# AP® Biology Syllabus

| Curricular Requirements | Page(s) |
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| **CR 1** Students and teachers use a recently published (within the last 10 years) college-level biology textbook. | 2 |
| **CR 2** The course is structured around the enduring understandings within the big ideas as described in the AP® Biology Curriculum Framework. | 2 |
| **CR3a** Students connect the enduring understandings within Big Idea 1 (the process of evolution drives the diversity and unity of life) to at least one other big idea. | 12, 13, 17 |
| **CR3b** Students connect the enduring understandings within Big Idea 2 (biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis) to at least one other big idea. | 5, 7, 8, 18 |
| **CR3c** Students connect the enduring understandings within Big Idea 3 (living systems store, retrieve, transmit, and respond to information essential to life processes) to at least one other big idea. | 11, 19 |
| **CR3d** Students connect the enduring understandings within Big Idea 4 (biological systems interact and these systems and their interactions possess complex properties) to at least one other big idea. | 17, 18, 21 |
| **CR4a** The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 1. | 12-16 |
| **CR4b** The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 2. | 7-9, 17, 20-22 |
| **CR4c** The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3. | 7-13, 20 |
| **CR4d** The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 4. | 35-6, 17, 21-23 |
| **CR5** The course provides students with opportunities to connect their biological and scientific knowledge to major social issues (e.g., concerns, technological advances, innovations) to help them become scientifically literate citizens. | 3, 11, 19, 23 |
| **CR6** The student-directed laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Biology Curriculum Framework and include at least two lab experiences in each of the four big ideas. | 2 |
| **CR7** Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent of instructional time. | 2 |
| **CR8** The course provides opportunities for students to develop and record evidence of their verbal, written and graphic communication skills through laboratory reports, summaries of literature or scientific investigations, and oral, written, or graphic presentations. | 3 |

**Course Overview**

This course introduces the concepts of modern biology, organized around four fundamental themes of cellular metabolic processes and energy use for growth and reproduction (Big Idea 2), the genetic basis of information storage and interpretation driving life processes and inheritance (Big Idea 3), the complexities of interactions at every level of biological organization from microscopic cells to ecologyical systems (Big Idea 4) and evolution as the underlying explanation for the diversity and similarities in all forms of living organisms (Big Idea 1) **[CR 2**]. Topics include the definition of a living organism; the molecular basis, metabolic functions, and structure of cells; the process of genetic inheritance in cell reproduction; the process of gene expression and manipulation; the production, storage, and release of energy through cellular respiration and photosynthesis; evidence for the current theory of evolution; the diversity and classification of living beings; plant and animal anatomy, physiology (with emphasis on human anatomy and physiology); animal behavior; ecology; and the responsibilities of the human community as stewards of the earth. **[CR 5]**

**Instructional Resources**

Students are required to obtain the following texts:

*Biology: Concepts and Connections*, Jane B. Reece, Martha R. Taylor, Eric J. Simon, Jean L. Dickey (for 2013-14, this will be the 7th edition, published 2011) with Open Access Study Area (http://wps.aw.com/bc_campbell_concepts_7_oa/215/55135/14114612.cw/-/t/index.html) support for animations, simulations, pre- and post- chapter quizzes. [Benjamin Cummings ISBN 03216986816.] **[CR 1]**

*Study Guide for Biology, Concepts and Connections*, Jane B. Reece, Martha R. Taylor, Eric J. Simon, Jean L. Dickey, Richard Liebaert, 7th edition (2011) [Benjamin Cummings.] **[CR 1]**

*Advanced Placement Biology Investigative Labs: An Inquiry-Based Approach*, current edition [AP Program: The College Board] **[CR 1]**

Recommended but not required texts:

*All Lab, No Lecture Illustrated Guide to Home Biology Experiments*, Robert Bruce Thompson and Barbara Fritchman Thompson (2012) [O'Reilly] **[CR 1]**

**Instructional Context**

Class meets twice a week for 38 weeks in online live chat sessions of 90 minutes each to discuss assigned text readings, web-hosted lecture materials, and study guide exercises. Sessions involve extensive use of Internet resources including simulations, pictures, diagrams, animations, short videos, and recent articles pertinent to the current topics. Chat logs are available as soon as chat ends for students who missed class or need to review discussions.

Students also attend a 60 minute live chat session weekly to discuss lab exercises and materials not discussed in the text, and to address skill and concept development in areas suggested by their performance in their homework or lab work. These quasi-tutorial sessions bridge the high-school-to-college gaps in their backgrounds and provide specific preparation for testing situations, including review of representative free-exercise questions from previous AP exams.

**Investigative Laboratory Component**

Students are required to obtain lab equipment to perform a minimum of 15 labs, spending 3-5 hours for each on lab setup, execution, and reporting, for a total commitment of 25% of their course time **[CR 7]**. Labs are selected from a bank of lab exercisesm, ten of which must be from the *Advanced Placement Biology Investigative Labs: An Inquiry-Based Approach 2010 edition* **[CR 6]**. Some of these have been adapted by the teacher for individual students working outside a school laboratory; students may also substitute appropriate labs from *All Lab, No Lecture Illustrated Guide to Home Biology Experiments*. This flexibility is necessary for students in different geographic locations and with different financial resources and access to equipment and supplies. Several labs require students to build their own equipment, helping them develop an understanding of the relationship between the measuring device and the quantity measured, as well as challenging their creative skills. Most are hands-on labs designed to develop specific skills (microscope use, slide preparation, field observation techniques) or demonstrate specific biological processes (osmosis, circulation through capillaries, DNA replication through models). Some labs make use of publicly available simulations or dry-lab data because students will not have access to equipment, or to an environment where student safety can be ensured. A series of field labs to be done in the same area throughout the year allows students to become familiar with field observation techniques and encourages students

to observe and "think like a scientist" even after the course ends. Students must complete and upload formal laboratory reports to a common bulletin board for teacher and peer review, and maintain a laboratory notebook as evidence of their work. Live-chat and asynchronous bulletin-board discussions of lab exercise processes, individual adaptations required by local conditions, and data analysis techniques allow students to develop skill in precisely communicating lab experiences, and to work together to identify successful strategies for current and subsequent laboratory work. Students gain additional experience in analyzing data and drawing conclusions using assigned simulation activities from the Lab Bench website, and through instruction in using spreadsheets such as Excel for data manipulation and presentation. **[CR 8]**.

Students prepare individual research proposals each semester in which they determine a narrow focus area for research and explain its importance, the methods and techniques necessary to gather and analyze data, and the range of conclusions possible based on their findings. Students are encouraged to choose a topic for which they have some personal passion or curiosity; as a result, this is an extremely popular assignment despite the work involved. They are not required to actually perform the proposed research, since equipment may not be available in their home situations, but they are required to demonstrate that they understand the nature of scientific investigation, including how to design a field observation or lab experiment with the necessary controls, identify the appropriate equipment to collect valid data, and determine what techniques should be used to analyze their data to determine supportable conclusions. **[CR 8]**

**Teaching Strategies**

All our school courses are designed to take advantage of our asynchronous environment and based on a “flipped classroom” approach. This course uses a Biology content site developed by the teacher and a Moodle course content delivery system, along with standard email, to support asynchronous access to course materials, including web-based lecture notes, course calendars and lecture schedule, quizzes, forums, and wikis. The latter two techniques allow students to enter materials at their own convenience and share their homework assignments and study notes with each other, supporting a cooperative learning environment. In the content site, along with general study aids, there is a homework assignment page for each chat session, with study notes for the day's reading assignment, a teacher-written web-based lecture that provides additional material and explains many concepts in more detail, and instructions for the lab associated with that unit.

Students are expected to demonstrate a high level of self-discipline and self-motivation in preparing for our limited discussion time. All preparation work (reading text, completing exercises in the study guide, posting assigned essays must be completed prior to chat sessions. In particular, materials normally presented by a teacher standing in front of a class and lecturing are presented instead as teacher-written web lectures, read at the student's own convenience. These may employ teacher-designed animations, or refer to animation and simulations on the web to better explain processes.

Live chat time is devoted to addressing students' questions, reviewing assignments posted to the class online forum, presenting supplementary materials (especially graphics, including web-based animations and simulations) or raising discussion topics suggested by the text, current events, or ongoing student concerns. **[CR 5, CR 8]**

Students are assigned individual weekly essays from topics suggested in the textbook and study guide, and essay exercises from past AP Exams. Students publish these essays the Moodle Biology forum for teacher and peer review, developing skills in communicating scientific concepts, supporting theses with detailed examples, and addressing controversial issues with respect for different points of view.

Evolution is presented as the theory which currently best explains or accommodates the most observed phenomena about living and once-living organisms. Students recognize that any competing theories must address with equal completenss and integration observed phenomena such as similarities in DNA, homologous structures, and account for differences that result in speciation. Since this course generally has students with a range of strongly-held opinions on evolution, each is encouraged to examine personal assumptions and identify key areas where he or she finds the presented evidence for evolution compelling or lacking, then determine whether that acceptance or objection rests on scientific principles, or on some other method or authority. Students come to understand why many modern scientists find the current interpretation better accounts for observed phenomena than the alternatives that have been presented, and are challenged to express their own positions clearly and with charity, in recognition of a common effort to find the truth.

Students are taught to view science as a complex human endeavor, and examine the benefits and limitations of current scientific methodologies. Supplemental historical, philosophical, and religious materials from books, articles, and current events are used to help students understand the interaction of scientific theories with human societies, especially where theories involve ethical and religious issues, as in the areas of genetics, origins of life, and ecology.

