AP® Connections: Campbell Biology 12e and the Curriculum Framework

Highlighted connections from the print AP Edition text to the College Board's Curriculum Framework

Chapter	AP® Big Ideas (found in this chapter)	Scientific Skills Exercises (supporting the Science Practices)	Sample AP-Style Question (to assign with this chapter)
1	Underlying the study of life are four 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, reproduce, and maintain dynamic homeostasis. **BIG IDEA 3**: Living systems store, retrieve, transmit, and respond to information essential to life processes. **BIG IDEA 4**: Biological systems interact, and these systems and their interactions possess complex properties.	Interpreting a Pair of Bar Graphs, AP® Science Practices 2, 3, 4, 6 *(page 23)*	Why is life considered to be an emergent property of a cell? **(BIG IDEA 4)**
2	Chemical reactions underlie many species-specific strategies that communicate information **(BIG IDEA 3)** vital to natural selection and evolution **(BIG IDEA 1)** and can serve as the mechanisms by which populations interact **(BIG IDEA 4)**.	Calibrating a Standard Radioactive Isotope Decay Curve and Interpreting Data, AP® Science Practices 1, 4, 5 *(page 33)*	What are the characteristics of the chemical elements common to the molecular building blocks that are needed to capture and store energy in biological systems? **(BIG IDEA 2)**
3	Water figures into any theory about the origins of life, as it provides a medium in which the building blocks of life organize into more complex molecules and form simple cells **(BIG IDEA 1)**. The chemical and physical properties of water support living things in both their internal and external environments **(BIG IDEAS 2 & 4)**. Water's complex properties relate directly to its molecular structure.	Interpreting a Scatter Plot with a Regression Line, AP® Science Practices 1, 2, 4, 5 *(page 54)*	How do the polar covalent bonds that form between oxygen and hydrogen atoms in a water molecule contribute to all the different emergent properties of water upon which living systems depend? **(BIG IDEA 2)**
4	Carbon is one of the key elements around which living matter is organized and core biological processes have evolved **(BIG IDEA 1)**. It plays a vital role in the capture, use, and storage of energy needed to support life **(BIG IDEA 2)**, and it serves as the backbone for a great diversity of biomolecules that are synthesized and/or degraded as it cycles through the environment **(BIG IDEA 4)**.	Working with Moles and Molar Ratios, AP® Science Practices 5, 6 *(page 58)*	Of all the elements in the periodic table, why is carbon central to all forms of life? **(BIG IDEA 2)**
5	All life-forms on Earth share biochemical similarities **(BIG IDEA 1)** that include large, complex molecules synthesized from common building blocks **(BIG IDEA 4)**.	Analyzing Polypeptide Sequence Data, AP® Science Practices 2, 4, 5, 6 *(page 89)*	How do the sequence and subcomponents of a biological polymer determine its properties? **(BIG IDEA 4)**
6	Many structures and processes of cells that maintain dynamic homeostasis **(BIG IDEA 2)** and respond to the environment **(BIG IDEA 3)** reflect a shared ancestry **(BIG IDEA 1)**.	Using a Scale Bar to Calculate Volume and Surface Area of a Cell, AP® Science Practices 2, 5 *(page 99)*	In general, eukaryotic cells have a smaller surface-to-volume ratio than prokaryotic cells, but they contain internal membrane-bound organelles. How do these internal membranes affect the overall functional efficiency of a cell and offset the low surface-to-volume ratio? **(BIG IDEAS 2 & 4)**
7	The plasma membrane is a structure conserved across domains **(BIG IDEA 1)** yet highly specialized to species and their internal and external environments **(BIG IDEA 2)**. The plasma membrane's emergent properties **(BIG IDEA 3)** regulate the complex interactions of cells **(BIG IDEA 4)**.	Interpreting a Scatter Plot with Two Sets of Data, AP® Science Practices 2, 3, 4, 6 *(page 136)*	Cell membranes control the exchange of molecules and ions between the internal and external environments of cells. Evolution has selected for a membrane structure that associates a higher energy cost in transporting hydrophilic substances than hydrophobic ones. How do you explain this, given that water is critical to life? **(BIG IDEA 2)**

