Passaic County Technical Institute Wayne, NJ

AP Biology

Course # 0174

5 Credits

August 2019

I. Course Description:

The AP Biology course is designed to be the equivalent of a college-level introductory biology course. The intent of the course is to expose students to higher level biological principles, concepts, and skills and allow them the opportunity to apply their knowledge to real-life applications. Rather than learning from a micro level outward, students learn from a macro level inward. Students are also expected to learn not by memorization of facts, but through content and concept application via the AP Biology science practices. The syllabus for this course is designed by the College Board. In the revised AP Biology course, the teacher serves as the facilitator while the students develop as independent thinkers and learners, especially through laboratory investigations. Many concepts that are considered prerequisite knowledge for the course can be reviewed as home study using rich resources such as assigned websites, WebQuests, and journal articles. In class, students are given opportunities to learn and apply their knowledge through the process of inquiry rather than learning from lectures and/or prescribed lab protocols. A sense of wonder and use of original thought are fostered as students are encouraged to extend their learning via scaffolded conceptual understandings and open inquiry. The learning process in the AP Biology course should be rich and impactful. When a student completes the course, he or she should be prepared to do well on the AP Exam as well as in the sequent course in a college or university setting.

II. Units:

<table>
<tr><th>Content Area:</th><th>AP Biology</th><th>Grade(s)</th><th>11,12</th></tr>
<tr><td>Unit Plan Title:</td><td colspan="3">1. Chemistry of Life</td></tr>
<tr><td colspan="4">Learning Objectives *</td></tr>
<tr><td colspan="4">SYI-1. A Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function
ENE-1. A Describe the composition of macromolecules required by living organisms
SYI-1. B Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules
SYN-1. C Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecules
IST- 1. A Describe the structural similarities and differences between DNA and RNA
*from AP BIOLOGY</td></tr>
</table>

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or	**LS1.A: Structure and Function** (pp. 143-145, NRC, 2012) • Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1- 1) (Note: This	**Systems and System Models** (pp. 91-94, NRC, 2012) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2) **Structure and Function** (pp. 96-98, NRC, 2012) • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the

between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** (pp. 67 -71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the	Disciplinary Core Idea is also addressed by HS-LS3-1.) • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1- 2) • • 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. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) **LS1.C: Organization for Matter and Energy Flow in Organisms** (pp. 147-148, NRC, 2012) • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)	structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) - **Connections to Nature of Science** **Scientific Investigations Use a Variety of Methods** (pp. 96-101, Appendix H) Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3) **Systems and System Models** (pp. 91-94, NRC, 2012) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1) **Developing and Using Models** (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7) • Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5) **Using Mathematics and Computational Thinking**(pp. 64-67, NRC, 2012) Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze,	• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7) • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)	

represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6),(HS-LS2-3)		
NJSLS Standard(s) Addressed		

- LS1.A Explain the connection between the sequence and the subcomponents of a biomolecule and its properties. *[Clarification Statement: Emphasis is on the general structural properties that define molecules. Examples include r-groups of amino acids, protein shapes, the nucleotide monomers of DNA and RNA, hydrophilic and hydrophobic regions.] [Assessment Boundary: Assessment does not include identification or the molecular sequence and structure of specific molecules.]*
- 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**.** *[Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]*
- HS-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**.** *[Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]*

Essential Questions (3-5)

- What is the role of energy in the making and breaking of polymers?
- How do living systems transmit information in order to ensure their survival?
- How would living systems function without the polarity of the water molecule?

Anchor Text

Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

Informational Texts (3-5)

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.

Suggested Formative & Summative Assessments

AP Biology exams, Instructor guided laboratory assignments and formal reports, Homework, Student guided laboratory assignments and formal reports, Unit tests, Quizzes and tests on canvas, Laboratory based past exam questions, Projects, General AP Biology free response questions assignment

Resources (websites, Blackboard, documents, etc.)

Canvas Instructure Learning Management System, The College Board Website, Khan's Academy

Labs

Water Lab with Statistics

Suggested Time Frame:	2 Weeks

Content Area:	**AP Biology**	**Grade(s)**	**11,12**
Unit Plan Title:	**2. Cell Structure and Function**		

Learning Objectives

SYI-1. D Describe the structure and/or function of subcellular components and organelles *
SYI-1. E Explain how subcellular components and organelles contribute to the function of the cell
SYI-1. F Describe the structural features of a cell that allow organisms to capture, store, and use energy

ENE-1. B Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment
ENE-1.C Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment
ENE-2. A Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell
ENE-2. B Describe the Fluid Mosaic Model of cell membranes
ENE-2. C Explain how the structure of biological membranes influences selective permeability
ENE-2. D Describe the role of the cell wall in maintaining cell structure and function
ENE-2. E Describe the mechanisms that organisms use to maintain solute and water balance
ENE-2. F Describe the mechanisms that organisms use to transport large molecules across the plasma membrane
ENE-2. G Explain how the structure of a molecule affects its ability to pass through the plasma membrane
ENE-2. H Explain how concentration gradients affect the movement of molecules across membranes
ENE-2. I Explain how osmoregulatory mechanisms contribute to the health and survival of organisms
ENE-2. J Describe the processes that allow ions and other molecules to move across membranes
ENE-2. K Describe the membrane-bound structures of the eukaryotic cell
ENE-2. L Explain how internal membranes and membrane-bound organelles contribute to compartmentalization of eukaryotic cell functions
EVO-1. A Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells
VO-1. B) Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts
*from AP BIOLOGY

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** (pp. 67 -71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)	component of the next level. (HS-LS1- 2) • 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. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)	- **Connections to Nature of Science** **Scientific Investigations Use a Variety of Methods** (pp. 96-101, Appendix H) Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3) **Systems and System Models** (pp. 91-94, NRC, 2012) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5) **Energy and Matter** (pp. 94-96, NRC, 2012) • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) • Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7),(HS-LS2-4) • Energy drives the cycling of matter within and between systems. (HS-LS2-3) - ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** (pp. 96-101, Appendix H) Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3) **Energy and Matter** (pp. 94-96)

Developing and Using Models (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7) • Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5) **Using Mathematics and Computational Thinking**(pp. 64-67, NRC, 2012) Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.		• The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) • Energy drives the cycling of matter within and between systems. (HS-ESS2-3) **Structure and Function** (pp. 96-98) • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5) **Stability and Change** (pp. 98-101) Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

• Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6),(HS-LS2-3)		

NJSLS Standard(s) Addressed

- LS1.A Construct models that explain the movement of molecules across membranes with membrane structure and function. *[Clarification Statement: Emphasis is on the structure of cell membranes, which results in selective permeability; the movement of molecules across them via osmosis, diffusion and active transport maintains dynamic homeostasis.]*
- HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. *[Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water*

delivery, and organism movement in response to neural stimuli. One example a student might develop is an artery depends on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level, or identification of specific cells, tissues and organs.]

- HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis**.** *[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]*

Essential Questions (3-5)

- Defend the origin of eukaryotic cells.
- How do the mechanisms for transport across membranes support energy conservation?
- What are the advantages and disadvantages of cellular compartmentalization?
- How are living systems affected by the presence or absence of subcellular components?

Anchor Text

Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

Informational Texts (3-5)

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Resources (websites, Blackboard, documents, etc.)

Canvas Instructure Learning Management System, The College Board Website, Khan's Academy

Labs

4. Diffusion and Osmosis

Suggested Time Frame:	3 Weeks

Content Area:	**AP Biology**	**Grade(s)**	**11,12**
Unit Plan Title:	**3. Cellular Energetics**		

Learning Objectives

- ENE-1. D Describe the properties of enzymes
- ENE-1. E Explain how enzymes affect the rate of biological reactions
- ENE-1. F Explain how changes to the structure of an enzyme may affect its function
- ENE-1. G Explain how the cellular environment affects enzyme activity
- ENE-1. H Describe the role of energy in living organisms

- ENE-1. I Describe the photosynthetic processes that allow organisms to capture and store energy
- ENE-1. J Explain how cells capture energy from light and transfer it to biological molecules for storage and use
- ENE-1. K Describe the processes that allow organisms to use energy stored in biological macromolecules
- ENE-1. L Explain how cells obtain energy from biological macromolecules in order to power cellular functions
- SYI-3. A Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in difference environments

*from AP BIOLOGY

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• Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
Planning and Carrying Out Investigations (pp. 59-61, NRC, 2012)
Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost,</td>
<td>LS1.C: Organization for Matter and Energy Flow in Organisms (pp. 147-148, NRC, 2012)
• The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)
• The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)
• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)
• As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen</td>
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• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)
Structure and Function (pp. 96-98, NRC, 2012)
• Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)
Stability and Change (pp. 98-101, NRC, 2012)
• Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)
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risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** (pp. 67 -71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1) **Developing and Using Models** (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems	molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** (pp. 152-154, NRC, 2012) • Photosynthesis and cellular respiration • (Including anaerobic processes) provide most of the energy for life processes. (HS-LS2- 3) • Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)	replicability of results, and honest and ethical reporting of findings. (HS-LS1-3) **Systems and System Models** (pp. 91-94, NRC, 2012) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5) **Energy and Matter** (pp. 94-96, NRC, 2012) • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) • Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7),(HS-LS2-4) • Energy drives the cycling of matter within and between systems. (HS-LS2-3) - ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** (pp. 96-101, Appendix H) Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3) **Energy and Matter** (pp. 94-96) • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) • Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

or between components of a system. (HS-LS1-5),(HS-LS1-7) • Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5) **Using Mathematics and Computational Thinking**(pp. 64-67, NRC, 2012) Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with	• Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2- 5) **PS3.D: Energy in Chemical Processes** (pp. 128-130, NRC, 2012) The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS-LS2-5*	

scientific ideas, principles, and theories. • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6),(HS-LS2-3)		

NJSLS Standard(s) Addressed

- HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. *[Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]*
- HS-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. *[Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]*
- HS-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 *[Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]*
- 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. *[Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]*
- HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. *[Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different*

environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

- HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. *[Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]*

Essential Questions (3-5)

- How is energy captured and then used by a living system?
- How do organisms use energy or conserve energy to respond to environmental stimuli?

Anchor Text

Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

Informational Texts (3-5)

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.

Suggested Formative & Summative Assessments

AP Biology exams, Instructor guided laboratory assignments and formal reports, Homework, Student guided laboratory assignments and formal reports, Unit tests, Quizzes and tests on canvas, Laboratory based past exam questions, Projects, General AP Biology free response questions assignment

Resources (websites, Blackboard, documents, etc.)

Canvas Instructure Learning Management System, The College Board Website, Khan's Academy

Labs

5. Photosynthesis; 6. Cellular Respiration; 13. Enzyme Activity

Suggested Time Frame:	4 Weeks

Content Area:	**AP Biology**	**Grade(s)**	**11,12**
Unit Plan Title:	**4. Cell Communication and Cell Cycle**		

Learning Objectives

- IST-3. A Describe the ways that cells can communicate with one another*
- IST-3. B Explain how cells communicate with one another over short and long distances
- IST-3. C Describe the components of a signal transduction pathway
- IST-3. D Describe the role of components of a signal transduction pathway in producing a cellular response
- IST-3. E Describe the role of the environment in eliciting a cellular response
- IST3. F Describe the difference types of cellular responses elicited by a signal transduction pathway

- IST-3. G Explain how a change in the structure of any signaling molecule affects the activity of the signaling pathway
- ENE-3. A Describe positive and/or negative feedback mechanisms
- ENE-3. B Explain how negative feedback helps to maintain homeostasis
- ENE-3.C Explain how positive feedback affects homeostasis
- IST-1. B Describe the events that occur in the cell cycle
- IST-1.C Explain how mitosis results in the transmission of chromosomes from one generation to the next
- IST-1. D Describe the role of checkpoints in regulating the cell cycle
- IST-1. E Describe the effects of disruptions to the cell cycle on the cell or organism

*from AP BIOLOGY

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems (pp. 54-56, NRC, 2012) Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Developing and Using Models** (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4) **Analyzing and Interpreting Data** (pp. 61-63, NRC, 2012) Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing	**LS1.A: Structure and Function** (pp. 143-145, NRC, 2012) • Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1- 1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.) • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1- 2) • • 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. Feedback mechanisms can	**Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2) **Scale, Proportion, and Quantity** (pp. 89-91, NRC, 2012) • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3) **Systems and System Models** (pp. 91-94, NRC, 2012) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4) - -- ***Connections to Nature of Science*** **Science is a Human Endeavor** (Appendix H) Technological advances have influenced the progress of science

more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3) **Engaging in Argument from Evidence** (pp. 71-74, NRC, 2012) Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)	encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)	

NJSLS Standard(s) Addressed

- HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. *[Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]*
- 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. *[Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]*

- 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. *[Clarification Statement: Emphasis is on the cause and effect relationships between DNA, the proteins it codes for, and the resulting traits observed in an organism.] [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]*
- HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms**.** *[Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. One example a student might develop is an artery depends on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level, or identification of specific cells, tissues and organs.]*
- HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. *[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]*

Essential Questions (3-5)

- In what ways do cells use energy to communicate with one another?
- How does the cell cycle aid in the conservation of genetic information?
- Why and in what ways do cells communicate with one another?

