



Park Hill School District

Building Successful Futures • Each Student • Every Day

High School Topics Biology I Curriculum

This document contains the entire Biology I Curriculum that is taught in a regular education setting. Items **highlighted in yellow have been designated as priority information that should be taught in the Biology I class. Items in **red font** are additional modifications suggested by special education teachers.*

Course Description: Topics Biology is an introductory high school science course that covers the principles governing all life. It includes topics in cells and cell reproduction, genetics, natural selection, ecology, and environmental issues. It provides the basis for study in the more advanced life science courses. This course is a prerequisite for all other sciences.

Curriculum Standards: Missouri Learning Standards

Scope and Sequence:

Timeframe	Unit	Instructional Topics
8-10 blocks	<u>Unit 0: Introduction to Biology</u>	<u>Topic 1: Vocabulary Prefixes and Suffixes</u> <u>Topic 2: Parts of an Experiment</u> <u>Topic 3: General Chemistry</u> <u>Topic 4: Graphing Data</u>
10-12 blocks 8-10 blocks	<u>Unit 1: Earth and Human Activity</u>	<u>Topic 1: Environmental Impacts on Humans</u> <u>Topic 2: Human Activities on Environment</u> <u>Topic 3: Solutions and Sustainability</u>
9-11 blocks 8-10 blocks	<u>Unit 2: Ecology</u>	<u>Topic 1: Energy Flow in Ecosystems</u> <u>Topic 2: Nutrient Cycles</u> <u>Topic 3: Interactions of Organisms</u> <u>Topic 4: Population Dynamics</u>

8-10 blocks 8-10 blocks	Unit 3: Energy	Topic 1: Macromolecules Topic 2: Photosynthesis Topic 3: Aerobic and Anaerobic Respiration
10-12 blocks 12-14 blocks	Unit 4: Organization and Homeostasis	Topic 1: Levels of Organization Topic 2: Body Systems Topic 3: Homeostasis
10-12 blocks 8-10 blocks	Unit 5: Reproduction	Topic 1: DNA and Chromosomes Topic 2: Cell Cycle and Mitosis Topic 3: Meiosis and Fertilization
13-15 blocks 13-15 blocks	Unit 6: Gene Expression and Heredity	Topic 1: DNA and RNA Topic 2: Protein Synthesis Topic 3: Mutations Topic 4: Punnett Squares and Pedigrees
8-10 blocks 8-10 blocks	Unit 7: Evolution	Topic 1: Co-Evolution of Earth and Life Topic 2: The Process of Natural Selection Topic 3: Evidence for Evolution
3-8 blocks	EOC Review	

Alternative Scope and Sequence

This sequence provides a different pathway through Biology content for a topics-based special education setting. While the general education sequence moves macro → micro, this sequence moves micro → macro, beginning with foundational concepts like introduction to chemistry, cells, and genetics before building to ecosystems and human impact. This approach supports students in developing a strong foundation and making connections across increasingly complex systems. This sequence does not rely on students having as much prior knowledge. Teachers are encouraged to choose the sequence that best meets the needs of their students.

Timeframe	Unit	Instructional Topics
8-10 blocks	Unit 0: Introduction to Biology	Topic 1: Vocabulary Prefixes and Suffixes Topic 2: Parts of an Experiment Topic 3: General Chemistry Topic 4: Graphing Data
10-12 blocks 12-14 blocks	Unit 4: Organization and Homeostasis	Topic 1: Levels of Organization Topic 2: Body Systems Topic 3: Homeostasis

8-10 blocks 8-10 blocks	Unit 3: Energy	Topic 1: Macromolecules Topic 2: Photosynthesis Topic 3: Aerobic and Anaerobic Respiration
10-12 blocks 8-10 blocks	Unit 5: Reproduction	Topic 1: DNA and Chromosomes Topic 2: Cell Cycle and Mitosis Topic 3: Meiosis and Fertilization
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8-10 blocks 8-10 blocks	Unit 2: Ecology	Topic 1: Energy Flow in Ecosystems Topic 2: Nutrient Cycles Topic 3: Interactions of Organisms Topic 4: Population Dynamics
12-14 blocks 8-10 blocks	Unit 1: Earth and Human Activity	Topic 1: Environmental Impacts on Humans Topic 2: Human Activities on Environment Topic 3: Solutions and Sustainability
3-8 blocks 3-10 blocks	EOC Review	

Curriculum Revision Tracking

Spring 2026

- Learning Targets Added
- Deleted ISTE and TT standards
- “Introduction to Science Processes” unit was removed
- “Reproduction” unit split from Heredity
- Order of units was changed
- Topics in units were updated

Spring 2019

- Topics six “Ecology” and seven “Evolution” switched and became topic six “Evolution” and topic seven “Ecology”
- Timeframes for all units adjusted

Unit 0: Introduction to Science Process

Subject: Biology

Grade: 9

Name of Unit: Introduction to Sciences Process

Length of Unit: 5-8 blocks

Overview of Unit: This unit is an introduction to the scientific practices such as lab safety, lab equipment and procedures, as well as analyzing and displaying data in science. Students will become familiar with qualitative and quantitative measurements used in lab experiments and how to approach a problem thinking logically and scientifically. Students will also be given the tools to break down scientific words to derive meaning and understanding.

Priority Standards for unit:

- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 9-12-ETS-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.
- 9-12-ETS3-3 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.

Essential Questions:

1. How is experimental design used as a means to conduct scientific investigations?
2. How are quantitative and qualitative measurements observed and analyzed in scientific experiments?
3. Why is it useful to display data and experimental evidence in charts or graphs?

Enduring Understanding/Big Ideas:

1. Experiments are used to test hypotheses in scientific investigations. Designing reliable and valid experiments are necessary to collect, analyze, and communicate data and results that focus on scientific concepts.
2. Quantitative and qualitative measurements can be collected using scientific tools and organized into data tables.
3. Charts and graphs are a way to visually represent data. These representations can provide an analysis and summary of scientific results.

Unit Vocabulary:

- Scientific method
- Observation
- Hypothesis
- Experiments
- Theory
- Constants
- Control group
- Experimental group
- Line graph
- Bar graph
- Independent variable
- Dependent variable

Prefixes/Suffixes:

- A- or an-
- Aqua-
- Auto-
- Bi- or di-
- Bio-
- Chloro-
- Endo-
- Exo-
- Hyper-
- Hypo-
- Hetero-
- Cyto-
- Homo-
- Micro-
- Macro-
- Photo-
- Poly-
- Tri-
- Zoo-
- -ology
- -synthesis
- -troph

Learning Targets:

Priority Standard: 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
Learning Targets	Webb's DOK Level
	Bloom's Level
Students will learn Latin prefixes commonly used in Biology.	DOK 1
	Understanding
Students will apply their knowledge of Latin prefixes to break down words in order to derive their meaning.	DOK 2
	Applying
Students will collect both qualitative and quantitative data and create data tables.	DOK 2
	Applying
Students will analyze data provided in a variety of tables or charts in order to make educated conclusions about the world around them.	DOK 3
	Analyzing

Priority Standard: 9-12-ETS-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.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will create a testable hypothesis in relation to an observation made about their world.	DOK 3
	Analyzing
Students will demonstrate the understanding of conducting proper experiments in order to support their hypothesis.	DOK 4
	Evaluating
Students will conduct an experiment to test their hypothesis and determine if a new hypothesis is needed.	DOK 4
	Evaluating

Priority Standard: 9-12-ETS3-3 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.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will apply the Scientific Method to test hypotheses in order to evaluate solutions to complex real-world problems.	DOK 3
	Analyzing
Students will evaluate proposed solutions to real-world problems by thinking like a scientist.	DOK 4
	Evaluating

Topic 1: Vocabulary Prefixes and Suffixes

Engaging Experience 1

Title: Play the game - Headbands

Suggested Length of Time: 20-30 minutes

Standards Addressed

Priority:

- 9-12-ETS-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Detailed Description/Instructions: Make some vocabulary cards that use the prefixes and suffixes they are learning. They have to hold the card in front of their forehead while the other students try to give them clues as to what the word is. They cannot say the prefix or suffix as a clue. The person holding the card gets 5 guesses and then they can look.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 2: Parts of an Experiment

Engaging Experience 1

Title: Identify Parts of an Experiment

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12-ETS3-3 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..

Detailed Description/Instructions: Give students scientific questions on slips of paper. While working in groups, have the students identify the independent variable and dependent variable for each possible experiment. Then have the students construct a strong Hypothesis statement for each experiment.

Questions:

1. How does the solute concentration affect the density of solutions?
2. How is the pitch of a guitar string affected by tension?
3. What is the effect of temperature on the rate at which sugar dissolves?
4. How does sulfur dioxide air pollution affect the acidity of water?
5. What is the effect of calcium on the growth of baby mice?

Use the templet “If ____ (IV) ____ is increased, then ____ (DV) ____ will increase” for the hypothesis.

Bloom’s Levels: Analyzing

Webb’s DOK: 3

Topic 3: General Chemistry

Engaging Experience 1

Title: Sort the Elements from the Compounds

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12-ETS-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.

Detailed Description/Instructions: Put students into groups or pairs. Give them a list of elements or compounds and have them sort them into two groups. They can be diagrams and/or formulas of each element or compound.

Bloom's Levels: Understanding

Webb's DOK: 1

Topic 4: Graphing Data

Engaging Experience 1

Title: Penny Drop Lab

Suggested Length of Time: 30 minutes

Standards Addressed

Priority: 9-12-ETS3-3 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.

Detailed Description/Instructions: Have students get into groups or pairs to complete the lab. Give them each a small pipet, water, penny, paper plate, and paper towels. Have them complete the lab and graph their findings. Talk about where the independent and dependent variable goes on the graph. Also talk about the control of the experiment.

Link for Lab: https://www.lhschools.org/Downloads/2015_penny_drop_lab_-_hypothesis.pdf

Bloom's Levels: Evaluating

Webb's DOK: 4

Unit 1: Earth and Human Activity

Subject: Biology

Grade: 9

Name of Unit: Earth and Human Activity

Length of Unit: 10-12 Blocks (8-10 Blocks)

Overview of Unit: This unit investigates the impact of human activity on Earth's systems. Students will explore Earth's natural resources and how human activity has impacted these natural resources and altered Earth's systems. Additionally, students will investigate and develop solutions to address these changes to Earth's systems in order to preserve and maintain natural resources.

Priority Standards for unit:

- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
- 9-12.LS2.C.2 Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.
- 9-12.LS4.C.3 Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity.
- 9-12.ESS3.A.1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- 9-12.ESS3.A.2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on economic, social, and environmental cost-benefit ratios.
- 9-12.ESS3.C.1 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- 9-12.ESS3.C.2 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems in order to restore stability and or biodiversity of the ecosystem as well as prevent their recurrences.
- 9-12.ESS3.D.1 Analyze geoscientific 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.
- 9-12.ESS3.D.2 Predict how human activity affects the relationships between Earth systems in both positive and negative ways.

Science & Engineering Practices

Developing and Using Models

- *Develop a model based on evidence to illustrate the relationships between systems or components of a system*

Constructing Explanations and Designing Solutions

- *Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations*
- *Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer reviews) 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*

Using Mathematics and Computational Thinking

- *Create or revise a simulation of a phenomenon, designed device, process, or system*
- *Create a computational model or simulation of a phenomenon, designed device, process, or system*
- *Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations*

Engaging in Argument from Evidence

- *Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).*

Analyzing and Interpreting Data

- *Analyze data using computational models in order to make valid and reliable scientific claims.*

Scientific Investigations Use a Variety of Methods

- *Science investigations use diverse methods and do not always use the same set of procedures to obtain data.*
- *New technologies advance scientific knowledge.*
- *Science arguments are strengthened by multiple lines of evidence supporting a single explanation*

Disciplinary Core Ideas

Cycles of Matter and Energy Transfer in Ecosystems

- *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.*

Energy in Chemical Processes

- *The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis*

Ecosystems, Dynamics, Functioning, and Resilience

- *Anthropogenic changes (changes induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.*

Biodiversity and Humans

- *Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).*
- *Humans depend on the living world for the resources and other benefits provided by biodiversity.*
- *But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.*
- *Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.*

Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability, aesthetics and to consider social, cultural, and environmental impacts
- Both physical models and computers can be used in various ways to aid in the engineering design process.
- Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical and in making a persuasive presentation to a client about how a given design will meet his or her needs

Adaptation

- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species

Natural Resources

- Resource availability has guided the development of human society.
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations

Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts

Weather and Climate

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

Crosscutting Concepts

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible
- Feedback (negative or positive) can stabilize or destabilize a system

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects

Influence of Science, Engineering, and Technology on Society and the Natural World

- *Modern civilization depends on major technological systems*
- *Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.*
- *Analysis of costs and benefits is a critical aspect of decisions about technology.*
- *New technologies can have deep impacts on society and the environment, including some that were not anticipated*

Science Addresses Questions About the Natural and Material World

- *Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.*
- *Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.*
- *Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.*

Science is a Human Endeavor

- *Science is a result of human endeavors, imagination, and creativity.*

Learning Targets:

Priority Standard: 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

[Clarification Statement: The primary forms of carbon include carbon dioxide, hydrocarbons, waste, and biomass. Examples of models could include simulations and mathematical and conceptual models.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will evaluate the impact of combustion on the carbon cycle.	DOK 3
	Analyzing
Students will model how photosynthesis and respiration remove and add carbon dioxide from the atmosphere.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Applying

Priority Standard: 9-12.LS2.C.2 Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.

