AP Biology

Curriculum/Content Area: Science	**Course Length:** 2 Terms
Course Title: AP Biology	**Date last reviewed:** 2018
Prerequisites: Biology and Chemistry	**Board approval date:** May 2018
Primary Resource:	

Desired Results

Course description and purpose:
Advanced Placement Biology is designed to be the equivalent of a college level, introductory biology course taken by biology majors. This course differs significantly from the usual high school biology course in respect to the range and depth of topics covered and the time and effort required. A heavy emphasis will be placed on inquiry-based laboratory investigations. For each unit students will design and execute at least two investigations and present their findings. All investigations and activities will emphasize seven science practice that are designed to deepen students understanding of each big idea and allow connections to be made between each one. AP Biology will provide opportunities for students to develop, record, and communicate the results of laboratory investigations.

Enduring Understandings:
AP Biology Enduring Understandings are defined within each unit.

Big Idea #1: The process of evolution drives the diversity and unity of life.
Enduring Understandings: 1. Change in the genetic makeup of a population over time is evolution. 2. Organisms are linked by lines of descent from common ancestry. 3. Life continues to evolve within a changing environment. 4. The origin of living systems is explained by natural processes.
Standards:
<u>**Advanced Placement Essential Knowledge**</u> **EK1.A.1** Natural selection is a major mechanism of evolution. **EK1.A.2** Natural selection acts as on phenotypic variations in populations.

EK1.A.3 Evolutionary change is also driven by random processes.
EK1.A.4 Biological evolution is supported by scientific evidence from many disciplines, including mathematics.
EK1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
EK1.B.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
EK1.C.1 Speciation and extinction have occurred throughout the Earth's history.
EK1.C.2 Speciation may occur when two populations become reproductively isolated from each other.
EK1.C.3 Populations of organisms continue to evolve.
EK1.D.1 There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
EK1.D.2 Scientific evidence from many different disciplines supports models of the origin of life.

Advanced Placement Science Practices

SP1 The student can use representations and models to communicate scientific phenomena and solve scientific problems.
SP2 The student can use mathematics appropriately.
SP3 The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
SP4 The student can plan and implement data collection strategies in relation to a particular scientific question.
SP5 The student can perform data analysis and evaluation of evidence.

SP5 The student can perform data analysis and evaluation of evidence.
SP6 The student can work with scientific explanations and theories.
SP7 The student is able to connect and relate knowledge across various scales concepts, and representations in and across domains.

Learning Targets:

- I can convert a data set from a table of numbers that reflect a change in the genetic makeup of a population over time and to apply mathematical methods and conceptual understandings to investigate the cause(s) and effect(s) of this change. (EK1.A.1, SP1, SP2)
- I can evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution. (EK1.A.1, SP2, SP5)
- I can apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. (EK1.A.1, SP2)
- I can evaluate data-based evidence that describes evolutionary changes in the genetic

makeup of a population over time. (EK1.A.2, SP5)

- I can connect evolutionary changes in a population over time to a change in the environment.(EK1.A.2, SP7)
- I can use data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and effects of selection in the evolution of specific populations. (EK1.A.3, SP1, SP2)
- I can 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. (EK1.A.3, SP2)
- I can make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population. (EK1.A.3, SP6)
- I can evaluate evidence provided by data from many scientific disciplines that support biological evolution. (EK1.A.4, SP5)
- I can refine evidence based on data from many scientific disciplines that support biological evolution. (EK1.A.4, SP5)
- I can design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology. (EK1.A.4, SP4)
- I can connect scientific evidence from many scientific disciplines to support the modern concept of evolution. (EK1.A.4, SP7)
- I can construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution. (EK1.A.4, SP1, SP2)
- I can pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth. (EK1.B.1, SP3)
- I can 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. (EK1.B.1, SP7)
- I can justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. (EK1.B.1, SP6)
- I can 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. (EK1.B.2, SP3)
- I can evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. (EK1.B.2, SP5)
- I can create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set. (EK1.B.2, SP1)
- I can analyze data related to questions of speciation and extinction throughout the Earth's history. (EK1.C.1, SP5)

