PUBLIC SCHOOLS OF EDISON TOWNSHIP

OFFICE OF CURRICULUM AND INSTRUCTION

AP Biology

Length of Course:	Term
Elective/Required:	Elective
Schools:	High Schools
Eligibility:	Grade 11-12
Credit Value:	7 Credits
Date Approved:	August 17, 2021

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Modifications will be made to accommodate IEP mandates for classified students.

STATEMENT OF PURPOSE

Advanced Placement courses are designed to allow qualified students to experience college level studies while still in high school, and in many instances, to obtain college credit via successful performance on an AP Exam. For years Advanced Placement Biology has successfully prepared students for this exam and for careers in the life sciences.

Understandably, the course is designed for our finest science students and therefore, admission requires departmental approval. Since the subject is presented as a first year course in biology at the collegiate level, qualified students must have completed, or be simultaneously enrolled in the completion of the traditional three years of college prep biology, chemistry and physics.

While those enrolled in the course should be encouraged to prepare for the AP exam, they are not required to take it, and the primary purpose of the offering is to provide our most advanced science students with a challenging course of study in the life sciences that is an extension of their previous experiences with biology and commensurate with their abilities.

This curriculum guide was written in the Spring of 2012 following the adaptation of the new state standards in science. As always with an Advanced Placement course, every attempt has been made to follow the recommendations of the College Entrance Examination Board, who prescribes much of the curriculum for courses of this nature, but at the same time our own experienced instructors have contributed many of the ideas and activities herein.

This guide was again revised in Fall of 2020 and in August 2021 to reflect changes to both the updated AP Course and Exam Description (CED) and the current NJSLS-S/NGSS standards.

The committee members responsible for this revision are:
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Unit of Study: Unit 1: Chemistry of Life (allow approximately 3 Weeks)

Targeted State Standards ((NJSLS-S/NGSS): LS1.A, LS1.C, ESS2.C

Unit Objectives/Enduring Understandings: Living systems are organized in a hierarchy of structure. The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules. Living systems are organized into a hierarchy of structural levels that interact. Heritable information provides for continuity of life.

Essential Questions: 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?

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
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) As matter and energy flow through different organizational levels of living systems, chemical elements	Chemical elements to support life Biological Polymers Macromolecules Molecules of life are exchanged between organisms and the environment Polymer structure and properties Enzyme structure	Justify the selection of data regarding the types of molecules that an animal, plant, or bacterium will take up as necessary building blocks and excrete as waste products. Explain the connection between the sequence and the subcomponents of a biological polymer and its properties. Macromolecules Construct explanations based on evidence of how variation in	Laboratory Investigations: (optional, but not limited to the following) Lab – Water Lab – Biomolecules Optional Gizmo Labs/Activities - Dehydration Synthesis - Identifying Nutrients Optional Pivot Labs/Activities - Properties of Water - Organic Molecules	Formative Assessment Class Discussions Class Activities Informal Polling Summative Assessments Quizzes

are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7) 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) The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)	Enzyme activity	molecular units provides cells with a wider range of functions. Represent graphically or model quantitatively the exchange of molecules between an organism and its environment, and the subsequent uses of these molecules to build new molecules that facilitate dynamic homeostasis, growth, and reproduction. Refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer. Use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule. Analyze data to identify how molecular interactions affect structure and function.	- Characteristics of Life -Introduction to Acids and Bases Text-Campbell Biology Chapter 2: "The Chemical Context of Life" Chapter 3: "Water and Life" Chapter 4: "Carbon and the Molecular Diversity of Life" Chapter 5: "The Structure And Function of Large Biological Molecules"	Tests Performance Assessments Lab Investigations Projects

Resources: Essential Materials, Supplementary Materials, Links to Best Practices	**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings
AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012. *AP Biology Lab Manual*. New York: The College Board, 2001. Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014. *AP Biology Course and Exam Description.* The College Board, 2020 https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf Suggested Illustrated Examples: Cellulose Vs Starch Vs. Glycogen	

Unit of Study: Unit 2: Cell Structure and Function (Allow approximately 4 Weeks)

Targeted Standards (NJSLS-S/NGSS): LS1.A,

Unit Objectives/Enduring Understandings: Living systems are organized in a hierarchy of structural levels that interact. The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules. Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments. Evolution is characterized by a change in the genetic makeup of a population over time and is supported b multiple lines of evidence.

Essential Questions: How can you defend the origin of the 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?

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
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	Importance of cell surface area Cell size and shape Limitations Cell membrane structure Cell membrane function	Use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion. Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination. Explain how internal	Laboratory Investigations: (optional, but not limited to the following) Lab Diffusion and Osmosis Optional Gizmo Labs/Activities - Cell Types - Diffusion (STEM Case) - Osmosis (STEM Case) Optional Pivot Labs/Activities - Osmosis and water potential	Formative Assessment Class Discussions Class Activities Informal Polling Summative Assessments

instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) 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.	Cell organelles Prokaryotes vs eukaryotes Organelle interactions Membrane components and selective permeability Evolution of organisms Endosymbiont theory Domains of life	membranes and organelles contribute to cell functions. Use representations and models to describe differences in prokaryotic and eukaryotic cells. Make a prediction about the interactions of subcellular organelles. Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions. Use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. Construct models that connect the movement of molecules across membranes with	with Vegetables and Fruit - Cell Size and Diffusion - Diffusion, osmosis, and membranes - Transpiration Rates - Egg Osmosis Text-Campbell Biology Chapter 6: “A Tour of the Cell” Chapter 7: “Membrane Structure and Function” Chapter 27: “Prokaryotes”	Quizzes Tests Performance Assessments Lab Investigations Projects

		membrane structure and function. Use representations and models to analyze situations or solve problems qualitatively or quantitatively to investigate whether dynamic homeostasis is maintained by the active movement of molecules across membranes. Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. Pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth.		
Resources: Essential Materials, Supplementary Materials, Links to Best Practices *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: The College Board, 2012. *AP Biology Lab Manual*. New York: The College Board, 2001. Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014. *AP Biology Course and Exam Description.* The College Board, 2020 https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf Suggested Illustrated Examples: - Glycosylation and other chemical modifications of proteins that take place within the Golgi and determine protein function or targeting			**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings	

- SA/V Ratios and Exchange – Root hair cells, guard cells, gut epithelial cells - Vacuoles - Cilia - Stomata - Contractile vacuole in protists - Central Vacuoles in plant cells - Connections to Body Systems – Cardiovascular, Respiratory, Integumentary, Muscular, Nervous, Digestive, Excretory	

Unit of Study: Unit 3: Cellular Energetics (Allow approximately 5 Weeks)

Targeted State Standards (NJSLS-S/NGSS): LS1.A, LS1.C, LS2.B, PS3.D,

Unit Objectives/Enduring Understandings: The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules. Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

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

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) 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	Metabolic pathways allow for regulation with feedback mechanisms The shapes of enzymes allow for competitive and non competitive inhibitors. Energy flow in the ecosystem Cycling of chemicals In the ecosystem	Explain how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow, and to reproduce. Justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or reproduce, but that multiple strategies exist in different living systems. Predict how changes in free energy availability affect organisms, populations, and ecosystems.	Laboratory Investigations: (optional, but not limited to the following) Lab - Enzymes Lab Cellular Respiration Lab Photosynthesis Optional Gizmo Labs/Activities - Enzymes (STEM Case) - Photosynthesis (STEM Case) - Cell Energy Cycle - Photosynthesis Lab - Cell Respiration (STEM Case) - Plants & Snails Optional Pivot Labs/Activities	Formative Assessment Class Discussions Class Activities Informal Polling Summative Assessments Quizzes Tests

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) 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	The role of ATP as a cell's energy currency Process of Cellular Respiration and the ways in which disease or toxins may affect its workings. Fermentation as a mechanism for making ATP when oxygen is not available. Process of Photosynthesis and how it can be affected by environmental conditions.	Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter. Use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store, and use free energy. Construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store, or use free energy. Describe specific examples of conserved core biological processes and features shared by all domains or within one domain of life, and how these shared, conserved core processes and features support the concept of common ancestry for all organisms.	- Garden of Splendor: Photosynthesis and Cellular Respiration - Exploring Respiration Rates - Catalase Activity Investigation - Introduction to Cellular Respiration - Lights and Photosynthesis - Exploring Enzymes: Enzyme concentration - Introduction to Photosynthesis - Introduction to Fermentation - Comparing Human respiration before and after running Text-Campbell and Reese Chapter 8: "An Introduction to Metabolism" Chapter 9: "Cellular Respiration and Fermentation" Chapter 10: "Photosynthesis"	Performance Assessments Lab Investigations Projects

