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Biology

Content Area: Science
Grade Span: 9
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COURSE OVERVIEW

Description

This Biology curriculum guide is the first in an anticipated three-year course sequence where proficiency and mastery are built upon students' science understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts from earlier grades. Biology students in high school develop understanding of key concepts that will help them make sense of NGSS life science standard bundles. The conceptual flow of the biology course builds on the understanding that life on Earth today is reflective of deep, complex, and hierarchical organization of systems on multiple scales. This curriculum guide includes performance expectations from Life Sciences, Earth/Space Sciences, and Engineering Design that allow students to develop a natural flow of understanding of how and why the abiotic and biotic realms are interwoven and interdependent, why living organisms share so many commonalities of structure and function, and the mechanisms that allow a rich diversity of life to exist within a wide variety of ecosystems. Students can also consider the human species' place in, and effects on, Earth's living systems. The performance expectations for high school Biology blend disciplinary core ideas with scientific and engineering practices and crosscutting concepts to support students in developing usable knowledge that can be applied across students' current and future science disciplines. This five-credit course in Biology is intended for all high school students. There are three options to fulfil this science requirement for graduation: Conceptual Biology, Academic Biology, or Honors Biology.

Goals

The goals of this inquiry based lab course are to provide students with learning opportunities that are designed to build scientific literacy, critical thinking, problem solving and analytical skills through the process of inquiry. This course is structured to engage students actively in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas. The units in this curriculum document guide students through the use of the SEPs, CCC, and DCIs to be able to answer the essential questions. The learning experiences will engage students in the fundamental questions about the world around them and how scientists investigate and find answers to those questions. Students will have the opportunity to carry out scientific investigations and engineering design projects related to the disciplinary core ideas in life sciences.

Scope and Sequence

Unit	Topic	Length
Unit 1	Introduction To Biology & Structure And Function	15 blocks
Unit 2	Matter And Energy In Organisms And Ecosystems	15 blocks
Unit 3	Interdependent Relationships In Ecosystems	20 blocks
Unit 4	Inheritance And Variation Of Traits	15 blocks
Unit 5	Natural Selection And Evolution	20 blocks

UNIT 1 - INTRODUCTION TO BIOLOGY & STRUCTURE AND FUNCTION

Summary and Rationale

In this unit, students demonstrate that they can use models to explain how cellular processes maintain homeostasis within cells and therefore within the organism, and defend the claim that living things are organized entities, developed through mitotic division and differentiated into a hierarchy of cells, tissues, organs, etc. Students will conduct investigations and gather evidence to support explanations of cell function and reproduction. The cellular processes can be used as a model for understanding of the hierarchical organization of organisms. Crosscutting concepts of matter and energy, structure and function, and systems and system models provide students with insights to the structures and processes of organisms.
It is important to note that the performance expectations described are intended as end-of-instructional unit expectations and additional practices should be used throughout instruction.

Recommended Pacing

15 blocks

State Standards (Performance Expectations)

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.

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.

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

Clarification Statement	Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.

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.

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- Systems and System Models (HS-LS1-2), (HS-LS1-4)
- Structure and Function (HS-LS1-1)
- Stability and Change (HSLS1-3)
- ***Connections to Nature of Science:*** Scientific Investigations Use a Variety of Methods

Unit Essential Questions

- How do the structures of organisms enable life's functions?
- What systems and processes keep organisms alive? What happens when those systems break down?
- How does mitosis help to grow and maintain living organisms?

Objectives

Students will know (DCIs):

- **Structure and Function** Systems of specialized cells within organisms help them perform the essential functions of life. 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. 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.
- **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.

Students will be able to (SEPs):

- Developing and Using Models
- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions

UNIT 2 - MATTER AND ENERGY IN ORGANISMS AND ECOSYSTEMS

Summary and Rationale	
The performance expectations in this unit allow students to develop a model to explain photosynthesis, cellular respiration, and the cycling of matter and flow of energy in living organisms, and throughout the biosphere, atmosphere, hydrosphere, and geosphere. Students will become aware that as matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Students defend the claim that 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. It is important to note that the performance expectations described are intended as end-of-instructional unit expectations and additional practices should be used throughout instruction.	
Recommended Pacing	
15 blocks	
State Standards (Performance Expectations)	
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.
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.
Clarification Statement	Assessment does not include the details of the specific chemical reactions or identification of macromolecules.
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.
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.
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.
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.

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- Energy and Matter (HS-LS1-5), (HS-LS1-6), (HS-LS1-7), (HS-LS2-4), (HS-LS2-3)
- Cause and Effect (HS-LS2-8)
- Scale, Proportion, and Quantity (HS-LS2-1), (HS-LS2-2)
- Systems and System Models (HS-LS2-5)
- Stability and Change (HS-LS2-6),(HSLS2-7)

Unit Essential Questions

- How do organisms obtain and use energy they need to live and grow? How do matter and energy move through ecosystems?