Anchor Text

Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

Informational Texts (3-5)

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012**.**

Suggested Formative & Summative Assessments

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Resources (websites, Blackboard, documents, etc.)

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Labs

7: Cell Division: Mitosis and Meiosis

Suggested Time Frame:	3 Weeks

Content Area:	AP Biology	Grade(s)	11,12
Unit Plan Title:	5. Heredity		

Learning Objectives

- IST-1F Explain how meiosis results in the transmission of chromosomes from one generation to the next*
- IST-1. G Describe similarities and/or differences between the phases and outcomes of mitosis and meiosis
- IST-1.H Explain how the process of meiosis generates genetic diversity
- EVO-2. A Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms
- IST-1.1 Explain the inheritance of genes and traits as described by Mendel's Laws
- IST-1. J Explain deviations from Mendel's model of the inheritance of traits
- SYI-3. B Explain how the same genotype can result in multiple phenotypes under different environmental conditions
- SYI-3.C Explain how chromosomal inheritance generates genetic variation in sexual reproduction

*from AP BIOLOGY

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems (pp. 54-56, NRC, 2012) Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Developing and Using Models** (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4)	**LS1.A: Structure and Function** (pp. 143-145, NRC, 2012) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.) **LS1.B: Growth and Development of Organisms** (pp. 145-147, NRC, 2012) • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce	**Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2) **Scale, Proportion, and Quantity** (pp. 89-91, NRC, 2012) • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3) **Systems and System Models** (pp. 91-94, NRC, 2012) • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4) - -- ***Connections to Nature of Science*** **Science is a Human Endeavor** (Appendix H) • Technological advances have influenced the progress of science and science has

Analyzing and Interpreting Data (pp. 61-63, NRC, 2012) Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3) **Engaging in Argument from Evidence** (pp. 71-74, NRC, 2012) Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)	and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HSLS1-4) **LS3.A: Inheritance of Traits** (pp. 158-159, NRC, 2012) • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) **LS3.B: Variation of Traits** (pp. 160-161, NRC, 2012) • In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)	influenced advances in technology. (HS-LS3-3) • Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

	• Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)	

NJSLS Standard(s) Addressed

- HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms**.** *[Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]*
- 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. *[Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]*
- 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**.** *[Clarification Statement: Emphasis is on the cause and effect relationships between DNA, the proteins it codes for, and the resulting traits observed in an organism.] [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]*
- 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. *[Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]*
- HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. *[Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]*

Essential Questions (3-5)

- How is our understanding of evolution influenced by our knowledge of genetics?
- Why is it important that not all inherited characteristics get expressed in the next generation?
- How would Mendel's laws have been affected if he had studied a different type of plant?
- How does the diversity of a species affect inheritance?

Anchor Text

Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

Informational Texts (3-5)

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.
Suggested Formative & Summative Assessments
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Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan's Academy
Labs
3. Comparing DNA sequences

Suggested Time Frame:	3 weeks

Content Area:	**AP Biology**	**Grade(s)**	**11,12**
Unit Plan Title:	**6. Gene Expression and Regulation**		

Learning Objectives

- IST-1. K Describe the structures involved in passing hereditary information from one generation to the next*
- IST-1. L Describe the characteristics of DNA that allow it to be used as the hereditary material
- IST-1. M Describe the mechanisms by which genetic information is copied for transmission between generations
- IST-1. N Describe the mechanisms by which genetic information flows from DNA to RNA to protein
- IST-1. O Describe how the phenotype of an organism is determined by its genotype
- IST-2. A Describe the types of interactions that regulate gene expression
- IST-2. B Explain how the location of regulatory sequences relates to their function
- IST-2.C Explain how the binding of transcription factors to promoter regions affects gene expression and/or the phenotype of the organism
- IST-2. D Explain the connection between the regulation of gene expression and phenotypic differences in cells and organisms
- IST-2. E Describe the various types of mutation
- IST-4. A Explain how changes in genotype may result in changes in phenotypes
- IST-4. B Explain how alterations in DNA sequences contribute to variation that can be subject to natural selection
- IST-1. P Explain the use of genetic engineering techniques in analyzing or manipulating DNA

*from AP BIOLOGY

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems (pp. 54-56, NRC, 2012) Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and	**LS1.A: Structure and Function** (pp. 143-145, NRC, 2012) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that	**Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2)

evaluating empirically testable questions and design problems using models and simulations.

- Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

Developing and Using Models (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

• Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4)

Analyzing and Interpreting Data (pp. 61-63, NRC, 2012)
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)

Engaging in Argument from Evidence (pp. 71-74, NRC, 2012)

contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)

LS1.B: Growth and Development of Organisms (pp. 145-147, NRC, 2012)

- In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HSLS1-4)

LS3.A: Inheritance of Traits (pp. 158-159, NRC, 2012)

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4)

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Connections to Nature of Science

Science is a Human Endeavor (Appendix H)

- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)
- Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)	regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) **LS3.B: Variation of Traits** (pp. 160-161, NRC, 2012) • In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) • Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)	

NJSLS Standard(s) Addressed

- HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. *[Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]*
- 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. *[Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]*
- 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. *[Clarification Statement: Emphasis is on the cause and effect relationships between DNA, the proteins it codes for, and the resulting traits observed in an organism.] [Assessment Boundary: Assessment does not include*

identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.] • 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. *[Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]* • HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. *[Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]*
Essential Questions (3-5)
• How does gene regulation relate to the continuity of life? • How is a species genetic information diversified from generation to generation?
Anchor Text
Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444
Informational Texts (3-5)
AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.
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Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan's Academy
Labs
8: Biotechnology: Bacterial Transformation; 9: Biotechnology: Restriction Enzyme Analysis of DNA

Suggested Time Frame:	4 Weeks

Content Area:	**AP Biology**	**Grade(s)**	**11,12**
Unit Plan Title:	**7. Natural Selection**		
Learning Objectives			
• EVO-1. C Describe the causes of natural selection * • EVO-1. D Explain how natural selection affects populations • EVO-1. E Describe the importance of phenotypic variation in a population			