# AP Biology Syllabus with reference to Learning Objectives and Science Practices

| **Text Unit/ Chapters** | **Text / Lecture / Discussion Topics** | **Opportunities to achieve specific Learning Objectives using class discussion, Study Guide exercises, or selected AP Free Exercise questions. Not all assignments are listed here.** | **Coordinated Lab or Field Investigation** | **Big Idea, Enduring Understanding, Essential Learning** |
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| Introduction: 1 week | **Microbiology, Cells, Energy** | | | |
| None | **Introduction to Course**<br>• Course methods and expectations<br>• Online resources (Moodle, forum use, posting homework, quizzes, email)<br>• Textbook, study guide, online textbook companion site use | Sample Quiz, essay entry into courseware | Review of Lab requirements (Notebook, Safety) | |
| 1: 1-11 | **The Scientific Study of Living Things**<br>• Definitions of living things based on physiological, metabolic, biochemical, genetic, thermodynamic criteria<br>• Fundamental assumptions:<br>1. Common properties of living things (order, reproduction, growth, energy-based metabolism, response to stimuli, internal regulation, evolutionary adaptation); common and emergent properties)<br>2. Structure of cells allow organisms to gather, store, and use energy, and to create structures to store, transmit, and respond to information<br>3. Organisms exchange matter and energy with environment, sense and respond to environment changes<br>4. Evolution is the core principle used to explain diversity and unity of organic structures and processes<br>• Processes of science: observation, experiment, hypotheses, theories and laws<br>• Holistic vs. reductionism approaches<br>• How induction and deduction function in scientific methods | **Essay**: defining life characteristics, scientific processes.<br>**Class Exercise:** analyzing data from a rat maze experiment. | **Field Lab 1: Baseline, Late Summer**<br>*(Teacher-written lab)*<br>Students identify an outdoor area at least 10x10 meters to which they can return for subsequent labs at different periods throughout the year. They conduct a formal survey to:<br>• Identify species present using field guides.<br>• Count, map locations, and describe conditions of larger stationary plants for comparison with winter and spring conditions.<br>• Note locations of larger animals or insect colonies.<br>**Goals:** Establish baseline for continuing observations that will demonstrate the complexity and ambiguity inherent in field research, while acquainting students with the characteristics of specific plants and animals. Data from all field labs will be revisited during evolution/diversity and ecology units so that students can compare species, identify biomes, and use information in population studies.<br>**Report:** Students submit formal reports justifying selection of study area, tables of species identified and population estimates, along with scanned maps of area. | **BIG Ideas 1-4**<br>**CR 2:** Text, discussion relates all 4 Big Ideas to organization levels of biological entities |

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| UNIT 1: Chapters 2-7 (7 weeks) | **Microbiology, Cells, Energy** | | | **CR 2: Focus on Big Idea 2 and 4** Emphasis on Enduring Understandings 2A, 2B, 2C, 2D, 4A, 4B |
| 2: 1-9 | **Atoms and Molecules, Elements, Chemical Bonds**<br>• Elements, substances<br>• Protons, electrons, neutrons: atomic number, atomic weight, isotopes, ions<br>**Chemical Bonds**<br>• Electron shells: range of ionic to covalent bonds; hydrogen bonds<br>• Molecules: Isomers<br>• Moles, gram weight | **Homework:** Students create diagrams of molecules, identifying bonding electrons and bond type. *[**CR4b**: LO 2.9; **CR4d**: LO 4.1, 4.3]* | **Properties of Water** *(Teacher Written Lab)*<br>Students directly observe and measure properties of water discussed in the text. All three sections must be completed.<br>1. Students heat measured amounts of water to boiling, noting temperature changes in centigrade as periodic measurements.<br>2. Students float a needle on water surface and add measured amounts of detergent to observe how water cohesion breaks down.<br>3. Students devise an experiment to measure surface tension as a function of surface area required to support masses<br>**Goals:** Students learn to handle hot lab equipment safely, to measure temperature with centigrade thermometers, to graph data and interpret implications of steepness of slope, to understand the difference between heat used for temperature increase and heat used to accomplish phase change.<br>**Report:** Students submit minimal reports (no description of procedure) with tables and graphs of data for part 1, and formal reports for their self-devised experiments to measure surface tension. Students pool data in estimating surface tension as a function of mass/unit area. | **EU 2A**<br>**2.A.3**<br><br>**EU 4.A**<br>**4.A.1**<br>**4.A.2**<br><br>**EU 4.B**<br>**4.B.1**<br><br>**CR3b: 2A to 4B** |
| 2: 11-16 | **The Special Properties of Water**<br>• Polar covalent molecules, bent shape of water<br>• Hydrogen bonds cause high boiling point<br>• Density of ice: implications for cells, bodies of water<br>• Solutions: solvents and solutes<br>• Acids and bases; pH (review of logarithms)<br>• Chemical reactions: conservation of mass, activation energy | **AP Free Exercise:** Discuss three properties of water and their implications for life processes and viability. *[**CR4b**: LO 2.9, **CR4d** 4.22]* | | **EU 4.A**<br>**4.A.1**<br>**4.A.2**<br><br>**EU 4.B**<br>**4.B.1** |

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| 3: 1-6 | **Organic Compounds: General Concepts, Functional Groups**<br>• Special properties of carbon<br>• Organic molecules classed by functional groups<br>• Monomers in dehydration synthesis and hydrolysis reactions<br>**Organic Compounds: Carbohydrates**<br>• Starch, glycogen, cellulose<br>• Hydrophobic/hydrophilic properties of lipids<br>• Saturated/unsaturated hydrocarbon chains | **Class Exercise:** Students view and discuss animation of dehydration synthesis and hydrolysis between functional groups. [***CR4d**: LO 4.1, 4.2, 4.3*] | **Microscope Basics** *(Teacher-written Lab, based on Lab Topic #4, Laboratory Investigations, by Jean Dickey)*<br>Students use a light microscope with multiple objectives. They must identify the parts of the microscope and using a prepared slide or one they have made,<br>• Adjust focus properly, and compare magnifications, sample orientation in field of view with position on slide, and light amounts for each objective<br>• Use a ruler to determine field of view and estimate the size of at least six sample objects.<br>**Goals:** Students learn basic microscope skills required for this and subsequent courses.<br>**Report:** Students answer questions identifying the microscope they used and its objectives, field of view, and resolving power. Data for sample sizes observed is presented in tables so that students can compare their own work with that of other students. | **EU 4.A**<br>**4.A.1**<br>**4.A.2**<br><br>**EU 4.B**<br>**4.B.1** |
| 3: 7-16 | **Organic Compounds: Lipids**<br>• Phospholipids, waxes, steroids<br>• Health issues of steroid use<br>**Organic Compounds: Proteins**<br>• Amino acid structure: Polar, non-polar, and ionic. Left and right forms<br>• Peptide chain formation using ester bonds<br>• Protein structural levels, primary through quaternary<br>• Denaturing proteins<br>**Organic Compounds: Nucleic Acids**<br>• DNA and RNA component overview: phosphate, ribose, nucleotide base<br>• Information content and transmission | **AP Free Exercise:** Describe three types of chemical bonds or interactions found in proteins and the role of each in protein structure. [***CR4d**: LO 4.9, 4.10, 4.11* ] | **Microscope Slide Preparation** *(Teacher-written lab)*<br>Students continue to develop microscope skills with particular attention to slide preparation by<br>• Making dry and wet mount slides and comparing light transmission and clarity<br>• Making micrometer and using it to make thin-slice cross-sections of onion root tips.<br>• Using a staining kit or dilute iodine to stain onion root tips, other plant samples, and insect parts (e.g. wings) if available from their field area.<br>**Goals:** Develop slide-making skills and produce slides necessary for mitosis/ meiosis lab.<br>**Report:** Students describe processes used for staining samples and their resulting slides for comparison. They evaluate different stains for effectiveness in highlighting various parts of their samples, and recommend the best stain for a particular observation. | **EU 4.A**<br>**4.A.1**<br>**4.A.2**<br><br>**EU 4.B**<br>**4.B.1** |