[Clarification Statement: Examples of solutions may include captive breeding programs, habitat restoration, pollution mitigation, energy conservation, agriculture and mining programs, and ecotourism.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe the benefits of biodiversity and how all living things, including humans, depend on it.	DOK 2
	Applying
Students will identify and describe how humans are positively impacting biodiversity.	DOK 2
	Applying

Priority Standard: 9-12.LS4.C.3 Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity.

[Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how humans are negatively impacting biodiversity.	~~DOK 2~~ DOK 2
	~~Applying~~ Understand
Students will evaluate mitigation strategies to improve biodiversity.	DOK 3
	Evaluate

Priority Standard: 9-12.ESS3.A.1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

[Clarification Statement: Examples of key natural resources include access to freshwater, regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather. Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will examine why humans settle in areas where resources are abundant.	DOK 3
	Analyzing
Students will analyze how humans migrate based on climate change, natural disasters, and geological changes.	DOK 3
	Analyzing

Priority Standard: 9-12.ESS3.A.2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on economic, social, and environmental cost-benefit ratios.

[Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shale), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems — not what should happen.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will evaluate solutions to ensure sustainability.	DOK 3
	Analyzing
Students will identify different types of energy and natural resources.	DOK 1
	Remembering
Students will evaluate the costs and benefits of using renewable vs. non-renewable energy sources.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Understanding

Priority Standard: 9-12.ESS3.C.1 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

[Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will define the concept of sustainability.	DOK 1
	Understanding
Students will describe how management of resources will impact future populations.	DOK 2
	Applying
Students will explain how new technologies play a vital role in resource management and sustainability.	DOK 2
	Applying

Priority Standard: 9-12.ESS3.C.2 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems in order to restore stability and or biodiversity of the ecosystem as well as prevent their recurrences.

[Clarification Statement: Examples of human activities could include forest fires, acid rain, flooding, urban development, pollution, deforestation, and introduction of an invasive species.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will evaluate technological solutions and/or mitigation strategies to reduce human impacts.	DOK 3
	Evaluating
Students will identify the impacts of human activities on biodiversity.	DOK 1
	Remembering

Priority Standard: 9-12.ESS3.D.1 Analyze geoscientific 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 for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain the role of combustion and other human activities on the atmospheric carbon dioxide levels.	DOK 2
	Applying
Students will identify current data trends in greenhouse gases and temperature.	DOK 2
	Applying
Students will determine the relationship between greenhouse gases and temperature.	DOK 2
	Applying
Students will investigate the impacts of rising temperatures on Earth's systems.	DOK 3
	Analyzing

Priority Standard: 9-12.ESS3.D.2 Predict how human activity affects the relationships between Earth systems in both positive and negative ways.
[Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the Earth's spheres and explain how they impact each other.	DOK 2
	Applying
Students will use evidence to describe how human activity (both positively and negatively) could affect the relationships between the spheres.	DOK 2
	Applying

Essential Questions:

1. How do ecosystems respond to biological or physical disturbances?
2. How can human activities have both positive and negative effects on ecosystems?
3. How is biodiversity important for sustaining all life on Earth?

Enduring Understanding/Big Ideas:

1. 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.

2. Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. However, things like new technologies, farming practices, and changes in legislation can help reduce and even reverse those effects.
3. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Unit Vocabulary:

- | | | |
|-------------------------------------|-----------------------|--------------------------|
| ● acid rain | ● habitat restoration | ● natural resources |
| ● deforestation | ● pollution | ● renewable resources |
| ● invasive species | ● mitigation | ● nonrenewable resources |
| ● pollution | ● ecotourism | ● anthropogenic |
| ● urban planning | ● energy | ● combustion |
| ● endangered/
threatened species | ● conservation | ● natural resources |
| ● fossil fuels | ● greenhouse effect | |
| ● sustainability | ● climate change | |
| | ● biodiversity | |

Topic 1: Environmental Impacts on Humans

Engaging Experience 1

Title: Human Population Growth Cause and Effects (Explore)

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12.ESS3.A.1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Detailed Description/Instructions: Students will be given a list of events (e.g. improvements in agriculture, deforestation, increase fossil fuel use, spread of disease, loss of biodiversity) to evaluate whether the events would cause an increase in the human population or is an effect of the human population growth.

Accommodations/Modifications: Create 4-5 scenarios based on the list provided above with details about what is being changed. Label one side of the room “Increase in human population” and label the other side of the room “Caused by human population growth”. Read the scenarios to the class and have the students vote by moving to the correct side of the room they believe this scenario reflects. Talk through their ideas as a class. Help students defend their responses. You could even discuss if there is a tipping point where this scenario would create the opposite outcome.

Bloom’s Levels: Applying

Webb’s DOK: 2

Engaging Experience 2

Title: How Does the Environment Impact Human Activity Project (Explore)

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- 9-12.ESS3.A.1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity

Detailed Description/Instructions: Students will research the before and after effects of a natural disaster or ecological event, such as Hurricane Katrina, Mount St. Helens or the Dust Bowl, and how they have altered human activity. Students will aggregate their information into a

presentation that can be shared with peers. A suggested activity is a gallery walk activity in which students share individually created posters of specific natural resources they researched.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 2: Human Activities on Environment

Engaging Experience 1

Title: Rising CO₂, Temperatures & Global Change (Explore)

Suggested Length of Time: 45-60 min

Standards Addressed

Priority:

- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
- 9-12.ESS3.D.1 Analyze geoscientific 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.
- 9-12.ESS3.D.2 Predict how human activity affects the relationships between Earth systems in both positive and negative ways.

Detailed Description/Instructions: Students investigate how human activities are driving global environmental change and how those changes affect Earth's interconnected systems. Framed around the guiding question, "How are rising temperatures and CO₂ causing Earth's spheres to change?", students act as environmental scientists gathering evidence from multiple sources to build a complete, systems-based explanation.

Students begin by exploring a series of infographic resources that highlight real-world consequences of increased atmospheric CO₂ and rising global temperatures. These resources focus on impacts such as sea level rise, wildfires, extreme weather events, human health, coral reef decline, and biodiversity loss. As students analyze each infographic, they record detailed notes in a data table, practicing the skill of obtaining and synthesizing information from scientific sources rather than copying isolated facts.

After gathering evidence, students use their notes to construct a written explanation that connects human-driven climate change to changes across all five Earth spheres: Atmosphere, Hydrosphere, Biosphere, Geosphere, Anthrosphere.

Atmosphere (increased CO₂ and rising temperatures)

Hydrosphere (melting ice, sea level rise, ocean changes)

Biosphere (ecosystem disruption, species loss, coral bleaching)

Geosphere (increased erosion, wildfires, land degradation)

Anthrosphere (human health, infrastructure, and societal impacts)

Accommodations/Modifications: Take the series of infographic resources and give one to each team of students (2-4 students). Have each group gather information from their infographic to share with the class. Give them about 5-10 to gather their information. Then come back together as a whole class. Have someone from each group share their information and as they share, decide as a whole class which Earth sphere this infographic is focusing on. Once all groups have shared, tie all of them together by having a discussion that connects human-driven climate change to all five Earth spheres.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 2

Title: Human Impact on the Environment (Explore)

Suggested Length of Time: 45-60 minutes

Standards Addressed

Priority:

- 9-12.ESS3.D.2 Predict how human activity affects the relationships between Earth systems in both positive and negative ways.

Detailed Description/Instructions: In “The Anthropocene: Human Impact on the Environment” from HHMI BioInteractive, students explore key human impacts on the environment and how they have affected Earth’s landscape, ocean, atmosphere, and biodiversity.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 3: Solutions and Sustainability

Engaging Experience 1

Title: Issues and Solutions (Explore & Explain)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS2.C.2 Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.
- 9-12.LS4.C.3 Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity.
- 9-12.ESS3.C.1 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- 9-12.ESS3.C.2 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems in order to restore stability and or biodiversity of the ecosystem as well as prevent their recurrences.
- 9-12.ESS3.A.2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on economic, social, and environmental cost-benefit ratios.

Detailed Description/Instructions: Students are provided with a variety of environmental issues (plastic pollution in ocean, ground water depletion, overuse of fertilizers, use of fossil fuels, loss of biodiversity) and several solutions per issue. With each solution, there are actions, costs, and environmental impacts that students must weigh to decide which solution is the most feasible, and has the best cost-benefit ratio. This is usually done in groups of 4. Each group evaluated a different solution and then they will share their reasoning with individuals from other groups.

Accommodations/Modifications: If you have a class size that accommodates groups of 4, this can be done un-changed. If you have a smaller class, you can always do this as a whole group and maybe even do it as an introduction to class over multiple days. Just cover one environmental issue each day with 2-3 solutions to talk through and then take a vote to see which solution won. You can even have students defend their choice.

Bloom's Levels: Evaluating

Webb's DOK: 4

Engaging Scenario

Engaging Scenario: Environmental Issue and Solution Project

Students will choose an environmental issue (air pollution, water pollution, soil pollution, loss of habitat, excessive waste, loss of biodiversity, etc.) in a specific region, county, or city. Students will research the cause/source of the issue, discuss how it's affecting that specific ecosystem, and present a solution for that issue. Students will then present their findings to the classroom.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Environmental Impacts on Humans	Human Population Growth Cause and Effects	Students will be given a list of events (e.g. improvements in agriculture, deforestation, increase fossil fuel use, spread of disease, loss of biodiversity) to evaluate whether the events would cause an increase in the human population or is an effect of the human population growth.	~~15 minutes~~ 20-30 minutes
Environmental Impacts on Humans	How Does the Environment Impact Human Activity Project	Students will research the before and after effects of a natural disaster or ecological event, such as Hurricane Katrina, Mount St. Helens or the Dust Bowl, and how they have altered human activity. Students will aggregate their information into a presentation that can be shared with peers. A suggested activity is a gallery walk activity in which students share individually created posters of specific natural resources they researched.	90 minutes
Human Activities on Environment	Rising CO ₂ , Temperatures & Global Change	Students investigate how human activities drive global environmental change by acting as environmental scientists answering the guiding question, "How are rising temperatures and CO ₂ causing Earth's spheres to change?" They analyze a series of real-world infographics on impacts like sea level rise, wildfires, extreme weather, human health, coral reef decline, and biodiversity loss, recording and	45-60 minutes

		synthesizing evidence in a data table. Using this evidence, students construct a systems-based explanation that connects climate change to changes across all five Earth spheres—Atmosphere, Hydrosphere, Biosphere, Geosphere, and Anthrosphere.	
Human Activities on Environment	Human Impact on the Environment	In “The Anthropocene: Human Impact on the Environment” from HHMI BioInteractive, students explore key human impacts on the environment and how they have affected Earth’s landscape, ocean, atmosphere, and biodiversity.	45-60 minutes
Solutions and Sustainability	Issues and Solutions	Students are provided with a variety of environmental issues (plastic pollution in the ocean, ground water depletion, overuse of fertilizers, use of fossil fuels, loss of biodiversity) and several solutions per issue. With each solution, there are actions, costs, and environmental impacts that students must weigh to decide which solution is the most feasible, and has the best cost-benefit ratio. This is usually done in groups of 4. Each group evaluated a different solution and then they share their reasoning with individuals from other groups.	60 minutes OR 15 minutes over 3-5 days as an intro.

Unit 2: Ecology

Subject: Biology

Grade: 9

Name of Unit: Ecology

Length of Unit: 9-11 Blocks (8-10 Blocks)

Overview of Unit: This unit explores the abiotic and biotic factors that affect different levels of organization within ecosystems. Students will analyze energy flow, nutrient cycling, population growth, and interactions among organisms to develop an understanding of how Earth's systems support life on Earth.

