# Biology: The Living Earth A/B

Santa Maria Joint Union High School District

**New Course Approved**

Feb 28, 2020
Rebecca Wingerden

## asic Course Information

**hool(s) Offering This Course:**

| ;chool Name | Course Learning Environment | Transcript Code(s) | |
|---|---|---|---|
| | | Abbreviation | Course Code |
| ;anta Maria High School (053305) | Classroom Based | BioLivingEarthA | SC6100 |
| | | BioLivingEarthB | SC6101 |
| :rnest Righetti High School (053303) | Classroom Based | BioLivingEarthA | SC6100 |
| | | BioLivingEarthB | SC6101 |
| )elta High School (053302) | Classroom Based | BioLivingEarthA | SC6100 |
| | | BioLivingEarthB | SC6101 |
| 'ioneer Valley High School (053847) | Classroom Based | BioLivingEarthA | SC6100 |
| | | BioLivingEarthB | SC6101 |

**Title:** Biology: The Living Earth A/B

**Length of course:** Full Year

**Subject area:** Science (D) / Biology/Earth & Space Sciences

**UC honors designation?** No

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|---|---|
| **Prerequisites:** | None |
| **Co-requisites:** | Algebra 1 (Required)<br>Physics of the Universe (Required) |
| **Integrated (Academics / CTE)?** | No |
| **Grade levels:** | 9th, 10th, 11th, 12th |

## ourse Description

**ourse overview:**

*Biology: The Living Earth AB* is a laboratory-based college preparatory course. This course is defined in the 2019 California Science Framework, integrating Biology and Earth and Space Science standards from the California Next Generation Science Standards (NGSS). The course is divided into seven units, the first of which is a unit that focuses on executive science skills. The following six 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.

**ourse content:**

**0. Setting the Stage**

This unit focuses on the executive science skills necessary for planning and conducting an investigation, collecting and analyzing data, using mathematics and computational thinking, and engaging in argument from evidence. Students are introduced to and connections are made between Biology and Earth & Space Science, which are anchored to Earth Spheres.

**Essential Questions:**

1. How do you make sense of the world around you?
2. What is biology?
3. What skills are needed to conduct biological investigations?
4. How are Scientific Questions generated and tested?
5. How can trends in data be identified, analyzed, and applied?

**Performance Expectations:**

- Generate scientific questions.
- Identify and measure independent and dependent variables and constants.
- Write a data collection procedure.
- Identify and analyze graphical trends and patterns.
- State a claim about the scientific question being investigated through a written Claim-Evidence-Reasoning concluding paragraph.
- Evaluate the consistency of the data and relate to sources of error.

**NGSS Science and Engineering Practices (SEPs):**

- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Engaging in Argument from Evidence

**NGSS Cross-cutting Concepts (CCCs):**

- Patterns
- Scale, Proportion, and Quantity
- Structure and Function

**Unit Assignment(s):**

**Unit Assignments:**

Assignments in this unit aim to aid students in the development of scientific reasoning skills. Observing phenomena through the lenses of the SEP's and CCC's will be included. In addition, basic science skills will be reinforced through the use of a BioZone: The Living Earth resource, in which development of the SEP's are supported.

**Unit Lab Activities:**

**Unit Lab Activities:**

Mystery Tubes, Black Box, and Know Your Seed activities are used to build and reinforce science executive skills such as how to make qualitative and quantitative observation, use scientific inquiry, logic, and reasoning to answer questions about the living world. Claim, evidence, reasoning (CER) format will be used to facilitate student's development of logic and reasoning.

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## 1. Ecosystem Interaction and Energy

The Ecosystem Interaction and Energy unit engages students to build an understanding of the transfer of matter, atoms and molecules, abiotic and biotic factors within ecosystems, and models of energy flow. Students use mathematical and computer models to determine and predict the effect of factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Students conduct investigations to test how different parameters change population sizes, and then analyze their findings to identify the most important factors that determine biodiversity, population numbers, and the resulting effect on carrying capacity. Students provide evidence to support an explanation for the effects of both living and nonliving factors on biodiversity and population size, as well as the interactions of ecosystems on different scales and the effects of disturbances on an ecosystems' resilience. Using the conceptual model of energy pyramids, students find that very large populations of producers are required to support much smaller populations of tertiary consumers for the ecosystem to remain stable.