- EVO-1. F Explain how humans can affect diversity within a population
- EVO-1. G Explain the relationship between changes in the environment and the evolutionary changes in the population
- EVO-1. H Explain how random occurrences affect the genetic makeup of a population
- EVO-1. I Describe the role of random processes in the evolution of specific populations
- EVO-1. J Describe the change in the genetic makeup of a population over time
- EVO-1. K Describe the conditions under which allele and genotype frequencies will change in populations
- EVO-1. L Explain the impacts on the population in any of the conditions of Hardy-Weinberg are not met
- EVO-1. M Describe the types of data that provide evidence for evolution
- EVO-1. N Explain how morphological, biochemical, and geological data provide evidence that organisms have changed over time
- EVO-2. B Describe the fundamental molecular and cellular features shared across all domains of life, which provide evidence of common ancestry
- EVO-2. C Describe structural and fundamental evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes
- EVO-3. A Explain how evolution is an ongoing process in all living organisms
- EVO-3. B Describe the types of evidence that can be used to infer an evolutionary relationship
- EVO-3. C Explain how a phylogenetic tree and/or cladogram can be used to infer evolutionary relatedness (EVO-3.C)
- EVO-3. D Describe the conditions under which new species may arise
- EVO-3. E Describe the rate of evolution and speciation under difference ecological conditions
- EVO-3. F Explain the processes and mechanisms that drive speciation
- EVO-3. G Describe factors that lead to the extinction of a population
- EVO-3.H Explain how the risk of extinction is affected by changes in the environment
- EVO-3. I Explain species diversity in an ecosystem as a function of speciation and extinction rates
- EVO-3. J Explain how extinction can make new environments available for adaptive radiation
- SYI-3. D Explain how the genetic diversity of a species or population affects its ability to withstand environmental pressures
- SYI-3. E Describe the scientific evidence that provides support for models of the origin of life on Earth

*from AP BIOLOGY

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data (pp. 61-63, NRC, 2012) Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	**LS4.A: Evidence of Common Ancestry and Diversity** (pp. 162-163, NRC, 2012) • Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of	**Patterns** (pp. 85-87, NRC, 2012) • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1),(HS-LS4-3) **Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)

Constructing Explanations and Designing Solutions (pp. 67-71, NRC, 2012)
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2),(HS-LS4-4)

Engaging in Argument from Evidence (pp. 71-74, NRC, 2012)
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.

different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

LS4.B: Natural Selection (pp. 163-164, NRC, 2012)

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2),(HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

LS4.C: Adaptation (pp. 164-166, NRC, 2012)

- 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. (HS-LS4-2)

claims about specific causes and effects. (HS-LS4-2),(HS-LS4-4),(HS-LS4-5)

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Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1),(HS-LS4-4)

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

A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)

• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5) **Obtaining, Evaluating, and Communicating Information** (pp. 74-77, NRC, 2012) Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1)	• Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3),(HS-LS4-4) • Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5) • Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)	
NJSLS Standard(s) Addressed		

- HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. *[Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]*
- HS-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. *[Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]*
- HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. *[Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]*
- HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. *[Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming and how these behaviors influence reproduction.]*
- HS-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. *[Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]*
- HS-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. *[Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]*

Essential Questions (3-5)

- What conditions in a population make it more or less likely to evolve?
- Scientifically defend the theory of evolution.
- How does species interaction encourage or slow changes in species?

Anchor Text

Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

Informational Texts (3-5)	
AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.	
Suggested Formative & Summative Assessments	
AP Biology exams, Instructor guided laboratory assignments and formal reports, Homework, Student guided laboratory assignments and formal reports, Unit tests, Quizzes and tests on canvas, Laboratory based past exam questions, Projects, General AP Biology free response questions assignment	
Resources (websites, Blackboard, documents, etc.)	
Canvas Instructure Learning Management System, The College Board Website, Khan's Academy	
Labs	
1: Artificial Selection; 2. Mathematical Modeling	
Suggested Time Frame:	5 Weeks

Content Area:	**AP Biology**	**Grade(s)**	**11,12**
Unit Plan Title:	**9. Cumulative Project**		

Learning Objectives

Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function (SYI-1.A)
Describe the composition of macromolecules required by living organisms (ENE-1.A)
Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules (SYI-1.B)
Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecules (SYI-1.C)
Describe the structural similarities and differences between DNA and RNA (IST-1.A)
Describe the structure and/or function of subcellular components and organelles (SYI-1.D)
Explain how subcellular components and organelles contribute to the function of the cell (SYI-1.E)
Describe the structural features of a cell that allow organisms to capture, store, and use energy (SYI-1.F)
Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment (ENE-1.B)
Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment (ENE-1.C)
Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell (ENE-2.A)
Describe the Fluid Mosaic Model of cell membranes (ENE-2.B)
Explain how the structure of biological membranes influences selective permeability (ENE-2.C)
Describe the role of the cell wall in maintaining cell structure and function (ENE-2.D)
Describe the mechanisms that organisms use to maintain solute and water balance (ENE-2.E)
Describe the mechanisms that organisms use to transport large molecules across the plasma membrane (ENE-2.F)

Explain how the structure of a molecule affects its ability to pass through the plasma membrane (ENE-2.G)
Explain how concentration gradients affect the movement of molecules across membranes (ENE-2.H)
Explain how osmoregulatory mechanisms contribute to the health and survival of organisms (ENE-2.I)
Describe the processes that allow ions and other molecules to move across membranes (ENE-2.J)
Describe the membrane-bound structures of the eukaryotic cell (ENE-2.K)
Explain how internal membranes and membrane-bound organelles contribute to compartmentalization of eukaryotic cell functions (ENE-2.L)
Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells (EVO-1.A)
Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts (EVO-1.B)
Describe the properties of enzymes (ENE-1.D)
Explain how enzymes affect the rate of biological reactions (ENE-1.E)
Explain how changes to the structure of an enzyme may affect its function (ENE-1.F)
Explain how the cellular environment affects enzyme activity (ENE-1.G)
Describe the role of energy in living organisms (ENE-1.H)
Describe the photosynthetic processes that allow organisms to capture and store energy (ENE-1.I)
Explain how cells capture energy from light and transfer it to biological molecules for storage and use (ENE-1.J)
Describe the processes that allow organisms to use energy stored in biological macromolecules (ENE-1.K)
Explain how cells obtain energy from biological macromolecules in order to power cellular functions (ENE-1.L)
Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in difference environments (SYI-3.A)
Describe the ways that cells can communicate with one another (IST-3.A)
Explain how cells communicate with one another over short and long distances (IST-3.B)
Describe the components of a signal transduction pathway (IST-3.C)
Describe the role of components of a signal transduction pathway in producing a cellular response (IST-3.D)
Describe the role of the environment in eliciting a cellular response (IST-3.E)
Describe the difference types of cellular responses elicited by a signal transduction pathway (IST-3.F)
Explain how a change in the structure of any signaling molecule affects the activity of the signaling pathway (IST-3.G)
Describe positive and/or negative feedback mechanisms (ENE-3.A)
Explain how negative feedback helps to maintain homeostasis (ENE-3.B)
Explain how positive feedback affects homeostasis (ENE-3.C)
Describe the events that occur in the cell cycle (IST-1.B)
Explain how mitosis results in the transmission of chromosomes from one generation to the next (IST-1.C)
Describe the role of checkpoints in regulating the cell cycle (IST-1.D)
Describe the effects of disruptions to the cell cycle on the cell or organism (IST-1.E)
Explain how meiosis results in the transmission of chromosomes from one generation to the next (IST-1.F)
Describe similarities and/or differences between the phases and outcomes of mitosis and meiosis (IST-1.G)
Explain how the process of meiosis generates genetic diversity (IST-1.H)
Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms (EVO-2.A)
Explain the inheritance of genes and traits as described by Mendel’s Laws (IST-1.I)

