Advanced Placement Biology Syllabus

The Advanced Placement (AP) Biology Course is designed to give students a college-level survey course. It emphasizes the biological concepts as specified in the theme Topics: 1) molecules and cells, 2) heredity and evolution 3) organisms and populations and 4) environmental and social concerns. The students will develop an understanding of science as a process rather than an accumulation of facts, recognition of evolution as the foundation of modern biological models and thoughts, the integration of the general topics of biological knowledge and critical thinking to environmental and social concerns. The main goals of the AP Biology course are for students to have a solid understanding of the concepts in biology and to grasp its relevance to themselves and society. It also aims to promote self-learning among the students. AP Biology includes a laboratory component that fulfills all of the objectives of the 12 recommended AP Biology Laboratories. Students spend a minimum of 25% of instructional time engaged in hands-on laboratory work.

The AP Course is organized into eight units, and the following syllabus is distributed to students on the first day of class. Every unit includes an exercise designed to integrate the topic of that unit into the eight major themes of the AP Biology Course Description. Throughout the time spent on each unit, the class will discuss how the topic at hand relates to and fits within each theme and how these themes transcend all of the unit topics. For example, in Unit 1 (Ecology and Behavior):

Theme 1 – Science as Process – Students engage in a project demonstrating the use of scientific reasoning to solve a problem.

Theme 2 – Evolution – Students compare ecological time with evolutionary time and examine how they correspond.

Theme 3 – Energy transfer – Students are asked to describe the movement, conversion, and storage of energy within an ecosystem, usually originating with the sun, then stored and converted to chemical energy by autotrophs, then passed on to heterotrophs and/or dissipated as heat.

Theme 4 – Continuity and change – Students are asked to consider how specific changes to an ecosystem (geological, climatic, introduction of new organisms, etc.) can affect the organisms that live within it.

Theme 5 – Relationship of Structure to Function – Students consider how organisms are physically adapted to survive and reproduce in their environment.

Theme 6 – Regulation – Students are to understand how an organism's regulatory mechanisms (such as those that control body temperature) serve to aid or hinder its survival in particular environments.

Theme 7 – Interdependence in Nature – The very key to ecology – how organisms interact within their environment, and how they cannot survive without such interactions.

Theme 8 – Science, Technology and Society – Students are asked to consider how the population growth of human beings has influenced local ecosystems throughout history, and how it continues to do so, even to the extent of affecting the entire biosphere.

The sources utilized for this class are as follows:

Campbell, Neil A., and J. Reece, and L. Mitchell. (2002).Biology, 6th Edition, Benjamin Cummings Publishing.

Campbell, Neil A., and J. Reece, and L. Mitchell. (2002). Student Study Guide for Campbell's Biology, 6th Edition, Benjamin Cummings Publishing.

Campbell, Neil A., and J. Reece, and L. Mitchell. (2002). CD-ROM: Interactive Study Partner, 6th Edition, Benjamin Cummings Publishing.

College Board. AP Biology Lab Manual for Students (2001). I.N. 991461

Textbook website: www.phschool.com/access

AP Biology Lecture & Lab 2006-2007 Course Syllabus

I. Molecules & Cells (25%)

Topics	Required Readings	# of days & % of AP Exam	Labs & Assessments	Major Assignments & Projects
A. Chemistry of Life • Introduction • Water • Organic molecules in organisms	Ch 1 & 2 (read on your own) Ch 3 Ch 4, 5 & 6	+/- 11 7%	"Toothpickase" from Carolina Scientific (1 class) Lab #2 Enzyme Catalysis (2 classes) <u>Assessment</u> Ch 3-6	Science Project AP Current Biological Research Project (2 summaries of journal articles per 9 weeks)
B. Cells • General cell structure & function • Membranes • Cellular Energetics 1. Fermentation & Cellular Respiration 2. Photosynthesis 3. Sub-cellular, Cell cycle, & Cellular Communication	 Ch 7 Ch 8 Ch 9 Ch 10 Ch 11 & 12	+/- 27 18%	Lab #1 Diffusion & Osmosis (2 classes) <u>Assessment</u> Ch 7-8 Lab #5 Cell Respiration (2 classes) Original Set up and GLX Explorer Hardware Lab #4 Plant Pigments & Photosynthesis (1-2 class periods) <u>Assessment</u> Ch 9 & 10 Lab #3 Mitosis & Meiosis (2 class periods) <u>Assessment</u> Ch 11 & 12	Science Project

