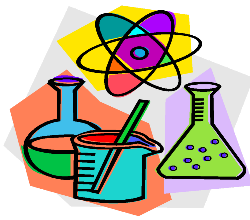

CLASS SYLLABUS

School Year: 2020-21

CLASS: AP Biology

Teacher: Mrs. Tiller

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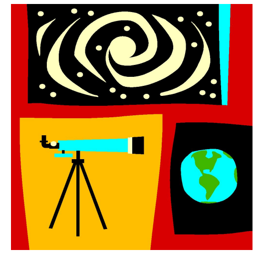

Course Overview:

Our Advanced Placement Biology course is designed to offer students a solid foundation in introductory college-level biology. By structuring the course around the four big ideas, enduring understandings, and science practices we assist students in developing an appreciation for the study of life and help them identify and understand unifying principles within a diversified biological world.

What we know today about Biology is a result of inquiry. Science is a way of knowing. Therefore, the process of inquiry in science and developing critical thinking skills is a very important component of this course.

At the end of the course, students will have an awareness of the integration of other sciences in the study of biology, understand how the species to which we belong is similar to, yet different from, other species, and be knowledgeable and responsible citizens in understanding biological issues that could potentially impact their lives. We foster a safe and nurturing environment — one that reflects respect, integrity, trust, and caring — in order to best support students as they develop the skills and knowledge they need to be successful in college as well as develop into responsible citizens and lifelong learners.

Instructional Context:

AP Biology is offered to sophomores who are motivated to accept the challenge of a college-level course. Students meet for AP biology five days a week for 54 minutes. Course format includes lecture, instructional activities, formative, and summative assessments and inquiry-based lab investigations.

Instructional Resources

Reece, Jane, et al., Campbell Biology, 9th Edition, 2011, Pearson Benjamin Cummings.

A+ College Ready

National Math & Science Initiative-Laying the Foundation

AP College Board

Student Evaluation and Assessment:

It is the expectation that students are to watch lessons, either live or recorded, complete all assignments and practice work, take weekly assessments, ask questions when needed, and submit work weekly. A breakdown of the grading system is listed below. Each assignment will have a due date. There will be no grade period on due dates. Assignments submitted late will lose points. After 7 days, late work will not be accepted. If you have extenuating circumstances you must contact me before the due date. While we are doing virtual learning, your lab grade may be a written reflection of a virtual lab. Exams are given at appropriate times during each semester. Exams consist of AP test bank multiple choice questions, a math question, short response, and/or a long free response essay to provide students with practice in AP exam format. Tests are timed throughout the year.

Grade Breakdown:

Quizzes………………..…...………………………....25%
Labs/Journal Reviews/Projects…..…………………...25%
Exams……………..………………...……………..…..50%

Grade Scale:

A	B	C	D
100-90	89-80	79-70	69-60

Required Materials

* writing utensils- (pen and pencil)
* composition notebook journal (Bell Ringers/Learning Objectives/Quizzes/Exit Slips/Reflections)

Recommended Material

* calculator (On AP Exam you may only use a four function with square root $\sqrt{\ }$; however, for class activities a graphing calculator is provided)

Advanced Placement Biology Content:

The AP course is structured around the four big ideas, the enduring understandings within the big ideas and the essential knowledge within the enduring understandings.

The BIG Ideas:

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

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

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

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

Science Practices for AP Biology

A practice is a way to coordinate knowledge and skills in order to accomplish a goal or task. The science practices enable students to establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. These science practices capture important aspects of the work that scientists engage in, at the level of competence expected of AP Biology students.

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.

Units of Instruction

Unit 1 Part A: Biochemistry & Cells- Estimated Time 3 Weeks
Big Ideas 2 & 4

Laboratory Investigations:

AP Biology Lab Manual (2001) Animal Behavior (Transitioned to a student directed lab activity)
AP Biology Lab Manual (2012) Transpiration

Essential Questions/Connecting to Enduring Understandings Big Ideas 2 & 4

(2.C.2) What kind of data is needed to answer scientific questions about how organisms respond to changes in their external environment?
(2.A.3) How do organisms exchange matter with the environment to grow, reproduce and maintain organization?
(2.A.1) Why do all living systems require constant input of free energy?
(2.A.2) How do organisms capture and store free energy for use in biological processes?
(4.A.2) How does the structure and function of sub-cellular components, and their interactions, provide essential cellular processes?
(4.A.1) How do the subcomponents of biological molecules and their sequence determine the properties of that molecule?
(4.C.1) How does variation in molecular units provide cells with a wider range of functions?

Learning Objectives	Materials	Instructional Activities & Assessments
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 2.21, SP 4.1]**	Campbell Chapter 1: "Introduction: Themes in the Study of Life" AP Biology Lab Manual (2001), Lab 11: Animal Behavior	**Instructional Activity**: Students design and conduct an experiment to test the environmental factors they believe may determine where isopods live. This activity is student directed and teacher facilitated. **Formative Assessment:** Students complete lab reports in their research laboratory notebooks based on their lab investigation of isopod behavior and response. I provide corrective and informative feedback during discussion with students and via comments on the specific lab components presented in the lab report. Subsequent instructional activities (i.e., lab extension activities) may be modified based on student lab report evaluation.
Justify the selection of data regarding the types of molecules an animal, plant, or bacterium will take up as necessary building blocks and excrete as waste products. **[LO 2.8, SP 4.1]** Represent graphically or model quantitatively the exchange of molecules between an organism and its environment, and the subsequent use of these molecules to build	Campbell Chapter 2: "The Chemical Context of Life" Campbell Chapter 3: "Water and the Fitness of the Environment" Campbell Chapter 4: "Carbon and the Molecular Diversity of Life" **Web**	**Instructional Activity:** Students use construction paper to make models of atoms, ions, and molecules represented in Chapter 2. Students use the models to understand and explain (with justification) how and why properties of elements (CHNOPS) make them essential to life and how pH, ions, and hydrogen bonding

new molecules that facilitate dynamic homeostasis, growth, and reproduction. **[LO 2.9, SP 1.1, SP 1.4]**	"Chemistry of Water and Its Effects on Pond Ecology" **Web** "The effects of oil spills on birds"	impact living systems. This activity is student directed and teacher facilitated. **Instructional Activity:** Students create mini-posters to explain how either the carbon or nitrogen cycles provide essential chemical elements to support life in an ecosystem. Students make predictions about the impact of human activity on the cycles. This activity is student directed and teacher facilitated. **Instructional Activity:** This activity includes a set of three lab stations that demonstrate surface tension, capillary action, and water as a temperature buffer. In station #1(surface tension), students attempt to float a needle on distilled water. Students will then be able to test various substances and their effect on surface tension by adding detergent, oil, and/or other substances. In station #2, students investigate capillary action, testing several capillary tubes to investigate how plants transpire. Student discussion questions are based on cohesion and adhesion properties. In station #3, students test water as a temperature buffer and compare how temperature rises with water, alcohol, and air. **Formative Assessment:** Students create annotated drawings that represent how water can move up a 168 ft. Kentucky yellow poplar tree and why a pond of water doesn't freeze. I provide corrective and informative feedback via discussion on the assessment results.
Predict how changes in free energy availability affect organisms, populations, and ecosystems. **[LO 2.3, SP 6.4]** Use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store, and use free energy. **[LO 2.4, SP 1.4, SP 3.1]** Make a prediction about the interactions of sub-cellular organelles. **[LO 4.4, SP 6.4]** Construct explanations based on scientific evidence as to how interactions of sub-cellular structures provide essential functions**.** **[LO 4.5, SP 6.2]**	AP Biology Lab Manuel (2012), Transpiration	**Instructional Activity:** In groups of four, students pose scientific questions regarding the mechanisms and structural features that affect the transpiration rates of certain plants and variables of their choice. Students predict transpiration rates of their chosen plants, construct explanations of their observations, and use their representations to analyze their investigations qualitatively. Students record the lab results in their lab notebooks. **Formative Assessment:**

Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions. **[LO 4.6, SP 1.4]**		Student groups create PowerPoint presentations with data tables, graphs, and diagrams explaining how the interactions of subcellular structures provide essential functions for transpiration. They should also explain how the variables and the questions posed were answered, making sure that predictions of subcellular interactions were included. Students post their PowerPoint presentations on edmodo.com and comment on two other presentations they review.
Explain the connection between the sequence and the subcomponents of a biological polymer and its properties. **[LO 4.1, SP 7.1]** Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions. **[LO 4.22, SP 6.2]** Represent graphically or model quantitatively the exchange of molecules between an organism and its environment, and the subsequent uses of these molecules to build new molecules that facilitate dynamic homeostasis, growth, and reproduction. **[LO 2.9, SP 1.1, SP 1.4]** Refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer. **[LO 4.2, SP 1.3]** Use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule. **[LO 4.3, SP 6.1, SP 6.4]** Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions. **[LO 4.22, SP 6.2]**	Campbell Chapter 5: "The Structure and Function of Macromolecules" Molecular model kits or alternative (e.g., foam balls and toothpicks). **Web** "The Chemical Building Blocks of Life: Building Macromolecules" **Web** Case Study-"A Can of Bull: Do Energy Drinks Really Provide a Source of Energy?"	**Instructional Activity:** Using molecular model kits, students justify the claim that organisms need the SPONCH elements to build complex molecules and recycle elements necessary for life by constructing models of key biomolecules from their monomers. The models should be ones that students can manipulate to represent concepts such as dehydration synthesis & hydrolysis. This activity is teacher facilitated and student driven. **Instructional Activity:** Students analyze the case study "A Can of Bull: Do Energy Drinks Really Provide a Source of Energy?" They describe and categorize chemically the components of various popular energy drinks, determine the physiological role of these components in the body, and explain scientifically how the marketing claims for these drinks are supported (or not). Students present their findings and evaluations of the marketing claims for the drinks. **Formative Assessment:** Students use food nutritional labels to explain the role of macromolecules in the human body. Small groups of students each fold a large piece of paper into four squares, labeling each square with the name of a macromolecule. Students explain and justify how the food item will or will not supply the essential building blocks, and explain why it is necessary to continue to take in food for homeostatic purposes. Groups present and defend (with

		justification) their findings to the class. I correct misconceptions and content inaccuracies verbally and also provide feedback on sticky notes, which I place in their folders. All models are posted in the classroom for student study and peer review. **Formative Assessment:** Each student is given a picture of bacteria, plants, or animals. Students explain either through narrative or visual representations (e.g., diagram with annotation) how the SPONCH elements move from the environment to synthesize complex biomolecules (e.g., carbohydrates, lipids, proteins, nucleic acids, ATP) necessary for cellular processes for their pictured organism. **Formative Assessment:** Students respond to the following prompts based on the molecule-building activity, using their models to help them explain how the variation in each macromolecule provides the cell with a wider range of functionality: 1. Suppose you eat a serving of green beans. What reactions must occur for the amino acid monomers in the protein to be converted to proteins in your body? 2. What would happen to a cow given antibiotics that killed all the prokaryotes in its stomach? 3. Suppose a membrane surrounded an oil droplet, as it does in the cells of plant seeds. Describe and explain the form the molecule might take.
		Summative Assessment: Exam consisting of 15 multiple-choice questions, two short free-response questions, and one long free-response question with emphasis on the application of quantitative skills, science practices, and data analysis.