**Essential Questions:**

1. What factors affect the size of populations within an ecosystem?
2. What are common threats to remaining natural ecosystems and biodiversity

**NGSS Performance Expectations (PEs):**

- **HS-LS2-1.** Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales.
- **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.
- **HS-LS2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- **HS-LS2-8.** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

**NGSS Science and Engineering Practices (SEPs):**

- Developing and Using Models
- Using Mathematics and Computational Thinking
- Engaging in Argument from Evidence

**NGSS Cross-cutting Concepts (CCCs):**

- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter: Flows, Cycles, and Conservation

## Unit Assignment(s):

**Unit Assignments:**

In this unit, students are lead to the understanding that organisms have commonalities and differences within common groups.  Students will be exposed to a variety of organisms to categorize in an activity. Then students will examine the population dynamics between wolves and moose on Isle Royale to determine how populations increase/decrease in size based on environmental variables. Further examples of factors affecting populations will be examined using *BioZone: The Living Earth* resource and computer simulations (PhET and Gizmos). This exploration will provide students with the background to derive their own conceptual model of the interactions that shape ecosystems.

## Unit Lab Activities:

**Unit Lab Activities:**

Owl and Mice - In this activity, students play a game in which owls and mice populations are charted through successive generations as a means of acquiring an understanding of population density and predation. This activity provides a set of data students can analyze and draw conclusions to better understand the dynamics of relationships between different populations in the same environment.

Population Dynamics Case Study - Students explore population change in real populations by investigating the moose and wolves on Isle Royale. Students analyze data, read background information, and play a game to begin developing a model that helps explain the connection between the processes of birth, death, population growth, and decline. Students conduct additional research and revise their initial model ideas about what factors might be affecting the wolf population. Students then use their models to predict the behavior of moose populations over the past decade. They analyze new data, revise their model and work as a class to develop a consensus model of population regulation in the context of food webs. Students develop arguments based on evidence to make recommendations for this ecosystem and participate in a summit or debate to share their position.

## 2. History of Earth's Atmosphere: Photosynthesis and Respiration

The History of Earth's Atmosphere: Photosynthesis and Respiration unit, guides students in creating a model 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. Students observe how the distinctive patterns of CO2 concentrations are caused by the geographic distribution of landforms in different hemispheres across the 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, and student-generated models of photosynthesis to construct an argument that life has been an important influence on other components of the Earth system. Finally, students investigate carbon reservoirs within the Earth system.

**Essential Questions:**

1. How do living things acquire energy and matter for life?
2. How do organisms store energy?
3. How are photosynthesis and cellular respiration connected?
4. How do organisms use the raw materials they ingest from the environment?
5. How has the cycling of energy and matter changed over Earth's history?

**NGSS Performance Expectations (PEs):**

- **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.
- **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.
- **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.
- **HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- **HS-ESS2-7.** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

- **HS-ESS3-6.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

**NGSS Science and Engineering Practices (SEPs):**

- Developing and Using Models
- Using Mathematics and Computational Thinking
- Constructing Explanations (for science) and Designing Solution (for engineering)
- Engaging in Argument from Evidence

**NGSS Cross-cutting Concepts (CCCs):**

- Patterns
- Systems and System Models
- Energy and Matter: Flows, Cycles, and Conservation
- Stability and Change

## 💻 Unit Assignment(s):

**Unit Assignments:**

In this unit, students are presented with information about the carbon molecule and they explore why Carbon's structure leads to this element's ability to create many different compounds that are the foundation of life on Earth. A focus on carbon dioxide gas leads to discussions on where the gas comes from, storage, and conversion of the gas through carbon sinks, aerobic respiration, and photosynthesis. Students then apply this knowledge about how carbon moves through biotic and abiotic systems to include all matter. A variety of online simulations are used to help students formulate answers to the driving question of how organisms derive and transform matter. The *BioZone: The Living Earth* resource is used to emphasize Earth's biogeochemical cycles, as well as, the co-evolution of Earth's systems. Assignments modified from ENSI, Carbon Time, and MBER are utilized as well.

## ⚗ Unit Lab Activities:

**Unit Lab Activities:**

Atmosphere-Ocean System - In this activity, students develop a simple physical model of the atmosphere-ocean system by adding a 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 interact 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. In this activity, students engage in the scientific practices of analyzing data and arguing from evidence to build a model of the movement of carbon through Earth's systems.

Photosynthesis and Respiration Lab - In this activity, students will use models of photosynthesis and cellular respiration to predict the presence or absence of CO2 in tubes with elodea and bromothymol blue indicator. Students will observe and record the results of the exposure of elodea to the bromothymol blue indicator in the presence and absence of light. Analyzing data collected during the lab, students will explain the relationship between the two processes.