II. Heredity & Evolution (25%)

Topics	Required Readings	# of days & % of AP Exam	Labs & Assessments	Major Assessments & Projects
C. Heredity • Meiosis & Gametogenesis • Inheritance patterns • Eukaryotic chromosomes	Ch 13 Ch 14 Ch 15	+/- 11 17%	Lab # 7 Genetics of Organisms & Chi-Square Analysis (5-6 classes) or M & M®Lab (1 class) **Assessments** Ch 13-15	Science Project AP Current Biological Research Project (2 per nine weeks)
D. Molecular Genetics • RNA & DNA • Viral structure, replication, nucleic acid technology • Gene regulation • Mutations	Ch 16 & 17 Ch 18 Ch 19	+/- 20	Lab # 6 Molecular Biology (2 classes) Actual or Virtual Lab DNA Extraction Lab (1 class) **Assessment** Ch 16 & 17 **Assessment** Ch 18 & 19	Science Project
E. Evolutionary Biology & Diversity of Organisms • Early evolution & survey of diversity (historic background behind Darwin's Theory) • Evidence for Evolution & Evolutionary Patterns • Mechanisms of Evolution & Evolutionary relationships • Modern Synthesis, population genetics • Natural Selection, microevolution events, preservation of variation • Phylogenetic classification	Ch 22 Ch 23 Ch 24 Ch 25	+/-20 8% 8%	Lab # 8 Population Genetics (1 class) **Assessment** Ch 22-25	*Lab:* Genetics of Organisms (AP Lab 7) *Lab:* Population Genetics and Evolution (AP Lab 8) Debate The class is organized into two groups, pro and con, based on a controversial issue in biology. The students select three leaders to represent their side of the panel. Members of each group provide the panel with information to help them win the debate. The winning side

				formulates the most well-documented counterarguments. The side that wins the debate is treated to lunch, usually pizza, the day before school ends for the winter break. This is a nongraded assignment. Topics have included stem cell research and female preference in dating.

III. Organisms & Population (50%)

Topics	Required Readings	# of days & % of AP Exam	Labs	Projects
F. Plants • Plant structure & growth • Nutrition & transport in plants • Reproduction & Development responses in plants	Ch 35 Ch 36-37 Ch 38-39	+/- 20 12%	Lab #9 Transpiration (2 classes) Assessment Ch 35-37 Lab # 12 Dissolved Oxygen & Aquatic Primary Productivity (2 classes)	AP Current Biological Research Project (2 per nine weeks) Plant Project
G. Animals • Digestive & Excretory • Circulatory & Respiratory • Lymphatic • Endocrine • Reproductive & Development • Nervous, Sensory, & Muscular/Skeletal	Ch 41 & 44 (Presentation) Ch 42 (Presentation) Ch 43 (Presentation) Ch 45 (Presentation) Ch 46/47 (Presentation) Ch 48/49 (Presentation)	+/- 25 20%	Assessment Ch 38/39 Lab #10 Physiology of the Circulatory System (1 class) Lab #11 Animal Behavior (1 class) Fetal Pig Dissection (1-2 classes)	Body Systems Project Lesson Planning Project
H. Ecology	Ch 50-55	+/- 6 10%		

Laboratory Objectives

Lab# 1 DIFFUSION AND OSMOSIS

In this laboratory you will investigate the process of diffusion and osmosis in a model of a membrane system. You also will investigate the effect of solute concentration on water potential as it relates to living plant tissues.

OBJECTIVES

- the mechanisms of diffusion and osmosis and their importance to cells
- the effects of solute size and concentration gradients on diffusion across selectively permeable membranes
- the effects of a selectively permeable membrane on diffusion and osmosis between two solutions separated by the membrane
- the concept of water potential
- the relationship between solute concentration and pressure and the water potential of a solution
- the concept of molarity and its relationship to osmotic concentration
- measure the water potential of a solution in a controlled experiment
- determine the osmotic concentration of living tissue or an unknown solution from experimental data
- describe the effects of water gain or loss in animal and plant cells
- relate osmotic potential to solute concentration and water potential

LAB# 2 ENZYME CATALYSIS

In this laboratory you will measure the amount of product generated and then calculate the rate of conversion of hydrogen peroxide (H_2O_2) to water and oxygen gas by the enzyme catalase.

