AP Biology Overview and Sequence

The AP Biology course is an advanced science course, designed to explore life science at a college level. This course is open to students who have excelled in previous science courses, have good reading, writing, and math skills, and have the motivation and maturity that will enable them to make a commitment to completing the program. This course is a full year, two-semester program that is offered from August to June. It offers a continuation in biological studies, focusing on more advanced topics. Assessments include students' notebook, tests, quizzes, essays, lab reports, activities, and projects on specific topics.

This course will cover a wide range of concepts in modern biology. Though topics in the life sciences are expansive, there are recurring themes that connect the concepts. This course is organized around these major themes. Students should remember these themes as we move through the course, using them as a way to organize concepts and topics into a conceptual, "big picture" framework. These major themes are as follows:

1. Evolution
2. Biological Systems & Processes
3. Genetics & Information Transfer
4. Interactions in Biological Systems

The student is required to complete a number of labs that have been recommended by the AP Biology College Board, as follows:

OVERVIEW OF THE INVESTIGATIVE LABS

TIME ESTIMATE
(lab period = 45 min. unless otherwise noted)
Timing details are provided in each lab.

LAB	TIME ESTIMATE	LEVEL OF INQUIRY	QUANTITATIVE SKILLS
BIG IDEA 1: EVOLUTION			
1: Artificial Selection	7 weeks, including a 10-day growing period (See investigation for lab period breakdown.)	Guided, then open	Counting, measuring, graphing, statistical analysis (frequency distribution)
2: Mathematical Modeling	3 lab periods	Guided, then open	Mendelian genetics equations, Hardy-Weinberg equation, Excel and spreadsheet operations
3: Comparing DNA Sequences	3 lab periods	Guided, then open	Statistical analysis, mathematical modeling, and computer science (bioinformatics)
BIG IDEA 2: CELLULAR PROCESSES: ENERGY AND COMMUNICATION			
4: Diffusion and Osmosis	4–5 lab periods	Structured, then guided	Measuring volumes, calculating surface area-to-volume ratios, calculating rate, calculating water potential, graphing
5: Photosynthesis	4 lab periods	Structured, then open	Calculating rate, preparing solutions, preparing serial dilutions, measuring light intensity, developing and applying indices to represent the relationship between two quantitative values, using reciprocals to modify graphical representations, utilizing medians, graphing
6: Cellular Respiration	4 lab periods	Guided, then open	Calculating rate, measuring temperature and volume, graphing
BIG IDEA 3: GENETICS AND INFORMATION TRANSFER			
7: Cell Division: Mitosis and Meiosis	5–6 lab periods	Structured, then guided, then open	Measuring volume, counting, chi-square statistical analysis, calculating crossover frequency
8: Biotechnology: Bacterial Transformation	4–5 lab periods	Structured, then guided	Measuring volume and temperature, calculating transformation efficiency
9: Biotechnology: Restriction Enzyme Analysis of DNA	3–4 lab periods	Structured, then guided, then open	Measuring volume and distance, graphing/plotting data using log scale, extrapolating from standard curve
BIG IDEA 4: INTERACTIONS			
10: Energy Dynamics	4–5 lab periods	Structured, then guided, then open	Estimating productivity and efficiency of energy transfer, accounting and budgeting, measuring biomass, calculating unit conversions in simple equations
11: Transpiration	4 lab periods	Structured, then guided, then open	Measuring distance, volume, and mass; estimating surface area; calculating surface area; graphing; calculating rate
12: Fruit Fly Behavior	4 lab periods	Structured, then open	Preparing solutions, counting, graphing
13: Enzyme Activity	3–4 lab periods	Structured, then guided, then open	Measuring volume and mass, measuring color change, graphing, calculating rates of enzymatic reactions

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Students will complete formal lab reports that will be scored using a rubric. The rubric is designed to follow current standards in scientific publications. The rubric is shown below:

Lab Report Rubric

Levels/ Criteria	1: Incomplete/Incorrect	2: Incomplete/Many Errors	3: Acceptable/Minor Errors	4: Exemplary	Score
Overall	The lab report is incomplete or incorrect, or it is too difficult & confusing to follow.	The lab report is incomplete & needs additional work, clarification, & other revision.	The lab report is correct & complete with only minor errors.	The lab report is extremely well-done, easy to understand, complete & correct.	
Grammar, Spelling, etc.	The lab report has more than 10 errors in spelling or grammar.	The lab report has 6-10 errors in spelling or grammar.	The lab report has 1-5 errors in spelling or grammar.	The lab report has no errors in spelling or grammar.	
Abstract	The lab report includes an abstract, but it is an incomplete summary.	The lab report includes a basic abstract, but with 2 errors or missing items.	The lab report includes an abstract, a summary, but with 1 error or missing item.	The lab report includes a very well written abstract, a complete summary, of the introduction, methods, results, & conclusions.	
Introduction	The lab report includes an incomplete introduction.	The lab report includes an introduction, but with 2 error or missing items.	The lab report includes an introduction, but with 1 error or missing item.	The lab report includes a very well written introduction, summarizing background information, the project question, & hypothesis.	
Materials & Methods	The lab report includes an incomplete materials & methods section.	The lab report includes a basic materials & methods section, but it lacks some details.	The lab report includes a basic materials & methods section, detailing the protocol used to set up & complete the experiments & to collect data.	The lab report includes a very well written materials & methods section, detailing the protocol used to set up & complete the experiments & to collect data. No extraneous information is added.	
Results	The lab report includes incomplete results.	The lab report includes basic results, but they lack some details.	The lab report includes results, describing the actual information gathered through experimentation.	The lab report includes very well written results, describing the actual information gathered through experimentation. No extraneous information is added.	
Tables & Graphs	The lab report includes tables & graphs to show data, but with more than 2 errors.	The lab report includes tables & graphs to show data, but with 2 errors.	The lab report includes tables & graphs to show data, but with 1 error or missing item.	The lab report includes appropriate tables & graphs to show data, with all titles, axes & units included.	
Discussion	The lab report includes an incomplete discussion.	The lab report includes a discussion, but with 2 error or missing items.	The lab report includes a discussion, but with 1 error or missing item.	The lab report includes a very well written discussion, referring to the original question & hypothesis, analyzing & explaining results, describing possible significance, & suggesting possible further research.	
References	Sources used are incorrectly listed, & in-text citations are not included.	Sources used are incorrectly listed, or in-text citations are not included.	Sources used in this investigation are listed in APA format, & includes in-text citations, with minor errors.	All sources used in this investigation are listed in proper APA format. Also, all listed sources have proper in-text citations.	

AP BIOLOGY CURRICULUM MAP:

Unit name	Pacing *Number of weeks proposed*	Instructional Block *Number of lessons with time*	Standards and Scientific Practices
1. The Science of Biology	2 weeks	5 lessons	Learning objective 2.15The student 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. Learning objective 2.16The student is able to connect how organisms use negative feedback to maintain their internal environments. Learning objective 2.17The student is able to evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms. Learning objective 2.18The student can make predictions about how organisms use negative feedback mechanisms to maintain their internal environments

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			Learning objective 2.19 The student is able to make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models. Learning objective 2.20 The student is able to justify that positive feedback mechanisms amplify responses in organisms. Learning objective 2.21 The student is able to 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. Learning objective 2.42 The student is able to pose a scientific question concerning the behavioral or physiological response of an organism to a change in its environment. Learning objective 2.28 The student is able to use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. Learning objective 4.8The student is able to evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts. Learning objective 4.9The student is able to predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s). Learning objective 4.10The student is able to refine representations and models to illustrate biocomplexity due to interactions of the constituent parts.
2. Biochemistry	3 weeks	6 lessons	Learning objective 2.2The student is able to justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies for obtaining and using energy exist in different living systems. Learning objective 2.3The student is able to predict how changes in free energy availability affect organisms, populations, and/or ecosystems. Learning objective 2.4The student is able to use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store and use free energy. Learning objective 2.8The student is able to 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. Learning objective 2.9 The student is able to 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. Learning objective 4.1The student is able to explain the connection between the sequence and the subcomponents of a biological polymer and its properties. Learning objective 4.2The student is able to refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer. Learning objective 4.3The student is able to use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule. Learning objective 4.17The student is able to analyze data to identify how molecular interactions affect structure and function. Learning objective 4.22The student is able to construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.
3. Cell Structure & Function	3 weeks	6 lessons	Learning objective 2.14The student is able to use representations and models to describe differences in prokaryotic and eukaryotic cells. Learning objective 1.12The student is able to connect scientific evidence from many scientific disciplines to support the modern concept of evolution. Learning objective 2.6The student is able to use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion. Learning objective 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. Learning objective 2.10The student is able to use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. Learning objective 2.11The student is able to construct models that connect the movement of molecules across membranes with membrane structure and function. Learning objective 2.12The student is able to 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. Learning objective 2.13The student is able to explain how internal membranes and organelles contribute to cell functions. Learning objective 3.29The student is able to construct an explanation of how viruses introduce genetic variation in host organisms. Learning objective 3.33The student is able to use representation(s) and appropriate models to describe features of a cell signaling pathway. Learning objective 3.34The student is able to construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. Learning objective 3.35The student is able to create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. Learning objective 3.36The student is able to describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.