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8	All living organisms require a constant input of energy, which is used for organization, growth, and reproduction **(BIG IDEA 2)**. Common to life are core processes that depend on enzymes to regulate the chemical reactions that drive the metabolic activities of life **(BIG IDEAS 1 & 4)**.	Making a Line Graph and Calculating a Slope, AP® Science Practices 1, 3, 4, 5 *(page 157)*	Virtually all aerobic organisms share some similar enzymes, such as those involved in carbohydrate metabolism and in hydrogen peroxide degradation. How is it possible to have specific shared functions in enzymes when organisms and their internal and external environments vary so much? **(BIG IDEAS 1 & 4)**
9	Heterotrophic organisms must capture energy from their environment to maintain life **(BIG IDEA 2)**. Common to all are core processes that move energy and matter through living systems and thereby support life **(BIG IDEAS 1 & 4)**.	Making a Bar Graph and Evaluating a Hypothesis, AP® Science Practices 1, 2, 3, 4 *(page 179)*	What controls the different mechanisms and structural features that organisms use to capture, store, and use energy? **(BIG IDEAS 2, 3, & 4)**
10	Photosynthetic organisms capture energy present in sunlight **(BIG IDEA 2)**, which is then available to heterotrophic organisms within a community as energy flows from one organism to another **(BIG IDEA 4)**. The core processes that define this interaction are enabled by cellular structures that evolved early on that allow the capture, storage, and use of energy **(BIG IDEA 1)**.	Making Scatter Plots with Regression Lines, AP® Science Practices 2, 4, 5, 6 *(page 205)*	Photosynthetic pigments alone cannot capture and store the energy in light. What evidence do you need to justify that claim? Could you design an experiment to prove the claim? **(BIG IDEA 2)**
11	Mechanisms for cell-to-cell communication have been preserved across domains, for both unicellular and multicellular organisms **(BIG IDEA 1)**. Cells can communicate via direct contact or through signaling molecules that act locally or over long distances **(BIG IDEA 3)**.	Using Experiments to Test a Model *(available only in Mastering Biology)*	Is all cell-to-cell communication regulated by the plasma membrane? What about apoptosis? **(BIG IDEA 3)**
12	The continuity of life depends on a cell cycle in which genetic information from a parent cell is passed on to daughter cells. In unicellular organisms, mitosis results in transmission of a complete genome through asexual reproduction **(BIG IDEA 3)**. For multicellular organisms, mitosis ensures the growth of an individual, given adequate energy **(BIG IDEA 2)**.	Interpreting Histograms, AP® Science Practices 1, 2, 4, 6 *(page 250)*	Cells undergoing mitosis in a eukaryote go through a highly conserved and controlled process. There are three major checkpoints in the control system, found in G1, G2, and M phases in a normal cell cycle. However, there are cancer cells that do not follow the same controls. What is out of control in cancer cells? **(BIG IDEA 3)**
13	Meiosis followed by fertilization ensures genetic diversity in sexually reproducing organisms **(BIG IDEA 3)** and provides genetic variation that plays a role in natural selection **(BIG IDEA 1)**. This cellular process is driven by the interaction of subcellular components **(BIG IDEA 4)** and uses energy that is required for the growth and reproduction of living systems **(BIG IDEA 2)**.	Making a Line Graph and Converting Between Units of Data, AP® Science Practices 2, 4, 5 *(page 264)*	Why is meiosis considered a successful evolutionary strategy to increase the fitness of eukaryotic organisms? **(BIG IDEAS 1 & 3)**
14	The meticulous work of Mendel and others in the 19th century provided evidence for a particulate mechanism of inheritance that led to our current understanding of the chromosomal basis of inheritance of genes from parent to offspring **(BIG IDEA 3)** and provided structural and functional evidence to support the relatedness of all domains **(BIG IDEA 1).**	Making a Histogram and Analyzing a Distribution Pattern, Science Practices 2, 4 *(page 283)*	Why was Mendel's choice of pea plants as an experimental organism so fortuitous in developing a model of inheritance? **(BIG IDEA 3)**