OBJECTIVES

- the general functions and activities of enzymes
- the relationship between the structure and function of enzymes
- the concepts of initial reaction rates of enzymes
- how the concept of free energy relates to enzyme activity
- how pH relates to enzyme activity

- that changes in temperature, pH, enzyme concentration, and substrate concentration can affect the initial reaction rates of enzyme-catalyzed reactions
- measure the effects of changes of temperature, pH, enzyme concentration, and substrate concentration on reaction rates of an enzyme-catalyzed reaction in a controlled experiment
- explain how environmental factors affect the rate of enzyme-catalyzed reactions

LAB# 3 MITOSIS AND MEIOSIS

Exercise 3A is a study of mitosis. You will use prepared slides of onion root tips to study plant mitosis and to calculate the relative duration of the phases of mitosis in the meristem of root tissue. Prepared slides of the whitefish blastula will be used to study mitosis in animal cells and to compare animal mitosis and plant mitosis

Exercise 3B is a study of meiosis. You will simulate the stages of meiosis by using chromosome models. You will study the crossing over and recombination that occurs during meiosis. You will observe the arrangements of ascospores in the asci from a cross between wild type and mutants for tan spore coat color in the fungus *Sordaria fimicola*. These arrangements will be used to estimate the percentage of crossing over that occurs between the centromere and the gene that controls that tan spore color.

OBJECTIVES

- the key mechanical and genetic differences between meiosis and mitosis
- the events of mitosis in animal and plant cells
- the events of meiosis (gametogenesis) in animal and plant cells
- recognize the stages of mitosis in a plant or animal cell
- calculate the relative duration of the cell cycle stages
- describe how independent assortment and crossing over can generate genetic variation among the products of meiosis
- use chromosome models to demonstrate the activity of chromosomes during Meiosis I and Meiosis II
- relate chromosome activity to Mendelian segregation and independent assortment
- calculate the map distance of a particular gene from a chromosome's center for between two genes using an organism of your choice in a controlled experiment
- demonstrate the role of meiosis in the formation of gametes using an organism of your choice, in a controlled experiment
- compare and contrast the results of meiosis and mitosis in plant cells
- compare and contrast the results of meiosis and mitosis in animal cells

Lab# 4 PLANT PIGMENTS AND PHOTOSYNTHESIS

In this laboratory you will separate plant pigments using chromatography. You also will measure the rate of photosynthesis in isolated chloroplasts. The measurement technique involves the reduction of the dye, DPIP. The transfer of electrons during the light-dependent reactions of photosynthesis reduces DPIP and changes its color from blue to colorless.

OBJECTIVES

- how chromatography separates two or more compounds that are initially present in a mixture
- the process of photosynthesis
- the function of plant pigments
- the relationship between light wavelength or light intensity and photosynthetic rate
- separate pigments and calculate their Rf values
- describe a technique to determine photosynthetic rates
- compare photosynthetic rates at different temperatures, different light intensities, and different wavelengths of light in a controlled experiment
- explain why the rate of photosynthesis vary under different environmental conditions

LAB# 5 CELL RESPIRATION

Seeds are living but dormant. When conditions necessary to begin growth are achieved, germination occurs, cellular reactions are accelerated, and the rate of respiration greatly increases. In this laboratory you will measure oxygen consumption during respiration as the change in gas volume in respirometers containing either germinating or nongerminating peas. In addition, you will measure the respiration of these peas at two different temperatures.

OBJECTIVES

- how a respirometer works in terms of the gas laws
- the general process of metabolism in living organisms
- test the effects of temperature on the rate of cell respiration in ungerminated versus germinated seeds in a controlled experiment
- calculate the rate of cell respiration from experimental data

- relate gas production to respiration rate

LAB# 6 MOLECULAR BIOLOGY

In this laboratory, you will investigate some basic principles of genetic engineering. Plasmids containing specific fragments of foreign DNA will be used to transform *Escherichia coli* cells, conferring antibiotic (ampicillin) resistance. Restriction enzyme digests of phage lambda DNA also will be used to demonstrate techniques for separating and identifying DNA fragments using gel electrophoresis.