- I can design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history. (EK1.C.1, SP4)
- I can 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. (EK1.C.2, SP6)
- I can justify the selection of data that address questions related to reproductive isolation and speciation. (EK1.C.2, SP4)
- I can describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection and/or genetic drift. (EK1.C.2, SP7)
- I can describe a model that represents evolution within a population. (EK1.C.3, SP1)
- I can evaluate given data sets that illustrate evolution as an ongoing process. (EK1.C.3, SP5)
- I can describe a scientific hypothesis about the origin of life on Earth. (EK1.D.1, SP1)
- I can evaluate scientific questions based on hypotheses about the origin of life on Earth. (EK1.D.1, SP3)
- I can describe the reasons for revisions of scientific hypotheses of the origin of life on Earth. (EK1.D.1, SP6)
- I can evaluate scientific hypotheses about the origin of life on Earth. (EK1.D.1, SP6)
- I can evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth. (EK1.D.1, SP4)
- I can justify the selection of geological, physical, and chemical data that reveal early Earth conditions.(EK1.D.2, SP4)

Assessment Evidence:

Performance Assessment Options *May include, but are not limited to the following:* •	**Other assessment options** *May include, but are not limited to the following:* •

Big Idea #2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.

Enduring Understandings:

1. Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
2. Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
3. Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
4. Growth and dynamic homeostasis of a biological system are influenced by changes in

the system's environment.

5. Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

Standards:

Advanced Placement Essential Knowledge

EK2.A.1 All living systems require constant input of free energy.
EK2.A.2 Organisms capture and store free energy for use in biological processes.
EK2.A.3 Organisms must exchange matter with the environment to grow, reproduce and maintain organization.
EK2.B.1 Cell membranes are selectively permeable due to their structure.
EK2.B.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
EK2.B.3 Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.
EK2.C.2 Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
EK2.C.2 Organisms respond to changes in their external environments.

EK2.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.
EK2.D.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.
EK2.D.3 Biological systems are affected by disruptions to their dynamic homeostasis.
EK2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.
EK2.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.
EK2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.
EK2.E.3 Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

Advanced Placement Science Practices

SP1 The student can use representations and models to communicate scientific phenomena and solve scientific problems.
SP2 The student can use mathematics appropriately.
SP3 The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
SP4 The student can plan and implement data collection strategies in relation to a particular

scientific question.

SP5 The student can perform data analysis and evaluation of evidence.

SP5 The student can perform data analysis and evaluation of evidence.
SP6 The student can work with scientific explanations and theories.
SP7 The student is able to connect and relate knowledge across various scales concepts, and representations in and across domains.

Learning Targets:

- I can 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.(EK2.A.1, SP6)
- I can justify a scientific claim that free energy is required for living systems to maintain organization, to grow or to reproduce, but that multiple strategies exist in different living systems. (EK2.A.1, SP6)
- I can predict how changes in free energy availability affect organisms, populations and ecosystems. (EK2.A.1, SP6)
- I can use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store and use free energy. (EK2.A.2, SP1, SP3)
- I can construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store or use free energy. (EK2.A.2, SP6)
- I can use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion. (EK2.A.3, SP2)
- I can explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination. (EK2.A.3, SP6)
- I can 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. (EK2.A.3, SP4)
- I can represent graphically or model quantitatively the exchange of molecules between an organism and its environment, and the subsequent use of these molecules to build new molecules that facilitate dynamic homeostasis, growth and reproduction. (EK2.A.3, SP1)
- I can use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. (EK2.B.1, SP1, SP3)
- I can construct models that connect the movement of molecules across membranes with membrane structure and function. (EK2.B.1, SP1, SP7)
- I can use representations and models to analyze situations or solve problems qualitatively and quantitatively to investigate whether dynamic homeostasis is maintained by the active movement of molecules across membranes. (EK2.B.2, SP1)
- I can explain how internal membranes and organelles contribute to cell functions.

