McGraw Hill Education

Alignment Guide

GLENCOE

BIOLOGY

Glencoe Biology—Your Partner in Understanding and Implementing NGSS*

Ease the Transition to Next Generation Science Standards

Meeting NGSS

Glencoe Science helps ease the transition to Next Generation Science Standards (NGSS). Our high school science programs ensure you are fully aligned to:

- Performance Expectations
- Science and Engineering Practices
- Disciplinary Core Ideas
- Crosscutting Concepts

We are committed to ensuring that you have the tools and resources necessary to meet the expectations for the next generation of science standards.

What is NGSS?

The purpose of the NGSS Framework is to act as the foundation for science education standards while describing a vision of what it means to be proficient in science. It emphasizes the importance of the practices of science where the content becomes a vehicle for teaching the processes of science.

Why NGSS?

The NGSS were developed in an effort to create unified standards in science education that consider content, practices, pedagogy, curriculum, and professional development. The standards provide all students with an internationally benchmarked education in science.

Correlation of NGSS Performance Expectations to Biology

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The Correlation Table lists a Performance Expectation that integrates a combination of Science and Engineering Practices, Discliplinary Core Ideas, and Crosscutting Concepts.

Performance Expectations

are tasks to evaluate student's knowledge. Each Performance Expectation is correlated to an Applying Practices activity written specifically for the purpose. These activities can be found in the resources for the section listed.

Science and Engineering Practices

are skills that scientists and engineers use in their work. Each Practice is correlated to a part of the Science and Engineering Practices Handbook, which can be found in the program resources.

Disciplinary Core Ideas

are the content knowledge students will need to learn. These are correlated to the main student text.

Crosscutting Concepts

are themes that appear throughout all branches of science and engineering. These are not directly correlated but are found implicitly in the other correlations listed on the page.

Find it here!

Code	Title/Text	Location
HS-LS4	Biological Evolution: Unity and Diversity	
HS-LS4-1	**Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.** Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.	**Activity:** *Evidence for Evolution,* Chapter 15 Section 2, Chapter 17 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
	• Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**Science and Engineering Practices Handbook:** Practice 8
	Connections to Nature of Science **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**	
	• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	**Science and Engineering Practices Handbook:** Practice 6 **Student Edition:** 11, 13
Disciplinary Core Ideas		
LS4.A	**Evidence of Common Ancestry and Diversity**	
	• Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.	**Student Edition:** 423–427, 491, 493–495
Crosscutting Concepts		
	Patterns	
	• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	
	Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
	• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	

Code	Title/Text	Location
HS-LS1	From Molecules to Organisms: Structures and Processes	
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.** Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.	**Activity:** *Transcription and Translation,* Chapter 12 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
	• Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
LS1.A	**Structure and Function**	
	• Systems of specialized cells within organisms help them perform the essential functions of life.	**Student Edition:** 256–257, 258, 632–638, 639–640, 694, 947–948, 962–963, 997–998, 1085–1089
	• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*	**Student Edition:** 171, 186, 193, 247, 249, 270, 272, 336–341, 342–345
Crosscutting Concepts		
	Structure and Function	
	• Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.	

Code	Title/Text	Location
HS-LS1	**From Molecules to Organisms: Structures and Processes** *continued*	
HS-LS1-2	**Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** **Clarification Statement:** Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system. **Assessment Boundary:** Assessment does not include interactions and functions at the molecular or chemical reaction level.	**Activity:** *Hierarchical Organization in Plants,* Chapter 22 Section 1, Chapter 22 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
	• Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas		
LS1.A	**Structure and Function**	
	• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.	**Student Edition:** 632–638, 639–640, 642, 728, 739, 747, 768, 796, 865, 886, 947–948, 962–967, 968–972, 973–976, 992–998, 1000–1003, 1005–1007, 1020–1024, 1031–1037
Crosscutting Concepts		
	Systems and System Models	
	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	

Code	Title/Text	Location
HS-LS1	**From Molecules to Organisms: Structures and Processes** *continued*	
HS-LS1-3	**Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** **Clarification Statement:** Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels. **Assessment Boundary:** Assessment does not include the cellular processes involved in the feedback mechanism.	**Activity:** *Investigate Osmosis,* Chapter 7 Section 4
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Planning and Carrying Out Investigations Planning and carrying out in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	
	• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**Science and Engineering Practices Handbook:** Practice 3
	Connections to Nature of Science **Scientific Investigations Use a Variety of Methods**	
	• Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.	**Science and Engineering Practices Handbook:** Practice 3 **Student Edition:** 16–21
Disciplinary Core Ideas		
LS1.A	**Structure and Function**	
	• Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.	**Student Edition:** 10, 203–206, 547, 556, 636–638, 639–640, 642, 644–647, 727, 739, 747, 767, 795, 825, 854, 884, 938–939, 946, 969–970, 992, 1005–1007, 1032–1037
Crosscutting Concepts		
	Stability and Change	
	• Feedback (negative or positive) can stabilize or destabilize a system.	

Code	Title/Text	Location
HS-LS1	**From Molecules to Organisms: Structures and Processes** *continued*	
HS-LS1-4	**Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** **Assessment Boundary:** Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.	**Activity:** *Mitosis and Cellular Differentiation,* Chapter 9 Section 1, Chapter 9 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
	• Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas		
LS1.B	**Growth and Development of Organisms**	
	• In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.	**Student Edition:** 246–247, 248–252, 270, 275, 696–697, 1055
Crosscutting Concepts		
	Systems and System Models	
	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	

Code	Title/Text	Location
HS-LS1	**From Molecules to Organisms: Structures and Processes** *continued*	
HS-LS1-5	**Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** **Clarification Statement:** Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models. **Assessment Boundary:** Assessment does not include specific biochemical steps.	**Activity:** *Modeling Photosynthesis,* Chapter 8 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
	• Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas		
LS1.C	**Organization for Matter and Energy Flow in Organisms**	
	• The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**Student Edition:** 41–44, 220, 222–227, 233, 235, 644–645
Crosscutting Concepts		
	Energy and Matter	
	• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	

Code	Title/Text	Location
HS-LS1	**From Molecules to Organisms: Structures and Processes** *continued*	
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.** **Clarification Statement:** Emphasis is on using evidence from models and simulations to support explanations. **Assessment Boundary:** Assessment does not include the details of the specific chemical reactions or identification of macromolecules.	**Activity:** *Exploring Macromolecules,* Chapter 6 Section 4
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
	• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
LS1.C	**Organization for Matter and Energy Flow in Organisms**	
	• The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.	**Student Edition:** 166–171, 222, 226, 229–232
	• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	**Student Edition:** 41–44, 45–49, 218–220, 222, 229–232, 1026–1029
Crosscutting Concepts		
	Energy and Matter	
	• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	