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) Photosynthesis and cellular respiration (including anaerobic processes) provide most				

of the energy for life processes. (HS-LS2-3) 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) 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)				
Resources: Essential Materials, Supplementary Materials, Links to Best Practices *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: The College Board, 2012. *AP Biology Lab Manual*. New York: The College Board, 2001. Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014. *AP Biology Course and Exam Description.* The College Board, 2020 https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf			**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings	

Suggested Illustrated Examples: -Different types of phospholipids in cell membranes allow the organism flexibility to adapt to different environmental temperatures. - Different types of hemoglobin maximize oxygen absorption in organisms at different developmental stages. - Different chlorophylls give the plant greater flexibility to exploit/absorb incoming wavelengths of light for photosynthesis. -Connections to Body Systems - Muscular	

Unit of Study: Unit 4: Cell Communication and Cell Cycle (Allowed approximately 3 Weeks)

Targeted State Standards (NJSLS-S/NGSS): LS1.A, LS1.B

Unit Objectives/Enduring Understandings: Cells communicate by generating, transmitting, receiving, and responding to chemical signals. Timing and coordination of biological mechanisms involved in growth, reproduction, and homeostasis depend on organisms responding to environmental cues. Heritable information provides for the continuity of life.

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

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis
and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various
scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
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	Phases of the Cell Cycle including, M, G1, G0, G2, S, Interphase. Main ideas underlying the importance of both fundamental Cell Cycle Checkpoints; G0 and M Cells cycles exhibit variability among tissues.	Describe basic chemical processes for cell communication shared across evolutionary lines of descent. Generate scientific questions involving cell communication as it relates to the process of evolution. Use representation(s) and appropriate models to describe features of a cell signaling pathway.	Laboratory Investigations: (optional, but not limited to the following) Lab – Cell Division: Mitosis and Meiosis (mitosis portion) Text-Campbell Biology Optional Gizmo Labs/Activities - Homeostasis - Cell Division	Formative Assessment Class Discussions Class Activities Informal Polling Summative Assessments

positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) 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. (HS-LS1-4)	Paracrine/endocrine signals. In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization. Cell communication processes share common features that reflect a shared evolutionary history. Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. Signal transduction pathways link signal reception with cellular response. Changes in signal transduction pathways can alter cellular response. Individuals can act on information and	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response. Justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response. Describe a model that expresses key elements to show how change in signal transduction can alter cellular response. Construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways. Make predictions about natural phenomena occurring during the cell cycle.	- Meiosis - Meowsis (STEM Case) Optional Pivot Labs/Activities - Homeostasis Examples - Mitosis of Onion Root Tip Chapter 11: “Cell Communication” Chapter 12: “The Cell Cycle”	Quizzes Tests Performance Assessments Lab Investigations Projects

	communicate it to others.	Describe the events that occur in the cell cycle. Construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization. Explain how signal pathways mediate gene expression, including how this process can affect protein production.		
Resources: Essential Materials, Supplementary Materials, Links to Best Practices *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: The College Board, 2012. *AP Biology Lab Manual*. New York: The College Board, 2001. Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014. *AP Biology Course and Exam Description.* The College Board, 2020 https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf Suggested Illustrated Examples: - Immune cells interact by cell-to-cell contact, antigen-presenting cells (APCs), helper T-cells, and killer T-cells. - Plasmodesmata between plant cells allow material to be transported from cell to cell. - Neurotransmitters - Plant immune response - Quorum sensing in bacteria - Morphogens in embryonic development - Insulin				

