TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

ADVANCED PLACEMENT BIOLOGY
Grades 10-12
Science Department

2018

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Curriculum Writing Team

Thomas Edwards Science Department Chairperson, Trumbull High School

Kevin Boken Science Teacher, Trumbull High School
Douglas Winters Science Teacher, Trumbull High School

Jonathan S. Budd, Ph.D., Assistant Superintendent of Curriculum, Instruction, & Assessments

Advanced Placement Biology
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The Trumbull Board of Education will continue to take Affirmative Action to ensure that no persons are discriminated against in its employment.

CORE VALUES AND BELIEFS

The Trumbull School Community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.

Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

Advanced Placement Biology is designed to be the equivalent of a college-level introductory biology course. As such, the course includes those topics covered in a course for biology majors. The units of study include ecology, chemistry of life, cell biology, molecular and applied genetics, evolution, plant biology, and animal biology. AP Biology differs from the typical high school biology course with respect to the kind of textbook used, the range and depth of topics covered, the rigor involved, the kind of laboratory work done by students, and the time and effort required of students. AP Biology aims to provide students with the conceptual framework, factual knowledge, and analytical skills necessary to deal critically with the rapidly changing science of biology. The intent of the course is to expose students to higher-level biological principles, concepts, and skills and allow them the opportunity to apply their knowledge to real-life applications. Students are also expected to learn not through memorization of facts, but through content and concept application via the AP Biology science practices. Core concepts and their application via the science practices are the basis of the curriculum. The concepts are organized around biological principles that permeate the entire course and focus on the following topics:

1. The process of evolution drives the diversity and unity of life.
2. Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.
3. Living systems store, retrieve, transmit, and respond to information essential to life processes.
4. Biological systems interact, and these systems and their interactions possess complex properties.

Advanced Placement Biology involves the process of testing ideas against observations in measurable and analytical ways. Students will be expected to employ the scientific method when investigating biological situations or problems and to use collected data to draw valid and appropriate conclusions.

COURSE GOALS

The course goals derive from the 2015 College Board Science Practices for AP Biology.

Science Practice 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.

1.1 The student can create representations and models of natural or man-made phenomena and systems in the domain.

1.2 The student can describe representations and models of natural or man-made phenomena and systems in the domain.

1.3 The student can refine representations and models of natural or man-made phenomena and systems in the domain.

1.4 The student can use representations and models to analyze situations or solve problems qualitatively and quantitatively.

1.5 The student can reexpress key elements of natural phenomena across multiple representations in the domain.

Science Practice 2: The student can use mathematics appropriately.

2.1 The student can justify the selection of a mathematical routine to solve problems.

2.2 The student can apply mathematical routines to quantities that describe natural phenomena.

2.3 The student can estimate numerically quantities that describe natural phenomena.

Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

3.1 The student can pose scientific questions.

3.2 The student can refine scientific questions.

3.3 The student can evaluate scientific questions.

Science Practice 4: The student can plan and implement data collection strategies appropriate to a particular scientific question.

4.1 The student can justify the selection of the kind of data needed to answer a particular scientific question.

4.2 The student can design a plan for collecting data to answer a particular scientific question.

4.3 The student can collect data to answer a particular scientific question.

4.4 The student can evaluate sources of data to answer a particular scientific question.

Science Practice 5: The student can perform data analysis and evaluation of evidence.

5.1 The student can analyze data to identify patterns or relationships.

5.2 The student can refine observations and measurements based on data analysis.

5.3 The student can evaluate the evidence provided by data sets in relation to a particular scientific question.

Science Practice 6: The student can work with scientific explanations and theories.

6.1 The student can justify claims with evidence.

6.2 The student can construct explanations of phenomena based on evidence produced through scientific practices.

6.3 The student can articulate the reasons that scientific explanations and theories are refined or replaced.

6.4 The student can make claims and predictions about natural phenomena based on scientific theories and models.

6.5 The student can evaluate alternative scientific explanations.

Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

7.1 The student can connect phenomena and models across spatial and temporal scales.

7.2 The student can connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- Change in the genetic makeup of a population over time is evolution.
- Organisms are linked by lines of descent from common ancestry.

- Life continues to evolve within a changing environment.
- Origin of living systems is explained by natural selection.
- Growth, reproduction, and maintenance of the organization of living systems require free energy and matter.
- Growth, reproduction, and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
- Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
- Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
- Many biological processes involved in growth, reproduction, and dynamic homeostasis include temporal regulation and coordination.
- Heritable information provides for continuity of life.
- Expression of genetic information involves cellular and molecular mechanisms.
- The processing of genetic information is imperfect and is a source of genetic variation.
- Cells communicate by generating, transmitting, and receiving chemical signals.
- Transmission of information results in changes within and between biological systems.
- Interactions within biological systems lead to complex properties.
- Competition and cooperation are important aspects of biological systems.
- Naturally occurring diversity between and among components within biological systems affects interactions with the environment.

COURSE ESSENTIAL QUESTIONS

- What role does evolution play in the organization of living things?
- What evidence supports our current models of the origin of life?
- How does the process of evolution drive diversity and the unity of life?
- How does life evolve in changing environments?
- How is the cell the basic unit of life?
- How do materials enter and leave the cell?
- What role does the cell membrane play in cellular homeostasis?
- What are the relationships between structure and function of cell organelles?
- How are the characteristics of life manifested by the cell?
- How is free energy used in biological systems to facilitate growth, reproduction, and homeostasis sustainability?
- How is energy stored in biological systems?
- How are external signals converted into cellular responses?
- How are traits passed from one generation to the next?

- How do eukaryotic cells store, retrieve, and transmit genetic information?
- How does genotype affect phenotype?
- How are genotype and human disorder related?
- How does gene expression control the cell and determine its metabolism?
- What are the current trends in genetic engineering techniques that guide manipulation of genetic information?
- What social and ethical issues are raised by advances in genetic engineering?
- How do interactions between and within populations influence patterns of species distribution and abundance?
- How do living things use energy and matter to survive in an ecosystem?
- How do humans impact the biodiversity of ecosystems?
- What role does the environment play in sustaining homeostasis in biological systems?

COURSE KNOWLEDGE & SKILLS

Students will understand . . .

- natural selection as a major mechanism of evolution.
- natural selection that acts on phenotypic variations in populations.
- evolutionary change as also driven by random processes.
- biological evolution as supported by scientific evidence from many disciplines, including mathematics.
- organisms sharing many conserved core processes and features that evolved and are widely distributed among organism today.
- phylogenetic trees and cladograms that are graphical representations (models) of evolutionary history and can be tested.
- speciation and extinction that have occurred throughout the Earth's history.
- speciation that may occur when two populations become reproductively isolated from each other.
- populations of organisms that continue to evolve.
- several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
- scientific evidence from many different disciplines supporting models of the origin of life.
- all living systems requiring constant input of free energy.
- organisms capturing and storing free energy for use in biological processes.
- organisms required to exchange matter with the environment to grow, reproduce, and maintain organization.
- cell membranes selectively permeable due to their structure.

- growth and dynamic homeostasis maintained by the constant movement of molecules across membranes.
- eukaryotic cells maintaining internal membranes that partition the cells into specialized regions.
- organisms using feedback mechanisms to maintain their internal environments and respond to external environmental changes.
- organisms responding to changes in their external environments.
- all biological systems from cells and organisms to populations, communities and ecosystems being affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
- homeostatic mechanisms reflecting both common ancestry and divergence due to adaptation in different environments.
- biological systems being affected by disruptions to their dynamic homeostasis.
- plants and animals having a variety of chemical defenses against infections that affect dynamic homeostasis.
- timing and coordination of specific events necessary for the normal development of an organism, and these events being regulated by multiple mechanisms.
- timing and coordination of physiological events being regulated by multiple mechanisms.
- timing and coordination of behavior being regulated by various mechanisms and important in natural selection.
- DNA, and in some cases RNA, as the primary source of heritable information.
- heritable information, in eukaryotes, as passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.
- the chromosomal basis of inheritance providing an understanding of the pattern of passage (transmission) of genes from parent to offspring.
- the inheritance pattern of many traits not being simple Mendelian genetics.
- gene regulation resulting in differential gene expression, leading to cell specialization.
- a variety of intercellular and intracellular signal transmissions mediating gene expression.
- changes in genotype potentially resulting in changes in phenotype.
- biological systems having multiple processes that increase genetic variation.
- viral replication resulting in genetic variation, and viral infection potentially introducing genetic variation to the hosts.
- cell communication processes sharing common features that reflect a shared evolutionary history.
- cells communicating with each other through direct contact with other cells or from distance via chemical signaling.
- signal transduction pathways linking signal reception with cellular response.
- changes in signal transduction pathways potentially altering cellular response.
- individuals potentially acting on information and communicating it to others.

- animals having nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.
- the subcomponents of biological molecules and their sequence determining the properties of those molecules.
- the structure and function of subcellular components, and their interactions, providing essential cellular processes.
- interactions between external stimuli and regulated gene expression resulting in specialization of cells, tissues, and organs.
- organisms exhibiting complex properties due to interactions between their constituent parts.
- communities as composed of populations of organisms that interact in complex ways.
- interactions among living systems and with their environment resulting in the movement of matter and energy.
- interactions between molecules affecting their structure and function.
- cooperative interactions within organisms promoting efficiency in the use of energy and matter.
- interactions between and within populations influencing patterns of species distribution and abundance.
- distribution of local and global ecosystems changing over time.
- variation in molecular units providing cells with a wider range of functions.
- environmental factors influencing the expression of the genotype in an organism.
- the level of variation in a population affecting population dynamics.
- the diversity of species within an ecosystem potentially influencing the stability of the ecosystem.

