AP Biology Standards: Working Version

Big Idea 1: The process of evolution drives the diversity and unity of life.

EU 1.A: Change in the genetic makeup of a population over time is evolution.

Standard 1.1: Natural selection is a major mechanism of evolution.

- LO 1.1 . . .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. [SP 1.5, 2.2]
- LO 1.2 . . .evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution. [SP 2.2, 5.3]
- LO 1.3 . . .apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. [SP 2.2]

Standard 1.2: Natural selection acts on phenotypic variations in populations.

- LO 1.4 . . .evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time. [SP 5.3]
- LO 1.5 . . .connect evolutionary changes in a population over time to a change in the environment. [SP 7.1]

Standard 1.3: Evolutionary change is also driven by random processes.

- LO 1.6 . . .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. [SP 1.4, 2.1]
- LO 1.7 . . .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. [SP 2.1]
- LO 1.8 . . .make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population. [SP 6.4]

Standard 1.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics.

- LO 1.9 . . .evaluate evidence provided by data from many scientific disciplines that support biological evolution. [SP 5.3]
- LO 1.10 . . .refine evidence based on data from many scientific disciplines that support biological evolution. [SP 5.2]
- LO 1.11 . . .design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology. [SP 4.2]
- LO 1.12 . . .connect scientific evidence from many scientific disciplines to support the modern concept of evolution. [SP 7.1]
- LO 1.13 . . .construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution. [SP 1.1, 2.1]

EU 1.B: Organisms are linked by lines of descent from common ancestry.

Standard 1.5: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

- LO 1.14 . . .pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth. [SP 3.1]
- LO 1.15 . . .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. [SP 7.2]
- LO 1.16 . . .justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. [SP 6.1]

Standard 1.6: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.

- LO 1.17 . . .pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladograms 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. [SP 3.1]
- LO 1.18 . . .evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. [SP 5.3]
- LO 1.19 The student is able create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set. [SP 1.1]

EU 1.C: Life continues to evolve within a changing environment.

Standard 1.7: Speciation and extinction have occurred throughout the Earth's history.

- LO 1.20 . . .analyze data related to questions of speciation and extinction throughout the Earth's history. [SP 5.1]
- LO 1.21 . . .design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history. [SP 4.2]

Standard 1.8: Speciation may occur when two populations become reproductively isolated from each other.

- LO 1.22 . . .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. [SP 6.4]
- LO 1.23 . . .justify the selection of data that address questions related to reproductive isolation and speciation. [SP 4.1]
- LO 1.24 . . .describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection and/or genetic drift. [SP 7.2]

Standard 1.9: Populations of organisms continue to evolve.

- LO 1.25 . . .describe a model that represents evolution within a population. [SP 1.2]
- LO 1.26 . . .evaluate given data sets that illustrate evolution as an ongoing process. [SP 5.3]

EU 1.D: The origin of living systems is explained by natural processes.

Standard 1.10: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.

- LO 1.27 . . .describe a scientific hypothesis about the origin of life on Earth. [SP 1.2]

- LO 1.28 . . .evaluate scientific questions based on hypotheses about the origin of life on Earth. [SP 3.3]
- LO 1.29 . . .describe the reasons for revisions of scientific hypotheses of the origin of life on Earth. [SP 6.3]
- LO 1.30 . . .evaluate scientific hypotheses about the origin of life on Earth. [SP 6.5]
- LO 1.31 . . .evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth. [SP 4.4]

Standard 1.11: Scientific evidence from many different disciplines supports models of the origin of life.

- LO 1.32 . . .justify the selection of geological, physical, and chemical data that reveal early Earth conditions. [SP 4.1]

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

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

Standard 2.1: All living systems require constant input of free energy.

- LO 2.1 . . .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. [SP 6.2]
- LO 2.2 . . .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. [SP 6.1]
- LO 2.3 . . .predict how changes in free energy availability affect organisms, populations and ecosystems. [SP 6.4]

Standard 2.2: Organisms capture and store free energy for use in biological processes.

- LO 2.4 . . .use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store and use free energy. [SP 1.4, 3.1]
- LO 2.5 . . .construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store or use free energy. [SP 6.2]

Standard 2.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

- LO 2.6 . . .use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion. [SP 2.2]
- LO 2.7 Students will be able to explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination. [SP 6.2]
- LO 2.8 . . .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. [SP 4.1]
- LO 2.9 . . .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. [SP 1.1, 1.4]

EU 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.

Standard 2.4: Cell membranes are selectively permeable due to their structure.