Unit 1 Part B: Cells & Cellular Communication-Estimated Time 3 Weeks
Big Ideas 1, 2, 3, &4

Laboratory Investigations:

AP Biology Investigative Labs (2012), Investigation 4: Diffusion and Osmosis
"Osmosis in a Plant Cell: Plant Cell Plasmolysis"

Essential Questions/Connecting to Enduring Understandings Big Ideas 1, 2, 3, &4

(2.A.3) How do organisms exchange matter with the environment to grow, reproduce and maintain organization?
(1.B.1) How do organisms share many conserved core processes and features that evolved and are widely distributed among organisms today?
(2.B.1) How does the structure of cell membranes make them selectively permeable?
(2.B.3) How do eukaryotic cells maintain internal membranes that partition the cell into specialized regions?
(4.A.2) How does the structure and function of sub-cellular components, and their interactions, provide essential cellular processes?
(2.B.2) How does the constant movement of molecules across the cell membrane maintain growth and dynamic homeostasis of the cell?
(3.D.1) How can cell communication processes share common features that reflect a shared evolutionary history?
(3.D.2) How do cells communicate with each other through direct contact with other cells or from a distance via chemical signaling?
(3.D.3) How do signal transduction pathways link signal reception with cellular response?
(3.D.4) How can changes in signal transduction pathways alter cellular response?

Learning Objectives	Materials	Instructional Activities & Assessments
Use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion. **[LO 2.6, SP 2.2]** Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination. **[LO 2.7, SP 6.2]** Pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth**. [LO 1.14, SP 3.1]** Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. **[LO 1.16, SP 6.1]** 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 1.15, SP 7.2]**	Campbell Chapter 6: “A Tour of the Cell” Chapter 7: “Membrane Structure and Function” Chapter 27 “Prokaryotes” *AP Biology Investigative Labs* (2012), Investigation 4: Diffusion and Osmosis (Procedure 1) **Web** “CELLS *alive!*” **Multimedia** *The Domains of Life: Life’s Three Great Branches: Archaea, Bacteria, and Eukarya* **Web** “Compartmentalization”	**Instructional Activity:** In Procedure 1: Surface Area and Cell Size, students first learn about water potential with a class demonstration I conduct. Students then design and conduct independent investigations based on the predictions they’ve made regarding the relationship of surface area-to-volume ratios of agar (simulating artificial cells), with an acid (HCl) and a base (NaOH). **Instructional Activity:** In the “CELLS *alive!*” student-directed activity, students construct a Venn diagram comparing prokaryotic and eukaryotic cells. Students also explain organelles work together for homeostatic balance to maintain life. This is a teacher-facilitated activity. **Instructional Activity:** Students were given the homework assignment of viewing the Bozeman video “Compartmentalization.” In this video, the author addresses differences in prokaryotic/eukaryotic cells, surface-area-to-volume relationships, impact of compartmentalization seen in eukaryotic cells, and the endosymbiont hypothesis. Students defend the claims presented in this video in a student directed, teacher-facilitated whole-class discussion. **Instructional Activity:**

		Students review micrograph pictures of bacteria, plant, and animal cells, making comparisons and predictions (with justification) on how interactions of the subcellular structures provide essential functions. We can take micrographs with our digital microscopes or they can be in the form of a WebQuest or pictures that I have gathered from the Internet and presented to the class during lecture/notes. I facilitate the students' learning by helping them identify specific cell organelles and their specific functions. **Formative Assessment:** Students create a diagram with annotation to explain how approximately 300 million alveoli in a human lung increase surface area for gas exchange to the size of a tennis court. Students should use the diagram to explain how the cellular structures of alveoli, capillaries, and red blood cells allow for rapid diffusion of O2 and CO2 between them.
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 2.8, SP 4.1]** 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 2.9, SP 1.1, SP 1.4]** Use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. **[LO 2.10, SP 1.4, SP 3.1]** Construct models that connect the movement of molecules across membranes with membrane structure and function. **[LO 2.11, SP 1.1, SP 7.1, SP 7.2]**	AP Biology Investigative Labs (2012), Investigation 4: Diffusion and Osmosis (Procedures 2 and 3)	**Instructional Activity:** In Procedure 2: Modeling Diffusion and Osmosis, students investigate the relationship between cell surface area and cell size as well as diffusion depth in simulated agar cells. They construct models of living cells, using dialysis tubing, and fill their model cells with different solutions to determine diffusion rates across the cell membranes. Students independently design, select, and justify the experiment and data they will use. All students must make their own solutions (i.e., sucrose, NaCl, or glucose) and make predictions on the diffusion of those solutions. In Procedure 3: Observing Osmosis in Living Cells, students qualitatively observe osmosis in living cells and predict how solutions affect the homeostatic conditions of the *Elodea* cells. Students also design, experiment, justify, and analyze the effects of a variety of materials (potatoes, sweet potatoes, or yams) on cell membranes.
Explain how internal membranes and organelles contribute to cell functions. **[LO 2.13, SP 6.2]**	Campbell Chapter 6: "A Tour of the Cell"	**Instructional Activity:** Using inexpensive and common household items, students design a 3-D model of a specific cell (e.g., neuron, white blood cell, plant leaf cell, *Paramecium*, sperm cell,

Use representations and models to describe differences in prokaryotic and eukaryotic cells. **[LO 2.14, SP 1.4]** Make a prediction about the interactions of subcellular organelles. **[LO 4.4, SP 6.4]** Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. **[LO 4.5, SP 6.2]** Use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions. **[LO 4.6, SP 1.4]**		bacterium) that includes a *working* organelle that defines the overall function of the cell. Students explain their cell and organelle to the class. The representation should be given a size requirement. Students explain (with evidence) the role the subcellular components have in maintenance of cell homeostasis. These models are peer and teacher reviewed. **Formative Assessment:** Students create a visual representation, such as a diagram with annotation or a PowerPoint slide, to explain how four organelles work together to perform a specific function in a cell of your choice. Students should predict how a defect in the function of one of the organelles can affect the overall function of the cell. Students present their visual representations to the class for review and revision.
Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. **[LO 1.16, SP 6.1]** Pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth. **[LO 1.14, SP 3.1]**	Campbell Chapter 6: "A Tour of the Cell" Campbell Chapter 25:"Phylogeny and Systematics"; Campbell Chapter 26: "The Tree of Life: An Introduction to Biological Diversity," pp. 523–526 **Multimedia** The Domains of Life: The Eukaryotic Cell Evolves	**Instructional Activity:** Mystery Cell ID. Using a microscope, students identify the general type of cell (e.g., prokaryote/eukaryote, plant/animal) and support their observations by describing two distinctive features of each mystery cell. This activity is student directed and teacher facilitated. **Instructional Activity:** Ten-Minute Debate. Working in small teams, students create a visual representation to support the claim that eukaryotes evolved from symbiotic relationships between groups of prokaryotes. Then students identify one or two unanswered questions about Margulis's endosymbiont hypothesis. **Formative Assessment:** Students construct a diagram to explain the relationships that exist between the three domains of life (Archaea, Bacteria, and Eukarya) based on molecular processes and cellular features. Students present their diagrams to the class for review and revision.
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 2.12, SP 1.4]**	**Web** "Osmosis in a Plant Cell: Plant Cell Plasmolysis"	**Formative Assessment:** In groups of three, students do a think-pair-share on the following challenge: In the front of the room are six flasks of different sucrose solutions. The flasks contain

Explain how internal membranes and organelles contribute to cell functions. **[LO 2.13, SP 6.2]** Use representations and models to describe differences in prokaryotic and eukaryotic cells. **[LO 2.14, SP 1.4]**		solutions that are 0.0 M, 0.2M, 0.4M, 0.6M, 0.8M, or 1.0M. Unfortunately, we have a problem: My colleague, Mr. Clueless, forgot to label the flasks. Students devise a method for quantitatively determining which flask holds which solution. Students must analyze the situation, solve the problem in the challenge, and quantitatively show how they responded successfully to the challenge. I monitor the progress of each group by observing and providing feedback as needed for guidance in solving the challenge.
Construct models that connect the movement of molecules across membranes with membrane structure and function. **[LO 2.11, SP 1.1, SP 7.1, SP 7.2]**	**Web** "Build-a-Membrane"	**Instructional Activity:** Students construct a model of a membrane and complete the activity, "How Is the Structure of a Cell Membrane Related to Its Function?" Students use the models to demonstrate and explain how the structure of a cell membrane is related to its function and how this is connected to the movement of molecules across the membrane. They analyze a scenario of fish removed from a contaminated lake and placed in a tank full of clean water. Students make predictions regarding the change in toxin concentrations within the fish and in the water in the tank. They then analyze data and explain, with justification, the role of passive- and active-transport processes. This is a student-directed, teacher-facilitated activity.
Describe basic chemical processes for cell communication shared across evolutionary lines of descent**. [LO 3.31, SP 7.2]** Generate scientific questions involving cell communication as it relates to the process of evolution**. [LO 3.32, SP 3.1]** Use representation(s) and appropriate and models to describe features of a cell signaling pathway**. [LO 3.33, SP 1.4]** Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. **[LO 3.34, SP 6.2]** Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. **[LO 3.35, SP 1.1]** Describe a model that expresses the key elements of signal transduction pathways	Campbell and Reece, Chapter 11: "Cell Communication" **Web** "Amazing Cells: Cells Communicate" "Dropping Signals" "The Inside Story of Cell Communication"	**Instructional Activity:** In the Dropping Signals activity, students use an online interactive model to explore how cell signals travel through the body. The model describes the response of various cell types to different types of signals, depending on the type of cell the signal reaches. Students read and summarize "The Inside Story of Cell Communication," which describes other types of cell signaling models. Students reflect and summarize features of cell signaling they have learned in their exit slip notebook. **Instructional Activity:** Students engage in an online investigation that addresses how the cell communicates through signals aided by pathways made of mostly proteins. During this activity, students will:

by which a signal is converted to a cellular response. **[LO 3.36, SP 1.5]** Justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response. **[LO 3.37, SP 6.1]** Describe a model that expresses key elements to show how change in signal transduction can alter cellular response. **[LO 3.38, SP 1.5]** Construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways. **[LO 3.39, SP 6.2]**		• View a 3-D animation for cell communication, the fight or flight response. • Examine an in-depth view of how cells communicate during a fight or flight response. • Engage in an interactive exploration called "Dropping Signals." • Learn what happens when cell communication goes wrong. • Look at the inside story of cell communication. This activity is student directed and teacher facilitated. **Instructional Activity:** Students create a model using cutout pieces of construction paper to illustrate the key features/components in a G-protein receptor system and the three stages of cell signaling: reception, transduction, and cellular response. Students describe and present models for peer and teacher review and revision.
Construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. **[LO 3.34, SP 6.2]** Create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. **[LO 3.35, SP 1.1]**	Campbell and Reece, Chapter 11: "Cell Communication" **Web** *X-2 Theme Park Ride* "The Inside Story of Cell Communication" "An Example of Cell Communication: The Fight or Flight Response"	**Instructional Activity:** Students are shown the YouTube video *X-2 Theme Park Ride*. It depicts a ride in Magic Mountain (a theme park in California). Students discuss and record responses to the physiological symptoms they feel as they watch the video. Students also complete KWL graphic organizers on what they know about the fight or flight response. Students watch the 4-minute video, "An Example of Cell Communication: The Fight or Flight Response." After viewing, they construct an explanation of what they've learned about cell communication as depicted in the video (via chemical signaling), and, on their KWL graphic organizers, relate those findings to the way the cell membrane contributes to cell function. **Formative Assessment:** Students use their exit notebooks to summarize the information they learned about cell signaling and relate it to the fear or excitement they may feel as they board an unfamiliar thrill ride at a theme park. Students may discuss their summaries with a peer and describe the signaling (where and how it takes place) from the moment they

		experience fear or excitement to the symptoms that occur.
		Summative Assessment: Students take a test containing 15 multiple-choice questions based on the concepts of cell membranes and cell communication. The test also includes two short-answer questions (one asks students to evaluate scientific data on diffusion and osmosis; the other asks them to connect phenomena and models of cell communication to the importance of cell membranes) and one free-response question on the way cell communication relates to the process of evolution.

Unit 2: Bioenergetics: Energy & Enzymes-Estimated Time- 3 Weeks
Big Ideas 1, 2, & 4

Laboratory Investigations:

AP Biology Investigative Labs (2012), Investigation 13: Enzyme Activity
AP Biology Investigative Labs (2012), Investigation 6: Cellular Respiration
AP Biology Investigative Labs (2012), Investigation 5: Photosynthesis (floating leaf disk procedure)

Essential Questions/Connecting to Enduring Understandings Big Ideas 1, 2 & 4

(2.A.1) In what ways do all living systems require a constant input of free energy?
(2.A.2) How do organisms capture and store free energy for use in biological processes?
(4.B.1) How do interactions between molecules affect their structure and function?
(1.B.1) How do organisms share many conserved core processes and features that evolved and are widely distributed among organisms today?
(4.A.2) How does the structure and function of subcellular components, and their interactions, provide essential cellular processes.
(4.A.6) In what ways do interactions among living systems and with their environment result in the movement of matter and energy?

Learning Objectives	Materials	Instructional Activities & Assessments
Predict how changes in free energy availability affects organisms, populations and ecosystems. **[LO 2.3, SP 6.4]** Analyze data to identify how molecular interactions affect structure and function. **[LO 4.17, SP 5.1]**	Campbell Chapter 8: "An Introduction to Metabolism" *AP Biology Investigative Labs* (2012), Investigation 13: Enzyme Activity	**Instructional Activity:** In this student-guided investigation, students justify the claim that free energy is required for all living systems by extracting enzymes from various sources, such as peroxidase in turnips, tyrosinase in mushrooms, catalase in beef liver, and amylase in saliva. Students predict and test the effects of enzymes, using a variety of temperature ranges. They

Justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies exist in different living systems. **[LO 2.2, SP 6.1]**	Campbell Chapter 8: "An Introduction to Metabolism"	investigate claims on how different pH buffers affect the rate of reaction, and which factor has a greater effect on the rate of reaction — changing the concentration of the enzyme, or changing the concentration of the substrate. **Formative Assessment:** At the end of the period, students complete an exit slip with the following questions: 1. What are three or four factors that vary in the environment in which organisms live? 2. Which of those factors do you think can affect enzyme activity? 3. How would you modify your basic assay to test your hypothesis? I collect and evaluate the exit slips and read them to begin discussion the following day. I may follow up with individual students who remain unclear about the concepts in these three questions.
Predict how changes in free energy availability affect organisms, populations, and ecosystems. **[LO 2.3, SP 6.4]** Use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store, and use free energy. **[LO 2.4, SP 1.4, SP 3.1]** Explain how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow, and to reproduce. **[LO 2.1, SP 6.2]**	*AP Biology Investigative Labs* (2012), Investigation 6: Cellular Respiration	**Instructional Activity:** In groups of four, students design, predict, and conduct an experiment to investigate scientific questions on the mechanisms and structural features of cellular respiration on a chosen organism. Students learn how to calculate the rate of cellular respiration by using a respirometer. In this student-directed activity, students use a variety of organisms to answer questions they pose about cellular respiration. **Formative Assessment:** Using the four-corners strategy, students are asked a series of questions about their observations of the cellular respiration lab: 1. How did your group measure the rate of cellular respiration — by the amount of glucose consumed, the amount of oxygen consumed, the amount of carbon dioxide produced, or as measured another way? 2. What type of organism did you decide to use: insects, worms, seeds, or plants? 3. Cellular respiration uses glucose and oxygen, which have high levels of free energy, and releases CO_2 and water, which have low levels of free energy. Is respiration spontaneous or not? (2 corners)

		Is it exergonic or endergonic? (2 corners) What happens to the energy released from glucose—is it stored, or is it used? (2 corners) As questions are asked, I evaluate student corner choices and discuss their responses with informative and corrective feedback.
Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. **[LO 1.16, SP 6.1]** Construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store, or use free energy. **[LO 2.5, SP 6.2]** Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. **[LO 4.5, SP 6.2]** Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. **[LO 4.14, SP 2.2]**	Campbell and Reece, Chapter 10: “Photosynthesis” AP Biology Investigative Labs (2012), Investigation 5: Photosynthesis (floating leaf disk procedure)	**Instructional Activity:** Students pose scientific questions, then design and conduct an experiment on the mechanisms of photosynthesis. Students can collect data and apply mathematical routines based on a number of variables they are testing. Students explain how the interactions of these variables inhibit or promote the interaction of subcellular structures to provide functions essential to photosynthesis. **Formative Assessment:** Students record their scientific questions, collect data, and use mathematical methods to write a formal lab report they will turn in for homework.
		Summative Assessment: Students are given a test containing 15 multiple-choice questions based on the concepts of cellular respiration and photosynthesis; two short-answer questions (one on photosynthesis, the other on cellular respiration); and one free-response question, which asks students to compare and contrast the process of photosynthesis and cellular respiration in relation to the way organisms require, capture, store, and use free energy.

Unit 3: Molecular Genetics--Estimated Time- 5 Weeks
Big Ideas 1, 2, 3, & 4

Laboratory Investigations:

AP Biology Investigative Labs (2012), Investigation 8: Biotechnology: Bacterial Transformation
AP Biology Investigative Labs (2012), Investigation 9: Biotechnology: Restriction Enzyme Analysis of DNA

Essential Questions/Connecting to Enduring Understandings Big Ideas 1, 2, 3, & 4

(3.A.1) How is DNA, and in some cases RNA, the primary source of heritable information?
(1.A.2) How does natural selection act on phenotypic variations in populations?
(1.C.3) How do populations of organisms continue to evolve?
(3.B.1) How does gene regulation result in differential gene expression, leading to cell specialization?

(3.B.2) In what ways do a variety of intercellular and intracellular signal transmissions mediate gene expression?
(3.C.3) How does viral replication result in genetic variation, and how can viral infection introduce genetic variation into the hosts?
(4.A.3) How do interactions between external stimuli and regulated gene expression result in specialization of cells, tissues, and organs?
(4.C.1) How does variation in molecular units provide cells with a wider range of functions?
(3.C.2) How do biological systems have multiple processes that increase genetic variation?
(2.C.1) How do organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes?
(2.E.1) In what ways are timing and coordination of specific events necessary for the normal development of an organism, and how are these events regulated by a variety of mechanisms?

