Biology

Year At A Glance						
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Biology

Unit 1: Systems Cellular

Enduring Understanding:

- All living things are composed of 4 macromolecules: carbohydrates, lipids, proteins, and nucleic acids.
- All organisms obtain energy through photosynthesis and cellular respiration.
- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
- 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 environment.

Essential Question(s):

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

Time Frame: 6 weeks

Topics:

- Macromolecules
- Photosynthesis
- Aerobic and Anaerobic Respiration

Student Learning Expectation(s):

Students will be able to:

- Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements.
- Create and use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.
- Use a model to demonstrate that cellular respiration is a chemical process.
- Observe the process of photosynthesis through lab

Standard(s):

BI-LS1-6: Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
BI-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
BI-LS1-7: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

Key Terminology/Vocabulary:

Energy Metabolism Photosynthesis Cellular Respiration Oxygen Carbon Dioxide	Macromolecules Polymer Carbohydrate Lipid Phospholipid Light Energy	Protein Amino Acid Nucleic Acid Nucleotide Glucose Chemical Energy

Activities & Assessments

Macromolecules Activity: Students will identify and compare the different elements and monomers that compose carbohydrates, lipids, proteins, and nucleic acids. Activity can include drawing, sorting, classifying and creating a concept map
Identify and compare the different elements and monomers compose the macromolecules.
Photosynthesis Lab: Students will observe the process of photosynthesis through a lab and will create a model to demonstrate how photosynthesis converts light energy into chemical energy.
Draw, sort, classify and create a concept map of the macromolecules.
Photosynthesis Lab
Carbon Transfer lab (Snails and Elodea)
Create a concept map comparing aerobic and anaerobic respiration
Exit tickets

Materials and Resources

Lesson plan, Textbook, Videos, Chart paper, Paper/pencils/ pens/ coloring pencils, Science-Consortium, Discovery Channel Interactive Science Journal for students, Science News, Kahoots, QRC Codes Edpuzzle.com, On-line Virtual Labs , PHet, The Physics classroom.com, Labster, chemcollective.org, openstax.org, Periodic Table, Khan Academy, Apex, Edgenuity

Unit 2: Structure and Function

Enduring Understanding:

- All living organisms are composed of cells, use energy, respond to stimuli, reproduce, grow and develop, maintain homeostasis, and as populations, evolve over time.
- Living organisms are organized into different levels, which are studied by biologists. These levels in multicellular organisms include the following: atoms, molecules, cells, tissues, organs, organ systems, and organism.
- The structure and function of subcellular components, and their interactions, provide essential cellular processes.
- Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.
- Variation in molecular units provides cells with a wider range of functions.
- There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
- Cell membranes are selectively permeable due to their structure.
- Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
- Homeostasis is regulated through negative and positive feedback mechanisms. Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range.
- Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.
- Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.
- Viral replication results in genetic variation and viral infection can introduce genetic variation into the hosts.

Essential Questions:

1. How has life on Earth changed throughout history?
2. How can scientific evidence support hypotheses of the origin of life on Earth?
3. How do different disciplines support models of the origin of life?
4. How does the structure of membranes make them selectively permeable?
5. How does the movement of molecules help a cell maintain homeostasis?
6. Why are internal membranes important to eukaryotic cells?
7. How can one distinguish between a living and a non-living thing?
8. How do living organisms display organization?
9. How do cells maintain homeostasis?

Time Frame: ***6 weeks***

Topics:

- Characteristics of Life
- Early Earth
- The Cell
- Cell Function
- Cell Membrane Structure
- Cell Transport
- Energy
- Levels of Organization
- Homeostasis
- Viruses

Student Learning Expectations:

Students will be able to:

- Describe the role of the cell membrane and organelles in maintaining homeostasis.
- Describe the life cycle of a cell.
- Examine the life cycle of viruses as acellular but also obligate intracellular parasites.
- Evaluate scientific questions based on hypotheses about the origin of life on Earth.
- Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination.
- Use models and representations to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure.
- Construct models that connect the movement of molecules across membranes with membrane structure and function.
- Represent graphically or model quantitatively the exchange of molecules between an organism and its environment, and the subsequent use of these molecules to build new molecules that facilitate dynamic homeostasis, growth and reproduction.
- Construct an explanation of how viruses introduce genetic variation in host organisms.
- Use representations to describe how viral replication introduces genetic variation in the viral population.
- Make predictions about the interactions of subcellular organelles.
- Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular Organisms. Describe functions at the organism system level such as nutrient uptake, water delivery, and organism movement

Standards

BI-LS1-1: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
BI-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
BI-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Key Terms/Vocabulary

Abiogenesis biology growth development reproduction species Stimulus Cambrian explosion Endocytosis Pinocytosis Phagocytosis Endomembrane system Endoplasmic reticulum Smooth ER Rough ER Ribosomes Viral envelope Host range Obligate Bacteriophage Capsid Gap junctions Desmosomes	Reducing atmosphere Response Cell tissue Organ organ system Organism Endosymbiosis Isotonic Hypotonic Hypertonic Organelles Nucleus Nucleolus Ribosomes Lysosome Intracellular Parasite Restriction enzyme Vaccine Viroids Prions	Protobionts Homeostasis plasma membrane passive transport active transport diffusion osmosis facilitated diffusion Receptor mediated transport Exocytosis Cytology Cell fractionation Electrophoresis Prokaryotic cells Eukaryotic cells Nuclear pores Lytic cycle Lysogenic cycle Retrovirus Reverse transcriptase Tight junctions Plasmodesmata

Activities and Assessments

Glue Monster Activity: students make observations about an “organism” in a petri dish and discuss what makes it alive. The organisms are drops of Deco Cement glue in water that are projected onto a screen with a light source so as to not reveal that the materials are non-living.
Levels of Organization Flowchart/Anchor chart: students will create a flowchart that will include drawings of each level of organization ranging from smallest to most complex.
Osmosis Lab: students will complete an experiment to test conditions which affect the rate of osmosis across a membrane
Digital 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.

Cell Membrane: students will build paper membranes to predict movement of molecules (both actively and passively) across the cell membrane, and predict the efficiency of cells using their understanding of surface area to volume ratios. *Virus Creation*: students will create a fake social media account for a virus of their choosing. They must include details on the types of cells the virus targets, how it enters through the cell membrane, which organelles it affects and how it disrupts the host cell's cycle. Cell Organelle analogy, virus webquest, Quick writes, Exit tickets, Lab analysis, Graphs, Data Presentations, Card Sort(Vocabulary), Digital Lab notebook, Quizlet, QRC Codes, Lesson Quiz, Scientific Investigations, Teacher/Student Models, Student Response Questions, Concept Map(Vocabulary)
Materials and Resources
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Unit 3: Population and Ecosystem Dynamics

Enduring Understanding:

- 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.
- The number of individuals affects the abundance of species in any given ecosystem.
- 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.
- Carbon, nitrogen, phosphorus, and water are examples of nutrients that cycle through Earth's biosphere, atmosphere, hydrosphere, cryosphere, and geosphere
- 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, 3) the extinction of other species

Essential Questions:

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

Time Frame: ***5 weeks***

Topics:

- Ecological Levels
- Population Growth
- Interaction of Organisms
- Nutrient Levels

Student Learning Expectations:

Students will be able to:

- Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem
- Construct and revise an explanation based on evidence
- Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem
- Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion

- Explain the cycling of carbon in ts various forms among the biosphere, atmosphere, hydrosphere, and geosphere
- Evaluate the claims, evidence, and reasoning that interactions in ecosystems maintain consistent populations of species
- Construct an argument about the simultaneous coevolution of Earth's System and life on Earth

Standards

BI-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
BI-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
BI-LS2-6: Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
BI-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
BI-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Key Terms/Vocabulary

biotic abiotic limiting factor carrying capacity food chain food web competition symbiosis Biomass Nutrient cycle	Parasitism mutualism commensalism autotroph heterotroph Producer Consumer Combustion Species Population Community	hydrosphere biosphere cryosphere geosphere Atmosphere Climate Weather Ecosystem Ecological pyramid

Activities and Assessments

Levels of Organization Illustration: Students will label, classify, and illustrate the levels of organization within an ecosystem.
Population Biology Activity: 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.
Food Web Activity: students construct and analyze a food web for energy flow among trophic levels and population changes related to biotic and

abiotic factors in the ecosystem *Carbon Dioxide and the Carbon Cycle*: 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 Quick writes, Exit tickets, Lab analysis, Graphs, Data Presentations, Card Sort(Vocabulary), Digital Lab notebook, Quizlet, QRC Codes, Lesson Quiz, Scientific Investigations, Teacher/Student Models, Student Response Questions, Concept Map(Vocabulary)
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Unit 4: Natural Resources and Human Activity

Enduring Understanding:

- The health of an ecosystem depends on the population remaining stable.
- Survival of the human race is dependent on reducing and mitigating the adverse impact on biodiversity.
- The scale of the population is dependent on the resources available .

Essential Questions(s):

- How do Earth Living and nonliving parts interact and affect the survival of organisms?
- What makes an ecosystem healthy and stable?
- How is biodiversity affected by humans and other populations in the ecosystem?
- How do abiotic and biotic factors shape ecosystems?
- How Have human activity shaped local and global ecology?

Time Frame/Concepts & Content: ***5 weeks***

Topics:

- Ecology?
- Energy, Producers, and Consumer
- Energy Flow in Ecosystem
- Cycle of Matter
- Ecosystem and communities
- Aquatic Ecosystems
- Population
- How Population Grows
- Limits to Growth
- Human Population Growth
- Humans in the Biosphere
- Resources
- Biodiversity
- Ecological Challenges

Student Learning Expectations:

Students will be able to:

- The students will explain how the health of an ecosystem is dependent upon the population being stable.
- The students will identify and use data to explain factors that affect the biodiversity of the population in the ecosystem
- The students will explain and use data to justify the ways human activity has an adverse impact on biodiversity.

Standards:

BI-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to the Earth systems.

BI-ESS2-4: Use modeling to describe how variation in the flow of energy into and out of Earth's systems result in changes in climate.

BI-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on the Earth's material and surface processes.

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

BI-ESS3-2: Evaluate competing designs solutions for developing, managing, and utilizing energy and minerals resources based on cost-benefit ratios.

BI-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Key Terminology/Vocabulary:

Biosphere	Weather	Population Density	Monoculture
Species	Climate	Age Structure	renewable resource
Population	Microclimate	Immigration	nonrenewable resource
Community	Greenhouse Effect	Emigration	Sustainable Development Magnification
Ecology	Tolerance	Exponential Growth	
Ecosystem	Habitat	logistic Growth	Desertification
Biome	Niche		Deforestation
Biotic Factor	Resource	Limiting Factor	Polluant
Abiotic Factor	Competitive Exclusion Principle	Density-dependent Limiting Factor	Biological Magnification
	Predation	Density-independent Limiting Factor	Smog
Autotroph	Herbivory	Demography	Acid Rain

Primary Producer Photosynthesis Chemosynthesis Heterotroph Consumer Carnivore Herbivore Scavenger Omnivore Decomposer Detritivore Food Chain Phytoplankton Food Web Zooplankton Trophic Level Ecological Pyramid Biomass Biogeochemical Cycle Nutrient Nitrogen Fixation Denitrification Limiting Nutrient	Keystone Species Symbiosis Mutualism Parasitism Commensalism Ecological Succession Primary Succession Pioneer Species Secondary Succession Canopy Understory Deciduous Coniferous Humus Taiga Permafrost Photic Zone Aphotic Zone Benthos Plankton Wetland Estuary	Demographic Transition Complex Interaction Simple Interaction interdependent factors Competitions Resources Mitigate Invasive species Deforestation Overpopulation Overexploitation Abiotic Factor Biotic Factor Equilibrium	Biodiversity Ecosystem Diversity Species Diversity Genetic Diversity Habitat Fragmentation Ecological Hot Spot Ecological footprint Ozone Layer Aquaculture Global Warming

Activities & Assessments:

Quick writes, Exit tickets, Lab analysis, Graphs, Data Presentations, Card Sort(Vocabulary), Digital Lab notebook, Quizlet, QRC Codes, Lesson Quiz, Scientific Investigations, Teacher/Student Models, Student Response Questions, Concept Map(Vocabulary)

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Unit 5: Genetics

Enduring Understanding:

- A cell is the basic unit of life; processes that occur at the cellular level provide the energy and basic structure organisms need to survive.
- DNA is the universal code for life: it enables an organism to transmit information and, along with the environment, determines an organism's characteristics.

Essential Questions(s):

- What are some of the difficulties a cell faces as it increases?
- How do asexual and sexual reproduction compare?
- What is the role of chromosomes in cell division?
- What are the main events of the cell cycle?
- What events occur in each of the four phases of mitosis?
- How do daughter cells split apart after mitosis?
- How is the cell cycle regulated?
- How do cancer cells differ from other cells?
- How do cells become specialized for different functions?
- What are stem cells?
- What are some possible benefits and issues associated with stem cell research?
- How does biological information pass from one generation to another?
- Where does an organism get its unique characteristics?
- How are different forms of a gene distributed to offspring?
- What is the structure of DNA, and how does it function in genetic inheritance?
- How does information flow from the cell nucleus to direct the synthesis of protein in cytoplasm?
- How can we study human inheritance?

Time Frame: *6 weeks*

Topics:

- Scientific Processes
- Genetic tendencies
- DNA
- RNA and Protein Synthesis
- Human Heredity

Student Learning Expectations:

Students will be able to:

- Explain the problems that growth causes for cells.
- Compare asexual and sexual reproduction.
- Describe the role of chromosomes in cell division.
- Name the main events of the cell cycle.
- Describe what happens during the phases of mitosis.
- Describe the process of cytokinesis.
- Explain how cancer cells are different from other cells.
- Describe Mendel's studies and conclusions about inheritance.
- Describe What happens during segregation.
- Explain how geneticists use the principles of probability to make Punnett squares.
- Explain the principle of independent assortment.
- Explain how Mendel's principles apply to all organisms.
- Describe the other inheritance patterns.
- Explain the relationship between genes and the environment.
- Contrast the number of chromosomes in body cells and gametes.
- Summarize the events of meiosis.
- Contrast meiosis and mitosis.
- Describe how alleles from different genes can be inherited together.
- Summarize the process of bacterial transformation.
- Describe the role of bacteriophages in identifying genetic material.
- Identify the role of DNA in heredity.
- Identify the chemical components of DNA.
- Discuss the experiments leading to the identification of DNA as the molecule that carries the genetic code.
- Describe the steps leading to the development of the double-helix model of DNA.
- Summarize the events of DNA replication.
- Compare DNA replication in prokaryotes with that of eukaryotes
- Contrast RNA and DNA.
- Explain the process of transcription.
- Identify the genetic code and explain how it is read.
- Summarize the process of translation.
- Describe central dogma of molecular biology.
- Define mutation and describe the different types of mutations.
- Describe the effects mutations can have on genes.
- Describe gene regulation in prokaryotes.
- Explain how most eukaryotic genes are regulated.

- Relate gene regulation to development in multicellular organisms.

Standards:

BI-LS 1-4: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
BI-LS 3-1: Ask questions to clarify relationships about the role of DNA and chromosome in coding the instructions for characteristic traits passed from parents to offsprings.
BI-LS 3-2: Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
BI-LS 3-3: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Key Terminology/Vocabulary:

Cell Division	Genetics	Transformation	Genome
Asexual Reproduction	Fertilization	Bacteriophage	Karyotype
Sexual Reproduction	Trait	Base Pairing	Sex Chromosome
Chromosome	Hybrid	Replication	Autosome
Chromatin	Gene	DNA Polymerase	Sex-linked Gene
Cell Cycle	Allele	TelomereRNA	Pedigree
Interphase	Principle of Dominance	Messenger RNA	Nondisjunction
Mitosis	Segregation	Ribosomal RNA	Restricted Enzyme
Cytokinesis	Gamete	Transfer RNA	Gel Electrophoresis
Prophase	Probability	Transcription	Bioinformatics
Centromere	Homozygous	RNA Polymerase	Genomics
Chromatid	Heterozygous	Promoter	Anaphase
Centriole	Phenotype	Intron	Telophase
Metaphase	Genotype	Exon	Independent Assortment
	Punnett Square		

Activities & Assessments:

Quick writes, Exit tickets, Lab analysis, Graphs, Data Presentations, Card Sort(Vocabulary), Digital Lab notebook, Quizlet, QRC Codes, Lesson Quiz, Scientific Investigations, Teacher/Student Models, Student Response Questions, Concept Map(Vocabulary)

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Unit 6: Evolution by Natural Selection

Enduring Understanding:

- 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.
- 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.
- 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.
- 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.

Essential Questions:

1. How does the process of evolution through natural selection occur in populations?
2. How do molecular and structural comparisons among organisms provide evidence for evolution?
3. How are adaptations related to the genetic makeup of a population?
4. How do changes in the environment lead to speciation and extinction?

Time Frame: ***4 weeks***

Topics:

- Geological Evolution
- Natural selection
- Evolution
- Speciation
- Extinction

Student Learning Expectations:

Students will be able to:

- Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence
- 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.
- 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.
- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Standards

BI-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
BI-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
BI-LS4-3: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
BI-LS4-4: Construct an explanation based on evidence on how natural selection leads to adaptation of populations.
BI-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
BI-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
BI-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Key Terms/Vocabulary

natural selection adaptation fitness mutation gene flow genetic drift	population bottleneck founder effect speciation geographic isolation behavioral isolation reproductive isolation	homologous structure analogous structure vestigial structure ecological succession

Activities and Assessments

Natural Selection Lab: 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.
Evidence for Evolution Lab: 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.

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Unit 7: Human and Global Change

Enduring Understanding:

- 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 can challenge the functioning of ecosystems in terms of resources and habitat availability.
- 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.
- 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.
- 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.

Essential Questions:

1. How do ecosystems respond to biological or physical disturbances?
2. How do human activities disrupt an ecosystem?
How does human activity affect the relationship between the Earth System in both positive and negative ways?
What technological solution is there to reduce the impact of human activity on the natural system in order to restore stability?
3. How is biodiversity important for sustaining all life on Earth?

Time Frame: 4 weeks

Topics:

- Environmental Impacts
- Human Activities
- Solutions

Student Learning Expectations:

Students will be able to:

- Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.

- Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity.
- 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
- Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity
- Evaluate or refine a technological solution that reduces impacts of human activities on natural system in order to restore stability and or biodiversity of the ecosystem as well as prevent their recurrences
- Predict how human activity affects the relationships between Earth System in both positive and negative ways.

Standards

BI-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
BI-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
BI-ESS3-6: Use computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Key Terms/Vocabulary

acid rain mass wasting deforestation invasive species pollution urban planning endangered/threatened species fossil fuels Natural resources	sustainability agricultural efficiency captive breeding programs habitat restoration pollution mitigation ecotourism energy conservation climate change biodiversity anthropogenic

Activities and Assessments

Human Activity Project: students will research the before and after affects of a natural disaster or ecological event. Students will aggregate their information into a presentation that can be shared with peers. A gallery walk can be done to view posters of specific natural disasters and resources. Quick writes, Exit tickets, Lab analysis, Graphs, Data Presentations, Card Sort(Vocabulary), Digital Lab notebook, Quizlet, QRC Codes, Lesson Quiz, Scientific Investigations, Teacher/Student Models, Student Response Questions, Concept Map(Vocabulary)

Materials and Resources

Lesson plan, Textbook, Videos, Chart paper, Paper/pencils/ pens/ coloring pencils, Science-Consortium, Discovery Channel Interactive Science Journal for students, Science News, Kahoots, QRC Codes Edpuzzle.com, On-line Virtual Labs , PHet, The Physics classroom.com, Labster, chemcollective.org, openstax.org, Periodic Table, Khan Academy, Apex, Edgenuity

Extended Activities and Resources

(The following activities can be modified to fit into each Biology unit of study.)

Website Resources:

https://serendipstudio.org/sci_edu/waldron/

https://www.exploratorium.edu/snacks/subject/biology

Reading Activities:

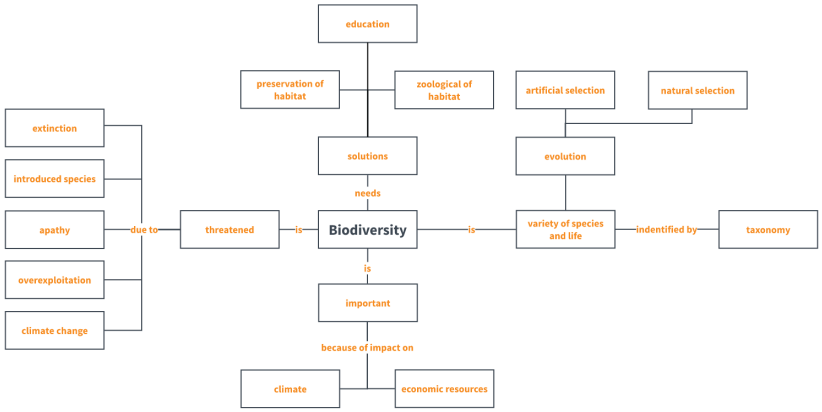
KWL

As students read text, have students use KWL format to write down what they know about the topic already, what they want to know about the topic, and after reading, have students write down what they learned. This strategy can best be used for

Know	Want to know	Learned

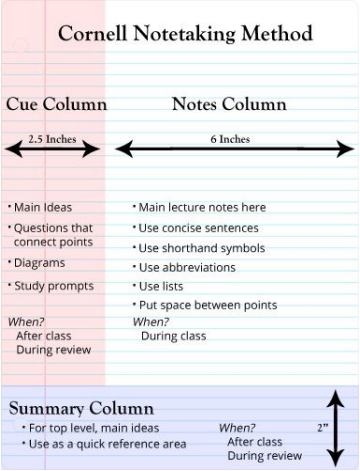
Concept Mapping

As students start to make sense and are exposed to concepts and terms, have students make connections between topics through concept and mind mapping. For example:



Cornell Notes:

For chapters that introduce a lot of new terminology and concepts, have students take notes using the Cornell Format.



Textbook Bingo:

Create a grid with questions from the chapter. Have students fill in the grid as they read. After reading, call on students to share their answers. For example:

An example of monoculture:	An example of a renewable resource:	An example of a nonrenewable resource:
How can sustainable development minimize the negative impact of human activities?	What ecological services do wetlands provide:	How do our daily activities affect the environment?

Explain why agriculture near Helena is an example of monoculture.	Draw a diagram or picture to summarize the chapter.	What is your key take-away from the chapter.

Graphic Organizers:
Use Venn Diagrams to compare and contrast terms (abiotic vs. biotic, renewable vs. nonrenewable, sexual vs. asexual reproduction, etc.)

Properties of Water Lab Stations:
Set up lab stations for students to observe adhesion, cohesion and capillary action.
Adhesion: Allow students to explore using a dropper of water to place water droplets on different materials. These materials can include paper, tin foil, wax paper, their skin, plastic bags, etc. Have students write down their observations.
Cohesion: Draw a maze on a piece of wax paper. Give students a droplet of water and a toothpick to move the water droplet through the maze. Have students write observations, and explain why the water droplets stuck together and stuck to the toothpick.
Drops on a Penny: Have students use a water dropper to place drops of water on the face of a penny. Have students count how many drops they can place on the penny. Have students write down observations.

Capillary Action: Give students two 2” strips of paper towel. Have students draw a line in magic marker on each paper towel strip. Have the students place the bottom of a paper towel strip in water, and the bottom of the other strip in oil. Have students measure the distance the magic marker climbs up the paper towel for both strips. Have students write observations, and explain what they are seeing.

Making Bread with Yeast:
Use and modify a bread recipe to test the effect of the amount of yeast on bread. Have students bake one loaf of bread without yeast. Have students make observations throughout the process, and measure the height (or volume) of the different bread loaves as they rise.
This experiment will help show the importance of enzymes and catalysts in nature. Page 50-53 of the textbook can supplement the lesson.

Below links can be useful in teaching enzymes:
https://serendipstudio.org/sci_edu/waldron/pdf/IsYeastAliveProtocol.pdf
https://serendipstudio.org/sci_edu/waldron/pdf/EnzymeProtocol.pdf

Biome Project: Have students build a model of a biome in a shoebox. Students should each do a different biome so that they can present to the class. Students should include the plants, animals, and geographic features of their biome. Have students label the biotic and abiotic components of their biome. Have students label the different consumers in their biomes (herbivores, omnivores, scavengers, decomposers, etc.). Have students include maps of where their biome is located. If time, have students write an essay about an animal or plant within their biome. Have students go around the classroom to look at the different biomes and write observations about each biome, so that they can learn from their peers. Chapter 3.1, and Chapter 4.4 can supplement the lesson.

Ecosystem in a 2L
Have students read about Energy flow and cycles of matter in chapters 3.3 and 3.4. Provide students with a 2L soda bottle, a fish (bait shop minnows work well), and abiotic and biotic factors to put inside the bottle. This can include sand, aquatic plants, water snails, algae, dirt, etc. Allow students to make their own ecosystems and choose what to put inside the bottle. Close the lid on the 2L soda bottle. Have students make observations about their ecosystem in a bottle for the next 10 days. Have students create their own diagrams of the nutrient cycles within their bottle (carbon cycle, nitrogen cycle, etc.).
Field Trip Idea take students to Storm Creek lake to collect their own materials.

Greenhouse Effect:
Provide students with two beakers. Have students put soil, rocks, etc in the bottom of each beaker. Place a thermometer in each beaker. Have students cover one beaker with plastic wrap and leave the other beaker uncovered. Bring students outside on a warm day to take the temperature of each beaker every 5 minutes. While students are waiting to record temperature, have student read National Geographic Greenhouse Effect Article. After 30 minutes, have students create graphs and write a summary about how their experiment models the greenhouse effect. Have them extend analogies for what the plastic wrap represents. Have students write about the importance of limiting GHGs.

Niche and Community:
Have each student in the class pick an animal in the local ecosystem. Examples could include coyote, rabbit, fox, deer, raccoon, mosquito, frog, water moccasin, etc. Have students create business cards that showcase their role in the ecosystem, where they can be found, and who will eat them. Based on this resource.
As a class, present the students with a limited amount of resources. Have students who would consume that resource raise their hand. Have students compete for the resource, and explain what would happen if they did not get their desired resources.
Extend the concept of niche: Have students write a one page personal essay about their niche in the community-- explaining their unique role in the community. For example, their role on the basketball team, their role in their family, and what they do for the community.

Patterns of Succession:
Have students read Ch 4.3. Take students on a walk in the woods behind Central. Have students make observations of the area and determine places of primary, and secondary succession. Take students to the concrete slab by the field. Have students make observations and describe how nature will slowly return to the concrete slab.

Populations:
Have students watch the video: https://www.youtube.com/watch?v=PUwmA3Q0_OE&t=236s
After viewing the video, have students explain how the population of earth grew, where it grew the fastest, and what caused population growth to increase in rate.
Introduce the concept of Age-Structure diagrams and population graphs with textbook Ch. 5.3. Set up lab stations by naming each table a country. (i.e. Guatemala, Japan, United States, China, Mexico, etc.) Place a print-out of the age-structure diagram on each table: https://www.indexmundi.com/factbook/countries has age structure diagrams and information for each country to print out. Have students go from table to table and create an explanation for why the age distribution is structured the way it is for each country.

Acid Rain Lab:
Have students watch the video linked here: https://www.nationalgeographic.com/environment/article/acid-rain and read the article. Create a flow-chart of acid rain formation.

Provide students with sea shells, rocks, plants, leaves, etc. Have students drop a low concentration of sulfuric acid on the substances. Have them write their observations. Have students write a summary about how pollution in the air can affect the environment.

Carbon Footprint:

Have students calculate their carbon footprint: https://www.conservation.org/carbon-footprint-calculator#/. Have students make a poster of the things affecting their carbon footprint by drawing their foot, and then drawing and labeling the ways in which they have a negative impact on the environment.
Outside of the footprint on the poster, have students write ways in which they can mitigate their carbon footprint.
Have students present their projects to the class and compare ways they can lessen their impact on the environment.

Cells:
Students should read Ch 7.1 and 7.2. Split the class in half and have half of students make plant cell models and half of the class make models of animal cells. (Students have used foam balls, made cakes, made shoe boxes, etc.) Have students compare and contrast their cell models and explain the differences between plant and animal cells.

Egg Osmosis Lab:
Have students read chapter 7.3. Have students draw diagrams of isotonic and hypotonic, and hypertonic solutions.
https://untamedscience.com/biology/cells/osmosis/
After completing the lab, have students draw diagrams and explain how water was moved through the egg.

Gummy Bear Osmosis Lab:
Provide students with materials (water, gummy bears, salt, sugar, corn syrup, etc) Have students work in groups to see who can make the largest gummy bear using osmosis. Next class period have students measure their bears and explain why certain bears grew larger.

Cell Surface Area:
Students typically struggle with the concept of surface area and volume. It may be necessary to complete the quicklab on page 275 of the textbook. Lab project can be linked here: https://www.exploratorium.edu/snacks/agar-cell-diffusion

Cell Division:
Onion Cells lab: https://www.lcps.org/cms/lib/VA01000195/Centricity/Domain/3725/LAB%20Cell%20Division%20Lab.pdf
Have students make a diagram/flow chart of cell division

Homeostasis Lab: Use the lab linked to have students measure how their body compensates for activity. Have students make graphs of their heart rate over time.

Photosynthesis:

Present students with a seed from a tree (such as an acorn, a pine seed, etc.) Show students a picture of a large tree, or take students outside to view a tree. Have students write their guesses about how the small seed turns into a big tree. Ask them: where do trees get their mass? What are trees made of? Where does that *stuff* come from? Have students write down observations of the tree and the seed. Have students write down questions that they have.

→ The following labs can be done at the same time over the course of 2-3 weeks ←

Does it come from the soil?
Have students design a lab to test if the mass of a plant come from the soil. This can be done by giving students seeds and dirt and having them weigh the mass of the dirt as the plant grows, or can be done by giving students seed and no dirt, and having students weigh the seedlings as they grow. The conclusion that students should discover is that mass of a plant does NOT come from the soil.

Have students watch: https://www.bbc.co.uk/bitesize/clips/zpgb4wx
Have students read: https://gmsciencein.com/2019/06/07/helmont/
Students can watch this video: https://www.youtube.com/watch?v=2KZb2_vcNTg and then summarize their initial beliefs about where trees get their mass, and then explain their new understanding.

Does it come from the water?
Have students design a lab to test if the mass of a plant comes from the water. This can be done…. how?

Effect of sunlight.
Have students grow plants as a class. Cover one group of plants with plastic wrap, one group of plants with green plastic wrap, and one group of plants with tin foil. Have students write observations of the plants each day. Have students read Chapter 8.2 and write a summary of their observations using the vocabulary words from the text.

What Do Plants Produce?
Have students complete the quick lab on page 234. Aquatic plants can be collected from local lakes, or they can be purchased from PetsMart.

End of Unit:
Present students with the equation for photosynthesis. Have students explain the equation and how plants grow with examples from what they have learned and seen in the lab activities. This should be done as an essay or a poster project presentation to REALLY summarize the learning.

Genetics:

Gregor Mendel Pea Plants:
Give students a sample of peas. Have students make observations-- some of the peas should be wrinkly, some should be yellow, and some should be green. These seed packs can be purchased at Walmart or H&M for $2.
Have students plant the seeds and take height measurements each day of their seed as well as observations.
Have the students read chapter 11.1 and 11.2 and take notes on key terms using Cornell notes.

Probability:
Have students write 3-5 sentences about what they already know about probability and and percentages. Give students pennies have them determine probabilities of various scenarios. (i.e. 2 pennies both landing on heads, one penny being heads, one being tails, etc.). Have students test out these probabilities, and then solve the probabilities mathematically. Introduce the concept of Punnet squares, and connect the lesson to the pea plants.

Superhero Punnett Square Project:
https://www.dentonisd.org/cms/lib/TX21000245/Centricity/Domain/9049/superhero%20genetics%20project%202017.pdf

Personal Punnett Square Project:
Have students explain why they look the way they do based on the traits of their parents. Traits can include eye shape, ear lobe attachment, skin color, eye color, height, body shape, hair, widows peak, etc. Have students include pictures of themselves, and any siblings to describe how they look compared to their siblings. If students do not know their parent or what their parent looks like, have them complete for a celebrity couple, or work backwards to guess what parent might have looked like, or determine what their child would look like, or as seen fit.

Meiosis and Mitosis:
Have students read the textbook and create a Venn diagram about the two terms. Have students draw and label a diagram of each term and explain both processes in their own words.

Strawberry DNA Extraction:
https://www.genome.gov/Pages/Education/Modules/StrawberryExtractionInstructions.pdf
Have students work in pairs to extract DNA. Have students look at DNA under the microscope. Have students write down their observations of the lab and of what they saw under the microscope.

DNA Models:
Have students create models of DNA. This can be done as pipe cleaner bracelets:
https://www.noble.org/globalassets/docs/noble-academy/lessons/dna-bracelet.pdf

Or done as paper and stickers, or done as just pipe cleaners and beads: https://www.palebluemarbles.com/build-a-dna-model-with-pipe-cleaners/
https://www.coriell.org/1/NHGRI/National-DNA-Day/Previous-DNA-Day-Activities

Human Heredity:
As a class make a list of potential traits to observe in people. The link: https://learn.genetics.utah.edu/content/basics/observable/ has examples of observable traits. Have students make observations of their classmates. Pair students up in groups and have students list each other's observable traits.

Lactose intolerance:
Have students complete the lab to learn about how and why some students are lactose intolerant.
https://www.exploratorium.edu/snacks/milk-makes-me-sick

PTC Testing:
https://www.genome.gov/Pages/Education/Modules/PTCTasteTestActivity.pdf
Have students explain why they were able or unable to taste the paper. Have students explain how this was a proper scientific experiment (ie. list the control, IV, DV, etc.) Have students graph the results of the class.

Observations of Creatures:
Take students outside to collect creatures and specimens. Have each group collect a cup full of critters/ plants, etc. Have students in each group make observations and then switch tables to observe another tables' specimens. This activity modeled from:
https://www.exploratorium.edu/snacks/critter-comparison

Darwin
You may steal this lesson plan from PBS:
https://myarkansaspbs.pbslearningmedia.org/resource/hs11.global.ancient.earl.lpintroevol/introduction-to-evolution-how-did-we-get-here/

Have students partner read: https://www.nationalgeographic.org/encyclopedia/theory-evolution/ and write down notes as they read.

Natural Selection:
Have students complete in groups the activity: https://www.exploratorium.edu/snacks/bean-counter-evolution
After completing the activity, have students write a summary of the activity and how it relates to natural selection.

Evolution Project:
Have students complete the Evolution Poster Project:
https://docs.google.com/document/d/18mIPTf2INzb1Cr7pnOeH6zIfLGDjHzeAX9LoMYo1ITU/edit?usp=sharing and present their findings to the class. This can be done as a 9 weeks final project.

Plants:
Have students conduct a plant dissection labs such as: https://www.bgci.org/files/Worldwide/US_Files/Lesson%203.pdf
Have the students write a summary about what can be learned through dissections and why dissection is a useful tool. Have students draw and label a diagram of plant and all of the parts within a plant.

Extension:
Have each student choose a plant local to Helena and conduct a dissection of the plant. Have students research the structure and function of the plant, describe how it reproduces, and its role in the ecosystem. Have students present their projects to the class.