

Unit 9 Evolution (NGSS)

Content Area: **Science**
Course(s): **Biology CP, Biology Honors, STEM Biology Honors**
Time Period: **September**
Length: **6 weeks**
Status: **Published**

Enduring Understandings

1. The process of evolution drives the diversity and unity of life
2. According to specific evidence, all life on Earth evolved from a common ancestor through evolutionary processes.
3. Natural selection only occurs if there is variation in the genetic information between organisms in a population and variation in traits that leads to differences in performance among individuals in a given environment.
4. Traits that positively affect survival are more likely to be reproduced and thus are more common in the population.
5. Genetic diversity within the population allows for reproductive success in the event of environmental change.
6. Like different structures, different behaviors may have adaptive advantages for individuals in a certain environment.
7. Genetic information, like the fossil record, provides evidence of evolution.
8. Multiple lines of descent can be inferred by comparing the DNA sequences of different organisms.
9. Human anatomy and physiology reflect the fact that our species has evolved from a common ancestor that we share with all primates.
10. Human activities can influence evolution of species both through actions upon the environment and directly through the manipulation of an organism's DNA.

Essential Questions

1. Why are there so many different kinds of organisms on Earth?
2. Are all organisms on Earth related to each other?
3. Why would organisms change over time?
4. What is Natural Selection?
5. How is speciation linked to environmental change?
6. Does behavior play a role in whether organisms survive and reproduce?

7. What evidence is there that organisms have changed over time during the course of Earth's history?
8. How can patterns of characteristics shared among organisms be used to categorize life's diversity according to relatedness?
9. Have humans evolved from earlier forms?
10. How are humans involved in controlling evolution?

Content

Essential Vocabulary:

Lamarckism, Darwinism, Evolution, Descent with Modification, Natural Selection, Artificial Selection, Sexual Selection, Microevolution, Mutation, Gene Pool, Gene Frequency, Genetic Drift, Gene Flow, Bioinformatics, DNA Sequence comparisons, BLAST, Molecular Clocks, Toolkit Genes (HOX genes), Cladogram, Speciation, Macroevolution, Comparative Anatomy, Homologous Structures, Fossil Record, Embryology, Biogeography,

Australopithecus, Medial Angle, Bipedal Locomotion

Skills

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

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

- **DCI: LS4.A** - Explain how the millions of different species on Earth today are related by common ancestry using evidence
- **CC: Patterns** - Recognize that a change in a species over time does not follow a set pattern or timeline

PE: 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

PE: 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.

- **DCI: LS4.B** - Recognize how heritable characteristics can strongly influence what capabilities an organism will have, therefore influencing how likely it is to survive and reproduce.
- **DCI: LS4.B** - Recognize how heritable characteristics can strongly influence how likely an individual is to survive and reproduce
- **DCI: LS4.B** - Analyze natural selection simulations and use the data generated to describe how environmentally favored traits are perpetuated over generations resulting in species survival, while less favorable traits decrease in frequency or may lead to extinction

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

- **DCI: LS4.C** - Recognize that changes in DNA (mutations) occur spontaneously at low rates, and some of these changes make no difference to the organism, whereas others can change cells and organisms
- **DCI: LS4.C** - Explain that only mutations in germ cells can create the variation that changes an organism's offspring
- **DCI: LS4.C** - Trace the progression of conditions that result from genetic mutation in a variety of different organisms
- **CC: Cause and Effect** - Describe how evolution involves changes in the genetic make-up of whole populations over time, not changes in the genes of an individual organism

PE: 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.

Elaboration of DCI'S:

LS4.A: 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 derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

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. (HS-LS4-2, HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced and thus are more common in the population. (HS-LS4-3)

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 variations 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 proliferating of those organisms that are better able to survive and reproduces in that environment. (HS-LS4-2)
- 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. (HS-LS4-3, HS-LS4-4)
- Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-2)
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new and distinct species as populations diverge under different conditions, and the decline - and sometimes the extinction - of some species. (HS-LS4-5)
- Species become extinct because they can no longer survive and reproduce in their altered environments. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

Resources

LAB DESCRIPTIONS

Sequence Comparison Lab

- Students will use Biology Workbench to run nuclear gene sequence alignments. These alignments will then be used to construct phylogenetic trees to examine the relatedness of various species based on their beta globin gene.

Did Darwin Do It All? Explanations of Evolution

- Students will access the evolution section of the University of California's Museum of Paleontology to explore some of the roots of evolutionary biology. They will then visit the Why Files site to learn about

Darwin's voyage to the Galapagos and the current state of these islands.

Natural Selection Simulation

- Students will explore natural selection by controlling the environment and causing mutations in rabbits.

Microevolution WebQuest

- Students will summarize each of 4 mechanisms of microevolutionary changes. They will then use the simulation to test different hypotheses about why some guppies are very brightly colored even though that makes them easy for predators to find.

Standards

Science and Engineering Practices

Practice 4. 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.

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

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.

Practice 7. 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/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Practice 8. 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 and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Crosscutting Concepts

The seven crosscutting concepts are as follows:

1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. Cause and effect: Mechanism and explanation . Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

SCI.HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
SCI.HS-LS4	Biological Evolution: Unity and Diversity
SCI.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.
SCI.HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
SCI.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.
SCI.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.
SCI.HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.