OBJECTIVES

- how gel electrophoresis separates DNA molecules present in a mixture
- the principles of bacterial transformation
- the conditions under which cells can be transformed
- the process of competent cell preparation
- how a plasmid can be engineered to include a piece of foreign DNA
- how plasmid vectors are used to transfer genes
- how antibiotic resistance is transferred between cells
- how restriction endonucleases function
- the importance of restriction enzymes to genetic engineering experiments
- use plasmids as vectors to transform bacteria with a gene for antibiotic resistance in a controlled experiment
- demonstrate how restrictions enzymes are used in genetic engineering
- use electrophoresis to separate DNA fragments
- describe the biological process of transformation in bacteria
- calculate transformation efficiency
- be able to use multiple experimental controls
- design a procedure to select positively for antibiotic resistant transformed cells
- determine unknown DNA fragment sizes when given DNA fragments of known size

LAB# 7 GENETICS OF ORGANISMS

In this laboratory, you will use fruit flies to do genetic crosses. You will learn how to collect and manipulate fruit flies, collect data from F1 and F2 generations, and analyze the results from a monohybrid, dihybrid, or sex-linked cross.

OBJECTIVES

- chi-square analysis of data
- the life cycle of diploid organisms useful in genetics studies
- investigate the independent assortment of two genes and determine whether the two genes are autosomal or sex-linked using a multi-generation experiment
- analyze the data from your genetic crosses chi-square analysis techniques

LAB# 8 POPULATION GENETICS AND EVOLUTION

In this activity, you will learn about the Hardy-Weinberg law of genetic equilibrium and study the relationship between evolution and changes in allele frequency by using your class as a sample population.

OBJECTIVES

- how natural selection can alter allelic frequencies in a population
- the Hardy-Weinberg equation and its use in determining the frequency of alleles in a population
- the effects on the allelic frequencies of selection against the homozygous recessive or other genotypes
- calculate the frequencies of alleles and genotypes in the gene pool of a population using the Hardy-Weinberg formula
- discuss natural selection and other causes of microevolution as deviations from the conditions required to maintain Hardy-Weinberg equilibrium

LAB# 9 TRANSPIRATION

In this laboratory, you will apply what you learned about water potential from Laboratory 1 (Diffusion and Osmosis) to the movement of water within the plant. You will measure transpiration under different laboratory conditions. You also will study the organization of the plant stem and leaf as it relates to these processes by observing sections of tissue.

OBJECTIVES

- how water moves from roots to leaves in terms of physical/chemical properties of water and the forces provided by differences in water potential
- the role of transpiration in the transport of water within a plant
- the structures used by plants to transport water and regulate water movement
- test the effects of environmental variables on rates of transpiration using a controlled experiment
- make thin section of stem, identify xylem and phloem cells, and relate the function of these vascular tissues to the structures of their cells

LAB# 10 PHYSIOLOGY OF THE CIRCULATORY SYSTEM

OVERVIEW

In Exercise 10A, you will learn how to measure blood pressure. In Exercise 10B, you will measure pulse rate under different physiological conditions: standing, reclining, after the baroreceptor reflex, and during and immediately after exercise. The blood pressure and pulse rate will be analyzed and related to a relative fitness index. In Exercise 10C, you will measure the effect of temperature on the heart rate of the water flea, *Daphnia magna*.

OBJECTIVES

- the relationship between temperature and rates of physiological processes
- basic anatomy of various circulatory systems
- measure heart rate and blood pressure in a human volunteer
- describe the effect of changing body position on heart rate and blood pressure
- explain how exercise changes heart rate
- determine a human's fitness index
- analyze pooled cardiovascular data
- discuss and explain the relationship between heart rate and temperature

LAB# 11 ANIMAL BEHAVIOR

In this laboratory, you will observe the behavior of an insect and design an experiment to investigate its responses to environmental variables. You also will observe and investigate mating behavior.

OBJECTIVES

- the concept of distribution of organisms in a resource gradient
- the difference between a kinesis and a taxis

- measure the effects of environmental variables on habitat selection in a controlled experiment
- describe the different types of insect mating behaviors

LAB# 12 DISSOLVED OXYGEN AND AQUATIC PRIMARY PRODUCTIVITY

In Exercise 12A, you will measure and analyze the dissolved oxygen concentration in water samples at varying temperatures. In Exercise 12B, you will measure and analyze the primary productivity of natural waters or laboratory cultures as a function of light intensity.

OBJECTIVES

- the biological importance of carbon and oxygen cycling in ecosystems
- how primary productivity relates to the metabolism of organisms in an ecosystem
- the physical and biological factors that affect the solubility of gasses in aquatic ecosystems
- the relationship between dissolved oxygen and the process of photosynthesis and respiration as they affect primary productivity
- measure primary productivity based on changes in dissolved oxygen in a controlled experiment
- investigate the effects of changing light intensity and/or inorganic nutrient concentrations on primary productivity in a controlled experiment