15	Segregation and independent assortment of linear chromosomes result in genetic variation **(BIG IDEA 3)**, which is structural and functional evidence that supports the relatedness of all eukaryotes **(BIG IDEA 1)**. The unique patterns of inheritance involving Barr bodies are produced by the interaction of RNA and the X chromosome **(BIG IDEA 4)**.	Using the Chi-Square (x^2) Test, AP® Science Practices 5, 6 *(page 304)*	What observed action of chromosomes made them the likely location of the genetic factors Mendel postulated as carriers of genetic information? **(BIG IDEA 3)**

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16	The evidence that DNA and RNA carry genetic information in all life-forms **(BIG IDEA 1)** began with a series of historical experiments **(BIG IDEA 3)** that led to an understanding of how the structure and interaction of molecules **(BIG IDEA 4)** facilitate the replication and transfer of DNA and RNA across membranes **(BIG IDEA 3)**.	Working with Data in a Table, AP® Science Practices 1, 2, 4, 5, 6 *(page 318)*	Hershey and Chase concluded that DNA is the source of heritable information. Select the data from their experiments that support that claim. **(BIG IDEA 3)**
17	The highly conserved processes of gene transcription and translation **(BIG IDEA 3)** shared by all domains **(BIG IDEA 1)** result from molecular interactions that include specific enzymes **(BIG IDEA 4)**.	Interpreting a Sequence Logo, AP® Science Practices 2, 4, 5, 6 *(page 351)*	Given that polypeptides are the link between genotype and phenotype, how could this fact be used to support the hypothesis that RNA, not DNA, evolved first, sometimes referred to as the RNA World hypothesis? **(BIG IDEAS 1 & 4)**
18	Organisms use feedback mechanisms and transcription factors to maintain dynamic homeostasis through differential gene expression **(BIG IDEAS 2 & 3)**, conserved core processes, and features that are shared by all organisms **(BIG IDEA 1)**.	Analyzing DNA Deletion Experiments, AP® Science Practices 1, 2, 3, 4, 5, 6 *(page 376)*	*In situ* hybridization using fluorescent tags shows that certain probes built from *Drosophila* genes label not only specific locations within *Drosophila* embryos, but also similar locations in the embryos of many species of arthropods. Explain this result. **(BIG IDEA 1)**
19	Viral replication is unique in that it is dependent on the cellular machinery of its host **(BIG IDEA 3)**. Viruses can also introduce variation into the genetic material of a host, which can lead to rapid evolutionary change **(BIG IDEA 1)**. Disruption to ecosystems can expose plants and animals to different viruses **(BIG IDEA 4)**.	Analyzing a Sequence-Based Phylogenetic Tree to Understand Viral Evolution, AP® Science Practices 2, 4, 5, 6 *(page 411)*	Does the horizontal transfer of genes by viruses create problems for scientists who use gene sequences to determine evolutionary relationships? Justify your answer. **(BIG IDEAS 1 & 3)**
20	Biotechnology makes it possible to identify and manipulate DNA and RNA in order to make useful products **(BIG IDEA 3)**. Scientists can isolate, sequence, and transfer genes from one organism to another and thereby delineate the relationships of organisms, solve medical and criminal mysteries, and increase agricultural productivity **(BIG IDEA 4)**.	Analyzing Quantitative and Spatial Gene Expression Data *(available only in Mastering Biology)*	In bacterial transformation experiments, plasmids are typically constructed with a gene for antibiotic resistance. Explain why that is important. Explain why in some environments there is a selective advantage for bacteria with the plasmid, but in other environments, there is a selective disadvantage. **(BIG IDEAS 1 & 3)**
