



Northern York County School District

Curriculum Overview

Course: Biology	
Grade Level: 9/10	
Development/Revision Date: January 2025	Length of Time: 180 Days
Course Description: <p>In this course, students will delve into the intricate relationships between DNA structure, protein function, and the essential processes that sustain life within organisms. Through hands-on investigations and modeling activities, students will construct evidence-based explanations on how DNA determines protein structure, the hierarchical organization of cells and systems, and the mechanisms of cellular division and differentiation. Emphasis will be placed on developing models to illustrate feedback mechanisms that maintain homeostasis. Additionally, students will explore the vital roles of photosynthesis and cellular respiration in energy transformation and the cycling of carbon through various Earth systems. Students will use mathematical representations to analyze the flow of energy and matter in ecosystems, as well as the factors affecting biodiversity and carrying capacity.</p> <p>The course will also engage students in evaluating the impacts of human activities on the environment and biodiversity, promoting critical thinking about sustainable solutions. Through collaborative projects, students will analyze evidence for natural selection and adaptation, investigate the genetic variations that arise from various processes, and explore how changing environmental conditions can lead to shifts in species populations. Ultimately, students will be equipped with a comprehensive understanding of the molecular and ecological principles that govern life, fostering a deeper appreciation for the interconnectedness of biological systems.</p>	
Course Objectives: <ul style="list-style-type: none">• Students will explain how the structure of DNA determines the formation of proteins and how these proteins carry out essential life functions within specialized cells.• Students will develop and utilize models to illustrate the hierarchical organization of systems within multicellular organisms, demonstrating how these systems work together to perform specific functions.• Students will plan and conduct investigations to provide evidence of how feedback mechanisms maintain homeostasis within living systems, even as external conditions fluctuate.• Students will use models to illustrate the processes of cellular division (mitosis) and differentiation and their roles in producing and maintaining complex organisms.• Students will illustrate how photosynthesis converts light energy into stored chemical energy and how cellular respiration transfers energy through the breakdown of food molecules.• Students will construct explanations based on evidence of how carbon, hydrogen, and oxygen from sugar molecules combine to form amino acids and other large carbon-based molecules.	

- Students will use mathematical representations to support claims about the cycling of matter and energy flow among organisms in ecosystems and factors affecting their carrying capacities.
- Students will analyze the evidence regarding the factors that influence biodiversity and population dynamics in various ecosystems.
- Students will design, evaluate, and refine solutions to mitigate the impacts of human activities on the environment and biodiversity.
- Students will construct explanations for how natural selection drives adaptation and influences the emergence and extinction of species over time.
- Students will apply statistical concepts to explain the variation and distribution of traits within populations and support claims about genetic variation and common ancestry.
- Students will effectively communicate scientific information regarding molecular biology and ecological principles, including evidence of evolution and the interconnectedness of life systems.

Related Standards:

Pennsylvania STEELS State Standards

- **3.1.9-12.A** 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.
- **3.1.9-12.B** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- **3.1.9-12.C** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **3.1.9-12.D** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- **3.1.9-12.E** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- **3.1.9-12.F** 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.
- **3.1.9-12.G** 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.
- **3.1.9-12.H** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- **3.1.9-12.I** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- **3.1.9-12.J** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- **3.1.9-12.K** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- **3.1.9-12.L** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **3.1.9-12.M** 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.
- **3.1.9-12.N** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **3.1.9-12.O** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

- **3.1.9-12.P** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- **3.1.9-12.Q** 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.
- **3.1.9-12.R** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- **3.1.9-12.S** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- **3.1.9-12.T** 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.
- **3.1.9-12.U** 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.
- **3.1.9-12.V** Create or revise a simulation to test a solution to mitigate the adverse impacts of human activity on biodiversity.
- **3.1.9-12.W** Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- **3.1.9-12.X** 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.
- **3.3.9-12.N** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Units:

- Introduction to Biology
- Biochemistry
- Cytology
- Bioenergetics
- Cell Cycles
- Genetics
- Evolution
- **Ecology (Integrated in the above units)

Concepts:

- **STRUCTURE AND FUNCTION** - Specialized cell systems in organisms perform essential functions, containing DNA with genes that instruct protein formation, while hierarchical organization and feedback mechanisms help maintain internal balance and adapt to external changes.
- **GROWTH AND DEVELOPMENT OF ORGANISMS** - Multicellular organisms grow through mitosis, where a single fertilized egg divides to produce identical cells, forming complex tissues and organs that work together to support the organism.
- **ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS** - Photosynthesis converts light energy into stored chemical energy, producing sugars and oxygen, while cellular respiration transfers energy through the breakdown of food molecules, enabling the formation of complex molecules necessary for new cells.
- **CYCLES OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS** - Plants and algae are at the base of the food web, with energy and matter transferred inefficiently to higher levels, resulting in fewer organisms above, while photosynthesis and cellular respiration are crucial for the carbon cycle, enabling carbon exchange among different Earth systems.