Students will be able to . . .

- create representations and models of natural or man-made phenomena and systems in the domain.
- describe representations and models of natural or manmade phenomena and systems in the domain.
- refine representations and models of natural or man-made phenomena and systems in the domain.
- use representations and models to analyze situations or solve problems qualitatively and quantitatively.
- reexpress key elements of natural phenomena across multiple representations in the domain.
- justify the selection of a mathematical routine to solve problems.
- apply mathematical routines to quantities that describe natural phenomena.
- estimate numerically quantities that describe natural phenomena.

- pose scientific questions.
- refine scientific questions.
- evaluate scientific questions.
- justify the selection of the kind of data needed to answer a particular scientific question.
- design a plan for collecting data to answer a particular scientific question.
- collect data to answer a particular scientific question.
- evaluate sources of data to answer a particular scientific question.
- analyze data to identify patterns or relationships.
- refine observations and measurements based on data analysis.
- evaluate the evidence provided by data sets in relation to a particular scientific question.
- justify claims with evidence.
- construct explanations of phenomena based on evidence produced through scientific practices.
- articulate the reasons that scientific explanations and theories are refined or replaced.
- make claims and predictions about natural phenomena based on scientific theories and models.
- evaluate alternative scientific explanations.
- connect phenomena and models across spatial and temporal scales.
- connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.

COURSE SYLLABUS

Course Name

Advanced Placement Biology

Level

Advanced Placement

Prerequisites

Grade of B+ or higher in Honors Integrated Physical Science with teacher recommendation, or Completion of Advanced College-Preparatory Biology or Honors Biology with teacher recommendation and Department Chair permission

Materials Required

None

General Description of the Course

This is a college-level introductory biology course taught as a complete survey of all major biological theories. Development of laboratory skills along with independent research skills is an integral part of the program. This may not be taken as a pass-fail course. Summer work packets will be assigned during the summer prior to the course.

Assured Assessments

Formative Assessments:

- Creation of food web (Unit 1)
- Chi-squared analysis (Unit 2)
- Bacterial transformation investigation (Unit 3)
- Hardy-Weinberg investigation (Unit 4)
- Transpiration investigation (Unit 5)
- Fruit fly animal behavior investigation (Unit 6)
- Independent research and presentation (Unit 7)

Summative Assessments:

- End-of-unit test with multiple-choice questions, mathematical grid-in questions, short-response question, and essay question (Units 1, 2, 3, 4, 5, 6)
- Examination based on all independent research presentations (Unit 7)

Core Text

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

UNIT 1
Ecology

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

<u>Scope of Ecology</u>

LO 2.22 (SP 1.3, 3.2)	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.
LO 2.23 (SP 4.2, 7.2)	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.
LO 2.24 (SP 5.1)	Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities or ecosystems).
LO 4.14 (SP 2.2)	Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.
LO 4.15 (SP 1.4)	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.
LO 4.16 (SP 6.4)	Predict the effects of a change of matter or energy availability on communities.

<u>Population Ecology</u>

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

LO 3.40 (SP 5.1) Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.

LO 3.41 (SP 1.1) 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.

LO 3.42 (SP 7.1) Describe how organisms exchange information in response to internal changes or environmental cues.

LO 4.14 (SP 2.2) Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.

LO 4.15 (SP 1.4) 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.

LO 4.16 (SP 6.4) Predict the effects of a change of matter or energy availability on communities.

LO 4.19 (SP 5.2) Use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance.

LO 4.25 (SP 6.1) 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.

LO 4.26 (SP 6.4) Use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness.

Community Ecology

LO 1.32 (SP 4.1) Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

LO 2.38 (SP 5.1) Analyze data to support the claim that responses to information and communication of information affect natural selection.

LO 2.39 (SP 6.1) Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms.

LO 2.40 (SP 7.2) Connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior.

LO 3.29 (SP 6.2) Construct an explanation of how viruses introduce genetic variation in host organisms.

LO 3.30 (SP 1.4)	Use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population.
LO 3.40 (SP 5.1)	Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.
LO 3.41 (SP 1.1)	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.
LO 3.42 (SP 7.1)	Describe how organisms exchange information in response to internal changes or environmental cues.
LO 4.11 (SP 1.4, 4.1)	Justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities.
LO 4.12 (SP 2.2)	Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways.
LO 4.13 (SP 6.4)	Predict the effects of a change in the community's populations on the community.
LO 4.14 (SP 2.2)	Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.
LO 4.15 (SP 1.4)	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.
LO 4.16 (SP 6.4)	Predict the effects of a change of matter or energy availability on communities.
LO 4.19 (SP 5.2)	Use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance.
LO 4.20 (SP 6.3)	Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past.
LO 4.21 (SP 6.4)	Predict consequences of human actions on both local and global ecosystems.

Ecosystems

LO 1.32 (SP 4.1)	Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

LO 3.40 (SP 5.1)	Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.
LO 3.41 (SP 1.1)	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.
LO 3.42 (SP 7.1)	Describe how organisms exchange information in response to internal changes or environmental cues.
LO 4.11 (SP 1.4, 4.1)	Justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities.
LO 4.12 (SP 2.2)	Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways.
LO 4.13 (SP 6.4)	Predict the effects of a change in the community's populations on the community.
LO 4.14 (SP 2.2)	Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.
LO 4.15 (SP 1.4)	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.
LO 4.16 (SP 6.4)	Predict the effects of a change of matter or energy availability on communities.
LO 4.18 (SP 1.4)	Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.
LO 4.19 (SP 5.2)	Use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance.
LO 4.20 (SP 6.3)	Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past.
LO 4.21 (SP 6.4)	Predict consequences of human actions on both local and global ecosystems.
LO 4.27 (SP 6.4)	Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.

Global Ecology and Conservation/Restoration

LO 4.11 (SP 1.4, 4.1)	Justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities.
LO 4.12 (SP 2.2)	Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways.
LO 4.13 (SP 6.4)	Predict the effects of a change in the community's populations on the community.
LO 4.20 (SP 6.3)	Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past.
LO 4.21 (SP 6.4)	Predict consequences of human actions on both local and global ecosystems.
LO 4.27 (SP 6.4)	Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.

Unit Essential Questions

- How would changes in one land biome impact other land biomes?
- In a community, are some species interactions more common than others?
- Do communities ever truly reach climax status?
- What would happen to the trophic levels in a community if the producer base changed?
- What advantage do migratory birds have over their counterparts who do not migrate?
- What is the value of biodiversity to humans?
- Is the health of an ecosystem more important than human needs?
- Who is responsible for maintaining the Earth's biodiversity?
- Do population growth models apply to humans the same way they apply to other species?

Scope and Sequence

1. Scope of ecology
2. Population ecology
3. Community ecology
4. Ecosystem ecology
5. Conservation/Restoration of biodiversity

Assured Assessments
Formative Assessment:

- Students will be provided examples of complex food webs. In groups, students will add arrows to show the transfer of energy within the food webs. Students will then create their own food webs, but in their labeling they must detail three to five interspecific interactions that occur within their webs, such as competition, predation, herbivory, symbiosis, parasitism, mutualism, and/or commensalism. Once their food webs are created, students will make predictions (with justification) about what might happen if a component in the food web were to change. For example, what would be possible consequences if a disease were to kill most of the plants at the producer level, or a non-native species were introduced into the ecosystem? Students will be provided a rubric of the items used to evaluate the food webs. They will have the opportunity to peer-review one another's work.

Summative Assessment:

- Students will take a 48-minute test containing 18 multiple-choice questions, 2 mathematical grid-in questions, 1 short-response question, and 1 essay question. The short-response question will be selected from ecological data, for example interpreting logistic or exponential predictions of growth patterns in given populations. The essay section will ask students to select one of three questions to answer:
  - In what ways do communities interact within their environments that result in the movement of matter and energy?
  - In what ways do interactions between and within populations influence patterns of species distribution and abundance of local and global ecosystems changes over time?
  - How does the diversity of a species within an ecosystem influence the stability of the ecosystem?

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "Ecosystem Footprint Case Study."
- "Biome Project."

Time Allotment

- Approximately three weeks

UNIT 2
Chemistry of Life and Cells

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

<u>The Chemical Context of Life</u>

LO 1.27 (SP 1.2) Describe a scientific hypothesis about the origin of life on Earth.

LO 1.28 (SP 3.3) Evaluate scientific questions based on hypotheses about the origin of life on Earth.

LO 1.29 (SP 6.3) Describe the reasons for revisions of scientific hypotheses of the origin of life on Earth.

LO 1.30 (SP 6.5) Evaluate scientific hypotheses about the origin of life on Earth.

LO 1.31 (SP 4.4) Evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth.

LO 1.32 (SP 4.1) Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

LO 2.6 (SP 2.2) Use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion.

LO 2.7 (SP 6.2) Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination.

LO 2.8 (SP 4.1) 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.

LO 2.9 (SP 1.1, 1.4) 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.

LO 3.1 Construct scientific explanations that use the structures and mechanisms of DNA

(SP 6.5) and RNA to support the claim that DNA and, in some cases, RNA are the primary sources of heritable information.

LO 3.2 (SP 4.1) Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.

LO 3.3 (SP 1.2) Describe representations and models that illustrate how genetic information is copied for transmission between generations.