Objectives

Students will know (DCIs):

- **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. 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. 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.
- **Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- **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.

Students will be able to (SEPs):

- Developing and Using Models
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions

UNIT 3 - INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

Summary and Rationale
The performance expectations in this unit provide the foundation for students to use mathematical reasoning to demonstrate understanding of fundamental concepts of carrying capacity, factors affecting biodiversity and populations, and the cycling of matter and flow of energy among organisms in an ecosystem. These mathematical models provide support of students' conceptual understanding of systems and their ability to develop design solutions for reducing the impact of human activities on the environment and maintaining biodiversity. Crosscutting concepts of systems and system models play a central role in students' understanding of science and engineering practices and core ideas of ecosystems. It is important to note that the performance expectations described are intended as end-of-instructional unit expectations and additional practices should be used throughout instruction.

Recommended Pacing
20 blocks

State Standards (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.	
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.
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.
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.
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.
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.
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 testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	
Clarification Statement	Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.
HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	
Clarification Statement	Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.
Assessment Boundary	Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*	
Clarification Statement	Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).
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.	
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.	
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.	

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- Cause and Effect (HS-LS2-8)
- Scale, Proportion, and Quantity (HS-LS2-1), (HS-LS2-2)
- Systems and System Models Models (HS-LS2-5)
- Energy and Matter (HS-LS2-4), (HS-LS2-3)
- Stability and Change (HS-LS2-6),(HSLS2-7)

Unit Essential Questions

- What living and nonliving factors regulate ecosystem stability and/or cause change?
- How does biodiversity affect humans? How do humans affect biodiversity?

Objectives

Students will know (DCIs):

- **Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.

- **Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- **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.
- **Social Interactions and Group Behavior** Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
- **Biodiversity and Humans** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- **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.

Students will be able to (SEPs):

- Using Mathematics and Computational Thinking
- 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

UNIT 4 - INHERITANCE AND VARIATION OF TRAITS

Summary and Rationale

The performance expectations in this unit help students formulate answers to the questions: “How are characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?” Students demonstrate understanding of why individuals of the same species vary in how they look, function, and behave. Students can explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expression. Students are able to ask questions, make and defend a claim, and use concepts of probability to explain the genetic variation in a population. They then construct an explanation, outlining how DNA produces proteins and understand the role of proteins as essential to the work of the cell and living things. Crosscutting concepts of patterns and cause and effect are called out as organizing concepts for these core ideas.
It is important to note that the performance expectations described are intended as end-of-instructional unit expectations and additional practices should be used throughout instruction.

Recommended Pacing

15 blocks

State Standards (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.	
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.
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
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.
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
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.	

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- Cause and Effect (HS-LS3-1),(HS-LS3-2)
- Scale, Proportion, and Quantity (HSLS3-3)
- ***Connections to Nature of Science:*** Science is a Human Endeavor (HSLS3-3), (HS-LS3-3)

Unit Essential Questions

- What is the molecular basis of an organism's traits?
- What are the mechanisms of inheritance?
- How do traits span generations?
- How are the characteristics from one generation related to the previous generation?

Objectives

Students will know (DCIs):

- **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.
- **Inheritance of Traits** Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.
- **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. 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.

Students will be able to (SEPs):

- Asking Questions and Defining Problems
- Analyzing and Interpreting Data
- Engaging in Argument from Evidence

UNIT 5 - NATURAL SELECTION AND EVOLUTION

Summary and Rationale

In this unit, students can construct explanations for the processes of natural selection and evolution and communicate how multiple lines of evidence support these explanations. Students can evaluate evidence of the conditions that may result in new species and understand the role of genetic variation in natural selection. Additionally, students can apply concepts of probability to explain trends in populations as those trends relate to advantageous heritable traits in a specific environment. The crosscutting concepts of cause and effect and systems and system models play an important role in students' understanding of the evolution of life on Earth.

It is important to note that the performance expectations described are intended as end-of-instructional unit expectations and additional practices should be used throughout instruction.

Recommended Pacing

20 blocks

State Standards (Performance Expectations)

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.
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.
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.
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.
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.
HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	
Clarification Statement	Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).
HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	
Clarification Statement	Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.
HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	
Clarification Statement	Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.
Assessment Boundary	Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.

Instructional Focus

Unit Enduring Understandings (Cross Cutting Concepts)

- Patterns (HS-LS4-1),(HS-LS4-3)
- Cause and Effect (HS-LS4- 2),(HS-LS4-4),(HS-LS4-5)
- ***Connections to Nature of Science:*** Scientific Knowledge Assumes an Order and Consistency in Natural Systems (HSLS4-1),(HS-LS4-4)

Unit Essential Questions

- How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms?
- What factors change the distribution of traits in populations over time?
- What evidence supports the theory of evolution?

Objectives

Students will know (DCIs):

- **Evidence of Common Ancestry and Diversity** Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.
- **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.

- **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.

Students will be able to (SEPs):

- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- ***Connections to Nature of Science:*** Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena