AP Biology

Course Overview

Advanced Placement Biology (APB) is a high school course that is designed to be the equivalent of an introductory college course for biology. General Biology is a pre-requisite for APB. The completion of, or concurrent enrollment in, anatomy/physiology and chemistry is strongly recommended, however, enrollment is open to anyone. College-bound students are strongly encouraged to enroll in this course.

APB is an honors course patterned after a college level course. The course content and the depth of topics as well as the textbook are college level. The laboratory work is similar to and equivalent to that used in college biology courses. The 12 labs recommended by the College Board in its Biology Course Description will be completed. Students are expected to complete a 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. Additional lab work is included to round out the laboratory experience.

The grading is heavily based on major tests. Most tests, because of the cumulative nature of the AP exam, will be cumulative in nature. Students are allowed to do test corrections, where they must explain why the incorrect choices should be eliminated along with why they missed a particular question; this process provides further review of the material and provides the students even more study material for the end of year preparation for the AP Examination. There is also a writing component to the APB program and free response questions are assigned throughout the course. Participation in class discussions, homework, quizzes, and laboratory work will also count toward the final grade.

To help the students apply biological knowledge and critical thinking to environmental and social concerns, students will read and report on (both orally and written) one novel (with biology content in the story-line) and one work of nonfiction. For the novel, students must be able to explain the science in the book, as well as describe the accuracy of its use/presentation in the book. Between this discussion and monthly current event discussions, students are given the opportunity to see that biology is in their everyday lives and is not just a chapter in a textbook (explore societal and environmental concerns).

Students are not required, but are strongly encouraged, to take the APB Examination in May. This high school AP course is the “best of both worlds,” there exist the key components of a college course with the small class advantage of a high school course.

Teaching Strategies

The **textbook** used for this course is:
Starr and Taggert. BIOLOGY The Unity and Diversity of Life, 11th edition (2006)

Each student has access to the AP Biology Lab Manual for Students, revised 2001, as well as other laboratory worksheets as deemed necessary

The APB program is based on a set of eight major themes (science as a process, evolution, energy transfer, continuity and change, relationship of structure to function, regulation, interdependence in nature, and, science, technology and society) that are introduced at the beginning of the course and referred to throughout the course. To further keep these themes in the forefront of the students' minds, posters of the eight themes are on the wall of the classroom and the themes are constantly referenced with each unit. In addition, the theme of evolution is the foundation upon which the entire course is based.

Students begin each chapter with either a list of objectives to address as they read the chapter or a worksheet guiding them through the main points of the chapter; these become the framework of the students' class notes. Students are encouraged to add to these notes during class discussions. Class discussions include animations from various sources (textbook CDs, internet) to help the students visualize what they have read. Quizzes are interspersed throughout the unit to provide formative assessment information to both the students and me.

Student evaluation is on a sliding scale:

	1st trimester	2nd trimester	3rd trimester
Tests (one per unit)	30%	40%	50%
Free Response Questions	15%	15%	15%
Laboratory Work (12 AP Labs and supplemental)	25%	25%	25%
Daily (worksheets, quizzes, participation, etc.)	30%	20%	10%

Lab Component

Labs make up a minimum of 25% of the time students are in class. All 12 of the AP labs are performed (or discussed using a simulation, as in the case of Lab 11: Animal Behavior; this lab is performed in General Biology). Supplemental labs and activities are used to widen the range of topics covered in a hands-on, discovery mode to further simulate the college experience. (Supplemental labs are from various sources collected over 20+ years of teaching, including Starr/Taggert and other college lab books, Access Excellence, companies such as Carolina Biological, Ward's, and Flinn Scientific, provided by other AP teachers through the electronic discussion group, and those generated by myself.)

Lab work is performed in groups of 2 or 3 so that students can develop group skills and learn the importance of collaboration among scientists. Most labs take 2 class periods to perform, with additional time provided for post-lab discussion.

Course Planner

The three overarching topics (Molecules and Cells, Heredity and Evolution, and Organisms and Populations) have been broken down into the following units of study:

Unit 1. Introduction to Unifying Themes; Chemistry of Life (12 days)

Readings/Class Assignments

- Chapters 1-3
- Chapter Objectives
- Organic Nomenclature Worksheet (optional)

Lecture Topics and Skills

- Introduction to the eight unifying themes

Essential questions are presented here to demonstrate how the themes cross the entire curriculum:

Science as a Process

How have scientists worked together to develop the concepts of biology?

How have scientists built upon the discoveries of other scientists to develop a more complete picture of the world around us?

