AP® Biology
Syllabus 3
Course Overview

My AP® Biology course conforms to the standards instituted by the College Board for all AP courses and covers all of the topics in the *AP Biology Course Description*. These include biochemistry, cell structure and function, metabolism, genetics, molecular basis of inheritance, DNA technology, evolution, microbiology, classification, plants, animals, animal physiology, and ecology.

Furthermore, all the above topics are integrated throughout the course using the eight major themes from the AP Biology Curriculum Requirements. **[C6]**

C6—The integration of the general topics of biology through the eight major themes as specified in the *AP Biology Course Description*;
- Science as Process
- Evolution
- Energy Transfer
- Continuity and Change
- Relationship of structure to function
- Regulation
- Interdependence in nature
- Science, Technology and Society

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This is a laboratory course in which students are expected to use collected data to solve biological problems. **[C4]**

C4—An understanding of science as a process rather than an accumulation of facts.

The objectives of the course are that each student shall

- demonstrate skills in using various types of biological instrumentation and scientific methodologies,
- learn how to read and critique papers written by scientists in the field of biology,
- practice finding and using patterns in collected data to solve scientific problems, **[C4]**
- exhibit mastery of the major principles of biology, and
- apply biological knowledge and critical thinking to environmental and social concerns. **[C7]**

C7—Applications of biological knowledge and critical thinking to environmental and social concerns.

Ideally, each unit takes two weeks to complete and typically is organized like this:

Day 1	Day 2	Day 3	Day 4	Day 5
Lecture 1	Lecture 2	Lecture 3	Lecture 4	Review
Day 6	**Day 7**	**Day 8**	**Day 9**	**Day 10**
AP Lab **[C8]**	AP Lab **[C8]**	Other Lab **[C8]**	Recitation/ Lab Free-Response Question Practice	Unit Exam

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The textbook for the course is the seventh edition of Neil A. Campbell and Jane B. Reece's *Biology*. Students also use the *AP Biology Lab Manual for Students*. Additional labs are teacher-generated or come from other sources.

Evolutionary themes, which clearly unify all biology disciplines, are often ignored in standard biology courses. In order to bring together prevailing themes about evolution to every unit, the course is divided into four frameworks: Physical and Chemical Mechanisms, Historical, Organisms, and Populations. The idea of "change in a population over time" is highlighted through labs, homework assignments, lectures and readings in each framework. **[C5]**

#	Frameworks	Units	Explanation
1.	Physical and Chemical Mechanisms	1–8	Evolution of the Earth and organic molecules; mechanisms involved in the production of variants
2.	Historical Development	9	Events leading to the development of the theory of evolution
3.	Organisms (Organic Framework)	10–14	Systematics, classification, origin of different life forms
4.	Population	15	Mechanisms involved in producing new species, races, and cultures

C5—Recognition of evolution as the foundation of modern biological models and thought.

Course Planner

Lecture and Lab Schedule for AP Biology

Unit	Lecture and Lab Titles	Readings	Month
First Report Period			
1	**Chemistry of Life** [C1] • Structure of an atom • Types of chemical bonding • Functional groups • Classification and formation of macromolecules • Characteristics of enzymes • Water **Lab:** Molarity: An Expression of Concentration (teacher generated) **Lab:** Buffers and pH (teacher generated)	Chapters 2, 4, 5 Hough and Kahn article Fischl et al. article	Sept.
2	**Cellular Structure and Function** [C1] • Fluid mosaic model of the plasma membrane • Types of cellular transport • Subcellular organization • Prokaryotic and eukaryotic cells **Lab:** Diffusion and Osmosis (AP Lab 1) **Lab:** Compound Microscope (from Harley and Prescott) **Lab:** Donnan Equilibrium (from Abramoff and Thomson) [C8]	Chapters 3, 7, 8 Perk article Razin and Rottem article Reijngoud article	Sept.
3	**Communication** **Lab:** Enzyme Catalysis (AP Lab 2) **Lab:** Kinetics of the Enzyme Lactase (from Russo and Moothart) [C8]	Chapters 11, 39, 45 McCormick	Oct.