### 3. Evidence of Common Ancestry and Diversity

The Evidence of Common Ancestry and Diversity unit engages students to develop a model about how rock layers record evidence of evolution as fossils. Students focus on effectively communicating this evidence and relate 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 principles to living systems to explain the changes in populations that they observe. Students analyze DNA sequences as well as fossil evidence to determine the evolutionary relationships of various species. Students also construct an explanation that shows evolution is caused primarily by one or more of the 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. Students use evidence from analyzed data sets and reasoning to support common ancestry and biological evolution.

**Essential Questions:**

1. How do layers of rock form and how do they contain fossils?
2. Why do we see similar fossils across the world from each other but living organisms that are very different?
3. What evidence shows that different species are related?
4. How have modern-day humans evolved?

**NGSS Performance Expectations (PEs):**

- **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 the 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.
- **HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes
- **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, the occurrence of natural hazards, and changes in climate have influenced human activity
- **HS-ESS3-4.** Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems.

**NGSS Science and Engineering Practices (SEPs):**

- Planning and Carrying Out Investigations
- Constructing Explanation (for science) and Designing Solutions (for engineering)
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communication Information

**NGSS Crosscutting Concepts (CCCs):**

- Patterns
- Cause and Effect: Mechanism and Explanation
- Structure and Function
- Stability and Change

**Unit Assignment(s):**

**Unit Assignments:**

In this unit, students will utilize the fossil and DNA evidence regarding the evolution of the whale to identify patterns as well as the mechanism of evolution. From fossil evidence, students will assemble a timeline of whale structural changes supported by readings and video segments from Nova: Great Transformations. Students will compare the DNA of whales to a variety of organisms to determine closest relatives to the whales which will be compared to the movements of landmasses via Continental Drift and Theory of Plate Tectonics to help students better understand that changes in the environment create the conditions under which adaptations will occur. In addition, students will access graphs of population changes for various animals that will highlight our four Principles of Natural Selection. Videos such as "How the Earth Made Man" will be utilized to reinforce that concept as will a lab on the development of sedimentary rock. Readings and simulations on human evolution utilizing qualitative and quantitative data will allow students to better understand the modern evolution of humans through fossil evidence found in sedimentary rock.

**Unit Lab Activities:**

**Unit Lab Activities:**

The Galapagos Finch - After engaging in activities designed to demonstrate that more offspring are born than can survive and that variation occurs in a population, students take part in a hands-on investigation in which they are medium ground finches on the Galapagos island of Daphne Major. They simulate environmental conditions and collect data on the amount of food birds are able to forage and determine if those individuals who would be able to survive or not. They analyze their collected group and class data to determine which adaptations in beak size were more advantageous and enabled birds to survive and reproduce.

Stickleback Evolution Virtual Lab (HHMI) - This virtual evolution lab utilizes data collection and analysis to allow students to study evolutionary processes using modern stickleback fish and fossil specimens. Students virtually analyze the pelvic structures of the threespine stickleback fish, complete three experiments, each focusing on changes to the pelvic girdle and pelvic spines of freshwater stickleback populations. Students analyze and compare the pelvic structures of fossil stickleback specimens and analyze their data to determine the rate at which pelvic reductions evolved.

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## 4. Inheritance of Traits

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The Inheritance of Traits unit explores the inheritance of traits by explaining why offspring do not look exactly like their parents. Students explore the dynamics of gene expression and replication at a molecular level. This exploration provides them with a basis for examining some of the fundamental techniques of genetic engineering (including cell division), DNA replication, and protein synthesis. Students then begin their study of genetics and explore the transmission of genetic information, genetic variation, and inheritance patterns. Students will see how genetic information is passed between generations and how this provides biological continuity for species. They study the relationship between genotype and phenotype and explore how the environment plays an important role in phenotypic expression. Students will then 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. Students will also apply their understanding of heredity in relation to evolution by explaining why certain dominant traits such as dwarfism remain rare in a given population.  Students explore relevant scientific experiments and understand how science is a human endeavor. Students use physical models of chromosomes to visualize and provide evidence for how variation happens. Using other models, such as pedigrees, allows students to look for patterns of inheritance across generations.

**Essential Questions:**

1. How are the characteristics of one generation passed to the next?
2. What allows traits to be transmitted from parents to offspring?
3. How does variation affect a population under selective pressures?