Learning Objectives	Materials	Instructional Activities & Assessments
Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information. **[LO 3.2, SP 4.1]**	Campbell and Reece, Chapter 16: "The Molecular Basis of Inheritance" **Web** "DNAi Timeline: A Scavenger Hunt"	**Instructional Activity:** Provided with a time line and information on DNA investigations, students, in groups of three, learn about scientists whose work has contributed to the understanding of DNA. Students use the DNAi website to answer questions embedded in a scavenger hunt activity. They use clues to navigate through the DNAi time line, justify the selection of data to solve problems, and view the contributions scientists made regarding DNA from a historical perspective. I monitor their use of the DNAi website and their collection of scavenger hunt items as students respond to the clues on their activity handout. **Instructional Activity:** Students develop a poster series featuring a scientist or the work of a scientist highlighted on a time line. Students select and highlight the investigational data they think best supports the claim that DNA is the source of heritable information and defend their claim as they present it to the class.
Construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, that RNA are the primary sources of heritable information. **[LO 3.1, SP 6.5]** Connect evolutionary changes in a population over time to a change in the environment. **[LO 1.5, SP 7.1]** Describe representations and models that illustrate how genetic information is copied for transmission between generations. **[LO 3.3, SP 1.2]**	Campbell and Reece, Chapter 16: "The Molecular Basis of Inheritance"; Chapter 17: "From Gene to Protein"; Chapter 18: "Regulation of Gene Expression"; Chapter 19: "Viruses"; Chapter 20: "Biotechnology"; and Chapter 21: "Genomes and Their Evolution" AP Biology Investigative Labs (2012), Investigation	**Instructional Activity:** In this four-day lab investigation, students construct scientific explanations based on the structures and mechanisms of DNA by transforming bacterial cells with plasmid DNA. Students apply mathematical routines to describe the efficiency with which genetic information is transferred. Although this is a student-directed investigation, I monitor student data collection and representation and

Justify the claim that humans can manipulate heritable information by identifying *at least two* commonly used technologies. **[LO 3.5, SP 6.4]** Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. **[LO 3.6, SP 6.4]**	8: Biotechnology: Bacterial Transformation	review the explanations of their results in their lab notebooks. **Formative Assessment:** Individually, students investigate several applications of genetic transformation related to the manipulation of DNA by biotechnology. These applications are to be displayed on mini-posters with context, explanations, and justifications.
Describe a model that represents evolution within a population. **[LO 1.25, SP 1.2]** Justify the claim that humans can manipulate heritable information by identifying *at least two* commonly used technologies**. [LO 3.5, SP 6.4]** Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. **[LO 3.18, SP 7.1]** Describe the connection between the regulation of gene expression and observed differences between individuals in a population. **[LO 3.19, SP 7.1]**	AP Biology Investigative Labs (2012), Investigation 9: Biotechnology: Restriction Enzyme Analysis of DNA	**Instructional Activity:** In this lab investigation, students use the technique of gel electrophoresis and restriction enzyme analysis of DNA to solve a DNA profiling investigation. Students conduct a data analysis to determine the approximate sizes of DNA fragments produced by the restriction enzymes. In the last part of the lab, students design and conduct an experiment (and investigation) of their own, based on the knowledge and skills developed earlier in the lab. Although some components in this lab are student directed, I act as facilitator by monitoring or correcting investigative skills, lab techniques, and specific misunderstandings. Students record data, analysis, and conclusions in their lab notebooks.
Describe representations and models illustrating how genetic information is translated into polypeptides. **[LO 3.4, SP 1.2]** Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function. **[LO 3.20, SP 6.2]** Use representations to describe how gene regulation influences cell products and function. **[LO 3.21, SP 1.4]** Explain how signal pathways mediate gene expression, including how this process can affect protein production. **[LO 3.22, SP 6.2]** Use representations to describe mechanisms of the regulation of gene expression. **[LO 3.23, SP 1.4]** Create a visual representation to illustrate	Campbell and Reece, Chapter 16: "The Molecular Basis of Inheritance"; Chapter 17: "From Gene to Protein"; Chapter 18: "Regulation of Gene Expression"; Chapter 19: "Viruses"; Chapter 20: "Biotechnology"; and Chapter 21: "Genomes and Their Evolution" **Web** "DNA from the Beginning: Molecules of Genetics Activities 21–24"	**Instructional Activity:** Students use the DNA from the Beginning website to access concept explanations, animations, photo galleries, videos, and questions or problems. Based on artifacts and data obtained, students create a PowerPoint presentation to describe the regulation of gene expression mechanisms via transcription, translation, and protein synthesis. Students will illustrate one of the following: 1. How genetic information is translated into polypeptides 2. How regulation of gene expression is essential to the process of efficient cell function 3. How genes regulate and influence the function of a cell A rubric is provided to guide students' PowerPoint creation, preparation, and presentation. I use the rubric to evaluate student presentations.

how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. **[LO 3.25, SP 1.1]**		**Formative Assessment:** Using the presentation rubric and the activity they were assigned, students present their PowerPoint projects to the class.
Construct an explanation of how viruses introduce genetic variation in host organisms. **[LO 3.29, SP 6.2]** Use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population. **[LO 3.30, SP 1.4]** Refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues, and organs. **[LO 4.7, SP 1.3]** Construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions. **[LO 4.22, SP 6.2]** Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains. **[LO 3.27, SP 7.2]**	Campbell and Reece, Chapter 16: "The Molecular Basis of Inheritance"; Chapter 17: "From Gene to Protein"; Chapter 18: "Regulation of Gene Expression"; Chapter 19: "Viruses"; Chapter 20: "Biotechnology"; and Chapter 21: "Genomes and Their Evolution"	**Instructional Activity:** In this activity, students work in groups of three to complete a graffiti carousel. Questions and prompts are displayed on poster board around the room, and students examine and address the queries: • Compare the structures of the tobacco mosaic virus and the influenza virus, and how they differentiate in introducing genetic variation in a host organism. • Compare the effect on the host cell of a lytic (virulent) phage and a lysogenic (temperate) phage. • How do some viruses reproduce without possessing or ever synthesizing DNA? • Why is HIV considered a retrovirus? • Describe two ways a preexisting virus can become an emerging virus.
Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. **[LO 3.18, SP 7.1]** Describe the connection between the regulation of gene expression and observed differences between individuals in a population. **[LO 3.19, SP 7.1]** Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function. **[LO 3.20, SP 6.2]** Use representations to describe how gene regulation infl uences cell products and function**. [LO 3.21, SP 1.4]** Refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues, and organs. **[LO 4.7, SP 1.3]** 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 2.15, SP 6.1]** Explain how signal pathways mediate gene expression, including how this process can	Campbell and Reece, Chapter 20: "Biotechnology" and Chapter 21: "Genomes and Their Evolution" **Web** "Rediscovering Biology: Unit 7: Genetics of Development: Animations and Images"	**Instructional Activity:** In this student-guided activity, students use construction paper or other creative materials to construct models of the *lac* and/or *tryp* operons that include a regulator, promoter, operator, and structural genes. Students use the model to make predictions (with justification) about the effects of mutations in any of the regions on gene expression. I facilitate this activity. **Instructional Activity:** Students create PowerPoint presentations to distinguish between embryonic versus adult stem cells. Students work in small groups to explain (with justification) their arguments for and against stem cell research. This activity is student directed and teacher facilitated. **Instructional Activity:** Students watch animations and explain (with justification) how the normal hedgehog signaling pathway can be blocked, why the level of hedgehog protein that the cell binds to is important, and how the hedgehog signaling pathway can trigger expression of developmentally important genes.

affect protein production. **[LO 3.22, SP 6.2]** Use representations to describe mechanisms of the regulation of gene expression. **[LO 3.23, SP 1.4]** 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 2.31, SP 7.2]** 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 2.32, SP 1.4]** 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 2.33, SP 6.1]** Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis. **[LO 2.34, SP 7.1]**		Components of this activity are both student directed and teacher directed. **Formative Assessment:** As an exit ticket, students respond to the question, *What role does the hedgehog protein play in embryonic development?* **Formative Assessment:** Students distinguish between the terms *determination* and *differentiation* regard to gene expressions. Students work in pairs to provide an example and explanation of experimental evidence that supports the claim that different cell types result from differential gene expression in cells with the same DNA. This activity is teacher guided and student driven.
		Summative Assessment: In a 54 minute period, students answer 15 multiple-choice questions, 1 math, 2 short response and 1 long free response.

Unit 4: -Inheritance-Estimated Time- 4 Weeks
Big Ideas 3 & 4

Laboratory Investigations:

AP Biology Investigative Labs (2012), Investigation 7: Cell Division: Mitosis and Meiosis
AP Biology Lab Manual (2001), Lab 7: Genetics of Organisms (transitioned to be inquiry based and student directed.)

Essential Questions/Connecting to Enduring Understandings Big Ideas 3 & 4

(3.A.2) How is heritable information passed to the next generation in eukaryotes via the processes that include the cell cycle and mitosis or meiosis plus fertilization?
(3.C.2) In what ways do biological systems have multiple processes that increase genetic variation?
(3.A.3) In what ways does the chromosomal basis of inheritance provide an understanding of the patterns of transmission of genes from parent to offspring?
(4.C.2) How do environmental factors influence the expression of the genotype in an organism?
(4.C.3) How does the level of variation in a population affect population dynamics?
(4.C.4) In what ways does the diversity of a species within an ecosystem influence the stability of the ecosystem?

(3.A.4) In what ways are inheritance patterns of many traits explained other than through simple Mendelian genetics?
(3.C.1) In what ways do changes in genotype result in changes in phenotype?