C1—Molecules and Cells.

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Unit	Lecture and Lab Titles	Readings	Month
4	**Metabolism** • Free energy changes • Molecules and reactions involved in metabolism • Fermentation and cellular respiration • Light-independent and light-dependent reactions **Lab:** Cell Respiration (AP Lab 5) **Lab:** Photosynthesis and pH (Neumann and Jagendorf) **Lab:** Studying Photosynthesis with Leaf Disk Assays (from Steucek and Hill) **[C8]**	Chapters 6, 9, 10 Katz and Rognstad article Krebs and Johnson article Micks and Gibson article	Oct.
Second Report Period			
5	**Cellular Reproduction** • Stages involved in mitosis • Stages involved in meiosis • Alternation of generations • Spermatogenesis and Oogenesis **Lab:** Mitosis and Meiosis (AP Lab 3) **Lab:** Embryology of the Sea Urchin (teacher generated) **[C8]**	Chapters 12, 13, 46, 47 Pickett-Heaps article	Nov.
6	**Mendelian and Non-Mendelian Genetics** **[C2]** • Inheritance patterns: monohybrid, lethal, sex-linked, codominance, multi-hybrid crosses **Lab:** Genetics of Organisms (AP Lab 7) **[C8]**	Chapters 14, 15	Nov.
7	**Molecular Genetics—RNA and DNA structure and function** **[C2]** • Structure of prokaryotic and eukaryotic chromosomes • Gene regulation in prokaryotic and eukaryotic cells	Chapters 16, 17, 19 Blackburn article	Dec.

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C2—Heredity and Evolution.

Unit	Lecture and Lab Titles	Readings	Month
8	**Recombinant DNA Technology** • Recombination technology **Lab:** Electrophoresis of Dyes (teacher generated) **Lab:** Molecular Biology (AP Lab 6) **[C8]**	Chapters 18, 20, 21	Dec.
Winter Break			
9	**Evolution** **[C2]** • Chemical evolution **Lab:** Population Genetics and Evolution (AP Lab 8) **[C8]** **Lab:** Coacervates (from McMullen, Newton, and Becker)	Chapters 22, 23, 24, 25 Miller article Pruitt article	Jan.
Third Report Period			
10	**Microbiology** **[C3]** **Lab:** Gram Staining (from Harley and Prescott) **Lab:** Life Cycle of *Dictyostelium discoideum* (from Droter)	Chapters 26, 27, 28, 31	Jan.
11	**Plants** **[C3]** **Lab:** Plant Pigments and Photosynthesis (AP Lab 4) **Lab:** Transpiration (AP Lab 9) **[C8]**	Chapters 29, 30, 35, 36, 37, 38, 39	Feb.
12	**Invertebrates** **[C3]** **Lab:** Dichotomous Key to the Insects (Keeton, Dabney, and Zollinhoffer) **Lab:** Dissection of the Earthworm and Clam (teacher generated) **[C8]**	Chapters 32, 33	Mar.
13	**Vertebrates** **[C3]** **Lab:** Dissection of the Frog (teacher generated)	Chapters 34, 40, 41, 42, 43, 44	Mar.
Fourth Report Period			

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C2—Heredity and Evolution.

C3—Organisms and Populations

Unit	Lecture and Lab Titles	Readings	Month
14	**Comparative Anatomy and Physiology** **Lab:** Physiology of the Circulatory System (AP Lab 10) **Lab:** Sheep's Brain and Cow's Eye (from Marieb) [C8]	Chapters 45, 46, 47, 49 Penton-Voak article Simanton article	Apr.
Spring Break			
15	**Ecology** [C3] **Lab:** Dissolved Oxygen and Aquatic Primary Productivity (AP Lab 12) **Lab:** Biotic Index (from Burd, Carey, and Fowler) [C8]	Chapters 50, 51, 52, 53, 54, 55	Apr.
16	**Review for the AP Exam and final exam**		May