LO 3.4 (SP 1.2) Describe representations and models illustrating how genetic information is translated into polypeptides.

LO 3.5 (SP 6.4) Explain how heritable information can be manipulated using common technologies.

LO 3.6 (SP 6.4) Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression.

LO 4.1 (SP 7.1) Explain the connection between the sequence and the subcomponents of a biological polymer and its properties.

LO 4.2 (SP 1.3) Refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer.

LO 4.3 (SP 6.1, 6.4) Use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.

LO 4.17 (SP 5.1) Analyze data to identify how molecular interactions affect structure and function.

LO 4.22 (SP 6.2) Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.

<u>Cell Structure and Function</u>

LO 1.14 (SP 3.1) Pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth.

LO 1.15 (SP 7.2) 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.

LO 1.16 (SP 7.3) Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

LO 2.13 (SP 6.2)	Explain how internal membranes and organelles contribute to cell functions.
LO 2.14 (SP 1.4)	Use representations and models to describe differences in prokaryotic and eukaryotic cells.
LO 2.22 (SP 1.3, 3.2)	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.
LO 2.23 (SP 4.2, 7.2)	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.
LO 2.24 (SP 5.1)	Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities or ecosystems).
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 6.3)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 3.36 (SP 1.5)	Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.
LO 4.4 (SP 6.4)	Make a prediction about the interactions of subcellular organelles.
LO 4.5 (SP 6.2)	Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
LO 4.6 (SP 1.4)	Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.
LO 4.18 (SP 1.4)	Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

<u>Membrane Structure and Function</u>

LO 2.6 (SP 2.2)	Use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion.
LO 2.7	Explain how cell size and shape affect the overall rate of nutrient intake and the

(SP 6.2)	rate of waste elimination.
LO 2.8 (SP 4.1)	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.
LO 2.9 (SP 1.1, 1.4)	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.
LO 2.10 (SP 1.4, 3.1)	Use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure.
LO 2.11 (SP 1.1, 7.1., 7.2)	Construct models that connect the movement of molecules across membranes with membrane structure and function.
LO 2.12 (SP 1.4)	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.
LO 2.15 (SP 6.1)	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.
LO 2.16 (SP 7.2)	Connect how organisms use negative feedback to maintain their internal environments.
LO 2.17 (SP 5.3)	Evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms.
LO 2.18 (SP 6.4)	Make predictions about how organisms use negative feedback mechanisms to maintain their internal environments.
LO 2.19 (SP 6.4)	Make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models.
LO 2.20 (SP 6.1)	Justify that positive feedback mechanisms amplify responses in organisms.
LO 2.31 (SP 7.2)	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.
LO 2.32	Use a graph or diagram to analyze situations or solve problems (quantitatively or

(SP 1.4)	qualitatively) that involve timing and coordination of events necessary for normal development in an organism.
LO 2.33 (SP 6.1)	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.
LO 2.34 (SP 7.1)	Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis.
LO 2.35 (SP 4.2)	Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.
LO 2.36 (SP 6.1)	Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.
LO 2.37 (SP 7.2)	Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.31 (SP 7.2)	Describe basic chemical processes for cell communication shared across evolutionary lines of descent.
LO 3.32 (SP 3.1)	Generate scientific questions involving cell communication as it relates to the process of evolution.
LO 3.33 (SP 1.4)	Use representation(s) and appropriate models to describe features of a cell signaling pathway.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 2.4)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 3.36 (SP 1.5)	Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.
LO 3.37 (SP 6.1)	Justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response.

LO 3.38 (SP 1.5) Describe a model that expresses key elements to show how change in signal transduction can alter cellular response.

LO 3.39 (SP 6.2) Construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways.

LO 4.4 (SP 6.4) Make a prediction about the interactions of subcellular organelles.

LO 4.5 (SP 6.2) Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.

LO 4.6 (SP 1.4) Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.

LO 4.22 (SP 6.2) Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.

<u>Metabolism: Energy and Enzymes</u>

LO 1.32 (SP 4.1) Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

LO 2.4 (SP 1.4, 3.1) Use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store and use free energy.

LO 2.5 (SP 6.2) Construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store or use free energy.

LO 3.36 (SP 1.5) Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.

LO 3.37 (SP 6.1) Justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response.

LO 3.38 (SP 1.5) Describe a model that expresses key elements to show how change in signal transduction can alter cellular response.

LO 3.39 (SP 6.2) Construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways.

LO 4.1 (SP 7.1) Explain the connection between the sequence and the subcomponents of a biological polymer and its properties.

LO 4.2 Refine representations and models to explain how the subcomponents of a

(SP 1.3)	biological polymer and their sequence determine the properties of that polymer.
LO 4.3 (SP 6.1, 6.4)	Use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.
LO 4.4 (SP 6.4)	Make a prediction about the interactions of subcellular organelles.
LO 4.5 (SP 6.2)	Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
LO 4.6 (SP 1.4)	Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.
LO 4.14 (SP 2.2)	Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.
LO 4.15 (SP 1.4)	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.
LO 4.16 (SP 6.4)	Predict the effects of a change of matter or energy availability on communities.
LO 4.17 (SP 5.1)	Analyze data to identify how molecular interactions affect structure and function.
LO 4.18 (SP 1.4)	Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

<u>Cellular Respiration and Fermentation</u>

LO 4.4 (SP 6.4)	Make a prediction about the interactions of subcellular organelles.
LO 4.5 (SP 6.2)	Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
LO 4.6 (SP 1.4)	Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.
LO 4.14	Apply mathematical routines to quantities that describe interactions among living

(SP 2.2)	systems and their environment, which result in the movement of matter and energy.
LO 4.15 (SP 1.4)	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.
LO 4.16 (SP 6.4)	Predict the effects of a change of matter or energy availability on communities.

Photosynthesis

LO 4.4 (SP 6.4)	Make a prediction about the interactions of subcellular organelles.
LO 4.5 (SP 6.2)	Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
LO 4.6 (SP 1.4)	Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.
LO 4.14 (SP 2.2)	Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.
LO 4.15 (SP 1.4)	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.
LO 4.16 (SP 6.4)	Predict the effects of a change of matter or energy availability on communities.
LO 4.17 (SP 5.1)	Analyze data to identify how molecular interactions affect structure and function.

Unit Essential Questions

- What are the general characteristics shared by all living organisms?
- What is the relationship between evolutionary change and the study of biology?
- What unique properties do chemical elements have?
- How do elements interact with one another?
- How is it possible for inanimate chemical elements to produce a living organism?
- How can a relatively small number of chemicals be used to build many large, complex, and diverse molecules?
- Why can one organism use molecules from another organism to build its own?

- How are organic molecules combined to create the structure and functions necessary to support life?
- How is a cell more than simply the sum of its macromolecular parts?
- What characteristics enable cells to be alive and allow them to self-replicate?
- How are cells able to metabolize and respond to environmental changes so quickly?
- Why is creating compartments with membranes necessary for cellular life?
- How does compartmentalization increase cell efficiency and use of energy?
- In what ways have membranes enabled cells to specialize within an organism?
- What forms of energy does a cell use?
- How is energy used to drive biological processes within cells?
- What might happen if insufficient energy is available for cells to function?
- What relationships do heterotrophs have with the photosynthesizing autotrophs?
- How might the increased destruction of plants affect our environment, climate, and lives in the future?
- How does the ATP molecule store chemical energy needed to run biological processes?
- How are enzymes involved in regulating energy metabolism?
- If nearly all life on Earth uses ATP, what does that indicate about its origins and biological importance?

Scope and Sequence

1. Basic chemistry
2. Chemistry of organic molecules
3. Cell structure and function
4. Membrane structure and function
5. Metabolism: energy and enzymes
6. Cellular respiration and fermentation
7. Photosynthesis

Assured Assessments

Formative Assessment:

- Students will be asked to complete a chi-squared analysis, which is used to determine if the data they observed from an experiment is close enough to the predicted data. Calculating the X^2 values help the students determine whether the results follow the prediction and if the variations from the exact ratio are due to random chance. If the numbers differ greatly from their expected results, then it's possible that other factors may be influencing their results. Within this unit the students will be provided with bags of M&Ms along with company-supplied data describing the number produced for each color. Students are required to complete a chi-squared analysis of observed results (number of each color counted) to determine whether they match the expected results. This is also called a "goodness of fit" statistic, because it measures how well the observed distribution of data fits with the distribution expected if the variables are independent.

Summative Assessment:

- Students will take a 48-minute test containing 18 multiple-choice questions, 2 mathematical grid-in questions, 1 short-response question, and 1 essay question. The short-response question will be selected from scientific data; students must perform a chi-squared analysis to determine whether the null hypotheses is “rejected” or “not rejected.” The essay section will ask students to answer the following questions:
  - Describe one characteristic of the plasma membrane that allows estrogens to passively cross the membrane.
  - In a laboratory experiment, a researcher generates antibodies that bind to purified estrogen receptors extracted from cells. The researcher uses the antibodies in an attempt to treat estrogen-dependent cancers but finds that the treatment is ineffective. Explain the ineffectiveness of the antibodies for treating estrogen-dependent cancers.