Priority Standards for unit:

- 9-12.LS2.A.1 Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.
- 9-12.LS2.B.2 Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Science & Engineering Practices

Using Mathematics and Computational Thinking

- *Use mathematical and/or computational representations of phenomena or design solutions to support explanations.*
- *Use mathematical representations of phenomena or design solutions to support claims.*

Developing and Using Models

- *Develop a model based on evidence to illustrate the relationships between systems or components of a system*

Engaging in Argument from Evidence

- *Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.*

Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence

- *Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.*

Disciplinary Core Ideas

Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.
- These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.
- This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

Cycles of Matter and Energy Transfer in Ecosystems

- 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.

Energy in Chemical Processes

- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.

Ecosystems Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep the ecosystem's 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.

Crosscutting Concepts

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Energy and Matter

- Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable

Learning Targets:

Priority Standard: 9-12.LS2.A.1 Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

[Clarification Statement: Examples of biotic factors could include relationships among individuals (e.g., feeding relationships, symbioses, competition) and disease. Examples of abiotic factors could include climate and weather conditions, natural disasters, and availability of resources. Genetic diversity includes within a population and species within an ecosystem. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify abiotic and biotic factors.	DOK 1
	Understanding
Students will describe and identify carrying capacity on a graph.	DOK 2
	Applying
Students will predict how various abiotic and biotic factors impact carrying capacity.	DOK 3
	Analyzing
Students will explain how various abiotic and biotic factors impact biodiversity.	DOK 3
	Analyzing

Priority Standard: 9-12.LS2.B.2 Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.

[Clarification Statement: Emphasis is on using a model of stored energy in biomass to describe the transfer of energy from one trophic level to another. Emphasis is on atoms and molecules as they move through an ecosystem.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify trophic levels of organisms in an ecosystem.	DOK 1
	Understanding
Students will create energy and biomass models, including food webs and pyramids.	DOK 4
	Creating

Students will explain how energy decreases, and therefore populations decrease, in higher levels of a food web.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Applying
Students will explain how matter and energy are conserved but are transformed in a food web.	DOK 1
	Understanding
Students will trace the path of matter between biotic and abiotic sources of the ecosystem.	DOK 2
	Applying

Priority Standard: 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
[Clarification Statement: The primary forms of carbon include carbon dioxide, hydrocarbons, waste, and biomass. Examples of models could include simulations and mathematical and conceptual models.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe how carbon cycles through the spheres between abiotic and biotic sources.	DOK 2
	Applying
Students will analyze how humans contribute to the carbon cycle.	DOK 3
	Analyzing
Students will demonstrate understanding of how the capturing of light and matter (in carbon) during photosynthesis is the foundation of many food webs.	~~DOK 2~~ DOK 1
	~~Applying~~ Understanding

Priority Standard: 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics. <i>[Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]</i>	
Learning Targets	Webb's DOK Level
	Bloom's Level

Students will identify various types of population growth.	DOK 1
	Understanding
Students will identify limiting factors of a population.	DOK 1
	Understanding
Students will predict how various limiting factors and changes in ecosystems can impact populations.	~~DOK 3~~ DOK 2
	Analyzing Applying

Essential Questions:

1. How is an ecosystem's carrying capacity affected by biotic and abiotic factors?
2. How do food webs illustrate the flow of energy in ecosystems?
3. How do nutrients cycle through Earth?

Enduring Understanding/Big Ideas:

1. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
2. Food webs and food chains indicate the feeding relationships among organisms in an ecosystem. These feeding relationships represent the transfer of energy from one trophic level to the next.
3. Carbon, nitrogen, phosphorus, and water are examples of nutrients that cycle through Earth's biosphere, atmosphere, hydrosphere, and geosphere.

Unit Vocabulary:

- biotic
- abiotic
- limiting factor
- carrying capacity
- exponential growth
- logistic growth
- food chain
- food web
- trophic level
- habitat
- competition
- niche
- symbiosis
- parasitism
- mutualism
- commensalism
- autotroph
- heterotroph
- producer
- consumer
- herbivore
- carnivore
- omnivore
- decomposer
- biomass
- ecological
pyramids
- nutrient cycle
- hydrosphere
- biosphere
- geosphere
- atmosphere
- decomposition
- combustion
- climate
- weather
- species
- population
- community
- biodiversity
- succession
- ecosystem
- extinction

Topic 1: Energy Flow in Ecosystems

Engaging Experience 1

Title: Dominoes (Engage)

Suggested Length of Time: 10 minutes

Standards Addressed

Priority:

- 9-12.LS2.B.2 Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- 9-12.LS2.A.1 Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Detailed Description/Instructions: In this activity, students build food chains using dominoes and demonstrate the transfer of energy by knocking the dominoes over. As an extension, students will pair with other groups to mimic the flow of energy in a food web. (STEMscopes - Flow of Energy in Ecosystems)

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 2

Title: Food Chain Game (Explore)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS2.B.2 Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- 9-12.LS2.A.1 Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Detailed Description/Instructions: Students will play a game to demonstrate how biomass is impacted as energy is transferred through a food chain. (STEMscopes - Flow of Energy in Ecosystems)

Accommodations/Modifications: Have the students do this activity in pairs or groups. Make sure you have the color coded key visible in the room. (written on the board to refer back to)

- Option 1 (Higher critical thinking): Have students do Part I of the Food Chain Game in their groups. Then pull them back into a large group to do Part II together as a class. Have them answer the questions on their own papers as you discuss them together.
- Option 2: Have students do Part I of the Food Chain Game and then answer the questions minus #3. Then have a discussion about their findings as a whole group. Talk through the answers to their questions.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 3

Title: Hunger Games (Explore)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS2.B.2 Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem.
- 9-12.LS2.A.1 Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.

Detailed Description/Instructions: In this activity, students will use population numbers and a given food web to create a biomass pyramid. Then students will answer a CER on how energy flow and the cycling of matter is impacted by removing a species from an expanded food web. (STEMscopes - FLOW of Energy in Ecosystems)

Bloom's Levels: Analyzing

Webb's DOK: 3

Topic 2: Nutrient Cycles

Engaging Experience 1

Title: Carbon Cycle Cards (Engage)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Detailed Description/Instructions: Students analyze and sort a set of carbon cycle cards with related terms, definitions, and applications into a data table. (STEMscopes - Carbon Flow in Ecosystems)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Carbon Cycle Game (Explore)

Suggested Length of Time: 45 minutes

Standards Addressed

Priority:

- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Detailed Description/Instructions: Students will physically model how a carbon atom moves through the carbon cycle by playing a game. They will then create a storyboard that illustrates the scenario. (STEMscopes - Carbon Flow in Ecosystems)

Accommodations/Modifications: You will need to show them how to fill out their storyboard by providing them an example. This activity can be done as written. You will need to provide encouragement to the students who get stuck in a specific station for a long time. It would be best to come back together at the end and discuss how each student had a different path and why some got stuck on specific stations. You will need to help them make real-world connections.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 3

Title: Carbon Dioxide and the Carbon Cycle by PBS Learning Media Interactive (Explore)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Detailed Description/Instructions: Students will explore how human activities alter the carbon cycle and cause atmospheric carbon dioxide to increase. Students will learn about the reservoirs and flows of the carbon cycle and how human activities increase the amount of carbon dioxide in the air and ocean. Then, students will have an online discussion about how higher carbon dioxide levels cause global warming.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 3: Interactions of Organisms

Engaging Experience 1

Title: Interactions In the Wild (Engage)

Suggested Length of Time: 30 min

Standards Addressed

Priority:

- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: Students explore how organisms interact with one another through real-world examples of symbiosis and competition. The experience begins with the teacher showing a curated series of short, high-interest video clips featuring organisms interacting in natural environments (for example: cleaner fish and sharks, lions competing for prey, fungi and plant roots, or birds nesting near larger animals).

As students watch each clip, they are prompted to think like ecologists. For every interaction, students first determine whether the organisms involved are the same species or different species. They then analyze how each organism is affected by the interaction.

Students record their observations on a worksheet designed to be both analytical and fun. For each organism, they select an emoji that best represents the outcome of the interaction:

- 😊 Happy (benefits)
- 😐 Neutral (unaffected)
- 😞 Sad (harmed)
- 🤕 Hurt (injured or stressed)
- 💀 Dead (killed as a result of the interaction)

Accommodations/Modifications: Reduce the outcome to Happy, Neutral, Hurt, and Dead. This will give the students less nuance and reduce their choices. Make the worksheet with the title of each interaction and then multiple choice using the emojis. I would go over the answers as a group and this is where I would bring in the scientific vocabulary of: commensalism, mutualism, parasitism, and predator/prey.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Exploring Competition & Ecosystem Interactions with *Won't You Be My Urchin?*
(Explore)

Suggested Length of Time: 30 - 45 min

Standards Addressed

Priority:

- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: Using the Data Nugget *Won't You Be My Urchin?*, students explore how competition for space and the presence of herbivores influences coral growth on reefs — an authentic ecological question rooted in real research by marine biologist Sarah W. Davies.

We begin with a short classroom discussion to activate prior knowledge about coral reefs, competition, and herbivory. Students are introduced to the context: corals must compete with algae for limited space, and herbivores like sea urchins may reduce this competition by eating algae, potentially allowing more room for corals to grow.

Students then work through the Data Nugget activity. They examine the experimental setup (repeated bins with and without sea urchins), interpret real data presented in tables and graphs, and make evidence-based claims about how the presence of urchins affected coral growth.

After students have drawn conclusions about the ecological question, the class discusses broader ecological and management implications: How could scientists use what we learned to help protect dying coral reefs? What might this tell us about the importance of species interactions in ecosystem health?

Bloom's Levels: Evaluate

Webb's DOK: 3

Topic 4: Population Dynamics

Engaging Experience 1

Title: Device Island Survivor Game (Engage)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: In this activity, students will simulate how many factors can impact the ability of an organism to survive, while playing a game of Survivor. (STEMscopes - Carrying Capacity)

Accommodations/Modifications: This game can be played as written. If your class size is too small for groups, you can do pairs or just the whole group. You can have the class or groups play as different devices and have a discussion about how that affected the game.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 2

Title: Factors Affecting Carrying Capacity (Explore)

Suggested Length of Time: 10 minutes

Standards Addressed

Priority:

- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: Students will be making predictions of whether various factors would increase or decrease the carrying capacity of an ecosystem. (STEMscopes - Carrying Capacity)

Accommodations/Modifications: Have the students label each scenario as something that will increase or decrease carrying capacity and provide their reasoning why. Bring them back together to discuss how Biotic factors and Abiotic factors cause the leveling off of the carrying

capacity. Then go through their ideas of which scenarios increase or decrease the carrying capacity and then graph the different scenarios together as a class. This will help them connect their learning to real-world scenarios.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 3

Title: Population Biology (Free) Virtual Lab from McGraw Hill (Explore)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: Students will demonstrate how competition for natural resources in the environment can affect population growth. Students will explain and analyze how availability of resources, such as food, can be limiting for populations.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 4

Title: Population Dynamics (Explore)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

Detailed Description/Instructions: In this activity, students will be given a scenario and asked to respond with a CER. Students will then be given a data set to graph and evaluate. Using the new data, students will then readdress the initial CER. (STEMscopes - Biodiversity and Changes in Ecosystems)