How are scientists able to test the validity of their ideas?

Evolution

What is the significance of structural and chemical adaptations to the resilience of living organisms?

How do individual species, populations, and biomes impact evolutionary change?

Energy Transfer

How does energy transfer occur at the molecular level within cells?

What are some examples of the relationship between evolution of organisms and energy transfer?

Continuity and Change

How can continuity within a species be controlled while still allowing for gradual change over time?

Relationship of Structure to Function

How does structure control function at the molecular/cellular level?

How does structure control function at the organism/population level?

Regulation

How is the movement of molecules into and out of cells regulated?

How is homeostasis maintained by an organism?

Interdependence in Nature

How can interdependence in nature be seen at the molecular level?

How do cells of one organ/tissue rely on the existence of cells in other organs/tissues?

How are all organisms interdependent on each other; how does this relate to evolution?

Science, Technology and Society

What advances have been made in laboratory technology to allow scientists to simulate the natural world?

What is the affect of scientific research and technological innovations on society?

- Process of science reviewed

--Scientific method, with emphasis on the fact that there is not ONE way to do science

--Explain what is meant by scientific theory

--Graphing skills

- Evolution established as foundational theme

--Lamarck vs. Darwin

--Define mechanism of natural selection and briefly describe what is occurring when a population is said to evolve

--Compare/contrast natural and artificial selection

- Chemistry of Life

--Atomic structure

--Chemical bonding (covalent, ionic, hydrogen)
--Identify basic elements of living organisms
--Distinguish between inorganic and organic compounds
--List and describe water's unique properties; relate properties to structure; describe importance of these properties to living organisms
--Contrast condensation reactions (dehydration synthesis) and hydrolysis
--Describe characteristics, structure, and function of organic compounds (carbohydrates, proteins, lipids, nucleic acids)

Lab

- Safety Lecture (teacher generated)
- Scientific Method
    - Emphasis on development of testable hypothesis, identification of independent, dependent and controlled variables, and data analysis using mathematics and graphing (teacher generated)
- Introduction to LabPro (adapted from Vernier)
    - Objectives include: become familiar with LabPro and DataMate program using various probes (gas pressure, temperature, pH, calorimeter, etc.)
- Measurement (Starr/Taggert)
    - Objectives include: work with major forms of lab equipment; measure and estimate length, volume, mass and temperature; explain advantages of the metric system of measurement
- Molecules of Life BioKit (from Carolina Biological); used as needed with highly visual learners
    - Students construct models of carbohydrates, lipids and proteins

Free Response

- 2002 #2

Unit 2. Ecology and Behavior (16 days)

Readings/Class Assignments

- Chapters 45-49
- Chapter Objectives

Lecture Topics and Skills

- Population Ecology

--Demographics
--Analyze and interpret logistic and exponential growth curves
--Explain the three survivorship curves and age structure diagrams

- Community Structure and Biodiversity

--Contrast types of symbiosis
--Distinguish between realized and fundamental niche
--Relate community interactions to coevolution
--Describe succession within a community; give an example

- Ecosystems

--Describe biogeochemical cycles

--Analyze trophic levels and flow of energy through food chain/web/pyramid
--Explain the process of biological magnification
- Biosphere

--General overview of biomes
--Discussion: Impact of humans on the biosphere. What can we do? What should we do? (explore societal and environmental concerns)
- Behavioral Ecology

--Name and describe types of animal behavior; give examples
--Compare/contrast the role of the environment and genes on behavior with both animal and plant examples
--Explain how adaptive behavior, social behavior, selfish behavior, and altruism can all promote an individual's reproductive success (fitness); what are the costs/benefits of each behavior?

Lab
- AP Lab 11: Animal Behavior (reviewed with simulation as it was performed in General Biology)
- AP Lab 12: Dissolved Oxygen and Aquatic Primary Productivity
- Ecology: Living Organisms in Their Environment (Starr/Taggert); parts 3-5
    - Objective: identify the three basic types of survivorship curves and describe the trends exhibited by each
- Competition or Cooperation (old Prentice Hall lab)
    - Objective: determine whether competition or cooperation among team members is more efficient when it comes to completing a task

Free Response
- Ecology, 1986
- 1998 #4

Unit 3. Evolutionary Biology; Classification and Origin of Life (16 days)
Readings/Class Assignments
- Chapters 17-20, 28
- Chapter Objectives
- Hardy-Weinberg practice problems

Lecture Topics and Skills
- Evidence of Evolution

--Describe the evidence Darwin used to develop the theory of natural selection
- Microevolutionary Processes