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10^{th} ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- “AP Lab Investigation 4: Diffusion and Osmosis.” “AP Lab Investigation 10: Energy Dynamics.” *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- “AP Lab Investigation 5: Photosynthesis.” “AP Lab Investigation 10: Energy Dynamics.” *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- “AP Lab Investigation 6: Cellular Respiration.” “AP Lab Investigation 10: Energy Dynamics.” *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- “AP Lab Investigation 13: Enzyme Activity.” “AP Lab Investigation 10: Energy Dynamics.” *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- “Surface Area to Volume Ratio Inquiry Lab.”
- “Molecules of Life Lab Activity.”
- “Protein Folding Lab Activity.”
- “Water Inquiry Activities.”
- “Case Study: A Curious Mission to Mars.”

Time Allotment

- Approximately ten weeks

UNIT 3
Genetic Basis of Life

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

<u>The Cell Cycle and Cellular Reproduction</u>

LO 2.35 (SP 4.2)	Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.
LO 2.36 (SP 6.1)	Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.
LO 2.37 (SP 7.2)	Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.
LO 3.7 (SP 6.4)	Make predictions about natural phenomena occurring during the cell cycle.
LO 3.8 (SP 1.2)	Describe the events that occur in the cell cycle.
LO 3.9 (SP 6.2)	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.
LO 3.10 (SP 7.1)	Represent the connection between meiosis and increased genetic diversity necessary for evolution.
LO 3.11 (SP 5.3)	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.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.

LO 3.35 (SP 1.2)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 3.36 (SP 1.5)	Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.
LO 3.37 (SP 6.1)	Justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response.
LO 3.38 (SP 1.5)	Describe a model that expresses key elements to show how change in signal transduction can alter cellular response.
LO 3.39 (SP 6.2)	Construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways.
LO 4.4 (SP 6.4)	Make a prediction about the interactions of subcellular organelles.
LO 4.5 (SP 6.2)	Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
LO 4.6 (SP 1.4)	Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions.

<u>Meiosis and Sexual Reproduction</u>

LO 3.7 (SP 6.4)	Make predictions about natural phenomena occurring during the cell cycle.
LO 3.8 (SP 1.2)	Describe the events that occur in the cell cycle.
LO 3.9 (SP 6.2)	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.
LO 3.10 (SP 7.1)	Represent the connection between meiosis and increased genetic diversity necessary for evolution.
LO 3.11 (SP 5.3)	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.
LO 3.12 (SP 1.1, 7.2)	Construct a representation that connects the process of meiosis to the passage of traits from parent to offspring.

LO 3.13 (SP 3.1) Pose questions about ethical, social or medical issues surrounding human genetic disorders.

LO 3.14 (SP 2.2) Apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets.

LO 3.18 (SP 7.1) Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.

LO 3.19 (SP 7.1) Describe the connection between the regulation of gene expression and observed differences between individuals in a population.

LO 3.20 (SP 6.2) Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.

LO 3.21 (SP 1.4) Use representations to describe how gene regulation influences cell products and function.

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.27 (SP 7.2) Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.

LO 3.28 (SP 6.2) Construct an explanation of the multiple processes that increase variation within a population.

LO 4.27 (SP 6.4) Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.

Mendelian Patterns of Inheritance

LO 3.15 (SP 6.5) Explain deviations from Mendel’s model of the inheritance of traits.

LO 3.16 (SP 6.3) Explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics.

LO 3.17 (SP 1.2) Describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel’s model of the inheritance of traits.

LO 3.27 Compare and contrast processes by which genetic variation is produced and

(SP 7.2) maintained in organisms from multiple domains.

LO 3.28 (SP 6.2) Construct an explanation of the multiple processes that increase variation within a population.

Molecular Biology of the Gene

LO 3.1 (SP 6.5) 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.

LO 3.2 (SP 4.1) Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.

LO 3.4 (SP 1.2) Describe representations and models illustrating how genetic information is translated into polypeptides.

LO 3.5 (SP 6.4) Explain how heritable information can be manipulated using common technologies.

LO 3.6 (SP 6.4) Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression.

LO 3.24 (SP 6.4, 7.2) Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.

LO 3.25 (SP 1.1) Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.

LO 3.26 (SP 7.2) Explain the connection between genetic variation in organisms and phenotypic variation in populations.

LO 3.27 (SP 7.2) Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.

LO 3.28 (SP 6.2) Construct an explanation of the multiple processes that increase variation within a population.

LO 3.29 (SP 6.2) Construct an explanation of how viruses introduce genetic variation in host organisms.

LO 3.30 (SP 1.4) Use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population.

LO 3.36 (SP 1.5) Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.

LO 4.1 (SP 7.1) — Explain the connection between the sequence and the subcomponents of a biological polymer and its properties.

LO 4.2 (SP 1.3) — Refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer.

LO 4.3 (SP 6.1, 6.4) — Use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.

LO 4.18 (SP 1.4) — Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

Regulation of Gene Expression

LO 2.31 (SP 7.2) — 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.

LO 2.32 (SP 1.4) — 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.

LO 2.33 (SP 6.1) — 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.

LO 2.34 (SP 7.1) — Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis.

LO 2.35 (SP 4.2) — Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.

LO 2.36 (SP 6.1) — Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.

LO 2.37 (SP 7.2) — Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.

LO 3.15 (SP 6.5) — Explain deviations from Mendel’s model of the inheritance of traits.

LO 3.16 (SP 6.3) — Explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics.

LO 3.17 (SP 1.2) — Describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel’s model of the inheritance of traits.

LO 3.18 (SP 7.1)	Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.
LO 3.19 (SP 7.1)	Describe the connection between the regulation of gene expression and observed differences between individuals in a population.
LO 3.20 (SP 6.2)	Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.
LO 3.21 (SP 1.4)	Use representations to describe how gene regulation influences cell products and function.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.24 (SP 6.4, 7.2)	Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.
LO 3.25 (SP 1.1)	Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
LO 3.26 (SP 7.2)	Explain the connection between genetic variation in organisms and phenotypic variation in populations.
LO 3.27 (SP 7.2)	Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.
LO 3.28 (SP 6.2)	Construct an explanation of the multiple processes that increase variation within a population.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 1.4)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 3.36 (SP 1.5)	Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.
LO 4.7 (SP 1.3)	Refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs.
LO 4.17	Analyze data to identify how molecular interactions affect structure and function.

(SP 5.1)

LO 4.23 (SP 6.2) Construct explanations of the influence of environmental factors on the phenotype of an organism.

LO 4.24 (SP 6.4) Predict the effects of a change in an environmental factor on gene expression and the resulting phenotype of an organism.

Viruses, Bacteria, and Archaea

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.27 (SP 7.2) Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.

LO 3.28 (SP 6.2) Construct an explanation of the multiple processes that increase variation within a population.

LO 3.29 (SP 6.2) Construct an explanation of how viruses introduce genetic variation in host organisms.

LO 3.30 (SP 1.4) Use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population.

Biotechnology and Genomics

LO 2.29 (SP 1.1, 1.2) Create representations and models to describe immune responses.

LO 2.30 (SP 1.1, 1.2) Create representations or models to describe nonspecific immune defenses in plants and animals.

LO 3.18 (SP 7.1) Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.

LO 3.19 (SP 7.1) Describe the connection between the regulation of gene expression and observed differences between individuals in a population.

LO 3.20 (SP 6.2) Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.

LO 3.21 Use representations to describe how gene regulation influences cell products and

(SP 1.4)	function.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.24 (SP 6.4, 7.2)	Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.
LO 3.25 (SP 1.1)	Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
LO 3.26 (SP 7.2)	Explain the connection between genetic variation in organisms and phenotypic variation in populations.
LO 4.22 (SP 6.2)	Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.

Unit Essential Questions

- What is the normal sequence of events in the process of cellular reproduction?
- What are the roles of the checkpoints in a cell cycle?
- How do tumor suppressor genes regulate the cell cycle?
- What is the role of meiosis in introducing variation?
- Why is genetic variation necessary for species survival?
- What effects are seen when different combinations of chromosomes are produced?
- How does the collection of chromosomes we inherit from our parents affect our body's appearance and function?
- What patterns of inheritance can be observed across generations?
- How does meiosis help predict the probability of producing gametes and inheriting a trait?
- How does the flow of genetic information from DNA to protein to trait work?
- What mechanisms are in place to ensure that genetic information is accurately expressed?
- How might the expression of a gene change in response to environmental conditions?
- How does gene regulation differ between prokaryotes and eukaryotes?
- Where in the process of gene expression does regulation occur in a eukaryotic organism?
- How might mutations influence the ability of a cell to regulate gene expression?
- Based on the characteristics shared by all living things, should viruses be considered living?
- How might a rapid mutation rate of virus and bacteria genomes affect our ability to treat disease?

- What procedures are used to introduce a bacterial gene into a plant?
- What is the difference between genetically modified organisms and transgenic organisms?
- How are animals being genetically modified?

Scope and Sequence

1. The cell cycle and cellular reproduction
2. Meiosis and sexual reproduction
3. Mendelian patterns of inheritance
4. Molecular biology of the gene
5. Regulation of gene expression
6. Viruses, bacteria, archaea
7. Biotechnology and genomics

Assured Assessments
Formative Assessment:

- In a bacterial transformation investigation, students will first acquire the tools to transform *E. coli* bacteria to express new genetic information using the plasmid system and then apply mathematical routines to determine transformation efficiency. Students will then have the opportunity to design and conduct individual experiments to explore transformation in more depth. For example, students can select a factor of their choice and explore its ability to induce mutations with observable phenotypes, or they can investigate if bacteria take up more plasmid in some environmental conditions and less in others. They also can explore answers to questions about plasmids and transformation that may have been raised during the initial investigation.