Learning Objectives	Materials	Instructional Activities & Assessments
Make predictions about natural phenomena occurring during the cell cycle. **[LO 3.7, SP 6.4]** 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 3.9, SP 6.2]** Represent the connection between meiosis and increased genetic diversity necessary for evolution. **[LO 3.10, SP 7.1]** Describe the events that occur in the cell cycle. **[LO 3.8, SP 1.2]** 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 3.11, SP 5.3]** Construct an explanation of the multiple processes that increase variation within a population**. [LO 3.28, SP 6.2]**	Campbell and Reece, Chapter 12: “The Cell Cycle” *AP Biology Investigative Labs* (2012), Investigation 7: Cell Division: Mitosis and Meiosis Campbell and Reece, Chapter 13: “Meiosis and Sexual Life Cycles,” Concepts 13.1–13.3	**Instructional Activity:** This activity contains four parts: 1. Modeling mitosis: Students model mitosis with pipe cleaners and beads as a prelab activity. 2. Effects of environment on mitosis: Students set up an experiment and make predictions about the effects of lectin on onion root-tip cells undergoing mitosis in the environment. Students compare and count onion cells in various phases and record their data. Students make predictions and construct explanations as to how DNA in chromosomes is transmitted to the next generation via mitosis. They then calculate chi-square for the expected number of cells versus the actual counted. 3. Loss of cell cycle control in cancer: Students use HeLa cells and karyotype pictures of normal cells to form hypotheses as to how chromosomes of a cancer cell might appear in comparison to a normal cell. 4. Modeling meiosis: Students use household items to model meiosis and crossing-over events and to simulate nondisjunction and the relationship to genetic disorders. Students devise explanations of multiple processes that increase variation by measuring cross-over frequencies and genetic outcomes in fungus *Sordaria*.
Construct a representation that connects the process of meiosis to the passage of traits from parent to offspring. **[LO 3.12, SP 1.1, SP 7.2]** Apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. **[LO 3.14, SP 2.2]** Construct explanations of the influence of environmental factors on the phenotype of an organism. **[LO 4.23, SP 6.2]**	Campbell and Reece, Chapter 14: “Mendel and the Gene Idea” *AP Biology Lab Manual* (2001), Lab 7: Genetics of Organisms (transitioned to be inquiry based and student directed)	**Instructional Activity:** Students construct representations that connect the process of meiosis by investigating an independent assortment of two genes and determining whether they are autosomal or sex-linked. Students collect and analyze data from a genetic cross they will perform with fruit flies and mathematically determined Mendelian patterns of inheritance. Students perform a chisquare analysis of the results and predict the diversity of flies (i.e., influences the ecosystem). Students also make predictions (with justification) on the effects of a

Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability. **[LO 4.27, SP 6.4]** Predict the effects of a change in an environmental factor on the genotypic expression of the phenotype. **[LO 4.24, SP 6.4]** 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 4.25, SP 6.1]**	**Web** "Genetic Disease Information — *pronto!*"	change in environment on the genotype expression of the fruit flies, by investigating changes students may add or manipulate in the flies' environment. **Instructional Activity:** Students use the Human Genome research site to explore single-gene disease disorders (sickle-cell anemia, Tay-Sachs disease, Huntington's disease, X-linked color blindness, Trisomy 21/Down syndrome, and Klinefelter's syndrome). After researching these diseases individually, students work in small groups to discuss ethical, social, and medical issues that surround human disorders. At the end of the lesson the groups report in a class discussion for which I serve as facilitator. **Formative Assessment:** Students solve monohybrid and dihybrid test crosses. The focus of the assessment is student understanding of phenotypic and genotypic ratios and how traits are passed from one generation to the next. Students report their results to the class for peer and teacher review. The lesson is student directed and teacher facilitated.
Explain deviations from Mendel's model of the inheritance of traits. **[LO 3.15, SP 6.5]** Explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. **[LO 3.16, SP 6.3]** Describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits**. [LO 3.17, SP 1.2]** Explain the connection between genetic variations in organisms and phenotypic variations in populations. **[LO 3.26, SP 7.2]** Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection**. [LO 3.24, SP 6.4, SP 7.2]**	Campbell and Reece, Chapter 15: "The Chromosomal Basis of Inheritance," Concepts 15.1–15.5 and "Testing Your Knowledge: Genetics Problems," pp. 303–304	**Instructional Activity:** In groups of three, students work on genetics problems, using calculators and their understanding of Mendel's model of inheritance to explain patterns of inheritance. They predict (with justification) how a change in genotype provides variation that can be subject to natural selection. Students present their work to the class, explaining and justifying their calculations and answers.
Pose questions about ethical, social, or medical issues surrounding human genetic disorders. **[LO 3.13, SP 3.1]**	Campbell and Reece, Chapter 15: "The Chromosomal Basis of Inheritance," Concept 15.4 **Web** "Sickle Cell Bioinformatics"	**Instructional Activity:** Students learn about sickle cell bioinformatics by role-playing. Each student, acting as a public health specialist, designs a DNA probe to diagnose carriers of sickle cell

		anemia, using the UCSC Genome Browser. Students pose questions about the medical issues surrounding this human genetic disorder.
		Summative Assessment: In a 54 minute period, students answer 15 multiple-choice questions, 1 math, 2 short free and one and long free-response questions.

Unit 5: Evolution--Estimated Time- 4 Weeks
Big Ideas 1, 2, & 4

Laboratory Investigations:

AP Biology Lab Manual (2001), Lab 8: Population Genetics and Evolution
AP Biology Investigative Labs (2012), Investigation 2: Mathematical Modeling: Hardy-Weinberg
AP Biology Investigative Labs (2012), Investigation 1: Artificial Selection
AP Biology Investigative Labs (2012), Investigation 3: Comparing DNA Sequences to Understand Evolutionary Relationships with BLAST

Essential Questions/Connecting to Enduring Understandings Big Ideas 1, 2, & 4

(1.A.1) How does evolution by natural selection drive the diversity and unity of life?
(2.E.3) In what ways is the timing and coordination of behavior regulated by various mechanisms and how are they important in natural selection?
(1.A.2) How does natural selection act on phenotypic variations in populations?
(1.A.3) How is evolutionary change also driven by random processes?
(4.C.3) How does the level of variation in a population affect population dynamics?
(1.A.4) What scientific evidence from many disciplines, including mathematics, supports models about the origin of life on Earth and biological evolution?
(1.B.2) How can phylogenetic trees and cladograms be used to graphically model evolutionary history among species?
(2.D.2) How do homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments?
(1.C.1) How have speciation and extinction occurred throughout the Earth's history?
(1.C.2) In what ways does speciation occur when two populations become reproductively isolated from each other?
(1.C.3) How do populations of organisms continue to evolve?
(1.D.1) What are several hypotheses about the natural origin of life on Earth, including their supporting evidence?
(1.D.2) What scientific evidence from many different disciplines supports models of the origin of life?

Learning Objectives	Materials	Instructional Activities & Assessments
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 1.1, SP 1.5, SP 2.2]** Evaluate evidence provided by data to	Campbell and Reece, Chapter 22: "Descent with Modification: A Darwinian View of Life," pp. 438–448; and Chapter 23: "The Evolution of Populations" *AP Biology Lab Manual* (2001),	**Instructional Activity:** AP Lab 8: Population Genetics and Evolution or AP Biology Investigation 2: Mathematical Modeling: Hardy-Weinberg. Introduces students to application of the Hardy-Weinberg equation to study changes in allele frequencies in a population and to examine

qualitatively and quantitatively investigate the role of natural selection in evolution. **[LO 1.2, SP 2.2, SP 5.3]** Analyze data to support the claim that responses to information and communication of information affect natural selection. **[LO 2.38, SP 5.1]** Apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. **[LO 1.3, SP 2.2]** Evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time. **[LO 1.4, SP 5.3]** Connect evolutionary changes in a population over time to a change in the environment. **[LO 1.5, SP 7.1]** 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 1.6, SP 1.4, SP 2.1]** Justify data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and the effects of selection in the evolution of specific populations. **[LO 1.7, SP 2.1]** Use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness**. [LO 4.26, SP 6.4]** Make predictions about the effects of genetic drift, migration, and artificial selection on the genetic makeup of a population. **[LO 1.8, SP 6.4]**	Lab 8: Population Genetics and Evolution or *AP Biology Investigative Labs* (2012), Investigation 2: Mathematical Modeling: Hardy-Weinberg *AP Biology Investigative Labs* (2012), Investigation 1: Artificial Selection Leslie, "Kidney Disease is Parasite-Slaying Protein's Downside" Genovese, et al., "Association of Trypanolytic ApoL1 Variants with Kidney Diseases in AfricanAmericans"	possible causes for these changes. Although the first part of this lab is teacher directed, inquiry based questions for students to answer are included. **Instructional Activity:** AP Biology Investigation 1: Artificial Selection. Using Wisconsin Fast Plants, students explore evolution by conducting an artificial selection investigation. Students then can apply principles to determine if extreme selection can change expression of a quantitative trait. **Instructional Activity:** Students read the two articles from *Science* about genetic variants/kidney disease/*Trypanosoma*. They then answer the following question either in writing or class discussion: *How does the information apply to the study of population genetics and support the concept of continuing evolution by natural selection?* **Instructional Activity:** Provided with data from real or simulated populations, students apply the Hardy-Weinberg mathematical model to determine if selection is occurring. If it is determined that the populations are *not* in H-W equilibrium, students should describe possible reasons for the deviation(s).
Evaluate evidence provided by data from many scientific disciplines to support biological evolution. **[LO 1.9, SP 5.3]** Refine evidence based on data from many scientific disciplines that support biological evolution. **[LO 1.10, SP 5.2]** Design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry, and geology. **[LO 1.11, SP 4.2]** Connect scientific evidence from many scientific disciplines to support the modern concept of evolution. **[LO 1.12, SP 7.1]**	Campbell and Reece, Chapter 22: "Descent with Modification: A Darwinian View of Life," pp. 448–452 Weiner, *The Beak of the Finch: A Story of Evolution in Our Time* **Web** "Lesson 3: What is the Evidence for Evolution? Activity 1: Evolution and Time" **Video** *Beyond Genesis: The Origin of Species*	**Instructional Activity:** Students work through the online PBS activity "Evolution and Time," following the instructions to create a journal entry to evaluate and describe the geological ecosystem of a particular time period. **Instructional Activity:** Students read teacher-selected excerpts from Weiner's *The Beak of the Finch* (either aloud in class or as a homework assignment) and highlight evidence that supports evolution by natural selection as an explanation for the observed