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C3—Organisms and Populations

Teaching Strategies

I have written a total of 55 detailed outlines that correspond to the topics covered in the textbook and each item on the topic outline in the Course Description (see the sample lecture outline section of this syllabus for an example). I give these to my students throughout the year to use in class as lecture aids. My lectures, which cover selected concepts from each textbook chapter, are supplemented with diagrams, explanations, visuals, examples, and demonstrations. I ask students to add any information they have obtained from the lecture directly to the outlines. They also work on questions I pose in class that can be answered by the information covered in the outlines.

In addition to the textbook readings, I regularly assign primary research articles as required reading for homework. Most of the articles are considered classics in the field. Periodically I show DVDs, most of which deal with diversity of life, and I also invite guest lecturers to speak to the class.

Students are not required to take the AP Biology Exam, but an overwhelming majority of them do. I use a variety of strategies to prepare them during the school year for the AP Biology Exam in May.

- **Oral Unit Questions.** During the review period, students orally answer as quickly as possible a series of questions relating to a particular unit. At the conclusion of the question–answer session, they answer 10 multiple-choice questions in writing.

- **Multiple-Choice Questions.** Students complete 50 multiple-choice questions during each unit exam. Multiple-choice questions test at the higher educational objectives of synthesis, analysis, judgment, and comprehension. I generally square the final test average in the first two report periods. By squaring the test averages, I am able to use very demanding questions on each unit exam without sacrificing students' grade point averages in these report periods. Additionally, the students use the multiple-choice and free-response sections of the AP Released Exams from 1986, 1990, 1994, 1999, and 2002 as practice exams. By responding to the multiple-choice items on all five exams, the students learn how these items are structured around a concept and how incorrect answers affect their score.
- **Free-Response Questions.** I write most of my own free-response questions. Students use a scoring guideline to grade these free-response writing assignments, and I read their responses as well.
- **Other Test Prep Aids.** I encourage my students to seek sources such as AP Biology websites created by teachers or test preparation books that provide them with additional practice tests.

Lab Component

Students work in pairs to complete each lab during two one-hour periods. On the first day of a lab, each group gathers materials, sets up the lab, prepares stock solutions, cultures the specimen, and begins some parts of the lab. They complete the lab on the second day. Students work on labs with very little assistance from me. When possible, the AP Biology labs are modified to use smaller quantities of perishable and nonperishable items in the exercises. Some of the units do not have labs. We lose time throughout the year as a result of senior activities, time that can be made up during the units that do not have scheduled labs.

We complete one field lab on scatology/evolution at the Philadelphia Zoo. Students look at animal scats to identify relationships between various caged animals. Animal keepers, veterinarians, and other zoo professionals talk with the students about the animals' diet, health, and behavior. No write-up is involved with this activity.

- Students gain a deeper understanding and appreciation of topics they explore through firsthand observations during laboratory investigations. They perform two types of lab activities: those in the *AP Biology Lab Manual for Students* and those I have designed or taken from other sources.

All labs count and are graded individually. Therefore I consider all lab work my students complete and submit to be formal lab work. For the AP labs, students answer the questions in the *AP Biology Lab Manual* and submit their lab manuals to me for grading. For the other labs I require a special format. Instead of repeating the same instructions, a flow diagram of the laboratory's protocol is placed under the materials and methods section of the report. Students usually use data, submitted in tabular form or graphs with interpretation to follow, to answer lab questions or to solve a problem.

Student Evaluation

Students are evaluated on their performance on the unit exams, free-response questions, labs, and the homework they complete. I assign a certain number of points for each assignment students complete for credit. Their final grade average is determined by the percentage of the total points earned during the report period.

Assignment	Points	Percentage of Grade
Unit Exams and Final Exam	100	75%
Free-Response Questions	25	10%
Labs	10	10%
Homework	5	5%
Total	140	100%

Research Paper

The Wistar Institute, Philadelphia, sponsors an essay-writing competition each year for high school students attending public schools in that city. The competition requires that students write an essay on a current topic in biology. All students are required to submit two copies of their essay to me: one that is competition-ready and the other for grading. After selecting a topic, they generally analyze the methods and results of scientific investigations in several primary research reports to draw a valid conclusion about topic. I give them six weeks to work on it, and it is due near the end of the third report period. The essay counts as a test grade.

Research Project [C4]

C4—An understanding of science as a process rather than an accumulation of facts.

Each year the American Academy of Neurology sponsors the Neuroscience Research Prize competition. The competition began in 1992 to encourage high school students to explore, through investigative laboratory research, topics related to the brain and the nervous system. I require my students to complete a nonbehavioral research project that can be entered in this competition, following the Academy's guidelines. All of my students use living earthworms, *Lumbricus terrestris*, as the experimental organism. When presenting their projects, students use the same format that scientists use to present their research in a primary research report. I introduce this project during the first week of school, and it is generally due during the second week of October. While the project is research driven, not unit driven, I try to tie it in with the Communication unit (Unit 3). For more information about this competition, go to the American Academy of Neurology's website at www.aan.com/professionals, click on "Awards & Fellowships," and scroll down and click on "Neuroscience Research Prize."

Debate

The class is organized into two groups, pro and con, based on a controversial issue in biology. [C7] 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 counter-arguments. 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 preferences in dating.

C7—Applications of biological knowledge and critical thinking to environmental and social concerns.

Calorie Study

Students keep a complete record of what they eat and do during a seven-day period. Using Nutritive Value of American Foods, students try to compute the number of calories they consumed and how many calories they expended over the seven-day period. The primary objective of this paper is to validate or invalidate current dieting trends and determine how a change in lifestyle might improve an individual's health. This activity is graded as a free-response question. [C7]

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Free-Response Questions

Learning how to answer free-response questions is an important part of my course, and I give students a great deal of practice with this. During every report period they do 20-minute in-class, graded assignments that are designed to help them become comfortable with this kind of evaluation.

Sample Lecture Outline

One purpose of the inclusion of the following lecture outline is to provide an example of how I integrate one of the overarching topics (in this case, "Heredity and Evolution") in light of the eight major themes as specified in the course description.

Lecture Unit 6: Chapter 14, Mendel and the Gene Idea

A. Mendel's Laws (regulation) [C6]

1. Mendel's experiments (science as process) [C6]
2. Law (Principle) of dominance: when two contrasting traits of the parent generation (P) are crossed, the dominant trait appears in the first generation (F_1, or filial one)
   a) Dominant trait: symbolized with a capital letter (A)
   b) Recessive trait: symbolized with a lower case letter (a)
3. Law of segregation: for each character an organism inherits two factors, one from each parent, that separates during gamete formation
   a) Homozygous: having a pair of identical alleles (alternative version of a gene)
   b) Heterozygous: having two different alleles for a trait

4. Law of independent assortment: genes located on different chromosomes assort independently of one another
    a) Genotype: actual genetic information
    b) Phenotype: expression of the genes
5. The advantages in adaptation of sexual reproduction. (evolution) Genetically determined traits tend to propagate through generations as a result of selection by, among other things, attraction to mates (favorable) and predators (unfavorable). (interdependence in nature) **[C6]**

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B. Probability (the likelihood that a specific event will occur)

1. P = M/N; M = the number of one kind of event, N = the total number of events
    a) Probability ranges from 0 to 1, where 1 is certain to occur
    b) Expressed as a decimal, percent, or fraction
    c) Expected ratios are most likely to occur when the population size in the study is very large
2. Rule of multiplication: the chance that two or more independent events will occur simultaneously is equal to the product of their chances occurring separately (law of probability)
    a) Punnett Square: a mathematical tool used to determine the probability of inheriting traits
3. Rule of addition: to determine the probability of an event occurring in two or more different ways, add the separate probabilities of each way that the event can occur