Summative Assessment:

- Students will take a 48-minute test containing 18 multiple-choice questions, 2 mathematical grid-in questions, 1 short-response question, and 1 essay question. The short-response question will require students to identify different stages of mitosis and explain what is occurring with their assigned stage. The essay section will ask students to answer the following question:
    - A research team has genetically engineered a strain of fruit flies to eliminate errors during DNA replication. The team claims that this will eliminate genetic variation in the engineered flies. A second research team claims that eliminating errors during DNA replication will not entirely eliminate genetic variation in the engineered flies.
        - Provide one piece of evidence that would indicate new genetic variation has occurred in the engineered flies.
        - Describe one mechanism that could lead to genetic variation in the engineered strain of flies.
        - Describe how genetic variation in a population contributes to the process of evolution in the population.

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- "AP Lab Investigation 7: Cell Division: Mitosis and Meiosis." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "AP Lab Investigation 8: Biotechnology: Bacterial Transformation." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "AP Lab Investigation 9: Biotechnology: Restriction Enzyme Analysis of DNA." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "Mendelian Genetic Problems."
- "Building DNA Lab Activity."
- "Genetic Counselor Case Study."

Time Allotment

- Approximately seven weeks

UNIT 4
Evolution

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

<u>Darwin and Evolution</u>

LO 1.9 (SP 5.3)	Evaluate evidence provided by data from many scientific disciplines that support biological evolution.
LO 1.10 (SP 5.2)	Refine evidence based on data from many scientific disciplines that support biological evolution.
LO 1.11 (SP 4.2)	Design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology.
LO 1.12 (SP 7.1)	Connect scientific evidence from many scientific disciplines to support the modern concept of evolution.
LO 1.13 (SP 3.2)	Construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution.
LO 4.20 (SP 6.3)	Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past.
LO 4.21 (SP 6.4)	Predict consequences of human actions on both local and global ecosystems.

<u>How Populations Evolve</u>

LO 1.1 (SP 1.5, 2.2)	Convert a data set from a table of numbers that reflect a change in the genetic makeup of a population over time and apply mathematical methods and conceptual understandings to investigate the cause(s) and effect(s) of this change.
LO 1.2 (SP 2.2, 5.3)	Evaluate evidence provided by data to qualitatively and/or quantitatively investigate the role of natural selection in evolution.
LO 1.3 (SP 2.2)	Apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future.

LO 1.4 (SP 5.3)	Evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time.
LO 1.5 (SP 7.1)	Connect evolutionary changes in a population over time to a change in the environment.
LO 1.6 (SP 1.4, 2.1)	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.
LO 1.7 (SP 2.1)	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.
LO 1.8 (SP 6.4)	Make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population.
LO 1.20 (SP 5.1)	Analyze data related to questions of speciation and extinction throughout the Earth's history.
LO 1.21 (SP 4.2)	Design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history.
LO 2.38 (SP 5.1)	Analyze data to support the claim that responses to information and communication of information affect natural selection.
LO 2.39 (SP 6.1)	Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms.
LO 2.40 (SP 7.2)	Connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior.
LO 3.24 (SP 6.4, 7.2)	Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.
LO 3.25 (SP 1.1)	Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
LO 3.26 (SP 7.2)	Explain the connection between genetic variation in organisms and phenotypic variation in populations.
LO 3.27 (SP 7.2)	Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.
LO 3.28 (SP 6.2)	Construct an explanation of the multiple processes that increase variation within a population.

LO 4.25 (SP 6.1) — 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.

LO 4.26 (SP 6.4) — Use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness.

LO 4.27 (SP 6.4) — Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability.

Speciation and Macroevolution

LO 1.20 (SP 5.1) — Analyze data related to questions of speciation and extinction throughout the Earth's history.

LO 1.21 (SP 4.2) — Design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history.

LO 1.22 (SP 6.4) — 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.

LO 1.23 (SP 4.1) — Justify the selection of data that address questions related to reproductive isolation and speciation.

LO 1.24 (SP 7.2) — Describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection and/or genetic drift.

LO 1.25 (SP 1.2) — Describe a model that represents evolution within a population.

LO 1.26 (SP 5.3) — Evaluate given data sets that illustrate evolution as an ongoing process.

LO 3.27 (SP 7.2) — Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.

LO 3.28 (SP 6.2) — Construct an explanation of the multiple processes that increase variation within a population.

LO 4.20 (SP 6.3) — Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past.

LO 4.21 (SP 6.4) — Predict consequences of human actions on both local and global ecosystems.

The Origin and History of Life

LO 1.14 (SP 3.1)	Pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth.
LO 1.15 (SP 7.2)	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.
LO 1.16 (SP 7.1)	Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
LO 1.27 (SP 1.2)	Describe a scientific hypothesis about the origin of life on Earth.
LO 1.28 (SP 3.3)	Evaluate scientific questions based on hypotheses about the origin of life on Earth.
LO 1.29 (SP 6.3)	Describe the reasons for revisions of scientific hypotheses of the origin of life on Earth.
LO 1.30 (SP 6.5)	Evaluate scientific hypotheses about the origin of life on Earth.
LO 1.31 (SP 4.4)	Evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth.
LO 1.32 (SP 4.1)	Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.
LO 3.24 (SP 6.4, 7.2)	Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.
LO 3.25 (SP 1.1)	Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
LO 3.26 (SP 7.2)	Explain the connection between genetic variation in organisms and phenotypic variation in populations.
LO 3.31 (SP 7.2)	Describe basic chemical processes for cell communication shared across evolutionary lines of descent.
LO 3.32 (SP 3.1)	Generate scientific questions involving cell communication as it relates to the process of evolution.

LO 3.33 (SP 1.4) Use representation(s) and appropriate models to describe features of a cell signaling pathway.

Taxonomy, Systematics, and Phylogeny

LO 1.9 (SP 5.3) Evaluate evidence provided by data from many scientific disciplines that support biological evolution.

LO 1.10 (SP 5.2) Refine evidence based on data from many scientific disciplines that support biological evolution.

LO 1.11 (SP 4.2) Design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology.

LO 1.12 (SP 7.1) Connect scientific evidence from many scientific disciplines to support the modern concept of evolution.

LO 1.13 (SP 3.2) Construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution.

LO 1.17 (SP 3.1) 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.

LO 1.18 (SP 5.3) Evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation.

LO 1.19 (SP 1.1) Create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set.

LO 1.20 (SP 5.1) Analyze data related to questions of speciation and extinction throughout the Earth's history.

LO 1.21 (SP 4.2) Design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history.

LO 1.27 (SP 1.2) Describe a scientific hypothesis about the origin of life on Earth.

LO 1.28 (SP 3.3) Evaluate scientific questions based on hypotheses about the origin of life on Earth.

LO 1.29 (SP 6.3) Describe the reasons for revisions of scientific hypotheses of the origin of life on Earth.

LO 1.30 (SP 6.5)	Evaluate scientific hypotheses about the origin of life on Earth.
LO 1.31 (SP 4.4)	Evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth.
LO 1.32 (SP 4.1)	Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

Unit Essential Questions

- How do the features of fossil organisms tell us something about an organism's behavior and the environment in which it lived?
- How does Darwin's theory of natural selection explain the intermediate features of modern and fossil organisms?
- What is the link between genes, populations, and evolution?
- How does a population geneticist determine whether a population is evolving?
- How is a population defined? Can a human contain his/her own population of organisms?
- With regard to populations, how does natural selection work to shape genetic diversity?
- How do scientists determine whether an organism is a new species?
- What processes drive the evolution of new species? Are they different from those that drive the evolution of populations?
- What can the fossil record tell us about the origin and extinction of species over time?
- Does the theory of evolution explain the origins of life? Why or why not?
- How do scientists measure the age of life on Earth from the fossil record?
- What types of scientific evidence, including the fossil record, tell us something about the history of life on Earth?
- How are the study of macroevolution and the study of systematic biology interrelated?
- Why is it important to classify biodiversity, and why is evolutionary history important to this classification?
- What is a phylogeny? What does it represent, and what can one tell us about the history of Life on Earth?

Scope and Sequence

1. Darwin and evolution
2. How populations evolve
3. Speciation and macroevolution
4. The origin and history of life
5. Taxonomy, systematics, and phylogeny
6. Protist evolution and diversity (if time permits)
7. Fungi evolution and diversity (if time permits)

Assured Assessments

Formative Assessment:

- In the Hardy-Weinberg investigation, the students will build a model that shows how a hypothetical gene pool changes from one generation to the next. This model will allow for the exploration of parameters that affect allele frequencies, such as selection, mutation, and migration. The second part of the investigation will ask the students to generate their own questions regarding the evolution of allele frequencies in a population. Then students will explore possible answers to those questions by applying more sophisticated computer models. This investigation will also provide an opportunity for students to review concepts they studied previously, including: natural selection as the major mechanism of evolution; the relationship among genotype, phenotype, and natural selection; and fundamentals of classic Mendelian genetics.

Summative Assessment:

- Students will take a 48-minute test containing 18 multiple-choice questions, 2 mathematical grid-in questions, 1 short-response question, and 1 essay question. The short-response question will ask students to examine and analyze a scientific experiment concerning the evolution of guppies. The essay section will ask students to answer the following question:
  - The amino acid sequence of cytochrome c was determined for five different species of vertebrates. (Students will be provided with a table showing the number of differences in the sequence between each pair of species.)
    - Using the data in the table, create a phylogenetic tree on the template provided to reflect the evolutionary relationships of the organisms. Provide reasoning for the placement on the tree of the species that is least related to the others.
    - Identify whether morphological data or amino acid sequence data are more likely to accurately represent true evolutionary relationships among species, and provide reasoning for your answer.

