04 Evolution

Content Area: **Science**
Course(s): **Biology CP**
Time Period: **Semester 2**
Length: **3 weeks**
Status: **Published**

Standards

	Patterns
ETS1.A	Defining Engineering Problems
ETS1.B	Developing Possible Solutions
	Analyzing and Interpreting Data
ETS1.B	Developing Possible Solutions
	Cause and Effect
	Engaging in Argument from Evidence
	Obtaining, Evaluating, and Communicating Information
	Constructing Explanations and Designing Solutions
	Stability and Change
	Developing and Using Models
LS2.D	Social Interactions and Group Behavior
HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
LS4.A	Evidence of Common Ancestry and Diversity
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.
LS4.B	Natural Selection
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.
LS4.C	Adaptation
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads 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.
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.
ESS2.B	Plate Tectonics and Large-Scale System Interactions
PS1.C	Nuclear Processes
ESS1.C	The History of Planet Earth
HS-ESS2-1	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

ESS2.A	Earth Materials and Systems
ESS2.D	Weather and Climate
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
ESS2.E	Biogeology
SCI.HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Enduring Understandings

1. Group behavior has evolved as an adaptation because membership can increase the chances of survival for individuals and their genetic relatives.

2. Genetic information and the fossil record, provide 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.

3. 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. The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.

4. Natural selection is the result 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.

5. 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.

6. Adaptation also means that the distribution of traits in a population can change when conditions change. 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. 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 too drastic, the opportunity for the species' evolution is lost.

7. Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts. Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. The top part of the mantle, along with the crust, forms structures known as tectonic plates (link to ESS2.B). Motions of the mantle and

its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior.

8. The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

9. Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. Continental rocks, which can be older than 4 billion years, are generally much older than rocks on the ocean floor, which are less than 200 million years old. Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches. Although active geological processes, such as plate tectonics (link to ESS2.B) and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.

10. The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.

11. The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

12. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Biological extinction, being irreversible, is a critical factor in reducing the planet's natural capital.

Essential Questions

1. How do organisms interact in groups so as to benefit individuals?

2. How can there be so many similarities among organisms yet so many different kinds of plants, fungi animals, and microorganisms?

3. How does biodiversity affect humans?

4. What evidence shows that different species are related?

5. How does genetic variation among organisms affect survival and reproduction?

6. How does the environment influence populations of organisms over multiple generations?

7. How do size of population and isolation impact changes in allele frequencies?

8. What can we learn about earth by studying its geologic history and what are some methods use to study and investigate earth's geologic age?

9. How and why is Earth constantly changing?
10. How do Earth's major systems interact?
11. Why do the continents move, and what causes earthquakes and volcanoes?
12. How do living organisms alter Earth's processes and structures?

Knowledge and Skills

Knowledge:

1. Students will know that 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. (DCI LS4.A Evidence of Common Ancestry and Diversity)

2. Students will know that 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. (DCI LS4.B Natural Selection)

3. Students will know that 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. (DCI LS4.C Adaptation)

4. Students will know that 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. (DCI LS4.C Adaptation)

5. Students will know that adaptation also means that the distribution of traits in a population can change when conditions change. (DCI LS4.C Adaptation)

6. Students will know that continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (DCI ESS1.C The History of Planet Earth)

7. Students will know that plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic

history. (DCI ESS2.B Plate Tectonics and Large-Scale System Interactions)

8. Students will know that spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (DCI PS1.C Nuclear Processes)

9. Students will know that Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (DCI ESS2.A Earth Materials and Systems)

10. Students will know that plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (DCI ESS2.B Plate Tectonics and Large-Scale System Interactions)

11. Students will know that gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (DCI ESS2.D Weather and Climate)

12. Students will know that the many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a coevolution of Earth's surface and the life that exists on it. (DCI ESS2.E Biogeology)

Skills:

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

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.

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.

4. Construct an explanation based on evidence for how natural selection leads to adaptation in populations.

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.

6. 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.

7. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor.

8. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Resources

Core Resources:

Modern Biology by Holt, Rinehart & Winston

Supplemental Resources:

Unit 4: Evolution

- Computational Modeling - Biology and Ecology
- HHMI Lizard Lab
- HHMI Rock Pocket Mice
- Scientific American - Voyage to the Galapagos
- How Endosymbiosis Changed Life
- SEPUP - Natural Selection Simulation
- 2022 - Overview of Evolution - Reading
- Phet - Natural Selection - Bunny Lab
- Antibiotic Resistance Dataclassroom

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing