Big Idea 4: Interactions of Biological Systems

Content Area: **Science**
Course(s): **Biology AP**
Time Period: **MarApr**
Length: **40 days**
Status: **Published**

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Big Idea 4

"Biological systems interact, and these systems and their interactions possess complex properties."

A.P. Biology

Belleville Board of Education

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Board Approved:Aug 27, 2018

Unit Overview

"All biological systems are composed of parts that interact with each other. These interactions result in characteristics not found in the individual parts alone. In other words, *the whole is greater than the sum of its parts.* All biological systems from the molecular level to the ecosystem level exhibit properties of biocomplexity and diversity. Together, these two properties provide robustness to biological systems, enabling greater resiliency and flexibility to tolerate and respond to changes in the environment. Biological systems with greater complexity and diversity often exhibit an increased capacity to respond to changes in the environment.."

NGSS

SCI.HS-LS2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
SCI.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
SCI.HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
SCI.HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
SCI.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
SCI.HS-LS2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
	Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by

	a star symbol (★).
SCI.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
SCI.HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
	Modeling
	Modeling links classroom mathematics and statistics to everyday life, work, and decision-making. Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions. Quantities and their relationships in physical, economic, public policy, social, and everyday situations can be modeled using mathematical and statistical methods. When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and comparing predictions with data.
SCI.HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
SCI.HS	Interdependent Relationships in Ecosystems
SCI.HS-LS2-6	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Exit Skills

By the end of Big Idea 4, A.P. Biology Students should be able to:

- The student is able to apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways.
- The student is able to apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.
- The student is able to use visual representations to analyze situations or solve problems qualitatively to illustrate how interactions among living systems and with their environment result in the movement of matter and energy.
- The student is able to analyze data to identify how molecular interactions affect structure and function.
- The student is able to use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.
- The student is able to use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance.

Enduring Understanding

Enduring understanding 3.A: Heritable information provides for continuity of life.

Enduring understanding 3.B: Expression of genetic information involves cellular and molecular mechanisms.

Enduring understanding 3.C: The processing of genetic information is imperfect and is a source of genetic variation.

Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals.

Enduring understanding 3.E: Transmission of information results in changes within and between biological systems.

Essential Questions

Essential knowledge 3.A.1: In which organisms is RNA not DNA the primary source of heritable information?

Essential knowledge 3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include what 4 processes?

Essential knowledge 3.A.3: Which inheritance theory provides an understanding of the pattern of passage (transmission) of genes from parent to offspring?

Essential knowledge 3.A.4: The inheritance pattern of many traits cannot be explained by what type of inheritance pattern?

Essential knowledge 3.B.1: Gene regulation results in differential gene expression, and what does it then lead to?

Essential knowledge 3.B.2: Name specific intercellular and intracellular signal transmissions that mediate gene expression:

Essential knowledge 3.C.1: Changes in genotype can result in changes to what other genetic characteristic?

Essential knowledge 3.C.2: Biological systems have multiple processes, and what do they serve to increase?

Essential knowledge 3.C.3: Viral replication results in genetic variation, but what can viral infection introduce into hosts?

Essential knowledge 3.D.1: What do Cell communication processes share that reflect a shared evolutionary history?

Essential knowledge 3.D.2: How do Cells communicate with each other locally vs Long distance?

Essential knowledge 3.D.3: Signal transduction pathways link signal reception with cellular response.

Essential knowledge 3.D.4: Changes in signal transduction pathways can alter which responses?

Essential knowledge 3.E.1: Individuals can act on information and do what with it eventually?

Essential knowledge 3.E.2: Animals have nervous systems that detect, transmit, and integrate, what 3 things?

Learning Objectives

- The student is able to explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past.
- The student is able to predict consequences of human actions on both local and global ecosystems.
- The student is able to construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.
- The student is able to construct explanations of the influence of environmental factors on the phenotype of an organism.
- The student is able to predict the effects of a change in an environmental factor on gene expression and the resulting phenotype of an organism.
- The student is able to use evidence to justify a claim that a variety of phenotypic responses to a single environmental factor can result from different genotypes within the population.
- The student is able to use theories and models to make scientific claims and/ or predictions about the effects of variation within populations on survival and fitness.
- The student is able to make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.