(EK2.B.3, SP6)

- I can use representations and models to describe differences in prokaryotic and eukaryotic cells. (EK2.B.3, SP1)
- I can 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. (EK2.C.1, SP6)
- I can connect how organisms use negative feedback to maintain their internal environments. (EK2.C.1, SP7)
- I can evaluate data that show the effects of changes in concentrations of key molecules on negative feedback mechanisms. (EK2.C.1, SP5)
- I can make predictions about how organisms use negative feedback mechanisms to maintain their internal environments. (EK2.C.1, SP6)
- I can make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models.(EK2.C.1, SP6)
- I can justify that positive feedback mechanisms amplify responses in organisms. (EK2.C.1, SP6)
- I can 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. (EK2.C.2, SP4)
- I can pose a scientific question concerning the behavioral or physiological response of an organism to a change in its environment. (EK2.C.2, SP3)
- I can 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. (EK2.D.1, SP1, SP3)
- I can 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. (EK2.D.1, SP4, SP7)
- I can analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities or ecosystems). (EK2.D.1, SP5)
- I can construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments. (EK2.D.2, SP6)
- I can 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. (EK2.D.2, SP5)
- I can connect differences in the environment with the evolution of homeostatic mechanisms. (EK2.D.2, SP7)
- I can use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. (EK2.D.3, SP1)
- I can create representations and models to describe immune responses. (EK2.D.4, SP1)
- I can can create representations or models to describe nonspecific immune defenses in

plants and animals. (EK2.D.3, SP1)

- I can connect the concept of cell communication to the functioning of the immune system. (EK2.D.4, SP7)
- I can connect concepts in and across domains to show that timing and coordination of specific events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms. (EK2.E.1, SP7)
- I can use a graph or diagram to analyze situations or solve problems (quantitatively or qualitatively) that involve timing and coordination of events necessary for normal development in an organism. (EK2.E.1, SP1)
- I can justify scientific claims with scientific evidence to show that timing and coordination of several events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms. (EK2.E.1, SP6)
- I can able to describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis. (EK2.E.1, SP7)
- I can design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation. (EK2.E.2, SP4)
- I can justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.(EK2.E.2, SP6)
- I can connect concepts that describe mechanisms that regulate the timing and coordination of physiological events. (EK2.E.2, SP7)
- I can analyze data to support the claim that responses to information and communication of information affect natural selection. (EK2.3, SP5)
- I can justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms. (EK2.E.3, SP6)
- I can connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior.(EK2.E.3, SP7)

Assessment Evidence:

Performance Assessment Options *May include, but are not limited to the following:* •	**Other assessment options** *May include, but are not limited to the following:* •

Big Idea #3: Living systems store, retrieve, transmit and respond to information essential to life processes.

Enduring Understandings:

1. Heritable information provides for continuity of life.
2. Expression of genetic information involves cellular and molecular mechanisms.

3. The processing of genetic information is imperfect and is a source of genetic variation.
4. Cells communicate by generating, transmitting and receiving chemical signals.
5. Transmission of information results in changes within and between biological systems.

Standards:

Advanced Placement Essential Knowledge

EK3.A.1 DNA, and in some cases RNA, is the primary source of heritable information.
EK3.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.
EK3.A.3 The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.
EK3.A.4 The inheritance pattern of many traits cannot be explained by simple mendelian genetics.
EK3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.
EK3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression.
EK3.C.1 Changes in genotype can result in changes in phenotype.

EK3.C.2 Biological systems have multiple processes that increase genetic variation.
EK3.C.3 Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.
EK3.D.1 Cell communication processes share common features that reflect a shared evolutionary history.
EK3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.
EK3.D.3 Signal transduction pathways link signal reception with cellular response.
EK3.D.4 Changes in signal transduction pathways can alter cellular response.
EK3.E.1 Individuals can act on information and communicate it to others.
EK3.E.2 Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.

Advanced Placement Science Practices

SP1 The student can use representations and models to communicate scientific phenomena and solve scientific problems.
SP2 The student can use mathematics appropriately.
SP3 The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
SP4 The student can plan and implement data collection strategies in relation to a particular scientific question.
SP5 The student can perform data analysis and evaluation of evidence.

SP5 The student can perform data analysis and evaluation of evidence.

SP6 The student can work with scientific explanations and theories.
SP7 The student is able to connect and relate knowledge across various scales concepts, and representations in and across domains.

