researchers estimate population size and then use that data, in this activity students consider how to use mathematical and computational thinking to describe changes in population size. They use a computer simulation to explore two models of population growth, and examine the patterns in the data generated by the two models. By drawing on the disciplinary core ideas from middle school regarding abiotic and biotic resources that can limit population size, students begin thinking about what might cause the population changes depicted in Activity 1. *Working Toward* HS-LS2-1	LS2.A	Using Mathematics and Computational Thinking Developing and Using Models	Scale, Proportion, and Quantity Patterns Stability and Change	Mathematics: MP.2 MP.4 HSN.Q.A.1 HSN.Q.A.2 HSS-IC.A.1
3	**Factors Affecting Population Size** Students examine factors affecting the nesting success, and thus the population growth, of song sparrows on Mandarte Island. Students use a computer simulation based on real data to perform a quantitative analysis and comparison of multiple factors affecting the carrying capacity of song sparrows, including resources, climate, competition, and characteristics of individual birds. This activity completes the first learning sequence and provides an opportunity to assess Performance Expectation HS-LS2-1. *Assessing* HS-LS2-1 *Working toward* HS-LS2-2	LS2.A LS2.C	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data	Scale, Proportion, and Quantity Cause and Effect	Mathematics: MP.2 MP.4 HSN.Q.A.1 HSN.Q.A.2 HSS-IC.A.1

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
4	**Scaling Up: Ecosystems** Students obtain information about four different ecosystems to determine what defines an *ecosystem*. They use the crosscutting concept of *systems and system models* to identify that ecosystems are defined by their components, the interactions among those components, and their boundaries. They also use the crosscutting concept of *scale, proportion, and quantity* to realize that an ecosystem can exist at many different scales, from vast to tiny. *Working Toward* HS-LS2-2 *Applying* HS-LS2-1	LS2.A LS2.C	Developing and Using Models Obtaining, Evaluating, and Communicating Information	Scale, Proportion, and Quantity Systems and System Models	ELA/ Literacy: RST.11-12.5
5	**Patterns of Biological Diversity** Students examine quantitative data, represented on maps, for five different groups of organisms to identify patterns in their distribution across the United States or the world. Students look at one map and develop an initial explanation for what might cause the different distribution patterns they observe. After examining maps of additional abiotic factors that might help explain these patterns, students revise their explanations. This activity provides an opportunity to assess Performance Expectation HS-LS2-2. *Assessing* HS-LS2-2	LS2.A LS2.C	Analyzing and Interpreting Data Constructing Explanations Using Mathematics and Computational Thinking Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Scale, Proportion, and Quantity Patterns Cause and Effect	Mathematics: MP.2 MP.4 ELA/ Literacy: RST.11-12.5
6	**Producers and Consumers** Students begin their investigation of the flow of energy and the cycling of matter in ecosystems by looking at these processes on a macroscopic scale. They analyze patterns in population data and use their observations as evidence to develop explanations for the role of phytoplankton as the basis for the ocean ecosystem. Students draw on disciplinary core ideas from middle school that relate to the cycling of matter and the flow of energy, food web models, and interactions of organisms within ecosystems. *Working toward* HS-LS2-3 *Working toward* HS-LS2-4	LS2.B	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	Energy and Matter Scale, Proportion, and Quantity	ELA/ Literacy: RST.11-12.7 RST.11-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
7	**The Photosynthesis and Cellular Respiration Shuffle** Students investigate the cellular processes of photosynthesis and cellular respiration in order to develop explanations of how these processes drive matter cycling and energy flow in ecosystems. Students deepen their understanding of the inputs, outputs, and cyclical nature of these processes as they revise their ecosystem models from the previous activity to incorporate cellular-level interactions. *Working toward* HS-LS2-3 *Working toward* HS-LS2-4	LS2.B	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	Energy and Matter Scale, Proportion, and Quantity	ELA/ Literacy: RST.11-12.7 RST.11-12.9
8	**Life in the Dark** Having constructed an initial explanation for the cycling of matter and the flow of energy in an ecosystem where photosynthesis provides the energy for life processes, students use video and text to obtain more information about other conditions in which these life processes occur. Students revise their initial explanations to include the process of chemosynthesis, while deepening their understanding that independent of the source of energy, all ecosystems rely on the flow of energy and the cycling of matter. This activity provides an opportunity to assess Performance Expectation HS-LS2-3. *Assessing HS-LS2-3*	LS2.B	Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information Connections to Nature of Science: Knowledge is Open to Revision in Light of New Evidence	Energy and Matter	ELA/ Literacy: RST.11-12.7 RST.11-12.9
9	**Modeling Energy Flow in Ecosystems** Students evaluate models of energy transfer in ecosystems in order to determine the best representation of that process. They use proportional reasoning to determine the inefficiencies in this process, and analyze mathematical representations and text-based evidence to support and revise their evaluations, ultimately developing an evidence-based explanation for their choice of best model. *Working toward* HS-LS2-4	LS2.B	Using Mathematics and Computational Thinking Engaging in Argument from Evidence Developing and Using Models	Energy and Matter Scale, Proportion, and Quantity	Mathematics: MP.2 MP.4 ELA/ Literacy: RST.11-12.7 RST.11-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
10	**Crossing Ecosystem Boundaries** Students expand their existing models of the ocean-based orca ecosystem to show how Chinook salmon cross ecosystem boundaries. Students then develop new models to illustrate the connections between energy flow and matter cycling in the river ecosystem, including mathematical representations of energy transformation efficiencies within this ecosystem. They use these models to construct explanations for the cycling of matter, the flow of energy, and how matter and energy are conserved within the ecosystem. Build Understanding item 2 is an opportunity to formally assess Performance Expectation HS-LS2-4. *Assessing* HS-LS2-4	LS2.B	Using Mathematics and Computational Thinking Engaging in Argument from Evidence Developing and Using Models	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Mathematics: MP.2 MP.4 ELA/ Literacy: RST.11-12.7 RST.11-12.9
11	**Ecosystems and the Carbon Cycle** Students develop an initial system model based on atmospheric carbon dioxide data to explain the cycling of carbon among Earth's four subsystems. Based on this model, students explain the role of cellular respiration and photosynthesis in the flux of carbon dioxide between the biosphere and the atmosphere. *Working toward* HS-LS2-5	LS2.B PS3.D	Developing and Using Models Analyzing and Interpreting Data	Systems and System Models Energy and Matter	Mathematics: MP.2 MP.4
12	**Rebalancing the Equation?** Students revise their system models of the global carbon cycle to account for the increase in atmospheric carbon dioxide levels in the last 100 years. Students incorporate additional data on increased carbon dioxide production that results from human activity. They use their revised models to analyze the feasibility of ecosystem-based solutions for the increased carbon dioxide levels. Procedure Step 4 provides an opportunity to formally assess Performance Expectation HS-LS2-5. *Assessing* HS-LS2-5	LS2.B PS3.D	Developing and Using Models Analyzing and Interpreting Data	Systems and System Models Energy and Matter	Mathematics: MP.2 MP.4 ELA/ Literacy: RST.11-12.5