21	Using scientific evidence from different disciplines, humans have been able to sequence the genome of many species **(BIG IDEA 3)**, providing evidence of shared ancestry and evolution **(BIG IDEA 1)**.	Reading an Amino Acid Sequence Identity Table, AP® Science Practices 2, 4, 5 *(page 458)*	Scientists have sequenced many model organisms and estimated the number of protein coding genes in each, including rice, 36,000; the nematode *C. elegans*, 20,000; and humans, 21,300. Explain the significance of these findings. **(BIG IDEAS 1 & 3)**
22	Evolution is supported by scientific evidence from many disciplines **(BIG IDEAS 1, 2, 3, 4)**.	Making and Testing Predictions, AP® Science Practices 2, 3, 4, 6 *(page 483)*	Does evolution proceed in a one-way direction or is it reversible? Justify your claim. **(BIG IDEA 1)**
23	Genetic variation within a population makes natural selection and evolution possible. Mathematics can be used to calculate changes **(BIG IDEA 1)** and the distribution of genes or alleles **(BIG IDEA 3)** within a population.	Using the Hardy-Weinberg Equation to Interpret Data and Make Predictions, AP® Science Practices 2, 3, 4, 5, 6 *(page 493)*	Are the p and q allele frequencies always equal when a population is in Hardy-Weinberg equilibrium? Explain your response. **(BIG IDEA 1)**

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24	Speciation may occur when two populations become reproductively isolated from one another **(BIG IDEA 1)**. This can lead to differences in timing and coordination of behavior and changes in modes of intercellular and intracellular signal transmission **(BIG IDEA 3)**. Reproductive isolation can also affect relationships with other species in the environment and bring about adaptation or morphological change **(BIG IDEA 4)**.	Identifying Independent and Dependent Variables, Making a Scatter Plot, and Interpreting Data, AP® Science Practices 2, 3, 4, 5 *(page 513)*	How is speciation in an isolated population connected to a change in the environment? **(BIG IDEA 1)**
25	Speciation and extinction have occurred throughout Earth's history **(BIG IDEA 1)**, with changes in the conditions on Earth leading to divergence in homeostatic **(BIG IDEA 2)** and developmental mechanisms **(BIG IDEA 3)**.	Estimating Quantitative Data from a Graph and Developing Hypotheses, AP® Science Practices 2, 3, 5 *(page 538)*	How does one evaluate evidence from fossils, morphological differences, and/or biochemical differences to determine an evolutionary connection between organisms that span time and space? **(BIG IDEA 1)**
26	Phylogenetic trees and cladograms are models of common ancestry and evolutionary history that can be used to establish the relatedness of different species through analysis of similarities in morphology **(BIG IDEA 1)** or comparison of DNA and proteins **(BIG IDEA 3)**.	Using Protein Sequence Data to Test an Evolutionary Hypothesis, AP® Science Practices 2, 4, 5, 6 *(page 570)*	Could the early tree of life be a ring? What evidence could be used to support a circular lineage for early life? **(BIG IDEAS 1 & 3)**
27	Evidence supports the evolution of complex structures and processes in prokaryotes **(BIG IDEA 1)** that use energy to support growth, reproduction, and dynamic homeostasis **(BIG IDEA 2)**. Having evolved through rapid genetic change **(BIG IDEA 3)**, diverse forms of prokaryotes interact with other organisms and play crucial roles in the biosphere **(BIG IDEA 4)**.	Calculating and Interpreting Means and Standard Errors, AP® Science Practices 3, 4, 6 *(page 590)*	Justify the claim that humans have more traits in common with the genus *Sulfolobus*, a prokaryote that lives in extremely hot and sulfur-rich water, than they do with *E. coli*, a prokaryote that lives symbiotically in human intestines. **(BIG IDEAS 1 & 4)**
28	Protists represent a very diverse group of organisms. Structural evidence such as membrane-bound organelles **(BIG IDEAS 2 & 4)** and research techniques in biotechnology **(BIG IDEA 3)** support the relatedness of all eukaryotes **(BIG IDEA 1)**.	Interpreting Comparisons of Genetic Sequences, AP® Science Practices 2, 3, 4 *(page 595)*	Summarize the changes that occur in the cellular slime mold *Dictyostelium* when food is scarce **(BIG IDEAS 2 & 3)**, and infer why such "behavior" might be adaptive **(BIG IDEA 1)**.