- LO 2.10 . . .use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. [SP 1.4, 3.1]
- LO 2.11 . . .construct models that connect the movement of molecules across membranes with membrane structure and function. [SP 1.1, 7.1, 7.2]

Standard 2.5: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.

- LO 2.12 . . .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. [SP 1.4]

Standard 2.6: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.

- LO 2.13 . . .explain how internal membranes and organelles contribute to cell functions. [SP 6.2]
- LO 2.14 . . .use representations and models to describe differences in prokaryotic and eukaryotic cells. [SP 1.4]

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.

Standard 2.7: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

- LO 2.15 . . .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. [SP 6.1]
- LO 2.16 . . .connect how organisms use negative feedback to maintain their internal environments. [SP 7.2]
- LO 2.17 . . .evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms. [SP 5.3]
- LO 2.18 . . .make predictions about how organisms use negative feedback mechanisms to maintain their internal environments. [SP 6.4]
- LO 2.19 . . .make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models. [SP 6.4]
- LO 2.20 . . .justify that positive feedback mechanisms amplify responses in organisms. [SP 6.1]

Standard 2.8: Organisms respond to changes in their external environments.

- LO 2.21 . . .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. [SP 4.1]

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

Standard 2.9: 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.

- LO 2.22 . . .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. [SP 1.3, 3.2]
- LO 2.23 . . .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. [SP 4.2, 7.2]
- LO 2.24 . . .analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities or ecosystems). [SP 5.1]

Standard 2.10: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.

- LO 2.25 . . .construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments. [SP 6.2]
- LO 2.26 . . .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. [SP 5.1]
- LO 2.27 . . .connect differences in the environment with the evolution of homeostatic mechanisms. [SP 7.1]

Standard 2.11: Biological systems are affected by disruptions to their dynamic homeostasis.

- LO 2.28 . . .use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. [SP 1.4]

Standard 2.12: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.

- LO 2.29 . . . create representations and models to describe immune responses. [SP 1.1, 1.2]
- LO 2.30 . . . create representations or models to describe nonspecific immune defenses in plants and animals.[SP 1.1, 1.2]

EU 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

Standard 2.14: 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.

- LO 2.31 . . .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. [SP 7.2]
- LO 2.32 . . .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. [SP 1.4]

- LO 2.33 . . .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. [SP 6.1]
- LO 2.34 . . .describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis. [SP 7.1]
- LO 2.36 . . .justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation. [SP 6.1]
- LO 2.37 . . .connect concepts that describe mechanisms that regulate the timing and coordination of physiological events. [SP 7.2]

Standard 2.15: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

- LO 2.38 . . .analyze data to support the claim that responses to information and communication of information affect natural selection. [SP 5.1]
- LO 2.39 . . .justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms. [SP 6.1]
- LO 2.40 . . .connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior. [SP 7.2]

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

EU 3.A: Heritable information provides for continuity of life.

Standard 3.1: DNA, and in some cases RNA, is the primary source of heritable information.

- LO 3.1 . . .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. [SP 6.5]
- LO 3.2 . . .justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information. [SP 4.1]
- LO 3.3 . . .describe representations and models that illustrate how genetic information is copied for transmission between generations. [SP 1.2]
- LO 3.4 . . .describe representations and models illustrating how genetic information is translated into polypeptides. [SP 1.2]
- LO 3.5 . . .justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies. [SP 6.4]
- LO 3.6 . . .predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. [SP 6.4]

Standard 3.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.

- LO 3.7 . . .make predictions about natural phenomena occurring during the cell cycle. [SP 6.4]
- LO 3.8 . . .describe the events that occur in the cell cycle. [SP 1.2]
- LO 3.9 . . .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. [SP 6.2]

- LO 3.10 . . .represent the connection between meiosis and increased genetic diversity necessary for evolution. [SP 7.1]
- LO 3.11 . . .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. [SP 5.3]

Standard 3.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.

- LO 3.12 . . .construct a representation that connects the process of meiosis to the passage of traits from parent to offspring. [SP 1.1, 7.2]
- LO 3.13 . . .pose questions about ethical, social or medical issues surrounding human genetic disorders. [SP 3.1]
- LO 3.14 . . .apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. [SP 2.2]

Standard 3.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.

- LO 3.15 . . .explain deviations from Mendel's model of the inheritance of traits. [SP 6.5]
- LO 3.16 . . .explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. [SP 6.3]
- LO 3.17 . . .describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits. [SP 1.2]

EU 3.B: Expression of genetic information involves cellular and molecular mechanisms.

Standard 3.5: Gene regulation results in differential gene expression, leading to cell specialization.

- LO 3.18 . . .describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. [SP 7.1]
- LO 3.19 . . .describe the connection between the regulation of gene expression and observed differences between individuals in a population. [SP 7.1]
- LO 3.20 . . .explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function. [SP 6.2]
- LO 3.21 . . .use representations to describe how gene regulation influences cell products and function. [SP 1.4]

Standard 3.6: A variety of intercellular and intracellular signal transmissions mediate gene expression.

- LO 3.22 . . .explain how signal pathways mediate gene expression, including how this process can affect protein production. [SP 6.2]
- LO 3.23 . . .use representations to describe mechanisms of the regulation of gene expression. [SP 1.4]

EU 3.C: The processing of genetic information is imperfect and is a source of genetic variation.

Standard 3.7: Changes in genotype can result in changes in phenotype.

- LO 3.24 . . .predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. [SP 6.4, 7.2]
- LO 3.25 . . .create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. [SP 1.1]
- LO 3.26 . . .explain the connection between genetic variations in organisms and phenotypic variations. [SP 7.2]

Standard 3.8: Biological systems have multiple processes that increase genetic variation.

- LO 3.27 . . .compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains. [SP 7.2]
- LO 3.28 . . .construct an explanation of the multiple processes that increase variation within a population. [SP 6.2]

Standard 3.9: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.

- LO 3.29 . . .construct an explanation of how viruses introduce genetic variation in host organisms. [SP 6.2]
- LO 3.30 . . .use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population. [SP 1.4]

EU 3.D: Cells communicate by generating, transmitting and receiving chemical signals.

Standard 3.10: Cell communication processes share common features that reflect a shared evolutionary history.

- LO 3.31 . . .describe basic chemical processes for cell communication shared across evolutionary lines of descent. [SP 7.2]
- LO 3.32 . . .generate scientific questions involving cell communication as it relates to the process of evolution. [SP 3.1]
- LO 3.33 . . .use representation(s) and appropriate models to describe features of a cell signaling pathway. [SP 1.4]

Standard 3.11: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.

- LO 3.34 . . .construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. [SP 6.2]
- LO 3.35 . . .create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. [SP 1.1]

Standard 3.12: Signal transduction pathways link signal reception with cellular response.

- LO 3.36 . . .describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response. [SP 1.5]

Standard 3.13: Changes in signal transduction pathways can alter cellular response.

- LO 3.37 . . .justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response. [SP 6.1]
- LO 3.38 . . .describe a model that expresses key elements to show how change in signal transduction can alter cellular response. [SP 1.5]
- LO 3.39 . . .construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways. [SP 6.2]

EU 3.E: Transmission of information results in changes within and between biological systems.

Standard 3.12: Individuals can act on information and communicate it to others.

- LO 3.40 . . .analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior. [SP 5.1]
- LO 3.41 . . .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. [SP 1.1]
- LO 3.42 . . .describe how organisms exchange information in response to internal changes or environmental cues. [SP 7.1]

Standard 3.13: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.

- LO 3.43 . . .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. [SP 6.2, 7.1]
- LO 3.44 . . .describe how nervous systems detect external and internal signals. [SP 1.2]
- LO 3.45 . . .describe how nervous systems transmit information. [SP 1.2]
- LO 3.46 . . .describe how the vertebrate brain integrates information to produce a response. [SP 1.2]
- LO 3.47 . . .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. [SP 1.1]
- LO 3.48 . . .create a visual representation to describe how nervous systems detect external and internal signals. [SP 1.1]
- LO 3.49 . . .create a visual representation to describe how nervous systems transmit information. [SP 1.1]
- LO 3.50 . . .create a visual representation to describe how the vertebrate brain integrates information to produce a response. [SP 1.1]

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

EU 4.A: Interactions within biological systems lead to complex properties.

Standard 4.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.

- LO 4.1 . . .explain the connection between the sequence and the subcomponents of a biological polymer and its properties. [SP 7.1]
- LO 4.2 . . .refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer. [SP 1.3]
- LO 4.3 . . .use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule. [SP 6.1, 6.4]

Standard 4.2: The structure and function of subcellular components, and their interactions, provide

essential cellular processes.

- LO 4.4 . . .make a prediction about the interactions of subcellular organelles. [SP 6.4]
- LO 4.5 . . .construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. [SP 6.2]
- LO 4.6 . . .use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions. [SP 1.4]

Standard 4.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.

- LO 4.7 . . .refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs. [SP 1.3]

Standard 4.4: Organisms exhibit complex properties due to interactions between their constituent parts.