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| 4: 1-12 | **Cells: Basic Structure and Size**<br>• Methods of observing cell properties<br>• Historical background: Boyle, Shawn, Vichrow<br>• Advantages/disadvantages of light, scanning, transmitting electron microscopes<br>• Surface-to-volume limitations<br>**Cells: Membranes and Components**<br>• Cell Components: structure and function (Prokaryotic vs. eukaryotic comparison & plant/animal comparison)<br>• Nucleic materials (nucleus, nucleolus, chromatin, information content: DNA, RNA; ribosome replication)<br>• Endomembrane system: endoplasmic reticulum, ribosomes, lysosomes, vacuoles, Golgi bodies | **Text-based essays and class exercise:** surface-to-volume ratio calculations. [***CR4b**: LO 2.6, 2.7*] | **Osmosis** *(2012 AP Lab #4 or alternate lab for home students)*<br>Students perform AP Lab #4 with the following alternatives (since students must prepare their own solutions):<br>• If IKI is not available, students use a dilute iodine solution prepared as directed by the teacher.<br>• If glucose is not available, students prepare a cornstarch-only solution as directed by the teacher.<br>• Students may use balloons, cellophane or sausage casings if dialysis tubing is not available.<br>• Students use Testape supplied by the teacher.<br>• Students may need to build their own balance in order to accurately measure mass of potato core.<br>**Goals:** Enhanced mastery of the principles of osmosis and diffusion through direct observation and measurement of the phenomena. Use of indicator to detect presence of specific molecules.<br>**Report:** Students complete the AP lab manual worksheets and upload data for joint analysis and determination of osmolarity and osmotic potential. | **EU 2.A**<br>**2.A.1**<br>**2.A.2**<br>**2.A.3**<br><br>**EU 4.C**<br>**4.C.1**<br><br>**CR3b: 2A to 4C**<br><br>**LAB:** LO 2.6-7, 2.10-12. SP 2.1, 2.2, 4.2-4.4, 5.1-5.3 |
| 4: 13-22 | **Cells: Energy conversion, Cell surfaces**<br>• Double-Membrane structures<br>• Energy converting organelles: mitochondria and chloroplasts<br>• Cell stability: Microfilaments, microtubules<br>• Cell mobility: Flagella and cilia<br>• Cell connectivity: Anchoring cell to cell: anchoring, tight junctions, transmitting materials: plasmodesmata, gap junctions | **AP Free Exercise (modified)** Using appropriate graphics from the web or text, identify three macromolecules that are components of the plasma membrane and explain the function of each. [***CR4b**: LO 2.10, 2.13, 2.14; **CR4d** 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10*] | | **EU 2.A**<br>**2.A.1**<br><br>**EU 3.D**<br>**3.D.2**<br><br>**CR3b: 2A to 3D** |
| 5:1-9 | **Cell Membranes Structure and Function**<br>• Plasma membrane composition: phospholipid bilayer (hydrophilic/ hydrophobic properties), embedded proteins, glycogens, markers - Transport across membranes: diffusion and osmosis, concentration gradients; passive transport; active transport, exocytosis and endocytosis | **AP Free Exercise:** Graph and interpret data of sucrose molarity and percent change in mass to determine osmolarity and water potential. [***CR4b**: LO 2.10, 2.11, 2.12; **SP 5***] | **Enzymes** *(2012 AP Lab #13 or Virtual lab adapted for home students)*<br>Because the chemicals required for this lab are not easily available for individual students and require careful handling, students perform the virtual lab at<br>http://bioweb.wku.edu/courses/Biol114/enzyme/enzyme1.asp | **EU 2.B**<br>**2.B.1**<br>**2.B.2**<br>**2.B.3**<br><br>**LAB:** LO 2.2, 2.3, 4.3, 4.17. SP 5.1, 6.1,6.4,7.4 |

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| 5: 10-16 | **Basic Concepts of free energy; Enzyme Functions**<br>• Laws of Thermodynamics: Kinetic vs. potential energy, conservation of energy, open/closed/isolated systems, Gibbs free energy, entropy<br>• Activation energy, endergonic and exergonic reactions and coupled reactions<br>• ATP as energy storage molecule; Phosphorylation<br>• Enzymes: function (lock and key modeled<br>• Enzyme disruption (denaturing proteins): heat, acidity<br>• Enzyme disruption and inhibition | **AP Free Exercise:** Graph temperature and respiration rate (determined by bubbles per minute) to determine optimal temperature for yeast metabolism. Design a follow-on experiment to determine effects of pH changes to yeast environments. *[**CR4b**: LO 2.15, 2.16, 2.17,2.18, 2.19, 2.20; LO 2.22, 2.23, 2.24; **CR4d**: LO 4.17; **SP 5.1**]* | Students discuss the lab setup in live chat and we work through a sample together before they perform the lab on their own.<br>**Goals:** Familiarity with enzyme activity by direct observation; experience with experimental setup for comparison of concentrations.<br>**Report:** Answers to the online lab using a form similar to that at<br>http://www.biologycorner.com/bio3/enzymelab_web.html | **EU 2.C**<br>**2.C.1**<br>**2.C.2**<br><br>**EU 2.D**<br>**2.D.3**<br><br>**EU 4.B**<br>**4.B.2**<br><br>**CR3b: 2A to 4B** |
| 6: 1-6 | **Cellular Respiration: Overview and Glycolysis**<br>• Cellular dependence on ATP production<br>• Characteristics of oxidation/reduction reactions<br>• Overview: Glycolysis, Citric Acid Cycle, Oxidative Phosphorylation (Chemiosmosis/Electron Transport)<br>• Structure of mitochondria<br>• Glycolysis steps, enzyme dependencies | **AP Free Exercise:** Discuss the structure and production levels of ATP in glycolysis, the Krebs cycle, and chemiosmosis, and the use of ATP in at least two specific cell processes. *[**CR4b**: LO 2.4, 2.5; **CR4d**: LO 4.17, 4.18]* | **Respiration** *(2012 AP Lab #6 or Teacher-written lab based on Lab Topic #6, Laboratory Investigations by Jean Dickey adapted to home students)*<br>Since students may not have access to KOH for Lab #5, this experiment provides a similar experience in measuring volumes of gas produced by fermentation and cellular respirations. Students measure volumes of<br>1. $CO_2$ generated by yeast in different concentrations of dextrose solutions (corn syrup) as indicators of fermentation activity.<br>2. $O_2$ generated by elodea in different light situations to determine dependence of<br>**Goals:** Direct observation of cellular respiration and fermentation processes. Experience in gas-production reaction lab techniques.<br>**Report:** Students complete a worksheet recording data and compare results for different concentrations and light levels, ultimately producing a joint formal report. | **EU 2.A**<br>**2.A.3**<br><br>**LAB:** LO 1.15-1.16; 2.2, 2.4, 2.14, 4.5, 4.14. SP 1.4, 2.2, 3.1, 6.1, 7.2 |
| 6: 7-16 | **Cellular Respiration: Krebs (citric acid) cycle, Chemiosmosis**<br>• $NADH$, $FADH_2$ production<br>• Oxidative phosphorylation<br>• Energy harvest in the electron transport chain<br>**Fermentation**<br>• Advantages/disadvantages of lactic acid fermentation<br>• Evidence for glycolysis in early life forms<br>• Alternate metabolic pathways for respiration activities | **Study Guide Exercise:** Label stages of cellular respiration and identify location of each process. Label diagram depicting oxidative phosphorylation and identify total ATP output from each process. *[**CR4b**: LO 2.8, 2.9, 2.10, 2.11]* | | **EU 2.A**<br>**2.A.3** |
| 7: 1-9 | **Photosynthesis: Light Reactions**<br>• Review of electron orbital structure, energy transitions, light absorption/emission<br>• Oxidation/reduction reactions<br>• Structure of pigments, chlorophyll (beta-carotene)<br>• Structure of chloroplasts (mesophyll, chloroplast, thylakoid, stroma, granum)<br>• Photosystems I & II: photophosphorylation | **AP Free Exercise:** Explain how paper chromotography can be used to separate pigments based on chemical and physical properties, and discuss the role of pigments in capturing light energy. Use solvent line height to determining the $R_f$ value of a given pigment. *[**CR4b**: LO 2.4, 2.5; **CR4d**: LO 4.6, 4.10]* | **Photosynthesis** *(2012 AP Lab #5 or Teacher-written lab based on 2002 AP Lab #12 adapted for home students)*<br><br>**Goals**: Measure oxygen productivity in an aquatic system and the effect of light on photosynthesis using either the Winkler | **EU 2.A**<br>**2.A.2**<br>**2.A.3**<br><br>**LAB:** LO 1.15-1.16, 2.2, 2.4, 2.14, 4.5, 4.14. SP 1.4, 2.2, 3.1, 6.1, 6.2, 7.2 |

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| 7: 10-14 | **Photosynthesis: Dark Reactions**<br>• Calvin cycle steps, related enzymes; chemiosmosis ATP yield<br>• Carbon fixation in glucose synthesis<br>• CAM, C4 reactions<br>• Comparison of photosynthesis with cellular respiration<br>• Energy source for ecosystems; influence on global climate, ozone | **AP Free Exercise:** Discuss temperature, soil composition, and annual precipitation limits on plant productivity in deserts. Using graphed data, explain anatomical and physical differences in the carbon dioxide uptake of two plant species over a 24 hour period. [***CR4b**: LO 2.9, 2.10, 2.11*] | photosynthesis using either the Winkler method or other common indicators of dissolved oxygen.<br><br>**Report**: Completion of AP Lab Manual worksheet and presentation of data for comparison | **EU 2.A**<br>**2.A.2** |
| **Unit 2: Chapters 8-12 (5 weeks)** | **Genetic Information: Inheritance, Reproduction, Expression** | | | **CR 2: Focus on Big Idea 3**<br>Emphasis on Enduring Understandings 3A, 3B, 3C |
| 8: 1-10 | **Cellular Reproduction: Mitosis**<br>• Asexual vs. sexual reproduction: genetic diversity<br>• Prokaryotic reproduction (binary fission)<br>• Cellular life cycle<br>• Mitosis stages (interphase, prophase, pro-metaphase, metaphase, anaphase, telophase & cytokinesis) | **AP Free Exercise:** Describe the phases of the cell cycle, and explain the role of the following in mitosis or cytokinesis: kinetochores, microtubules, motor proteins, actin filaments. [***CR4c**: LO 3.3, 3.7, 3.8, 3.9*] | **Mitosis and Meiosis** *(2012 AP Lab #7 adapted for home)*<br>Students examine slides previously prepared during Microscope Slide Preparation lab or photographs available online to examine onion root tips for meiosis. The exercise at<br>http://www.biology.arizona.edu/cell_bio/activities /cell_cycle/31i.html reinforces concepts for classifying onion root tip cells. | **EU 3.A**<br>**3.A.2**<br><br>**LAB:** LO 3.7-3.12, 3.28 SP 1.2, 5.3, 6.2, 6.3, 6.4, 7.1 |
| 8: 11-23 | **Cellular Reproduction: Meiosis**<br>• Haploid vs. diploid cells<br>• Crossing-over leads to genetic diversity<br>• Mapping chromosomes (karyotypes)<br>• Chromosomal defects: polyploidy, monosomy; trisomy in human populations; autosomal vs. sex chromosome defects | **AP Free Exercise:** Describe the structure and function of a eukaryotic chromosome; compare it to prokaryotic chromosomes. Discuss the adaptive significance of organizing genes in chromosomes. [***CR4c**: LO 3.6, 3.10, 3.11, 3.12*] | • Students simulate meiosis using a "kit" of jelly beans and toothpicks.<br>• Students analyze simulated data provided by the teacher of a Sordaria crossover to complete the lab.<br><br>**Goals:** Direct observation of chromosome duplication and separation during meiosis stages in cells.<br><br>**Report:** Students complete the AP laboratory worksheets and present data for comparison with results recorded by other students. | **EU 3.A**<br>**3.A.2**<br>**3.A.3**<br><br>**EU 3.C**<br>**3.C.1**<br>**3.C.2** |
| 9: 1-10 | **Mendelian Genetics**<br>• Mendel's techniques: generation notation, cross-fertilization, self-fertilization; law of independent assortment<br>• Allele: heterozygous/homozygous genes; simple traits, dominant/recessive alleles<br>• Statistics of gene combination/permutations; Punnett squares<br>• Pedigree chart creation | **Set of 9 Text-based exercises** requiring application of Mendelian inheritance laws to specific situations. [***CR4c**: LO 3.63.14, 3.15, 3.24*] | **Field Lab 2: Fall** *(Teacher-written lab)*<br>Revisit field area for fall observations.<br>• Describe condition of previously catalogued plants, noting changes in appearance, particularly if species are deciduous or gymnosperms.<br>• Identify any new species not previously noted.<br>• Record changes in the bird | **EU 3.A**<br>**3.A.3**<br>**3.A.4** |

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| 9: 11-23 | **Complex traits**<br>• Multiple alleles, gene: trait ratios, polygenic inheritance, incomplete dominance, codominance<br>• Linked genes, gene mapping, sex chromosomes (and defects)<br>• Inherited defects: recessive/ dominant disorders in humans<br>• Ethical issues of genetic testing | **AP Free Exercise:** Chi-squared analysis of fruit flies eye/wing color frequencies.<br>[***CR4c**: LO 3.6, 3.13, 3.16, 3.17, 3.26*] | Record changes in the bird population.<br>• Record changes in the fungi population.<br>• Look for moth casings, spiders, and other insects active in the fall.<br>• Collect pollen or other specimen for viewing under microscope.<br>**Goals:** Observe changes in deciduous plant life (if any).<br>**Report:** Formal report on area with updated tables noting changes to previously catalogued specimens and additional species observed and drawing or description of specimen viewed under microscope. | **EU 3.A**<br>**3.A.3**<br>**3.A.4** |
| 10: 1-16 | **DNA Structure**<br>• Historical evidence for gene: trait relationships, DNA (Garrod, Beadle/ Tatum, Griffith, Hershey/Chase, Franklin/Wilkins, Watson/Crick)<br>• Phosphate, ribose, nucleotides (thymine, cytosine, adenine, guanine)<br>• Pairing restrictions: compare pyrimidine and purine sizes, number of H-bonds<br>• DNA replication<br>• DNA transcription to mRNA codons | **AP Free Exercise:** Explain how a single base-pair mutant in DNA can alter the structure and function of a protein. Explain the potential consequences of the production of a mutant protein to the structure and function of the cells of an organism.<br>[***CR4c**: LO 3.3.1, 3.2, 3.3*] | **DNA Sequencing** *(2012 AP Lab #3 or Teacher-written lab adapted forhome students)*<br>Students model DNA replication and RNA transcription.<br>• Identify DNA and RNA subcomponents and assign representative "beads" (jelly beans) to each DNA, RNA nucleotide and to each amino acid.<br>• Construct a DNA sequence of at least 100 nucleotides and explain how the model simulates it.<br>• Separate the DNA strands and correctly create duplicated strands.<br>• Separate the DNA strands and correctly create mRNA "copy".<br>• Create peptide sequences as dictated by mRNA.<br>**Goals:** Direct experience with the steps involved in replicating and translating DNA.<br>**Report:** Descriptions, diagrams, or photographs of individual models are uploaded to the site for comparison with work by other students. | **EU 3.A**<br>**3.A.1** |
| 10: 17-23 | **RNA translation and protein fabrication**<br>• Endoplasmic reticulum/ribosome combination<br>• Information flow from DNA to protein; control points; mutations (mis-sense, nonsense, frameshift)<br>• Viruses: DNA, hosts, disease vectors | **AP Free Exercise:** Essay on protein synthesis explaining transcription and translation, and post-translation changes to proteins.<br>[***CR4c**: LO 3.6, 3.18, 3.20, 3.21, 3.26*] | | **EU 3.B**<br>**3.B.2**<br><br>**EU 3.C**<br>**3.C.3** |

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| 11: 1-11 | **Gene Regulation** -Prokaryotic gene expression (lactose enzyme operon) - Eukaryotic gene expression: constitutive/inducible/repressible; specialization, DNA packing; promoter/activators<br>• Differentiation: chromosome deactivation of X in humans<br>• Transcription/translation mechanisms, RNA splicing, intron and entron replication | **AP Free Exercise:** Discuss two mechanisms of protein regulation in eukaryotic cells as examples of positive and negative feedback mechanisms. [***CR4b**: LO 2.19, 2.20; **CR4c:** LO 3.4, 3.18, 3.19, .20, 3.21, 3.25*] | **Bacteria Cultures** *(2012 AP Lab #8 or Teacher-written lab adapted for home students)*<br>This lab allows students gain skills in sterilization and inoculation techniques using agar or gelatin media without undue exposure to dangerous strains. Students will<br>• Collect organic samples from various locations in the home.<br>• Prepare and inoculate agar or gelatin-based media with samples.<br>• Culture samples in different conditions of light and temperature.<br>• Identify bacterial and fungal colonies.<br>• Determine rate of growth of colonies.<br>• Identify and count baseline of colonies of bacteria from known sources and clone colonies.<br>**Goals:** Develop lab and safety techniques in handling bacteria samples.<br>**Report:** Formal report including lab setup, procedures, data from labelled bacterial colonies cultured in different conditions. Students compare results and identify strategies for successful bacterial colony generation. | **EU 3.B**<br>**3.B.1**<br><br>**EU 3.D**<br>**3.D.1**<br>**3.D.2**<br><br>**LAB:** LO 1.5, 3.5, 3.6, 3.13 , 3.21. SP 1.4, 3.1, 6.2, 6.4, 7.1, 7.2 |
| 11: 12-19 | **Genetic Regulation**<br>• Cloning, stem cell research: methods and issues<br>• Cell differentiation: signal transduction, homeotic genes<br>• Cancer: somatic cell mutations, oncogenes, carcinogens | **AP Free Exercise:** Describe the role of each component listed in the flow of genetic information from DNA to protein in eukaryotic cells: RNA polymerase, snRNP, codons, ribosomes, tRNA. [***CR4b**: LO 2.15-2.21, 2.31-2.33; **CR4c:** LO 3.22, 3.23, 3.25, 3.31-3.33, 3.36-3.39*] | | **EU 3.B**<br>**3.B.2**<br><br>**EU 3.D**<br>**3.D.2**<br>**3.D.3**<br><br>**EU 4.C**<br>**4.C.1**<br><br>**CR3c: 3B to 4C** |
| 12: 1-10 | **Gene Technology**<br>• Recombinant DNA techniques: Restriction enzymes, plasmids, virus/ bacterial vectors<br>• Genomic libraries, reverse transcriptase, cDNA<br>• Pharmaceutical applications<br>• Ethical issues of gene modification | **Class discussion and essay assignments:** Discuss the advantages and disadvantages, along with the ethical issues, of gene modification for one of the following cases:<br>• gene therapy for Huntington's Disease<br>• gene substitution for viral immunities in food crops<br>• gene substitution for growth hormones in animals<br>[***CR4c:** LO 3.5, 3.29, 3.30; **CR5***] | **Bacterial Identification Lab** *(Virtual lab)*<br>Students use a publicly accessible simulation at http://www.hhmi.org/biointeractive/vlabs/ to model the processes required for bacterial identification. While different in intent, this lab uses most of the techniques and skills required for AP Biology Lab #6. Students<br>• follow directed steps to isolate a blood sample and extract the bacterial DNA<br>• clone DNA using PCR methods<br>• sequence the DNA using gel electrophoresis<br>• analyze the data and identify the bacteria<br>**Goals:** Students gain understanding and skills in gene technologies, including use | **EU 3.C**<br>**3.C.3** |

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| 12: 11-21 | **Gene Technology**<br>• Gel Electrophoresis, polymerase chain reaction<br>• DNA Profiling<br>• Human Genome project results: non-coding sequences, level of complexity<br>• Ethical issues: ownership of genetic sequences; use of genetically modified organisms | **AP Free Exercise:** Create a restriction map of a bacterial plasmid using gel electrophoresis data. [***CR4c:*** *LO 3.5*] | of equipment they otherwise would not have available.<br>**Report:** Students log responses and results, and upload data and analysis for comparison with other students' work. | **EU 3.A**<br>**3.A.1** |
| Unit 3: Chapters 13-15 (3 weeks) | **Evolution** | | | **CR 2: Focus on Big Idea 1**<br>Emphasis on Enduring Understandings 1A, 1B, 1C, 1D 4B |
| 13: 1-10 | **Introduction to Evolution**<br>• Historical roots in Anaximander, Aristotle, Buffon, Lamarck, Lyell<br>• Darwin's explorations and observation<br>• Concept of natural selection; comparison with Lamarck<br>• Evidence: fossils, biogeography, comparative anatomy and embryology, DNA sequences and chemical composition of amino acids<br>• Population basis of evolution: gene pool changes, Hardy-Weinberg equation | **Class exercise:** Hardy Weinberg scenario. [***CR4a****: LO 1.1, 1.3, 1.6, 1.7*] | **Mathematical Modeling - Population Genetics**<br>*(2012 Lab #2 or Teacher-written alternative based on 2002 AP Lab #8 )*<br>Students use supplies provided by the teacher to administer the taste tests to relatives. This lab is usually scheduled for Christmas vacation to increase access to student families. Students may be assigned to work in pairs. Simulated data may be presented to increase opportunities for data modeling.<br>**Goals:** To use the Hardy-Winberg law of genetic equilibrium by studying allele frequencies in the class population.<br>**Report:** Students complete the AP Lab Manual worksheet and upload their data for discussion. | **EU 1.A**<br>**1.A.1**<br>**LAB:** 1.1, 1.2, 1.4, 1.6, 1.7, 1.25, 1.26. SP 1.2, 1.4, 1.5, 2.1, 2.2 |
| 13: 11-17 | **Mechanisms of Microevolution**<br>• Decreasing variation: genetic drift (bottleneck effect, founder effect), gene flow, extinction of species<br>• Increasing variation: mutation, sexual recombination (meiosis), diploidy, heterozygous advantage<br>• Natural selection: stabilizing, directional, disruptive; limited to existing alleles | **AP Free Exercise:** Essay on preserving the diversity of living things, identifying mechanisms as increasing or decreasing diversity [***CR3a****: Connects EU 1A to EU 4B;* ***CR4a****: LO 1.2, 1.3, 1.4, 1.5, 1.8, 1.22.* ***CR4c:*** *3.27, 3.28*] | | **EU 1.A**<br>**1.A.2**<br>**1.A.3**<br>**EU 4.B**<br>**CR3a: 1A to 4B** |
| 14: 1-11 (All) | **Origin of species: macroevolution**<br>• Definition of term ""species""<br>• Reproductive barriers - pre-zygotic (temporal, geographical behavioral, mechanical, gametic) & post-zygotic (hybrid inviability, sterility, breakdown)<br>• Examples of geographic isolation leading to behavioral isolation: allopatric and sympatric speciation<br>• Models of speciation: rate-related (gradualism vs. punctuated equilibrium), trend-related [but not goal-driven] (e.g., increasing size) | **AP Free Exercise:** Using specific examples, describe asexual and sexual reproduction. Explain three ways that sexual reproduction increases genetic variability and diversity in offspring. Discuss and give examples of two prezygotic isolating mechanisms that prevent hybridization between two species. [***CR4a:*** *LO 1.20-1.26;* ***CR4c:*** *LO 3.9, 3.10*] | | **EU 1.C**<br>**1.C.1**<br>**1.C.2**<br>**1.C.3**<br>**EU 3.A**<br>**3.A.1**<br>**CR3a: 1C to 3A** |

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| 15: 1-13 | **Origin of Life**<br>• Miller-Urey (amino acids)<br>• Sidney Fox (polymers)<br>• RNA synthesis<br>• protobionts.<br>Prokaryotes:<br>• fossil evidence<br><br>**Evidence for Macroevolution; use in classification**<br>• Fossil records, continental drift, mass extinctions | **AP Free Exercise:** Identify examples of homologous features (structural, molecular, developmental, physiological, or behavioral) used to support claims that a) chloroplasts are related to photosynthetic prokaryotes; b) spiders and insects are closely related; c) echinoderms are related to chordates; d) reptiles and birds are closely related, and e) humans and chimpanzees are closely related. *[**CR4a**: LO 1.9, 1.10, 1.11, 1.12, 1.20-1.26; **CR4d**: LO 4.20 ]* | **Field Lab 3: Winter** *(Teacher-written lab)*<br>Students return to their field area for winter survey activities, and<br>• complete a new survey, comparing conditions of prior catalogued species and individuals with current conditions, noting in particular loss of leaves, and pre-spring buds on plants<br>• identify new species<br>• identify missing species (with special attention to fungi, bird, insect, and amphibian species)<br>• collect specimen and view under microscope. | **EU 1.D**<br>**1.D.1**<br>**1.D.2**<br>**EU 1.A**<br>**1.A.4**<br>**EU 4.B**<br>**4.B.4**<br>**EU 4.C**<br>**4.C.2**<br><br>**CR3a: 1A,D to 4B, 4C** |
| 15: 14-19 | **Phylogeny**<br>• Phylogeny and cladistics: homologous and analogous structures, systematics and classification, use of DNA sequencing | **AP Free Exercise:** Use amino acid differences in cytochrome c [or the presence of specific DNA sequences] to create a phylogenetic tree for the listed species using the principle of parsimony; explain the relationships and identify which animals are most closely related. Compare the strength of two types of evidence (other than the comparison of proteins) that can be used to determine the phylogeny of a set of organisms.<br>**Study Guide Exercise** to identify key chemical reactions required for formation of amino acids, RNA/DNA, and protcells structure. *[**CR4a**: LO 1.13, 1.14, 1.15, 1.17, 1.18, 1.19]* | **Goals:** Collect data for ecology evaluation as part of final unit.<br>**Report:** Formal report on area with updated tables noting changes to previously catalogued specimens and additional species observed and drawing or description of specimen viewed under microscope. | **EU 1.B**<br>**1.B.1**<br>**1.B.2**<br><br>**EU 3.A**<br>**3.A.1**<br><br>**CR3a: 1B to 3A** |
| Unit 4: Chapters 16-19 (4 weeks) | **Evolution of Biological Diversity** | | | **CR 2: Focus on Big Idea 1**<br>Emphasis on Enduring Understandings 1B, 1C |

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| 16: 1-12 | **Single Cell organisms:** Prokayrotic cells: bacteria and archaea, cell structures, bacteria-caused diseases | **AP Free Exercise:** Essay assignment to discuss the organization of genetic material in prokaryotes and eukaryotes. [***CR4a**: LO 1.16, 1.17*] | **Pond Water Examination** *(Teacher-written lab)* Students collect water samples from multiple sites. Using microscope techniques developed in earlier labs, students<br>• count organisms and determine populations<br>• observe and note differences in protist forms<br>• estimate size of individual species observed<br>• (optional) test water for quality<br>**Goals:** Direct observation of protist types discussed in text and development of skills in handling possibly polluted water samples safely.<br>**Report:** Formal report including description of sites used for collection, number of species involved, drawings of at least two specimens observed with identifications based on characteristics. If water tests were done, students should correlate protist populations with water quality. | **EU 1.B**<br>**1.B.1** |
| 16: 13-21 | **Single Cell organisms:** Eukaryotic cell structures: membranes, endosymbiosis origins of nucleus, mitochondria, chloroplasts. Protists: algae, protozoans, slime molds and reclassification by DNA sequences: flagellates, alveolates, stramenopiles | **Class Exercise:** Discuss changes in criteria used to classify prokayrotic and eukaryotic orginsms. [***CR4c**: LO 3.27*] | | **EU 1.B**<br>**1.B.1**<br><br>**EU 1.C**<br>**1.C.3** |
| 17: 1-13 | **Plants**<br>• General characteristics: haploid/ diploid generations alternate<br>• Mosses, ferns, gymnosperms<br>• Angiosperms: seed and fruit structures, successful competition, possible coevolution with animals | **AP Free Exercise:** Discuss reproductive structures found in mosses, gymnosperms and angiosperms and explain the adaptive significance of each as a limiting or success factor. [***CR4d**: LO 4.23-4.25*] | **Artificial Selection** *(2012 AP Lab #1) Students prepare plants and make initial observations.*<br><br>*Students prepare plants for growth. Students electing not to complete this lab perform Field lab #5 instead at a later date.* | **EU 1.B**<br>**1.B.1**<br><br>**LAB:** LO 1.1-1.5. SP 1.5, 2.2, 5.3, 7.1 |
| 17: 14-21 | **Fungi**<br>• Structural and nutritional differences with plants<br>• Types: Zygomycetes, ascomycetes, basidiomycetes, chrytrids and glomeromycetes<br>• Parasitic and mutualistic relationships (lichens)<br>• Practical uses in agriculture, pharmaceuticals | **Study Guide Exercise** to describe fungal cellular structure and reproduction. [***CR4b**: LO 2.22, 2.23, 2.24, 2.38, 2.39*] | | **EU 1.B**<br>**1.B.1**<br>**1.C.3** |

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| 18: 1-9 | **Invertebrate Diversity**<br>• Early embryonic development (zygote, blastula, gastrula, formation of ectoderm, mesoderm, endoderm), radial vs. bilateral symmetry<br>• Classification by phylogenetic trees based on body parts<br>• Invertebrates: sponges, cnidarians, flatworms, nematodes, molluscs. | **AP Free Exercise adaptation:** Essay discussion of evolutionary significance of flatworm characteristics (multiple germ layers, symmetry, cephalization), segmented worm characteristics (segmentation, coelem, digestive system), reptiles (amniotic eggs, waterproof skin, lungs). *[**CR4d**: LO 4.22, 4.26]* | **Field Lab 4: Collect plants and flowers** *(Teacher-written lab)*<br>Students survey field area, this time focussing on plant life, plant structures, and plant reproductive organs. [If plants are not available because of weather conditions, students may substitute plant specimens from florists, grocers, or pet stores.] Students will<br>• collect specimens from fungus, moss, fern, conifer, and angiosperms, if possible<br>• describe and compare similar plant structures from each phyla identified<br>• prepare tissue slides from two or more specimens and describe differences in structures.<br>• explain how key characteristics give observed species survival advantages in its current environment.<br>**Goals:** Close observation of individual plant species, and recognition of key adaptations to local habitats.<br>**Report:** Formal report on area with updated tables noting changes to previously catalogued specimens and additional species; identification of species collected and studied under microscope, presentation of species and adaptations in tabular form for comparison with observations made by other students. | **EU 1.B**<br>**1.B.1**<br>**1.B.2** |
| 18: 10-16 | **Invertebrate Diversity**<br>• Annelids<br>• Arthropods (emphasis on insect adaptations and success of species in varieties of habitats)<br>• Echinoderms<br>• Chordata<br>• Phylogeny and diversity | **Study Guide Exercise**<br>Essay comparing characteristics arising from unsymmetrical, bilaterally symmetric, and radially symmetric cell organization in tissue development. *[**CR4a**: LO 1.15, 1.16; **CR4d**: LO 4.8, 4.9, 4.10]* | | **EU 1.C**<br>**1.C.3** |
| 19: 1-10 | **Vertebrate Diversity**<br>• Vertebrates: lampreys, jawed fish, amphibians, reptiles, birds, mammals | **Study Guide Exercise**<br>Create vertebrate phylogenetic tree. *[**CR4a**: LO 1.15, 1.16; **CR4d**: LO 4.8, 4.9, 4.10]* | **Bacteria technology** *(2012 AP Lab #9 or Teacher-written lab adapted for home students)*<br>Using bacterial and fungal colonies produced as in bacteria lab earlier, students isolate resistant strains for further | **EU 1.B**<br>**1.B.2**<br><br>**LAB:** LO 23.5, 3.13 SP 3.1, 6.4 |

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| 19: 11-17 | **Human Evolution**<br>• hominid groups: humans, gibbons, orangutans, gorillas, chimpanzees.<br>• human characteristics: enlarged brain, upright posture<br>• fossil evidence for development of species, language, tool-making, agriculture | **Study Guide Exercise**<br>Refine vertebrate phylogenetic tree, add primate tree. Emphasis on the recent development of diversity within closely related species.<br>*[**CR4a**: LO 1.17, 1.18, 1.25, 1.26]* | research. Students will<br>• identify and count baseline of colonies of bacteria from known sources and clone colonies.<br>• introduce spices or acids (such as vinegar) to colony sets.<br>• identify strains which survive specific changes to the environment.<br>• dispose of colonies safely.<br>**Goals:** Gain skills in isolating specific strains of bacteria or fungal colonies, and comprehension of how variation in alleles can provide resistance to changes in environment.<br>**Report:** Formal report describing apparatus and procedures, presentation of data in tabular form with recommendations for isolating samples by resistance to spices and acids. | **EU 1.C**<br>**1.C.3** |
| Review | Review of units 1-4 for fall semester exam | **AP Free Exercise**: Compare two kingdoms or domains, describing 3 characteristics shared by each group and 3 characteristics that can be used to distinguish each group, suggesting reasons for the simularties and differences of the groups. | No New Lab assignment<br>Catchup Period | |
| Unit 5: Chapters 20-30 (9 weeks) | **Animals: Form and Function** | | | **CR 2: Focus on Big Ideas 2 and 4**<br>Emphasis on Enduring Understandings 2D, 2E, 3D, 3E, 4A |
| 20: 1-15 | **Animal Structures**<br>• Tissue types: epithelial, connective, muscle, nervous<br>• Organs and organ systems | **In class exercise:**<br>Determine characteristics to use in identifying tissue types from microscope slides.<br>**In class discussion:**<br>Overview of organ system interactions to preserve homeostasis using negative feedback mechanisms.<br>*[**CR4b**: LO 2.28]* | No New Lab assignment<br>Catchup Period | **EU 4.A**<br>**4.A.3** |

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| 21: 1-13 | **Digestion**<br>• Phases: ingestion, digestion, absorption, excretion<br>• Comparison of digestive organs across animal species: specialization for available diets<br>• Human digestive system | **AP Free Exercise:** Identify non-vertebrate organisms that digest food intracellularly and extracellularly and describe each process. Describe two structural features of the human stomach and show how each feature relates to the function of the stomach. [***CR4b**: LO 2.22-2.24*] | **Vitamin C: Measuring nutrient content** *(Teacher-written lab)*<br>Students will learn techniques for measuring nutrient content in foods. Using the iodine-citric acid reaction, students create a dilute iodine solution and<br>• titrate and measure the amount of iodine solution needed to react with cornstarch in solution with at least three different juices.<br>**Goals:** Students gain experience in titration techniques and directly observe the variation of nutrient levels in different foods.<br>**Report:** Formal report on techniques used in titrating the solutions. Data is uploaded for comparison with work done by other students to determine relative Vitamin C content in sampled foods. | **EU 2.D**<br>**2.D.1**<br>**2.D.2**<br><br>**EU 4.A**<br>**4.A.3**<br><br>**CR3d: 4A to 2D** |
| 21: 14-22 | **Nutrition**<br>• Chemical energy requirements, measurements using calories<br>• Fatty acids, amino acids; application to vegetarian diets<br>• Vitamins and minerals: related deficiency diseases<br>• Dietary health: cardiovascular problems, obesity | **Study Guide exercise:** Energy conversion rates (food calories to exercise). [***CR4b**: LO 2.25*] | | **EU 2.A**<br>**2.A.2**<br><br>**EU 2.D**<br>**2.D.3** |
| 22: 1-12 | **Gas Exchange**<br>• Exchanges across membranes, control of internal environment, homeostasis<br>• Exchange of oxygen and carbon dioxide across skin, gills, tracheal systems<br>• Human respiratory system: organs and process<br>• Oxygen and carbon dioxide exchange/transport in blood | **AP Free Exercise:** Discuss the structural and physiological adaptations for oxygen uptake in a paramecium, a fish, and a mammal [***CR4d**: LO 4.18*] | **Measuring Lung Capacity** *(Teacher-written lab)*<br>Students use displaced-water volume methods to measure lung capacity.<br>• Student exhales into inverted, submersed water bottle.<br>• Displaced water determines volume of gas exhaled.<br>• Multiple runs are subjected to statistical analysis.<br>**Goals:** Direct observation of amount of air inhaled/exhaled, and technique for measuring gas volumes by water displacement. Statistical methods of averaging data and determining deviation are employed.<br>**Report:** Students prepare formal reports describing materials and procedures used. Data is compared along with physiological factors (age, gender, weight, height, self-assessed level of activity) to determine whether these factors influence lung capacity in young adults. | **EU 2.D**<br>**2.D.1**<br>**2.D.2**<br><br>**EU 4.A**<br>**4.A.3**<br><br>**EU 4.B**<br>**4.B.1**<br>**4.B.2**<br><br>**CR3a: 4A,B to 2D** |
| 23: 1-6 | **Internal transport systems**<br>• open vs. closed systems, variation in heart structures (number of chambers), relationship to lungs/gills/skin oxygenation<br>• structures: blood vessels (arteries, veins, capillaries; transport across capillary membranes); mammalian heart chambers, SA/AV nodes; heart attack<br>• blood pressure measurement as indicator of cardiovascular health | **Study Guide Exercise:** Diagram movement of blood, calculate amount of blood moved per pulse and total blood pumped per day as evidence of closed system. [***CR4b**: LO 2.31, 2.32*] | **Physiology of the Circulatory System** *(2002 AP Lab #10 Modified for home use)*<br>Students observe capillary pulse action in the tail of goldfish to count heartbeats in various environments.<br>**Goals:** Direct observation of circulatory response to temperature change in | **EU 2.D**<br>**2.D.1**<br><br>**EU 2.E**<br>**2.E.1**<br>**2.E.2** |

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| 23: 7-15 | **Blood**<br>• composition: erythrocytes, leukocytes, platelets<br>• clotting<br>• stem cell possibilities | **AP Free Exercise:** Discuss how homeostasis is maintained in 3 of the following systems (blood glucose levels, body temperature, blood pH, osmotic concentration of blood). [***CR4b**: LO 2.16*] | response to temperature change in ectothermic animals.<br>**Report:** Students complete the AP Lab Manual worksheets, and upload data for comparison with other students' work. | **EU 2.C**<br>**2.C.1**<br>**EU 4.A**<br>**4.A.3**<br>**CR3b: 2C to 4A** |
| 24: 1-9 | **Immune system**<br>• Generic defenses: inflammatory response, mucous membranes<br>• Lymphatic system organs: immune response to specific organisms<br>• B cell hormonal immunity: recognition of antigens, clonal selection of antibodies | **AP Free Exercise:** Explain how the immune system achieves immediate nonspecific immune responses, activates T and B cells, responds to a later exposure to the same infectious agent, distinguishes self from non-self. [***CR4b**: LO 2.29-2.30*] | **Immunology techniques** *(Virtual lab at http://www.hhmi.org/biointeractive/vlabs/)* Students use a simulation to perform an enzyme-linked immunosorbent assay.<br>**Goals:** Students gain experience in immunology techniques, and experience with concepts of antibodies. The simulation emphasizes some of the limitations and ambiguities involved in assay work, underlining the complexity of systems subject to multiple factors.<br>**Report:** Students keep a running log of their entries and decisions, and upload their report for comparison with other students' data. | **EU 2.D**<br>**2.D.4**<br>**EU 4.A**<br>**4.A.3**<br>**CR3d: 4A to 2D** |
| 24: 10-17 | **Acquired immunities**<br>• T cell cell-mediated immunities: helper and cytotoxic T cells<br>• Malfunctions: AIDS, autoimmune diseases and allergies | **Class Discussion:** Students discuss ramifications of immune system failures due to mutations, signal transduction failures, or other causes. [***CR4c**: LO 3.37, 3.38* | | **EU 3.D**<br>**3.D.4** |
| 25: 1-10 | **Thermoregulation and Osmoregulation**<br>• Heat loss/gain by conduction, convection, radiation, evaporation<br>• Loss regulation, metabolic rates to maintain temperature Osmoregulation<br>• Water gain/loss dependency on environment, exercise, concentration of wastes<br>• Excretory system organs: kidney components, nephron structures and blood filtration | **Study Guide Exercise:** Identify positive and negative feedback mechanisms in thermoregulation and osmoregulation across plant and animal domains. [***CR4b**: LO 2.22-24*] | **Artificial Selection:** *(Complete 2012 AP Lab #1)*<br>**OR**<br>***Alternative*: Field Lab #5: Collect animal for observation** *(Teacher-written lab, based on techniques in Animals Alive! an Ecological Guide to Animal Activities by Dennis Holley)*<br>Students survey field area for at least one hour at two different times of day, this time focussing on animal life, habitat locations, and populations. Students will | **EU 2.D**<br>**2.D.2**<br>**EU 2.E**<br>**2.E.2**<br>**EU 4.A**<br>**4.A.3**<br>**4.A.6**<br>**CR3d: 4A to 2D,2E** |