		differences in beak sizes over several seasons. **Formative Assessment:** Using excerpts from *The Beak of the Finch,* students write a brief narrative explaining how evidence from many scientific disciplines supports the observations of Charles Darwin as well as Peter and Rosemary Grant regarding differences in beak sizes and, thus, supports evolution by natural selection. Then, in small groups, students share and discuss their explanations. **Summative Assessment:** Thirty-minute quiz consisting of 10 multiple-choice questions and two short free-response questions based on (1) the application of the Hardy-Weinberg equation and (2) evidence for evolution by natural selection within a population(s).
Construct and/or justify mathematical models, diagrams, or simulations that represent processes of biological evolution. **[LO 1.13, SP 1.1, SP 2.1]** 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 1.17, SP 3.1]** Evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. **[LO 1.18, SP 5.3]** Create a phylogentic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set. **[LO 1.19, SP 1.1]** 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 2.25, SP 6.2]**	Campbell and Reece, Chapter 25: "Phylogeny and Systematics" Waterman and Stanley, "Tree Thinking" **Web** "Classroom Cladogram of Vertebrate/Human Evolution" *AP Biology Investigative Labs* (2012), Investigation 3: Comparing DNA Sequences To Understand Evolutionary Relationships with BLAST	**Instructional Activity:** "Tree Thinking." An inquiry-based, investigative set of activities that introduces students to cladogram and phylogenetic tree construction and then asks them to apply systematics and biotechnology to a forensic study. **Instructional Activity:** Given some groups of organisms and some of their distinguishing characteristics, students construct a cladogram and properly interpret and analyze that cladogram in terms of how it shows common ancestry and degrees of evolutionary relationships. Students display their work on posters for a gallery walk for peer and teacher review. **Instructional Activity:** AP Biology Investigation 3: Comparing DNA Sequences to Understand Evolutionary Relationships with BLAST. Students use BLAST to compare several genes from different organisms and then use the information to construct a cladogram to visualize evolutionary relatedness among species. This lab introduces students to methods of bioinformatics with many applications, including to better understand genetic disease.

		This lab is student directed and teacher facilitated. **Formative Assessment:** Provided with a data table identifying shared characteristics among a group of organisms, students construct a phylogenetic tree or cladogram to reflect the evolutionary history of the group. Students then share the cladogram with peers for review and revision.
Analyze data related to questions of speciation and extinction throughout the Earth's history. **[LO 1.20, SP 5.1]** Design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history. **[LO 1.21, SP 4.2]** 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 1.22, SP 6.4]** Justify the selection of data that addresses questions related to reproductive isolation and speciation. **[LO 1.23, SP 4.1]** Describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection, and/or genetic drift. **[LO 1.24, SP 7.2]** Describe a model that represents evolution within a population. **[LO 1.25, SP 1.2]** Evaluate given data sets that illustrate evolution as an ongoing process. **[LO 1.26, SP 5.3]**	Campbell and Reece, Chapter 24: "The Origin of Species"	**Instructional Activity:** Students conduct online research to identify examples of recent or ongoing speciation events and prepare a poster or PowerPoint slide(s) to share their speciation event with the class for discussion. **Instructional Activity:** Back to the Birds. Students make predictions about what the data might reflect and what conclusions might be drawn about natural selection and evolution if researchers were to visit the Galapagos Islands today and reexamine beak sizes in finches. **Formative Assessment:** Beginning with an extant, familiar species, students imagine its evolution to a new species and create a mini-poster showing their ideas. They should include at least five intermediate stages that reflect concepts of speciation explored in class. Students then share the posters with peers for review, discussion, and revision.
Describe a scientific hypothesis about the origin of life on Earth**. [LO 1.27, SP 1.2]** Evaluate scientific questions based on hypotheses about the origin of life on Earth. **[LO 1.28, SP 3.3]** Describe the reasons for revisions of scientific hypotheses of the origin of life on Earth. **[LO 1.29, SP 6.3]** Evaluate scientific hypotheses about the origin of life on Earth. **[LO 1.30, SP 6.5]**	Campbell and Reece, Chapter 26: "Phylogeny and the Tree of Life" **Web** "Exploring Life's Origins: A Timeline of Life's Evolution"	**Instructional Activity:** I begin this activity with a class discussion about the origin of life. Students propose a hypothesis regarding how the Earth formed. Students then write a description of early Earth using biotic and biotic factors, and explore a web-based time line that details events in the history of life on Earth. Through this exploration, students will describe and evaluate scientific hypotheses about the origin of the Earth. Students will also evaluate their personal hypotheses against the

Evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth. **[LO 1.31, SP 4.4]** Justify the selection of geological, physical, and chemical data that reveal early Earth conditions. **[LO 1.32, SP 4.1]**		web-based model of the origin and evolution of Earth. The initial classroom discussion is led by me, however, the remaining parts of this activity are student directed.
		Summative Assessment: 54 Minute exam consisting of 15 multiple-choice questions, two short response questions, and one long-response question drawing from data pertaining to evidence supporting natural selection and evolution.

Unit 6 Ecology--Estimated Time- 4 Weeks
Big Ideas 2, 3, 4

Laboratory Investigations:

AP Biology Investigative Labs (2012), Investigation 12: Fruit Fly Behavior
AP Biology Investigative Labs (2012), Investigation 10: Energy Dynamics

Essential Questions/Connecting to Enduring Understandings Big Ideas 2, 3, & 4

(2.D.1) How are biological systems from cells to organisms to populations, communities, and ecosystems affected by complex biotic and abiotic interactions involving exchange of matter and free energy?
(2.E.3) In what ways is the timing and coordination of behavior regulated by various mechanisms and how are they important in natural selection?
(3.E.1) In what ways can individuals act on information and communicate it to others?
(4.A.5) How are communities composed of populations of organisms that interact in complex ways?
(4.A.6) What interactions among living systems and with their environment result in the movement of matter and energy?
(2.A.1) In what ways do all living systems require constant input of free energy?
(4.A.4) How do organisms exhibit complex properties due to interactions between their constituent parts?
(4.B.3) In what ways do interactions between and within populations influence patterns of species distribution and abundance?
(4.B.4) How does the distribution of local and global ecosystems change over time?
(4.C.4) How does the diversity of a species within an ecosystem influence the stability of the ecosystem?
(2.D.3) How are biological systems affected by disruptions to their dynamic homeostasis?

Learning Objectives	**Materials**	**Instructional Activities & Assessments**
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 2.22, SP 1.3, SP 3.2]**	Campbell and Reece, Chapter 51: “Animal Behavior” Chapter 52: “An Introduction to Ecology and the Biosphere” Chapter 53: “Population Ecology”; Chapter 54: “Community Ecology”; and Chapter 55: “Ecosystems”	**Instructional Activity:** Students create a concept map based on prior knowledge of biotic and abiotic interactions of different biological systems. In groups of three, students work with 20 vocabulary terms and concepts (selected by me). Students write the terms and concepts on sticky notes and arrange them to create a concept map of their current understanding of ecology. While creating the concept maps, students pose scientific questions about the

		different interactions, and refine their maps based on their understandings. Part of this activity is teacher directed (i.e., the selection of vocabulary terms and concepts); however, it quickly segues into a more student-directed activity, as students work to create their concept maps.
Justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms. **[LO 2.39, SP 6.1]** Analyze data to support the claim that responses to information and communication of information affect natural selection. **[LO 2.38, SP 5.1]** Connect concepts in and across domain(s) to predict how environmental factors affect responses to information and change behavior. **[LO 2.40, SP 7.2]** Analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior. **[LO 3.40, SP 5.1]** 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 3.41, SP 1.1]** Describe how organisms exchange information in response to internal changes or environmental cues. **[LO 3.42, SP 7.1]**	Campbell and Reece, Chapter 51: "Animal Behavior" *AP Biology Lab Manual* (2012), Lab 12: Fruit Fly Behavior **Web** "Circadian Rhythms"	**Instructional Activity:** In this lab investigation, students construct choice chambers to investigate behaviors that underlie chemotaxis. Students will design and conduct experiments based on their own research questions. This lab is student directed and facilitated by me. **Instructional Activity:** Students independently explore an interactive tutorial on circadian rhythms. This tutorial includes examples of measurements of biological rhythms. Students use this activity to explain and justify how timing and coordination of behavioral events in organisms are regulated. The students are self-guided and I am the facilitator. **Instructional Activity:** Students choose and observe specifi c behaviors in three different breeds of dogs. In written reports, students describe how dogs exchange information in response to internal changes and external cues. Students make recommendations to determine which type of dog is best suited to live on a farm, in a loft apartment, and/or in a condominium. This activity is student guided and facilitated by me. **Formative Assessment:** Students answer two short free-response questions based on the animal behavior lab, and their peers and I review their responses.
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 2.23, SP 4.2, SP 7.2]** Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, or	Campbell and Reece, Chapter 53: "Population Ecology" **Web** "Alien Plant Invasion: A Field Study Project at Saguaro National Park: Sample Study Plots on the Football Field	**Instructional Activity:** In small groups, students designate an area of the school football field as a plot to make observations and then design and implement a study of interactions between organisms and their environment. One group might collect data on the number of weeds versus native grass populations, to explore the effects of alien species on native species, while another

ecosystems). **[LO 2.24, SP 5.1]**		group investigates insect infestation. Students then read an article from the Saguaro National Park Field Study and compare the ways in which various biological systems can be affected by complex biotic and abiotic interactions. This activity is student directed and requires little teacher facilitation. **Formative Assessment:** Students analyze the data they collected from their football field plots and formulate hypotheses as to how the biological systems are affected by complex biotic and abiotic interactions. Students discuss their hypotheses with their peers, and they critique one another's ideas.
Justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities**. [LO 4.11, SP 1.4, SP 4.1]** Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways**. [LO 4.12, SP 2.2]**	Campbell and Reece, Chapter 53: "Population Ecology,"	**Instructional Activity:** To introduce the exponential and logistic models of population growth, I select examples in the textbook to explain how to use these mathematical routines to analyze data and make predictions about the effects of change in a community if data were to change. This activity takes place in a whole-class setting and is teacher guided. **Formative Assessment:** In a think-pair-share activity, students discuss with a partner the questions listed below. Students will share their answers with another group for review. 1. An important assumption of the mark-recapture method is that marked individuals have the same probability of being recaptured as unmarked individuals. Describe a situation in which this assumption might not be valid, and explain, with justification, how the estimate of population size would be affected. 2. Explain, with justification, why a constant rate of increase (r_{max}) for a population produces a growth graph that is J-shaped rather than a straight line. 3. When a farmer abandons a field and it is quickly colonized by fast-growing weeds, are these species more likely to be K-selected or r-selected species? Use evidence to explain and justify your answer.

