AP Biology Course Syllabus

Course Overview

The goal of this AP biology course is to prepare students to transition from high school to college by developing their critical thinking and problem solving skills, laboratory techniques, and establishing an enduring understanding of biological concepts. In order to accomplish these goals it is essential to engage students in the course through the use of hands-on activities and laboratory investigations that allow for inquiry-based learning. That being said approximately 35% of this course will be completed within a lab setting [CR7]. The labs will focus on hypothesis development, creating controlled experimental designs, data collection and analysis, and discussion of results. A minimum of two labs will be conducted in each Big Idea category however time permitting three labs for each Big Idea would be preferred [CR6]. The students will be responsible for composing formal lab reports for all labs and for presenting their findings on specified labs [CR8].

Another goal of this course is to make students aware of the current issues in science by linking current developments to discussed topics. Students are required to submit one abstract per quarter from reputable, easily available journals such as *Science, Scientific American, National Geographic,* or *Nature* that link the topic being studied to a current social concern or to an advancement in technology. These abstracts form the basis of the Current Development discussions [CR5].

Student Evaluation:

Grades are calculated on an unweighted total of points that typically break down as:

- Homework : ~ 10%
- Lab Reports: ~ 40%
- Tests & Quizzes: ~40%
- Class work and activities: ~10%

There is no extra credit, so put forth the effort the first time through.

Meeting Times:

Three 45-min. periods and two 90-min. periods every five days with a *minimum* of 90 min. every five days spent with students conducting labs.

Textbooks/Resources

Each student will have access to receive a copy of [CR1]:

- (2001). *AP Biology Lab Manual*. U.S.A.: College Entrance Examination Board.
- Campbell, N., & Reece, J. (2005). *AP Edition Biology 7th Edition*. San Francisco: Pearson Education, Inc..

Students will have access to:

- Released multiple choice and free response questions on old AP exams
- Morgan, J., & Carter, E. (2005). *Investigating Biology Laboratory Manual*. San Francisco: Pearson Education, Inc..
- Wartski, Burt (2005). *Biology Advanced Placement Teacher Manual*. North Carolina: Duke University Talent Identification Program.
- *AP Biology Investigative Labs: An Inquiry-Based Approach Student Manual,* The Colelge Board, 2012.
- Copies of procedures and lab questions for any labs that are not located within the AP Biology Lab Manual

AP Biology Course Content and Curriculum Requirements:

This AP Biology course meets all of the standards put forth by the College Board for AP courses and covers all of the enduring understandings encompassed by the four big ideas from the AP Biology Curriculum Framework. The interconnectedness of the four big ideas tie the units together to emphasize broad concepts in biology.

<u>Big Ideas and Supporting Enduring Understandings</u>

- Big Idea 1: The process of evolution drives the diversity and unity of life.
    - EU 1.A: Change in the genetic make up of a population over time is evolution.
    - EU 1.B: Organisms are linked by lines of descent from common ancestry.
    - EU 1.C: Life continues to evolve within a changing environment
    - EU 1.D: The origin of living systems is explained by natural processes

- Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis
    - EU 2.A: Growth, reproduction, and maintenance of the organization of living systems require free energy and matter.
    - EU 2. B: Growth, reproduction, and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.

    - EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction and to maintain dynamic homeostasis.
    - EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
    - EU 2.E: Many biological processes involved in growth, reproduction, and dynamic homeostasis include temporal regulation and coordination.

- Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes.
    - EU 3.A: Heritable information provides for continuity of life.
    - EU 3.B: Expression of genetic information involves cellular and molecular mechanisms.
    - EU 3.C: The processing of genetic information is imperfect and is a source of genetic variation.
    - EU 3.D: Cells communicate by generating, transmitting, and receiving chemical signals.
    - EU 3.E: Transmission of information results in changes within and between biological systems.

- Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.
    - EU 4.A: Interactions within biological systems lead to complex properties.
    - EU 4.B: Competition and cooperation are important aspects of biological systems.
    - EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions within the environment.

<u>Science Practices for AP Biology</u>

- SP 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.
- SP 2: The students 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.

AP Biology Units & Activities (2012 – 2013)

I. Introduction of Major Themes (Summer Assignment + 3 days)

1. Readings

    a. Chapter 1: *Introduction and Major Themes*

    (Campbell and Reece, 2005)

    b. Summarizing Your Data, Data Analysis and Graph

    (www.sciencebuddies.org, 2010)

2. Lab

    a. Topic 1: Lab Scientific Investigation and Presentation of Data (SP 2)

    (Morgan and Carter, 2005)

II. Molecules, Cells, & Energy—Big Ideas 1, 2, 3, & 4 [CR2]

A. Molecules—Big Idea 4 (Summer Assignment + 9 days)

1. Readings

    a. Chapter 2: *The Chemical Context of Life*

    b. Chapter 3: *Water and the Fitness of the Environment*

    c. Chapter 4: *Carbon and the Molecular Diversity of Life*

    d. Chapter 5: *The Structure & Function of Macromolecules*

2. Labs

    a. Safe Laboratory Practices and Lab Techniques

    Purpose – Reinforce safety procedures and practice lab techniques

    b. Water Properties

    Purpose – Design several demonstrations that illustrate various water properties.

    c. AP Inquiry Lab: *Diffusion and Osmosis* (SP 2, 3, 4, & 5)

Purpose – Investigate diffusion, osmosis, and water potential with a membrane model and plant tissue.

3. Supplemental/Extension Activities

a. Free Response Practice

b. Current Event Abstract

c. Using kits to build macromolecule models [CR4a] (SP 1)

d. Have students create a video, song, or poster about element cycles including amounts and how much each element is transferred during different events [CR4b], [CR4d], & [CR8]

B. The Cell: Structure and Function—Big Ideas 1 & 2 (Summer assignment + 9 days)

1. Readings

a. Chapter 6: *A Tour of the Cell*

b. Chapter 7: *Membrane Structure and Function*

c. Chapter 11: *Cell Communication*

2. Labs

a. Microscopy

Purpose – Video Capture of Live Cells

b. Lab Topic 3: Microscopes and Cells (Morgan and Carter, 2005)

Purpose – Become proficient in the use of light microscopy and observe living cells and describe their structures.

c. Duke TIP: *Gelatin and Enzyme Activity (Activity 2)* (Wartski, 2005)

Purpose – Design an experiment with gelatin and laundry detergent to observe enzyme reactions and to determine the most effective laundry detergent per price. [CR4b]

d. AP Lab*: Restriction Enzyme Analysis* (SP 3 & 6)

Purpose: - Study enzyme-catalyzed reactions by varying temperature, pH, and enzyme concentration of the process

3. Supplemental/Extension Activities

a. Articles about organelle-based health problems

b. Observing normal versus plasmolyzed cells

c. modeling/comparing 3 different cell types from 3 different kingdoms [CR3a], [CR4a], [CR4c], & [CR8]

d. Cell feedback mechanism presentations

e. Reading/discussion on the evolution of eukaryotic cell formation via the endosymbiont hypothesis [CR3b]

C. Cellular Energetics, Cell Communication, and Immunity—Big Ideas 1, 2, 3, & 4 (24 days)

1. Readings

a. Chapter 8: *An Introduction to Metabolism*

b. Chapter 9: *Cellular Respiration*

c. Chapter 43: *The Immune System*

2. Labs

a. AP Lab: *Cell Respiration* (SP 1, 2, 3, & 6)

Purpose – Use germinating and nongerminating peas and respirometers to measure the rate of cell respiration at various temperatures to identify and measure factors that influence cell respiration.

b. AP Lab: *Cell Cycle – Part A* (SP 1, 5, 6, & 7)

Purpose – Estimate the length of the cell cycle stages using fixed slide specimens.

c. ELISA Lab

Purpose- Have students understand that antibodies are specific and bind only to the compatible epitopes on various antigens

3. Supplemental/Extension Activities

a. Statistical Analysis of Experimental Data

b. Practice AP Exam

c. Current Event Abstract

III. Heredity and Evolution—Big Ideas 1 & 3 (25%)

A. Heredity (12 days)

1. Readings

a. Chapter 12: *The Cell Cycle*

b. Chapter 13: *Meiosis and Sexual Life Cycle*

c. Chapter 14: *Mendelian Genetics*

d. Chapter 15: *The Chromosomal Basis of Inheritance*

2. Labs

a. AP Lab: *Cell Cycle – Part B* (SP 1, 5, 6, & 7)

Purpose – Use *Sordaria fimicola* to study the crossing over and recombination that occurs during meiosis.

b. AP Lab: *Genetics of Organisms* (SP 1, 3, 4, 5, 6, & 7)

Purpose – Conduct genetic crosses with *Drosophilia melanogaster* and collect data from multiple generations to further understand the principles of independent assortment and sex-linked genes.

c. Duke TIP: *Genetic Dice Lab (Activity 7)*

Purpose – Compare the predicted and actual probability of blood groups in a population using labeled dice.

d. AP Investigative Lab: Mitosis and Meiosis (E.U. 3.A connects to BI1) [CR3c] & [CR6]

3. Supplemental/Extension Activities

a. Fly Fundamentals

b. Free Response Practice

c. Chi-Square Analysis Activity

d. Current Event Abstract

e. Karyotyping lab with research on the genetic condition shown in the karyotype [CR4c]

B. Molecular Genetics (15 days)

1. Readings

a. Chapter 16: *The Molecular Basis of Inheritance (DNA)*

b. Chapter 17: *From Gene to Protein*

c. Chapter 18: *The Genetics of Viruses and Bacteria*

d. Chapter 19: *Eukaryotic Genomes: Organization, Regulation, and Evolution*

e. Chapter 20: *DNA Technology and Genomics*

f. Chapter 21: *The Genetic Basis of Development (skim)*

2. Labs

a. Investigative AP Lab: *Molecular Biology* (SP 1, 3, 5, 6, & 7)

Purpose – Investigate basic principles of genetic engineering by transforming *E. coli* to be more resistant to certain antibiotics. Gel electrophoresis will be used to separate DNA fragments that have undergone a restriction enzyme digest.

b. Duke TIP: *Amylase Regulation in Prokaryotes (Activity 5)*

Purpose – Observe the regulation of amylase in prokaryotic cells and explain the regulation using the operon model.

c. DNA extraction

Purpose- Students will design a procedure that should successfully enable them to extract DNA from a strawberry based on the structure of cells and DNA

3. Supplemental/Extension Activities

a. Paper Plasmid Activity

Purpose – Use paper to model a restriction enzyme digest and develop a map of the transformed plasmid.

b. Current Event Abstract

c. Research project on the history of DNA

Purpose- Students should knowhow scientists determined that DNA not proteins transmitted genetic information from one generation to the next.

d. Applications of genetic engineering and the ethics of manipulating organisms [CR5]

- read an excerpt from *The Immortal Life of Henrietta Lacks* and discuss applications of cell lines

C. Evolutionary Biology (11 days)

1. Readings

a. Chapter 22: *Decent With Modification*

b. Chapter 23: *The Evolution of Populations*

c. Chapter 24: *The Origin of Species*

d. Chapter 25: *Phylogeny and Systematics*

e. Chapter 26: *The Tree of Life (selected sections)*

2. Labs

a. AP Lab: *Population Genetics* (SP 2 & 5)

Purpose - Study the Hardy-Weinberg Theorem, evolution, and allele frequency using the class members and rules to model various changes in populations.

b. Duke TIP: *Evolution With Food (Activity 8)*

Purpose – Use a simple food model to demonstrate the concept of evolution through natural selection.

c. Lab Topic 11: *Population Genetics I: The Hardy-Weinberg Theorem* (SP 2 & 5)

Purpose – Use a bead model to demonstrate the conditions necessary for evolution and be able to describe the conditions necessary to maintain Hardy-Weinberg equilibrium.

3. Supplemental/Extension Activities

a. Current Event Abstract

IV. Organisms and Populations—Big Ideas 1, 3, & 4 (50%)

A. Diversity of Organisms (8 days)

1. Readings

a. Chapter 27: *Prokaryotes*

b. Chapter 28: *Protists*

c. Chapter 31: *Fungi*

d. Chapter 32: *An Introduction to Animal Diversity*

e. Chapter 33: *Invertebrates*

2. Labs

a. Lab Topic 13: *Bacteriology (Gram Staining*)

Purpose - Learn Gram Staining techniques and how it relates to cell wall chemistry. Practice asceptic techniques to produce bacterial streaks, smears, and lawns. Apply knowledge of the control of bacterial growth to life situations,

b. Lab Topic 14: *Protists and Fungi (Selected Portions)*

Purpose – Study several samples of protists and fungi and identify several characteristics of each organism. Design and perform an independent investigation of one of the organisms.