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| 26: 1-11 | **Chemical Regulation**<br>• Endocrine system organs and products: thyroid (thyroxin, triiodothyronine), parathyroid (PTH), pancreas (insulin), adrenal glands (epinephrine/norepinephrine, mineralocorticoids, glucocorticoids), gonads (estrogen, progestin, testosterone). | **Study Guide Exercise:** Identify endocrine system glands and products, with emphasis on signal transduction dependencies and cascading effects. [***CR4b**: LO 2.15-2.21, 2.25-2.28; **CR4c:** 3.35*] | • record animal species observed, location, and time of day observed.<br>• use safe capture methods to collect a specimen for close observation and release it back to the wild<br>• if no animal collection is possible, students may use a pet for close observation<br>• observe their collected specimen for at least 24 hours, noting when animal is active, identifying eating habits, hunting methods, etc.<br>• identify which characteristics give the specimen a survival advantage in its habitat.<br>**Goals:** Close observation of animal activities and identification of species differences that result in survival advantages.<br>**Report:** Formal report on area with updated tables noting changes to previously catalogued specimens and additional species; identification of species collected and studied in situ or in captivity, presentation of species and adaptations in tabular form for comparison with observations made by other students. | **EU 2.E**<br>**2.E.1**<br><br>**EU 3.D**<br>**3.D.2**<br>**3.D.3**<br><br>**CR3c: 3D to 2E** |
| 27: 1-8 | **Human reproductive systems:**<br>• Male and female reproductive organs<br>• formulation of sperm and ova during meiosis<br>• sexual activity and contraception methods<br>• ethical issues of contraception<br>• reproductive technology options | **Class discussion:** Ethical issues involved in different contraception methods. [***CR4b**: LO 2.31, 2.34-2.35. **CR5***] | **Transgenic Fly Lab** *(Virtual Lab)* Students manipulate the *period* gene to create a transgenic fly using the publicly simulation at http://www.hhmi.org/biointeractive/vlabs/. Students<br>• follow directed steps to prepare DNA and fly embryos<br>• "virtually" inject flies with DNA<br>• breed the flies and select transgenic progeny<br>• examine light output to determine which individual flies inherited the genes.<br>**Goals:** Students gain understanding and skills in manipulating genes directly and through crossbreeding, as well as cell differentiation and embryonic development.<br>**Report:** Students log responses and results, and upload data and analysis for comparison with other students' work. | **EU 2.E**<br>**2.E.1** |
| 27: 9-19 | **Human embryonic development**<br>• Embryonic development: fertilization, cleavage, gastrulation, cell migration, differentiation<br>• Human embryonic development by trimester | **Study Guide Exercise:** Identify key stages of human development where cell differentiation and cell death lead to specialized tissues, organs, and features.[***CR4b**: LO 2.31, 2.32*] | | **EU 2.E**<br>**2.E.1** |

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| 28: 1-9 | **Nervous system**<br>• Neuron structure and function: membrane potential, action potential propagation, neurotransmitters cross synapses, feedback, amplification<br>• Nervous system organs: comparison across species in system types, brain size, divisions, and function; peripheral vs. central | **Class Exercise:** Create description and diagram of cell response to stimulus.[***CR4b**: LO 2.38-2.40; **CR4c**: LO 3.31, 3.32, 3.34, 3.35, 3.39, 3.42-3.45*] | **Nerve Sensitivity** *(Teacher-written lab)*<br>Students test family members for reaction and sensitivity to cold and pressure.<br>• Using hot, lukewarm, and cold water, subjects are tested for temperature sensitive in the index finger and whole hand.<br>• Using two pins, subjects are tested for the ability to distinguish one point from two as the pins are moved apart.<br>**Goals:** Students become acquainted with methods for testing nerve responses, as well as the difficulty in reducing and correlating data that is primarily subjective for formal analysis.<br>**Report:** Students submit a formal report describing procedural methods, controls, and data on range of sensitivity to temperature and pressure. Combining class data, students look for correlations to age, gender, weight, and self-assessed general health. | **EU 3.D**<br>**3.D.2**<br>**3.D.3**<br>**3.D.4**<br><br>**EU 3.E**<br>**3.E.2** |
| 28: 10-21 | **Human brain**<br>• cerebral cortex, midbrain, puns, medulla oblongata, cerebellum; glands (pituitary, thalamus, hypothalamus), limbic system<br>• Injuries and neurological disorders | **Study Guide Exercise:** Compare differences in brain structure and function among different animal species. [***CR4b**: LO 2.38-2.40; **CR4c**: LO 3.46-3.50*] | | **EU 3.E**<br>**3.E.1**<br>**3.E.2** |
| 29: 1-6 | **Senses I**<br>• Sensory perception: changes in chemicals, pressure, light, electrical charge, magnetic fields, heat<br>• Primary sense organs: Hearing and balance (ears) | **Essay Exercise:** Explain stimulus - to - interpretation pathway for nerve signals for different sensory organis (eye, ear, touch, taste).[***CR4c**: LO 3.40-3.45*] | **Peripheral Vision** *(Teacher-written lab)*<br>Students measure range of peripheral vision in themselves and family members, varying conditions of<br>• available light<br>• color of object<br>• motion of object<br>**Goals:** To help students realize the sensitivity of the human eye to peripheral motion, color, or light intensity.<br>**Report:** Students prepare a formal report describing materials, procedures, and presenting data and range of vision as a function of type of object. By pooling data, students attempt to determine under which conditions peripheral vision is most acute. | **EU 4.A**<br>**4.A.3**<br>**4.A.4** |
| 29: 7-13 | **Senses II**<br>• Primary sense organs: vision (eyes), hearing (ears), balance (inner ear), taste and odor (mouth and nose) | **Class Discussion:** Explain results of disruption of stimulus - to - interpretation pathway for nerve signals for different sensory organis (eye, ear, touch, taste).[***CR4c**: LO 3.40-3.45*] | | **EU 4.A**<br>**4.A.3**<br>**4.A.4** |
| 30: 1-12 | **Animal Movement: skeletal support**<br>• Comparison of exoskeletons and endoskeletons<br>• Human skeletons: bone composition and structure Animal Movement: muscle systems<br>• Muscle systems, tendons, ligaments, and joints<br>• Muscle contraction process: motor neurons, muscle fibers, sarcomere contraction, sliding filament model | **Class Discussion and online simulation:** Use and interpret model of molecular interactions necessary for muscle contraction process. [***CR4d**: LO 4.23*] | **Dissection** *(Teacher-written lab)*<br>Students obtain appropriate dissection samples from a reliable source such as Edmund Scientific or Carolina Biological Supply, and perform a formal dissection, taking notes and identifying bones, muscles, and organs studied during the current unit. [Students may substitute the Virtual Frog Dissection activity at http://frog.edschool.virginia.edu// if they have objections to dissection or are unable to locate a specimen.]<br>**Goals:** To directly observe the anatomical structures studied in the previous weeks.<br>**Report:** Running log of dissection process and description of organs observered, including drawings if possible. | **EU 4.A**<br>**4.A.3**<br>**4.A.4** |