- Human growth hormone - Testosterone - Estrogen - Use of Signal Transduction to respond to the environment – Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing) – Epinephrine stimulation of glycogen breakdown in mammals. - Cytokines regulate gene expression to allow for cell replication and division. - Mating pheromones in yeast trigger mating gene expression. - Expression of the SRY gene triggers the male sexual development pathway in animals - Ethelene levels cause changes in the production of different enzymes allowing fruits to ripen. - Hox genes and their role in development. - Blood sugar regulation by insulin/glucagon - Lactation in mammals - Onset of labor in childbirth - Ripening of fruit - Comparison of Life Cycles – plant, animal, fungus - Connections to Body Systems – Muscular, Endocrine, Immune, Reproductive/Development	

Unit of Study: Unit 5: Heredity (Allowed approximately 4 Weeks)

Targeted State Standards (NJSLS-S/NGSS): LS1.A, LS3.B,

Unit Objectives/Enduring Understandings: Heritable information provides for continuity of life. Organisms are linked by lines of descent from common ancestry. Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential Questions: 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?

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
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	If X = DNA content and Y = Chromosome number then Meiosis begin with cells = X, Y and produces cells = 0.25X and 0.5Y. Meiosis segregates genes on Homologous chromosomes, which are usually allelic, into gametes	Construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization. Represent the connection between meiosis and increased Genetic diversity necessary for	Laboratory Investigations: (optional, but not limited to the following) Lab – Cell Division: Mitosis and Meiosis (Meiosis Portion) Optional Gizmo Labs/Activities -Human Karyotyping - Mouse Genetics	Formative Assessment Class Discussions Class Activities

mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) 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	which, most likely randomly form a union during fertilization. Epigenetic controls override classical Mendelian outcomes hybrid crosses resulting in such as 3:1 or 9:3:3:1 phenotypic outcomes. Epigenetic controls affect phenotype. E.g., Genomic Imprinting. Phenotypes are not always a result of a single genotype, for example: Polygenic Inheritance. Patterns of inheritance Predicting genetic outcomes genetic counseling Gene linkage & mapping Genetic Mutations In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.	evolution. Evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another through mitosis, or meiosis followed by fertilization. Construct a representation that connects the process of meiosis to the passage of traits from parent to offspring. Pose questions about the ethical, social, or medical issues surrounding human genetic disorders. Apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. Explain deviations from Mendel's model of the inheritance of traits. Explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. Describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits.	-Chicken Genetics 1 Trait - Chicken Genetics 2 traits - Fast Plants 1 - Fast Plants 2 - Hardy-Weinberg Equilibrium Optional Pivot Labs/Activities - Plant Genetics – Single trait - Fruit Fly Genetics – Single trait - Fruit Fly Genetics - sex-linked genes - Fruit Fly Genetics – Two trait crosses - Hardy Weinberg with PhET - Linked Genes Text-Campbell Biology Chapter 13: "Meiosis and Sexual Life Cycles Chapter 14: "Mendel and the Gene Idea" Chapter 15: "The Chromosomal Basis of Inheritance"	Informal Polling Summative Assessments Quizzes Tests Performance Assessments Lab Investigations Projects

population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)	The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. Changes in genotype can result in changes in phenotype.	Construct explanations of the influence of environmental factors on the phenotype of an organism. Use evidence to justify a claim that a variety of phenotypic responses to a single environmental factor can result from different genotypes within the population.		
Resources: Essential Materials, Supplementary Materials, Links to Best Practices *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: The College Board, 2012. *AP Biology Lab Manual*. New York: The College Board, 2001. Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014. *AP Biology Course and Exam Description.* The College Board, 2020 https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf Suggested Illustrated Examples: - Sex-linked genes reside on sex chromosomes. - IN mammals and flies, females are XX and males are XY; as such X-linked recessive treats are always expressed in males. - In certain species, the chromosomal basis of sex determination is not based on X and Y chromosomes (such as ZW in birds haploidy in bees). - Height and weight in humans - Flower color based on soil pH - Seasonal fur color in arctic animals - Sex determination in reptiles - Effect of increased UV on melanin in animals - Presence of the opposite mating type on pheromone production in yeast and other fungi			**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings	

- Sickle cell anemia - Tay-Sachs disease - Huntington's disease - X-linked color blindness - Trisomy 21/ Down Syndrome - Connections to Body Systems – Reproductive/Development	

Unit of Study: Unit 6: Gene Expression and Regulation (Allowed approximately 7 Weeks)

Targeted State Standards (NJSLS-S/NGSS): LS1.A, LS3.A, LS3.B,

Unit Objectives/Enduring Understandings: Heritable information provides for continuity of life. Differences in the expression of genes account for some of the differences between organisms. The processing of genetic information is imperfect and is a source of genetic variation.