Code	Title/Text	Location
HS-LS1	**From Molecules to Organisms: Structures and Processes** *continued*	
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.** **Clarification Statement:** Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. **Assessment Boundary:** Assessment should not include identification of the steps or specific processes involved in cellular respiration.	**Activity:** *Modeling Cellular Respiration,* Chapter 8 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
	• Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas		
LS1.C	**Organization for Matter and Energy Flow in Organisms**	
	• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	**Student Edition:** 220, 228–233
	• As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.	**Student Edition:** 220, 228–233
Crosscutting Concepts		
	Energy and Matter	
	• Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics**	
HS-LS2-1	**Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** **Clarification Statement:** Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets. **Assessment Boundary:** Assessment does not include deriving mathematical equations to make comparisons.	**Activity:** *Carrying Capacity of Nectar-Feeding Bats,* Chapter 4 Section 1
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
	• Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	**Science and Engineering Practices Handbook:** Practice 5
Disciplinary Core Ideas		
LS2.A	**Interdependent Relationships in Ecosystems**	
	• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.	**Student Edition:** 94–99, 105
Crosscutting Concepts		
	Scale, Proportion, and Quantity	
	• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
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.** **Clarification Statement:** Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data. **Assessment Boundary:** Assessment is limited to provided data.	**Activity:** *Biodiversity in Leaf Litter,* Chapter 5 Section 1, Chapter 5 Section 2, Chapter 5 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
	• Use mathematical representations of phenomena or design solutions to support and revise explanations.	**Science and Engineering Practices Handbook:** Practice 5
	Connections to Nature of Science **Scientific Knowledge is Open to Revision in Light of New Evidence**	
	• Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	**Science and Engineering Practices Handbook:** Practice 6, Practice 7 **Student Edition:** 11–14, 16–20
Disciplinary Core Ideas		
LS2.A	**Interdependent Relationships in Ecosystems**	
	• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.	**Student Edition:** 94–99, 105
LS2.C	**Ecosystem Dynamics, Functioning, and Resilience**	
	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	**Student Edition:** 60–64, 94–99, 122–128, 134–135
Crosscutting Concepts		
	Scale, Proportion, and Quantity	
	• Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
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.** **Clarification Statement:** Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. **Assessment Boundary:** Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.	**Activity:** *The Cycling of Matter and Flow of Energy in Aerobic and Anaerobic Conditions,* Chapter 2 Section 1, Chapter 2 Section 2, Chapter 2 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
	• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**Science and Engineering Practices Handbook:** Practice 6
	Connections to Nature of Science **Scientific Knowledge is Open to Revision in Light of New Evidence**	
	• Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	**Science and Engineering Practices Handbook:** Practice 6, Practice 7 **Student Edition:** 11–14, 16–20
Disciplinary Core Ideas		
LS2.B	**Cycles of Matter and Energy Transfer in Ecosystems**	
	• Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.	**Student Edition:** 41–44, 47, 197, 219–220, 222–227, 228–233, 235
Crosscutting Concepts		
	Energy and Matter	
	• Energy drives the cycling of matter within and between systems.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
HS-LS2-4	**Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** **Clarification Statement:** Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem. **Assessment Boundary:** Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.	**Activity:** *Ecological Pyramids,* Chapter 2 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
	• Use mathematical representations of phenomena or design solutions to support claims.	**Science and Engineering Practices Handbook:** Practice 5
Disciplinary Core Ideas		
LS2.B	**Cycles of Matter and Energy Transfer in Ecosystems**	
	• Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.	**Student Edition:** 41–44, 45–49, 219–220
Crosscutting Concepts		
	Energy and Matter	
	• Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
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.** **Clarification Statement:** Examples of models could include simulations and mathematical models. **Assessment Boundary:** Assessment does not include the specific chemical steps of photosynthesis and respiration.	**Activity:** *Modeling the Carbon Cycle,* Chapter 2 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
	• Develop a model based on evidence to illustrate the relationships between systems or components of a system.	**Science and Engineering Practices Handbook:** Practice 2
Disciplinary Core Ideas		
LS2.B	**Cycles of Matter and Energy Transfer in Ecosystems**	
	• Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.	**Student Edition:** 43, 45, 47, 219–220
PS3.D	**Energy in Chemical Processes**	
	• The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.	**Student Edition:** 41, 197, 222–227, 233
Crosscutting Concepts		
	Systems and System Models	
	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
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.** Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.	**Activity:** *Local Ecosystem Dynamics,* Chapter 2 Section 1, Chapter 3 Section 1, Chapter 5 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
	• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	**Science and Engineering Practices Handbook:** Practice 7
	Connections to Nature of Science **Scientific Knowledge is Open to Revision in Light of New Evidence**	
	• Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	**Science and Engineering Practices Handbook:** Practice 1, Practice 7, Practice 8 **Student Edition:** 14, 20, 1127
Disciplinary Core Ideas		
LS2.C	**Ecosystem Dynamics, Functioning, and Resilience**	
	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	**Student Edition:** 34–40, 62–64, 94–98, 123–128
Crosscutting Concepts		
	Stability and Change	
	• Much of science deals with constructing explanations of how things change and how they remain stable.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
HS-LS2-7	**Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.	**Activity:** *Microbeads, Mega-Problem,* Chapter 3 Section 3, Chapter 5 Section 2, Chapter 5 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
	• Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
LS2.C	**Ecosystem Dynamics, Functioning, and Resilience**	
	• Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.	**Student Edition:** 120, 122–128, 744, 801, 833, 841, 860, 869
LS4.D	**Biodiversity and Humans**	
	• Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)*	**Student Edition:** 116–118, 122–123, 131–135
	• Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*	**Student Edition:** 118–120, 123–128, 129–135
ETS1.B	**Developing Possible Solutions**	
	• When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (*secondary to HS-LS2-7)*	**Science and Engineering Practices Handbook:** Practice 1, Practice 6 **Student Edition:** 129–135
Crosscutting Concepts		
	Stability and Change	
	• Much of science deals with constructing explanations of how things change and how they remain stable.	