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Scenario

Engaging Scenario: African Lions Population

Students will analyze a population to determine how abiotic and biotic factors affect its growth and survival. A suggested activity is the African Lions: Modeling Populations (Concord Consortium) online activity in which students learn to distinguish between exponential and logistic growth of populations, identify carrying capacity, differentiate density-dependent and density-independent limiting factors, apply population models to data sets and determine carrying capacity from population data. Students also make predictions on graphs and interpret graphical data to analyze factors that influence population growth.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Energy Flow in Ecosystems	Dominoes	In this activity, students build food chains using dominoes and demonstrate the transfer of energy by knocking the dominoes over. As an extension, students will pair with other groups to mimic the flow of energy in a food web. (STEMscopes - Flow of Energy in Ecosystems)	10 minutes
Energy Flow in Ecosystems	Food Chain Game	Students will play a game to demonstrate how biomass is impacted as energy is transferred through a food chain. (STEMscopes - Flow of Energy in Ecosystems)	20 minutes
Energy Flow in Ecosystems	Hunger Games	In this activity, students will use population numbers and a given food web to create a biomass pyramid. Then students will answer a CER on how energy flow and the cycling of matter is impacted by removing a species from an expanded food web. (STEMscopes - FLOW of Energy in Ecosystems)	30 minutes
Nutrient Cycles	Carbon Cycle Cards	Students analyze and sort a set of carbon cycle cards with related terms, definitions, and applications into a data table. (STEMscopes - Carbon Flow in Ecosystems)	20 minutes
Nutrient Cycles	Carbon Cycle Game	Students will physically model how a carbon atom moves through the carbon cycle by playing a game. They will then create a storyboard that illustrates the	~~45 minutes~~ 90 minutes

		scenario. (STEMscopes - Carbon Flow in Ecosystems)	
Nutrient Cycles	Carbon Dioxide and the Carbon Cycle by PBS Learning Media Interactive	Students will explore how human activities alter the carbon cycle and cause atmospheric carbon dioxide to increase. Students will learn about the reservoirs and flows of the carbon cycle and how human activities increase the amount of carbon dioxide in the air and ocean. Then, students will have an online discussion about how higher carbon dioxide levels cause global warming.	30 minutes
Interactions of Organisms	Interactions in the Wild	Students investigate how organisms interact by analyzing real-world examples of symbiosis and competition through engaging video clips of organisms in natural environments. As they watch, students think like ecologists by identifying whether the organisms are the same or different species and determining how each is affected by the interaction. They record their observations on a fun, analytical worksheet, using emojis to represent outcomes such as benefiting, being unaffected, harmed, injured, or killed.	~~30 minutes~~ 60 minutes
Interaction of Organisms	Exploring Competition & Ecosystem Interactions with <i>Won't You Be My Urchin?</i>	Using the Data Nugget, <i>Won't You Be My Urchin?</i> , students explore how competition for space and herbivory influence coral growth through an authentic research-based investigation. After a brief discussion to activate prior knowledge about coral reefs, competition, and herbivores, students analyze an experimental setup	30 - 45 minutes

		comparing reefs with and without sea urchins, interpret real data from tables and graphs, and make evidence-based claims about coral growth. The lesson concludes with a class discussion connecting their findings to broader ecological and conservation implications for reef health.	
Population Dynamics	Device Island Survivor Game	In this activity, students will simulate how many factors can impact the ability of an organism to survive, while playing a game of Survivor. (STEMscopes - Carrying Capacity)	~~20 minutes~~ 30 minutes
Population Dynamics	Factors Affecting Carrying Capacity	Students will be making predictions of whether various factors would increase or decrease the carrying capacity of an ecosystem. (STEMscopes - Carrying Capacity)	~~10 minutes~~ 20-30 minutes
Population Dynamics	Population Biology (Free) Virtual Lab from McGraw Hill	Students will demonstrate how competition for natural resources in the environment can affect population growth. Students will explain and analyze how availability of resources, such as food, can be limiting for populations.	30 minutes
Population Dynamics	Population Dynamics	In this activity, students will be given a scenario and asked to respond with a CER. Students will then be given a data set to graph and evaluate. Using the new data, students will then readdress the initial CER. (STEMscopes - Biodiversity and Changes in Ecosystems)	30 minutes

Unit 3: Energy

Subject: Biology

Grade: 9

Name of Unit: Energy

Length of Unit: 8-10 Blocks

Overview of Unit: This unit explores how all living things are composed of 4 macromolecules: carbohydrates, lipids, proteins, and nucleic acids. It also explains how all organisms obtain energy through photosynthesis and cellular respiration.

Priority Standards for unit:

- 9-12.LS1.C.1 Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.
- 9-12.LS1.C.2 Use a model to demonstrate that cellular respiration is a chemical process whereby the bonds of molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
- 9-12.LS1.C.3 Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.
- 9-12.LS2.B.1 Construct and revise an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the cycling of matter and flow of energy through ecosystems and that environmental conditions restrict which reactions can occur.
- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Science & Engineering Practices

Developing and Using Models

- *Use a model based on evidence to illustrate the relationships between systems or between components of a system*

Constructing Explanations and Designing Solutions

- *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 on 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*

Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence

- *Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence*

and/or reinterpretation of existing evidence

Disciplinary Core Ideas

Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.
- Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles.
- Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment
- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used to form new cells

Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- 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

Energy in Chemical Processes

- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis

Crosscutting Concepts

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy, matter flows into, out of, and within that system
- Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.
- Energy drives the cycling of matter within and between systems.

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales

Learning Targets:

Priority Standard: 9-12.LS1.C.1 Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.

[Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the inputs, outputs, and location of photosynthesis.	DOK 1
	Remembering
Students will describe the energy transformation from light to chemical during photosynthesis.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Applying
Students will model the process of photosynthesis.	DOK 2
	Applying

Priority Standard: 9-12.LS1.C.2 Use a model to demonstrate that cellular respiration is a chemical process whereby the bonds of molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

[Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the inputs, outputs, and location of cellular respiration.	DOK 1
	Remembering
Students will describe the energy transformation from chemical energy in food to chemical energy in ATP.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Applying
Students will model the process of respiration.	DOK 2
	Applying

Priority Standard: 9-12.LS1.C.3 Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.

[Clarification Statement: Large carbon-based molecules included are proteins, carbohydrates, nucleic acids, and lipids.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe how elements from sugar molecules can be recombined into different molecules needed for life.	DOK 2
	Applying
Students will identify the elements, monomers, and function of carbohydrates, lipids, proteins, and nucleic acids.	DOK 1
	Remembering

Priority Standard: 9-12.LS2.B.1 Construct and revise an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the cycling of matter and flow of energy through ecosystems and that environmental conditions restrict which reactions can occur.

[Clarification Statement: Examples of environmental conditions can include the availability of sunlight or oxygen.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how biotic sources are involved in cycling of matter and flow of energy in ecosystems.	DOK 2
	Applying
Students will recognize that producers perform both photosynthesis or chemosynthesis AND a form of respiration.	DOK 1
	Understanding
Students will analyze how respiration is the process that drives energy flow through trophic levels.	DOK 3
	Analyzing
Students will describe how anaerobic respiration produces energy in the absence of oxygen.	DOK 2
	Applying
Students will evaluate environmental conditions that could limit these processes.	DOK 3
	Analyzing

Priority Standard: 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
[Clarification Statement: The primary forms of carbon include carbon dioxide, hydrocarbons, waste, and biomass. Examples of models could include simulations and mathematical and conceptual models.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will model how most producers use photosynthesis to remove carbon dioxide from the atmosphere.	~~DOK 3~~ DOK 2
	Analyzing Applying
Students will model how all organisms perform respiration which releases carbon dioxide to the atmosphere.	~~DOK 3~~ DOK 2
	Analyzing Applying
Students will explain that decomposition cycles carbon into the geosphere and atmosphere when organisms die.	DOK 2
	Applying

Essential Questions:

1. How do the different types of macromolecules compare in structure and function?
2. How does photosynthesis produce energy?
3. How does the process of cellular respiration release energy to be used by cells?
4. How is anaerobic respiration different from aerobic respiration?

Enduring Understanding/Big Ideas:

1. The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.
2. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
3. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.
4. Anaerobic respiration releases energy stored in carbohydrate compounds for use in the cell without the use of oxygen.

Unit Vocabulary:

- Energy
- Metabolism
- Photosynthesis
- Cellular respiration
- Oxygen
- Carbon dioxide
- Light energy
- Chemical energy
- Macromolecule
- Polymer
- Monomer
- Carbohydrate
- Monosaccharide
- Lipid
- Enzyme
- Protein
- Amino acid
- Nucleic acid
- Nucleotide
- Glucose
- Anaerobic
- Aerobic respiration
- ATP
- Chemosynthesis

Topic 1: Macromolecules

Engaging Experience 1

Title: You Are What You Eat (Engage)

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.3 Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.

Detailed Description/Instructions: In this Hook activity, the teacher introduces the students to the concept of macromolecules. Students learn to compare three of the four types of macromolecules (including carbohydrates, lipids, and proteins) in the context of the nutrients humans acquire from their diet. They also make inferences based on promotional materials for a food product by analyzing the nutritional facts labels on common food products in order to learn the role of macromolecules as a part of everyday eating habits. (STEMscopes - Molecules of Life)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Biomolecules (Explore)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.3 Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.

Detailed Description/Instructions: Students will examine diagrams of molecules from the four major classes of biomolecules as well as describe similarities and differences among the molecules. The goal is for students to conclude that glucose can provide most of the elements needed to build other biomolecules. (STEMscopes - Molecules of Life)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 3

Title: Building Biomolecules (Explore)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.3 Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules.

Detailed Description/Instructions: Students will model how lipids, proteins, and nucleic acids are formed from glucose and other substances from the surrounding environment. They will then write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, “If you lived only on a diet of sugars, could you survive?” (STEMscopes - Molecules of Life)

Accommodations/Modifications: Have the students eat the cracker as they describe in the activity and document their observations and why they think this happened. Demonstrate with colored beads in containers for the whole class. Have the formula for a monosaccharide on the board and have 6 black beads (Carbons), 12 pink beads (Hydrogens) and 6 blue beads (Oxygen) in a small container. Talk about this is all the elements needed to make a sugar molecule. Have 4 of these containers created. Then put the formula for a Lipid on the board. Ask the students if they can make a Lipid only using what is found in the sugar molecules? Ask them if they would need more than one sugar molecule to make the Lipid? Then put the formula for a protein on the board. Ask the students if they can make a protein molecule with only the sugar molecules? What is missing? Where would you get Nitrogen? Then have them answer the questions on Part III independently. Discuss the answers as a group. Note: Creating the models in Part II is very difficult for our students. They struggle with the fine motor skills and the abstract understanding of how elements are structured. Reducing this to just groups of molecules, helps them get the concept without getting bogged down in the execution.

Bloom’s Levels: Applying

Webb’s DOK: 2

Topic 2: Photosynthesis

Engaging Experience 1

Title: Dominoes (Engage)

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.1 Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.

Detailed Description/Instructions: Students work collaboratively to create the equation for photosynthesis and review what they have previously learned. (STEMscopes - Cellular Energy)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Inputs and Outputs - Cellular Energy (Explore)

Suggested Length of Time: 15-20 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.1 Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.

Detailed Description/Instructions: Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms. (STEMscopes - Cellular Energy)

Accommodations/Modifications: If your students are having difficulty making the large glucose molecule, you can just provide a container (dixie cups) for them to put all the elements together to represent that sugar molecule. They wouldn't have to sketch the sugar molecule. Talk through the questions as a large group. Either as they work through the process or at the end.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 3

Title: Photosynthesis Lab (Explore)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.1 Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.

Detailed Description/Instructions: Students will observe the process of photosynthesis through a lab (e.g. students observe spinach leaf discs beginning to float in a bicarbonate solution under fluorescent lights) and will create a model to demonstrate how photosynthesis converts light energy into chemical energy. A suggested activity would be a photosynthesis virtual lab where students work through simulations to research the process of photosynthesis and factors that affect the process.

Accommodations/Modifications: Have the students watch the lab demonstration and talk through the process with them. Then have them answer some questions based on the findings of the lab. This needs lots of whole group discussion to connect the learning.

Bloom's Levels: Analyze

Webb's DOK: 3

Topic 3: Aerobic and Anaerobic Respiration

Engaging Experience 1

Title: Inputs and Outputs - Cellular Energy (Explore)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.2 Use a model to demonstrate that cellular respiration is a chemical process whereby the bonds of molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
- 9-12.LS2.B.1 Construct and revise an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the cycling of matter and flow of energy through ecosystems and that environmental conditions restrict which reactions can occur.
- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Detailed Description/Instructions: Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms. (STEMscopes - Cellular Energy)

Accommodations/Modifications: If your students are having difficulty making the large glucose molecule, you can just provide a container (dixie cups) for them to put all the elements together to represent that sugar molecule. They wouldn't have to sketch the sugar molecule. Talk through the questions as a large group. Either as they work through the process or at the end.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Let it Burn! (Explore)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS1.C.2 Use a model to demonstrate that cellular respiration is a chemical process whereby the bonds of molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

- 9-12.LS2.B.1 Construct and revise an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the cycling of matter and flow of energy through ecosystems and that environmental conditions restrict which reactions can occur.
- 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.

Detailed Description/Instructions: Students will time how long they can do a wall squat to conceptualize aerobic and anaerobic cellular respiration. (STEMscopes - Bioenergetics)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Scenario

Engaging Scenario: CO₂ and Trees — Too Much of a Good Thing?

Students step into the role of scientists investigating a real ecological and global change question: *Does rising atmospheric carbon dioxide (CO₂) help trees grow, or can too much of a good thing actually be harmful?* This Data Nugget uses authentic research data to tie together students' understanding of energy flow, photosynthesis, cellular respiration, and organism responses to environmental change.