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
13	**Ecosystems at the Tipping Point** Students obtain information about the causes and short- and long-term effects of natural and anthropogenic disruptions in two ecosystems. Students obtain information from a video about the Aral Sea. They identify the cause-and-effect relationships that led to the instability and ultimate collapse of this ecosystem. They evaluate claims, or make a new claim, about disruptions to this ecosystem based on evidence from the video. *Working toward* HS-LS2-6 *Working toward* HS-LS2-7	LS2.C LS2.A	Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information	Cause and Effect Stability and Change	ELA/ Literacy: RST.11-12.5 RST.11-12.7 WHST.9-12.1
14	**The Great Lakes Ecosystem** Students obtain and evaluate scientific information from a variety of sources to evaluate the claim that if two species of carp were to invade the Great Lakes, the ecosystem would be permanently changed and possibly collapse. Students explore engineering solutions to prevent this invasion. *Assessing* HS-LS2-6 *Working toward* HS-LS2-7	LS2.C LS2.A	Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Cause and Effect Stability and Change	Mathematics: MP.2 ELA/ Literacy: RST.11-12.9 WHST.9-12.7 WHST.9-12.1
15	**Is Aquaculture a Solution?** Students begin to consider strategies for reducing the impact of human activities on the environment, specifically related to fisheries. Students examine the complexity of interactions in these ecosystems and how the ecosystems are impacted by human activity. They begin to develop criteria and constraints for possible solutions, based on scientific evidence and trade-off considerations. *Applying* HS-LS2-6 *Working toward* HS-LS2-7	ETS1.A ETS1.B LS2.C LS4.D	Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Stability and Change	Mathematics: MP.2 HSS-IC.B.6 ELA/ Literacy: RST.11-12.7 WHST.9-12.7

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
16	**Sustainable Fisheries Case Studies** Students evaluate four possible strategies for sustainable fisheries, incorporating information on ecosystem dynamics, functioning, and resilience. Students consider the possible economic, social, and environmental impact of these changes to the associated ecosystems and how lessons learned from their evaluation could be applied to designing, evaluating, and refining a solution for another fishery. *Applying* HS-LS2-6 *Working toward* HS-LS2-7	ETS1.A ETS1.B LS2.C LS4.D	Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Stability and Change	Mathematics: MP.2 HSS-IC.B.6 ELA/ Literacy: RST.11-12.7 WHST.9-12.7
17	**Making Sustainable Fisheries Decisions** Students complete the unit by designing a monitoring plan for one fisheries-management strategy, setting the criteria and constraints for the plan. They evaluate the plan using data based on their monitoring plan. Their final task is to refine or change their plan based on their data evaluation. *Assessing* HS-LS2-7	S2.C LS4.D ETS1.B	Constructing Explanations and Designing Solutions	Stability and Change	Mathematics: MP.2 ELA/ Literacy: RST.11-12.7 WHST.9-12.7