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| Unit 6: Chapters 20-30 (3 weeks) | **Plants: Form and Function** | | | **CR 2: Focus on Big Ideas 2 and 4** Emphasis on Enduring Understandings 2D, 2E, 3E, 4A |
| 31: 1-8 | **Plant Structure:**<br>• Angiosperms, monocots vs. dicots,<br>• Modifications to roots, stems, leaves as adaptations<br>• Plant tissue systems: dermal, vascular, ground: stomata and guard cells, mesophyll<br>• Primary and secondary growth | **Study Guide Exercise:** Identify stem parts, distinguish monocot and dicot stems from cross-sectional specimens. [***CR4d**: LO 4.5, 4.6, 4.15*] | **Field Lab 6: Plants** *(2002 AP Lab #9B Variation)*<br>Students return to field study area and collect sample monocots and dicots for closer observation. They will<br>• use a home-made microtome to make thin-slice slides of root and stem cross-sections to observe differences between phloem and xylem organization between monocots and dicots<br>• make thin-slice slides of root tips and stem tips to observe differences in apical meristems.<br>**Goals:** Direct observation of differences in plant structures between monocots and dicots.<br>**Report:** Description (and drawings, if possible) of microscope observations. | **EU 4.A**<br>**4.A.3** |
| 31: 9-15 | **Plant Reproduction - sexual vs. cloning**<br>• Flower structure: petals, carpel (ovary, style, stigma), stamen (anther, filament)<br>• Fruit structures, types, agricultural importance | **AP Free Exercise:** Discuss patterns of sexual reproduction in plants, including alternation of generations, mechanisms for bringing gametes together and methods of dispersing offspring to new locations. [***CR4b:** LO 2.31, 2.32, 2.33*] | | **EU 2.E**<br>**2.E.1** |
| 32: 1-11 | **Plant Nutrition**<br>• History of investigations: van Helmont experiments<br>• Nutrition intake: nutritional requirements, soil composition; root membranes and Casparian strip; stoma and guard cells<br>• Nutrition transport: xylem and phloem vessels, root pressure, cohesion and adhesion, transpiration and tension mechanisms, sugar source and sinks | **AP Free Exercise:** Using graphical data for water loss (volume) over time from two plants, calculate the rate of transpiration for each plant and identify at least three different structural or physiological adaptations that could account for different transpiration rates. [***CR4b:** LO 2.23*] | **Plant Transport:** *(2012 AP Lab #11)*<br>Students use bush beans or other similar plants to measure water transpiration under different conditions as prescribed in the lab manual.<br>**Goals:** Direct observation of factors affecting plant transpiration.<br>**Report:** Completion of lab manual worksheets and presentation of data for comparison with other students' work. | **EU 2.D**<br>**2.D.1**<br>**2.D.2**<br><br>**EU 4.A**<br>**4.A.5**<br><br>**CR3d: 4A to 2D**<br><br>**LAB:** LO 2.23, 2.24, 4.14-4.16.<br>SP 1.4, 2.2, 4.1, 6.4, 7.1 |
| 32: 12-14 | **Nitrogen fixation**<br>• bacteria, legumes, fungi | **Study Guide Exercise:** Identify natural and industrial processes that may improve or deplete soil nutrients.[***CR4a:** LO 4.13*] | | |
| 33: 1-8 | **Plant control systems**<br>• Historical note: Went experiments<br>• Hormone types, functions, uses in agriculture: Auxin, cytokinins, gibberellins, abscisic acid, ethylene | **Study Guide Exercise:** Predict Darwin/West light tropism experiment outcomes. [***CR4b:** LO 2.35, 2.36, 2.37*] | **Plant Response: Light and Gravity Tropisms** *(Teacher-written lab)*<br>Students investigate plant tropisms.<br>• Using house plants, students count leaves in "normal" positions, then change direction of lighting and time changes to plant leaf orientation. | **EU 2.E**<br>**2.E.2**<br><br>**EU 4.A**<br>**4.A.3**<br>**4.A.6**<br><br>**CR3d: 4A to 2E** |

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| 33: 9-13 | **Growth responses and biological rhythms**<br>• Tropisms: light, gravity, touch<br>• Rhythms: biological clocks, photoperiods, IR and far-IR phytochrome triggers | **Study Guide Exercise:** Students predict effects of UV, IR, and far-IR light exposures on short-night and long-night plant species. [**CR4b:** LO 2.31, 2.34-2.37] | • Using sprouted beans, students rotate beans on regular basis and observe change in direction of leaf/root growth.<br>**Goals:** Direct observation of plant response to light and direction of gravity.<br>**Report:** Informal description of plant responses. | **EU 2.E**<br>**2.E.3** |
| Unit 7: Chapters 34-38 (5 weeks) | **Ecology** | | | **CR 2: Focus on Big Ideas 2, 3, 4**<br>Emphasis on Enduring Understandings 2E, 3E, 4B, 4C |
| 34: 1-7 | **The Biosphere and Aquatic Biomes**<br>• Biosphere, ecosystems, communities, populations, species<br>• Physical (abiotic) and organic (biotic) factors<br>• Aquatic biomes: marine vs. freshwater, water circulation | **Student Reports:** Students do interactive presentations on representative aquatic biomes, including temperature variation, salt concentration, plant and animal species, with justification of population size and species richness based on energy resources. *[**CR4b:** LO 2.1-2.4, **CR4d:** LO 4.16]* | **Biome Identification:** *(Teacher-written exercise)*<br>Based on prior field labs, students answer a series of questions to identify study area biomes and energy availability at produce and consumer levels.<br>**Goals:** Begin generalizations from data collected in the field.<br>**Report:** Justification of biome identification and energy flow within biome. Usually this results in the realization that the study area exhibits characteristics of more than one of the classically identified biomes. | **EU 4.B**<br>**4.B.3**<br>**4.B.4** |
| 34: 8-18 | **Terrestrial biomes**<br>• Characteristics for comparison: climate, terrain and altitude, energy flow, biodiversity and richness<br>• Types: tropical, savanna, desert, chaparral, temperate grassland, temperate forest, coniferous forest, tundra | **Student Reports:** Students do interactive presentations on representative terrestrial biomes, including climate, precipitation, plant and animal species, with justification of population size and species richness based on energy resources. *[**CR4b:** LO 2.1-2.4, **CR4d:** LO 4.16]* | | **EU 4.C**<br>**4.C.3** |
| 35: 1-11 | **Behavior and Learning**<br>• Proximate vs. ultimate causality (cf. Aristotelian causality); genetic vs. environmental factors<br>• Genetic: Fixed (inherited) action patterns<br>• Learned: habituation, imprinting (parent-child bonding), spatial learning and cognitive mapping (navigation), associative learning, social learning, problem solving. | **AP Free Exercise:** Analyze experiment and data collected on behavior of fish in a tank with a 20-degree temperature differential. *[**CR4b:** LO 2.38-2.40]* | **Animal Behavior: Habitat Selection** *(2012 AP Lab #12 or Teacher-written adaptation to 2002 AP Lab #11)*<br>Students acquire and raise brine shrimp from a local pet store for this exercise.<br>**Goals:** Direct observation of animal response to habitat conditions in selecting preferred habitat. | **EU 2.E**<br>**2.E.3**<br>**EU 3.E**<br>**3.E.1**<br>**3.E.2**<br>**CR3c: 3E to 2E**<br>**LAB:** LO 2.22-2.24; 2.38-2.40 SP 1.4, 2.2, 3.2, 5.1, 5.2, 6.1, 7.2 |

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| 35: 12-23 | **Social behavior**<br>• Foraging, Mating, and Social Behaviors | **Student Guide Exercise:** Students propose research possibilities to identify whether innate and/or learned behaviors enhance species' survival rates (including ethical considerations). *[**CR4b:** LO 2.21. **CR5**]* | **Report:** Completion of AP Lab Manual worksheet and presentation of data for comparison with other students' work. | **EU 2.C**<br>**2.C.2** |
| 36: 1-11 | **Population Dynamics**<br>• Density and dispersion patterns; population models: exponential growth, logistic growth - chaos math | **AP Free Exercise:** Essay explaining how survival of organisms is influenced by environmental factors, and how predation affects populations. *[**CR4b:** LO 2.15-2.21; **CR4d:** LO 4.14-4.15, 4.27]* | **Energy Flow Investigation** (*2012 AP Lab #10*)<br>OR<br>**Population Density** *(Teacher-written lab)* Based on field observations, students identify at least three species in their study area and determine the dispersal pattern and its dependency on energy supplies from sunlight and producers.<br>**Goals:** Understand how dispersal patterns reflect resources available, energy flow, or predator conditions.<br>**Report:** Presentation of mapping dating, energy flow diagrams, and justification of dispersal pattern identification. | **EU 4.B**<br>**4.B.3** |
| 37: 1-13 | **Communities**<br>• Interactions and interdependencies: competition, predation, symbiotic relationships, trophic structures | **AP Free Exercise:** Discuss the succession of communities from annual plants to hardwood trees over time. Identify the abiotic changes that lead to the succession pattern. Discuss the effect of two disturbances (clearcutting, volcanic erruptions) on ecosystem succession. *[**CR4d:** LO 4.11-4.13, 4.19]* | | **EU 4.A**<br>**4.A.5**<br><br>**LAB:** LO 2.22, 2.23, 2.24; 4.14-4.16<br>SP1.3, 2.2, 4.2, 5.1, 6.1, 7.2 |
| 37: 14-23 | **Ecosystems**<br>• Energy dependencies: energy source (solar energy available), dispersal through food chains.<br>• Chemical resource dependencies: water, carbon, nitrogen, phosphorus | **AP Free Exercise:** Design dissolved oxygen experiment and forecast results that would support hypothesis. *[**CR4d:** LO 4.19-4.20]* | | **EU 4.B**<br>**4.B.3** |
| 38: 1-13 | **Conservation Biology**<br>• Threats to biodiversity: habitat destruction, pollution, hunting; human responsibilities<br>• Conservation practices and examples | **AP Free Exercise:** Describe the role of regulators in the following processes: a) cyclin on cell cycles; b) thyroxine on metabolic rates; c) FSH on ovarian cycles; d) Predators on prey; e) fire on ecological succession. *[**CR4d:** LO 4.8-4.10, 4.21]* | **Recycling Success**: (*Teacher-written lab*) Students plan and monitor recycling efforts. | **EU 4.B**<br>**4.B.3**<br><br>**EU 4.C**<br>**4.C.4** |
| Review (1 Week) | **Ramifications and Connections** | | | **CR 2: Revisiting Big Ideas 1-4** |
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