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			Learning objective 3.37The student is able to justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response. Learning objective 3.38The student is able to describe a model that expresses key elements to show how change in signal transduction can alter cellular response. Learning objective 3.39The student is able to construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways. Learning objective 4.4The student is able to make a prediction about the interactions of subcellular organelles. Learning objective 4.5The student is able to construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. Learning objective 4.6The student is able to use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.
4. Cellular Processes	2 weeks	4 lessons	Learning objective 2.5The student is able to construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store or use free energy. Learning objective 2.41The student is able to evaluate data to show the relationship between photosynthesis and respiration in the flow of free energy through a system.
5. Cellular Reproduction	3 weeks	6 lessons	Learning objective 2.1The student is able to 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. Learning objective 2.34 The student is able to describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis. Learning objective 3.7The student can make predictions about natural phenomena occurring during the cell cycle. Learning objective 3.8The student can describe the events that occur in the cell cycle. Learning objective 3.9The student is able to 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. Learning objective 3.10The student is able to represent the connection between meiosis and increased genetic diversity necessary for evolution. Learning objective 3.11The student is able to 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. Learning objective 3.12The student is able to construct a representation that connects the process of meiosis to the passage of traits from parent to offspring.
6. Genetics	4 weeks	9 lessons	Learning objective 3.1The student is able to construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, RNA are the primary sources of heritable information. Learning objective 3.2The student is able to justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information. Learning objective 3.3The student is able to describe representations and models that illustrate how genetic information is copied for transmission between generations. Learning objective 3.4The student is able to describe representations and models illustrating how genetic information is translated into polypeptides. Learning objective 3.6The student can predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. Learning objective 3.13The student is able to pose questions about ethical, social or medical issues surrounding human genetic disorders. Learning objective 3.14The student is able to apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. Learning objective 3.15The student is able to explain deviations from Mendel's model of the inheritance of traits. Learning objective 3.16The student is able to explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. Learning objective 3.17The student is able to describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits. Learning objective 3.18The student is able to describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. Learning objective 3.19The student is able to describe the connection between the regulation of gene expression and observed differences between individuals in a population. Learning objective 3.20The student is able to explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function. Learning objective 3.21The student can use representations to describe how gene regulation influences cell products and function. Learning objective 3.22The student is able to explain how signal pathways mediate gene expression, including how this process can affect protein production.

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			Learning objective 3.23The student can use representations to describe mechanisms of the regulation of gene expression. Learning objective 3.24The student is able to predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. Learning objective 3.25The student can create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. Learning objective 4.23The student is able to construct explanations of the influence of environmental factors on the phenotype of an organism. Learning objective 4.24The student is able to predict the effects of a change in an environmental factor on gene expression and the resulting phenotype of an organism. Learning objective 4.25The student is able to 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.
7. Biotechnology	3 weeks	8 lessons	Learning objective 3.5The student can explain how heritable information can be manipulated using common technologies. Learning objective 3.30The student is able to use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population.
8. Evolution	4 weeks	9 lessons	Learning objective 1.1The student is able to 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. Learning objective 1.2The student is able to evaluate evidence provided by data to qualitatively and/or quantitatively investigate the role of natural selection in evolution. Learning objective 1.3The student is able to apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. Learning objective 1.4 The student is able to evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time. Learning objective 1.5The student is able to connect evolutionary changes in a population over time to a change in the environment. Learning objective 1.8The student is able to make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population. Learning objective 1.9The student is able to evaluate evidence provided by data from many scientific disciplines that support biological evolution. Learning objective 1.10The student is able to refine evidence based on data from many scientific disciplines that support biological evolution. Learning objective 1.11The student is able to design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology. Learning objective 1.13The student is able to construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution. Learning objective 1.14The student is able to pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth. Learning objective 1.15The student is able to 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. Learning objective 1.16The student is able to justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. Learning objective 1.17The student is able to 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. Learning objective 1.18The student is able to evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. Learning objective 1.19The student is able create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set. Learning objective 1.20The student is able to analyze data related to questions of speciation and extinction throughout the Earth's history. Learning objective 1.21The student is able to design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history. Learning objective 1.22The student is able to 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. Learning objective 1.23The student is able to justify the selection of data that address questions related to reproductive isolation and speciation. Learning objective 1.24The student is able to describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection and/or genetic drift. Learning objective 1.25The student is able to describe a model that represents evolution within a population. Learning objective 1.26The student is able to evaluate given data sets that illustrate evolution as an ongoing process.