Learning Targets:

- I can 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.(EK3.A.1, SP6)
- I can justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information. (EK3.A.1, SP 4)
- I can describe representations and models that illustrate how genetic information is copied for transmission between generations. (EK3.A.1, SP1)
- I can describe representations and models illustrating how genetic information is translated into polypeptides. (EK3.A.1, SP1)
- I can justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies. (EK3.A.1, SP6)

- I can predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. (EK3.A.1, SP6)
- I can make predictions about natural phenomena occurring during the cell cycle. (EK3.A.2, SP6)
- I can describe the events that occur in the cell cycle.EK3.A.2, SP1)
- I can 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. (EK3.A.2, SP6)
- I can represent the connection between meiosis and increased genetic diversity necessary for evolution. EK3.A.2, SP7)
- I can evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another generation through mitosis, or meiosis followed by fertilization. (EK3.A.2, SP5)
- I can construct a representation that connects the process of meiosis to the passage of traits from parent to offspring. (EK3.A.3, SP1, SP7)
- I can pose questions about ethical, social or medical issues surrounding human genetic disorders. (EK3,A.3, SP3)
- I can apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. (EK3.A.3, SP2)
- I can explain deviations from Mendel's model of the inheritance of traits. (EK3.A.4, SP6)
- I can explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. (EK3.A.4, SP6)
- I can describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits. (EK3.A.4, SP1)

- I can describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.(EK3.B.1, SP7)
- I can describe the connection between the regulation of gene expression and observed differences between individuals in a population. (EK3.B.1, SP7)
- I can explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function. (EK3.B.1, SP6)
- I can use representations to describe how gene regulation influences cell products and function. (EK3.B.1, SP1)
- I can explain how signal pathways mediate gene expression, including how this process can affect protein production. (EK3.B.2, SP6)
- I can use representations to describe mechanisms of the regulation of gene expression. (EK3.B.2, SP1)
- I can predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.(EK3.C.1, SP6, SP7)
- I can create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. (EK3.C.1, SP1)
- I can explain the connection between genetic variations in organisms and phenotypic variations in populations. (EK3.C.1, SP7)
- I can compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains. (EK3.C.2, SP7)
- I can construct an explanation of the multiple processes that increase variation within a population. (EK3.C.2, SP6)
- I can construct an explanation of how viruses introduce genetic variation in host organisms. (EK3.C.3, SP6)
- I can use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population. (EK3.C.3, SP1)
- I can describe basic chemical processes for cell communication shared across evolutionary lines of descent. (EK3.D.1, SP7)
- I can generate scientific questions involving cell communication as it relates to the process of evolution. (EK3.D.1, SP3)
- I can use representation(s) and appropriate models to describe features of a cell signaling pathway. (EK3.D.1, SP1)
- I can construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. (EK3.D.2, SP6)
- I can create representations that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. (EK3.D.2, SP1)
- I can describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response. (EK3.D.3, SP1)
- I can justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response. (EK3.D.4, SP6)
- I can describe a model that expresses key elements to show how change in signal transduction can alter cellular response. (EK3.D.4, SP1)

- I can construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways. (EK3.D.4, SP6)
- I can analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior. (EK3.E.1, SP5)
- I can 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. (EK3.E.1, SP1)
- I can describe how organisms exchange information in response to internal changes or environmental cues. (EK3.E.1, SP7)
- I can construct an explanation, based on scientific theories and models, about how nervous systems detect external and internal signals, transmit and integrate information, and produce responses. (EK3.E.2, SP6, SP7)
- I can describe how nervous systems detect external and internal signals. (EK3.E.2, SP1)
- I can describe how nervous systems transmit information. (EK3.E.2, SP1)
- I can describe how the vertebrate brain integrates information to produce a response. (EK3.E.2, SP1)
- I can create a visual representation of complex nervous systems to describe/explain how these systems detect external and internal signals, transmit and integrate information, and produce responses. (EK3.E.2, SP1)
- I can create a visual representation to describe how nervous systems detect external and internal signals. (EK3.E.2, SP1)
- I can create a visual representation to describe how nervous systems transmit information. (EK3.E.2, SP1)
- I can create a visual representation to describe how the vertebrate brain integrates information to produce a response.(EK3.E.2, SP1)

Assessment Evidence:	
Performance Assessment Options *May include, but are not limited to the following:* •	**Other assessment options** *May include, but are not limited to the following:* •

Big Idea #4: Biological systems interact, and these systems and their interactions possess complex properties

Enduring Understandings:

1. Interactions within biological systems lead to complex properties.
2. Competition and cooperation are important aspects of biological systems.
3. Naturally occurring diversity among and between components within biological systems

affects interactions with the environment.