29	As organisms colonized land, the changed environment acted as a selective mechanism for particular traits that ensured reproductive success **(BIG IDEA 1)** and led to differentiation in the use of energy as organisms exchanged matter with the environment **(BIG IDEA 2)** and interacted with each other, recycling matter **(BIG IDEA 4)**.	Making Bar Graphs and Interpreting Data, AP® Science Practices 1, 3, 4 *(page 628)*	As plants began to colonize land, how was the cycling of matter on Earth affected? **(BIG IDEAS 2 & 4)**
30	Flowering plants regulate the development of pollen and seeds, responding to environmental conditions such as water availability and temperature **(BIG IDEA 2)** in ways that optimize the survival of the next generation **(BIG IDEA 4)**.	Using Natural Logarithms to Interpret Data, AP® Science Practices 5, 6 *(page 639)*	What important changes happened to the mechanisms and structures in the life cycle of angiosperms that gave them greater opportunity to spread geographically? **(BIG IDEAS 2 & 4)**
31	Molecular evidence indicates that fungi were among the earliest colonizers of land **(BIG IDEA 3)**, successfully using their large surface area to absorb water and nutrients **(BIG IDEA 2)**. They diverged from animals over 1 billion years ago **(BIG IDEA 1)** and play a critical role in the environment through mutualistic relationships and nutrient recycling **(BIG IDEA 4)**.	Interpreting Genomic Data and Generating Hypotheses, AP® Science Practices 1, 2, 4, 6 *(page 657)*; Synthesizing Information from Multiple Data Sets *(available only in Mastering Biology)*	Many lichens are very sensitive to changes in atmospheric chemistry, and lichen die-offs can serve as environmental indicators of air pollution. Which of the mutualistic organisms that make up lichens (fungi or algae/cyanobacteria) is most likely to be affected by changes in the air, causing the entire lichen to die? **(BIG IDEAS 2 & 4)**

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32	Animals are linked by lines of descent from common ancestors **(BIG IDEA 1)**. Speciation leads to different mechanisms that enable animals to respond to changes in their external environment and to capture energy from other organisms **(BIG IDEA 2)**.	Calculating and Interpreting Correlation Coefficients, AP® Science Practices 4, 5, 6 *(page 678)*	Do organisms with radial symmetry, such as sea anemones, have *Hox* genes? Explain your thinking. **(BIG IDEAS 1 & 3)**
33	Through natural selection, invertebrates have adapted to almost every habitat on Earth **(BIG IDEA 1)**. Invertebrates account for the majority of known animal species, and they interact with virtually all organisms on Earth **(BIG IDEA 4)**.	Understanding Experimental Design and Interpreting Data, AP® Science Practices 3, 4, 6 *(page 700)*	The vast majority of animals are invertebrates, which have niches in every ecosystem on Earth. Justify the claim that one group of invertebrates, dung beetles, has a huge ecological impact. **(BIG IDEAS 2 & 4)**
34	Natural selection within the phylum Chordata led to the evolution of a great variety of species whose bodies are supported by a backbone **(BIG IDEA 1)**. This adaptation has enabled vertebrates to compete successfully for resources on land, in the sea, and in the air **(BIG IDEA 4)**.	Determining the Equation of a Regression Line, AP® Science Practices 4, 5 *(page 751)*	Identify some of the derived traits in the evolution of vertebrates that enabled many vertebrate species to live on land. **(BIG IDEAS 1 & 4)**
35	Interactions within biological systems lead to the complex properties of the cells, tissues, and organs of plants **(BIG IDEA 4)**— some of these are controlled by environmental factors as plants use feedback mechanisms to grow, differentiate cells, and develop **(BIG IDEA 2)**.	Using Bar Graphs to Interpret Data, AP® Science Practices 4, 6 *(page 762)*	Studies with *Arabidopsis* confirm that asymmetrical cell division leads to the formation of stomata and that the regulators of stomata formation are themselves regulated by environmental changes. How would environmental interactions control the formation of stomata? **(BIG IDEA 4)**
