

Big Idea 3: Living Systems Utilize Information

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Big Idea 3

Department of Curriculum and Instruction



Belleville Public Schools

Curriculum Guide

Big Idea 3

"Living systems store, retrieve, transmit and respond to information essential to life processes."

A.P. Biology

Belleville Board of Education

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Unit Overview

"Genetic information provides for continuity of life and, in most cases, this information is passed from parent to offspring via DNA. The double-stranded structure of DNA provides a simple and elegant solution for the transmission of heritable information to the next generation; by using each strand as a template, existing information can be preserved and duplicated with high fidelity within the replication process. However, the process of replication is imperfect, and errors occur through chemical instability and environmental impacts. Random changes in DNA nucleotide sequences lead to heritable mutations if they are not repaired. To protect against changes in the original sequence, cells have multiple mechanisms to correct errors. Despite the action of repair enzymes, some mutations are not corrected and are passed to subsequent generations. Changes in a nucleotide sequence, if present in a protein-coding region, can change the amino acid sequence of the polypeptide. In other cases, mutations can alter levels of gene expression or simply be silent. In order for information in DNA to direct cellular processes, information must be transcribed and, in many cases, translated. The products of transcription and translation play an important role in determining metabolism, i.e., cellular activities and phenotypes. Biotechnology makes it possible to directly engineer heritable changes in cells to yield novel protein products."

NGSS

SCI.HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. 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.
SCI.HS-LS3-2	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.

SCI.HS-LS3-1

Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

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

Inheritance and Variation of Traits

SCI.HS-LS3-3

Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

SCI.HS-LS1-3

Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

SCI.HS

Structure and Function

Exit Skills

By the end of Big Idea 3, A.P. Biology Students should be able to:

- The student is able to construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, RNA are the primary sources of heritable information.
- The student is able to construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization.
- The student is able to represent the connection between meiosis and increased genetic diversity necessary for evolution.
- The student is able to evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another generation through mitosis, or meiosis followed by fertilization.
- The student is able to construct a representation that connects the process of meiosis to the passage of traits from parent to offspring.
- The student is able to pose questions about ethical, social or medical issues surrounding human genetic disorders.
- The student is able to apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets.
- The student can create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
- The student is able to create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
- The student is able to describe a model that expresses key elements to show how change in signal transduction can alter cellular response.
- The student is able to create a visual representation of complex nervous systems to describe/explain how these systems detect external and internal signals, transmit and integrate information, and produce responses.
- The student is able to create a visual representation to describe how the vertebrate brain integrates information to produce a response.

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 construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, RNA are the primary sources of heritable information.
- The student is able to justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.
- The student is able to describe representations and models that illustrate how genetic information is copied for transmission between generations.
- The student is able to describe representations and models illustrating how genetic information is translated into polypeptides.
- The student can explain how heritable information can be manipulated using common technologies.
- The student can predict how a change in a specific DNA or RNA sequence can result in changes in gene expression.
- The student can make predictions about natural phenomena occurring during the cell cycle.
- The student can describe the events that occur in the cell cycle.
- The student is able to construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization.
- The student is able to represent the connection between meiosis and increased genetic diversity necessary for evolution.
- The student is able to evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another generation through mitosis, or meiosis followed by fertilization.
- The student is able to describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.
- The student is able to describe the connection between the regulation of gene expression and observed differences between individuals in a population.
- The student is able to explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.
- The student can use representations to describe how gene regulation influences cell products and function.
- The student is able to explain how signal pathways mediate gene expression, including how this process can affect protein production.
- The student is able to construct an explanation, based on scientific theories and models, about how nervous systems detect external and internal signals, transmit and integrate information, and produce responses.
- The student is able to describe how nervous systems detect external and internal signals.
- The student is able to describe how nervous systems transmit information.
- The student is able to describe how the vertebrate brain integrates information to produce a response.
- The student is able to create a visual representation of complex nervous systems to describe/explain how these systems detect external and internal signals, transmit and integrate information, and produce responses.
- The student is able to create a visual representation to describe how nervous systems detect external and internal signals.
- The student is able to create a visual representation to describe how nervous systems transmit information.

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 21st century.

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 clarify
- 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