ADVANCED BIOLOGICAL SYSTEMS
Unit #1: Evolution

The first unit of Advanced Biological Systems is focused on the theory of evolution, the mechanisms of evolutionary change, and discussions of the biological species concept. We discuss briefly how biodiversity stabilizes ecosystems. A study of biological evolution is placed first in the sequence of our curriculum to establish a foundation that explains the diversity of organisms, as well as biochemical processes, and the ongoing change process we witness today. These concepts will later be utilized in our curriculum to highlight cellular and metabolic diversity, the development of cancers, the interactions of bacteria with the ecosystem of the human host, and society's creation of a human-engineered ecosystem.

We start with student research and presentation on the various eras in Earth' history to establish a recognition that change has always occurred and is correlated with environmental changes. This is followed quickly by having students examine the evidentiary supports for the evolution of species from common ancestry. The samples under study run from models of fossil specimens, whole or parts of contemporary organisms, and protein and nucleic acid sequences. After evidence for evolution is provided, the mechanisms that drive biological evolution are discussed. Special attention is given to genetic drift and bottle neck effects to emphasize the roots of these changes found in random inheritance of traits, but also to highlight the outsized effects these mechanisms have on small populations. The unit ends with discussion on the biological species concept and the biological value of biodiversity. To support this discussion, we develop a considerable focus on reading primary literature.

This unit on evolution consists of eight student activities listed here. Each activity is connected to pertinent NGSS (see below). Instructional resources are contained in separate documents.

- History of Life
- Evolutionary Evidence
- Evolution on the Web Questions
- Genetic Drift and Founder Effect Simulations
- Selection Simulation
- Globin Genes in Humans
- Speciation Jigsaw
- Ecosystem Disrupted

The unit is completed with a literature-based test where students are asked to apply their understanding of the important concepts of the unit to a research article.

Learning outcomes	Major assessments
Understand current environmental issues in the context of geological history.	
• Look at trends in biogeochemical cycles over time through the current era. • Evaluate interactions between the geographical, oceanic, atmospheric, and climate characteristics in historical eras and biodiversity. • Connect historical extinctions, cause and effect, to understand current era	• Historical Timeline presentations w/ focus on data (CO_2 levels, water levels, temperature, etc.)
Provide evidentiary support for the theory of evolution; Integrate different variables that affect the process of speciation.	
• Analyze and reframe misconceptions through evidentiary support. • Analyze the relationships inherent in biological structures and classify similarities and differences. • Integrate evolutionary mechanisms into understanding and predictions in change. • Deconstruct natural selection as a process by examining specific types of selective pressures. • Analyze different aspects of genetics and population diversity that impact rates of speciation.	• Genetic Drift and Bottleneck lab: graphing and captions. • Origami birds: graphing and statistical analysis. • Phylogenetic trees for globin genes.
Evaluate evidence to model an interconnected and stable ecosystem; Research examples of human impact on ecosystems	
• Integrate data on biodiversity as key to ecological stability including niche and keystone species. • Research a disrupted ecosystem of student choice. • Articulate potential solutions recognizing multiple perspectives, limitations, needs.	• Video recording of researched presentation.

We have made an effort to address the following Next Generation Science Standards in this unit of instruction. We will connect each of the instructional resources to the Standards we recognize as applying.

NGSS addressed in this unit:	
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
HS-ESS3-3	Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-LS2-6	Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS2-8	Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
HS-LS4-4	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.