Lehighton Area School District

Lehighton Area High School

Grade: 11-12 Subject: AP Biology

	August/September	October	November
Essential Questions/PA Academic Standards	How do biologists investigate the natural world using inquiry and the scientific method? How are scientists limited by bioethics? How is biological evolution supported by scientific evidence from many disciplines? How do the structures of biological molecules determine their functions? How do small molecules assemble into macromolecules? How do functional groups influence the properties of molecules? What activities in living things are macromolecules essential for? Standards: 3.1.10.A1, 3.1.10.A7, 3.1.12.A1, 3.1.12A5, 3.1.B.A1, 3.1.B.A7, BIO.A.2.1, BIO.A.2.2, 3.1.10C1 R11.A.1.3.1, R11.A.2.1.2, R11.A.2.5.1 M11.A.2.1.1, M11A.1.1.2	What similarities and differences between prokaryotic and eukaryotic cells account for their evolutionary relationships? How are cells organized to perform the work they do? How do cells differentiate into different types? How do cells work together to maintain homeostasis? What are the parts and function of the endomembrane system? How do surface structures of cells help them survive? Standards: 3.1.10A, 3.1.10B, 3.2.10A, 3.3.10B, 3.3.10D, 3.1.12A1,A2,A5,A8 & A9 R11.A.1.3.1, R11.A.2.1.2, R11.A.2.5.1	What is the role of ATP in cells' anabolic and catabolic processes? How do photosystems convert solar energy to chemical energy? How does chemiosmosis generate ATP? What metabolic adaptations do C4 and CAM plants have? What are the products of linear electron flow? What is the structure and function of the mitochondrion? What is the difference between fermentation and cellular respiration? How does pyruvate enter the citric acid cycle? What is chemiosmosis? How does the cell cycle ensure genetic continuity? What is the structure of the replicated chromosome? What are the stages of mitosis? What is the role of kinases and cyclin in the regulation of the cell cycle? Standards: 3.1.12A4, 3.1.12A2, 3.1.10A, 3.1.10 C, 3.1.10E, 3.3.10A, 3.3.10B R11.A.1.3.1, R11.A.2.1.2, R11.A.2.5.1 M11.E.3.1.1.1
AP Biology Big Ideas	**Big Idea 1:** The process of evolution drives the diversity and unity of life. **Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis. **Big Idea 3:** Living systems store, receive, transmit, and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these interactions possess complex properties.	**Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis. **Big Idea 3:** Living systems store, receive, transmit, and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these interactions possess complex properties.	**Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis. **Big Idea 3:** Living systems store, receive, transmit, and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these interactions possess complex properties.
AP Biology Enduring Understandings	**Enduring Understanding 1.A. Change in the genetic makeup of a population over time is evolution** 1.A.1: Natural selection is a major mechanism of evolution 1.A.2: Natural selection acts on phenotypic variations in populations 1.A.3: Evolutionary change is also driven by random processes 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics **Enduring Understanding 1.D: The origin of living systems is explained by natural processes** 1.D.1: There are several hypotheses about the natural origin of life on earth, each with supporting evidence 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life **Enduring Understanding 2.A. Growth, reproduction and maintenance of the organization of living systems require free energy and matter** 2.A.1: All living systems require constant input of free energy 2.A.2: Organisms capture and store free energy for use in biological processes 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization **Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cell create and maintain internal environments that are different from their external environments** 2.B.1: Cell membranes are selectively permeable due to their structure 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules	**Enduring Understanding 2.A. Growth, reproduction and maintenance of the organization of living systems require free energy and matter** 2.A.1: All living systems require constant input of free energy 2.A.2: Organisms capture and store free energy for use in biological processes 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization **Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cell create and maintain internal environments that are different from their external environments** 2.B.1: Cell membranes are selectively permeable due to their structure 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions **Enduring understanding 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.** 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.C.2: Organisms respond to changes in their external environments. **Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment**	**Enduring Understanding 2.A. Growth, reproduction and maintenance of the organization of living systems require free energy and matter** 2.A.1: All living systems require constant input of free energy 2.A.2: Organisms capture and store free energy for use in biological processes 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization **Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cell create and maintain internal environments that are different from their external environments** 2.B.1: Cell membranes are selectively permeable due to their structure 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions **Enduring understanding 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.** 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.C.2: Organisms respond to changes in their external environments. **Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment**