Code	Title/Text	Location
HS-LS2	**Ecosystems: Interactions, Energy, and Dynamics** *continued*	
HS-LS2-8	**Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.	**Activity:** *Investigating Group Behavior,* Chapter 31 Section 1, Chapter 31 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
	• Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.	**Science and Engineering Practices Handbook:** Practice 7
	Connections to Nature of Science **Scientific Knowledge is Open to Revision in Light of New Evidence**	
	• Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	**Science and Engineering Practices Handbook:** Practice 1, Practice 7, Practice 8 **Student Edition:** 14, 20, 1127
Disciplinary Core Ideas		
LS2.D	**Social Interactions and Group Behavior**	
	• Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.	**Student Edition:** 909–915, 916–923
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

Code	Title/Text	Location
HS-LS3	**Heredity: Inheritance and Variation of Traits**	
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.** Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.	**Activity:** *Meiosis,* Chapter 10 Section 1
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.	
	• Ask questions that arise from examining models or a theory to clarify relationships.	**Science and Engineering Practices Handbook:** Practice 1
Disciplinary Core Ideas		
LS1.A	**Structure and Function**	
	• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)*	**Student Edition:** 193, 247, 249, 270, 272, 336–341, 342–344
LS1.A	**Structure and Function**	
	• Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.	**Student Edition:** 247, 270, 329–332, 336–341, 342–345, 373
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

Code	Title/Text	Location
HS-LS3	**Heredity: Inheritance and Variation of Traits** *continued*	
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.** **Clarification Statement:** Emphasis is on using data to support arguments for the way variation occurs. **Assessment Boundary:** Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.	**Activity:** *Investigating Genetic Variation,* Chapter 10 Section 1, Chapter 10 Section 2, Chapter 10 Section 3, Chapter 11 Section 3, Chapter 12 Section 4
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
	• Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
LS3.B	**Variation of Traits**	
	• In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.	**Student Edition:** 271–276, 283–285, 312–313, 342–349
	• Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.	**Student Edition:** 309–310
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

Code	Title/Text	Location
HS-LS3	**Heredity: Inheritance and Variation of Traits** *continued*	
HS-LS3-3	**Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** **Clarification Statement:** Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits. **Assessment Boundary:** Assessment does not include Hardy-Weinberg calculations.	**Activity:** *Punnett Squares,* Chapter 10 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
	• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	**Science and Engineering Practices Handbook:** Practice 4
Disciplinary Core Ideas		
LS3.B	**Variation of Traits**	
	• Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.	**Student Edition:** 309–310
Crosscutting Concepts		
	Scale, Proportion, and Quantity	
	• Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	
	Science is a Human Endeavor	
	• Technological advances have influenced the progress of science and science has influenced advances in technology.	
	• Science and engineering are influenced by society and society is influenced by science and engineering.	

Code	Title/Text	Location
HS-LS4	**Biological Evolution: Unity and Diversity**	
HS-LS4-1	**Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.** Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.	**Activity:** *Evidence for Evolution,* Chapter 15 Section 2, Chapter 17 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
	• Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**Science and Engineering Practices Handbook:** Practice 8
	Connections to Nature of Science **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**	
	• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	**Science and Engineering Practices Handbook:** Practice 6 **Student Edition:** 11, 13
Disciplinary Core Ideas		
LS4.A	**Evidence of Common Ancestry and Diversity**	
	• Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.	**Student Edition:** 423–427, 491, 493–495
Crosscutting Concepts		
	Patterns	
	• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	
	Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
	• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	

Code	Title/Text	Location
HS-LS4	**Biological Evolution: Unity and Diversity** *continued*	
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.** **Clarification Statement:** Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning. **Assessment Boundary:** Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.	**Activity:** *Pest Management and Natural Selection,* Chapter 15 Section 1, Chapter 15 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
	• Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
LS4.B	**Natural Selection**	
	• Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.	**Student Edition:** 420–422
LS4.C	**Adaptation**	
	• Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.	**Student Edition:** 420–422, 431–436
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

Code	Title/Text	Location
HS-LS4	**Biological Evolution: Unity and Diversity** *continued*	
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.** **Clarification Statement:** Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. **Assessment Boundary:** Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.	**Activity:** *Could You Beat Natural Selection Using Camouflage?*, Chapter 15 Section 1
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
	• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	**Science and Engineering Practices Handbook:** Practice 4
Disciplinary Core Ideas		
LS4.B	**Natural Selection**	
	• Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.	**Student Edition:** 420–422
	• The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.	**Student Edition:** 420, 434–436
LS4.C	**Adaptation**	
	• Adaptation also means that the distribution of traits in a population can change when conditions change.	**Student Edition:** 428–430
Crosscutting Concepts		
	Patterns	
	• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	

