

| Curricular Requirements | Page(s) |
|---|------------------------------|
| CR1 Students and teachers use a recently published (within the last 10 years) college-level biology textbook. | 1 |
| CR2 The course is structured around the enduring understandings within the big ideas as described in the AP [®] Biology Curriculum Framework. | 1,3,5,6,7,8,10, 11,13 |
| 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. | 5 |
| 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. | 4,5 |
| 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 |
| 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. | 14 |
| CR4a The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 1. | 11,12,13 |
| CR4b The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 2. | 4,5,7 |
| CR4c The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3. | 7,8,9,13 |
| CR4d The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 4. | 12,14,15 |
| 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. | 8,9,11,13,14 |
| 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. | 2,4,6,7,9,10,11, 14 |
| 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. | 4,6,7,9,10,11, 14 |

Course Overview

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

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

At the end of the course, students will have an awareness of the integration of other sciences in the study of biology, understand how the species to which we belong is similar to, yet different from, other species, and be knowledgeable and responsible citizens in understanding biological issues that could potentially impact their lives.

Instructional Context

I teach AP Biology to juniors and seniors at a high school that employs a modified block schedule. I meet with students four days a week. Two days are 50 minute periods and two days are 80 minute periods.

Students must have completed both first year biology and chemistry prior to enrolling in AP Biology. A summer assignment is used to review basic principles of biology and chemistry. This strategy enables me to more quickly begin topics in biochemistry.

Instructional Resources

Reece, Jane, et al., *Campbell Biology*, 9th Edition, 2011, Pearson Benjamin Cummings. **[CR1]**

Giffen, Cynthia and Heitz, Jean. *Practicing Biology* (to accompany Campbell-Reece Biology), 3rd Edition, 2008, Pearson Benjamin Cummings.

<www.campbellbiology.com> (The website to accompany the main text provides animations, investigations, PowerPoint and other audio-visual sources to enhance instruction)

AP Biology Investigative Labs: an Inquiry Based Approach.

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]**

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

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.

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.

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.

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.

Topics and Timelines (Modified Block Schedule of four blocks per week
= 1-50 min, 2-80 min, 3-80 min, 4-50 min)

Units of Instruction

Unit 1: First Week and Introduction (Review summer assignment, 4 Classes) [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. Introduction: Themes in the Study of Life
2. The Chemical Context of Life
3. Water and the Fitness of the Environment

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

Activities:

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

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

Unit 2: Biochemistry and Introduction to the Cell (11 Classes) [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.

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

- 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.

Chapters:

- 4. Carbon and the Molecular Diversity of Life
- 5. The Structure and Function of Large Biological Molecules
- 6. A Tour of the Cell
- 7. Membrane Structure and Function

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. From *Practicing Biology*, 3rd Edition.
 - Activity 4.1/5.1 “How can you identify organic macromolecules?”
 - Activity 4.2/5.2 “What predictions can you make about the behavior of organic macromolecules if you know their structure?”
 - Activity 4.2/5.2 Test Your Understanding “Explain your reasoning as to the outcome of experiments whose outcomes depend on the chemical characteristics of the four major types of macromolecules.” **[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 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]**
4. Whole Class Discussion (Campbell, pg 91) Evolution Connection: Would you expect the amino acid sequences of all the proteins of a given set of living species to show the same degree of divergence? Why or why not? (SP 6)

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.

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.

Unit 3: Cellular Energy and Related Processes (14 Classes) [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.

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

Chapters:

- 8. An Introduction to Metabolism
- 9. Cellular Respiration
- 10. Photosynthesis

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. From *Practicing Biology*, 3rd Edition (SP 1)

Activity 9.1 A Quick Review of Energy Transformations.

Activity 9.2 Modeling cellular respiration: How can cells convert the energy in glucose to ATP.

Activity 10.1 Modeling photosynthesis: How can cells use the sun's energy to convert carbon dioxide and water into glucose (10.1 Test Your Understanding)

Activity 10.2 How do C₃, C₄, and CAM photosynthesis compare? (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]

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.

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

Big idea #2 Laboratory Investigations:

- 1. Pea Respiration. Using knowledge of the process of cellular respiration and of how to set timed experiments using the Vernier labquest and carbon dioxide probes, 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 Laboratory: 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]**

3. Laboratory: Students will be allowed to explore with the Vernier labquest system and a gas pressure probe, learning how to set up timed experiment. Concepts related to enzyme structure and function will have been learned. In this inquiry based investigation, students will design an experiment to test a variable on the rate of reaction of catalase with hydrogen peroxide. Appropriate materials will be available to them to test the variable of their choice and to explore to find answers to open ended questions that they have. Posters will be prepared for presentations to the class of the outcome, including rate calculations and meaning of data as it relates to enzyme structure and function. (Supports big idea 2; SP 2, 3, 4, 5) **[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.

Unit 4: Cell Communication and the Cell Cycle (9 Classes) **[CR2]**

Big ideas: 1, 2, 3

Connected to enduring understandings:

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

Chapters:

- 11. Cell Communication
- 12. The Cell Cycle

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. *Practicing Biology*, 3rd Edition Activity 11.1 How are chemical signals translated into cellular responses? **[CR4c]**

3. Whole class discussion: How do hormones and other signaling molecules work? (Animals and Plants, Chapters 45 and 39) **[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:

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 (7 Classes) **[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.