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- "AP Lab Investigation 1: Artificial Selection." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "AP Lab Investigation 2: Mathematical Modeling: Hardy-Weinberg." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "AP Lab Investigation 3: Comparing DNA Sequence to Understand Evolutionary Relationships with BLAST." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "Predator/Prey Habitat Natural Selection Activity."
- "Cladistics Lab Activity."

Time Allotment

- Approximately five weeks

UNIT 5
Plant Evolution and Biology

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

Plant Evolution and Diversity

LO 4.8 (SP 3.3)	Evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts.
LO 4.9 (SP 6.4)	Predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s).
LO 4.10 (SP 1.3)	Refine representations and models to illustrate biocomplexity due to interactions of the constituent parts.

Flowering Plants: Structure and Organization

LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 1.3)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.

Flowering Plants: Nutrition and Transport

LO 2.25 (SP 6.2)	Construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.
LO 2.26 (SP 5.1)	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.
LO 2.27 (SP 7.1)	Connect differences in the environment with the evolution of homeostatic mechanisms.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35	Create representation(s) that depict how cell-to-cell communication occurs by

(SP 1.4) direct contact or from a distance through chemical signaling.

<u>Flowering Plants: Control of Growth Responses</u>

LO 2.29 (SP 1.1, 1.2) Create representations and models to describe immune responses.

LO 2.30 (SP 1.1, 1.2) Create representations or models to describe nonspecific immune defenses in plants and animals.

LO 2.31 (SP 7.2) 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.

LO 2.32 (SP 1.4) 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.

LO 2.33 (SP 6.1) 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.

LO 2.34 (SP 7.1) Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis.

LO 2.35 (SP 4.2) Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.

LO 2.36 (SP 6.1) Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.

LO 2.37 (SP 7.2) Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.34 (SP 6.2) Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.

LO 3.35 (SP 1.4) Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.

LO 3.7 (SP 6.4)	Make predictions about natural phenomena occurring during the cell cycle.
LO 3.8 (SP 1.2)	Describe the events that occur in the cell cycle.
LO 3.9 (SP 6.2)	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.
LO 3.10 (SP 7.1)	Represent the connection between meiosis and increased genetic diversity necessary for evolution.
LO 3.11 (SP 5.3)	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.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 1.4)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 4.17 (SP 5.1)	Analyze data to identify how molecular interactions affect structure and function.

Flowering Plants: Reproduction

LO 2.31 (SP 7.2)	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.
LO 2.32 (SP 1.4)	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.
LO 2.33 (SP 6.1)	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.

LO 2.35 (SP 4.2)	Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.
LO 2.36 (SP 6.1)	Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.
LO 2.37 (SP 7.2)	Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.
LO 3.7 (SP 6.4)	Make predictions about natural phenomena occurring during the cell cycle.
LO 3.8 (SP 1.2)	Describe the events that occur in the cell cycle.
LO 3.9 (SP 6.2)	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.
LO 3.10 (SP 7.1)	Represent the connection between meiosis and increased genetic diversity necessary for evolution.
LO 3.11 (SP 5.3)	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.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 1.4)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 4.17 (SP 5.1)	Analyze data to identify how molecular interactions affect structure and function.

Unit Essential Questions

- What environmental challenges did plants have to overcome in order to survive on land?
- Why are angiosperms more widespread than all other groups of plants?
- What characteristics are unique to each of the major groups of plants?

- What structural features are necessary for the function of flowering plants?
- How do monocot and eudicot structural differences adapt them to their various roles in the environment?
- Which nutrients are essential for plant growth?
- What structures enable plants to absorb water and minerals from the soil?
- Why does fluid "leak" from a branch when it is cut?
- Which hormones are essential for plant growth?
- What environmental stimuli trigger various plant responses?
- How are flowering plants adapted to a terrestrial lifestyle?
- What would happen to the diversity of flowering plants if a large percentage of insect species were to disappear in a given community?
- What are the advantages of sexual reproduction versus asexual reproduction in flowering plants?

Scope and Sequence

1. Plant evolution and diversity
2. Flowering plants: structure and organization
3. Flowering plants: nutrition and transport
4. Flowering plants: control of growth responses
5. Flowering plants: reproduction

Assured Assessments
Formative Assessment:

- The transpiration investigation will encourage independent student thinking and ultimately provide them the opportunity for more open-ended experimentation. The students will begin this investigation by exploring methods to calculate leaf surface area and then determine the average number of stomata per square millimeter in a particular kind of plant. From their data, several questions about the process of transpiration in plants should emerge. Students will explore these questions in their own investigations.

Summative Assessment:

- Students will take a 48-minute test containing 18 multiple-choice questions, 2 mathematical grid-in questions, 1 short-response question, and 1 essay question. The short-response question will ask students to examine and analyze a scientific experiment concerning transpiration in various plants; using data, students will graph and analyze the result and form a conclusion with supporting evidence. The essay section will ask students to answer the following question:
    - The graph above illustrates the percent dry weight of different parts of a particular annual plant (plants that live less than one year) from early May to late August. The percent dry weight can be used to estimate the amount of energy a plant uses to produce its leaves, vegetative buds, stems, roots, and reproductive parts (seeds, receptacles, and flowers).

- Identify the direct source of the energy used for plant growth during the first week of May, and identify the part that grew the most during the same period.
- Based on the data on the graph, estimate the percent of the total energy that the plant has allocated to the growth of leaves on the first day of July.
- Compared with perennials (plants that live more than two years), annual plants often allocate a much greater percentage of their total energy to growth of their reproductive parts in any given year. Propose one evolutionary advantage of the energy allocation strategy in annual plants compared with that in perennial plants.

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- "AP Lab Investigation 11: Transpiration." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "Seed Germination Lab: Geotropism."
- "Flower/Seed/Fruit Dissection."
- "Plant Tissue Microscopy."

Time Allotment

- Approximately four weeks

UNIT 6
Comparative Animal Biology

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

<u>Animal Evolution and Diversity</u>

LO 4.8 (SP 3.3)	Evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts.
LO 4.9 (SP 6.4)	Predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s).
LO 4.10 (SP 1.3)	Refine representations and models to illustrate biocomplexity due to interactions of the constituent parts.

<u>Animal Organization and Homeostasis</u>

LO 2.15 (SP 6.1)	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.
LO 2.16 (SP 7.2)	Connect how organisms use negative feedback to maintain their internal environments.
LO 2.17 (SP 5.3)	Evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms.
LO 2.18 (SP 6.4)	Make predictions about how organisms use negative feedback mechanisms to maintain their internal environments.
LO 2.19 (SP 6.4)	Make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models.
LO 2.20 (SP 6.1)	Justify that positive feedback mechanisms amplify responses in organisms.
LO 2.21 (SP 4.1)	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.

LO 2.35 (SP 4.2) Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.

LO 2.36 (SP 6.1) Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.

LO 2.37 (SP 7.2) Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.

LO 3.36 (SP 1.5) Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.

LO 3.37 (SP 6.1) Justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response.

LO 3.38 (SP 1.5) Describe a model that expresses key elements to show how change in signal transduction can alter cellular response.

LO 3.39 (SP 6.2) Construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways.

LO 4.8 (SP 3.3) Evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts.

LO 4.9 (SP 6.4) Predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s).

LO 4.10 (SP 1.3) Refine representations and models to illustrate biocomplexity due to interactions of the constituent parts.

LO 4.18 (SP 1.4) Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

<u>Circulation and Cardiovascular Systems</u>

LO 2.25 (SP 6.2) Construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.

LO 2.26 (SP 5.1) 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.

LO 2.27 (SP 7.1) Connect differences in the environment with the evolution of homeostatic mechanisms.

LO 4.18 (SP 1.4)	Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

The Lympathic and Immune System

LO 2.29 (SP 1.1, 1.2)	Create representations and models to describe immune responses.
LO 2.30 (SP 1.1, 1.2)	Create representations or models to describe nonspecific immune defenses in plants and animals.
LO 3.22 (SP 6.2)	Explain how signal pathways mediate gene expression, including how this process can affect protein production.
LO 3.23 (SP 1.4)	Use representations to describe mechanisms of the regulation of gene expression.
LO 3.29 (SP 6.2)	Construct an explanation of how viruses introduce genetic variation in host organisms.
LO 3.30 (SP 1.4)	Use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population.
LO 3.31 (SP 7.2)	Describe basic chemical processes for cell communication shared across evolutionary lines of descent.
LO 3.32 (SP 3.1)	Generate scientific questions involving cell communication as it relates to the process of evolution.
LO 3.33 (SP 1.4)	Use representation(s) and appropriate models to describe features of a cell signaling pathway.
LO 3.34 (SP 6.2)	Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.
LO 3.35 (SP 1.4)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 4.17 (SP 5.1)	Analyze data to identify how molecular interactions affect structure and function.
LO 4.22 (SP 6.2)	Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions.

Digestive Systems and Nutrition

LO 2.25 (SP 6.2) Construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.

LO 2.26 (SP 5.1) 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.

LO 2.27 (SP 7.1) Connect differences in the environment with the evolution of homeostatic mechanisms.

LO 4.18 (SP 1.4) Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

Respiratory Systems

LO 2.25 (SP 6.2) Construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.

LO 2.26 (SP 5.1) 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.