Students begin by recalling how photosynthesis uses CO₂, water, and sunlight to build glucose—storing energy and carbon in plant tissues—and how cellular respiration breaks down glucose to release energy for life processes. They discuss how higher CO₂ levels might affect plant growth, and what other factors (like heat stress or water availability) might change how a tree balances growth and energy release through respiration.

Next, students work through the *CO₂ and Trees* Data Nugget activity, where they analyze simplified, real scientific data collected by researchers who tracked tree growth, mortality, and carbon storage over time. Students interpret graphs, compare patterns across treatments or time periods, and determine whether forests seem to gain more carbon through growth or lose carbon due to stress and death. Through guided questions, students practice interpreting data, drawing evidence-based conclusions, and connecting those conclusions to the broader ecological and energy transfer concepts learned earlier in the unit.

Finally, students reflect on why this question matters: trees play a key role in the global carbon cycle and influences on climate change, and understanding whether forests are carbon sinks or sources helps scientists and policymakers make better decisions about conservation and climate action.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Macro-molecules	You Are What You Eat	In this Hook activity, the teacher introduces the students to the concept of macromolecules. Students learn to compare three of the four types of macromolecules (including carbohydrates, lipids, and proteins) in the context of the nutrients humans acquire from their diet. They also make inferences based on promotional materials for a food product by analyzing the nutritional facts labels on common food products in order to learn the role of macromolecules as a part of everyday eating habits. (STEMscopes - Molecules of Life)	15 minutes
Macro-molecules	Biomolecules	Students will examine diagrams of molecules from the four major classes of biomolecules as well as describe similarities and differences among the molecules. The goal is for students to conclude that glucose can provide most of the elements needed to build other biomolecules. (STEMscopes - Molecules of Life)	30 minutes
Macro-molecules	Building Biomolecules	Students will model how lipids, proteins, and nucleic acids are formed from glucose and other substances from the surrounding environment. They will then write a scientific explanation that includes a claim, evidence, and	60 minutes

		reasoning (CER) to answer the question, “If you lived only on a diet of sugars, could you survive?” (STEMscopes - Molecules of Life)	
Photosynthesis	Dominoes	Students work collaboratively to create the equation for photosynthesis and review what they have previously learned. (STEMscopes - Cellular Energy)	15 minutes
Photosynthesis	Inputs and Outputs - Cellular Energy	Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms. (STEMscopes - Cellular Energy)	~~15-20 minutes~~ 60 minutes
Photosynthesis	Photosynthesis Lab	Students will observe the process of photosynthesis through a lab (e.g. students observe spinach leaf discs beginning to float in a bicarbonate solution under fluorescent lights) and will create a model to demonstrate how photosynthesis converts light energy into chemical energy. A suggested activity would be a photosynthesis virtual lab where students work through simulations to research the process of photosynthesis and factors that affect the process.	~~60 minutes~~ 20-30 minutes
Aerobic and Anaerobic Respiration	Inputs and Outputs - Cellular Energy	Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for	60 minutes

		use in organisms. (STEMscopes - Cellular Energy)	
Aerobic and Anaerobic Respiration	Let it Burn!	Students will time how long they can do a wall squat to conceptualize aerobic and anaerobic cellular respiration. (STEMscopes - Bioenergetics)	20 minutes

Unit 4: Organization and Homeostasis

Subject: Biology

Grade: 9

Name of Unit: Organization and Homeostasis

Length of Unit: 10-12 Blocks

Overview of Unit: In this unit, students will explore how multicellular organisms are organized into interacting systems—from cells to tissues, organs, and organ systems—that work together to perform specific life functions. Students will develop and use models to visualize these hierarchical relationships and explain how structure supports function in living organisms. Through hands-on investigations, students will examine how feedback mechanisms help maintain homeostasis in response to internal and external changes. By the end of the unit, students will understand how coordination among body systems is essential for survival and stability.

Priority Standards for unit:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- 9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Science & Engineering Practices

Developing and Using Models

- *Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.*

Planning and Carrying Out Investigations

- *Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence and in the design*
 - *decide on types, quantity, and accuracy of data needed to produce reliable measurements;*
 - *consider limitations on the precision of the data (e.g., number of trials, cost, risk, time);*
 - *refine the design accordingly.*

Scientific Investigations Use a Variety of Methods

- *Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, reliability of results, and honest and ethical reporting of findings.*

Disciplinary Core Ideas

Structure and Function

- *Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.*

Crosscutting Concepts
System and System Models - Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. Stability and Change - Feedback (negative or positive) can stabilize or destabilize a system

Learning Targets:

Priority Standard: 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. <i>[Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to stimuli.]</i>	
Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the different levels of organization inside of organisms.	DOK 1
	Remembering
Students will identify major structures and systems inside of multicellular organisms.	DOK 1
	Understanding
Students will identify major functions of systems inside of multicellular organisms.	DOK 1
	Understanding
Students will describe relationships between two or more body systems and how they work together and contribute to the overall function of an organism.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Applying
Students will identify the 2 main types of cells (prokaryotes and eukaryotes) and their differences.	DOK 1
	Understanding

Priority Standard: 9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomata response to moisture and temperature, and root development in response to water levels.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain the concept of homeostasis and its importance to survival.	DOK 1
	Understanding
Students will compare and contrast positive and negative feedback.	DOK 2
	Applying
Students will evaluate scenarios as examples of positive or negative feedback.	~~DOK 3~~ DOK 2
	Analyzing Applying
Students will describe the role of body systems in feedback mechanisms.	DOK 2
	Applying
Students will be able to plan, collect data, and evaluate an investigation.	DOK 4
	Creating and Evaluating

Essential Questions:

1. How do the different levels of organization in multicellular organisms work together to carry out life functions?
2. How does structure relate to function in cells, tissues, organs, and organ systems?
3. How do organisms maintain internal stability despite changes in their environment?
4. How do multiple body systems interact to support the survival and stability of a multicellular organism?

Enduring Understanding/Big Ideas:

1. Multicellular organisms are hierarchically organized, with cells forming tissues, tissues forming organs, and organs working together in organ systems to perform specific and coordinated functions.
2. The structure of biological systems at each level of organization is directly related to their function, allowing organisms to efficiently carry out essential processes needed for survival.
3. Organisms use feedback mechanisms, particularly negative feedback loops, to regulate internal conditions and maintain homeostasis in response to internal and external changes.

4. Body systems do not work independently; they interact and depend on one another to deliver materials, remove wastes, respond to stimuli, and maintain homeostasis within a multicellular organism.

Unit Vocabulary:

- | | | |
|---------------------|----------------------------|-------------------------------------|
| ● cell | ● diffusion | ● Digestive system |
| ● tissue | ● Osmosis | ● Immune system |
| ● organ | ● Positive feedback | ● Lymphatic system |
| ● organ system | ● Negative feedback | ● Endocrine system |
| ● organism | ● Nervous system | ● Integumentary system |
| ● prokaryotes | ● Muscular system | ● Respiratory system |
| ● eukaryotes | ● Skeletal system | ● Cardiovascular/Circulatory System |
| ● homeostasis | ● Urinary/excretory system | |
| ● plasma membrane | ● Reproductive system | |
| ● passive transport | | |
| ● active transport | | |

Topic 1: Levels of Organization

Engaging Experience 1

Title: Addressing an Envelope from Outer Space (Engage)

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- 9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Detailed Description/Instructions: Students are introduced to the concept of system interactions by recognizing the importance of levels of organization found everywhere. This will draw attention to how organization is essential and how, in different levels of organization, the subsequent level encompasses all previous levels. (STEMscopes - Organization of Systems)

Bloom's Levels: Understanding

Webb's DOK: 1

Engaging Experience 2

Title: Levels of Organization Flow Chart (Engage)

Suggested Length of Time: 20-30 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Detailed Description/Instructions: Students will create a flowchart that will include drawings of each level of organization ranging from smallest to most complex.

Accommodations/Modifications: Allow students to work in groups or pairs. Give each group a set of pictures for each level and have them organize them into a flowchart from smallest to most complex. Then talk with them about this organization. Pictures of: atom, molecule, cell, tissue, organ, organ system, and organism.

Bloom's Levels: Understanding

Webb's DOK: 2

Engaging Experience 3

Title: Prokaryotic and Eukaryotic Cell Comparison (Explore)

Suggested Length of Time: 30-45 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Detailed Description/Instructions: Students can write a diamante poem (AVID strategies) or any other graphic organizer to compare and contrast prokaryotic and eukaryotic cells. Students will then share their work with their classmates (e.g. gallery walk, pair share, etc.).

Accommodations/Modifications: Give students a two circle Venn diagram to organize their ideas on comparing and contrasting prokaryotic and eukaryotic cells. They can work in pairs or individually. Come back together as a group and talk about what characteristics they put into each category. It would be helpful to give them a list of characteristics to work with.

Bloom's Levels: Analyzing

Webb's DOK: 3

Topic 2: Body Systems

Engaging Experience 1

Title: Organization of Systems

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Detailed Description/Instructions: Students will work toward the goal of figuring out why or how something happens. Students will view a video that shows the cardiovascular and respiratory systems working together. (STEMscopes - Organization of Systems- Engage - Investigative Phenomena)

Accommodations/Modifications: Watch the video as a class and discuss how the two systems work together to support the body.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: 3-D Body Systems (Explore)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Detailed Description/Instructions: Students will create a 3-D model of an organ system. The 3-D model will allow the students to develop and illustrate the organization of the organ system from the macroscopic level to the microscopic level, including structure and function. (STEMscopes - Organization of Systems)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 3

Title: Let's Communicate (Explore)

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Detailed Description/Instructions: By making a skit, students will demonstrate how organ systems and their structures interact to support the overall functioning of an organism.
(STEMscopes - Organization of Systems)

Bloom's Levels: Creating

Webb's DOK: 4

Topic 3: Homeostasis

Engaging Experience 1

Title: Homeostasis: A Delicate Balance (Engage)

Suggested Length of Time: 15 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Detailed Description/Instructions: Students analyze what is occurring in a series of photographs that show different internal feedback mechanisms, then briefly discuss each picture.

(STEMscopes - Feedback and Homeostasis)

Accommodations/Modifications: Go through each scenario together as a class. Give the students time to document what their responses are to each of the questions after the group discussion on that scenario.

Bloom's Levels: Understanding

Webb's DOK: 1

Engaging Experience 2

Title: Exercise and Pulse Rate Experiment (Explore)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Detailed Description/Instructions: Students will design and run an experiment investigating how exercise impacts pulse rate. Students can choose the type of exercise, duration of exercise, intensity of exercise, etc. and/or alter the dependent variable as well (ex. performance of a simple task, etc.).

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 3

Title: Osmosis Lab (Explore)

Suggested Length of Time: 60-90 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Detailed Description/Instructions: Students will complete an experiment to test conditions which affect the rate of osmosis across a membrane. Options could include: dialysis tube, potato, gummy bears.

Accommodations/Modifications: Have your students watch “The Sci Guys: Naked Egg and Osmosis Lab. Talk them through the process and point out key points of osmosis. Have them answer questions about osmosis dealing with the lab.