Explain deviations from Mendel's model of the inheritance of traits (IST-1.J)
Explain how the same genotype can result in multiple phenotypes under different environmental conditions (SYI-3.B)
Explain how chromosomal inheritance generates genetic variation in sexual reproduction (SYI-3.C)
Describe the structures involved in passing hereditary information from one generation to the next (IST-1.K)
Describe the characteristics of DNA that allow it to be used as the hereditary material (IST-1.L)
Describe the mechanisms by which genetic information is copied for transmission between generations (IST-1.M)
Describe the mechanisms by which genetic information flows from DNA to RNA to protein (IST-1.N)
Describe how the phenotype of an organism is determined by its genotype (IST-1.O)
Describe the types of interactions that regulate gene expression (IST-2.A)
Explain how the location of regulatory sequences relates to their function (IST-2.B)
Explain how the binding of transcription factors to promoter regions affects gene expression and/or the phenotype of the organism (IST-2.C)
Explain the connection between the regulation of gene expression and phenotypic differences in cells and organisms (IST-2.D)
Describe the various types of mutation (IST-2.E)
Explain how changes in genotype may result in changes in phenotypes (IST-4.A)
Explain how alterations in DNA sequences contribute to variation that can be subject to natural selection (IST-4.B)
Explain the use of genetic engineering techniques in analyzing or manipulating DNA (IST-1.P)
Describe the causes of natural selection (EVO-1.C)
Explain how natural selection affects populations (EVO-1.D)
Describe the importance of phenotypic variation in a population (EVO-1.E)
Explain how humans can affect diversity within a population (EVO-1.F)
Explain the relationship between changes in the environment and the evolutionary changes in the population (EVO-1.G)
Explain how random occurrences affect the genetic makeup of a population (EVO-1.H)
Describe the role of random processes in the evolution of specific populations (EVO-1.I)
Describe the change in the genetic makeup of a population over time (EVO-1.J)
Describe the conditions under which allele and genotype frequencies will change in populations (EVO-1.K)
Explain the impacts on the population in any of the conditions of Hardy-Weinberg are not met (EVO-1.L)
Describe the types of data that provide evidence for evolution (EVO-1.M)
Explain how morphological, biochemical, and geological data provide evidence that organisms have changed over time (EVO-1.N)
Describe the fundamental molecular and cellular features shared across all domains of life, which provide evidence of common ancestry (EVO-2.B)
Describe structural and fundamental evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes (EVO-2.C)
Explain how evolution is an ongoing process in all living organisms (EVO-3.A)
Describe the types of evidence that can be used to infer an evolutionary relationship (EVO-3.B)
Explain how a phylogenetic tree and/or cladogram can be used to infer evolutionary relatedness (EVO-3.C)
Describe the conditions under which new species may arise (EVO-3.D)
Describe the rate of evolution and speciation under difference ecological conditions (EVO-3.E)
Explain the processes and mechanisms that drive speciation (EVO-3.F)

Describe factors that lead to the extinction of a population (EVO-3.G) Explain how the risk of extinction is affected by changes in the environment (EVO-3.H) Explain species diversity in an ecosystem as a function of speciation and extinction rates (EVO-3.I) Explain how extinction can make new environments available for adaptive radiation (EVO-3.J) Explain how the genetic diversity of a species or population affects its ability to withstand environmental pressures (SYI-3.D) Describe the scientific evidence that provides support for models of the origin of life on Earth (SYI-3.E) Explain how the behavioral and/or physiological response of an organism is related to changes in internal or external environment (ENE-3.D) Explain how the behavioral responses of organisms affect their overall fitness and may contribute to the success of the population (IST-5.A) Describe the strategies organisms use to acquire and use energy (EBE-1.M) Explain how changes in energy availability affect populations and ecosystems (ENE-1.N) Explain how the activities of autotrophs and heterotrophs enable the flow of energy within an ecosystem (ENE-1.O) Describe the factors that influence growth dynamics of populations (SYI-1.G) Explain how the density of a population affects and is determined by resource availability in the environment (SYI-1.H) Describe the structure of a community according to its species composition and diversity (ENE-4.A) Explain how interactions within and among populations influence community structure (ENE-4.B) Explain how community structure is related to energy availability in the environment (ENE-4.C) Describe the relationship between ecosystem diversity and its resilience to changes in the environment (SYI-3.F) Explain how the addition or removal of any component of an ecosystem will affect its overall short-term and long-term structure (SYI-3.G) Explain the interaction between the environment and random or preexisting variations in populations (EVO-1.O) Explain how invasive species affect ecosystem dynamics (SYI-2.A) Describe human activities that lead to changes in ecosystem structure and/or dynamics (SYI-2.B) Explain how geological and meteorological activity leads to changes in ecosystem structure and/or dynamics (SYI-2.C)		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop and use a model based on evidence to illustrate the relationships between systems or	**Developing and Using Models** (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or	**Developing and Using Models** (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that

between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** **Developing and Using Models** (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** (pp. 67 -71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer	provide evidence for and test conceptual, mathematical, physical, and empirical models. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** (pp. 67 -71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1) **Developing and Using Models** (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)

Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

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Constructing Explanations and Designing Solutions

Developing and Using Models (pp. 56-59. NRC, 2012)
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)

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- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

Using Mathematics and Computational Thinking(pp. 64-67, NRC, 2012)
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are

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• Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