--Distinguish between microevolution and macroevolution
--Explain the difference between gene pool, alleles, and allele frequency
--List the five conditions that must be met for the Hardy-Weinberg rule to apply
--Define and provide an example of directional selection, stabilizing selection, and disruptive selection
--Distinguish the founder effect from a bottleneck
--Distinguish between an adaptation and an evolutionary adaptation
- Evolutionary Patterns, Rates, and Trends

--State the basic principles of the biological species concept; pre/post-zygotic mechanisms; allopatric and sympatric speciation
--Explain the relationship between gene flow and genetic divergence
--Explain how taxonomy reflects evolutionary history
--Explain the consequences of mass extinctions

- Life's Origin and Early Evolution

--Summarize the current hypothesis for how and where life began
--Explain why DNA is the preferred molecule for the hereditary material
--Describe how the endosymbiosis theory may help explain the origin of eukaryotic cells; describe the modern evidence supporting this theory
--Understand the basic time line of the evolution of life and the key events along the time line

- Plants and Animals—Common Challenges

--Define homeostasis in relation to the internal environment of an organism
--Explain how a cell may use diffusion and active transport to maintain an internal environment
--Explain how the surface-to-volume ratio defines the physical size of a cell
--Define the term circadian rhythm
--Explain the process of apoptosis

Lab

- AP Lab 8: Population Genetics and Evolution
    - Modified: due to constraints of a small class size, all Case Studies are discussed in detail and students are provided with sample data (obtained from APB electronic discussion group) to perform the calculations; students collect data from friends and relatives on thumb-folding, handedness and eye color to use in place of the PTC taste test
- Evolutionary Agents (Starr/Taggert)
    - Objectives include: determine allele frequencies for a gene in a model population; calculate expected ratios of phenotypes based on Hardy-Weinberg proportions; describe factors that influence Hardy-Weinberg equilibrium of a population; describe the effects of different selection pressures on identical model populations; identify the level at which selection operates in a population; describe the impact of the founder effect on the genetic structure of populations.
- Natural Selection Simulation Using Random Numbers (from Am Bio Teacher, 52 (8), 497-499)

Free Response

- Evolution, 1989
- 1999 #3

Unit 4. Diversity of Organisms—Kingdom Overview (12 days)
Readings/Class Assignments

- Chapters 21-26
- Chapter Objectives

Lecture Topics and Skills

- Discuss and compare the kingdoms in relation to evolution of structures, metabolism, and cellular organization; classification (systematics, phylogeny, cladograms); role in the biosphere (niche); life cycles

--Prokaryotes and Viruses
--Protists—The Simplest Eukaryotes
--Plant Evolution
--Fungi
--Animal Evolution—The Invertebrates; The Vertebrates

Lab

- Taxonomy: Classifying and Naming Organisms (Starr/Taggert); part 1
    - Objectives include: write out scientific binomials in the form appropriate to the Linnaean system; construct a dichotomous key
- Use of Simple Dichotomous Key (teacher generated)

Free Response

- 1999 #3
- Evolution, 1994
- 1998 #3
- Evolution, 1990

Unit 5. Animal Structure and Function (22 days)

Readings/Class Assignments

- Chapters 33-44
- Chapter Worksheets

Lecture Topics and Skills

Although the emphasis is on human structure and function, comparative anatomy and physiology of animals is the focus of the unit. In addition, the systems are constantly connected to demonstrate the interdependence among all systems rather than just looked at as separate entities

- Animal Tissues and Organ Systems
- Neural Control
- Sensory Perception
- Endocrine Control
- Structural Support and Movement
- Circulation
- Immunity
- Respiration
- Digestion and Human Nutrition
- The Internal Environment
- Principles of Animal Reproduction and Development
- Human Reproduction and Development
- Discussion: Why is high blood pressure called the “silent killer?” What can you do to avoid high blood pressure (explore societal and environmental concerns)

- Discussion: What role can you play in the fight against childhood obesity? (explore societal and environmental concerns)

Lab
- AP Lab 10: Physiology of the Circulatory System
- Homeostasis (Starr/Taggert); parts 1, 2, 4
    - Objectives include: Define vocabulary; explain the logarithmic nature of the pH scale; use a sphygmomanometer and stethoscope to estimate blood pressure

Free Response
- 2006 #4
- 1996 #2
- 2001 #1

Unit 6. Cell Structure and Function (11 days)
Readings/Class Assignments
- Chapters 4-5
- Chapter Worksheets

Lecture Topics and Skills
- Demonstrate proper microscope techniques
- Cell Structure and Function