Predict the effects of a change in the community's populations on the community. **[LO 4.13, SP 6.4]** 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 4.15, SP 1.4]**	Campbell and Reece, Chapter 54: "Community Ecology" poster paper and markers	**Instructional Activity:** Students are provided with examples of complex food webs. In groups, students add arrows to show the transfer of energy within the food webs. Students then create their own food webs, but in their labeling they must detail three to five interspecific interactions that occur within their food webs, such as competition, predation, herbivory, symbiosis, parasitism, mutualism, and/or commensalism. Once their food webs are created, students make predictions (with justification) about what might happen if a component in the food web changes. For example, what are possible consequences if a disease kills most of the plants at the producer level, or a non-native species is introduced into the ecosystem?
Explain how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow, and to reproduce. **[LO 2.1, SP 6.2]** Justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies exist in different living systems. **[LO 2.2, SP 6.1]** Predict how changes in free energy availability affect organisms, populations, and ecosystems. **[LO 2.3, SP 6.4]** 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 2.22, SP 1.3, SP 3.2]** 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 2.23, SP 4.2, SP 7.2]** Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, or	AP Biology Investigative Labs (2012), Investigation 10: Energy Dynamics	**Instructional Activity:** Students complete AP Biology Investigation 10: Energy Dynamics in teams of three. A pre-lab activity helps students establish a context for energy dynamics in living systems. Students then develop skills needed to monitor the biomass in growing plants and butterfly larvae. Then, students investigate their own questions via a long-term study of energy dynamics. This study includes collecting biomass data at different intervals and during the observations of the interactions of the organisms. Students design and investigate experiments to answer their questions. Wisconsin Fast Plants (*Brassica rapa*) and cabbage white butterflies (*Pieris rapae*) are used for this study of the basic ecological concepts of energy flow, role of producers, primary consumers, and complex interactions between organisms. **Formative Assessment:** Students are provided with a rubric of the identifying items that will be used to evaluate the food webs. They will have the opportunity to peer review one another's work.

ecosystems). **[LO 2.24, SP 5.1]**		
Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. **[LO 4.14, SP 2.2]** Predict the effects of a change of matter or energy availability on communities. **[LO 4.16, SP 6.4]** Explain how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow, and to reproduce. **[LO 2.1, SP 6.2]** Justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies exist in different living systems. **[LO 2.2, SP 6.1]** Predict how changes in free energy availability affect organisms, populations, and ecosystems. **[LO 2.3, SP 6.4]**	Campbell and Reece, Chapter 55: "Ecosystems," AP Biology Lab Manual (2001), Lab 12: Dissolved Oxygen and Aquatic Primary Productivity (transitioned to be inquiry based and student directed)	**Instructional Activity:** Dissolved Oxygen Lab: Primary Plant Productivity (transitioned from 2001 Lab 12: Dissolved Oxygen and Aquatic Primary Productivity). Students are guided by the teacher to investigate how algae grow in various environmental conditions and how to calculate the amount of oxygen produced under normal conditions. Based on the data obtained from the lab activity, students make predictions about how different environmental conditions might affect oxygen production and then design their own experiment, choosing variables that may affect the production of oxygen in other types of algae or plants of their choice. Students record data, analysis, and conclusions in their lab notebooks. **Formative Assessment:** Students give oral presentations explaining and justifying their experimental design, and articulating their results.
Evaluate scientifi c questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts. **[LO 4.8, SP 3.3]** Predict the effects of a change in a component(s) of a biological system on the functionality of an organism(s). **[LO 4.9, SP 6.4]** Refine representations and models to illustrate biocomplexity due to interactions of the constituent parts. **[LO 4.10, SP 1.3]** Justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities. **[LO 4.11, SP 1.4, SP 4.1]** Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. **[LO 4.12, SP 2.2]** Predict the effects of a change in the community's populations on the community. **[LO 4.13, SP 6.4]** Predict the effects of a change of matter or energy availability on communities.	Campbell and Reece, Chapter 53: "Population Ecology"; Chapter 54: "Community Ecology"; Chapter 55, "Ecosystems"; Chapter 40: "Basic Principles of Animal Form and Function"; Chapter 56: "Conservation Biology and Restoration Ecology"	**Instructional Activity:** Students work in groups to describe five talking points (each) regarding populations, communities, and ecosystems. The students explain (with justification) the talking points on chart paper. Each group posts their paper on the wall in different places in the classroom for a gallery walk. Groups visit each posted paper and discuss how the three topics relate to one another. These posts are reviewed by me and other students. This activity is student focused and facilitated by me. **Summative Assessment:** Students create visual representations that illustrate biocomplexity and interactions in the environment. Each representation should be a depiction across systems (starting from the biosphere and going to the habitat of an organism). The following should also be included: biosphere, biome, ecosystem, community, population, organism, habitat, and niche. Abiotic and biotic factors should be included where applicable.

[LO 4.16, 6.4] Use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance. **[LO 4.19, SP 5.2]** Predict consequences of human actions on both local and global ecosystems. **[LO 4.21, SP 6.4]** Make scientifi c claims and predictions about how species diversity within an ecosystem infl uences ecosystem stability. **[LO 4.27, SP 6.4]**	Heitz and Giffen, Practicing Biology: A Student Workbook, Activity 43.1 **Web** "Are All Invasive Species Bad?"	**Instructional Activity:** Students work through activity 43.1 in the Heitz and Giffen workbook to explore models that scientists use to calculate population growth rates. Students apply the growth model $dN/dt=rN$ to several different populations and make predictions (with justification) regarding the effects of changes in populations. The students are self-guided in this activity, and I am the facilitator. **Formative Assessment:** Students create posters that illustrate the effect of a change in matter and energy availability in an ecosystem. Students are self-guided as they describe the trophic structure of the ecosystem and explain how organisms receive inputs of energy and nutrients, where outputs go, and the effects each organism has on the others. They include energy transformations and transfers based on the hypothetical assumption that 10,500 J of net energy is available at the producer level, and they determine the organisms that are placed in each trophic level. Students share their posters with the class for peer review. My role in this assessment is one of facilitator. **Instructional Activity:** Students are self-guided as they research how the oil spill in the Gulf of Mexico (April 20, 2010) affected marine life. Students extend learning to researching what effect the gulf spill had globally. Students report on the current forecast for marine life in the gulf as a result of the spill. I am the facilitator in this activity. **Instructional Activity:** Students are self-guided as they read and analyze the article, "Are All Invasive Species Bad?" (usnews.com). Students complete an article analysis and include a personal response to the article's claims. The teacher is the facilitator in this activity and provides a summary of the student analyses and personal responses. **Instructional Activity:** Students are self-guided as they research rubber as a Brazilian

		rainforest product and explain how it is harvested. Students make connections between the role of humans and the effect the rubber production business has had on the Amazon rainforest environment. I am the facilitator in this activity. **Instructional Activity:** Students are self-guided as they research the biology and natural history of the cougar, its status in the habitats of North America, and how cougars and humans interact. Through their research, students determine the best way to reconcile human land development with cougar survival. I am the facilitator in this activity.
Use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. **[LO 2.28, SP 1.4]** Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past**. [LO 4.20, SP 6.3]**	Campbell and Reece, Chapter 56: ”Conservation Biology and Restoration Ecology,” Waterman and Stanley, Biological Inquiry: A Workbook of Investigative Cases, “Back to the Bay,” pp. 106–118	**Instructional Activity:** Students recognize and explain (with justification) potential issues and major topics in the investigative case study “Back to the Bay.” In this student directed activity, students, after reading a hypothetical advertisement on gull distress calls, explore the behavior of gulls. Following their work on a series of activities and data analyses, students design an experiment to investigate the population growth in gulls and the impact of human activity on environmental conditions of Chesapeake Bay. Teachers act as facilitators in this activity.
Predict consequences of human actions on both local and global ecosystems. **[LO 4.21, SP 6.4]** Make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability. **[LO 4.27, SP 6.4]**	**Web** ”Investigative Case 8: Back to the Bay”	**Instructional Activity:** Working in small groups, students choose from a variety of ethical papers on gull and human interactions to explain the consequences of human actions on ecosystems. Students then form larger groups to debate predictions based on scientific claims about the interactions of gulls and humans in the San Diego area.
		Summative Assessment: Students take a 54-minute test containing 15 multiple-choice questions, two short-response questions, one math and one long free response. The two short-response questions are selected from ecological data, such as interpreting logistic or exponential predictions of growth patterns in given populations. The essay section asks students to select one of three questions.

Unit 7: Organism Form & Function--Estimated Time- 3 Weeks
Big Ideas 2, 3, & 4

Laboratory Investigations:

AP Biology Lab Manual (2001), Lab 10: Physiology of the Circulatory System, Exercise 10C: Heart Rate and Temperature (transitioned to a student directed lab activity)

Essential Questions/Connecting to Enduring Understandings Big Ideas 2, 3, & 4

(2.C.1) How do organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes?
(2.D.3) In what ways are biological systems affected by distributions to their dynamic homeostasis?
(2.D.2) How do homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments?
(4.B.2) How do cooperative interactions within organisms promote efficiency in the use of energy and matter?
(2.C.2) In what ways do organisms respond to changes in their external environments?
(2.E.2) In what ways are timing and coordination of physiological events regulated by multiple mechanisms?
(2.D.3) How are biological systems affected by distributions to their dynamic homeostasis?
(4.B.4) How does distribution of local and global ecosystems change over time?
(2.D.4) In what ways do plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis?
(3.E.2) How does the nervous system in animals detect external and internal signals, transmit and integrate information, and produce responses?