LO 2.27 (SP 7.1) Connect differences in the environment with the evolution of homeostatic mechanisms.

LO 4.18 (SP 1.4) Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

Body Fluid Regulation and Excretory Systems

LO 2.25 (SP 6.2) Construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.

LO 2.26 (SP 5.1) 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.

LO 2.27 (SP 7.1) Connect differences in the environment with the evolution of homeostatic mechanisms.

LO 3.34 Construct explanations of cell communication through cell-to-cell direct contact

(SP 6.2) or through chemical signaling.

LO 3.35 (SP 1.4) Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.

LO 4.18 (SP 1.4) Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

Neurons and Nervous Systems

LO 2.21 (SP 4.1) 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.

LO 2.38 (SP 5.1) Analyze data to support the claim that responses to information and communication of information affect natural selection.

LO 2.39 (SP 6.1) Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms.

LO 2.40 (SP 7.2) Connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior.

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.34 (SP 6.2) Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.

LO 3.35 (SP 1.4) Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.

LO 3.40 (SP 5.1) Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.

LO 3.41 (SP 1.1) 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.

LO 3.42 (SP 7.1) Describe how organisms exchange information in response to internal changes or environmental cues.

LO 3.44 (SP 1.2) Describe how nervous systems detect external and internal signals.

LO 3.45 (SP 1.2) Describe how nervous systems transmit information.

LO 3.46 (SP 1.2) Describe how the vertebrate brain integrates information to produce a response.

LO 3.47 (SP 1.1) 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.

LO 3.48 (SP 1.1) Create a visual representation to describe how nervous systems detect external and internal signals.

LO 3.49 (SP 1.1) Create a visual representation to describe how nervous systems transmit information.

LO 3.50 (SP 1.1) Create a visual representation to describe how the vertebrate brain integrates information to produce a response.

LO 4.17 (SP 5.1) Analyze data to identify how molecular interactions affect structure and function.

Sense Organs

LO 2.21 (SP 4.1) 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.

LO 2.38 (SP 5.1) Analyze data to support the claim that responses to information and communication of information affect natural selection.

LO 2.39 (SP 6.1) Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms.

LO 2.40 (SP 7.2) Connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior.

LO 3.35 (SP 1.4) Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.

LO 3.40 (SP 5.1) Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.

LO 3.41 (SP 1.1) 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.

LO 3.42 (SP 7.1) Describe how organisms exchange information in response to internal changes or environmental cues.

LO 3.44 (SP 1.2) Describe how nervous systems detect external and internal signals.

LO 3.45 (SP 1.2) Describe how nervous systems transmit information.

LO 3.46 (SP 1.2) Describe how the vertebrate brain integrates information to produce a response.

LO 3.47 (SP 1.1) 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.

LO 3.48 (SP 1.1) Create a visual representation to describe how nervous systems detect external and internal signals.

LO 3.49 (SP 1.1) Create a visual representation to describe how nervous systems transmit information.

LO 3.50 (SP 1.1) Create a visual representation to describe how the vertebrate brain integrates information to produce a response.

LO 4.17 (SP 5.1) Analyze data to identify how molecular interactions affect structure and function.

<u>Locomotion and Support Systems</u>

LO 3.40 (SP 5.1) Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.

LO 3.41 (SP 1.1) 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.

LO 3.42 (SP 7.1) Describe how organisms exchange information in response to internal changes or environmental cues.

LO 3.43 Construct an explanation, based on scientific theories and models, about how

(SP 6.2, 7.1) nervous systems detect external and internal signals, transmit and integrate information, and produce responses.

LO 3.44 (SP 1.2) Describe how nervous systems detect external and internal signals.

LO 3.45 (SP 1.2) Describe how nervous systems transmit information.

LO 3.46 (SP 1.2) Describe how the vertebrate brain integrates information to produce a response.

LO 3.47 (SP 1.1) 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.

LO 3.48 (SP 1.1) Create a visual representation to describe how nervous systems detect external and internal signals.

LO 3.49 (SP 1.1) Create a visual representation to describe how nervous systems transmit information.

LO 3.50 (SP 1.1) Create a visual representation to describe how the vertebrate brain integrates information to produce a response.

LO 4.17 (SP 5.1) Analyze data to identify how molecular interactions affect structure and function.

<u>Hormones and Endocrine Systems</u>

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.31 (SP 7.2) Describe basic chemical processes for cell communication shared across evolutionary lines of descent.

LO 3.32 (SP 3.1) Generate scientific questions involving cell communication as it relates to the process of evolution.

LO 3.33 (SP 1.4) Use representation(s) and appropriate models to describe features of a cell signaling pathway.

LO 3.34 Construct explanations of cell communication through cell-to-cell direct contact

(SP 6.2)	or through chemical signaling.
LO 3.35 (SP 1.4)	Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling.
LO 3.36 (SP 1.5)	Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.
LO 3.40 (SP 5.1)	Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.
LO 3.41 (SP 1.1)	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.
LO 3.42 (SP 7.1)	Describe how organisms exchange information in response to internal changes or environmental cues.
LO 3.43 (SP 6.2, 7.1)	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.
LO 3.44 (SP 1.2)	Describe how nervous systems detect external and internal signals.
LO 3.45 (SP 1.2)	Describe how nervous systems transmit information.
LO 3.46 (SP 1.2)	Describe how the vertebrate brain integrates information to produce a response.
LO 3.47 (SP 1.1)	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.
LO 3.48 (SP 1.1)	Create a visual representation to describe how nervous systems detect external and internal signals.
LO 3.49 (SP 1.1)	Create a visual representation to describe how nervous systems transmit information.
LO 3.50 (SP 1.1)	Create a visual representation to describe how the vertebrate brain integrates information to produce a response.
LO 4.17 (SP 5.1)	Analyze data to identify how molecular interactions affect structure and function.

Reproductive Systems

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.31 (SP 7.2) Describe basic chemical processes for cell communication shared across evolutionary lines of descent.

LO 3.32 (SP 3.1) Generate scientific questions involving cell communication as it relates to the process of evolution.

LO 3.33 (SP 1.4) Use representation(s) and appropriate models to describe features of a cell signaling pathway.

LO 3.34 (SP 6.2) Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling.

LO 3.35 (SP 1.4) Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling

LO 3.40 (SP 5.1) Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior.

LO 3.41 (SP 1.1) 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.

LO 3.42 (SP 7.1) Describe how organisms exchange information in response to internal changes or environmental cues.

Animal Development and Aging

LO 2.31 (SP 7.2) 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.

LO 2.32 (SP 1.4) 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.

LO 2.33 (SP 6.1) 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.

LO 2.34 (SP 7.1) Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis.

LO 2.35 (SP 4.2) Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation.

LO 2.36 (SP 6.1) Justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation.

LO 2.37 (SP 7.2) Connect concepts that describe mechanisms that regulate the timing and coordination of physiological events.

LO 3.18 (SP 7.1) Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.

LO 3.19 (SP 7.1) Describe the connection between the regulation of gene expression and observed differences between individuals in a population.

LO 3.20 (SP 6.2) Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.

LO 3.21 (SP 1.4) Use representations to describe how gene regulation influences cell products and function.

LO 3.22 (SP 6.2) Explain how signal pathways mediate gene expression, including how this process can affect protein production.

LO 3.23 (SP 1.4) Use representations to describe mechanisms of the regulation of gene expression.

LO 3.36 (SP 1.5) Describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response.

LO 4.7 (SP 1.3) Refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs.

Animal Behavior

LO 1.32 (SP 4.1) Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

LO 2.38 (SP 5.1) Analyze data to support the claim that responses to information and communication of information affect natural selection.

LO 2.39 (SP 6.1) Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms.

LO 2.40 (SP 7.2) Connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior.

Unit Essential Questions

- Where do invertebrates fit into the evolutionary history of eukaryotes? of animals?
- What evolutionary advantage might there be to invertebrates having multiple developmental stages, each with a different body form, habitat, and lifestyle?
- What are the traits that set vertebrates apart from other animals?
- How are vertebrates important to the day-to-day life of humans?
- When in the history of life did vertebrates evolve?
- What does the replacement model tell us about the evolution of our species?
- How might an understanding of evolutionary patterns in other animals help us understand our evolutionary history?
- How did the evolution of specialized tissue, organs, and organ systems allow animals to better adapt to their environment?
- What are some of the most important functions of animal skin?
- How does the disruption of homeostasis lead to disease?
- What are the essential components of any circulatory system, and their functions?
- Through what major blood vessels does a human red blood cell normally pass as it travels from the aorta to a capillary in the lower leg, and back to the heart?
- Why are the processes that occur in capillaries essential to life?
- What are the most essential components of the immune system?
- How do the lymphatic and immune systems work together?
- What different types of strategies have animals evolved to efficiently obtain nutrients?
- In what ways do the types of diets that humans choose to consume play a role in our health, as well as in the quality of our environment?
- What are some possible evolutionary pressures that might explain why a strictly terrestrial species, such as humans, would have a diving response?
- Besides salt glands, what other types of strategies have animals developed to either conserve or excrete salt?
- By what mechanism is the human kidney able to regulate the salt concentration of urine it produces?
- How did the evolution of the nervous system provide advantages to animals?
- What specific types of processes occur uniquely in nervous tissue?
- Why are diseases of the human nervous system generally difficult to treat?
- How does the ability to detect infrared energy provide snakes with competitive advantage over predators lacking this ability?

