

AP Biology

Instructor: Mrs. Amy Taylor
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Prerequisite: successful completion of Biology/ H. Biology AND 2 semesters, 1 credit
Chemistry/H. Chemistry with current science teacher recommendation

This AP Biology course is equivalent to a two-semester college introductory biology course. The course is designed to enable you to develop advanced inquiry and reasoning skills, such as designing a plan for collecting data, analyzing data, applying mathematical routines, and connecting concepts in and across domains. The result will be readiness for the study of advanced topics in subsequent college classes. Study will be centered on the overarching concepts of evolution, cellular processes, genetics, and the interactions between biological systems.

Graduation Standards (the number of the standard is referenced in the performance indicators listed in each unit):

4- Life Sciences: Structure, Function, and Information Processing Understand and analyze molecular, structural, and chemical biology. (LS 1)

5- Life Sciences: Matter And Energy in Organisms and Ecosystems Understand and analyze the characteristics, functions, and behavioral interactions within an ecosystem. (LS 2)

6- Life Sciences: Growth, Development, and Reproduction of Organisms, Natural Selection, and Adaptations Understand and analyze genetics, adaptation, and biodiversity. (LS 3 + LS 4)

8- Engineering, Technology, and Application of Science Demonstrate engineering concepts across multiple disciplines and novel situations. (HS-ETS1)

- 8 A. Ask questions/ define problems.
- 8 B. Develop and use models.
- 8 C. Plan and carry out investigations.
- 8 D. Analyze and interpret data.
- 8 E. Use mathematical and computational reasoning.
- 8 F. Construct explanations/ design solutions.
- 8 G. Engage in Argument from evidence.
- 8 H. Obtain, evaluate, and communicate information

Instructional Resources

Starr, Taggart, Evers, Starr. *Biology: The Unity and Diversity of Life*, 14th Edition, 2015, Cengage Learning. [CR1]

Hecht, Homlberg. *Student Interactive Workbook* (to accompany Starr and Taggart Biology), 2013. Brooks/Cole, Cengage Learning.

Trout, Laura (Ed.) *POGIL Activities for AP Biology*. 2012.

HSPI—The POGIL Project and Flinn Scientific, Inc.

AP Biology Investigative Labs: an Inquiry Based Approach.

CR1: Students and teachers use a recently published (within the last 10 years) college- level biology textbook.

Advanced Placement Biology Content

My AP course is structured around the four big ideas, the enduring understandings within the big ideas and the essential knowledge within the enduring understanding. [CR2]

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

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.

The Investigative Laboratory Component

The course is also structured around inquiry in the lab and the use of the seven science practices throughout the course.

Students are given the opportunity to engage in student-directed laboratory investigations throughout the course for a minimum of 25% of instructional time.

[CR7] Students will conduct a minimum of eight inquiry-based investigations (two per big idea throughout the course). [CR6] Additional labs will be conducted to deepen students' conceptual understanding and to reinforce the application of science practices within a hands-on, discovery based environment. All levels of inquiry will be used and all seven science practice skills will be used by students on a regular basis in formal labs as well as activities outside of the lab experience.

The course will provide opportunities for students to develop, record, and communicate the results of their laboratory investigations.

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.

Science Practices (SP)

1. The student can use representations and models to communicate scientific phenomena and solve scientific problems.
2. The student can use mathematics appropriately.
3. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
4. The student can plan and implement data collection strategies appropriate to a particular scientific question.
5. The student can perform data analysis and evaluation of evidence.
6. The student can work with scientific explanations and theories.
7. The student is able to connect and relate knowledge across various

scales, concepts and representations in and across domains.

Topics and Timelines (80 minute block schedule, meeting on alternating days; avg. of 200 min per week)

Units of Instruction:

Unit 1: Introduction to Biology (2 weeks) [CR2]

Big ideas: 1, 2 Connected to enduring understandings:

- 1.A Change in the genetic makeup of a population over time is evolution.
- 2.A Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

Chapters:

1. Invitation to Biology
2. Life's Chemical Basis

Unit 1 Overview of Lecture and Discussion Topics:

1. Darwin and the Theory of Natural Selection
2. Inquiry as a way to learn science
3. Structure of Atoms
4. Emergent Properties of Water

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

Activities/Labs:

1. Students use construction paper to make models of atoms and molecules with magnetic backs in order to facilitate discussion and functionally explain (using a magnetic board), basic chemistry concepts including essential elements of life, bonding, ions, properties of water due to hydrogen bonding and how these properties impact living systems. (SP 1, 7)
2. Assignment: Science Project (SP 2, 3, 4, 5) Open inquiry of a biological topic of choice.
Research topic to formulate a question, hypothesize, and design a controlled experiment to test the hypothesis (multiple trials), analyze data and make conclusions. Prepare a folder of the scientific work and prepare for a visual presentation.
3. **PROPERTIES OF WATER INQUIRY-** Students will visit stations that each demonstrate a discrepant event associated with water's unique properties. At each station they will record observations that lead to a research question to be addressed using CER. Following the stations, students will complete the water POGIL and then choose one station to explain based on water's chemical nature. Students will be expected to extend the significance of that property to life on Earth.

Unit 2: Biochemistry and Introduction to the Cell (3 weeks) [CR2]

Big ideas: 1, 2, 3, 4 Connected to enduring understandings:

- 1.D The origin of living systems is explained by natural processes.
- 2.A Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
- 2.B Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
- 3.A Heritable information provides for continuity of life.
- 4.A Interactions within biological systems lead to complex properties.
- 4.B Competition and cooperation are important aspects of biological systems.
- 4.C Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

Chapters:

4. Molecules of Life
5. Cell Structure

Unit 2 Overview of Lecture and Discussion topics:

1. The impact of carbon as the “backbone of life”
2. How monomers build polymers, including the roles of nucleic acids
3. Examples of organelles that are membrane bound to compartmentalize their functions.
4. Membrane structure and function

Activities/Labs:

1. FOR BIOLOGICAL MOLECULES:

- A. Identifying Organic Macromolecules—Molecular model building and Game of Synthesis Card Game
- B. Predicting the Behavior of Organic Molecules from Structure
- C. Use CER to explain the outcome of observed behaviors of a biological molecule based on its chemical nature. **[CR3b] & [CR4b]**

2. Build-A-Membrane: <<http://learn.genetics.utah.edu/>> Cut, fold, and paste biological molecules to create a three-dimensional cell membrane with embedded proteins, followed by whole class discussion of membrane structure and function. (SP 1) Students complete animations and activities from Amazing Cells page of this website. **[CR3b]**

3. DIFFUSION AND OSMOSIS LAB INQUIRY: A demonstration using dialysis

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.)

CR4b: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 2.

tubing (model) will allow students to make observations and to provide evidence for the diffusion of molecules; students set up an experiment regarding osmosis and concentration gradients after hypothesizing the outcome; data collection, calculations of percent change, graphing percent change in mass of dialysis bags of varying sucrose molarities placed in water, and analysis of the data will follow. All work will be kept in the laboratory research notebook. (SP 1, 2, 3, 4, 5, 6) [CR3b], [CR6] & [CR8]

Unit 3: Cellular Energy and Related Processes (3-4 weeks)

[CR2]

Big ideas: 1, 2, 4 Connected to enduring understandings:

- 1.A Change in the genetic makeup of a population over time is evolution.
- 1.D The origin of living systems is explained by natural processes.
- 2.B Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
- 4.A Interactions within biological systems lead to complex properties.
- 4.B Competition and cooperation are important biological systems.

Chapters:

5. Ground Rules of Metabolism
6. Where It Starts-- Photosynthesis
7. How Cells Release Chemical Energy

Unit 3 Overview of Lecture and Discussion Topics:

1. Metabolic pathways
2. Laws of Energy Transformation
3. How ATP powers cellular work
4. Enzyme structure and function
5. Harvesting chemical energy: glycolysis, citric acid cycle, oxidative phosphorylation
6. Light reactions and the Calvin cycle
7. Evolution of alternative mechanism of carbon fixation

Activities:

1. Modeling Activities for:
 - A. Enzymes (toothpickase),
 - B. ATP—The Free Energy Carrier (*POGIL Activities for AP Biology*)

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.

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.

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

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.

C. photosynthesis (including comparison of C₃, C₄, and CAM processes)

D. cellular respiration (Connection of big idea #2 to enduring understanding 1.A) [CR3a] & [CR4b]

2. The Evolution Of The Cell: <<http://learn.genetics.utah.edu>>

The endosymbiotic theory explains how relatives of ancient bacteria ended up in modern-day cells. A whole class discussion is used to analyze the endosymbiotic theory, encouraging students to question how prokaryotes can carry on energy transfer processes without true membrane bound organelles. Students are given 5 minutes to write a conclusion to the discussion on a post-it note for posting on their way out of class. (SP 3, 6) [CR3b] & [CR4b]

Big idea #2 Laboratory Investigations:

1. CATALASE INQUIRY. Using yeast spheres, students will hypothesize and design an experiment, collect and analyze data, and report out conclusions using a poster format on their choice of one factor's effect on the rate of metabolic activity as it relates to the structure/function of the enzyme. (Supports big idea 2; SP 2, 3, 4, 5) [CR6]

2. PEA RESPIRATION. Using knowledge of the process of cellular respiration and of how to set timed experiments using the respirometers, students will engage in the process of inquiry as they conduct an experiment to measure the rate of cell respiration in germinating peas at room temperature. Next, students will design a controlled experiment to answer a question of their choice that they asked while conducting the experiment at room temperature. Students will collect and determine cellular respiration rates and demonstrate an understanding of concepts involved by preparing a report in their laboratory research. (Supports big idea 2; SP 2, 3, 4, 5) [CR6] & [CR8]

2. PHOTOSYNTHESIS: Student-directed and inquiry based investigations about photosynthesis using the floating leaf disc procedure. A write-up of the design and discussion of the outcome will be kept in their laboratory research notebook. (Supports big idea 2; SP 2, 3, 4) [CR6] & [CR8]

Unit 4: Cell Communication and the Cell Cycle (4 weeks) [CR2]

Big ideas: 1, 2, 3 Connected to enduring understandings:
2.E Many biological processes involved in growth,

CR4B: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 2.

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.

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.

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.

reproduction and dynamic homeostasis include temporal regulation and coordination

3.A Heritable information provides for continuity of life

3.B Expression of genetic information involves cellular and molecular mechanisms.

3.D Cells communicate by generating, transmitting and receiving chemical signals.

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

Chapters:

4. Cell Structure (revisited for signaling)

32. Neural Control (as examples of cell signaling)

34. Endocrine Control (as examples of cell signaling)

11. How Cells Reproduce

Unit 4 Overview of Lecture and Discussion Topics:

1. Evolution of cell signaling

2. Reception, transduction, response

3. Apoptosis

4. How mitosis produces genetically identical daughter cells

5. Evolution of Mitosis

6. How the eukaryotic cell cycle is regulated by a molecular control system

7. Origin of cell communication

Activities:

1. Pathways with Friends: <<http://learn.genetics.utah.edu>>

Directed by instructional cards, students kinesthetically model cell communication by acting as components in a cell signaling. Whole class discussion follows, assessing student understanding of cell communication. Animations of Cell Communication, An Example of Cell Communication, The Fight or Flight Response, How Cells Communicate during the Fight or Flight Response (These animations provide students with a model example of the concepts involved in cell signaling). (SP 1) [CR4c]

2. *POGIL Activities for AP Biology*: Cellular Communication and Signal Transduction Pathways

3. Whole class discussion: How do hormones and other signaling molecules work? (Animals and Plants) [CR4c]

4. Modeling the Cell Cycle. Students construct a model of the cell cycle, explain and present the major events in a presentation. (SP 1) [CR4b]

5. Using mitosis cards (such as from Ward's Natural Science), students estimate the time a cell spends in each of the mitotic stages and develops an appropriate graph to reveal data. (SP 5) [CR4b]

CR4C: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3.

CR4B: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 2.

Big idea # 3 Laboratory Investigations:

1. CELL DIVISION AND MITOSIS Student directed and inquiry based laboratory. Onion roots are treated with bean lectin to increase mitotic rate in cells. Students design a controlled experiment to test the effect of treated root squashes and use Chi Square to analyze data. A write-up of the laboratory and outcome, including calculations and analysis of data will be prepared in the laboratory research notebook. (Supports big idea 3; SP 2, 3, 4, 5) [CR6] & [CR8]

Unit 5: Genetic Basis of Life (3 weeks) [CR2]**Big ideas: 1, 3, 4 Connected to enduring understandings:**