- The student is able to explain the connection between the sequence and the subcomponents of a biological polymer and its properties.
- The student is able to refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer.
- The student is able to use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.
- The student is able to make a prediction about the interactions of subcellular organelles. [See SP 6.4; Essential knowledge 4.A.2] Learning objective 4.5 The student is able to construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
- The student is able to use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.
- The student is able to refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs.
- The student is able to evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts.
- The student is able to predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s). Essential knowledge
- The student is able to refine representations and models to illustrate biocomplexity due to interactions of the constituent parts.
- The student is able to justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities.
- The student is able to predict the effects of a change of matter or energy availability on communities.
- The student is able to predict the effects of a change in the community's populations on the community.

Interdisciplinary Connections

LA.11-12.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.
MA.9-12.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
TECH.8.1.12	All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
MA.9-12.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.9-12.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
LA.11-12.WHST.11-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
LA.11-12.WHST.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.11-12.WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
LA.11-12.WHST.11-12.9	Draw evidence from informational texts to support analysis, reflection, and research.
LA.11-12.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
HPE.2.1.12	All students will acquire health promotion concepts and skills to support a healthy, active lifestyle.
HPE.2.4.12	All students will acquire knowledge about the physical, emotional, and social aspects of human relationships and sexuality and apply these concepts to support a healthy, active lifestyle.

Alignment to 21st Century Skills & Technology

Key SUBJECTS AND 21st CENTURY THEMES

Mastery of key subjects and 21st century themes is essential for all students in the 21stcentury.

Key subjects include:

- English, reading or language arts
- World languages
- Arts
- Mathematics
- Economics
- Science
- Geography
- History
- Government and Civics

21st Century/Interdisciplinary Themes

- Environmental Literacy
- Global Awareness
- Health Literacy

21st Century Skills

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

Technology Infusion

- MS Powerpoint
- Google Drive
- Prezi
- Khan Academy
- Ted Talks
- Ted- ED
- Bozeman Science (Youtube)
- Windows Movie Maker
- Time Lapse
- Online Flow Chart maker
- MS Excel: graphs, charts, calculations, equations

Differentiation

As a Reminder:

The basis of good differentiation in a lesson lies in differentiating by content, process, and/or product.

Resources:

- NJDOE: Instructional Supports and Scaffolds for Success in Implementing the Common Core State

Standards http://www.state.nj.us/education/modelcurriculum/success/math/k2/

Special Education

- assistive technology
- computer or electronic device utilizes
- multi-sensory presentation
- preferential seating

ELL

- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing students to correct errors (looking for understanding)
- providing study guides

Intervention Strategies

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- providing study guides
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using videos, illustrations, pictures, and drawings to explain or clarify

Evidence of Student Learning-CFU's

- Common benchmarks: Actual AP Test Questions, released by College Board
- Create a Multimedia Presentation
- Evaluation rubrics
- Outline
- Quizzes
- Self- assessments
- Socratic Seminar
- Study Guide
- Teacher Observation Checklist

- Top 10 List
- Unit tests

Primary Resources

Pearson: AP Biology, 8th ed.

Campbell, N.A. and Reece, J.B. - California - Pearson, San Francisco - 2008

Pearson: Test Prep Series for AP Biology

Holtzclaw, F.W. , Holtclaw, T.K. - New Jersey - Pearson, Upper Saddle River - 2014

College Board: AP Biology Investigative Labs: An inquiry based approach

The College Board, New York, N.Y. - 2012

Ancillary Resources

- PearsonEasyBridge.com worksheets for review
- Chrome Book Projects/ Research/ Analysis
- Google Classroom
- Barron's Review Flash Cards