NGSS OVERVIEW

CELLS: IMPROVING GLOBAL HEALTH

Performance Expectations

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

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

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

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

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

HS-LS1-7: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

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

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1	**Survival Needs** A scenario involving an environment of extreme heat motivates students' exploration of the phenomenon of *homeostasis* and the environmental conditions that can challenge the body's ability to maintain homeostasis. Students investigate the effects of extreme heat by imagining a survival scenario in a desert and ranking the importance of 13 items (such as food, water, and clothing) for survival. Through this exploration of challenges to homeostasis, students develop concepts related to stability and change in the human body. Students begin to generate questions about how the body maintains homeostasis. *Working toward HS-LS1-3* *Working toward HS-LS2-7*	LS1.A ETS1.B	Asking Questions and Defining Problems	Stability and Change Patterns	Mathematics: MP.2

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
2	**Everyday Hydration** Students consider the effects of dehydration on the structure and function of the human body, using plant cells as a model. Students conduct an investigation of plant cells to explore the effects of changing conditions on homeostasis at the level of the cell. They apply what they observe at the cellular level to create an explanation of how these changing conditions affect other levels of structure and function. A question about tourist water consumption raises the issue of sustainability and prompts students to weigh evidence and consider the trade-offs of limiting the number of tourists at popular travel destinations. Note: "Review and Refresh: Cell Structure and Function," an optional reading provided in the Student Book, can serve as either a review of NGSS middle school cell concepts or a reference for students. *Working toward HS-LS1-2* *Working toward HS-LS1-3* *Working toward HS-LS2-7*	LS1.A	Constructing Explanations and Designing Solutions Planning and Carrying Out Investigations	Stability and Change Scale, Proportion, and Quantity	ELA/Literacy: RST.11-12.3
3	**Homeostasis Disrupted** Students explore three case studies on infectious and non-infectious diseases that explain how disruptions to homeostasis can result in illness or be caused by illness. They examine models of how the body's systems and subsystems work together to maintain homeostasis when challenged with changing external or internal conditions. The role of negative feedback loops in maintaining homeostasis is introduced. Students apply what they learn about specific feedback loops to create another model. *Working toward HS-LS1-2* *Working toward HS-LS1-3* *Working toward HS-LS2-7*	LS1.A	Developing and Using Models Constructing Explanations and Designing Solutions	Systems and System Models Stability and Change Cause and Effect	ELA/Literacy: RST.9-10.1

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
4	**Body Systems in Balance** As students sort cards representing levels of organization in the human body system, they develop models of four different systems—cardiovascular, digestive, respiratory, and endocrine—at varying levels of organization and scale. They apply what they learn to construct explanations for how various diseases disrupt the normal functions of body systems and thereby disrupt homeostasis. *Working toward HS-LS1-2* *Working toward HS-LS1-3*	LS1.A	Developing and Using Models Constructing Explanations and Designing Solutions	Structure and Function Stability and Change Systems and System Models Scale, Proportion, and Quantity	ELA/Literacy: RST.9-10.7
5	**Evidence of Disease** Based on their observations of the blood cells of normal individuals and individuals with disease symptoms, students construct causal explanations of how structural changes observed at the cellular level can lead to disruptions in the function of tissues, organs, body systems, and the organism and thereby disrupt homeostasis. Students discuss how knowing the ways in which levels of organization in a human body system interact helps doctors and scientists diagnose and study diseases. *Working toward HS-LS1-2* *Working toward HS-LS1-3*	LS1.A	Constructing Explanations and Designing Solutions Connections to Nature of Science	Connections to Nature of Science Stability and Change Structure and Function	ELA/Literacy: RST.9-10.7
6	**Specialized Cells and Disease** Students make sense of how various diseases disrupt normal cellular functions, and further develop the idea that a disruption at one level of hierarchy of a system can disrupt its overall functioning and homeostasis. Students use a computer simulation to explore how specialized cells and their specialized protein components carry out normal functions on a cellular level. Students then develop and use a model drawn from the simulation to construct explanations of how disease can disrupt normal functioning at the cellular level. This activity provides an opportunity to assess Performance Expectation HS-LS1-2 *Working toward HS-LS1-1* *Assessing HS-LS1-2*	LS1.A	Developing and Using Models Constructing Explanations and Designing Solutions	Systems and System Models Structure and Function Scale, Proportion, and Quantity	ELA/Literacy: SL.11-12.5 WHST.9-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
7	**Homeostasis and Medical Treatment** The worldwide spread of COVID-19 (caused by the novel coronavirus) highlights many issues related to global health, sustainability, and science. Students read about the effect of the disease on interacting systems and their functions. A feedback loop on breathing helps explain how homeostasis is disrupted. Students consider information about human immune responses and medical treatments used to restore homeostasis. Students are further assessed on Performance Expectation HS-LS1-2. *Assessing HS-LS1-2* *Working toward HS-LS1-3* *Working toward HS-LS2-7*	LS1.A	Developing and Using Models Constructing Explanations and Designing Solutions	Systems and System Models Stability and Change	ELA/Literacy: RST.9-10.1
8	**Feedback Loops in Humans** Students plan and conduct an investigation to gather data on how human body systems—specifically, the circulatory and respiratory systems—interact to maintain homeostasis. Students analyze and interpret data on their own heart and respiratory rates before and after exercise, and construct an explanation of how these two systems interact to perform a function. During their work in Procedure Part B, students are assessed on Performance Expectation HS-LS1-3. Students use the relevant science and engineering practice of *planning and carrying out investigations* as they complete Part B. Students later use the science and engineering practice of *constructing explanations and designing solutions* to communicate their understanding of how feedback mechanisms maintain homeostasis. *Applying HS-LS1-2* *Assessing HS-LS1-3*	LS1.A	Planning and Carrying Out Investigations Constructing Explanations and Designing Solutions Analyzing and Interpreting Data	Systems and System Models Stability and Change	ELA/Literacy: RST.11-12.3 RST.11-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
9	**Global Nutrition** Students interpret data to identify global disparities in the food supply and explain the impacts of an unhealthy food supply on human homeostasis related to energy balance. They begin to construct an explanation of the ways that humans use food as a source of energy and matter. *Applying HS-LS1-3* *Working toward HS-LS1-6* *Working toward HS-LS2-7*	LS1.A LS1.C ETS1.B	Constructing Explanations and Designing Solutions Developing and Using Models	Energy and Matter Scale, Proportion, and Quantity Patterns Systems and System Models	ELA/Literacy: RST.11-12.7
10	**Burning Calories** Students investigate the energy stored in food by measuring the energy transferred from food to the environment when the food is burned. They use their results and a systems approach to develop a model to explain the flow and conservation of energy in the food-environment-water system they are using to measure energy transfer. Students apply what they have learned to develop a preliminary idea of how to use graphs to model the energy changes that take place during a combustion reaction or cellular respiration. *Working toward HS-LS1-6* *Working toward HS-LS1-7* *Working toward HS-LS2-3*	LS1.C LS2.B	Developing and Using Models Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Connections to Nature of Science	Energy and Matter Systems and System Models	ELA/Literacy: RST.11-12.3
11	**How Plants Make Food** Students more closely examine the process of photosynthesis through experiments from the history of science. Students draw on their investigations in the previous activity and the evidence provided in this activity to construct and revise an explanation for the formation of carbon-based molecules and the storage of energy during photosynthesis. Students consider how new food products could potentially address global nutritional needs and how this relates to the issue of sustainability. *Assessing HS-LS1-5* *Working toward HS-LS1-6*	LS1.C	Constructing Explanations and Designing Solutions Connections to Nature of Science	Energy and Matter Connections to Nature of Science	ELA/Literacy: RST.9-10.1

