AP Biology Course Overview

This AP Biology course is designed to offer students a solid foundation in introductory college-level biology. The course is designed around four major concepts called Big Ideas 1-4. **[CR2]** Each Big idea contains enduring understandings and essential knowledge that relate to the big idea. Within the enduring understandings are essential knowledge and scientific practices that all students are required to understand.

Big Idea→ Enduring Understanding→ Essential Knowledge + Scientific Practices

These instructive learning components are married to laboratories and activities which may have far less instruction and far more trial and error components where the students are required to creatively answer questions with provided materials.

At the end of the course, students will be able to interrelate the big ideas, understand the art of scientific discovery and be able to explain the impacts of all living things on each other. **[CR2]**

The four Big Ideas are:

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.

Students will be given a copy of these big ideas and enduring understandings to self-monitor mastery of these major organizing tools. We will model the relationships between the Big Ideas and between the enduring understandings and their parent Big Ideas.

Learning objectives will be used to focus students on particular biological content while using scientific practices to bolster this understanding.
[CR2], [CR3a], [CR3b], [CR3c], [CR3d], [CR4a], [CR4b], [CR4c] & [CR4d]

Textbook: Hillis, David M., David Sadavah, Richard W. Will and Mary V. Price, *The Principles of Life*, 2nd Edition, 2014, Sinauer Associates. **[CR1]**

Lab Manual: *AP Biology Investigative Labs: An Inquiry Based Approach*.

Investigative Component

Laboratory investigations will make up a minimum of 25% of instructional time. **[CR7]** Students will conduct a minimum of eight inquiry-based investigations (two per Big idea) and apply the seven science practices. **[CR6]**

Science Practices:

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

Students will maintain a written record (lab notebook) of investigations conducted. In addition, they will be asked for the following throughout the course: **[CR8]**

Formal lab report that emphasizes the development and testing of a hypothesis, the ability to organize collected data, and the ability to analyze and clearly discuss the results. **[CR8]**

Poster presentations (create poster with main investigation components; present to small groups or whole class; field questions). **[CR8]**

Self-assessments of their ability to work in group investigations that will often be conducted in teams of 2 or 3 in order for students to develop group skills and learn the importance of collaboration among scientists. **[CR8]**

Investigations: ***(CR3, CR5, CR6)***
Below is a chart indicating several investigations with corresponding Big Ideas that will be conducted throughout the year. Science Practices that will be emphasized are indicated by an "X" in the chart. All investigations will be adapted from: *AP Biology Investigative Labs: An Inquiry-Based Approach*, The College Board, 2012.

Course Schedule

The following table describes how the enduring understandings/essential knowledge statements, learning objectives and seven science practices are the focus of each unit within the course.

Investigation/ Activity	Big Idea	SP1	SP2	SP3	SP4	SP5	SP6	SP7
1. Artificial Selection (S17)	1		X	X	X	X	X	
2. Mathematical Modeling: Hardy Weinberg* (S25) **(*CR3a*)**	1	X	X			X		X
3. Comparing DNA Sequences to Understanding Evolutionary Relationships With Blast (S41) **(*CR3a*)**	1	X				X	X	X
4. Diffusion and Osmosis (S51)	2		X	X	X	X		
		SP1	SP2	SP3	SP4	SP5	SP6	SP7
5. Photosynthesis (S61)	2		X	X	X	X		
6. Cellular Respiration (S71) **(*CR3b*)**	2	X	X	X			X	X
7. Cell Division: Mitosis and Meiosis (S83)	3	X				X	X	X
8. Biotechnology:								

Bacterial Transformation (S97) **(*CR3c*)**	3	X	X	X	X	X	X	X
9. Biotechnology: Restriction Enzyme Analysis of DNA (S111)	3	X			X	X		
10. Energy Dynamics (S125)	4	X		X	X	X		
11. Transpiration (S135) **(*CR3d*)**	4	X	X			X	X	X
12. Fruit Fly Behavior (S145)	4	X		X	X	X		
13. Enzyme Activity (S153)	4			X	X	X	X	

Units of Instruction

Unit 1: Principles of Life, Evolution and Diversity
Big ideas: 1, 4
Chapter 1 sections 1 and 4 (1.1, 1.4)
Chapter 15 sections 1-7 (15.1-15.7)
Chapter 16 sections 1-4 (16.1-16.4)
Chapter 17 sections 1-4 (17.1-17.4)
Chapter 19 sections 1-3
Chapter 20 sections 1-4
Chapter 22 sections 1-4

Connected to enduring understandings: **[CR3a]**
1.B.1 Living organisms share common aspects of structure, function and energy flow.
1.A.2 Evolution explains the diversity and the unity of life.
1.A.4 Biological evolution is supported by scientific evidence.
1.A.1 Natural selection is a major mechanism of evolution.
4.C.3 The level of variation in a population affects population dynamics.
1.C.1 Speciation and extinction have occurred throughout Earth's history.
1.B.2 Phylogenetic trees and cladograms are models of evolution.
Laboratory Investigations **[CR6] [CR7] [CR8]**

Artificial selection "Trichomes" – Observe the effect of artificial selection with the number of trichomes in the F1 generation varying significantly from the number in the P generation. **[CR6]**
Mathematical Modeling: Hardy-Weinberg – Build a spreadsheet that models how a hypothetical gene pool changes from one generation to the next. This will permit study of parameters that affect allele frequency. **[CR6] [*CR3a*]**
Comparing DNA Sequences to Understanding Evolutionary Relationships With Blast **[CR6] [*CR3a*]**

Activities **[CR4a]**
Hide and go Beak
Lesson of the Kaibob
NOVA; PBS video: "What Darwin Never Knew" **[CR3c], [CR4a], [CR5]**

Unit 2: Cells, Membranes and Cell Signals
Big ideas: 2, 3
Chapter 2 sections 2.1-2.5
Chapter 4 sections 4.1-4.5
Chapter 5 sections 5.1-5.6
Chapter 30 sections 30.1-30.4
Chapter 34 sections 34.1-34.5
Chapter 36 sections 36.1-36.3

Connected to enduring understandings: **[CR3b]**
2.A.3 Living organisms must exchange matter.
2.B.3 Eukaryotic cells maintain membranes.
2.B.1. Cell membranes are selectively permeable
2.D.2 Homeostatic mechanisms reflect common ancestry and divergence.

Laboratory Investigations **[CR6] [CR7] [CR8]**
Diffusion and Osmosis – Students will investigate the relationship among surface area, volume and the rate of diffusion. They will design experiments to measure the rates of osmosis.
Dialysis Lab

Activities **[CR4b]**
Fluid Mosaic Modelling of the cell membrane
Biomolecular Modeling

Unit 3: Biochemistry
Big ideas: 2, 3
Chapter 3 sections 3.3-3.4
Chapter 6 sections 6.1-6.4
Chapter 13 sections 13.1-13.4

Connected to enduring understandings: **[CR3c]**
3.A.1 DNA and RNA are the primary sources of heritable information.

2.A.2 Organisms capture and store free energy for use in biological processes.
2.c.2 Organisms respond to changes in their environment.
3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.
3.C.1 Changes in genotype can result in changes in phenotype.
4.C.2 Environmental factors influence the expression of the genotype in an organism.

Laboratory Investigations **[CR6] [CR7] [CR8]**
Bacterial Transformation –Students will investigate horizontal gene transfer in bacteria. They will explore the relationship between environmental factors and gene expression. Students will investigate the regulation of gene expression and how genetic information can be transferred between organisms.
Restriction Enzyme analysis

Activities **[CR4]**
Paper plasmid lab

Unit 4: Genetics
Big ideas: 2, 3
Chapter 7 sections 7.1-7.5
Chapter 8 sections 8.1-8.3
Chapter 9 sections 9.1-9.3
Chapter 10 sections 10.1-10.5
Chapter 11 sections 11.1-11.4
Chapter 12 sections 12.1-12.4
Chapter 14 sections 14.1-14.4

Connected to enduring understandings: **[CR2]**
3.A.2 In eukaryotes, heritable information is passed to the next generation.
3.A.3 The chromosomal basis of inheritance provides an understanding of gene passage.
3.B.1 Gene regulation results in differential gene expression, leading to cell specialization.
3.C.3 Viral replication results in genetic variation.
2.E.1 Timing and coordination of specific events are necessary for the normal development of an organism. **[CR3b]**

Laboratory Investigations **[CR6] [CR7] [CR8]**
Gummy Bear Genetics
Cell Division: Mitosis and Meiosis – Students will explain how DNA is transmitted to the next generation via mitosis and meiosis. They will understand how meiosis and crossing over leads to increased genetic diversity.