36	Cooperative interactions between plant cells and tissues enable the transport of water and nutrients **(BIG IDEA 2)** via specialized structures **(BIG IDEA 4)**, providing evidence of evolutionary change in response to environmental challenges **(BIG IDEA 1)**.	Calculating and Interpreting Temperature Coefficients, AP® Science Practices 2, 4, 5, 6 *(page 790)*	Because adaptations of organisms are related to a particular environment, what would you predict about the density of stomata in a particular plant species during drought years with high light exposure compared to years with more plentiful rainfall and cloud cover? **(BIG IDEAS 1 & 4)**
37	Plants depend upon and contribute to the biogeochemical cycles that enable the production of organic matter **(BIG IDEA 2)**. This organic matter is a critical part of the physical environment that supports the biotic components of all ecosystems **(BIG IDEA 4)**.	Making Observations, AP® Science Practices 1, 2, 6 *(page 812)*	Why do many trees begin development with a taproot and after one or two years change to a fibrous root system with many horizontal surface roots and only a few vertical, deep anchoring roots? **(BIG IDEA 2)**
38	Through natural selection **(BIG IDEA 1)**, cooperative behavior between plants and their pollinators influences the distribution and abundance of both **(BIG IDEA 4)**. Humans have aided the growth of some populations through genetic modification **(BIG IDEA 3)** and artificial selection **(BIG IDEA 1)**.	Using Positive and Negative Correlations to Interpret Data, AP® Science Practices 2, 4, 5, 6 *(page 834)*	A flowering plant has blue flowers, a different color pattern that is visualized under ultraviolet light, and a scent. Predict some characteristics of its likely pollinator and justify your claim. **(BIG IDEA 4)**
39	In plants, physiological events involve the interaction between environmental signals and internal molecular signals **(BIG IDEA 2)**. Plants' adaptations for cellular communication **(BIG IDEA 3)** enable them to respond to seasonal changes that can affect when and how they interact with other organisms in their environment **(BIG IDEA 4)**.	Interpreting Experimental Results from a Bar Graph, AP® Science Practices 2, 3, 4, 6 *(page 864)*	Compare the experimental design of the Darwins' coleoptile experiment in 1880 with that of Boysen-Jensen in 1913. How do their hypotheses differ? **(BIG IDEA 2)**
40	All animals require energy and matter to grow, reproduce, and maintain dynamic homeostasis **(BIG IDEA 2)**. They have diverse structures and mechanisms that ensure survival **(BIG IDEA 4)** and that help to define their relatedness **(BIG IDEA 1)**.	Interpreting Pie Charts, AP® Science Practices 2, 4, 6 *(page 892)*	Why are most animal homeostatic mechanisms controlled by negative feedback? Is that a characteristic of all organisms? **(BIG IDEA 2)**

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41	Cooperative interactions within the cells and systems of animals promote efficient use and exchange of energy and matter with the environment **(BIG IDEA 4)**, which all organisms need in order to grow, reproduce, and maintain organization **(BIG IDEA 2)**.	Interpreting Data from an Experiment with Genetic Mutants, AP® Science Practices 2, 3, 4, 5 *(page 918)*	Thinking in terms of surface-area-to-volume ratios, how do digestive processes influence the structure of different mammalian systems for digestion? **(BIG IDEA 2)**