**NGSS Performance Expectations (PEs):**

- **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.
- **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-LS3-3.** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population
- **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-LS4-3.** 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

**NGSS Science and Engineering Practices (SEPs):**

- Asking Questions and Defining Problems
- Analyzing and Interpreting Data
- Constructing Explanations (for science) and Designing Solution (for engineering)
- Engaging in Argument from Evidence

**NGSS Crosscutting Concepts (CCCs):**

- Patterns
- Cause and Effect: Mechanisms and Explanation
- Scale, Proportion, and Quantity

## ⊒ Unit Assignment(s):

**Unit Assignments:**

In this unit students first, take a survey on human genetics in themselves and family to start to predict where traits are coming from. Students investigate the inheritance of traits using Wisconsin Fast Plants, or alternatively, the online simulation, to look for patterns in the data. 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. Using these patterns students develop a model of inheritance and use that model to predict the outcome of future genetic crosses.

Additionally, students explore the history of our current understanding of DNA and its inheritance evolved. Students use physical models of chromosomes to visualize and provide evidence for how variation happens. Using other models such as pedigrees students will look for patterns of inheritance across generations.

**Unit Lab Activities:**

**Unit Lab Activities:**

Inheritance in Fast Plants Based on Gregor Mendel's experiments, students observe the inheritance of the purple stem trait and how trait factors interact. 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 supporting claims evidence and reasoning explanation addressing the focus question.

Genetic Disorders - Students research a genetic disorder to determine actual gene proteins through HHMI activities, OMIM, or other internet databases. Students will expand upon their findings to provide the details of the disorder, pulling in concepts related to mutations, chromosomes, and genetic frequency in the human population.

PTC: The Genetics of Bitter Taste - Students will use the HHMI Biointeractive activity, "The Genetics of Bitter Taste" to examine their perception of taste. The chemical PTC will be used in order to explain the inheritance pattern of this trait. Students will collect and analyze class data of tasters vs non-tasters of the chemical PTC. Students then determine if there is a correlation between taste and the number of taste buds on the human tongue. After graphing the data collected, students develop a model to explain the relationship between the number of taste buds and the perception of the taste of bitterness. Finally, students present their models.

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## 5. Structure, Function, and Growth

The Structure, Function, and Growth unit provides the opportunity for students to use models to create explanations of how DNA provides the code to construct proteins, build biomass, reproduce, and create complex multicellular organisms. Students relate the changes in the genetic code to changes in proteins that cells produce, and then to the physical features of an organism. Students also 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.

**Essential Questions:**

1. What happens if a cell in our body dies?
2. How does the structure of DNA affect how cells look and behave?
3. How do systems work in a multi-celled organism (emergent properties) and what happens if there is a change in the system?
4. How do organisms survive even when there are changes in their environment?

**NGSS Performance Expectations (PEs):**

- **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.
- **HS-LS1-2.** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- **HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **HS-LS1-4.** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

**NGSS Science and Engineering Practices (SEPs):**

- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Constructing Explanations (for science) and Designing Solutions (for engineering)

**NGSS Crosscutting Concepts (CCCs):**

- Systems and Systems Models
- Structure and Function
- Stability and Change

## 💻 Unit Assignment(s):

**Unit Assignments:**

In this unit, students will be using online simulations and activities to understand the properties of DNA and how DNA provides traits through the process of protein synthesis. Students will learn about mitosis and meiosis as a way to understand the need for proteins in cellular processes of energy acquisition, growth, and repair. Using homeostatic simulations, students will create a conceptual model of 1) the interaction and regulation that takes place within our cells and 2) the ways in which our cells are able to maintain stability within the entire function of the human body. Students will also explore examples of what happens when homeostasis is not maintained. After developing a model comparing normal cell division to cancer cell growth and division, students will research advancements in gene therapies and cancer treatments. Students will then add new information to their model to explain how these gene therapies are being used to fight cancers.

## ⚗ Unit Lab Activities:

**Unit Lab Activities:**

Cell Size and Diffusion Lab - In this investigation, students use cubes of agar to examine how cell size impacts diffusion. By infusing cubes of agar with a pH indicator, and then soaking the treated cubes in vinegar, students model how diffusion occurs in cells. Students observe cubes of different sizes, collect and analyze diffusion data to discover why larger cells might need extra help to transport materials. Students then examine different cells and the cell organelles to draw conclusions about cell size, structure, and function.

Homeostasis and Negative Feedback - Students will begin by analyzing and discussing concepts that develop their understanding of homeostasis and negative feedback. They will examine the differences between negative and positive feedback using the respiratory and circulatory systems as examples in providing $O2$ and the removal of $CO2$ from cells. Finally, students formulate a question concerning the effects of exercise on breathing, design and carry out a relevant experiment, analyze and interpret their data, and relate their results to homeostasis during exercise.