Bloom’s Levels: Applying

Webb’s DOK: 2

Engaging Scenario

Engaging Scenario: Body Systems Research and Presentation

Assign students a human body system (e.g. nervous, digestive, integumentary, circulatory, respiratory, immune, muscular, excretory) to research and determine how that system functions in order to maintain homeostasis. Students will present their results in digital format.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Levels of Organization	Addressing an Envelope from Outer Space	Students are introduced to the concept of system interactions by recognizing the importance of levels of organization found everywhere. This will draw attention to how organization is essential and how, in different levels of organization, the subsequent level encompasses all previous levels. (STEMscopes - Organization of Systems)	15 minutes
Levels of Organization	Levels of Organization Flow Chart	Students will create a flowchart that will include drawings of each level of organization ranging from smallest to most complex.	20-30 minutes 15-20 minutes
Levels of Organization	Prokaryotic and Eukaryotic Cell Comparison	Students can write a diamante poem (AVID strategies) or any other graphic organizer to compare and contrast prokaryotic and eukaryotic cells. Students will then share their work with their classmates (e.g. gallery walk, pair share, etc.).	30-45 minutes
Body Systems	Dominoes	Students will work toward the goal of figuring out why or how something happens. Students will view a video that shows the cardiovascular and respiratory systems working together. (STEMscopes - Organization of Systems)	15 minutes

Body Systems	3-D Body Systems	Students will create a 3-D model of an organ system. The 3-D model will allow the students to develop and illustrate the organization of the organ system from the macroscopic level to the microscopic level, including structure and function. (STEMscopes - Organization of Systems)	60 minutes
Body Systems	Let's Communicate	By making a skit, students will demonstrate how organ systems and their structures interact to support the overall functioning of an organism. (STEMscopes - Organization of Systems)	90 minutes
Homeostasis	Homeostasis: A Delicate Balance	Students analyze what is occurring in a series of photographs that show different internal feedback mechanisms, then briefly discuss each picture. (STEMscopes - Feedback and Homeostasis)	~~15 minutes~~ 20 minutes
Homeostasis	Exercise and Pulse Rate Experiment	Students will design and run an experiment investigating how exercise impacts pulse rate. Students can choose the type of exercise, duration of exercise, intensity of exercise, etc. and/or alter the dependent variable as well (ex. performance of a simple task, etc.).	60 minutes
Homeostasis	Osmosis Lab	Students will complete an experiment to test conditions which affect the rate of osmosis across a membrane. Options could include: dialysis tube, potato, gummy bears.	~~60-90 minutes~~ 30 minutes

Unit 5: Reproduction

Subject: Biology

Grade: 9

Name of Unit: Reproduction

Length of Unit: 10-12 Blocks

Overview of Unit: In this unit, students will explore how cells divide and specialize to build, maintain, and repair complex organisms. They will use models to understand how DNA is organized into chromosomes and how genetic information is passed from parents to offspring through meiosis and fertilization. Students will compare asexual and sexual reproduction to explain differences in genetic variation among offspring. Finally, they will analyze how inheritable genetic variation arises from meiosis and defend claims using scientific evidence.

Priority Standards for unit:

- 9-12.LS1.B.1 Develop and use models to communicate the role of mitosis, cellular division, and differentiation in producing and maintaining complex organisms.
- 9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
- 9-12.LS3.B.1 Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring.

Science & Engineering Practices

Developing and Using Models

- *Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system*

Obtaining, Evaluating and Communicating Information

- *Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats, including orally, graphically, textually, and mathematically*

Engaging in Argument from Evidence

- *Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence.*

Disciplinary Core Ideas

Growth and Development of Organisms

- *In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow.*
- *The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells.*
- *Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism*

Structure and Function

- All cells contain genetic information in the form of DNA molecules.
- Genes are regions in the DNA that contain the instructions that code for the formation of proteins.

Inheritance of Traits

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA.
- The instructions for forming species' characteristics are carried in DNA.
- All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.
- Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function

Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.
- Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation.
- Environmental factors can also cause mutations in genes, and viable mutations are inherited.
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.

Characteristics of Asexual and Sexual Reproduction

- Asexual reproduction produces genetically identical offspring, whereas sexual reproduction produces genetic variation

Crosscutting Concepts

Systems and System Models

- Models (e.g., physical, mathematical, computer) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects

Learning Targets:

Priority Standard: 9-12.LS1.B.1 Develop and use models to communicate the role of mitosis, cellular division, and differentiation in producing and maintaining complex organisms.

[Clarification Statement: Major events of the cell cycle include cell growth, DNA replication, preparation for division, separation of chromosomes, and separation of cell contents.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify and describe the stages of the cell cycle.	DOK 1
	Remembering

Students will describe how DNA is replicated.	DOK 1
	Understanding
Students will explain the purpose of cell division.	DOK 2
	Applying
Students will model how a single cell goes through cell division and differentiation to produce a complex organism.	DOK 2
	Applying
Students will identify the advantages of cell specialization.	DOK 1
	Understanding
Students will identify and describe the process of mitosis (including cell type, number of divisions, and outcome).	DOK 2
	Applying

Priority Standard: 9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify and describe the structure of DNA.	DOK 1
	Understanding
Students will explain the structure of chromosomes and how they help offspring inherit DNA from parents.	DOK 2
	Applying
Students will describe the purpose of meiosis and fertilization.	DOK 1
	Remembering
Students will identify and describe the process of meiosis (including cell type, number of divisions, and outcome).	DOK 1
	Understanding
Students will explain the role of haploid and diploid cells in meiosis and fertilization.	DOK 2
	Applying

Priority Standard: 9-12.LS3.B.1 Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring.

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how asexual reproduction produces offspring that are identical to the parent.	DOK 1
	Remembering
Students will describe how sexual reproduction creates genetic variation in the offspring.	DOK 1
	Understanding
Students will compare sexual and asexual reproduction and determine the benefits and drawbacks of each.	DOK 3
	Evaluating

Essential Questions:

1. How is DNA organized in chromosomes?
2. How do organisms grow and develop through the process of mitosis and cell differentiation?
3. How are new organisms produced through meiosis and fertilization?
4. How does sexual reproduction promote genetic variation compared to asexual reproduction?

Enduring Understanding/Big Ideas:

1. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA.
2. In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.
3. New organisms are produced through sexual reproduction, alternating between meiosis and fertilization to create genetically unique offspring. Meiosis reduces the chromosome number by half to create haploid gametes (sperm/egg) with high genetic variation. Fertilization then fuses two haploid gametes to restore the diploid number, forming a unique zygote that develops into an adult.
4. In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic

variation, along with fertilization. In asexual reproduction, parents create identical offspring to themselves.

Unit Vocabulary:

- Cell cycle
- Interphase (G₁, S, G₂)
- Mitosis
- Cytokinesis
- Meiosis
- Daughter cells
- Cell division
- Haploid
- Diploid
- Chromatin
- Chromatid
- Chromosomes
- DNA
- DNA Replication
- Karyotype
- Autosome
- Zygote
- Gamete
- Somatic Cell
- Fertilization
- Embryo
- Cell Differentiation/Specialization
- Stem cells
- Cancer

Topic 1: DNA and Chromosomes

Engaging Experience 1

Title: DNA Structure Model (Explore)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.

Detailed Description/Instructions: Students will use a physical model (paper or 3D) to practice their understanding of the structure of nucleotides, and the DNA double helix.

Accommodations/Modifications: Students will construct their own model of DNA using slips of paper in various colors. They must include 30 total nucleotides with two backbones. The nucleotides must either be single or double, based on the type and must have a double or triple bond to its mate. (This is done over three class periods)

Bloom's Levels: Understanding

Webb's DOK: 1

Engaging Experience 2

Title: Karyotype Activity (Explore)

Suggested Length of Time: 45 minutes

Standards Addressed

Priority:

- 9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.

Detailed Description/Instructions: Students will construct and analyze a karyotype. Suggested activities include Make a Karyotype from Learn.Genetics and Karyotyping Activity from The Biology Project, University of Arizona. In these online activities, students arrange chromosomes using size, banding pattern, and centromere position. Then students will analyze their karyotypes and determine the sex and genetic disorders of individuals.

Accommodations/Modifications: Give students the "Bug Karyotype Lab" worksheet and have them answer the questions for the different types of Karyotypes that are created. It is very helpful for you to do the cutting and organizing of the chromosomes, as the students

struggle with the fine motor skills to do this well and keep up with all the pieces. Post the chromosomes for each bug around the room in stations. Students can go to each station and organize the chromosomes into a karyotype and then read the karyotype to answer questions about the bug represented. Then come together to discuss findings as a group.

Bloom's Levels: Analyzing

Webb's DOK: 2

Engaging Experience 3

Title: Models of DNA Replication

Suggested Length of Time: 30-45 minutes

Standards Addressed

Priority:

- 9-12.LS1.B.1 Develop and use models to communicate the role of mitosis, cellular division, and differentiation in producing and maintaining complex organisms.

Detailed Description/Instructions: Using models, students will replicate a given DNA sequence to show the semiconservative process of DNA replication.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 2: Cell Cycle and Mitosis

Engaging Experience 1

Title: Life of a Cell (Explore)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS1.B.1 Develop and use models to communicate the role of mitosis, cellular division, and differentiation in producing and maintaining complex Organisms.

Detailed Description/Instructions: Students will explore the progression of a cell as it goes through cell division by sequencing pictures to model the process of mitosis. (STEMScopes - Cell Division and Complex Organisms)

Accommodations/Modifications: Have the students as a group watch the video “The Incredible Dance of Cell Division” video and pause the video at the different stages. Have your students come up with names for each of the stages. Let them be creative with the names, but have them vote on the one that the class wants to call it. Then use those class names to help them connect to the actual phases of mitosis. Phases seen: Interphase, Prophase, Metaphase, Anaphase, Telephase, and cytokinesis.

Bloom’s Levels: Applying

Webb’s DOK: 2

Engaging Experience 2

Title: The Cell Cycle Activity (Explore)

Suggested Length of Time: 45 minutes - 90 minutes

Standards Addressed

Priority:

- 9-12.LS1.B.1 Develop and use models to communicate the role of mitosis, cellular division, and differentiation in producing and maintaining complex Organisms.

Detailed Description/Instructions: Students work in collaborative groups to complete the POGIL where they will refer to models and data tables to observe patterns and determine what occurs in the cell cycle and how mutations occur that can affect cell division. POGILs are available through Flinn Scientific.

Bloom’s Levels: Applying

Webb’s DOK: 2

Topic 3: Meiosis and Fertilization

Engaging Experience 1

Title: Life of a Gamete (Explore)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.

Detailed Description/Instructions: Students will explore the progression of a cell as it goes through cell division by sequencing pictures to model the process of meiosis and fertilization. (modification of STEMscopes - Cell Division and Complex Organisms)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Mitosis and Meiosis Comparison (Explain)

Suggested Length of Time: 45 minutes

Standards Addressed

Priority:

- 9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
- 9-12.LS3.B.1 Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring.

Detailed Description/Instructions: Students will compare/contrast mitosis and meiosis.

Suggested tools include using a graphic organizer or diamante poem.

Accommodations/Modifications:

Option 1: Give students a two circle Venn diagram to organize their ideas on comparing and contrasting Mitosis and Meiosis. They can work in pairs or individually. Come back together as a group and talk about what characteristics they put into each category. It would be helpful to give them a list of characteristics to work with.

Option 2: They can also sort characteristics (listed on strips of paper) of both into two different groups. This can be done in groups or pairs.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 3

Title: Asexual and Sexual Reproduction Comparison (Engage)

Suggested Length of Time: 20 minutes

Standards Addressed

Priority:

- 9-12.LS3.B.1 Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring.

Detailed Description/Instructions: Students use Learn Genetics Sexual and Asexual Reproduction interactive to click on the organisms and read the description, and vote on whether they think the organism reproduces sexually, asexually, or both.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Scenario

Engaging Scenario: Normal vs. Cancerous Cell Cycles Infographic

Students watch a video (Cancer: Unregulated Cell Division - YouTube) of healthy cells replicating and then cancerous cells replicating. In the video there is a picture of what the cell looks like inside and students work together to identify the various stages of the cell cycle in the healthy cells. When analyzing the cancerous cells students discuss what is different compared to the healthy cells. Afterwards students create an infographic showing the difference between the two.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
DNA and Chromosomes	DNA Structure Model	Students will use a physical model (paper or 3D) to practice their understanding of the structure of nucleotides, and the DNA double helix.	~~60 minutes~~ Over 2-3 class periods
DNA and Chromosomes	Karyotype Activity	Students will construct and analyze a karyotype. Suggested activities include Make a Karyotype from Learn.Genetics and Karyotyping Activity from The Biology Project, University of Arizona. In these online activities, students arrange chromosomes using size, banding pattern, and centromere position. Then students will analyze their karyotypes and determine the sex and genetic disorders of individuals.	45 minutes
DNA and Chromosomes	Models of DNA Replication	Using models, students will replicate a given DNA sequence to show the semiconservative process of DNA replication.	30-45 minutes
Cell Cycle and Mitosis	Life of a Cell	Students will explore the progression of a cell as it goes through cell division by sequencing pictures to model the process of mitosis. (STEMScopes - Cell Division and Complex Organisms)	20 minutes
Cell Cycle and Mitosis	The Cell Cycle Activity	Students work in collaborative groups to complete the POGIL where they will refer to models and data tables to observe patterns and determine what occurs in the cell cycle and how mutations occur that can affect cell	45-90 minutes

		division. POGILs are available through Flinn Scientific.	
Meiosis and Fertilization	Life of a Gamete	Students will explore the progression of a cell as it goes through cell division by sequencing pictures to model the process of meiosis and fertilization. (modification of STEMscopes - Cell Division and Complex Organisms)	20 minutes
Meiosis and Fertilization	Mitosis and Meiosis Comparison	Students will compare/contrast mitosis and meiosis. Suggested tools include using a graphic organizer or diamante poem.	~~45 minutes~~ 20 minutes
Meiosis and Fertilization	Asexual and Sexual Reproduction Comparison	Students use Learn Genetics Sexual and Asexual Reproduction interactive to click on the organisms and read the description, and vote on whether they think the organism reproduces sexually, asexually, or both.	20 minutes

Unit 6: Gene Expression and Heredity

Subject: Biology

Grade: 9

Name of Unit: Gene Expression and Heredity

Length of Unit: 13-15 Blocks

Overview of Unit: In this unit, students will learn about the structure and function of DNA and how DNA codes for RNA, which guides protein synthesis. Students will also investigate how gene mutations affect proteins. Students will use their understanding of punnet squares and pedigree in order to show how mathematical concepts can be used to predict patterns of inheritance.