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
12	**Photosynthesis and the Environment** Students design and conduct an investigation of how environmental variables affect the rate of matter cycling and energy flow due to photosynthesis. They consider limitations on the precision of the data and refine their designs accordingly. They relate their findings to the previous activity on the effects of global changes on nutritional sustainability and to their understandings about the movement of matter and energy that they began to develop in Ecology: Living on Earth. *Applying HS-LS1-5*	LS1.C	Planning and Carrying Out Investigations Constructing Explanations and Designing Solutions	Energy and Matter Cause and Effect	ELA/Literacy: RST.11-12.3
13	**Feeding the World's Population** Students reinforce their understanding of global changes that can affect the supply and quality of food and how this has resulted in a decrease in available food calories in some parts of the world. Graphs and data sets provide multiple models from which students construct preliminary explanations of the changing supply and quality of food. Students generate questions, determine patterns they see in the data, and consider the sustainability of the food supply and how changes in food supply and quality might affect human health.. *Applying HS-LS1-5* *Working toward HS-LS1-6* *Working toward HS-LS2-7*	LS1.C LS2.B	Constructing Explanations and Designing Solutions Using Mathematics and Computational Thinking	Patterns Cause and Effect Connections to Nature of Science Stability and Change Energy and Matter	Mathematics: MP.2 ELA/Literacy: RST.11-12.7