Code	Title/Text	Location
HS-LS4	**Biological Evolution: Unity and Diversity** *continued*	
HS-LS4-4	**Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.	**Activity:** *Can Scientists Model Natural Selection?,* Chapter 15 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
	• Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
LS4.C	**Adaptation**	
	• Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.	**Student Edition:** 428–430
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	
	Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
	• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	

Code	Title/Text	Location
HS-LS4	**Biological Evolution: Unity and Diversity** *continued*	
HS-LS4-5	**Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.	**Activity:** *Evaluating Impacts of Environmental Change on Populations,* Chapter 5 Section 2
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.	
	• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**Science and Engineering Practices Handbook:** Practice 7
Disciplinary Core Ideas		
LS4.C	**Adaptation**	
	• Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline-and sometimes the extinction-of some species.	**Student Edition:** 122–128, 438
	• Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.	**Student Edition:** 122–123
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

Code	Title/Text	Location
HS-LS4	**Biological Evolution: Unity and Diversity** *continued*	
HS-LS4-6	**Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*** Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.	**Activity:** *Cleaning Up an Oil Spill,* Chapter 5 Section 2, Chapter 5 Section 3
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
	• Create or revise a simulation of a phenomenon, designed device, process, or system.	**Science and Engineering Practices Handbook:** Practice 5
Disciplinary Core Ideas		
LS4.C	**Adaptation**	
	• Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline-and sometimes the extinction-of some species.	**Student Edition:** 122–123, 438
LS4.D	**Biodiversity and Humans**	
	• Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)*	**Student Edition:** 118–121, 123–128
ETS1.B	**Developing Possible Solutions**	
	• When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*	**Science and Engineering Practices Handbook:** Practice 1, Practice 6 **Student Edition:** 134–135
	• Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(secondary)*	**Science and Engineering Practices Handbook:** Practice 2, Practice 5
Crosscutting Concepts		
	Cause and Effect	
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

Code	Title/Text	Location
HS-ETS1	**Engineering Design**	
HS-ETS1-1	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**	**Activity:** *Engineer a Better World: Analyze a Major Global Challenge,* for use as long-term project (see Program Resources)
	The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*	
Science and Engineering Practices		
	Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.	
	• Analyze complex real-world problems by specifying criteria and constraints for successful solutions.	**Science and Engineering Practices Handbook:** Practice 1
Disciplinary Core Ideas		
ETS1.A	**Defining and Delimiting Engineering Problems**	
	• Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.	**Science and Engineering Practices Handbook:** Practice 1, Practice 6
	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.	**Science and Engineering Practices Handbook:** Introduction, all Practices
Crosscutting Concepts		
	Connections to Engineering, Technology, and Applications of Science **Influence of Science, Engineering, and Technology on Society and the Natural World**	
	• New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	

Code	Title/Text	Location
HS-ETS1	**Engineering Design** *continued*	
HS-ETS1-2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.**	**Activity:** *Engineer a Better World: Design a Solution,* for use as long-term project (see Program Resources)
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.	
	• Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
ETS1.C	**Optimizing the Design Solution**	
	• Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.	**Science and Engineering Practices Handbook:** Practice 1, Practice 6

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Code	Title/Text	Location
HS-ETS1	**Engineering Design** *continued*	
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.**	**Activity:** *Engineer a Better World: Evaluate a Solution,* for use as long-term project (see Program Resources)
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.	
	• Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**Science and Engineering Practices Handbook:** Practice 6
Disciplinary Core Ideas		
ETS1.B	**Developing Possible Solutions**	
	• When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.	**Science and Engineering Practices Handbook:** Practice 1, Practice 6
Crosscutting Concepts		
	Connections to Engineering, Technology, and Applications of Science **Influence of Science, Engineering, and Technology on Society and the Natural World**	
	• New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	

Code	Title/Text	Location
HS-ETS1	**Engineering Design** *continued*	
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:** *Engineer a Better World: Use a Computer Simulation,* for use as long-term project (see Program Resources)
The performance expectation above was developed using the following elements from the NRC document *A Framework for K–12 Science Education:*		
Science and Engineering Practices		
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
	• Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.	**Science and Engineering Practices Handbook:** Practice 5
Disciplinary Core Ideas		
ETS1.B	**Developing Possible Solutions**	
	• Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.	**Science and Engineering Practices Handbook:** Practice 2, Practice 5, Practice 6
Crosscutting Concepts		
	Systems and System Models	
	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	
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