	across membranes. 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions **Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment** 2.D.1: 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 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. **Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.** 2.E.1: 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 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. **Enduring understanding 3.A: Heritable information provides for continuity of life**. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization. 3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. **Enduring understanding 4.A: Interactions within biological systems lead to complex properties.** 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. **Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems**. 4.B.1: Interactions between molecules affect their structure and function. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance. 4.B.4: Distribution of local and global ecosystems changes over time.	2.D.1: 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 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. **Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.** 2.E.1: 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 2.E.2: Timing and coordination of 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**Enduring understanding 4.A: Interactions within biological systems lead to complex properties.** 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. **Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.** 4.C.1: Variation in molecular units provides cells with a wider range of 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AP Biology Science Practices	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.
Content	**Introduction to AP Biology, Classical Darwinian Evolution:** - Introduction to the AP Big Ideas (1-4) - Unifying Themes of Biology and Evolution as the main Unifying Theme - The characteristics of life - Energy and Life's Organization - Unity and Diversity of Life - Evolutionary View of Diversity **Biochemistry** - Elements important to the functioning of organisms - Subatomic particles, atoms and compounds - Ionic, covalent and hydrogen bonds - Chemical reactions - The properties of water - The properties of carbon, carbon compounds, functional groups	**Cell Structure and Function** - Cell Theory - Prokaryotic and Eukaryotic Cells - Structural Organization of Membranes and Compartmentalization of Cell Organelles - The endomembrane system **Membrane Transport and Cell Signaling** - Fluid mosaic model and functioning of the cell membrane - Functioning of membrane proteins - Passive and Active Transport - Endo and Exocytosis - Cell signaling **Metabolism** - ATP, Metabolic Pathways, Laws of Thermodynamics - Free energy - Enzyme Activity - Regulation of enzyme activity	**Cellular Respiration and Fermentation** - Catabolic pathways and redox reactions - Oxidation of glucose, oxidative phosphorylation, chemiosmosis - Fermentation and anaerobic respiration - Alternative metabolic pathways **Photosynthesis** - Structure of the chloroplast - Function of ATP and NADPH - Light dependent and light independent reactions and sites - Sunlight as electromagnetic radiation and function of pigments - The Calvin Cycle - Evolution of alternative mechanisms of carbon fixation **The Cell Cycle** - Purpose of cell division - Organization of the genetic material - Distribution of the chromosomes during eukaryotic cell division - Phases of the cell cycle, phases of mitosis - Binary fission in bacteria and the evolution of mitosis - Regulation of the cell cycle in eukaryotic cells
Skills	- Collect and analyze data, utilize and apply statistical analysis to biological concepts and create, read and interpret graphs and data tables - Explain how evolution is the unifying theme of all biology - Relate structure and function to the organization of living things - Identify the characteristics of all living things - Evaluate the impact of scientific research on the environment and society. - Distinguish between forming a hypothesis and making a prediction - Differentiate a control group from an experimental group and an independent variable from a dependent variable. - Define the word theory as used by a scientist - Differentiate between atoms and elements - Analyze how compounds are formed - Distinguish between covalent bonds, hydrogen bonds, and ionic bonds - Understand and apply the chemical and physical properties of water - Relate the structure of the major molecules of life to their functions within living things - Understand how functional groups impact the functioning of biological compounds - Join and separate the monomer units of each group of biological molecules using dehydration synthesis and hydrolysis reactions	- List the 3 parts of the cell theory - Compare and contrast the characteristics of prokaryotic and eukaryotic cells - Compare and contrast the characteristics of plant and animal cells - Explain the fluid-mosaic model - Describe cellular organization - Relate cellular organization to cell differentiation - Relate cellular organization to the functioning of the endomembrane system - Discuss the first two laws of thermodynamics and relate entropy to free energy - Relate energy and chemical reactions - Describe the role of enzymes in chemical reactions - Use graphical analysis to determine the end point of an enzyme-catalyzed reaction - Design a controlled experiment to test the effect of varying pH or temperature on enzyme activity - Relate concentration gradients, diffusion, and equilibrium - Compare active transport with passive transport - Distinguish between endocytosis and exocytosis	- Describe the anatomy of the mitochondria and chloroplast - Understand and explain the movement of electrons across membranes and relate those movements to diffusion, redox reactions and enzyme activity - Compare and contrast aerobic and anaerobic respiration (function and ATP yield) - Analyze the flow of energy through living systems. - Summarize how energy is captured from sunlight in the first stage of photosynthesis. - Summarize the light dependent and independent reactions. - Analyze the function of electron transport chains. - Summarize glycolysis, fermentation and the Krebs Cycle - Evaluate the importance of oxygen in aerobic respiration. - Differentiate between a gene, a DNA molecule, a chromosome and a chromatid - Identify the major events that characterize each of the five phases of the cell cycle and summarize the events of the four stages of mitosis. - List and describe the regulation of the cell cycle and the biological basis of cancer
Assessment			