- 1.A Change in the genetic makeup of a population over time is evolution.
- 3.A Heritable information provides for continuity of life.
- 3.C The processing of genetic information is imperfect and is a source of genetic variation.
- 4.C Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Chapters:

12. Meiosis and Sexual Reproduction
13. Observing Patterns in Inherited Traits
14. Chromosomes and Human Inheritance

Unit 5 Overview of Lecture and Discussion Topics:

1. Genes are passed from parents to offspring by the inheritance of chromosomes
2. How meiosis reduces the number of chromosomes (diploid to haploid)
3. Evolutionary significance of genetic variation that results from sexual life cycles
4. Concepts of Mendelian genetics (laws of probability, inheritance patterns)
5. Genes are located along chromosomes (concepts of gene linkage, mapping distance between genes, causes of genetic disorders) [CR5]

Activities:

1. Knowing the % of each color in packages of M&M's, as

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.

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.

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

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.

published by the packaging company, students will count the colors in packages and apply the null hypothesis concept and Chi Square calculations on the data. (SP 2) [CR4c]

2. Students will be given data from a Genetics of Drosophila laboratory involving three crosses of the fruit flies. All of the observations will be given to them. They will develop a null hypothesis as to the mode of inheritance based on the data, and they will use the Chi Square statistical analysis to determine whether to accept or reject the hypothesis. (SP 2, 5)

3. Students will use a chromosome bead kit to simulate the process of meiosis and explain when haploidy occurs. (SP 1)

CR4C: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3.

Laboratory Investigation:

MEIOSIS IN SORDARIA Students analyze outcomes of Sordaria crosses, determine phenotypes due to crossover or non-crossover, and determine percent recombination and map units. They will compare their observations with the known map distance from gene to centromere. (SP 2, 5)

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

Unit 6: Gene Activity and Biotechnology (4 weeks) [CR2]

Big ideas: 1, 2, 3, 4 Connected to enduring understandings:

1.A Change in the genetic makeup of a population over time is evolution

2.C Organisms use feedback mechanisms to regulate growth and

reproduction, and to maintain dynamic homeostasis.

2.E Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

3.A Heritable information provides for continuity of life.

3.B Expression of genetic information involves cellular and molecular mechanisms.

3.C The processing of genetic information is imperfect and is a source of genetic variation.

4.A Interactions within biological systems lead to complex properties.

Chapters:

8. DNA Structure and Function

9. From DNA to Protein

10. Control of Gene Expression

20. Viruses, Bacteria, and Archaea

15. Studying and Manipulating Genomes

Unit 6 Overview of Lecture and Discussion Topics:

1. DNA is the genetic material (historical experiments, DNA structure and function, DNA replication)
2. Flow of genetic information (genetic code, role of other polymers, transcription, translation)
3. Mutations
4. Gene expression (operon systems in prokaryotes, eukaryotic gene expression)
5. Virus structure and activity
6. Restriction enzymes, plasmids, transformation
7. DNA technology (how gel electrophoresis works and applications of this technology) [CR5]

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.

Activities:

1. *POGIL Activities for AP Biology Gene Expression—Transcription, Gene Expression—Translation, Genetic Mutations* (SP 1, 3, 4, 5, 6) [CR4c]

2. Model of an operon: Following lecture and discussion of structure and function of an operon system, materials are made available for students to create a model of an operon and demonstrate to their classmates. (SP 1, 6)

3. DNA and Histone Model <<http://learn.genetics.utah.edu>> A 3-D cut-and-paste model depicting how histone, acetyl and methyl molecules control access to DNA and affect gene expression. (Connection of big idea 3 to enduring understanding 4.A; SP 1, 6)

CR4C: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3.

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.

Big idea # 3 Laboratory Investigations:

1. TRANSFORMATION LAB Students will perform a transformation experiment in which they transform a bacterial cell to contain a plasmid containing a gene which can be expressed so as to produce protein products which make the cell “glow”. Students will then study the structure of the plasmid and make predictions regarding growth on various agar plates (LB plates, plates with ampicillin and arabinose added). They will then examine the bacterial growth afterwards and collect quantitative data. They will calculate transformation efficiency. Students will then plan a controlled experiment that they think would improve the transformation efficiency. The entire laboratory study will be documented in the laboratory research notebook. (Supports big idea 3; SP 2, 3, 4, 5, 6) [CR6] & [CR8]

2. PCR AND ELECTROPHORESIS LAB Students will use micro-techniques to restrict DNA, and using a marker DNA along with “crime scene” and “suspect” DNA, predict which suspect

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.

matches the crime scene. Students will understand the principles of gel electrophoresis. Students will collect quantitative data by using the marker DNA results to graph data. They will utilize band migration distances and extrapolate band sizes by extrapolating from their graphs. The entire laboratory study will be documented in the laboratory research notebook. (Supports big idea 3; SP 2, 3, 4, 5, 6)

Unit 7: Evolution and Phylogeny (4 weeks) [CR2]

Big ideas: 1, 3, 4 Connected to enduring understandings:

- 1.A Change in the genetic makeup of a population over time is evolution.
- 1.B Organisms are linked by lines of descent from common ancestry.
- 1.C Life continues to evolve within a changing environment.
- 1.D The origin of living systems is explained by natural processes.
- 3.A Heritable information provides for continuity of life.
- 3.C The processing of genetic information is imperfect and is a source of genetic variation.
- 4.C Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

Chapters:

- 16. Evidence of Evolution
- 17. Processes of Evolution
- 18. Organizing Information About Species
- 19. Life's Origin and early Evolution

Unit 7 Overview of Lecture and Discussion Topics:

- 1. How natural selection serves as a mechanism for evolution
- 2. Scientific evidence supporting evolution
- 3. Hardy-Weinberg concept
- 4. How allele frequencies can be altered in a population
- 5. Concepts of speciation
- 6. Origin of Life; Fossil Records
- 7. Events in the "history of life" (origin of single-celled and multicellular organisms; mass extinctions; adaptive radiations)

Activities:

- 1. NOVA; PBS video: "What Darwin Never Knew." This video will be utilized in conjunction with whole class discussions to take a look at Charles Darwin's observations and conclusions and how modern day molecular biology is confirming

what Darwin documented. (Connects big idea 1 to enduring understanding 3.C) [CR3c], [CR4a] & [CR5]

2. Constructing a Phylogenetic Tree Using DNA Sequence Data Simulation: <<http://www.accessexcellence.org/AE/>> Students exchange the “ancestral DNA” with random mutations over time and make divergences into different evolutionary lines. A phylogenetic tree is constructed. Then, in a second part, students construct a phylogenetic tree of another group based strictly on nucleotide sequences of present-day organisms. (SP 1, 4, 5)

[CR4a]

3. Evolutionary Time: The Geologic Time String <<http://www.accessexcellence.org/AE/>> The Time String involves the use of a string. The string is 4.6 meters long, and each millimeter on the string represents 1 million years. Knots tied at distinct locations along the string represent extinctions, beginning of Eras, and so forth, in the geologic time table. (SP 7)

[CR4a]

4. *Practicing Biology*, 3rd Edition. Activity 23.1 A Quick Review of Hardy- Weinberg Population Genetics. Alternatively, present students with Hardy- Weinberg problems from a variety of resources. Students apply the Hardy- Weinberg equation to determine frequencies of phenotypes and alleles. (SP 2) [CR4a]

5. HHMI video: “Evolution” Students will view the lecture on artificial selection and a class discussion will follow.

Big idea # 1 Laboratory Investigations:

1. ORIGINS OF LIFE LAB After learning about and discussing experiments by Oparin, Miller and Urey, and others, students are guided through an inquiry in which they form coacervates by combining carbohydrate molecules with protein molecules as they vary pH. They observe the coacervates and collect quantitative data. Students then develop a question they would like to answer through experimentation about coacervate formation, and materials are made available as students design experiments to test the hypotheses they have made. The entire laboratory study will be documented in a laboratory research notebook. In addition, students will post outcomes on Moodle, and students will be required to comment on the findings of the

CR3C: Students connect the enduring understandings within Big Idea 3 (living systems store, retrieve, and respond to information essential to life processes) to at least one other big idea.

CR4A: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 1.

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.

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.