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
14	**Investigating Cellular Respiration** Students plan and carry out an investigation of respiration by germinated beans to produce data that will serve as evidence for the continual need for cellular respiration by bean plants. Students observe their evidence for the breakdown of glucose during the chemical process of respiration through the release of carbon dioxide as a product, and they identify factors that do and do not affect the rate of cellular respiration. Students apply the results of their investigation to explain how plants are able to survive in the winter after dropping their leaves and how the sustainability of the food supply might be affected by global changes that affect plants. *Working toward HS-LS1-6* *Working toward HS-LS1-7*	LS1.C LS2.B	Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Connections to Nature of Science	Energy and Matter Cause and Effect	ELA/Literacy: WHST.9-12.2
15	**Energy For Life** This activity provides a deeper dive into the mechanism for the energy changes that take place during cellular respiration. Students build their understanding of a critical difference between combustion and cellular respiration: In combustion, the chemical energy stored in food is released as thermal energy and light, whereas in cellular respiration, some of the chemical energy stored in food is released as thermal energy to maintain body temperature, but a significant amount is stored in a form useful to cells. Students continue to build their disciplinary knowledge about cellular respiration, and they use models to develop explanations for the flow and conservation of energy transferred from food to an organism. This activity provides an opportunity to assess Performance Expectation HS-LS1-7. It also provides an opportunity to assess the anaerobic aspect of Performance Expectation LS2-3. *Applying HS-LS1-5* *Working toward HS-LS1-6* *Assessing HS-LS1-7* *Assessing HS-LS2-3*	LS1.C	Developing and Using Models Constructing Explanations and Designing Solutions	Energy and Matter Scale, Proportion, and Quantity	ELA/Literacy: WHST.9-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
16	**Matter for Cells** Students use evidence from cards to develop models that explain how the body uses matter from food. Students relate what they learn about matter and energy at the levels of different structures of an organism to what they learned in Ecology: Living on Earth about the cycling of matter and the flow of energy in ecosystems. This activity completes the second learning sequence in this unit and provides an opportunity to assess Performance Expectation HS-LS1-6. *Assessing HS-LS1-6* *Applying HS-LS1-7*	LS1.A LS1.C LS2.B	Developing and Using Models Constructing Explanations and Designing Solutions	Energy and Matter	ELA/Literacy: WHST.9-12.2
17	**Designing Solutions: World Health** Students apply the concepts they have learned over the course of the unit to develop an integrated approach to human health, using a case study as a model. Students work as a class to apply this integrated approach to an emerging human health challenge in their local community. In their groups, students select an emerging global pattern on which to focus, and identify the stakeholders involved. Each group member selects a stakeholder to represent and then brainstorms a solution from that stakeholder's perspective. Group members integrate the various solutions into one proposal and present their work to the class. *Working toward HS-LS2-7*	ETS1.B	Constructing Explanations and Designing Solutions Asking Questions and Defining Problems	Stability and Change Connections to Nature of Science	ELA/Literacy: SL.11-12.5

NGSS OVERVIEW

GENETICS: FEEDING THE WORLD

Performance Expectations

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

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

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

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

HS-LS3-2: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

HS-LS3-3: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1	**Superweeds! Where Did They Come From?** Students begin the unit by engaging in argument from evidence pertaining to how *superweeds* (weeds that are herbicide-resistant) could have gotten into a farmer's corn fields. Students consider the cause and effect of growing genetically modified plants and consider if this is the explanation behind the presence of superweeds. They begin to explore the different ways that genes can be passed from one organism to another. *Working toward HS-LS3-2*	LS3.B	Engaging in argument from evidence	Cause and effect	Mathematics: MP.2 ELA/ Literacy: WHST.9-12.1
2	**Creating Genetically Modified Bacteria** To explore how scientists create GMOs, students genetically modify *E. coli* to express GFP and ampicillin resistance. They consider how the structure and function of a protein can yield a visible trait (e.g., glowing bacteria). They explore how genetic modification can be used to express proteins that can be used as biofuels. Students construct explanations about how they modified *E. coli*, what they observed, and how they know that the modification was successful. *Working toward HS-LS1-1*	LS1.A (LS1-1)	Constructing explanations and designing solutions	Structure and function	ELA/ Literacy: WHST.9-12.2 WHST.9-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
3	**Mitosis and Asexual Reproduction** To understand how genetic information is replicated and passed from parent to daughter cells, students develop and use a model to explain the process of mitosis. Students view a mitosis simulation and then create a system model by drawing and annotating each phase of mitosis. Students discuss the probability that daughter cells will receive an inserted gene from a genetically modified parent cell. *Working toward HS-LS1-4*	LS3.A LS1.B	Developing and using models	Systems and system models Structure and function	Mathematics: MP.4
4	**Breeding Corn** To understand how genes are passed from parent to offspring, students determine the genotypes of offspring by using a Punnett square for one trait. Students ask questions about and discuss the causes of varied phenotypes in the resulting offspring. Students predict the expected ratio from crossing two heterozygous parents, and analyze example crosses to determine parental genotypes based on offspring results. *Working toward HS-LS3-1* *Working toward HS-LS3-3*	LS3.A LS3.B	Asking questions and defining problems Analyzing and interpreting data Using mathematics and computational thinking	Cause and effect Scale, proportion, and quantity	ELA/ Literacy: RST.11-12.9
5	**Breeding Corn for Two Traits** Students extend their understanding of allelic frequency by applying concepts of probability as they consider crosses that feature two traits. Students ask questions about and discuss the cause of the varied phenotypes among the resulting offspring. *Working toward HS-LS3-1* *Working toward HS-LS3-3*	LS3.A LS3.B	Asking questions and defining problems Analyzing and interpreting data	Cause and effect Scale, proportion, and quantity	Mathematics: MP.2 ELA/ Literacy: RST.11-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
6	**How Did This Happen? Class Consensus** Students engage in argument from evidence about how superweeds arrived in the farmer's fields and were able to spread. Students consider evidence and arguments presented in previous activities to generate their own explanation of the phenomenon and to contribute to a class explanation. They also consider the possible effects that superweeds may have on future crop yields. This activity completes the first learning sequence and provides an opportunity to assess Performance Expectation HS-LS3-3. *Working toward HS-LS3-2* *Assessing HS-LS3-3*	LS3.B	Engaging in argument from evidence Analyzing and interpreting data	Cause and effect Scale, proportion, and quantity	Mathematics: MP.2 ELA/ Literacy: RST.11-12.1 WHST.9-12.1
7	**Protein Synthesis: Transcription and Translation** To understand how genetic modification changes the structure and function of proteins in organisms, students explore the process of protein synthesis in two phases, transcription and translation. Students generate models that support their explanations of how protein synthesis works in plant cells. *Working toward HS-LS1-1* *Working toward HS-LS3-1*	LS1.A	Constructing explanations and designing solutions Asking questions and defining problems	Structure and function Cause and effect	ELA/ Literacy: WHST.9-12.2 WHST.9-12.9
8	**Cell Differentiation and Gene Expression** To determine why cells in different tissues express different proteins and how environmental factors influence expression, students explore the expression of 11 different human genes. Students ask questions about the causes and effects of gene expression in four different cell types and how genes are passed from parent to offspring. Students are assessed on Performance Expectation HS-LS1-4. *Assessing HS-LS1-4* *Working toward HS-LS1-1*	LS1.B LS1.A	Developing and using models	Structure and function Systems and system models	Mathematics: MP.4