Constructing Explanations and Designing Solutions
(pp. 67-71, NRC, 2012)
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1- 6),(HS-LS2-3)

Systems and System Models (pp. 91-94, NRC, 2012) predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

Planning and Carrying Out Investigations (pp. 59-61, NRC, 2012)
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LS1.A: Structure and Function (pp. 143-145, NRC, 2012)

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

Structure and Function (pp. 96-98, NRC, 2012)

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

Stability and Change (pp. 98-101, NRC, 2012)

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

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Connections to Nature of Science

Scientific Investigations Use a Variety of Methods (pp. 96-101, Appendix H)

Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

Energy and Matter (pp. 94-96, NRC, 2012) • Changes of energy and matter in a system can be described in

9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)

Developing and Using Models (pp. 56-59, NRC, 2012)

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems

contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1- 1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)

- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1- 2)

• 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. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS1.A: Structure and Function (pp. 143-145, NRC, 2012)

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terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7),(HS-LS2-4)
- Energy drives the cycling of matter within and between systems. (HS-LS2-3)

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Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence (pp. 96-101, Appendix H)

Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3)

Energy and Matter (pp. 94-96)

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)
- Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

Structure and Function (pp. 96-98)

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

Stability and Change (pp. 98-101)

Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

Cause and Effect (pp. 87-89, NRC, 2012)

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2)

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or components of a system. (HS-LS2-5)
Using Mathematics and Computational Thinking(pp. 64-67, NRC, 2012)
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
• Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)
Constructing Explanations and Designing
Solutions
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Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1- 2)
• 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. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS2.A: Interdependent Relationships in Ecosystems (pp. 150-152, NRC, 2012)

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

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Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4)

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Connections to Nature of Science
Science is a Human Endeavor (Appendix H)
Technological advances have influenced the progress of science

Cause and Effect (pp. 87-89, NRC, 2012)

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2)

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and

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- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1- 6),(HS-LS2-3) **Using Mathematics and Computational Thinking** (pp. 64-67, NRC, 2012) Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. - Use mathematical and/or computational representations of phenomena or design	environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** (pp. 154-156, NRC, 2012) - A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) - Moreover, 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. (HS-LS2-7) **LS2.D: Social Interactions and Group Behavior** (pp. 156-157, NRC, 2012)	information flows—within and between systems at different scales. (HS-LS1-4) - -- ***Connections to Nature of Science*** **Science is a Human Endeavor** (Appendix H) - Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3) - Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3) s crosscutting concepts

solutions to support explanations. (HS-LS2-1) • Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2) • Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) • All previous science and engineering practices	• Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **LS4.C: Adaptation** (pp. 164-166, NRC, 2012) • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-6) **LS4.D: Biodiversity and Humans** (pp. 166-167, NRC, 2012) • Biodiversity is increased by the formation of a new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)* • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids	

	humanity by preserving landscapes of recreational or inspirational value. *(Secondary to HS-LS2-7), (HS-LS4-6.)* **ETS1.B: Developing Possible Solutions** (pp. 206- 208, NRC, 2012) • When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary to HS-LS2-7),(secondary to HS-LS4-6)* Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(secondary to HS-LS4-6)* ious disciplinary core ideas	

NJSLS Standard(s) Addressed
Developing and Using Models (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

Constructing Explanations and esigning Solutions (pp. 67 -71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)

Developing and Using Models (pp. 56-59, NRC, 2012)

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

Using Mathematics and Computational Thinking (pp. 64-67, NRC, 2012)

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

• Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

Constructing Explanations and Designing Solutions

(pp. 67-71, NRC, 2012)

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1- 6),(HS-LS2-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

Structure and Function (pp. 96-98, NRC, 2012)

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

Stability and Change (pp. 98-101, NRC, 2012)

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

- **Connections to Nature of Science**

Scientific Investigations Use a Variety of Methods (pp. 96-101, Appendix H)

Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

Energy and Matter (pp. 94-96, NRC, 2012) • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7), (HS-LS2-4)
- Energy drives the cycling of matter within and between systems. (HS-LS2-3)

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Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence (pp. 96-101, Appendix H)

Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3)

Energy and Matter (pp. 94-96)

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)
- Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

Structure and Function (pp. 96-98)

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

Stability and Change (pp. 98-101)

Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

Cause and Effect (pp. 87-89, NRC, 2012)

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1), (HS-LS3-2)

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4)

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Connections to Nature of Science

Science is a Human Endeavor (Appendix H)

Technological advances have influenced the progress of science

Cause and Effect (pp. 87-89, NRC, 2012)

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1), (HS-LS3-2)

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4)

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Connections to Nature of Science

Science is a Human Endeavor (Appendix H)

- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)
- Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

Essential Questions (3-5)

What is the role of energy in the making and breaking of polymers?

How do living systems transmit information in order to ensure their survival?

How would living systems function without the polarity of the water molecule? Defend the origin of eukaryotic cells. How do the mechanisms for transport across membranes support energy conservation? What are the advantages and disadvantages of cellular compartmentalization? How are living systems affected by the presence or absence of subcellular components? How is energy captured and then used by a living system? How do organisms use energy or conserve energy to respond to environmental stimuli? In what ways do cells use energy to communicate with one another? How does the cell cycle aid in the conservation of genetic information? Why and in what ways do cells communicate with one another? How is our understanding of evolution influenced by our knowledge of genetics? Why is it important that not all inherited characteristics get expressed in the next generation? How would Mendel's laws have been affected if he had studied a different type of plant? How does the diversity of a species affect inheritance? How does gene regulation relate to the continuity of life? How is a species genetic information diversified from generation to generation? What conditions in a population make it more or less likely to evolve? Scientifically defend the theory of evolution. How does species interaction encourage or slow changes in species? How does diversity among and between species in a biological system affect the evolution of a species within the system? How does the acquisition of energy relate to the health of a biological system? How do communities and ecosystems change, for better or worse, due to biological disruption?
Anchor Text
Campbell, Neil A., and Jane B. Reece. <u>Biology.</u> 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444
Informational Texts (3-5)
AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.
Suggested Formative & Summative Assessments
AP Biology exams, Instructor guided laboratory assignments and formal reports, Homework, Student guided laboratory assignments and formal reports, Unit tests, Quizzes and tests on canvas, Laboratory based past exam questions, Projects, General AP Biology free response questions assignment
Resources (websites, Blackboard, documents, etc.)
Canvas Instructure Learning Management System, The College Board Website, Khan's Academy
Labs