### 6. Ecosystem Stability and the Response to Climate Change

Students use computer models to investigate how Earth's systems respond to changes, including climate change. Students use the model to identify possible negative consequences of solutions that would outweigh their benefits. Students also develop conceptual models of ecosystem changes, evaluate different claims about the impacts of a new, hypothetical change, and how populations respond to the varied stresses from human activities and climate change. Students organize data from global climate models and climate observations over time that relate to the effect of climate change on different Earth systems. Students design a solution that involves reducing the negative effects of human activities on the environment and biodiversity that relies on scientific knowledge of the factors affecting changes.

**Essential Questions:**

1. What factors change in ecosystems that will affect populations?
2. What are the changes that are happening in the climate and what effects are those having on life?
3. How are human activities impacting Earth's systems and how does that affect life on Earth?
4. What can humans do to mitigate their negative impact on the environment?

**NGSS Performance Expectations (PEs):**

- **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.
- **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **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-LS4-6.** Create or revise a simulation to test a solution to mitigate the adverse impacts of human activity on biodiversity.
- **HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems [Clarification Statement: Examples of evidence, for both data and climate model outputs, are
- **HS-ESS3-6.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- **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.

**NGSS Science and Engineering Practices (SEPs):**

- Developing and using models
- Constructing explanations and designing solutions
- Obtaining, evaluating, and communicating information.

**NGSS Crosscutting Concepts (CCCs):**

- Patterns
- Stability and Change
- Scale, proportion, and quantity
- Energy and Matter
- Structure and Function

**Unit Assignment(s):**

**Unit Assignments:**

In this unit, students will build an understanding of the movement of matter and energy through environments as a basis for building a conceptual model of ecosystem stability and an organism's response to changes in the climate. Students will learn of the carbon cycle, the effect on humans, other populations and the atmosphere. Students will track their carbon footprint and propose ideas for mitigation of deleterious effects of increased carbon dioxide on our Earth. As the main agent of negative environmental changes, humans' effect on climate changes will be examined in their relationship to Earth's systems and ecosystem health.

Students will research a biome, how humans have impacted the biome, and create an action plan to reduce the human impact. Students choose a biome and research the following: major geologic features (mountains, deserts, oceans), climate (rainfall, temperature), natural resources available, common adaptations of animals and plants, other interesting facts or features. They then choose and provide more information about the human impact on this biome and describe how it has affected the biome. Students then research what has been done to mitigate the human impact, describe solutions to reduce the impact, and design an action plan to enact their solution. Students write a report and present their findings and proposal to the class.

**Unit Lab Activities:**

**Unit Lab Activities**

Urban Heat Islands - In this activity, students study urban heat islands to apply their model of the Earth's energy balance. They explore how human activities can alter the local climate system and ultimately design measures to reduce that impact.

Ocean Acidification - Students work in groups to brainstorm the sources of $CO_2$ entering the ocean, and then create a model of the causes and effects of ocean acidification. Students work to design solutions to mitigate ocean acidification which will be presented to the class using a variety of online resources.

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## ourse Materials

## Literary Texts

| ïtle | Author | Publisher | Edition | Website | Read in entirety |
|---|---|---|---|---|---|
| ioZone - Biology: The Living arth | Biozone | BIOZONE International | 2019 | http://www.thebiozone.com | No |

## Websites

| ïtle | Author(s)/Editor(s)/Compiler(s) | Affiliated Institution or Organization | URL |
|---|---|---|---|
| ΛBER- Modeling ased Educational esource | Dr. Cynthia Passmore | University of California, Davis | https://www.modelbasedbiology.com |
| hET Interactive imulation | [ empty ] | University of Colorado, Boulder | https://phet.colorado.edu/ |
| izmos imulations | [ empty ] | Explore Learning | https://www.explorelearning.com |
| K12.org | [ empty ] | CK12 Foundation | https://www.ck12.org |
| lewsELA.com | [ empty ] | NewsELA | https://newsela.com/ |
| NSI/SENSI | Evolution and the Nature of Science Instruction | Indiana University | http://www.indiana.edu/~ensiweb/ |
| arbon TIME | Carbon: Transformation Matter and Energy website | Michigan State University | https://carbontime.bscs.org/ |
| HMI iointeractive | [ empty ] | Howard Hughes Medical Center | https://www.hhmi.org/ |
| BS/NOVA | [ empty ] | Public Broadcasting Service/NOVA | https://www.pbs.org/wgbh/nova/brand/education . https://www.pbs.org/show/nova/episodes/ |
| )MIM | Online Mendelian Inheritance in Man | NCBI National Center for Biological Informaiton | https://www.ncbi.nlm.nih.gov/omim |