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
9	**Explaining Herbicide Resistance in Weeds** Students construct initial explanations of how herbicide resistance is generated in plants at the level of genes, proteins, and DNA. Students revise their models of genetic modification from Activity 7 to include how protein synthesis and gene expression lead to specific traits, such as herbicide resistance. *Working toward HS-LS1-1*	LS1.A LS4.B	Constructing explanations and designing solutions Asking questions and defining solutions	Structure and function	ELA/ Literacy: WHST.9-12.2 WHST.9-12.9
10	**Molecular Mechanism of Herbicide Resistance** To more fully understand the mechanism of herbicide resistance in plants, students read and analyze text about how scientists generate a mutation in a specific protein (EPSPS) to cause herbicide resistance. Students revise their initial explanations of genetic modification to include information about EPSPS, and construct an explanation about how herbicide resistance is created in plants. Students are assessed on Performance Expectation HS-LS1-1. *Assessing HS-LS1-1* *Working toward HS-LS3-1*	LS1.A	Constructing explanations and designing solutions Asking questions and defining problems	Structure and function Cause and effect	ELA/ Literacy: WHST.9-12.2 WHST.9-12.9
11	**Meiosis and Sexual Reproduction** To more deeply understand how genetic information is passed from parent to offspring, students use models to learn about the processes of meiosis and sexual reproduction. Students compare these processes as sources of inheritable genetic variation, and identify evidence that can be used to determine the cause of said variation. Students are assessed on Performance Expectation HS-LS3-1. *Assessing HS-LS3-1* *Working toward HS-LS3-2*	LS3.A LS1.A LS3.B	Asking questions and defining problems Developing and using models Engaging in argument from evidence	Cause and effect Systems and system models	Mathematics: MP.2 ELA/ Literacy: RST.11-12.1 WHST.9-12.1

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
12	**Genes and Chromosomes** To understand how genetic information is segregated into different sex cells, students track specific genes as they are carried by chromosomes to each egg or sperm cell and ultimately to a fertilized egg. Students use models to deepen their understanding of meiosis and inheritance in the context of reproduction in a genetically modified plant that leads to the generation of modified sperm (pollen) and how weeds can generate herbicide-resistant offspring. *Applying HS-LS3-1* *Working toward HS-LS3-2*	LS3.A LS1.A LS3.B	Asking questions and defining problems Developing and using models Engaging in argument from evidence	Cause and effect Systems and system models	Mathematics: MP.2 ELA/ Literacy: RST.11-12.9
13	**Which Plant Is Genetically Modified?** Students analyze DNA evidence from gel electrophoresis to determine whether gene migration from crops to weeds could have occurred in the superweeds in Farmer Green's fields. Students draw on this evidence to engage in argument about the cause of herbicide resistance among the superweeds in Farmer Green's fields. This activity completes the second learning sequence and provides an opportunity to assess Performance Expectation HS-LS3-2. *Assessing HS-LS3-2*	LS3.B	Engaging in argument from evidence	Cause and effect	ELA/ Literacy: WHST.9-12.1 WHST.9-12.2 WHST.9-12.9
14	**Genetically Modified Organisms and Biodiversity** To determine how superweeds affect local biodiversity, students analyze and interpret data that shows the patterns of weed and insect population changes prior to and after reports of superweeds being present in fields. Students draw conclusions about the benefits and trade-offs of genetically modified crops. *Working toward HS-LS4-3* *Assessing HS-LS3-3*	LS4.B LS4.C LS3.B	Analyzing and interpreting data Obtaining, evaluating, and communicating information	Patterns Scale, proportion, and quantity	Mathematics: MP.2 ELA/ Literacy: WHST.9-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
15	**Benefits and Trade-Offs of Genetically Modified Organisms** Students obtain and evaluate evidence about the benefits and trade-offs of GMOs. Students discuss the benefits and trade-offs and look for patterns in what communities should consider when deciding on the use of GMOs. *Working toward HS-LS4-3* *Applying HS-LS1-1*	LS1.A LS4.B LS4.C	Obtaining, and evaluating, and communicating information Constructing explanations and designing solutions Asking questions and defining problems	Patterns Structure and function Scale, proportion, and quantity	ELA/ Literacy: WHST.9-12.9
16	**Evaluating Genetically Modified Organisms** Students analyze data about the sustainability of a county's agriculture. Based on the patterns presented in the data, students make an evidence-informed recommendation as to whether the county should grow genetically modified soy. *Working toward HS-LS2-7* *Working toward HS-LS4-3*	LS2.C LS4.B LS4.C LS4.D ETS1.B	Analyzing and interpreting data	Patterns Stability and change	ELA/ Literacy: RST.11-12.8 WHST.9-12.9
17	**Alternatives to Farming Genetically Modified Organisms** Students evaluate four alternative farming proposals that address superweeds. With a focus on how the outcome of each proposal may affect the sustainability of agriculture in the county, and supported by evidence, students construct a recommendation for the proposal of their choice, present it to the class, and independently write their recommendation to the board. This activity concludes the third and final learning sequence of the unit. *Working toward HS-LS2-7*	LS2.C LS4.D ETS1.B	Constructing explanations and designing solutions	Stability and change	ELA/ Literacy: RST.11-12.8

