Biology of Living Earth/AB 360737/38

Title: Biology of the Living Earth AB
Length of course: Full Year
Subject area: Laboratory Science (D) / Biology / Life Sciences
UC honors designation: No
Prerequisites: Algebra (Required)
Co-requisites: Algebra (Recommended)
Integrated (Academics / CTE)? No
Grade levels: 9th, 10th, 11th, 12th

Course Description

Course overview:

Biology of Living Earth AB is a laboratory-based college preparatory course. *Biology of Living Earth AB* course is defined in the 2016 California Science Framework, integrating Biology and Earth and Space Science standards from the California Next Generation Science Standards (NGSS). The course is divided into six units, called Instructional Segments (I.S.) centered on questions about observations of a specific phenomenon. The units address the concepts of ecosystem interactions, energy flow in a system, evolution, genetics, cell theory, and climate change. Different phenomena require different amounts of classroom investigative time to explore and understand, so each Instructional Segment should take a different fraction of the school year. As students achieve the Performance Expectations (PEs) within the unit, they uncover Disciplinary Core Ideas (DCIs) from Life Science, Earth and Space Science, and Engineering. Students engage in multiple Science and Engineering Practices (SEPs) in each unit not just those explicitly indicated in the PEs. Students also focus on one or two Crosscutting Concepts (CCCs) as tools to make sense of their observations and investigations; the CCCs are recurring themes in all disciplines of science and engineering and help tie these seemingly disparate fields together.

Biology of Living Earth AB is a “d” course and meets the District Graduation requirement for laboratory life science.

Course content:

Ecosystem Interactions and Energy

Students use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Students apply the concepts of density-dependent and density-independent factors on a population’s carrying capacity. Students explain how energy is limited for populations at higher trophic levels. They explain how available nutrients cycle through both biotic and abiotic sources and how the availability of these nutrients can also limit population size.

Unit Assignment(s):

Students use computer simulations to test how different environmental parameters change population sizes, and then analyze their findings (SEP-4). Students graph their results in order to mathematically describe the population changes (SEP-5). Students use their descriptions to predict how population sizes and biodiversity are affected by human behaviors that alter the availability of ecosystem resources.

Unit Lab Activities:

Student dissects Owl Pellets charged with answering an essential question on the interdependence of food webs, ecosystems and populations. Charged with the focus question, “What do owl pellets reveal about population sizes?", students will first make observations of their pellet such as length, width, mass and for features of life such as feathers, wings, or insects and then use a toothpick to break apart the pellet and separate all the bones for identification using an organism bone chart. The number of organism types discovered, masses and qualities of owl pellets will be collected as a class via google sheets and graphed to show variations in the diet, variations in owl adaptations, and to ultimately help students construct a thorough food web showing the interdependence of organisms and cycling of matter and energy. Students will identify the ultimate source of energy (sun) and recognize how population size is maintained through predator prey interactions and other density dependent and density independent factors. Students will produce a model and claims evidence and reasoning explanation answering the focus question: "What do owl pellets reveal about population sizes?" where their model must include a food web, the cycling of matter and energy, interactions among organisms and their environment, and evidence from the owl pellet lab and ecology concepts from associated readings.

History of Earth's Atmosphere: Photosynthesis and Respiration

Students make a model (SEP- 2) that links photosynthesis and respiration in organisms to cycles of energy and matter in the Earth system. They gather evidence about the linked history of Earth's biosphere and atmosphere. Student observe how the distinctive patterns (CCC-1) of CO_2 concentrations are caused by geographic distribution of landforms in different hemispheres across earth. Students build upon their knowledge of energy flow as they are introduced to the two interdependent cellular processes: capturing light energy, and fixing atmospheric carbon into sugar molecules that can be used for energy storage or other anabolic biosynthetic pathways. Cellular respiration is explored as a process that results in ATP production and the recycling of carbon in the global carbon cycle. Students use available data (SEP-4), and student generated models of photosynthesis to construct an argument (SEP-7) that life has been an important influence on other components of the Earth system. Finally, students investigate carbon reservoirs within the Earth system.

Unit Assignment(s):

Students are presented with images of large redwood trees. Students are posed with the question: Where does the mass come from? Students draw a model (SEP-2) that explains how over time the redwood seed grows and adds mass to become the large tree. Students revise the model with new evidence from instruction on photosynthesis. As students revise their models to include cellular respiration, the revisions will indicate carbon cycling (CCC-4) through producers and consumers (CCC-5).

Unit Lab Activities:

Students develop a simple physical model of the atmosphere-ocean system by adding pH indicator to water in a closed container. Students use this model to investigate what happens as a plant grows, a candle burns, or a person exhales through a straw into the water. They notice that pH changes as $CO2$ from these sources interacts with the water to form carbonic acid. This same chemical reaction happens at the global scale with interactions between the atmosphere and the hydrosphere, making Earth's oceans one of the biggest reservoirs of carbon on the planet

Evidence of Evolution

Students develop a model about how rock layers record evidence of evolution as fossils. Students focus on effectively communicating this evidence and relate it to principles of natural selection. Students use evidence to support evolution such as fossils, homologous structures, and vestigial structures. They are also able to distinguish when analogous structures are due to convergent evolution and not common ancestry. Students apply Darwin's Postulates to living systems to explain the changes in populations that they observe. Students analyze DNA sequences as well as fossil evidence to determine evolutionary relationships of various species.