Essential Questions: How does gene regulation relate to the continuity of life? How is a species' genetic information diversified from generation to generation?

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis
and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various
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	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
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) Each chromosome consists of a single very	Nucleic Acid structure and orientation, i.e., 5' to 3' or 3' to 5' of DNA and RNA are essential concepts necessary to comprehend Polypeptide synthesis. The "Central Dogma of Biology" remains true, however, there are a variety of mechanisms cells employ to control gene expression.	Construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, that RNA are the primary sources of heritable information. Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.	Laboratory Investigations: (optional, but not limited to the following) Lab – Transformation Lab – Restriction Enzyme Analysis of DNA Optional Gizmo Labs/Activities - Building DNA - Genetic Engineering - RNA and Protein Synthesis - Protein Synthesis (STEM Case)	Formative Assessment Class Discussions Class Activities Informal Polling Summative Assessments

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)	Phenotypic mutations result from a range of mechanisms from simple SNPs (single nucleotide polymorphisms) to complex mutations such as DNA and RNA transposons. Repressible and inducible operons in prokaryotes. Enhancers and Proximal control elements in eukaryotes. In eukaryotes there are many opportunities to regulate gene expression; the chromatin level all the way up to blocking Translation. STPs (signal transduction pathways) operate within a cell from an outside stimulus. Evolutionary Developmental Biology (Evo-Devo Bio) studies how and when different homeotic genes regulate expression in embryonic tissue. Homeotic genes involved in Developmental Biology; gap genes, pair rule g=genes,	Describe representations and models that illustrate how genetic information is copied for transmission between generations. Describe representations and models illustrating how genetic Information is translated into information is translated into polypeptides. Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. Describe the connection between the regulation of gene expression and observed differences between individuals in a population. Explain how the regulation of gene expression is essential for the processes and structures	- GMO's and the Environment - DNA Analysis - DNA Profiling - Genetic Engineering Optional Pivot Labs/Activities - What contains DNA? - Control of Gene Expression with PhET - Gel Electrophoresis Basics - Gene Regulation: Yeast and Galactose Text-Campbell Biology Chapter 17: "Gene Expression: From Gene to Protein" Chapter 18: "Regulation of Gene Expression" Chapter 19: "Viruses" Chapter 20: "DNA Tools and Biotechnology" Chapter 21: "Genomes and their Evolution	Quizzes Tests Performance Assessments Lab Investigations Projects

	bicoid genes and segment polarity genes. Nuclear Transplantation and Gene Therapy. Maternal Cytoplasmic Determinants begin embryonic development result in many “genetic switches” in successive embryonic cells, i.e., Transcription Factors. This determines the differentiated fate of a cell. Apoptosis is necessary for tissue development. Molecular Biology and Bioengineering results in the manipulation of prokaryotic and eukaryotic cells**.** DNA, and in some cases RNA, is the primary source of heritable information. Gene regulation results in differential gene expression, leading to cell specialization. A variety of intercellular and intracellular signal transmissions mediate gene expression.	that support efficient cell function. Use representations to describe how gene regulation influences cell products and function. Refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues, and organs. Justify a claim made about the effect(s) on a biological system at the molecular, physiological, or organismal level when given a scenario in which one or more components within a negative regulatory system is altered. Use representations to describe mechanisms of the regulation of gene expression. Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis. Justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies.		

	Biological systems have multiple processes that increase genetic variation. Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.			

Resources: Essential Materials, Supplementary Materials, Links to Best Practices

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.
AP Biology Lab Manual. New York: The College Board, 2001.
Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014.
AP Biology Course and Exam Description. The College Board, 2020
https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf

Suggested Illustrated Examples:

- Mutations in the CFTR gene disrupt ion transport and result in cystic fibrosis.
- Mutations in the MC1R gene give adaptive melanism in pocket mice.
- Antibiotic resistance mutations
- Pesticide resistance mutations
- Sickle cell disorder and heterozygote advantage.
- Amplified DNA fragments can be used to identify organisms and perform phylogenetic analyses. Analysis of DNA can be used for forensic identification.
- Genetically modified organisms include transgenic animals.
- Gene cloning allows propagation of DNA fragments.
- Connections to Body Systems – Reproductive/Development

Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

Unit of Study: Unit 7: Natural Selection (Allow approximately 4 Weeks)

Targeted Standards (NJSLS-S/NGSS): LS4.A, LS4.B, LS4.C

Unit Objectives/Enduring Understandings: Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence. Organisms are linked by lines of descent from common ancestry. Life continues to evolve within a changing environment. Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential Questions: What conditions in a population make it more or less likely to evolve? How can you scientifically defend the theory of evolution? How does species interaction encourage or slow changes in species?

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and	Nature selects for phenotypes which are a result of genotypes. Natural selection is a major mechanism of evolution. Phenotypes in populations of organisms are a result of all possible genotypes resulting from all possible alleles in sexual organisms.	Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. Explain the connection between genetic variations in organisms and phenotypic variations in populations. Predict the effects of a change in an environmental factor on the genotypic expression of the	Laboratory Investigations: (optional, but not limited to the following) Lab – Artificial Selection Lab – Mathematical Modeling of Hardy-Weinberg Lab - Comparing DNA Sequences to Understand	Formative Assessment Class Discussions Class Activities Informal polling Summative Assessments

differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1) 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) Evolution is a consequence o 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	Nature selects for phenotypes to survive and reproduce in gene pools. Hardy Weinberg's Genetic equilibrium as applied to various gene pools. Recent studies such as Dodd, et, al, show how scientists can quantify natural selection, specifically reproductive isolation. Organisms in a population which are best able to perform intercellular, inter-organ system and inter-organismal communication, survive and reproduce in a population. Darwin's explorations and theory of descent with modification & natural selection Modes of Speciation: Gradualism and Punctuated Equilibrium	phenotype. Convert a data set from a table of numbers that reflect a change in the genetic makeup of a population over time and apply mathematical methods and conceptual understandings to investigate the cause(s) and effect(s) of this change. Evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution. Analyze data to support the claim that responses to information and communication of information affect natural selection. Apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. Evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time. Connect evolutionary changes in a population over time to a change in the environment. Use data from mathematical models based on the Hardy-	Evolutionary Relationships with BLAST Optional Gizmo Labs/Activities - Rainfall and Bird beaks - Coral Reefs 1 - Coral Reefs 2 - Microevolution - Evolution (STEM Case) - Evolution – Mutation & Selection - Cladograms - Evolution: Natural and Artificial Selection - Human Evolution – Skull Analysis - Natural Selection Optional Pivot Labs/Activities - Natural selection with PhET - Dichotomous Key - Phylogeny: Plant or Protist Campbell Biology Chapter 22: "Descent with Modification: A Darwinian View of Life" Chapter 23: "The Evolution of Populations" Chapter 24: "The Origin of Populations" Chapter 25: "The History of Life on Earth"	Quizzes Tests Performance Assessments Lab Investigations Projects

survive and reproduce, and (4) the ensuing proliferation o those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) 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)	Evidence for evolution (molecular analyses & morphological analyses Phylogeny & systematics: cladistics analysis Evolution of populations; mechanisms Hardy-Weinberg's Microevolution calculations including various scenarios and problems Differential reproductive success. Mechanisms of Natural Selection. Use of bioinformatics such widely used tools on NCBI's server: (BLASTn, BLASTx, BLASTp) to analyze genomes. Comparing & discussing genomic sequences in relation to evolution Natural selection acts on phenotypic variations in populations.	Weinberg equilibrium to analyze genetic drift and effects of selection in the evolution of specific populations. Justify data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and the effects of selection in the evolution of specific populations. Use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness. Make predictions about the effects of genetic drift, migration, and artificial selection on the genetic makeup of a population. Evaluate evidence provided by data from many scientific disciplines to support biological evolution. Refine evidence based on data from many scientific disciplines that support biological evolution. Design a plan to answer scientific questions regarding	Chapter 26: "Phylogeny and the Tree of Life	