- **INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS** - Ecosystems have carrying capacities that limit the number of organisms they can support, influenced by resource availability and challenges like predation and competition, which ultimately affects species abundance.
- **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.
- **ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE** - Ecosystems remain stable through complex interactions and resilience to minor disturbances, but extreme changes or human-induced disruptions can threaten their functioning and species survival.
- **BIODIVERSITY AND HUMANS** - Biodiversity, which is essential for ecosystem functioning and human well-being, is enhanced by speciation and diminished by extinction, with human activities posing significant threats through overpopulation, habitat destruction, pollution, and climate change, making its preservation vital for sustaining life on Earth.
- **SOCIAL INTERACTIONS AND GROUP BEHAVIOR** - Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
- **INHERITANCE OF TRAITS** - Each chromosome is made up of a long DNA molecule that carries genes responsible for an organism's characteristics, with all cells containing the same genetic material but expressing different genes due to regulation, while some DNA segments have known functions and others do not.
- **VARIATION OF TRAITS** - Sexual reproduction introduces genetic variation through chromosome swapping during meiosis and mutations caused by replication errors or environmental factors, with both genetic and environmental influences shaping the variation and distribution of traits in a population.
- **EVIDENCE OF COMMON ANCESTRY AND DIVERSITY** - Genetic information, along with the fossil record, provides evidence of evolution by highlighting DNA sequence variations and overlaps among species, as well as similarities in amino acid sequences, anatomy, and embryology, which indicate branching lines of descent.
- **NATURAL SELECTION** - Natural selection requires genetic variation among organisms in a population and differences in trait expression that affect individual performance, leading to the increased prevalence of traits that enhance survival.
- **ADAPTATION** - Evolution results from the interplay of a species' reproductive potential, genetic variation, resource competition, and natural selection, leading to adaptations that allow some organisms to thrive in changing environments while others may face extinction.

Competencies:

- Investigate materials and structures to analyze their properties, components, and connections to understand function and solve problems.
- Utilize models (physical, mathematical, computer) to simulate systems and interactions involving energy, matter, and information flows at various scales.
- Evaluate the effects of feedback (positive or negative) on the stability of systems.
- Describe energy and matter changes within a system in terms of their flows into, out of, and within the system.
- Explain that energy cannot be created or destroyed but moves between locations, objects, fields, or systems.
- Assess the significance of phenomena based on the scale, proportion, and quantity at which they occur.
- Analyze how energy drives the cycling of matter within and between systems.
- Apply the concept of orders of magnitude to relate models at different scales.
- Construct explanations of changes and stability in various scientific contexts.
- Gather empirical evidence to differentiate between cause and correlation, making claims about specific causes and effects.
- Employ algebraic thinking to examine scientific data and predict how changes in one variable affect another (e.g., linear vs. exponential growth).

- Investigate the interplay between technological advances and scientific progress, as well as their reciprocal influences.
- Explore the reciprocal influences between science, engineering, and society.
- Observe different patterns across scales in a system and use them to provide evidence for causality in explaining phenomena.
- Assume that natural laws operate consistently over time, underpinning scientific knowledge.
- Evaluate the evidence supporting changes and stability in scientific phenomena.

Learning Activities:

- Ask questions and define problems
- Plan and carry out investigations
- Engage in argument from evidence
- Develop and use models
- Analyze and interpret data
- Construct explanations and design solutions
- Obtain, evaluate, and communicate information
- Use math and computational thinking

Performance Tasks:

- Formative lesson assessments such as student discussion, questioning, peer collaborative activities, reflections, teacher observations
- Summative unit assessments and projects

Other Assessment Measures:

The Keystone Biology Exam is an end of course assessment that will be administered as required by applicable Pennsylvania Department of Education regulations.

Textbook/Primary Resource:

Houghton Mifflin Harcourt. (2018). *Science Dimensions*

Supplemental Resource Materials:

- Progress Learning
- Gizmos