	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)
Activities	- Inquiry cube activity - Properties of water activity - Case study from University of Buffalo - Pogil biochemistry basics activity - Animal Behavior lab #12 - Identification of carbon compounds lab - Using models to build carbon compounds	- Pogil Activity: Membrane Function - Pogil Acitivty: Cell communication - Enzyme active site/substrate modeling kit hands-on activity - Osmosis and Diffusion Lab #4 - Enzyme Lab # 13 - Case study from the University of Buffalo	- Pogil Activity: ATP – The free energy carrier - Student abstract search: Cellular Respiration and Photosynthesis - Pogil Activity: Oxidative Phosphorylation - Cellular Respiration Lab #6 - Photosynthesis Lab # 5 - Case study from the University of Buffalo (Cellular Respiration)
Resources	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams

	December/January	**January/February**	**February/March**
Essential Questions/PA Academic Standards	What features of meiosis are important to heredity? How are sperm and egg cells generated? How are mitosis and meiosis similar and different? Why is crossing-over important? How are traits passed on from parents to offspring? What is the relationship between genotypes and phenotypes? What is the difference between an allele and a gene? What are Mendel's 3 principles of inheritance? How is the inheritance of sex-linked genes different from regular inheritance? How can alteration of chromosome number or structurally altered chromosome lead to genetic disorders? How do you read a pedigree? How do the structure of nucleic acids relate to their functions of information storage and protein synthesis? What scientists were involved in the discovery of DNA? How was the structure of DNA discovered? How is DNA replicated? Standards: 3.1.12B1, 3.1.12B2, 3.1.12B3, 3.1.12B5 R11.A.1.3.1, R11.A.2.1.2, R11.A.2.5.1 M11.A.2.1.1, M11A.1.1.2	What role does natural selection play in the process of evolution? What scientists contributed to evolutionary theory? How do fossils support evolutionary theory? What is Charles Darwin's theory of natural selection? How do mutation and sexual reproduction lead to genetic variation? What are the conditions for Hardy-Weinberg equilibrium? How do you use the Hardy-Weinberg equation to see if a population is evolving? How do geographic barriers influence the development of new species? Distinguish between microevolution and macroevolution. How does reproductive isolation help maintain populations? Standards: 3.1.12C1, 3.1.12C2, 3.1.12C3, 3.1.10A, 3.1.10B, 3.3.10D R11.A.1.3.1, R11.A.2.1.2, R11.A.2.5.1	How does the organization of cells, tissues and organs determine the structures and functions in plant systems? How does the organization of cells, tissues and organs determine the structures and functions in animal systems? How may have life spontaneously arisen on Earth? What factors led to the divergence of organisms? How are bacteria different from eukaryotes in terms of genome, organelles, size, and reproduction? What are the unique features of bacterial life processes? What are the components of a virus? How do major groups of protists compare to other eukaryotes? What are the characteristics of fungi? What important ecological roles to fungi play in ecosystems? What are the stages of animal development? What advances in body structure made animals larger and more complex? Standards: 3.1.12A2, 3.1.12A5, 3.1.12C3, 3.1.B.A1, 3.1.B.A4, 3.1.12.C3, 3.1.B.A3,
AP Biology Big Ideas	**Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis. **Big Idea 3:** Living systems store, receive, transmit, and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these interactions possess complex properties.	**Big Idea 1:** The process of evolution drives the diversity and unity of life.	**Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis. **Big Idea 3:** Living systems store, receive, transmit, and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these interactions possess complex properties.

AP Biology Enduring Understandings	**Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.** 2.E.1: 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 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. **Enduring understanding 3.A: Heritable information provides for continuity of life**. 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information. 3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization. 3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. **Enduring understanding 3.B: Expression of genetic information involves cellular and molecular mechanisms.** 3.B.1: Gene regulation results in differential gene expression, leading to cell specialization 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression. **Enduring understanding 3.C: The processing of genetic information is imperfect and is a source of genetic variation.** 3.C.1: Changes in genotype can result in changes in phenotype. 3.C.2: Biological systems have multiple processes that increase genetic variation 3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts. **Enduring understanding 4.A: Interactions within biological systems lead to complex properties.** 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule. 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes. 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs. 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. **Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.** 4.C.1: Variation in molecular units provides cells with a wider range of functions. 4.C.2: Environmental factors influence the expression of the genotype in an organism. 4.C.3: The level of variation in a population affects population dynamics. 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.	**Enduring Understanding 1.A. Change in the genetic makeup of a population over time is evolution** 1.A.1: Natural selection is a major mechanism of evolution 1.A.2: Natural selection acts on phenotypic variations in populations 1.A.3: Evolutionary change is also driven by random processes 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics **Enduring Understanding 1.B: Organisms are linked by lines of descent from common ancestry** 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today 1.B.2: Phylogenetic trees and cladograms are graphical representations of evolutionary history that can be tested. **Enduring Understanding 1.C: Life continues to evolve within a changing environment** 1.C.1: Speciation and extinction have occurred throughout the Earth's history 1.C.2: Speciation may occur when two populations become reproductively isolated from each other 1.C.3: Populations of organisms continue to evolve **Enduring Understanding 1.D: The origin of living systems is explained by natural processes** 1.D.1: There are several hypotheses about the natural origin of life on earth, each with supporting evidence 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life	**Enduring Understanding 2.A. Growth, reproduction and maintenance of the organization of living systems require free energy and matter** 2.A.1: All living systems require constant input of free energy **Enduring understanding 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.** 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. 2.C.2: Organisms respond to changes in their external environments. **Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment** 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. **Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.** 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms. **Enduring understanding 3.C: The processing of genetic information is imperfect and is a source of genetic variation.** 3.C.2: Biological systems have multiple processes that increase genetic variation 3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts. **Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals.** 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling **Enduring understanding 3.E: Transmission of information results in changes within and between biological systems.** 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses. **Enduring understanding 4.A: Interactions within biological systems lead to complex properties.** 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts. **Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems**. 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.

