

08_Ecology

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **4-6 weeks**
Status: **Published**

General Overview, Course Description or Course Philosophy

Biology focuses on the diversity, complexity, and interdependence of life on Earth. Students will develop an understanding of how organisms evolve, reproduce, and adapt to their environments. This will include an exploration of how to relate the structure and function of molecules to their role in cell biology and metabolism. Further understanding of evolution and reproduction will be explored through the science of genetics. Knowledge of biodiversity and adaptation will be illustrated through the science of ecology.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.
- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.
- Much of science deals with constructing explanations of how things change and how they remain stable.

CONTENT AREA STANDARDS

	occurrence of natural hazards, and changes in climate have influenced human activity.
SCI.HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
SCI.HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
SCI.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.
SCI.HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
SCI.HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
SCI.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.
SCI.HS-LS2-4	Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
SCI.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.
SCI.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.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

LA.W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
LA.W.9-10.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach, or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience.
LA.W.9-10.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.RI.9-10.1	Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.
LA.RI.9-10.7	Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.
LA.RI.9-10.8	Describe and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and reasoning.
LA.RL.9-10.8	(Not applicable to literature)
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.
MA.S-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
MA.S-IC.B.6	Evaluate reports based on data.
MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
SCI.HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
SCI.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
SCI.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).

STUDENT LEARNING TARGETS

Declarative Knowledge

Students will understand that:

- Energy from photosynthesis and respiration drives the cycling of matter and flow of energy under aerobic or anaerobic conditions within an ecosystem.
- Anaerobic respiration occurs primarily in conditions where oxygen is not available.
- Matter flows between organisms and their environment.
- Energy flows from one trophic level to another as well as through the environment.
- The inputs and outputs of photosynthesis; the inputs and outputs of cellular respiration; and the biosphere, atmosphere, hydrosphere, and geosphere.
- 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.
- The resiliency of an ecosystem is subject to the degree of change in the biological and physical environment of an ecosystem.

Procedural Knowledge

Students will be able to:

- Students identify and describe the evidence to construct the explanation, including:
 - All organisms take in matter and rearrange the atoms in chemical reactions.
 - Photosynthesis captures energy in sunlight to create chemical products that can be used as food in cellular respiration.
 - Cellular respiration is the process by which the matter in food (sugars, fats) reacts chemically with other compounds, rearranging the matter to release energy that is used by the cell for essential life processes.
- Students use reasoning to connect evidence, along with 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, to construct their explanation. Students describe the following chain of reasoning used to construct their explanation:
 - Energy inputs to cells occur either by photosynthesis or by taking in food.
 - Since all cells engage in cellular respiration, they must all produce products of respiration.
 - The flow of matter into and out of cells must therefore be driven by the energy captured by photosynthesis or obtained by taking in food and released by respiration.
- Given new data or information, students revise their explanation and justify the revision (e.g., recent discoveries of life surrounding deep sea ocean vents have shown that photosynthesis is not the only driver for cycling matter and energy in ecosystems).
- Students identify and describe the components in the mathematical representations that are relevant to supporting the claims. The components could include relative quantities related to organisms, matter, energy, and the food web in an ecosystem.
- Students describe how the claims can be expressed as a mathematical relationship in the mathematical representations of the components of an ecosystem.
- Students use the mathematical representation(s) of the food web to:
 - Describe the transfer of matter (as atoms and molecules) and flow of energy upward between organisms and their environment.
 - Identify the transfer of energy and matter between trophic levels.
 - Identify the relative proportion of organisms at each trophic level by correctly identifying producers as the lowest trophic level having the greatest biomass and energy and consumers decreasing in numbers at higher trophic levels.
- Students describe relationships between components of their model, including:
 - The exchange of carbon (through carbon-containing compounds) between organisms and the environment.
 - The role of storing carbon in organisms (in the form of carbon-containing compounds) as part of the carbon cycle.
- Students assess the logic of the reasoning, including the relationship between degree of change and stability in ecosystems, and the utility of the reasoning in supporting the explanation of how:
 - Modest biological or physical disturbances in an ecosystem result in maintenance of relatively consistent numbers and types of organisms.
 - Extreme fluctuations in conditions or the size of any population can challenge the functioning of ecosystems in terms of resources and habitat availability, and can even result in a new ecosystem.
- Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
- 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.
- Use a computational representation to illustrate the relationships among Earth systems and how those

relationships are being modified due to human activity (i.e., climate change).

- Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

EVIDENCE OF LEARNING

Formative Assessments

- Checks for understanding during lesson.
- Use of student-friendly proficiency scales to track progress.
- Do Now activities.
- Student-centered questioning and discussion that is facilitated by instructor.
- Exit Tickets.

Summative Assessments

- Benchmarks – departmental benchmark given at the end of MP1, MP2, and MP3
- Alternative Assessments
 - Lab inquiries and investigations
 - Lab Practicals
 - Exploratory activities based on phenomenon
 - Gallery walks of student work
 - Creative Extension Projects
 - Build a model of a proposed solution
 - Let students design their own flashcards to test each other
 - Keynote presentations made by students on a topic
 - Portfolio

RESOURCES (Instructional, Supplemental, Intervention Materials)

[Miller & Levine Biology Textbook](#)

- Unit 2 - Ecology
 - Chapter 4 - Ecosystems
 - Video: *Flow of Energy Through Producers and Consumers*
 - Analyzing Data: *Ocean Water and Oxygen Concentration*
 - Interactivity: *Food Web*
 - Animation: *The Water Cycle*
 - Case Study: *The Nitrogen Cycle*
 - Exploration Lab: *The Effect of Fertilizer on Algae*
 - Chapter 5 - Populations
 - Analyzing Data: *Monarchs in Decline*
 - Chapter 6 - Communities and Ecosystem Dynamics
 - Quick Lab: *How does succession occur?*
 - Chapter 7 - Humans and Global Change
 - Case Study: *How Does Acid Affect Shells?*
 - Case Study: *Toxic Algal Bloom*

POGIL Biology

- Energy Transfer in Living Organisms
- Ecological Pyramids
- Nutrient Cycles
- Climate Change

Gizmos

- Cell Respiration (STEM Case)
- Photosynthesis (STEM Case)
- Carbon Cycle
- Cell Energy Cycle

[Brainpop](#)

[NSTA](#)

[Data Nuggets](#)

[Online Resources](#)

INTERDISCIPLINARY CONNECTIONS

ELA/Literacy

Mathematics

Technology

Earth Science

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.