--Review from General Biology the basic cellular components—structure and function
--Revisit the concept of surface-to-volume ratio in determining the size of a cell
--Revisit prokaryotic vs. eukaryotic cell structure

- A Closer Look at Cell Membranes

--Define the fluid mosaic model
--Explain the concept of selective permeability as it applies to cell membrane function; relate this to the structure of the phospholipid bilayer
--Distinguish between passive and active transport
--Describe how tonicity affects osmosis

Lab
- AP Lab 1: Diffusion and Osmosis
- Microscopy (Starr/Taggert)
    - Objectives include: correctly use a compound light microscope, including preparation of a wet mount; determine the field of view at low and high power; correctly use a dissecting microscope; explore the microscopic world around you

Free Response
- 1998 #1
- 2002 #4

Unit 7. Cellular Energetics (23 days)

Readings/Class Assignments

- Chapters 6-8
- Chapter Worksheets

Lecture Topics and Skills

- Ground Rules for Metabolism

--State the first and second laws of thermodynamics
--Explain how the world of life maintains a high degree of organization (continuity and change)
--Describe enzyme structure and function, and the relationship between enzymes and energy
--Describe how enzyme reactions are put together in an organism's metabolism
--Describe the role of the participants (substrates, intermediates, enzymes, cofactors, energy carriers, and products) in metabolic pathways

- Where It Starts—Photosynthesis

--Explain the role of plant structure to process of photosynthesis
--Describe the relationships between autotrophs and heterotrophs
--Describe the major processes that occur in the two stages of photosynthesis; associate each reaction to a particular cell component
--Compare/contrast noncyclic and cyclic pathways; relate to evolution in plants
--Describe evolutionary trends for dealing with differing climate conditions (C_3, C_4, and CAM plants)

- How Cells Release Chemical Energy

--Contrast anaerobic and aerobic respiration pathways
--Describe the major stages of aerobic respiration; associate each to a particular cell component
--List some sources of energy (other than glucose) that can be fed into the respiratory pathways

Lab

- AP Lab 2: Enzyme Catalysis
- AP Lab 4: Plant Pigments and Photosynthesis
- AP Lab 5: Cell Respiration
- Enzyme Catalysis Model (from Flinn Scientific)
    - Objective: create polyfoam models to illustrate an enzyme/substrate complex, the interaction of a competitive inhibitor, and the interaction of a noncompetitive inhibitor
- Toothpickase (adapted from Flinn Scientific and Access Excellence)
    - Objective: student acts as enzyme on toothpicks to demonstrate the effect of substrate concentration and inhibitors on the rate of reaction

Free Response

- Enzyme, 1994
- Enzyme, 1998
- Photosynthesis, 1986
- Cell Respiration, 1990
- Photosynthesis/Cell Respiration, 1982
- Cell Respiration, 1977

- Photosynthesis/Cell Respiration, 1993
- Cell Respiration, 1989

Unit 8. Plant Structure and Function (12 days)

Readings/Class Assignments

- Chapters 29-32
- Chapter Worksheets and Chapter Objectives
- Plant Hormone List

Lecture Topics and Skills

- Plant Tissues

--Compare simple and complex plant tissues
--Describe how plant tissues are combined to form organs and how these organs fit together to make up a plant

- Plant Nutrition and Transport

--Explain how plant cells regulate the movement of water and organic materials (bulk flow, translocation, and cohesion-tension theory)
--Compare to similar transport processes seen in other organisms

- Plant Reproduction

--Revisit alternation of generations
--Describe the double fertilization that occurs uniquely in the flowering plant life cycle
--Distinguish among parthenogenesis, vegetative propagation, and tissue culture propagation; give examples
--Define the botanical terms: fruit, vegetable

- Plant Growth and Development

--Differentiate between growth and development
--Describe the general role of each class of plant hormones
--List the three main types of tropisms and explain how each is regulated
--Describe the process of photoperiodism as it relates to circadian cycles and biological clocks
--Describe the action of phytochromes and the role they play in long-day, short-day, and day-neutral plants

Lab

- AP Lab 9: Transpiration
- Seed-Bearing Plant Tissues (old Prentice Hall Lab)
    - Objective: use a microscope to observe specialized plant tissues: epidermal, meristematic, xylem, phloem, schlerenchyma
- Estimating the Number of Stomata in a Leaf (old Prentice Hall lab)
- Leaf Structure (old Heath lab)
    - Objectives include: examine the structure of leaf tissue; relate leaf structure to function and its role in photosynthesis; determine the process controlling the opening and closing of stomata; observe the changes in the stomata