AP Biology Science Practices	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.
Content	**Meiosis and Sexual Life Cycles:** - Inheritance of genes - Purpose of reduction/division of Meiosis - Organization of the genetic material in meiosis - Distribution of the chromosomes during meiosis - Phases of meiosis - How genetic variation is produced during meiosis - The evolutionary significance of genetic variation **Mendelian Genetics** - Mendel's experiments and laws - Use of probability and Punnett squares - Inheritance patterns (both Mendelian and complex patterns) - Analysis of pedigrees and genetic disorders **DNA and Gene Expression** - Transformation and the discovery of DNA as the genetic material - The structure of DNA - The process of DNA replication - The structure of a chromosome - Genetic engineering (restriction enzymes, PCR, sequencing) - The flow of genetic information (central dogma) - The process of transcription and translation - RNA processing and regulation of gene expression - Mutations	**Decent with Modification** - Darwinian Evolution - Ideas about change over time, Lamarck's Hypothesis of Evolution - Decent with modification by natural selection - The voyage of the Beagle and the Galapagos Islands - Evidence of evolution **Phylogeny** - Classification and evolutionary relationships - Cladograms/Phylogenic trees - Molecular clocks - Acceptance of continuous change in biology **The Evolution of Populations** - Genetic variation - The Hardy-Weinberg Principle - Gene pools and Allele frequencies - Natural selection, genetic drift and gene flow - Adaptive evolution, Balancing selection, sexual selection	**Early Life and the Diversification of Prokaryotes** - Synthesis of organic compounds - Rapid reproduction, mutation and genetic recombination in prokaryotes - The role of prokaryotes in the biosphere **The Diversification of Eukaryotes** - Multicellularity - Endosymbiosis - Structural and functional diversity in prokaryotes - Rise of plant and animal diversity **Plant and Animal Form and Function** - Plant structure and growth - Plant Responses to Internal and External Signals - Animal structure and growth - The endocrine and nervous system of animals - Regulation of the internal environment, neuron function and immunity
Skills	- Use and apply the principles of probability and Punnett squares to determine the outcome of genetic crosses - Explain the mechanism of the principle patterns of inheritance - Create and interpret pedigrees to track traits through generations - Create and analyze linkage maps using cross-over rates - Explore the inheritance patterns of living organisms - Use technology and equipment to analyze data - Compare and contrast the structure and function of DNA and RNA - Compare and contrast the structure and function of replication and transcription - Understand and explain protein synthesis - Discuss prokaryotic gene regulation - Insert a gene into a bacterium	- Describe the current models for the origin of prokaryotic and eukaryotic cells - Explain the evidence supporting the evolutionary view of life - Discuss speciation and macroevolution - Explain how natural selection and heredity are involved in the process of evolution - Contrast between domains and kingdoms and relate to binomial nomenclature - Construct and analyze cladograms - Determine the frequency of alleles and genotypes in the gene pool of a population using the Hardy-Weinberg Law of Genetic Equilibrium - Use technology and equipment to generate and analyze data	- Describe the current models for the origin of prokaryotic and eukaryotic cells - Distinguish among the major tissue types of vascular plants - Trace transport of nutrients and water throughout a vascular plant - Identify and explain the biochemical structure and function of plant hormones - Provide examples of plant response to stimuli - Investigate animal communication and defense processes - Explain how cell signaling impacted homeostasis and differentiation in animal development - Explore the evolution, organization, and structure and function of the nervous, endocrine and immune systems - Investigate animal behavior patterns
Assessment	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)

Activities	- Review animations and view Sordaria Plate showing crossing over - Pogil Activity: Gene expression and Genetic Mutations - Pogil Acitivty: The statistics of inheritance - Pedigree problems, Punnett Square Problems, Chi square activity - Meiosis pipe cleaner activity - Mitosis and Meiosis Lab #7 - Restriction Enzyme Lab # 9 - Case study from the University of Buffalo	- Pogil Activity: Selection and Speciation - Pogil Acitivty: Phylogenic trees - Hardy-Weinberg Equation Activity - Hardy-Weinberg Lab #2 - BLAST Lab # 3 - Artificial Selection Lab #1 - Case study from the University of Buffalo	- Begin test prep (free response practice, timing, analysis) - Pogil Activity: plant hormones - Pogil Activity: neuron function and immunity - Transpiration Lab #11 - Case study from the University of Buffalo - Student abstract search: animal/plant communication
Resources	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams

	April/Beginning of May
Essential Questions/PA Academic Standards	How are living things affected by the abiotic and biotic factors in the environment? What provides energy for life and how does it flow through ecosystems? How are living things distributed according to the presence of natural resources? What factors limit population growth? What types of behaviors influence species interactions in ecosystems? What defines specie's niche? How does energy and materials flow through an ecosystem? What factors characterize the world's biomes? How does human activity impact ecosystems? Standards: 3.1.12.A5, 3.1.12.A8, 3.1.12.A9, 4.1.12.A, 4.1.12.B, 4.1.10.E, 4.1.12.F, 4.2.10.C R11.A.1.3.1, R11.A.2.1.2, R11.A.2.5.1 M11.A.2.1.1, M11A.1.1.2
AP Biology Big Ideas	**Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis. **Big Idea 3:** Living systems store, receive, transmit, and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these interactions possess complex properties.
AP Biology Enduring Understandings	**Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment** 2.D.1: 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 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis. **Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.** 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. **Enduring understanding 3.E: Transmission of information results in changes within and between biological systems.**

	3.E.1: Individuals can act on information and communicate it to others. **Enduring understanding 4.A: Interactions within biological systems lead to complex properties.** 4.A.5: Communities are composed of populations of organisms that interact in complex ways. 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. **Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems**. 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance. 4.B.4: Distribution of local and global ecosystems changes over time. **Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.** 4.C.3: The level of variation in a population affects population dynamics. 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.
AP Biology Science Practices	**Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice 2**: The student can use mathematics appropriately. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course. **Science Practice 4**: The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice 5**: The student can perform data analysis and evaluation of evidence. **Science Practice 6:** The student can work with scientific explanations and theories. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.
Content	**Population Ecology and the Distribution of Organisms** - Climate patterns and biomes - Aquatic biomes - Interactions between organisms and the environment - Biotic and Abiotic factors - Changes in population size, exponential growth and carrying capacity **Ecological Communities, Ecosystems and Energy** - Competition, exploitation and positive interactions amongst organisms - Diversity and community stability - Ecological succession and human disturbance - Conservation of energy and mass, trophic levels - Energy transfer between trophic levels and efficiency - Decomposition and nutrient cycling - Bioremediation - Human impact on Earth’s biodiversity and the biosphere
Skills	- Compare the effect of biotic and abiotic factors on population size and the structure of the community

	- Analyze energy flow through an ecosystem related to trophic structure - Understand and describe matter cycling (carbon, nitrogen and water cycles) through ecosystems - Describe the effects human populations have on ecosystems - Discuss the models that are used to describe population growth
Assessment	- Class Discussions - AP Biology Exam Practice Questions (Both multiple choice and written response) - Mastering Biology Dynamic Study Modules - Mastering Biology Chapter Quizzes - AP Biology Labs (formal lab reports/scientific papers and use of Pascoe scientific laboratory equipment) - Unit Exam (teacher made, multiple choice, modified true and false, fill in the blank, short answer and essay all in one test, infusion of AP Sample Questions and Written Response questions)
Activities	- Continue exam preparation through use of free response questions and sample test questions, timing and question analysis - Pogil Activity: Global climate change - Transpiration Lab #11 - Energy Dynamics Lab # 10 - Student abstract research - Case study from the University of Buffalo
Resources	- Urry et. al. (2020) *Campbell Biology in Focus*. Boston, MA: Pearson - Pearson: Mastering Biology - AP Biology Investigative Labs: College Board - Pascoe Scientific Lab Equipment - Pogil Activities for AP Biology - University of Buffalo Case Studies - College Board AP Practices Questions and Exams