Suggested Time Frame:	8 Weeks

III. Instructional Strategies

- Graphs and other visuals
- Engaging in discussions
- Reading silently and aloud
- Listening and speaking activities
- Watching and responding to media
- Brainstorming
- Listening
- Mapping
- Revising and editing
- Participating in small and large groups
- Researching to make connections to texts and classroom discussions
- Collaborative projects
- Answering questions (oral and written)
- Summarizing
- Practicing past AP Biology questions
- Analyzing texts, discussions, etc.
- Peer teaching
- Note taking and note making
- Writing

IV. Scope and Sequence

Objective	Grades 11,12
Change in the genetic makeup of a population over time is evolution.	IDR
Natural selection is a major mechanism of evolution.	IDR

Natural selection acts on phenotypic variations in populations.	IDR
Evolutionary change is also driven by random processes.	IDR
Biological evolution is supported by scientific evidence from many disciplines, including mathematics.	IDR
Organisms are linked by lines of descent from common ancestry	IDR
Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today	IDR
Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.	IDR
Life continues to evolve within a changing environment.	IDR
Speciation and extinction have occurred throughout the Earth's history	IDR
Speciation may occur when two populations become reproductively isolated from each other.	IDR
Populations of organisms continue to evolve.	IDR
The origin of living systems is explained by natural processes.	IDR
There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.	IDR
Scientific evidence from many different disciplines supports models of the origin of life.	IDR
Growth, reproduction and maintenance of the organization of living systems require free energy and matter	IDR
All living systems require constant input of free energy.	IDR
Organisms capture and store free energy for use in biological processes.	IDR
Organisms must exchange matter with the environment to grow, reproduce and maintain organization.	IDR
Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.	IDR
Cell membranes are selectively permeable due to their structure.	IDR
Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.	IDR
Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.	IDR
Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.	IDR
Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.	IDR
Organisms respond to changes in their external environments.	IDR
Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.	IDR
All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.	IDR
Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.	IDR
Biological systems are affected by disruptions to their dynamic homeostasis.	IDR
Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.	IDR
Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.	IDR
Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.	IDR
Timing and coordination of physiological events are regulated by multiple mechanisms.	IDR
Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.	IDR

Heritable information provides for continuity of life.	IDR
DNA, and in some cases RNA, is the primary source of heritable information.	IDR
In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.	IDR
The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.	IDR
The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.	IDR
Expression of genetic information involves cellular and molecular mechanisms.	IDR
Gene regulation results in differential gene expression, leading to cell specialization	IDR
A variety of intercellular and intracellular signal transmissions mediate gene expression.	IDR
The processing of genetic information is imperfect and is a source of genetic variation	IDR
Changes in genotype can result in changes in phenotype.	IDR
Biological systems have multiple processes that increase genetic variation.	IDR
Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.	IDR
Cells communicate by generating, transmitting and receiving chemical signals.	IDR
Cell communication processes share common features that reflect a shared evolutionary history.	IDR
Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.	IDR
Signal transduction pathways link signal reception with cellular response.	IDR
Changes in signal transduction pathways can alter cellular response.	IDR
Transmission of information results in changes within and between biological systems.	IDR
Individuals can act on information and communicate it to others.	IDR
Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.	IDR
Interactions within biological systems lead to complex properties.	IDR
The subcomponents of biological molecules and their sequence determine the properties of that molecule.	IDR
The structure and function of subcellular components, and their interactions, provide essential cellular processes.	IDR
Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.	IDR
Organisms exhibit complex properties due to interactions between their constituent parts.	IDR
Communities are composed of populations of organisms that interact in complex ways.	IDR
Interactions among living systems and with their environment result in the movement of matter and energy	IDR
Competition and cooperation are important aspects of biological systems.	IDR
Interactions between molecules affect their structure and function.	IDR
Cooperative interactions within organisms promote efficiency in the use of energy and matter.	IDR
Interactions between and within populations influence patterns of species distribution and abundance.	IDR
Distribution of local and global ecosystems changes over time.	IDR
Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	IDR

Variation in molecular units provides cells with a wider range of functions	IDR
Environmental factors influence the expression of the genotype in an organism.	IDR
The level of variation in a population affects population dynamics.	IDR
The diversity of species within an ecosystem may influence the stability of the ecosystem.	IDR

V. Course Textbooks, Instructional Resources, & Software

A. General Resources

1. AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.
2. AP Biology Lab Manual. New York: The College Board, 2001.
3. Campbell, Neil A., and Jane B. Reece. Biology. 8th ed. San Francisco: Pearson Benjamin Cummings, 2008. 978-0805368444

B. Unit 1 (Evolution) Resources

1. "Darwin Lives! Modern Humans Are Still Evolving." Eben, Harrell. Time.com. Accessed December 19, 2011. http://www.time.com/time/health/article/0,8599,1931757,00.html.
2. "Evolution: Species and Speciation." Connecting Concepts: Interactive Lessons in Biology. Accessed December 19, 2011. http://ats.doit.wisc.edu/biology/ev/sp/sp.htm.
3. "'Instant' Evolution Seen in Darwin's Finches, Study Says." Inman, Mason. National Geographic News. Accessed November 30, 2011. http://news.nationalgeographic.com/news/2006/07/060714-evolution.html.
4. Lamb, Trevor D. "Evolution of the Eye." Scientific American 305, no. 1 (2011): 64–69.
5. "Lesson 6: Why Does Evolution Matter Now?" PBS. Accessed December 7, 2011. http://www.pbs.org/wgbh/evolution/educators/lessons/lesson6/index.html.
6. "Making Cladograms: Phylogeny, Evolution, and Comparative Anatomy." ENSI (Evolution & the Nature of Science Institutes). Accessed November 30, 2011. http://www.indiana.edu/~ensiweb/lessons/mclad.html.
7. "Peanut Variation Lab." Accessed December 13, 2011. http://www.biology.fourcroy.org/chapters/90_ca_std/handouts/05peanutlab.htm.
8. "Speciation in Real Time." Understanding Evolution. Accessed December 19, 2011. http://evolution.berkeley.edu/evolibrary/news/100201_speciation.
9. "Visualizing Life on Earth: Data Interpretation in Evolution." Understanding Evolution. Accessed December 13, 2011. http://evolution.berkeley.edu/evolibrary/article/0_0_0/ldg_01.
10. "Welcome to Evolution 101!" Understanding Evolution. Accessed December 7, 2011. http://evolution.berkeley.edu/evolibrary/article/evo_01.
11. "Hardy-Weinberg Equilibrium." Stanhope, Judith. Accessed December 13, 2011. http://www.woodrow.org/teachers/bi/1994/hwintro.html

C. Unit 2 (Cellular Processes: Energy and Communication) Resources

1. "Amazing Cells: Cells Communicate." Genetic Science Learning Center: Learn.Genetics. Accessed November 30, 2011. http://learn.genetics.utah.edu/content/begin/cells/.
2. "CELLS alive!" Accessed December 19, 2011. http://cellsalive.com/.
3. "Cell Size." Massengale's Biology Junction. Accessed November 30, 2011. http://www.biologyjunction.com/cell_size.htm.
4. "Enzymes Help Us Digest Food." Hands-on Activities for Teaching Biology to High School or Middle School Students. Serendip. Accessed November 30, 2011. http://serendip.brynmawr.edu/sci_edu/waldron/#enzymes.