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),(HS-LS4-6) 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)	Evolutionary change is also driven by random processes. Biological evolution is supported by scientific evidence from many disciplines, including mathematics. Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. Speciation and extinction have occurred throughout the Earth's history. Speciation may occur when two populations become reproductively isolated from each other. Populations of organisms continue to evolve.	how organisms have changed over time using information from morphology, biochemistry, and geology. Connect scientific evidence from many scientific disciplines to support the modern concept of evolution. Construct and/or justify mathematical model, diagrams, or simulations that represent processes of biological evolution. Pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic tree. Construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.		

	There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence. Scientific evidence from many different disciplines supports models of the origin of life.	Analyze data related to questions of speciation and extinction throughout the Earth's history. Design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history. Use data from a real or simulated population(s), based on graphs or models of types of selection, to predict what will happen to the population in the future. Justify the selection of data that addresses questions related to reproductive isolation and speciation. Describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection, and/or genetic drift. Describe a model that represents evolution within a population. Evaluate given data sets that illustrate evolution as an ongoing process.		

Resources: Essential Materials, Supplementary Materials, Links to Best Practices	**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings
AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012. *AP Biology Lab Manual*. New York: The College Board, 2001. Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014. *AP Biology Course and Exam Description.* The College Board, 2020 https://apcentral.collegeboard.org/pdf/ap-biology-course-and-exam-description-0.pdf Suggested Illustrated Examples: - Flowering time in relation to global climate change. - Peppered moth - Sickle cell anemia - DDT resistance in insects - Graphical analysis of allele frequencies in a population - Hawaiian Drosophila - Caribbean Anolis - Apple maggot Rhagoletis - California condors - Black-footed ferrets - Prairie chickens - Potato blight - Corn rust - Genetic diversity and selective pressures - Antibiotic resistance in bacteria (Not all individuals in a diverse population are susceptible to a disease outbreak) - Evolutionary Trends in plant, animals, fungus, protists	

Unit of Study: Unit 8: Ecology (Allow approximately 5 Weeks)

Targeted State Standards (NJSLS-S/NGSS): LS2.A, LS2.B, LS2.C, LS2.D, LS4.D, PS3.4

Unit Objectives/Enduring Understandings: Timing and coordination of biological mechanisms involved in growth, reproduction, and homeostasis depend on organisms responding to environmental cues. The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules. Living systems are organized in a hierarchy of structural levels that interact. Communities and ecosystems change on the basis of interactions among populations and disruptions to the environment. Naturally occurring diversity among and between components within biological systems affects interactions with the environment. Evolution is characterized by change in the genetic make-up of a population over time and is supported by multiple lines of evidence. Competition and cooperation are important aspects of biological systems.

Essential Questions: How does diversity among and between species in a biological system affect the evolution of 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? How does a disruption of a biological system affect genetic information storage and transmission? How do species interactions affect the survival of an ecosystem?

Unit Assessment: The student can use representations and models to communicate scientific phenomena and solve scientific problems. The student can use mathematics appropriately. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. The student can plan and implement data collection strategies appropriate to a particular scientific question. The student can perform data analysis and evaluation of evidence. The student can work with scientific explanations and theories. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

	Core Content Objectives		**Instructional Actions**	
Disciplinary Core Ideas	**Concepts** *What students will know.*	**Skills** *What students will be able to do.*	**Activities/Strategies** Technology Implementation/ Interdisciplinary Connections	**Assessment Check Points**
Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors	Ecological interactions- biotic vs. abiotic Behavioral ecology- natural selection involvement Population dynamics-	Justify the selection of the kind of data needed to answer scientific questions about the relevant mechanism that organisms use to respond to changes in their external environment.	Laboratory Investigations: (optional, but not limited to the following) Lab – Energy Dynamics Lab – Fruit Fly Behavior	Formative Assessment Class Discussions Class Activities