Priority Standards for unit:

- 9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- 9-12.LS3.B.2 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- 9-12.LS3.B.3 Make and defend a claim that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) mutations occurring during replication, and/or (3) mutations caused by environmental factors.
- 9-12.LS3.B.4 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Science & Engineering Practices

Constructing Explanations and Designing Solutions

- *Construct 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.*

Developing and Using Models

- *Use a model based on evidence to illustrate the relationships between systems or between components of a system.*

Engaging in Argument from Evidence

- *Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence.*

Analyzing and Interpreting 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*

Disciplinary Core Ideas

Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life.
- All cells contain genetic information in the form of DNA molecules.
- Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells

Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.
- Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation.
- Environmental factors can also cause mutations in genes, and viable mutations are inherited.
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.

Crosscutting Concepts

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Systems and System Models

- Models (e.g., physical, mathematical, computer) can be used to simulate systems and interactions—including energy, matter and information flows—within and between systems at different scales.

Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Science Is a Human Endeavor

- Technological advances have influenced the progress of science, and science has influenced advances in technology.
- Science and engineering are influenced by society, and society is influenced by science and engineering.

Learning Targets:

Priority Standard: 9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

[Clarification Statement: Genes are the regions in DNA that code for proteins. Basic transcription and translation explain the roles of DNA and RNA in coding the instructions for making polypeptides.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how genes are sections of DNA that code for proteins.	DOK 1
	Remembering
Students will explain the function and importance of proteins.	DOK 1
	Understanding
Students will describe the structure and function of RNA molecules.	DOK 1
	Remembering
Students will compare and contrast DNA and RNA.	DOK 1
	Understanding
Students will model the basic steps of transcription and translation, explaining the roles of DNA and RNA.	~~DOK 3~~ DOK 2
	~~Analyzing~~ Applying

Priority Standard: 9-12.LS3.B.2 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

[Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe how mutations are the result of changes to DNA.	DOK 1
	Understanding
Students will determine how changes in DNA will result in changes in RNA, which will then result in changes to the protein and its function in the organism.	DOK 2
	Applying

Students will explain how mutations can be harmful to an organism, beneficial to an organism, or have no effect at all.	DOK 2
	Applying

Priority Standard: 9-12.LS3.B.3 Make and defend a claim that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) mutations occurring during replication, and/or (3) mutations caused by environmental factors.
[Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe how mutations can result in changes in genetic material that can be passed on to offspring.	DOK 2
	Applying
Students will explain how environmental factors can result in genetic mutations.	DOK 2
	Applying

Priority Standard: 9-12.LS3.B.4 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
[Clarification Statement: Emphasis is on the use of mathematics (Punnett Squares) to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students can explain how traits are inherited using the terms gene and allele.	DOK 1
	Understanding
Students can explain how some traits are observed while others aren't by using the terms phenotype, genotype, dominant, recessive, homozygous, and heterozygous.	DOK 2
	Applying
Students will create and analyze Punnett Squares to determine the probability of a trait being passed from parents to offspring.	DOK 3
	Analyzing
Students will be able to analyze pedigrees to determine genotypes of individuals and the inheritance patterns of traits.	~~DOK 3~~ DOK 1
	~~Analyzing~~ Understanding

Essential Questions:

1. Why is genetic information in cells important?
2. How is genetic information used to produce proteins?
3. How do genetic mutations occur in DNA? What are the impacts of mutations?
4. How are Punnett squares used to understand heredity?

Enduring Understanding/Big Ideas:

1. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.
2. DNA is transcribed to produce RNA. In turn, the information in RNA is translated into a chain of amino acids and folded into a protein.
3. DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. Mutations can alter proteins and produce new traits.
4. Punnett squares are a statistical tool used to predict the outcomes of genetic crosses involving traits of an organism.

Unit Vocabulary

- | | | |
|--------------------------|-------------------|------------------|
| ● DNA | ● Base-Pair | ● Dominant |
| ● Double helix | ● Protein | ● Homozygous |
| ● DNA replication | ● Ribosome | ● Heterozygous |
| ● RNA (mRNA, tRNA, rRNA) | ● Gene expression | ● Carrier |
| ● Transcription | ● Codon | ● Genotype |
| ● Translation | ● Anticodon | ● Phenotype |
| ● Amino acid | ● Mutagen | ● Punnett Square |
| ● Nucleotide | ● Mutation | ● Pedigree |
| | ● Trait | |
| | ● Recessive | |

Topic 1: DNA and RNA

Engaging Experience 1

Title: Origami DNA or Components of DNA (Engage)

Suggested Length of Time: 60 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Detailed Description/Instructions: Students will build a model of DNA. (STEMscopes - DNA to Proteins)

Bloom's Levels: Understanding

Webb's DOK: 1

Engaging Experience 2

Title: Venn Diagram of DNA and RNA Molecular Structure (Explore)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through a system of specialized cells.

Detailed Description/Instructions: Students will construct a Venn diagram that compares the structure of DNA and RNA molecules.

Accommodations/Modifications: This can be done as written or you can give the students a list of characteristics for them to sort into two groups: DNA vs RNA.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 2: Protein Synthesis

Engaging Experience 1

Title: Make Me a Sandwich (Explore)

Suggested Length of Time: 20-30 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Detailed Description/Instructions: Students will model protein synthesis, using a classroom scenario. They will compare the act of making a sandwich to the act of protein synthesis. (STEMscopes - DNA to Proteins)

Accommodations/Modifications: This activity can be done as written. If you have a very small class, you can just put the ingredients around the room for the students to go and find. Go over the questions as a whole class discussion to help them connect their learning.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Models of Protein Synthesis (Explain)

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- 9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through a system of specialized cells.

Detailed Description/Instructions: Students will create a model of the process of protein synthesis, including transcription and translation, to illustrate the roles of DNA and RNA molecules in protein synthesis. A suggested activity is *How Do Cells Make Proteins?* online activity through the Concord Consortium to determine how DNA is transcribed and translated to produce proteins.

Bloom's Levels: Applying

Webb's DOK: 2

Topic 3: Mutations

Engaging Experience 1

Title: Genetics vs. Environment (Explore)

Suggested Length of Time: 90 minutes

Standards Addressed

Priority:

- 9-12.LS3.B.2 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

Detailed Description/Instructions: Students will be defending a claim based on evidence in relation to risk factors for breast cancer. (STEMscopes - Variation in Traits)

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Mutations Activity (Explain)

Suggested Length of Time: 45 minutes

Standards Addressed

Priority:

- 9-12.LS3.B.2 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- 9-12.LS3.B.3 Make and defend a claim that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) mutations occurring during replication, and/or (3) mutations caused by environmental factors.

Detailed Description/Instructions: Students need to use a model to describe how gene mutations affect proteins. A suggested activity is *How Do Cells Make Proteins?* online activity through the Concord Consortium to determine how changes in DNA result in modified proteins.

Accommodations/Modifications: Depending on the critical thinking skills of your students, you might need to do this as a whole group and talk through the answers.

Bloom's Levels: Understanding

Webb's DOK: 2

Topic 4: Punnett Squares and Pedigrees

Engaging Experience 1

Title: Using Punnett Squares (Explore)

Suggested Length of Time: 30-45 minutes

Standards Addressed

Priority:

- 9-12.LS3.B.4 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Detailed Description/Instructions: Students will explore Mendelian genetics - our cells carry two copies of each trait or allele and some traits are dominant over others. Wisconsin Fast Plants over quick simulated crosses that students can use to observe dominant and recessive traits, phenotypes and genotypes, and heterozygous and homozygous individuals.

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 2

Title: Superhero Traits (Engage)

Suggested Length of Time: 30 minutes

Standards Addressed

Priority:

- 9-12.LS3.B.4 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Detailed Description/Instructions: In this brief activity, students will be introduced to the process by which traits are passed on from parents to offspring and how probability impacts traits. (STEMscopes - Variation in Traits)

Accommodations/Modifications: This activity can be done as written.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Scenario

Engaging Scenario: Build-A-Protein

Students will need to create a model/poster/video that explains the relationship between DNA, RNA, and proteins and explain how mutations can affect proteins. A suggested activity would be having students use their previously built models to create their own tutorial video in which they explain how cells produce proteins through transcription and translation and describe how DNA mutations can alter proteins and their functions. For example, if students used the “Make Me a Sandwich” activity, then students could revisit it and investigate what happens if the order changes.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
DNA and RNA	Origami DNA or Components of DNA	Students will build a model of DNA. (STEMscopes - DNA to Proteins)	60 minutes
DNA and RNA	Venn Diagram of DNA and RNA Molecular Structure	Students will construct a Venn diagram that compares the structure of DNA and RNA molecules.	30 minutes
Protein Synthesis	Make Me a Sandwich	Students will model protein synthesis, using a classroom scenario. They will compare the act of making a sandwich to the act of protein synthesis. (STEMscopes - DNA to Proteins)	~~20-30~~ minutes 30-45 minutes
Protein Synthesis	Models of Protein Synthesis	Students will create a model of the process of protein synthesis, including transcription and translation, to illustrate the roles of DNA and RNA molecules in protein synthesis. A suggested activity is <i>How Do Cells Make Proteins?</i> online activity through the Concord Consortium to determine how DNA is transcribed and translated to produce proteins.	90 minutes
Mutations	Genetics vs. Environment	Students will be defending a claim based on evidence in relation to risk factors for breast cancer. (STEMscopes - Variation in Traits)	90 minutes
Mutations	Mutations Activity	Students need to use a model to describe how gene mutations affect proteins. A suggested activity is <i>How Do Cells Make Proteins?</i> online activity through	45 minutes

		the Concord Consortium to determine how changes in DNA result in modified proteins.	
Punnett Squares and Pedigrees	Using Punnett Squares	Students will explore Mendelian genetics - our cells carry two copies of each trait or allele and some traits are dominant over others. Wisconsin Fast Plants over quick simulated crosses that students can use to observe dominant and recessive traits, phenotypes and genotypes, and heterozygous and homozygous individuals.	30-45 minutes
Punnett Squares and Pedigrees	Superhero Traits	In this brief activity, students will be introduced to the process by which traits are passed on from parents to offspring and how probability impacts traits. (STEMscopes - Variation in Traits)	30 minutes

Unit 7: Evolution

Subject: Biology

Grade: 9

Name of Unit: Evolution

Length of Unit: 8-10 Blocks

Overview of Unit: This unit provides an overview of biological evolution through natural selection. Students will explore the interdependence of Earth's geological evolution and biological evolution, develop an understanding of the process of natural selection, analyze evidence that supports biological evolution, and examine how adaptations modify populations based on environmental changes.

Priority Standards for unit:

- 9-12.LS4.A.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- 9-12.LS4.A.2 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
- 9-12.LS4.B.1 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.
- 9-12.LS4.B.2 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.
- 9-12.LS4.C.1 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- 9-12.LS4.C.2 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.
- 9-12.ESS2.E.1 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Science & Engineering Practices

Obtaining, Evaluating, and Communicating Information

- Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted.
- If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

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- If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence

Constructing Explanations and Designing Solutions

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' 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

Analyzing and Interpreting 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

Disciplinary Core Ideas

Evidence of Common Ancestry and Diversity

- Genetic information, like the fossil record, 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 also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence

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.
- The traits that positively affect survival are more likely to be reproduced and thus are more common in the population

Adaptation

- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation 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 proliferation of those organisms that are better able to survive and reproduce in that environment
- 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.
- Adaptation also means that the distribution of traits in a population can change when conditions change.
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost

Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

Biogeology

- The many dynamic and delicate feedback between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and that they will continue to do so in the future

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable

Learning Targets:

Priority Standard: 9-12.LS4.A.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

[Clarification statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development. Communicate could mean written report, oral discussion, etc.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will describe that all organisms share common ancestors and closer related organisms have more recent common ancestors.	DOK 1
	Understanding
Students will observe evidence (e.g. fossils, DNA) and explain how anatomical and genetic similarities demonstrate common ancestry.	DOK 2
	Applying

Students will observe evidence (e.g. fossils, DNA) and explain how it demonstrates heritable traits of organisms changing over time.	DOK 2
	Applying
Students will observe evidence and determine the relatedness of two species based on similarities and differences.	~~DOK 4~~ DOK 2
	~~Evaluating~~ Analyzing

Priority Standard: 9-12.LS4.A.2 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

[Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify anatomical similarities between embryos of different species using pictorial data.	DOK 2
	Applying
Students will reason that embryonic similarities support the idea of common ancestry.	DOK 1
	Understanding

Priority Standard: 9-12.LS4.B.1 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.

[Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on the number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the requirements for natural selection - variation, heritable traits, selective pressure, and differences in survival/reproduction.	DOK 1
	Understanding

Students will explain natural selection and how it can change the frequency of traits over time.	DOK 2
	Applying
Students will evaluate a scenario and explain how it demonstrates evolution through natural selection.	~~DOK 3~~ DOK 2
	Analyzing Applying

Priority Standard: 9-12.LS4.B.2 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.
[Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify that some mutations can be beneficial and help a species survive in its environment.	DOK 1
	Understanding
Students will describe that those species with favorable traits will be more likely to survive and pass on their genes.	DOK 1
	Understanding
Students will explain how organisms with beneficial traits will increase in number compared to organisms without them.	DOK 2
	Applying
Students will analyze how the relationship between changes in environments can cause changes in the distribution of traits.	DOK 3
	Analyzing

Priority Standard: 9-12.LS4.C.1 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
[Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to change in gene frequency over time, leading to adaptation of populations.]

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will explain how traits adapted for an environment will become more common in a population over time.	~~DOK 3~~ DOK 2
	Analyzing Applying

Students will describe the types of adaptations.	DOK 1
	Understanding

Priority Standard: 9-12.LS4.C.2 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. *[Clarification statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, and application of fertilizers, droughts, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]*

Learning Targets	Webb's DOK Level
	Bloom's Level
Students will identify the biological definition of a species.	DOK 1
	Remembering
Students will explain how certain organisms will be favored because of these environmental changes and will increase in number.	DOK 2
	Applying
Students will explain that if species do not have traits that allow them to survive in the new environment, they will eventually go extinct.	DOK 2
	Applying
Students will analyze that genetic combinations that were detrimental in the past can be favored under different conditions and lead to the emergence of new species.	DOK 3
	Analyzing

Priority Standard: 9-12.ESS2.E.1 Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.

[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth’s surface. Examples of coevolution include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for new life.]

Learning Targets	Webb’s DOK Level
	Bloom’s Level

Students will explain that changes to conditions on Earth have shaped natural selection and the evolution of organisms.	DOK 2
	Applying
Students will illustrate how the evolution of organisms has altered Earth’s systems.	DOK 2
	Applying

Essential Questions:

1. How have changes in Earth’s systems and living organisms influenced each other over time?
2. How does the process of evolution through natural selection occur in populations?
3. How do molecular and structural comparisons among organisms provide evidence for evolution?
4. How are adaptations related to the genetic makeup of a population?
5. How do changes in the environment impact populations of organisms?

Enduring Understanding/Big Ideas:

1. Earth’s geosphere, hydrosphere, atmosphere, and biosphere have coevolved, meaning changes in one system can drive changes in others, and life both responds to and actively shapes Earth’s environments over geological time.
2. Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation 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 proliferation of those organisms that are better able to survive and reproduce in that environment.

3. 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 also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.
4. Adaptations can be the traits that positively affect survival and are more likely to be reproduced, and thus are more common in the population. Adaptation also means that the distribution of traits in a population can change when conditions change.
5. Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.

Unit Vocabulary:

- | | | |
|---------------------|--------------|-------------------------|
| ● microbial life | ● variation | ● homologous structure |
| ● photosynthesis | ● fitness | ● analogous structure |
| ● dynamic Earth | ● mutation | ● vestigial structure |
| ● fossil | ● species | ● ecological succession |
| ● natural selection | ● speciation | |
| ● adaptation | ● extinction | |

Topic 1: Co-Evolution of Earth and Life

Engaging Experience 1

Title: Deep History of Earth's Timeline (Engage)

Suggested Length of Time: 15-20 minutes

Standards Addressed

Priority:

- 9-12.ESS2.E.1 Construct an argument based on evidence about the simultaneous co-evolution of Earth's System and life on Earth.

Detailed Description/Instructions: A suggested activity for investigating Earth's geological evolution is the HHMI Deep History of the Earth Timeline. Teachers can use this as a class demonstration to show the timeline of the Earth and its major events.

Bloom's Levels: Understanding

Webb's DOK: 1

Topic 2: The Process of Natural Selection

Engaging Experience 1

Title: Natural Selection Lab (Explore)

Suggested Length of Time: 45-60 minutes

Standards Addressed

Priority:

- 9-12.LS4.B.1 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.
- 9-12.LS4.C.2 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.
- 9-12.LS4.B.2 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.
- 9-12.LS4.C.1 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Detailed Description/Instructions: Students will explore how natural selection causes populations to change. Students will carry out a lab to determine how selective pressures affect the survival of individuals in a population and lead to natural selection of specific traits.

Accommodations/Modifications: Have students play “Natural Selection Game” where they eat the moths in two different environments and see how many of one color of moth survive. Have a group discussion about how adaptations affect the survival rate of different species in an environment. Link: <https://askabiologist.asu.edu/games-sims/peppered-moths-game/play.html>

Bloom’s Levels: Analyzing

Webb’s DOK: 3

Engaging Experience 2

Title: Environmental Influences and Natural Selection (Explore)

Suggested Length of Time: 20-30 minutes

Standards Addressed

Priority:

- 9-12.LS4.B.1 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.
- 9-12.LS4.C.2 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.
- 9-12.LS4.B.2 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.
- 9-12.LS4.C.1 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Detailed Description/Instructions: Students will be presented with three different scenarios about populations of limpets with color variations. Students will be challenged to write a claim, evidence, and reasoning about why and how the distribution of alleles for color changed within each population. (STEMScopes - Results of Natural Selection)

Bloom's Levels: Analyzing

Webb's DOK: 3

Engaging Experience 3

Title: "WHO WANTS TO LIVE A MILLION YEARS" Darwin Online Simulation Game (Explore)

Suggested Length of Time: 30-45 minutes

Standards Addressed

Priority:

- 9-12.LS4.B.1 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.
- 9-12.LS4.C.2 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.

- 9-12.LS4.B.2 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.
- 9-12.LS4.C.1 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Detailed Description/Instructions: Students learn about Charles Darwin and his voyage on the HMS Beagle, then create a population of animals to play Who Wants to Live a Million Years. Students will introduce mutations in hopes of surviving various environmental impacts.
<https://gettingnerdywithmelandgerdy.com/evolution-adaptation-game/>

Accommodations/Modifications: Students can play the game as written. Bring them back together after a while to play and have a discussion to make connections.

Bloom's Levels: Applying
Webb's DOK: 2

Topic 3: Evidence for Evolution

Engaging Experience 1

Title: Evidence of Common Ancestry Stations (Explore)

Suggested Length of Time: 60-90 minutes

Standards Addressed

Priority:

- 9-12.LS4.A.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- 9-12.LS4.A.2 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

Detailed Description/Instructions: Students will analyze evidence of common ancestry by rotating stations that contain different evidence, including anatomical, developmental, and molecular homologies. (STEMscopes - Evidence of Common Ancestry)

Accommodations/Modifications: Students should be able to do this activity as written. They should work in pairs or groups. You might need to stay close by on station 3 to help them read the information provided. It will be the most challenging station. You might want to make that last stage print bigger by separating the two groups of data onto two different pages. End with a whole group discussion so that you can help the students make connections.

Bloom's Levels: Applying

Webb's DOK: 2

Engaging Experience 2

Title: Comparison of Mammal Skulls (Explore)

Suggested Length of Time: 60-90 minutes

Standards Addressed

Priority:

- 9-12.LS4.A.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- 9-12.LS4.A.2 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

Detailed Description/Instructions: Students will analyze fossil evidence to determine the relatedness of three mammals. (STEMScopes - Evidence of Common Ancestry)

Bloom's Levels: Applying
Webb's DOK: 2

Engaging Experience 3

Title: Analyzing Evidence for Evolution Activity (Explore)

Suggested Length of Time: 45-60 minutes

Standards Addressed

Priority:

- 9-12.LS4.A.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- 9-12.LS4.A.2 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

Detailed Description/Instructions: Students will work in collaborative groups to answer questions about models in the POGIL activity where they refer to models and data tables to observe patterns and determine how DNA and comparative anatomy are used to show relatedness. POGILs can be found through Flinn Scientific.

Bloom's Levels: Applying
Webb's DOK: 2

Engaging Scenario

Engaging Scenario: Natural Selection Experiment

Students will design and conduct experiments about natural selection in populations. Variables that can be manipulated include mutations, environmental conditions, and selective pressures. A suggested tool for students to use in their experiments is the PhET Natural Selection online simulation.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Co-Evolution of Earth and Life	Deep History of Earth's Timeline	A suggested activity for investigating Earth's geological evolution is the HHMI Deep History of the Earth Timeline. Teachers can use this as a class demonstration to show the timeline of the Earth and its major events.	15-20 minutes
The Process of Natural Selection	Natural Lab Selection	Students will explore how natural selection causes populations to change. Students will carry out a lab to determine how selective pressures affect the survival of individuals in a population and lead to natural selection of specific traits.	45-60 minutes
The Process of Natural Selection	Environmental Influences and Natural Selection	Students will be presented with three different scenarios about populations of limpets with color variations. Students will be challenged to write a claim, evidence, and reasoning about why and how the distribution of alleles for color changed within each population. (STEMScopes - Results of Natural Selection)	20-30 minutes
The Process of Natural Selection	"WHO WANTS TO LIVE A MILLION YEARS" Darwin Online Simulation Game	Students learn about Charles Darwin and his voyage on the HMS Beagle, then create a population of animals to play Who Wants to Live a Million Years. Students will introduce mutations in hopes of surviving various environmental impacts. https://gettingnerdywithmelanderdy.com/evolution-adaptation-game/	30-45 minutes

Evidence for Evolution	Evidence of Common Ancestry Stations	Students will analyze evidence of common ancestry by rotating stations that contain different evidence, including anatomical, developmental, and molecular homologies. (STEMscopes - Evidence of Common Ancestry)	60-90 minutes
Evidence for Evolution	Comparison of Mammal Skulls	Students will analyze fossil evidence to determine the relatedness of three mammals. (STEMScopes - Evidence of Common Ancestry)	60-90 minutes
Evidence for Evolution	Analyzing Evidence for Evolution Activity	The Biology POGIL Evidence for Evolution activity requires students to refer to models and data tables to observe patterns and determine how DNA and comparative anatomy are used to show relatedness.	45-60 minutes

Unit of Study Terminology

Appendices: All Appendices and supporting material can be found in this course's shell course in the District's Learning Management System.

Assessment Leveling Guide: A tool to use when writing assessments in order to maintain the appropriate level of rigor that matches the standard.

Big Ideas/Enduring Understandings: Foundational understandings teachers want students to be able to discover and state in their own words by the end of the unit of study. These are answers to the essential questions.

Engaging Experience: Each topic is broken into a list of engaging experiences for students. These experiences are aligned to priority and supporting standards, thus stating what students should be able to do. An example of an engaging experience is provided in the description, but a teacher has the autonomy to substitute one of their own that aligns to the level of rigor stated in the standards.

Engaging Scenario: This is a culminating activity in which students are given a role, situation, challenge, audience, and a product or performance is specified. Each unit contains an example of an engaging scenario, but a teacher has the ability to substitute with the same intent in mind.

Essential Questions: Engaging, open-ended questions that teachers can use to engage students in the learning.

Priority Standards: What every student should know and be able to do. These were chosen because of their necessity for success in the next course, the state assessment, and life.

Supporting Standards: Additional standards that support the learning within the unit.

Topic: These are the main teaching points for the unit. Units can have anywhere from one topic to many, depending on the depth of the unit.

Unit of Study: Series of learning experiences/related assessments based on designated priority standards and related supporting standards.

Unit Vocabulary: Words students will encounter within the unit that are essential to understanding. Academic Cross-Curricular words (also called Tier 2 words) are those that can be found in multiple content areas, not just this one. Content/Domain Specific vocabulary words are those found specifically within the content.