5. “LabBench Activity: Enzyme Catalysis.” PHSchool — The Biology Page. Pearson. Accessed November 30, 2011. http://www.phschool.com/science/biology_place/labbench/lab2/intro.html.

D. Unit 3 (Genetics and Information Transfer) Resources

1. “Cracking the Code of Life: See Your DNA.” NovaTeachers. PBS. Accessed November 30, 2011. http://www.pbs.org/wgbh/nova/teachers/activities/2809_genome.html.
2. Gattaca. Directed by Andrew Niccol. 1997. Culver City, CA: Sony, 1998. DVD.
3. “Genetic Disease Information — pronto!” Human Genome Project Information. Genomics.energy.gov. Accessed November 30, 2011. http://www.ornl.gov/sci/techresources/Human_Genome/medicine/assist.shtml.
4. “Microscopic Close Up: Mammal Cell Undergoing Mitosis in Orange Environment.” Google Videos. Accessed November 30, 2011. http://video.google.com/videoplay?docid=8057806780595432977#.
5. “Mitosis & Meiosis: Doing It on the Table.” ENSI (Evolution & the Nature of Science Institutes). Accessed December 19, 2011. http://www.indiana.edu/~ensiweb/lessons/gen.mm.html.
6. “Rediscovering Biology: Unit 7: Genetics of Development: Animations and Images.” Annenberg Learner. Accessed November 30, 2011. http://www.learner.org/courses/biology/units/gendev/images.html.
7. “A Science Odyssey: You Try It: DNA Workshop.” PBS. Accessed December 19, 2011. http://www.pbs.org/wgbh/aso/tryit/dna/.
8. Skloot, Rebecca. The Immortal Life of Henrietta Lacks. New York: Random House, 2010.
9. “Who’s the Father?” Wisconsin Fast Plants. Accessed December 19, 2011. www.fastplants.org/pdf/WTF_mono.pdf.

E. Unit 4 (Interactions) Resources

1. ABO-Rh Blood Typing with Synthetic Blood Kit. Carolina Supply Company. http://www.carolina.com/product/700101.do.
2. “Are All Invasive Species Bad?” Arnold, Carrie. *US News and World Report: Science*. Accessed December 19, 2011. http://www.usnews.com/science/articles/2011/08/31/are-all-invasive-species-bad.
3. “Circadian Rhythms.” Accessed December 19, 2011. http://bcs.whfreeman.com/thelifewire/content/chp52/5202002.html.
4. “Exploring Life’s Origins: A Timeline of Life’s Evolution.” Exploring Life’s Origins. Accessed November 30, 2011. http://exploringorigins.org/timeline.html.
5. “Genetic Variation Increases HIV Risk in Africans.” *ScienceDaily*: Science News. Accessed December 19, 2011. http://www.sciencedaily.com/releases/2008/07/080716121355.htm.
6. “The Habitable Planet: Interactive Labs: Disease Lab.” Annenberg Learner. Accessed November 30, 2011. http://www.learner.org/courses/envsci/interactives/disease/.
7. Heitz, Jean, and Cynthia Giffen. *Practicing Biology: A Student Workbook*. 4th ed. (Supplement to Campbell Biology). San Francisco: Benjamin Cummings, 2011.
8. “How the Pill Works.” American Experience. PBS. Accessed December 19, 2011. http://www.pbs.org/wgbh/amex/pill/sfeature/sf_cycle.html.
9. “What You Should Know About Flu Antiviral Drugs.” Centers for Disease Control and Prevention. Accessed December 19, 2011. http://www.cdc.gov/flu/antivirals/whatyoushould.htm.

10. "H1N1 Flu: Questions & Answers: Antiviral Drugs, 2009–2010 Flu Season." Centers for Disease Control and Prevention. Accessed November 30, 2011. http://www.cdc.gov/h1n1flu/antiviral.htm.

VI. Student Handout

Course Description:

The AP Biology course is designed to be the equivalent of a college-level introductory biology course. The intent of the course is to expose students to higher level biological principles, concepts, and skills and allow them the opportunity to apply their knowledge to real-life applications. Rather than learning from a micro level outward, students learn from a macro level inward. Students are also expected to learn not by memorization of facts, but through content and concept application via the AP Biology science practices. The syllabus for this course is designed by the College Board. In the revised AP Biology course, the teacher serves as the facilitator while the students develop as independent thinkers and learners, especially through laboratory investigations. Many concepts that are considered prerequisite knowledge for the course can be reviewed as home study using rich resources such as assigned websites, WebQuests, and journal articles. In class, students are given opportunities to learn and apply their knowledge through the process of inquiry rather than learning from lectures and/or prescribed lab protocols. A sense of wonder and use of original thought are fostered as students are encouraged to extend their learning via scaffolded conceptual understandings and open inquiry. The learning process in the AP Biology course should be rich and impactful. When a student completes the course, he or she should be prepared to do well on the AP Exam as well as in the sequent course in a college or university setting.

Proficiencies:

1. Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution.
2. Enduring understanding 1.B: Organisms are linked by lines of descent from common ancestry
3. Enduring understanding 1.C: Life continues to evolve within a changing environment.
4. Enduring understanding 1.D: The origin of living systems is explained by natural processes.
5. Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter
6. Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
7. Enduring understanding 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
8. Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
9. Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
10. Enduring understanding 3.A: Heritable information provides for continuity of life.
11. Enduring understanding 3.B: Expression of genetic information involves cellular and molecular mechanisms.
12. Enduring understanding 3.C: The processing of genetic information is imperfect and is a source of genetic variation
13. Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals.
14. Enduring understanding 3.E: Transmission of information results in changes within and between biological systems.

15. Enduring understanding 4.A: Interactions within biological systems lead to complex properties.
16. Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems.
17. Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.