3. Supplemental/Extension Activities

a. Current Event Abstract

B. Structure and Function of Animals (20 days is possible)

1. Readings

    a. Chapter 34: *Vertebrates – Overview*

    b. Chapter 40: *Basic Principles of Animal Form & Function*

    c. Chapter 41: *Animal Nutrition (part)*

    d. Chapter 42: *Circulation & Gas Exchange*

    e. Chapter 43: *The Immune System**

    f. Chapter 44: *Osmoregulation & Excretion**

    g. Chapter 45: *Hormones & the Endocrine System*

    h. Chapter 46: *Animal Reproduction*

    i. Chapter 47: *Animal Development*

    j. Chapter 48: *Nervous System**

    k. Chapter 49: *Sensory and Motor Mechanisms*

** = indicates a required system other systems may or may not be discussed in class based on time constraints*

2. Labs

    a. AP Lab: *Physiology of the Circulatory System*

        Purpose – Study the circulatory system by measuring the heart rate of students under various physical conditions and observe *Daphnia magna* under various temperature conditions.

    b. Microscope – Tissue Identification

        Purpose – Examine fixed slide specimens to identify the characteristics of major tissue types.

    c. Lab: Senses and Nervous System

    d. Cat dissection

        Purpose – Use a fixed specimen to study muscle anatomy in detail

3. Supplemental/Extension Activities

a. Midterm Paper – Comparative analysis of two systems across invertebrate and vertebrate phyla/classes (including evolutionary adaptations) and a thorough discussion of all systems within one phylum/class

C. Structure and Function of Plants (16 days)

1. Readings

a. Chapter 10: *Photosynthesis*

b. Chapter 29: *Plant Diversity I: How Plants Colonized Land*

c. Chapter 30: *Plant Diversity 2: The Evolution of Seed Plants*

d. Chapter 35: *Plant Structure, Growth, and Development*

e. Chapter 36: *Transport in Vascular Plants*

f. Chapter 37: *Plant Nutrition*

g. Chapter 38: *Angiosperm Reproduction & Biotechnology*

h. Chapter 39: *Plant Responses to Internal & External Signals*

2. Labs

a. Duke TIP: *Plant Identification (Activity 9)*

Purpose – Use knowledge of classification techniques to identify several plants.

b. Microscope – Monocot/Dicot Identification

c. AP Investigative Lab: *Plant Pigments and Photosynthesis* (SP 3, 4, 6, & 7)

Purpose – Use DPIP to measure the rate of photosynthesis at various rates.

d. Lab Topic 19: *Plant Anatomy*

Purpose – Identify the structure and function of each cell type and tissue and relate its function to its structure. Relate primary and secondary growth to the growth habitat and adaptation of land plants as illustrated by its structure and function.

e. AP Investigative Lab: *Transpiration* (SP 2, 3, 4, & 5)

Purpose- Students will investigate water movement through plants using model systems

3. Supplemental/Extension Activities

a. Current Event Abstract

b. Plant dissection

D. Ecology (12 days)

1. Readings

a. Chapter 50: *Ecology Introduction*

b. Chapter 51: *Behavioral Ecology*

c. Chapter 52: *Population Ecology*

d. Chapter 53: *Community Ecology*

e. Chapter 54: *Ecosystems*

f. Chapter 55: *Conservation Biology & Restoration Ecology*

2. Labs

a. AP Lab: *Dissolved Oxygen and Aquatic Primary Productivity* (EU 4.A connects to BI 1) [CR3d], [CR5] & [CR6] (SP 2, 3, 4, 5, 6, & 7)

Purpose – Analyze the amount of dissolved oxygen in pond water under various conditions to measure primary productivity. Also to explore the relationship between temperature and dissolved oxygen.

b. Duke TIP: *Population Estimation and Growth Stimulation (Activity 11)*

Purpose – Use the mark and recapture method on a model population to estimate the size of a population, observe the effects of the population's carrying capacity.

c. Investigative Lab: *Fruit Fly Behavior* (SP 1, 3, 4, 5, 6, & 7)

Purpose- Students will design experiments and investigate the effect of different environmental factors on fruit fly behavior

3. Supplemental/Extension Activities

a. Denali Research Project

Purpose – Become aware of current research in an expansive environment. Write a proposal for additional research describing the ultimate and proximate questions, methods, and funding.

V. Exam Review (8 days)

1. Review Class Study Guides
2. AP Exam Prep Book
3. Practice exam

Works Cited

AP Biology Investigative Labs: An Inquiry-Based Approach Student Manual, The College Board, 2012.

AP Biology Lab Manual. U.S.A.: College Entrance Examination Board. 2001.

AP Biology Workshop Handbook and Resources. The College Board, 2012.

Campbell, N., & Reece, J. (2005). *AP Edition Biology 7th Edition*. San Francisco: Pearson Education, Inc..

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Waterman, M., & Stanley, E. (2005). *Biological Inquiry*. San Francisco: Pearson Education, Inc..