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.

various student groups. (SP 1, 3, 4, 5) [CR6] & [CR8]
2. Students will learn how to analyze cladograms and understand evolutionary relationships using the Basic Local Alignment Sequencing Tool. Students will analyze morphological details about a newly discovered fossil, hypothesize as to the position of the fossil in a pre-constructed cladogram, then test the hypothesis using BLAST. Once students become comfortable, they will use the tool to answer questions of their choice regarding gene sequences. Alternatively, students can explore and discover using Cold Spring Harbor DNA Learning Lab: DNA Subway. (Supports big idea 1; SP1, 3, 4, 5) [CR6] & [CR8]

Unit 9: Ecology (4 weeks) [CR2]

Big ideas: 1, 2, 3, 4 Connected to enduring understandings:

- 1.A Change in the genetic makeup of a population over time is evolution.
- 1.C Life continues to evolve within a changing environment.
- 2.A Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
- 2.C Organisms use feedback mechanisms to regulate growth, reproduction and dynamic homeostasis.
- 2.D Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
- 2.E Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
- 3.E Transmission of information results in changes within and between biological systems.
- 4.A Interactions within biological systems lead to complex properties.
- 4.B Competition and cooperation are important aspects of biological systems.
- 4.C Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Chapters:

- 43. Animal Behavior
- 44. Population Ecology
- 45. Community Ecology
- 46. Ecosystems
- 48. Human Impacts on the Biosphere

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.

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.

CR2: The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.

Unit 9 Overview of Lecture and Discussion Topics:

1. Aspects of animal behavior
2. Aspects of biomes
3. Models describing population growth
4. Regulation of population growth
5. Community interactions
6. Species diversity and composition
7. Community biodiversity
8. Energy flow and chemical cycling in ecosystems
9. Primary productivity
10. Energy transfer between trophic levels
11. Human activities that threaten biodiversity

Activities:

1. Students will design a model of a biome that demonstrates knowledge of biological processes and concepts across scales. Class presentations will demonstrate their knowledge of understanding. (Connects big idea 4 to enduring understanding 2.A; SP 7) **[CR3d] & [CR4d]**

2. Provide students with a copy of an article entitled “Invasive Plant Suppresses the Growth of Native Tree Seedlings by Disrupting Belowground Mutualisms”, by Kristina Stinson and others. Students will explore the research based study and analyze the data presented for its meaning. (SP 5) **[CR4d] & [CR5]**

3. Pose the following question to students: In order to improve species richness, you decide to add phosphate to a pond. How might you determine

how much phosphate to add in order to avoid eutrophication?

Students will prepare a visual on whiteboards and present their thinking to the class. (SP 3, 4) **[CR4d] & [CR5]**

5. Animated investigation: How Does the Fungus *Pilobolus* Succeed as a Decomposer? From: <www.campbellbiology.com>, Chapter 31. Students investigate this fungus as a decomposer, hypothesizing and collecting data in this animated investigation; they will study the adaptiveness of certain spore dispersal methods. (Connects big idea 4 to enduring understanding 1.A; SP 5, 6, 7) **[CR4d]**

6. Animated Investigation: How do Abiotic Factors Affect Distribution of Organisms? From: <www.campbellbiology.com>, Chapter 52. Students will use a simple model for observing

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.

CR4D: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 4.

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.

ecological impact that occurs when single abiotic factors are changes. By changing abiotic factors, data can be collected and analyzed. (Connection of big idea 2 to enduring understanding 4.A) [CR4d]

Big idea #4 Laboratory Investigations:

1. ISOPOD BEHAVIOR LAB Students design their own controlled experiments to investigate a question they have about animal behavior (kinesis and taxis in isopods, behavior with respect to selected stimuli). The entire laboratory and experimental design and analysis will be written in the laboratory research notebook. (Supports big idea 4; SP 1, 2, 3, 4, 5, 6, 7) [CR6] & [CR8]

2. DISSOLVED OXYGEN AND PRIMARY PRODUCTIVITY. Through guided inquiry, students will investigate how to measure dissolved oxygen using the Winkler method (ex: How does temperature affect the dissolved oxygen concentration in samples of water?) Continuing, students will explore respiration and photosynthesis processes in samples of a Chlorella culture as they study gross and net primary productivity. Students will then be challenged to write and conduct a controlled experiment to test the effect of a variable on primary productivity. The study will involve hypothesizing, designing the experiment, data collection of dissolved oxygen concentrations, calculations of primary productivity, graphing and making a conclusion. The entire laboratory investigation will be written in the laboratory research notebook. (Supports big idea 4; SP 1, 2, 3, 4, 5, 6, 7) [CR6]

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.

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.