Unit Assignment(s):

Students argue with evidence (SEP-7) if the increase in sea lion pup strandings in 2015 was a result of climate change (SEP-8). To gather evidence, students first obtain information about three different types of marine mammals. Students ask questions (SEP-1) about whether their similarities are inherited from a common ancestor. They then gather evidence by analyzing a sequence of fossils to

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trace the evolution of different marine mammals back to different land-dwelling ancestors. They then analyze the sequences of amino acids to determine the relative similarity of the DNA of these mammals (SEP-4). Students explain the mammals return to a marine environment using the principles of natural selection. They then analyze data (SEP-4) to determine the cause of increases and decreases of marine mammal diversity over time and ultimately correlate some of these fluctuations with changes in temperature.

Unit Lab Activities:

Students engage in a simulations about the effects of antibiotics on bacteria since they produce every few hours so students can observe their evolution. Students use colored index cards to represent individual bacteria organism. Cards colored differently other than white represent individuals of the same species that are somehow resistant to the antibiotic. During each round, an antibiotic is applied that kills three out of four of the white cards, but none of the resistant red cards. After each round, the bacteria reproduce. Students graph the data and identify a trend that the population has evolved to become resistant to antibiotics. Students formulate the rules of the index card game as a computational algorithm. Students make a prediction on what happens to the population of bacteria when a person with an infection stops taking antibiotics before the end of the prescription.

Inheritance of Traits

Students develop explanations about the specific mechanisms that enable parents to pass traits to their offspring. They make claims about which processes give rise to variation in DNA codes and calculate the probability that offspring will inherit traits from their parents. Students take a historical approach to the development of our current understanding of DNA and its inheritance. Student explore the relevant scientific experiments and understand how science is a human endeavor. Students use physical models (SEP-2) of chromosomes to visualize and provide evidence (SEP-7) for how variation happens. Using other models such as pedigrees student can look for pattern of inheritance across generations. Students will also explore how environmental factors may affect phenotypic expression.

Unit Assignment(s):

Students investigate (SEP-3) the inheritance of traits using Wisconsin Fast Plants, or alternatively, the online simulation, to look for patterns in the data. Using these patterns students develop a model of inheritance (SEP-2) and use that model to predict the outcome of future genetic crosses.

Unit Lab Activities:

Students observe the inheritance of the purple stem trait and how trait factors interact, essentially the same experiments that Mendel did to derive the concepts of inheritance such as dominance, recessivity, and so forth. Students observe and record the stem color of 2 parental lines and their F1 and F2 generation offspring (all grown in petri dishes) and after analysis determine from their observations that Wisconsin Fast Plants® seedlings inherit 2 genes for this stem color trait, 1 from each parent and that there are 2 versions (alleles) of the gene for stem color, and the purple allele is dominant while the non-purple allele is recessive. Students then count the numbers of purple and non-purple seedlings in order to determine the ratio of purple stem seedlings to non-purple stem seedling and discover the 3:1 inheritance pattern predicted by Mendelian genetics. Students create models of inheritance with a supporting claims evidence and reasoning explanation addressing the focus question.

Structure, Function, and Growth (from cells to organisms)

Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. Students relate changes in the genetic code to changes in protein that cell's produce and ultimately to the physical features of an organism. They investigate how organisms maintain stability in changing environmental conditions via the function of interacting systems. Students are able to explain multicellularity in terms of the growth and reproduction of genetically identical cells and how the differentiated cells of multicellular organisms are a result of different patterns of gene expression.

Unit Assignment(s):

Students construct an evidence-based explanation (SEP-6) of how society was able to decrease the number of people dying from tuberculosis. To gather evidence students correlate the death rate over time with innovations such as germ theory and the discovery of the tuberculosis bacteria and the first antibiotic trial. Students gather data about other scientific innovations that contributed to the decline of this deadly disease.

Unit Lab Activities:

Students develop their own investigation by changing conditions for plants or animals and watch how they respond. They can measure their own heart rate returning to normal after vigorous exercise, observe plants growing taller in the dark to reach new light sources, or observe the behavioral response of planaria flatworms as the amount of light changes. Students will gather evidence that organisms respond to changes and use that evidence to construct a conceptual model that can be used to predict outcomes of future experiments that vary parameters from their initial trials.

Ecosystem Stability & the Response to Climate Change

Students use computer models to investigate how Earth's systems respond to changes, including climate change. Students explore models of Earth's energy budget to make predictions of human impacts on climate. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere.

Unit Assignment(s):

Students use a kinesthetic model showing how climate change may affect Pika foraging areas in alpine meadows of California. As students walk through the simulation, quantity of food supplies dwindle as the foraging range changes due to proposed climatic changes. Data is kept and analysed for three different climate scenarios. Students then run a similar computer simulation and are able to pose questions and change variables within the simulation to model outcomes. Finally students use data from Cal-Adapt website to find forecasts of various climatic events, and predict the effects on Pikas.

Unit Lab Activities:

Students examine evidence of common ancestry from homologous structures, fossil sequences, and DNA similarity. Students seek to explain the evolutionary sequence of land mammals migrating to the ocean in terms of adapting to environmental changes. Many of these changes are related to human impacts on global climate, and they use computer simulations to predict future changes to marine mammal populations given different climate change scenarios.

Course Materials

Websites

Title	Author(s)/Editor(s)/Compiler(s)	Affiliated Institution or Organization	U
CK12.org	[empty]	CK12 Foundation	w
Online Simulations	[empty]	University of Colorado Boulder	h