42	Organisms have various mechanisms for obtaining nutrients and eliminating wastes **(BIG IDEA 2)** that are more efficient with cooperative interactions **(BIG IDEA 4)**.	Making and Interpreting Histograms, AP® Science Practices 2, 4, 5, 6 *(page 938)*	Homeostatic mechanisms for gas exchange reflect evolutionary strategies that have evolved in response to environmental conditions. How is this reflected in adaptations in animal systems? **(BIG IDEAS 2 & 4)**
43	To ensure survival **(BIG IDEA 1)** and the maintenance of dynamic homeostasis, plants and animals have a variety of chemical defenses that rely on cell-to-cell communication **(BIG IDEA 3)** and, in some cases, competition for antigen-binding sites **(BIG IDEA 4)**.	Comparing Two Variables on a Common *x*-Axis, AP® Science Practices 3, 4, 6 *(page 972)*	Consider an amoeba feeding upon microbes as the ancient precursor of the macrophages that are now part of the innate immune response. In this context, why would "nonself" recognition be an important characteristic of those early prototypic "macrophages"? **(BIG IDEAS 1 & 2)**
44	Organisms have various mechanisms for eliminating wastes and maintaining dynamic homeostasis **(BIG IDEA 2)** that are specialized for life in a particular environment and are more efficient with cooperative interactions **(BIG IDEA 4)**.	Describing and Interpreting Quantitative Data, AP® Science Practices 2, 4, 5 *(page 981)*	What internal and external signals regulate osmoregulatory changes when salmon migrate from salt water to fresh water to spawn? **(BIG IDEA 2)**
45	Many adaptations of organisms relate to how they obtain and use the energy and matter **(BIG IDEA 4)** needed to maintain dynamic homeostasis **(BIG IDEA 2)**.	Designing a Controlled Experiment, AP® Science Practices 3, 4, 5, 6 *(page 1014)*	Prolactin stimulates milk synthesis in mammals, fat metabolism in birds, metamorphosis in amphibians, and salt balance in freshwater fish. How is it possible for one hormone to have such a wide range of activity in vertebrates? Could it have a role in invertebrates? **(BIG IDEAS 1 & 2)**
46	Reproductive processes that increase genetic variation **(BIG IDEA 3)** are evolutionarily conserved in many eukaryotes **(BIG IDEA 1)**.	Making Inferences and Designing an Experiment, AP® Science Practices 2, 3, 6 *(page 1030)*	Explain why evolution selects for sexual reproduction instead of asexual reproduction, even though in sexual reproduction typically only half of the population actually produces offspring. **(BIG IDEAS 1 & 3)**
47	Despite the great diversity of species within the animal kingdom, aspects of early embryonic development are highly conserved **(BIG IDEA 1)**. Timing and coordination of cell and tissue specialization are highly regulated by a variety of mechanisms and include the induction of transcription factors and programmed cell death **(BIG IDEA 3)**.	Interpreting a Change in Slope, AP® Science Practices 2, 4, 6 *(page 1049)*	Compare pattern formation in the embryonic development of body plans in both plants and animals. Could you use this as an argument for a common ancestor? What evidence would you look for to make the case? **(BIG IDEAS 1 & 3)**
48	Organ systems have evolved to sense and process information, resulting in changes within and between biological systems **(BIG IDEA 1)**. Those systems interact to provide essential biological activities **(BIG IDEA 4)**.	Interpreting Data Values Expressed in Scientific Notation, AP® Science Practices 4, 5, 6 *(page 1082)*	Why does the neurotransmitter acetylcholine have two different types of receptors: a ligand-gated ion channel and a G-protein-coupled receptor? **(BIG IDEA 3)**
49	Interactions and coordination between systems enable essential biological activities **(BIG IDEA 4)** that detect signals, transmit and integrate information, and produce responses **(BIG IDEA 3)**.	Designing an Experiment Using Genetic Mutants, AP® Science Practices 2, 3, 4, 6 *(page 1095)*	Individual organisms act on information from internal changes or environmental cues and often communicate that information to others. What is a communication mechanism present in all organisms that can be traced back to common ancestors? **(BIG IDEAS 1, 2, & 3)**