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

Chapters:

13. Meiosis and Sexual Life Cycles
14. Mendel and the Gene Idea
15. The Chromosomal Basis of 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]**

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

Unit 6: Gene Activity and Biotechnology (13 Classes) **[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.

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

Chapters:

16. The Molecular Basis of Inheritance
17. From Gene to Protein
18. Regulation of Gene Expression
19. Viruses
20. Biotechnology
21. Genomes and their Evolution

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]**

Activities:

1. *Practicing Biology*, 3rd Edition.

Activity 16.1 Is the hereditary material DNA or protein?

Activity 16.2 How does DNA replicate? (modeling)

Activity 17.1 Modeling transcription and translation: What processes produce RNA from DNA and protein from mRNA (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)

Big idea # 3 Laboratory Investigations:

1. Biotechnology Lab 1: Transformation. 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. Students will use micro-techniques to restrict DNA, and using a marker DNA along with “crime scene” and “suspect” DNA, predict which suspect 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)

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.

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.

Unit 7: Evolution and Phylogeny (19 Classes) **[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:

- 22. Descent with Modification: A Darwinian View of Life
- 23. The Evolution of Populations
- 24. The Origin of Species
- 25. The History of Life on Earth
- 26. Phylogeny and the Tree of Life
- 27. Bacteria and Archae

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)

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 # 1 Laboratory Investigations:

1. 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 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

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.

explore and discover using Cold Spring Harbor DNA Learning Lab: DNA Subway.
(Supports big idea 1; SP1, 3, 4, 5) **[CR6] & [CR8]**

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.

Unit 8 Diversity in the Biological World: Organism Form and Function

(22 Classes) **[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.B Organisms are linked by lines of descent from common ancestry.
- 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 and reproduction, and to maintain 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.

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.

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.

- 4.A Interactions within biological systems lead to complex properties.
 4.B Competition and cooperation are important aspects of biological systems.

Chapters:

40. Basic Principles of Animal Form and Function
 43. The Immune System
 48. Neurons, Synapses, and Signaling
 49.2 The Vertebrate Brain

(Chapters 28-49 will be utilized to provide students with resources for the enduring understandings in this unit)

Unit 8 Overview of Lecture and Discussion Topics: This section covers a broad survey of the diversity of life; specific topics will connect big ideas and enduring understandings.

1. Evolutionary trends (endosymbiosis, adaptations that allowed plants to move from water to land, reproductive adaptations of angiosperms, environmental roles of fungi, animal body plans, progressively complex derived characters in animal groups)
2. Unique features of the angiosperm life cycles
3. Signal transduction pathways (plant and animal hormones)
4. Photoperiodism in plants
5. Feedback control loops in animals
6. Thermoregulation in animals
7. Energy allocation and use in animals
8. Examples of functioning units in mammal systems (alveoli in lungs, villi of small intestines, nephrons in kidneys)
9. Structure and function in immune systems
10. Structure and function in nervous systems (neurons, resting potential, action potential, synapses)
11. Structure and function of the human brain

Activities:

1. Working with cladograms and phylogenetic trees: given groups of organisms and some of their distinguishing characteristics, students will construct a cladogram and properly interpret and analyze it in terms of how it shows common ancestry. (SP 1 ,3, 5) **[CR4a] & [CR4d]**

2. *Practicing Biology*, 3rd Edition.

Activity 29.3 How are the events in plant evolution related?

Activity 34.1 What can we learn about the evolution of chordates by examining modern chordates?

Activity 36.1 How are water and food transported in plants?

Activity 40.1 How does an organism's structure help it maintain homeostasis?

Activity 43.1 How does the immune system keep the body free of pathogens?

Activity 48.2 How do neurons function to transmit information?

3. Jumpin' the Gap: <<http://learn.genetics.utah.edu>> Students act out communication at the neural level by behaving as vesicles, neurotransmitters, receptors, secondary messengers and transporters. (SP 1, 7) **[CR4d]**

CR4a: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 1.

CR4d: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 4.

4. What affects urine production? <www.campbellbiology.com>, Chapter 44. Through animation, students explore the role of a solute gradient on maximum urine production. Next, they explore the effect of hormones on urine production. Animated experiments are run and data is collected. Students analyze the outcomes of the experiments. (SP 1, 5, 7) **[CR4a]**

CR4a: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 1.

5. Research: Can stem cell-based therapy be used in brain and spinal cord injuries? Students will prepare presentations of their findings and responses to questions such as: Should embryonic stem cell research continue to be permitted? Should it be supported by government funding? Do the origins of embryonic stem cell lines make a difference? (SP 3) **[CR4c] & [CR5]**

CR4c: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3.

Unit 9: Ecology (17 Classes) **[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.

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.

Chapters:

51. Animal Behavior
- 52.2. Interactions between organisms and the environment limit the distribution of species.
53. Population Ecology
54. Community Ecology
55. Ecosystems
56. Conservation Biology and Global Change

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

Big idea #4 Laboratory Investigations:

1. Fruit Fly Behavior Lab. Students design their own controlled experiments to investigate a question they have about animal behavior (kinesis and taxis in isopods, fruit fly 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]**

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. Community Project: A science center in the school district is working with an adjacent state park to collect water quality data (i.e.: nitrates, phosphates, and temperature) from storm water ditches after heavy rains. Baseline data is available. Data is uploaded on a web-based database. Students will analyze the data and participate in the study to find any effects of water run-off on water quality in the state park. (SP 4, 5) **[CR4d]**

3. 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]**

4. 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]**

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.

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.

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.

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 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]**

CR4d: The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 4.