as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HSLS2-2) 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	growth & its regulations Communities & Ecosystems energy levels & flows, cycles, symbiosis & impact on evolution Positive & negative human influences on environments Organisms exhibit complex properties due to interactions between their constituent parts. Communities are composed of populations of organisms that interact in complex ways. Interactions among living systems and with their environment result in the movement of matter and energy. Interactions between molecules affect their structure and function. Cooperative interactions within organisms promote efficiency in the use of energy and matter.	Use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past. Analyze data to identify phylogenetic patterns or relationships, showing that homeostatic mechanisms reflect both continuity due to common ancestry and change due to evolution in different environments. Connect differences in the environment with the evolution of homeostatic mechanisms. Refine scientific models and questions about the effect of complex biotic and abiotic interactions on all biological systems, from cells and organisms to populations, communities, and ecosystems. Analyze data to identify phylogenetic patterns or relationships, showing that homeostatic mechanisms reflect both continuity due to common ancestry and change due to evolution in different environments.	Optional Gizmo Labs/Activities - Food Chain - Forest Ecosystem - Prairie Ecosystem - Rabbit Population by Season - Carbon Cycle - Pond Ecosystem - Nitrogen Cycle (STEM Case) Optional Pivot Labs/Activities -Animal Behavior: Brine Shrimp and Light - Population Dynamics of Algae - Biodiversity of Pond Microbiomes Campbell Biology Text Chapter 51: “Animal Behavior” Chapter 52: “An Introduction to Ecology and the Biosphere” Chapter 53: “Population Ecology” Chapter 54: “Community Ecology” Chapter 55: “Ecosystems and Restoration Ecology”	Informal Polling Summative Assessments Quizzes Tests Performance Assessments Lab Investigations Projects

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) 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) A complex set of interactions within an	Interactions between and within populations influence patterns of species distribution and abundance. Distribution of local and global ecosystems changes over time. Environmental factors influence the expression of the genotype in an organism. The level of variation in a population affects population dynamics. The diversity of species within an ecosystem may influence the stability of the ecosystem.	Connect differences in the environment with the evolution of homeostatic mechanisms. Refine scientific models and questions about the effect of complex biotic and abiotic interactions on all biological systems, from cells and organisms to populations, communities, and ecosystems. Design a plan for collecting data to show that all biological systems (cells, organisms, populations, communities, and ecosystems) are affected by complex biotic and abiotic interactions. Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, or ecosystems). Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms. Connect concepts in and across domain(s) to predict how environmental factors affect	Chapter 56: “Conservation Biology and Global Change”	

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)		responses to information and change behavior. Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior. Create a representation that describes how organisms exchange information in response to internal changes and external cues, and which can result in changes in behavior. Predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s). Justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities. Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. Predict the effects of a change in the community's populations on the community.		

Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HSLS2-8) Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HSLS2-7) 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		Predict the effects of a change of matter or energy availability on communities. Use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance. Predict consequences of human actions on both local and global ecosystems. Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.		

aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) 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) Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-1 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS2-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-4				

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-ESS3-5				

Resources: Essential Materials, Supplementary Materials, Links to Best Practices

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AP Biology Lab Manual. New York: The College Board, 2001.

Reece, Jane B., et al. *Campbell biology*. Boston: Pearson, 2014.

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Suggested Illustrated Examples:

- Photoperiodism and phototropism in plants
- Taxis and kinesis in animals
- Nocturnal and diurnal activity
- Fight-or-flight response
- Predator warnings
- Plant responses to herbivory
- Territorial marking in mammals
- Coloration in flowers
- Bird songs
- Pack behavior in animals
- Predator warnings
- Coloration
- Parent and offspring interactions
- Courtship and mating behaviors
- Foraging in bees and other animals
- Herd, flock, and schooling behavior in animals
- Colony and swarming behavior in insects

Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

- Kin selections - Seasonal reproduction in animals and plants - Life-history strategy (biennial plants, reproductive diapause) - Food chains/webs - Trophic pyramids/diagrams - Kudzu - Zebra mussels - Dutch elm disease - Potato blight - Smallpox - Global climate change - Logging - Urbanization - Mono-cropping - El Nino - Continental drift - Meteor impact on dinosaurs	