- Of the four types of sensory receptors – chemoreceptors, photoreceptors, mechanoreceptors, or thermoreceptors – which is more necessary for an animal to survive?
- What advantage do animals with a skeletal system have over animals that completely lack such a system?
- How does the nervous system specifically control the skeletal system?
- How do the sensory systems exert influence over the nervous system, and therefore over the muscular system?
- Why do more complex animals, such as mammals, tend to use some of the same hormones that are present in more primitive invertebrates, instead of evolving completely new hormones?
- What are some specific examples where the nervous system works with the endocrine system to control body functions?
- What are some specific examples where the endocrine system works independently?
- What are some common examples of secondary sex characteristics that develop in male animals in order to attract female mates?
- Why are so many similarities present in the early embryonic structures of animals as diverse as the lancelet, the frog, the chicken, and the human?
- Why is the developing embryo of any species more susceptible to harmful environmental factors, compared to the mature animal?
- What are some of the fundamental mechanisms by which cells can become specialized to form organs and tissues?

Scope and Sequence

1. Animal evolution and diversity
2. Animal organization and homeostasis
3. Circulation and cardiovascular systems
4. Lymphatic and immune systems
5. Digestive systems and nutrition
6. Respiratory systems
7. Body fluid regulation and excretory systems
8. Neurons and nervous systems
9. Sense organs
10. Locomotion and support systems
11. Hormones and endocrine systems
12. Reproductive systems
13. Animal development and aging
14. Animal behavior

Assured Assessments

Formative Assessment:

- The fruit fly animal behavior investigation will explore the environmental choices that fruit flies make. A choice chamber is designed to give fruit flies two choices during any one test, although students could also think about how to build an apparatus that would give fruit flies more than two choices. Adult fruit flies are attracted to substances that offer food or an environment in which to lay eggs and develop larvae. Typically those environments are rotting or fermenting fruit. Adult fruit flies are attracted to bright light, and their larvae move away from bright light. Adult fruit flies also demonstrate negative geotaxis; they climb up in their chambers against gravity. Movement toward a substance is a positive taxis. Consistent movement or orientation away from a substance is a negative taxis. In most cases, the experiments done in the choice chamber will be chemotactic experiments, as indicted by the number of flies that collect on one end of the chamber or another in response to a chemical stimulus. At some point, students may wish to investigate if the chemotactic response is greater than a geotactic or phototactic response. The flies could also exhibit a behavior that is not oriented toward or away from the stimulus; rather, the stimulus could elicit a random response.

Summative Assessment:

- Students will take a 48-minute test containing 18 multiple-choice questions, 2 mathematical grid-in questions, 1 short-response question, and 1 essay question. The short-response question will require students to examine and analyze a scientific experiment concerning circadian rhythms in mice; using data, students will graph and analyze the result and form a conclusion with supporting evidence. The essay section will ask students to answer the following question:
    - Information processing involves complex neural pathways that require a certain amount of time between recognition of a stimulus and the resulting response. For some types of stimuli, a reflex arc replaces the typical stimulus-response pathway. (A representation of a reflex arc will be shown to the students.)
        - Based on the figure, describe two ways that the reflex arc differs from typically stimulus-response transmission pathways. Provide reasoning to support the claim that reflex arcs help organisms avoid serious injury.

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- "AP Lab Investigation 12: Fruit Fly Behavior." "AP Lab Investigation 10: Energy Dynamics." *AP Biology Investigative Labs: An Inquiry-Based Approach*. New York: College Board, 2013. Print.
- "Heart Dissection."
- "Reaction Time Inquiry Lab Investigation."
- "Eye Dissection."
- "Sliding Filament Theory Model."

Time Allotment

- Approximately seven weeks

UNIT 7
Independent Learning (Post-AP Exam)

Unit Goals

Learning Objectives (LOs) derive from the 2015 College Board *AP Biology Course and Exam Description*, and are linked to the corresponding Science Practices for AP Biology.

At the completion of this unit, students will:

Student Research/Lesson Development

SP 3.1 Pose scientific questions.

SP 3.2 Refine scientific questions.

SP 3.3 Evaluate scientific questions.

SP 4.1 Justify the selection of the kind of data needed to answer a particular scientific question.

SP 4.2 Design a plan for collecting data to answer a particular scientific question.

SP 4.3 Collect data to answer a particular scientific question.

SP 5.2 Refine observations and measurements based on data analysis.

Instruction

SP 1.1 Create representations and models of natural or man-made phenomena and systems in the domain.

SP 1.2 Describe representations and models of natural or manmade phenomena and systems in the domain.

SP 1.3 Refine representations and models of natural or man-made phenomena and systems in the domain.

SP 1.4 Use representations and models to analyze situations or solve problems qualitatively and quantitatively.

SP 1.5 Reexpress key elements of natural phenomena across multiple representations in the domain.

SP 6.1 Justify claims with evidence.

SP 6.2 Construct explanations of phenomena based on evidence produced through scientific practices.

SP 6.3 Articulate the reasons that scientific explanations and theories are refined or replaced.

SP 6.4 Make claims and predictions about natural phenomena based on scientific theories and models.

SP 7.1 Connect phenomena and models across spatial and temporal scales.

SP 7.2 Connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.

<u>Assessment</u>

SP 4.4 Evaluate sources of data to answer a particular scientific question.

SP 5.1 Analyze data to identify patterns or relationships.

SP 5.3 Evaluate the evidence provided by data sets in relation to a particular scientific question.

SP 6.5 Evaluate alternative scientific explanations.

Unit Essential Questions

- How can I engage in meaningful independent research of an advanced topic in biology?
- How can I most meaningfully present my research to my peers?

Scope and Sequence

1. Research
2. Instruction
3. Assessment
4. Reflection

Assured Assessments
Formative Assessment:

- Students will choose an advanced biology topic of their choice to research and present to the class. The presentation must last forty minutes and students are required to incorporate a hands-on activity to reinforce their content. Each student is required to create an assessment based on his/her lesson, which is used to create a summative assessment.

Summative Assessment:

- Students will take a summative assessment based on all class presentations. Each year the type of exam and number of questions will differ based on the particular content presented.

Resources

Core

- Mader, Sylvia S., and Michael Windelspechet. *Biology*. 10th ed. New York: McGraw-Hill, 2013. Print.

Supplemental

- Various print and online resources selected by the student.

Time Allotment

- Approximately four weeks

COURSE CREDIT

1.25 credits in science
One class period daily, plus laboratory, for a full year

PREREQUISITES

Grade of B+ or higher in Honors Integrated Physical Science with teacher recommendation, or Completion of Advanced College-Preparatory Biology or Honors Biology with teacher recommendation and Department Chair permission.

CURRENT REFERENCES

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: College Board, 2013. Print.

AP Central. "AP Biology." https://apcentral.collegeboard.org/courses/ap-biology?course=ap-biology. Web.

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Writing Rubric (attached)
- Trumbull High School School-Wide Problem-Solving Rubric (attached)
- Trumbull High School School-Wide Independent Learning and Thinking Rubric (attached)

Trumbull High School School-Wide Writing Rubric

Category/ Weight	**Exemplary 4 Student work:**	**Goal 3 Student work:**	**Working Toward Goal 2 Student work:**	**Needs Support 1-0 Student work:**
Purpose X_______	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	• Does not establish a clear purpose • Demonstrates limited/no awareness of audience and task
Organization X_______	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization • Lacks logical progression of ideas • Maintains little/no focus • Utilizes ineffective or no transitions
Content X_______	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_______	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Problem-Solving Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X_______	• Student demonstrates clear understanding of the problem and the complexities of the task	• Student demonstrates sufficient understanding of the problem and most of the complexities of the task	• Student demonstrates some understanding of the problem but requires assistance to complete the task	• Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X_______	• Student gathers compelling information from multiple sources including digital, print, and interpersonal	• Student gathers sufficient information from multiple sources including digital, print, and interpersonal	• Student gathers some information from few sources including digital, print, and interpersonal	• Student gathers limited or no information
Reasoning and Strategies X_______	• Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	• Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	• Student demonstrates some critical thinking skills to develop a plan integrating some strategies	• Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X_______	• Solution shows deep understanding of the problem and its components • Solution shows extensive use of 21st-century technology skills	• Solution shows sufficient understanding of the problem and its components • Solution shows sufficient use of 21st-century technology skills	• Solution shows some understanding of the problem and its components • Solution shows some use of 21st-century technology skills	• Solution shows limited or no understanding of the problem and its components • Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide
Independent Learning and Thinking Rubric

Category/ Weight	**Exemplary 4**	**Goal 3**	**Working Toward Goal 2**	**Needs Support 1-0**
Proposal X_______	• Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	• Student demonstrates initiative by generating appropriate questions, creating original projects/work	• Student demonstrates some initiative by generating questions, creating appropriate projects/work	• Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X_______	• Student is analytical, insightful, and works independently to reach a solution	• Student is analytical, and works productively to reach a solution	• Student reaches a solution with direction	• Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_______	• Presentation shows compelling evidence of an independent learner and thinker • Solution shows deep understanding of the problem and its components • Solution shows extensive and appropriate application of 21st-century skills	• Presentation shows clear evidence of an independent learner and thinker • Solution shows adequate understanding of the problem and its components • Solution shows adequate application of 21st-century skills	• Presentation shows some evidence of an independent learner and thinker • Solution shows some understanding of the problem and its components • Solution shows some application of 21st-century skills	• Presentation shows limited or no evidence of an independent learner and thinker • Solution shows limited or no understanding of the problem and its components • Solution shows limited or no application of 21st-century skills