Standards:

Advanced Placement Essential Knowledge

EK4.A.1 The subcomponents of biological molecules and their sequence determine the properties of that molecule.
EK4.A.2 The structure and function of subcellular components, and their interactions, provide essential cellular processes.
EK4.A.3 Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.
EK4.A.4 Organisms exhibit complex properties due to interactions between their constituent parts.
EK4.A.5 Communities are composed of populations of organisms that interact in complex ways.
EK4.A.6 Interactions among living systems and with their environment result in the movement of matter and energy.
EK4.B.1 Interactions between molecules affect their structure and function.
EK4.B.2 Cooperative interactions within organisms promote efficiency in the use of energy and matter.
EK4.B.3 Interactions between and within populations influence patterns of species distribution and abundance.
EK4.B.4 Distribution of local and global ecosystems changes over time.
EK4.C.1 Variation in molecular units provides cells with a wider range of functions.
EK4.C.2 Environmental factors influence the expression of the genotype in an organism.
EK4.C.3 The level of variation in a population affects population dynamics.
EK4.C.4 The diversity of species within an ecosystem may influence the stability of the ecosystem.

Advanced Placement Science Practices

SP1 The student can use representations and models to communicate scientific phenomena and solve scientific problems.
SP2 The student can use mathematics appropriately.
SP3 The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
SP4 The student can plan and implement data collection strategies in relation to a particular scientific question.
SP5 The student can perform data analysis and evaluation of evidence.

SP5 The student can perform data analysis and evaluation of evidence.
SP6 The student can work with scientific explanations and theories.
SP7 The student is able to connect and relate knowledge across various scales concepts, and representations in and across domains.

Learning Targets:

- I can explain the connection between the sequence and the subcomponents of a biological polymer and its properties. (EK4.A.1, SP7)
- I can refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer. (EK4.A.1, SP1)
- I can use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule. (EK4.A.1, SP6)
- I can make a prediction about the interactions of subcellular organelles. (EK4.A.2, SP6)
- I can construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. (EK4.A.2, SP6)
- I can use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions. (EK4.A.2, SP1)

- I can refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs. (EK4.A.3, SP1)
- I can predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s). (EK4.A.4, SP3)
- I can refine representations and models to illustrate biocomplexity due to interactions of the constituent parts.(EK4.A.4, SP1)
- I can justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities. (EK4.A.5, SP1, SP4)
- I can apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. (EK4.A.5, SP2)
- I can predict the effects of a change in the community's populations on the community. (EK4.A.5, SP6)
- I can apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. (EK4.A.6, SP2)
- I can use visual representations to analyze situations or solve problems qualitatively to illustrate how interactions among living systems and with their environment result in the movement of matter and energy. (EK4.A.6, SP1)
- I can predict the effects of a change of matter or energy availability on communities. (EK4.A.6, SP6)
- I can analyze data to identify how molecular interactions affect structure and function.(EK4.B.1, SP5)
- I can use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter. (EK4.B.2, SP1)
- I can use data analysis to refine observations and measurements regarding the effect of

population interactions on patterns of species distribution and abundance. (EK4.B.3, SP2, SP5)

- I can explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past. (EK4.B.4, SP6)
- I can predict consequences of human actions on both local and global ecosystems.(EK4.B.4, SP6)
- I can construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions. (EK4.C.1, SP6)
- I can construct explanations of the influence of environmental factors on the phenotype of an organism. (EK4.C.2, SP6)
- I can predict the effects of a change in an environmental factor on the genotypic expression of the phenotype. (EK4.C.2, SP6)
- I can 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. (EK4.C.3, SP6)
- I can use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness. (EK4.C.3, SP6)
- I can make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability. (EK4.C.4, SP6)

Assessment Evidence:

Performance Assessment Options *May include, but are not limited to the following:* •	**Other assessment options** *May include, but are not limited to the following:* •