Learning Objectives	Materials	Instructional Activities & Assessments
Justify the 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 2.15, SP 6.1]** Connect how organisms use negative feedback to maintain their internal environments. **[LO 2.16, SP 7.2]** Evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms. **[LO 2.17, SP 5.3]** Make predictions about how organisms use negative feedback mechanisms to maintain their internal environments. **[LO 2.18, SP 6.4]** Make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models. **[LO 2.19, SP 6.4]**	Campbell Chapter 40: “Animal Form & Function” and Chapter 45: “Hormones and Endocrine Systems”	After reading and studying chapters 40 & 45, student pairs create a visual representation (e.g., a poster) that defines homeostasis, explains negative feedback mechanisms and positive feedback mechanisms with clear examples, and suggests evidence that would justify the examples. Students present their visual representations to the class and are required to defend their claims regarding homeostasis as other students pose questions following the presentations. This is a student directed, teacher-facilitated activity

Justify that positive feedback mechanisms amplify responses in organisms. **[LO 2.20, SP 6.1]**		
Use representation(s) or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. **[LO 2.28, SP 1.4]**	Campbell Chapter 42: "Circulation and Gas Exchange" *AP Biology Lab Manual* (2001), Lab 10: Physiology of the Circulatory System, Exercise 10C: Heart Rate and Temperature (transitioned to a student directed lab activity)	**Instructional Activity:** Through guided inquiry, students are led to an open-ended, student-directed investigation where they develop their own questions and design and conduct controlled experiments to test the effect of an environmental variable on the heart rate of *Daphnia magna*. The teacher is a facilitator in this activity. *Encourage some students with cell phone video access to capture videos of* Daphnia *projected on a screen (Video Flex connected to a microscope). Heartbeat data can be collected later by viewing and slowing down the video with computer technology. This type of differentiated instruction will motivate some of the more technologically advanced students.* **Formative Assessment:** Students are given sample data from an experiment that tests a hypothesis that caffeine will increase the heart rate in *Daphnia magna*. Students are expected to graph the data correctly, analyze data to identify patterns or relationships, and justify claims with the evidence as they form conclusions. I provide corrective and informative feedback via discussion on the assessment results.
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 2.25, SP 6.2]** Analyze data to identify phylogentic patterns or relationships, showing that homeostatic mechanisms reflect both continuity due to common ancestry and change due to evolution in different environments. **[LO 2.26, SP 5.1]** Connect differences in the environment with the evolution of homeostatic mechanisms. **[LO 2.27, SP 7.1]** Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter. **[LO 4.18, SP 1.4]**	Campbell Chapter 44: "Osmoregulation and Excretion" Campbell Chapter 42 : 918-920 "Respiratory Systems" **Web** "Homeostatic Evolution"	**Instructional Activity:** Students view "Homeostatic Evolution" before class. The video explains how the excretory system shows continuity through flatworms, earthworms, and vertebrates. It explains how the respiratory system shows change as organisms move onto land. Students prepare a poster presentation explaining how homeostasis reflects evolution through time. The presentation should explain homeostatic mechanisms and should include suggested experiments that would confirm principles learned. **Instructional Activity:** The "Homeostatic Evolution" posters are displayed in a gallery walk for peer and teacher review.

Connect how organisms use negative feedback to maintain their internal environments. **[LO 2.16, SP 7.2]** Evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback mechanisms. **[LO 2.17, SP 5.3]** Make predictions about how organisms use negative feedback mechanisms to maintain their internal environments. **[LO 2.18, SP 6.4]** Make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models. **[LO 2.19, SP 6.4]** Justify that positive feedback mechanisms amplify responses in organisms. **[LO 2.20, SP 6.1]**	Campbell and Reece, Chapter 39: "Plant Responses to Internal and External Signals"; Chapter 40: "Basic Principles of Animal Form and Function"; Chapter 45: "Hormones and the Endocrine System"; and Chapter 55: "Ecosystems"	**Instructional Activity:** Students create a diagram of an organism (of their choice) which shows how that organism maintains homeostasis. The diagram should include the control center, sensor, stimulus, effect, normal temperature, negative feedback, and positive feedback. Students' diagrams should include annotations that explain how organisms use negative feedback to maintain their internal environments. The students are self-directed in this activity, and I am the facilitator. **Instructional Activity:** Students are self-guided as they research a disease and explain (with justification) which body system the disease impacts as well as how it relates to homeostasis. The students should focus on the specific homeostatic mechanism that is affected by the disease. Students make predictions (with justification) regarding how pharmaceutical companies will need to design drugs that will fight the disease based on the negative feedback mechanisms the organism has. Students report their predictions and justification to the class. As facilitator, I provide a summary to the lesson. **Formative Assessment:** Students are assigned a body system (nervous, immune, or endocrine) to explain how the system helps to maintain homeostasis within the body. They write a short essay explaining (with justification) what role the system has in the homeostasis of the body. The essay should also include three examples of ways in which this system may be damaged.
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 2.21, SP 4.1]** Design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation**. [LO 2.35, SP 4.2]** Justify scientific claims with evidence to show how timing and coordination of	**Web** "PBS Animation"	**Instructional Activity:** After watching the PBS animation "How the Pill Works," students use note cards to explain and justify scientific claims that timing and coordination of certain events are necessary for normal development and are regulated by multiple mechanisms. This animation depicts how the menstrual cycle works and how it is affected by the contraceptive pill. Students complete a chart to represent the different hormones that are released with and

physiological events involve regulation. **[LO 2.36, SP 6.1]** Use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems. **[LO 2.28, SP 1.4]** Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past. **[LO 4.20, SP 6.3]** 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 2.26, SP 5.1]** Connect differences in the environment with the evolution of homeostatic mechanisms. **[LO 2.27, SP 7.1]**		without the pill. Students provide an explanation and justification for how the hormones in the pill can disrupt the dynamic homeostatic clock in a female reproductive system. The students are self-guided in this activity and I am the facilitator. **Instructional Activity:** Students choose two types of environmental disasters (e.g. hurricanes, floods, droughts, oil spills, earthquakes, tsunamis, disease epidemics) to explain how the distribution of changes in the ecosystem over time may affect changes in the future. Each student then makes a visual representation (e.g., poster) with annotation of one of those disasters, showing the before and after effects related to evolution. Students are self-guided, and I am the facilitator. **Instructional Activity:** Students research and analyze articles that include data on the effects of hormone replacement drugs. Students complete an article analysis focusing on the evaluation of collected data that supports the claim that timing and coordination of physiological events are regulated by multiple mechanisms. I guide the students as they review and evaluate the data in the articles. The research is self-guided for the student after I have provided research guidelines.
Create representations and models to describe immune responses. **[LO 2.29, SP 1.1, SP 1.2]** Create representations or models to describe nonspecific immune defenses in plants and animals. **[LO 2.30, SP 1.1, SP 1.2]** 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 3.43, SP 6.2, SP 7.1]** Describe how nervous systems detect external and internal signals. **[LO 3.44, SP 1.2]** Describe how nervous systems transmit information. **[LO 3.45, SP 1.2]**	Campbell and Reece, Chapter 39: “Plant Responses to Internal and External Signals”; Chapter 43: “The Immune System”; and Chapter 49: “Nervous Systems	**Instructional Activity:** Students create posters that describe the immune system. Each poster should show examples of how plants or animals use chemical defenses against infectious diseases. This lesson is student directed and facilitated by me. **Formative Assessment:** Students write a one-page response to the following statement: *A baby is born with its mother’s immune system.* After students complete their responses, I initiate a discussion by asking students to share those responses with the class. **Instructional Activity:**

Describe how the vertebrate brain integrates information to produce a response. **[LO 3.46, SP 1.2]** 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 3.47, SP 1.1]** Create a visual representation to describe how nervous systems detect external and internal signals. **[LO 3.48, SP 1.1]** Create a visual representation to describe how nervous systems transmit information. **[LO 3.49, SP 1.1]** Create a visual representation to describe how the vertebrate brain integrates information to produce a response. **[LO 3.50, SP 1.1]**	**Web** "A Bad Reaction: A Case Study in Immunology" ABO-Rh Blood Typing with Synthetic Blood Kit **Web** "Jumpin' the Gap"	"A Case Study in Immunology." Case involves the transfer of a food allergy to a patient who received a combined kidney and liver transplant from a donor who died as a result of an allergic reaction. Each group is assigned a research team to role-play. The team has been awarded a grant to cover costs of examining case histories of three patients. The goal is to make a diagnosis from these records and design a testable experiment that can be used to obtain future funding. This activity is student directed and teacher facilitated. **Formative Assessment:** Student teams each create a mini-poster display that depicts findings and plans for experimentation from the case study "A Bad Reaction: A Case Study in Immunology." Student work must explain, with justification, the roles of immune cells and cell signaling pathways that occur in the immune system. **Instructional Activity:** Students are self-guided as they use simulated blood and sera to investigate the relationship between antigens and antibodies. The students use ABO-Rh blood typing to describe a nonspecific immune defense found in the human body. I am the facilitator in this activity. **Instructional Activity:** Students role-play communication at the neural level by behaving as presynaptic vesicles, neurotransmitters, post-synaptic receptors, secondary messengers, and re-uptake transporters in the activity "Jumpin' the Gap." The first part is teacher directed. Then, students assume the direction of the role-playing by modifying the activity to illustrate the effects of drugs on the synapse (cocaine, methamphetamine, and ecstasy). **Instructional Activity:** Students work in small groups to design a teaching model of the nervous system to be used for patients in a doctor's office. In this activity, the students explain how the

		nervous system transmits information and how the brain integrates this information to produce a response. Students also create brochures that could be given to patients. The brochure explains (with justification) how the nervous system transmits information, how it detects external and internal signals, and how the brain integrates information to produce a response. This activity is student guided and facilitated by me.
		Summative Assessment: The students take a 54 minute assessment that consists of 15 multiple-choice questions, two short-response questions, one math and one long free-response question. The long free-response question is based on a scenario with data analysis covering homeostasis and regulatory mechanisms in biological systems (from cells to ecosystems).