Free Response

- 1996 #3
- Plant Systems, 1991

- Plant Reproduction, 1987

Unit 9. Cell Reproduction and Classical Genetics (15 days)
Readings/Class Assignments
- Chapters 9-12
- Chapter Worksheets
- Genetics Problems
- Chi-square Problems

Lecture Topics and Skills
- How Cells Reproduce

--List the stages of the cell cycle; explain what occurs during each stage
--Give a detailed description of the cellular events occurring in prophase, metaphase, anaphase and telophase of mitosis
--Explain the difference between mitotic division and cytokinesis; describe the differences in the processes between animal and plant cells
--Understand the process by which cancers form

- Meiosis and Sexual Reproduction

--Distinguish between the processes of mitosis and meiosis; distinguish between somatic and germ cells
--Explain why meiosis is important for survival of a species
--Give a detailed description of the cellular events that occur during each phase of meiosis I and meiosis II; sketch cell models of each stage
--Explain the importance and mechanism of crossing over
--Revisit plant and animal life cycles
--Revisit differences in gamete production in male and female animals
--Describe the three mechanisms that contribute to variation in the traits of offspring; explain why this is important to the survival of the species
--Explain some of the evolutionary relationships of mitosis and meiosis

- Observing Patterns in Inherited Traits

--Discuss the work of Mendel
--List and define the terminology of genetics
--Contrast inheritance patterns
--Construct and interpret Punnett squares; apply product rule
--Construct and interpret pedigrees

- Chromosomes and Human Inheritance

--List several examples of human inheritance patterns
--Discussion: What are some benefits of genetic screening and genetic counseling? Would you want to know if your child had a genetic disease? (explore societal and environmental concerns)

Lab
- AP Lab 3: Mitosis and Meiosis
- AP Lab 7: Genetics of Organisms

Free Response
- 2004 #1

- 1996 #4

Unit 10. Molecular Genetics (20 days)
Readings/Class Assignments
- Chapters 13-16
- Chapter Worksheets
- Attend *Sam Rhine Genetics Update Conference* (this usually occurs in November, giving us the opportunity to discuss his lecture throughout the course)
- Sequencing and Plasmid paper activities
- Protein Synthesis paper activity

Lecture Topics and Skills
- DNA Structure and Function

--Discuss the historical events leading to our current knowledge of DNA
--Draw a DNA molecule, labeling the parts of a nucleotide
--Generally describe how double-stranded DNA replicates from stockpiles of nucleotides
- From DNA to Protein

--Compare/contrast DNA and RNA
--Describe the stages of protein synthesis; translate a DNA code into a polypeptide chain
--Cite an example of a change in one DNA base pair that has a profound effect on the human phenotype (sickle cell anemia); revisit heterozygote advantage of this trait and malaria
--List some of the environmental agents that can cause mutations; describe types of DNA mutations
--Explain why mutations in germ cells are usually more of a problem than mutations in somatic cells
--Discussion: Why is the genetic code almost universal? How did the few alterations occur?
- Controls Over Genes

--List and define the levels of gene control in eukaryotes; contrast this with prokaryotic gene control
- Studying and Manipulating Genomes

--Discuss modern techniques used in genetics, such as recombinant DNA, using DNA fragments, production of transgenic organisms
--Explain how knowing the composition of genes can help scientists derive counterattacks against rapidly mutating organisms
--Discussion: How does knowing the genetic makeup of Earth's organisms help us reconstruct the evolutionary history of life?
Discussion: What problems might be involved in trying to clone extinct animals? (explore societal and environmental concerns)

Lab
- AP Lab 6: Molecular Biology
- Biotechnology: Bacterial Transformation (Starr/Taggert); part 2
    - Objective: explore online sources of information such as National Center for Biotechnology Information, Human Genome Project, and Cold Spring Harbor Laboratory

- Protein Synthesis—An Interactive Game (from Am. Bio. Teacher, Volume 60, No. 6, 1998, pp. 427-429)
    - Objective: provide students with game format to "see" the relationship between DNA, RNA and proteins

Free Response

- 1995 #4
- 2003 B#1
- 1994 #4
- 2000 #3
- 2001 #4

Practice Tests; Semester Tests; Review of Course; Post-AP Exam assignment (16 days)

- Full-length, released tests used throughout course for diagnostic purposes
- Review format determined by needs to students
- Post-AP assignment varies from year to year; determined by interests of students; may include writing review sheets for General Biology class, mammalian dissections, performance of student-generated labs, making video for General Biology class, etc.