- LO 4.8 . . .evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts. [SP 3.3]
- LO 4.9 . . .predict the effects of a change in a component of a biological system on the functionality of an organism. [SP 6.4]
- LO 4.10 . . .refine representations and models to illustrate complexity due to interactions of the constituent parts.[SP 1.3]

Standard 4.5: Communities are composed of populations of organisms that interact in complex ways.

- LO 4.11 . . .justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities. [SP 1.4, 4.1]
- LO 4.12 . . .apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. [SP 2.2]
- LO 4.13 . . .predict the effects of a change in the community's populations on the community. [SP 6.4]

Standard 4.6: Interactions among living systems and with their environment result in the movement of matter and energy.

- LO 4.14 . . .apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. [SP 2.2]
- LO 4.15 . . .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. [SP 1.4]
- LO 4.16 . . .predict the effects of a change of matter or energy availability on communities.[SP 6.4]

EU 4.B: Competition and cooperation are important aspects of biological systems.

Standard 4.7: Interactions between molecules affect their structure and function.

- LO 4.17 . . .analyze data to identify how molecular interactions affect structure and function. [SP 5.1]

Standard 4.8: Cooperative interactions within organisms promote efficiency in the use of energy and matter.

- LO 4.18 . . .use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter. [SP 1.4]

Standard 4.9: Interactions between and within populations influence patterns of species distribution and abundance.

- LO 4.19 . . .use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance. [SP 5.2]

Standard 4.10: Distribution of local and global ecosystems changes over time.

- LO 4.20 . . .explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past. [SP 6.3]
- LO 4.21 . . .predict consequences of human actions on both local and global ecosystems. [SP 6.4]

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Standard 4.11: Variation in molecular units provides cells with a wider range of functions.

- LO 4.22 . . .construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions. [SP 6.2]

Standard 4.12: Environmental factors influence the expression of the genotype in an organism.

- LO 4.23 . . .construct explanations of the influence of environmental factors on the phenotype of an organism. [SP 6.2]
- LO 4.24 . . .predict the effects of a change in an environmental factor on the genotypic expression of phenotype. [SP 6.4]

Standard 4.13: The level of variation in a population affects population dynamics.

- LO 4.25 . . .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. [SP 6.1]
- LO 4.26 . . .use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness. [SP 6.4]

Standard 4.14: The diversity of species within an ecosystem may influence the stability of the ecosystem.

- LO 4.27 . . .make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability. [SP 6.4]

Skill Standard 1: Use representations and models to communicate scientific phenomena and solve scientific problems.

- 1.1 . . .create representations and models of natural or man-made phenomena and systems in the domain.
- 1.2 . . .describe representations and models of natural or man-made phenomena and systems in the domain.
- 1.3 . . .refine representations and models of natural or man-made phenomena and systems in the domain.
- 1.4 . . .use representations and models to analyze situations or solve problems qualitatively and quantitatively.

- 1.5 . . .re-express key elements of natural phenomena across multiple representations in the domain.

Skill Standard 2: Use mathematics appropriately.

- 2.1 . . .justify the selection of a mathematical routine to solve problems.
- 2.2 . . .apply mathematical routines to quantities that describe natural phenomena.
- 2.3 . . .estimate numerically quantities that describe natural phenomena.

Skill Standard 3: Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

- 3.1 . . .pose scientific questions.
- 3.2 . . .refine scientific questions.
- 3.3 . . .evaluate scientific questions.

Skill Standard 4: Plan and implement data collection strategies appropriate to a particular scientific question.

- 4.1 . . .justify the selection of the kind of data needed to answer a particular scientific question.
- 4.2 . . .design a plan for collecting data to answer a particular scientific question.
- 4.3 . . .collect data to answer a particular scientific question.
- 4.4 . . .evaluate sources of data to answer a particular scientific question.

Skill Standard 5: Perform data analysis and evaluation of evidence.

- 5.1 . . .analyze data to identify patterns or relationships.
- 5.2 . . .refine observations and measurements based on data analysis.
- 5.3 . . .evaluate the evidence provided by data sets in relation to a particular scientific question.

Skill Standard 6: Work with scientific explanations and theories.

- 6.1 . . .justify claims with evidence.
- 6.2 . . .construct explanations of phenomena based on evidence produced through scientific practices.
- 6.3 . . .articulate the reasons that scientific explanations and theories are refined or replaced.
- 6.4 . . .make claims and predictions about natural phenomena based on scientific theories and models.
- 6.5 . . .evaluate alternative scientific explanations.

Skill Standard 7: Connect and relate knowledge across var. scales, concepts and representations in/across domains.

- 7.1 . . .connect phenomena and models across spatial and temporal scales.
- 7.2 . . .connect concepts in and across domain(s) to generalize or extrapolate in and/or across EUs and/or big ideas.