NGSS OVERVIEW

EVOLUTION: MANAGING CHANGE

Performance Expectations

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

HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

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

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

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

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

HS-LS 4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

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

HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1	**Changing Environments** Students analyze and interpret data on factors affecting the evolution of body size in marine iguanas. They engage in arguments from evidence for how a changing environment will affect marine iguana body size in the future. Students construct explanations about the evolution of body size in marine iguanas based on natural selection, adaptation, and social behavior. *Working toward* LS4-2 *Working toward* LS4-3 *Working toward* LS4-4 *Working toward* LS2-8	LS4.B LS4.C LS2.D	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Cause and Effect Patterns Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Mathematics: MP.2 MP.4 ELA/Literacy: RST.11-12.7 RST.11-12.8

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
2	**Increasing Temperatures** Students investigate the effects of temperature on competition for resources among aquatic plants. Students analyze and interpret data and then use the data to explain that some individuals are better adapted to a particular environment than others are, leading to a proliferation of those adaptations in the population. *Working toward* LS4-2 *Working toward* LS4-3 *Working toward* LS4-4	LS4.B LS4.C	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Cause and Effect Patterns	Mathematics: MP.2 ELA/Literacy: RST-11.12.1 WHST.9-12.2
3	**Social Behavior** Students analyze and interpret data on how other factors, especially biotic factors, lead to the proliferation of other kinds of traits, including social behavior. Students engage in argument from evidence on how alarm calls in prairie dogs are an example of one such trait. Students are assessed on Performance Expectation HS-LS2-8. *Assessing* LS2-8 *Working toward* LS4-2 *Working toward* LS4-3 *Working toward* LS4-4	LS2.D LS4.B LS4.C	Engaging in Argument from Evidence Analyzing and Interpreting Data Connections to Nature of Science: Scientific Knowledge is Open to Revision in Light of New Evidence	Cause and Effect Patterns	Mathematics: MP.2 MP.4 ELA/Literacy: RST-11.12.7 RST.11-12.8
4	**Genetic Variation and Change** Students use a computer simulation to analyze and interpret data that demonstrates the theorized connection between the protective effects of being a carrier of the cystic fibrosis mutation and reduced symptoms (and increased survival rate) when contracting TB. Students look for patterns across the data and apply statistical tests to analyze their results. Students are assessed on Performance Expectation HS-LS4-3. *Assessing* LS4-3 *Working toward* LS4-2 *Working toward* LS4-4	LS4.B LS4.C	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	Patterns	Mathematics: MP.2 MP.4 ELA/Literacy: RST-11.12.1 WHST.9-12.2