C. Mendelian inheritance patterns (complete dominance)

1. Monohybrid cross
    a) Albinism: lack of pigmentation in skin and eyes; recessive and nonlethal
    b) Cystic fibrosis: defective chlorine pump; chlorine accumulates in cells, causing mucus that surrounds the cells to become thick; recessive and lethal
    c) Polydactyly: extra digits on hands and feet; dominant and nonlethal
    d) Huntington's disease: production of quinolinic acid, a stimulant
    e) Achondroplasia (a type of dwarfism): heterozygous, disproportionate limbs
    f) Tay-Sachs disease: absence of hexosaminidase A; gangliosides are stored in the brain, which progressively kill brain cells until there is a loss of function and death; recessive disorder

2. Special crosses: used to determine genetic background

    a) Testcross: used to determine the genotype of a dominant phenotype; cross the unknown dominant phenotype with the recessive phenotype or with a dominant phenotype of known lineage

    b) Backcross: used to uncover hidden or carried genes (mate offspring with parent)

3. Multiple hybrid crosses: mating that involves at least two traits. There are four rules for performing a dihybrid or multiple hybrids cross:

    a) Determine the frequency of the genotypes in each cross using the Punnett Square

    b) Let one set of genotypes form the base of a branching diagram

    c) Distribute the genotypic frequencies of the second cross on the genotypic frequencies of the first cross (if you are working with multiple hybrid crosses, distribute the genotypic frequencies of the third cross on the genotypic frequencies of the second cross, and so on)

    d) Find the product of the genotypic frequencies for each branch of your branching diagram

D. Non-Mendelian inheritance patterns (no complete dominance)

1. Incomplete dominance: blending of traits; partial expression of two alleles in the offspring

    a) *RR* = red snapdragons, *RW* = pink, *WW* = white

    b) Phenotype equals the genotype; pink is an intermediate phenotype

2. Codominance: expressions of two alternative forms of an allele in the phenotype of the offspring

    a) *RR* = reddish brown cow, *RW* = roan (spotted-white and reddish brown), *WW* = white

3. Pleiotropy: the ability of a *single* gene to have multiple effects on an organism, e.g., sickle cell anemia. Although a serious disease, the gene may actually provide a resistance to malaria by making red blood cells more fragile than normal, interrupting the life cycle of the disease-causing microorganism. So, a structural anomaly in the proteins of the cell that would be a disadvantage in other circumstances actually provides an advantage in areas where malaria is common (relationship of structure to function). **[C6]**

4. Epistasis: a gene at one locus alters the phenotypic expression of a gene at a second locus (multiple hybrid cross)

5. Polygenic inheritance: requires the additive effects of two or more genes for the expression of a phenotype (e.g., height, skin color in humans, etc.)

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6. Multifactorial characters: both genetic and environmental collectively influence a phenotype

E. Pedigree analysis (continuity and change) **[C6]**

1. Pedigree: a family tree describing the interrelationships of parents and children across several generations

   a) Symbols commonly used in pedigree charts:

   (1) Male = square

   (2) Female = circle

   (3) Affected = shaded square or circle

   (4) Unaffected = unshaded square or circle

   (5) Mating = horizontal line

   (6) Descendents = vertical line

F. Technology used in genetic counseling and testing (science, technology and society) **[C6]**

1. Amniocentesis: between the fourteenth and sixteenth weeks of gestation, a physician inserts a needle into the uterus and extracts about 10 mL of amniotic fluid (the fluid that bathes the fetus). Tests are performed on the then-cultured cells. Complications include maternal bleeding or fetal death.
2. Karyotype: a picture of the metaphase chromosomes
3. Chorionic villus sampling (CVS)—a physician suctions off a small amount of fetal tissue from the placenta, usually getting enough mitotic cells to perform a karyotype immediately
4. Ultrasound: a noninvasive procedure that uses sound waves to produce an image of the fetus

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