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			Learning objective 1.27The student is able to describe a scientific hypothesis about the origin of life on Earth. Learning objective 1.28The student is able to evaluate scientific questions based on hypotheses about the origin of life on Earth. Learning objective 1.29The student is able to describe the reasons for revisions of scientific hypotheses of the origin of life on Earth. Learning objective 1.30The student is able to evaluate scientific hypotheses about the origin of life on Earth. Learning objective 1.31The student is able to evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth. Learning objective 1.32The student is able to justify the selection of geological, physical, and chemical data that reveal early Earth conditions. Learning objective 2.25 The student 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. Learning objective 2.26 The student is able to 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. Learning objective 2.27 The student is able to connect differences in the environment with the evolution of homeostatic mechanisms. Learning objective 2.38The student is able to analyze data to support the claim that responses to information and communication of information affect natural selection. Learning objective 3.26The student is able to explain the connection between genetic variation in organisms and phenotypic variation in populations. Learning objective 3.27The student is able to compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains. Learning objective 3.31The student is able to describe basic chemical processes for cell communication shared across evolutionary lines of descent. Learning objective 3.32The student is able to generate scientific questions involving cell communication as it relates to the process of evolution. Learning objective 4.26The student is able to use theories and models to make scientific claims and/ or predictions about the effects of variation within populations on survival and fitness.
9. Ecology	4 weeks	10 lessons	Learning objective 1.6The student is able to 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. Learning objective 1.7The student is able to justify the selection of 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. Learning objective 2.22 The student is able to 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. Learning objective 2.23 The student is able to 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. Learning objective 2.24 The student is able to analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities or ecosystems). Learning objective 2.39The student is able to justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms. Learning objective 2.40The student is able to connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior. Learning objective 3.28The student is able to construct an explanation of the multiple processes that increase variation within a population. Learning objective 3.40The student is able to analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior. Learning objective 3.41The student is able to 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. Learning objective 3.42The student is able to describe how organisms exchange information in response to internal changes or environmental cues. Learning objective 4.11The student is able to justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities. Learning objective 4.12The student is able to apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. Learning objective 4.13The student is able to predict the effects of a change in the community's populations on the community.

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			Learning objective 4.14The student is able to apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. Learning objective 4.15The student is able to 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. Learning objective 4.16The student is able to predict the effects of a change of matter or energy availability on communities. Learning objective 4.18The student is able to use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter. Learning objective 4.19The student is able to use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance. Learning objective 4.20The student is able to explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past. Learning objective 4.21The student is able to predict consequences of human actions on both local and global ecosystems. Learning objective 4.27The student is able to make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.
10. Anatomy & Physiology	4 weeks	9 lessons	Learning objective 2.29 The student can create representations and models to describe immune responses. Learning objective 2.30The student can create representations or models to describe nonspecific immune defenses in plants and animals. Learning objective 2.43The student is able to connect the concept of cell communication to the functioning of the immune system. Learning objective 2.31 The student 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. Learning objective 2.32 The student is able to 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. Learning objective 2.33 The student is able to 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. Learning objective 2.35The student is able to design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation. Learning objective 2.36The student is able to justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation. Learning objective 2.37The student is able to connect concepts that describe mechanisms that regulate the timing and coordination of physiological events. Learning objective 3.43The student is able to 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. Learning objective 3.44The student is able to describe how nervous systems detect external and internal signals. Learning objective 3.45The student is able to describe how nervous systems transmit information. Learning objective 3.46The student is able to describe how the vertebrate brain integrates information to produce a response. Learning objective 3.47The student is able to 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. Learning objective 3.48The student is able to create a visual representation to describe how nervous systems detect external and internal signals. Learning objective 3.49The student is able to create a visual representation to describe how nervous systems transmit information. Learning objective 3.50The student is able to create a visual representation to describe how the vertebrate brain integrates information to produce a response. Learning objective 4.7The student is able to refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs.
	Total: 32 weeks		

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