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
5	**Is It Evolution?** To understand how natural events and human actions affect the evolution of populations over time, students analyze scenarios that include examples of evolutionary and non-evolutionary events. Students draw on disciplinary core ideas about how changes in the physical environment contribute to evolutionary changes, and examine the cause-and-effect relationship between resource use by humans and the impact on populations of other organisms. Students are assessed on Performance Expectation HS-LS4-2. *Assessing* LS4-2 *Working toward* LS4-4 *Applying* LS4-3	LS4.B LS4.C	Constructing Explanations and Designing Solutions	Cause and Effect Patterns	ELA/Literacy: RST-11.12.1 WHST.9-12.2 SL.11-12.4
6	**Increasing Timescales** Students examine what happens to a population when natural selection occurs over a longer period of time by obtaining and evaluating information from videos about two species: a species of salamander, which illustrates speciation in progress, and anoles in the Caribbean, which illustrates speciation completed. Students are assessed on Performance Expectation HS-LS4-4. *Assessing* LS4-4 *Applying* LS4-2 *Applying* LS4-3 *Working toward* LS4-1 *Working toward* LS4-5	LS4. A LS4.B LS4.C	Constructing Explanations and Designing Solutions	Cause and Effect Patterns Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	ELA/Literacy: RST-11.12.1 RST-11.12.7 WHST.9-12.9
7	**Extinction** Students investigate changes in life-forms over time, including the evolution of new forms (speciation) and the disappearance of previous forms (extinction). They look for patterns and consider the possible causes of major extinction events due to massive changes in the environment. *Working toward* LS4-5 *Working toward* LS4-1	LS4.C	Constructing Explanations and Designing Solutions Analyzing and Interpreting Data	Patterns Cause and Effect Scale, Proportion, and Quantity	Mathematics: MP.2 ELA/Literacy: RST.11-12.8 WHST.9-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
8	**The Anthropocene** Students analyze and interpret data to consider the role of human activity in the loss of biodiversity due to environmental changes. They engage in argument about whether humans are causing another major extinction event. Students are assessed on Performance Expectation HS-LS4-5. *Assessing* LS4-5 *Working toward* LS4-1	LS4.C LS4.D	Engaging in Argument from Evidence Analyzing and Interpreting Data	Patterns Cause and Effect Scale, Proportion, and Quantity	Mathematics: MP.2 ELA/Literacy: RST.11-12.8 WHST.9-12.9
9	**Evidence and the Theory of Evolution** Students obtain information from texts and graphics about several types of evidence to support the theory of evolution. Students synthesize this information, and communicate their understanding of evolution as the unifying principle in life science. *Working toward* LS4-1 *Applying* LS4-5	LS4.A	Obtaining, Evaluating, and Communicating Information	Patterns	ELA/Literacy: RST.11-12.1 WHST.9-12.2 SL.11-12.4
10	**Applying Evolutionary Thinking** Students evaluate the evidence and trade-offs of different conservation choices for a fictional island. Students apply their understanding of the types of evidence used to support the theory of evolution to a practical problem: the conservation of biodiversity and sustainability. Students prepare a report outlining their decision. Students are assessed on Performance Expectation HS-LS4-1. *Assessing* LS4-1 *Applying* LS4-5 *Working toward* LS2-7	LS4.A LS2.C	Obtaining, Evaluating, and Communicating Information Constructing Explanations and Designing Solutions	Patterns Stability and Change	ELA/Literacy: RST.11-12.1 WHST.9-12.2 SL.11-12.4
11	**The Evolution of Resistance** To better understand how natural selection affects a population, students construct explanations about a medical case study on antibiotic resistance. Students conduct an experiment that models antibiotic resistance, explain their results, and connect the experiment to natural selection. *Applying* LS4-4	LS4.C	Constructing Explanations and Designing Solutions Developing and Using Models	Cause and Effect Connections to Nature: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	ELA/Literacy: RST-11.12.1 WHST.9-12.2 WHST.9-12.9

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
12	**Emerging Diseases** Students examine patterns of disease outbreaks, epidemics, and pandemics. They obtain information about the possible causes for the growing rate of emerging diseases, and they apply evolutionary thinking as they envision how to predict and prevent future outbreaks. *Applying* LS4-2 *Applying* LS4-4 *Working toward* LS4-6	LS4.D LS4.B LS4.C	Obtaining, Evaluating, and Communicating Information	Cause and Effect Patterns	Mathematics: MP.2 ELA/Literacy: RST-11.12.7
13	**Shrinking Salmon** Students develop a system model to make sense of the evolutionary effect of human impact on salmon body size. They explore this complex problem and use their model to ask questions and make connections to the three pillars of sustainability. *Working toward* LS4-6 *Working toward* ETS1-3 *Working toward* ETS1-4 *Applying* LS2-7	LS4.D LS4.B LS4.C ETS1.B LS2.C	Constructing Explanations and Designing Solutions	Systems and System Models Cause and Effect Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Stability and Change	Mathematics: MP.2 ELA/Literacy: RST.11-12.8
14	**Mitigating Change** Students engage in a computer simulation to assess the evolutionary impact of human activity on Chinook body size. Students develop proposed solutions to this problem and test the impact of these solutions on both biodiversity and human systems. Students consider numerous criteria and constraints as they evaluate each solution. Students are assessed on Performance Expectations HS-LS4-6, HS-ETS1-3, HS-ETS1-4, and HS-LS2-7. *Assessing* LS4-6 *Assessing* ETS1-3 *Assessing* ETS1-4 *Assessing* LS2-7	LS4.C LS4.D ETS1.B LS2.C	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	Cause and Effect Systems and System Models Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Stability and Change	Mathematics: MP.2 MP.4 HSN.QA.1 ELA/Literacy: WHST.9-12.7

Activity	NGSS Integration	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
15	**Human Impact on Evolution** To make connections between human activity and evolution, students construct a presentation about a focal issue from this unit (e.g., emerging diseases, pollution, antibiotic resistance). In their presentations, students outline their issue, explain its connection to evolution, and suggest strategies to prevent or reduce negative outcomes of this issue on biodiversity and sustainability. *Assessing* LS2-7	LS2.C LS4.D ETS1.B	Obtaining, Evaluating, and Communicating Information	Stability and Change	ELA/Literacy: RST.9-10.8 RST.11-12.7 RST.11-12.8 WHST.9-12.7