Activities **[CR4c]**
Human Traits activity

Watch the film GATTACA **[CR5]**
Reebops

Unit 5: Plant Biology
Big ideas: 1, 2, 3, 4
Chapter 21 sections 21.1-21.5
Chapter 24 sections 24.1-24.3
Chapter 25 sections 25.1-25.4
Chapter 26 sections 26.1-26.4
Chapter 27 sections 27.1-27.3
Chapter 28 sections 28.1-28.3

Connected to enduring understandings: **[CR2]**
3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression.
2.A.3 Organisms must exchange matter with the environment to grow, reproduce and maintain organization.
2.C.1 Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes.
2.C.2 Organisms respond to chages in their external environments.
2.D.3 Biological systems are affected by disruptions to their dynamic homeostasis.**[CR3c]**
2.D.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.

Laboratory Investigations **[CR6] [CR7] [CR8]**
Photosynthesis lab – Students will conduct an experiment that demonstrates oxygen gas production of plant leaves. They will relate plant structure and function to their results.
Transpiration lab – Students will relate the density of stomata per species of plant to the transpiration rate of that plant. They will design experiments to test other factors that may affect transpiration. The students will relate the structure and function of the plant leaves to their experimental results.

Activities **[CR4]**
Comparison of electron transport in respiration and photosynthesis **[CR4b] [CR4c]**

Unit 6: Animal Biology
Big ideas: 1, 2, 3, 4
Chapter 23 sections 23.1-23.7
Chapter 29 sections 29.1-29.5
Chapter 32 sections 32.1-32.5
Chapter 33 sections 33.1-33.5
Chapter 37 sections 37.1-37.5
Chapter 38 sections 38.1-38.6
Chapter 39 sections 39.1-39.4

Chapter 40 sections 40.1-40.5
Chapter 41 sections 41.1-41.6

Connected to enduring understandings: **[CR2]**
1.C.2 Speciation may occur when two populations become reproductively isolated from each other.
2.B.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
2.D.1 All biological systems are affected by complex biotic and abiotic interactions.
2.E.2 Timing and coordination of physiological events are regulated by multiple mechanisms.**[CR3c]**
2.E.3 Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.
3.E.2 Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.
4.B.4 Distribution of local and global ecosystem changes over time. **[CR4d]**
4.C.1 Variation in molecular units provides cells with a wider range of functions.

Laboratory Investigations **[CR6] [CR7] [CR8]**
Fruit Fly Behavior – Students will investigate the relationship between a fruit fly and environmental conditions. They will design a controlled experiment to either attract or repel fruit flies. The students will connect concepts such as genetics, animal behavior and development.

Activities **[CR4]**
Blood Pressure activity **[CR4d]**

Unit 7: Ecology
Big ideas: 1, 2, 4
Chapter 42 sections 42.1-42.6
Chapter 43 sections 43.1-43.6
Chapter 44 sections 44.1-44.4
Chapter 45 sections 45.1-45.6
Chapter 46 sections 46.1-46.6

Connected to enduring understandings: **[CR3d]**
1.C.3 Populations of organisms continue to evolve.
2.A.1 All living systems require constant input of free energy.
4.A.5 Communities are composed of populations of organisms that interact in complex ways.
4.A.6 Interactions among living systems result in the movement of matter and energy.
4.C.4 The diversity of species within an ecosystem may influence the stability of the ecosystem.

Laboratory Investigations **[CR6] [CR7] [CR8]**

Energy Dynamics lab - Students will investigate about energy capture and flow in an ecosystem. They will interspecific ecological interactions and their effects. The students will make the explicit connection between biological content and the investigative experience.

Activities **[CR4d]**
Endangered species activity **[CR4d]**
Discuss global warming **[CR5]**