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50	Transmission of information results in changes within and between biological systems **(BIG IDEA 3)**. Transmission has been enhanced through the evolution of organ systems to sense and process information **(BIG IDEA 1)**.	Interpreting a Graph with Log Scales, AP® Science Practices 2, 4, 5, 6 *(page 1136)*	How did natural selection play a role in the limited color vision in many mammals (excluding primates) compared to the acute color vision in most birds, insects, reptiles, amphibians, and fish? **(BIG IDEAS 1 & 3)**
51	Organisms exhibit complex properties when they respond to their environment and other organisms **(BIG IDEA 4)**.	Testing a Hypothesis with a Quantitative Model, AP® Science Practices 1, 4 *(page 1150)*	Is behavior an emergent property? Does the fact that some behaviors vary within the human species affect your answer? Justify your claim. **(BIG IDEA 4)**
52	Species extinction rates are higher in times of ecological stress **(BIG IDEA 1)**, with more risk to those populations with little genetic diversity **(BIG IDEA 4)** that face decreases in the availability of energy **(BIG IDEA 2)**.	Making a Bar Graph and a Line Graph to Interpret Data, AP® Science Practices 3, 4, 6 *(page 1186)*	Can you predict the effect of a change within an ecological community if the climate changes? What type of data would you need to assess the impact? **(BIG IDEA 4)**
53	Mathematical and computer models can be used to define the structure of an ecological community, whose attributes can be measured in different ways **(BIG IDEA 4)**. Within a community, different populations interact in complex ways that affect the nutrients available within the ecosystem and hence its carrying capacity **(BIG IDEA 2)**.	Using the Logistic Equation to Model Population Growth, AP® Science Practices 1, 2, 4, 5, 6 *(page 1200)*	Picture the interaction of populations within an ecosystem as a self-correcting feedback loop. What biotic and abiotic factors regulate a population's density and size? **(BIG IDEA 4)**
54	Interactions between populations affect population distributions and the reproductive success of individuals within populations **(BIG IDEAS 1 & 4)** by limiting or providing energy and matter **(BIG IDEA 2)**.	Making a Bar Graph and a Scatter Plot, AP® Science Practices 2, 3, 4, 6 *(page 1217)*	Are there ecological communities in which humans could be considered a founder or keystone species? Could they be considered an invasive or introduced species in others? What evidence do you need to evaluate the question? **(BIG IDEA 4)**
55	All living systems require a constant input of energy and an exchange of matter with the environment **(BIG IDEA 2)**. In an ecosystem, energy flows but matter is recycled **(BIG IDEA 4)**. Ecosystems maintain dynamic homeostasis by regulating the transfer of energy and matter **(BIG IDEA 2)**.	Interpreting Quantitative Data, AP® Science Practices 4, 5 *(page 1247)*	Explain why energy decreases through a food chain but the available matter does not. **(BIG IDEA 2)**
56	Human impact accelerates changes at local and global levels (**BIG IDEA 4**), which can change the energy and matter available in an ecosystem **(BIG IDEA 2)** and act as a selective mechanism on populations **(BIG IDEA 1)**. An ecosystem is more stable when there is species and genetic diversity, providing resilience if the system changes **(BIG IDEA 1)**.	Graphing Data and Evaluating Evidence, AP® Science Practices 4, 5, 6 *(page 1279)*	Why is it important to protect species diversity in an era of global climate change? **(BIG IDEAS 1 & 4)**