Advanced Placement Biology Syllabus

Course Goal (www.collegeboard.com): The AP Biology course is designed to be taken by students after the successful completion of a first course in high school biology and one in high school chemistry. It aims to provide students with the conceptual framework, factual knowledge, and analytical skills necessary to deal critically with the rapidly changing science of biology.

The two main goals of AP Biology are to help students develop a conceptual framework for modern biology and to help students gain an appreciation of science as a process. The ongoing information explosion in biology makes these goals even more challenging. Primary emphasis in an AP Biology course should be on developing an understanding of concepts rather than on memorizing terms and technical details. Essential to this conceptual understanding are the following: a grasp of science as a process rather than as an accumulation of facts; personal experience in scientific inquiry; recognition of unifying themes that integrate the major topics of biology; and application of biological knowledge and critical thinking to environmental and social concerns.

Big Ideas in AP Biology: The course is based on four Big Ideas, which encompass core scientific principles, theories, and processes that cut across traditional boundaries and provide a broad way of thinking about living organisms and biological systems. The following are Big Ideas:

- **Big Idea 1: Evolution:** The process of evolution drives the diversity and unity of life.
- **Big Idea 2: Cellular Processes: Energy and Communication:** Biological systems utilize free energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
- **Big Idea 3: Genetics and Information Transfer:** Living systems store, retrieve, transmit, and respond to information essential to life processes.
- **Big Idea 4: Interactions:** Biological systems interact, and these systems and their interactions possess complex properties.

Science Practices: Students establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Focusing on these disciplinary practices enables teachers to use the principles of scientific inquiry to promote a more engaging and rigorous experience for AP Biology students. Such practices require that students:

- Use representations and models to communicate scientific phenomena and solve scientific problems;
- Use mathematics appropriately;
- Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course;
- Plan and implement data collection strategies in relation to a particular scientific question;
- Perform data analysis and evaluation of evidence;
- Work with scientific explanations and theories; and
- Connect and relate knowledge across various scales, concepts, and representations in and across domains.

Inquiry-Based Investigations: Twenty-five percent of instructional time is devoted to hands-on laboratory work with an emphasis on inquiry-based investigations. Investigations require students to ask questions, make observations and predictions, design experiments, analyze data, and construct arguments in a collaborative setting, where they direct and monitor their progress.

AP Biology Exam Overview: Exam questions are based on learning objectives, which combine science practices with specific content. Students learn to

- Solve problems mathematically — including symbolically
- Design and describe experiments and analyze data and sources of error
- Explain, reason, or justify answers with emphasis on deeper, conceptual understanding
- Interpret and develop conceptual models

Due to the increased emphasis on quantitative skills and application of mathematical methods in the questions, students are allowed to use simple four-function calculators (with square root) on the entire exam. Students also receive a formula list as part of their testing materials.

Format of Assessment: **Section I:** Multiple Choice | 69 Questions | 90 Minutes | 50% of Exam Score

- Multiple-Choice: 63 Questions: Discrete Questions, Questions in sets
- Grid-In: 6 Questions: Discrete Questions, Questions integrate biology and mathematical skills

Section II: Free Response | 8 Questions | 90 minutes | 50% of Exam Score

- Long Free Response (2 questions, one of which is lab or data-based)
- Short Free Response (6 questions, each requiring a paragraph-length argument/response)

Big Idea 1: Evolution: The process of evolution drives the diversity and unity of life

Enduring Understanding 1.A. Change in the genetic makeup of a population over time is evolution
1.A.1: Natural selection is a major mechanism of evolution
1.A.2: Natural selection acts on phenotypic variations in populations
1.A.3: Evolutionary change is also driven by random processes
1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics
Enduring Understanding 1.B: Organisms are linked by lines of descent from common ancestry
1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today
1.B.2: Phylogenetic trees and cladograms are graphical representations of evolutionary history that can be tested.
Enduring Understanding 1.C: Life continues to evolve within a changing environment
1.C.1: Speciation and extinction have occurred throughout the Earth's history
1.C.2: Speciation may occur when two populations become reproductively isolated from each other
1.C.3: Populations of organisms continue to evolve
Enduring Understanding 1.D: The origin of living systems is explained by natural processes
1.D.1: There are several hypotheses about the natural origin of life on earth, each with supporting evidence
1.D.2: Scientific evidence from many different disciplines supports models of the origin of life

Big Idea 2: Energy: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis

Enduring Understanding 2.A. Growth, reproduction and maintenance of the organization of living systems require free energy and matter
2.A.1: All living systems require constant input of free energy
2.A.2: Organisms capture and store free energy for use in biological processes
2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization
Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cell create and maintain internal environments that are different from their external environments
2.B.1: Cell membranes are selectively permeable due to their structure
2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions
Enduring understanding 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
2.C.2: Organisms respond to changes in their external environments.
Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment
2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy
2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments
2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis.
2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.
Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.
2.E.1: Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms
2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms.
2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

Big Idea 3: Information: Living systems store, retrieve, transmit and respond to information essential to life processes.

Enduring understanding 3.A: Heritable information provides for continuity of life.
3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.
3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.
3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring
3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.
Enduring understanding 3.B: Expression of genetic information involves cellular and molecular mechanisms.
3.B.1: Gene regulation results in differential gene expression, leading to cell specialization
3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.
Enduring understanding 3.C: The processing of genetic information is imperfect and is a source of genetic variation.
3.C.1: Changes in genotype can result in changes in phenotype.
3.C.2: Biological systems have multiple processes that increase genetic variation
3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.
Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals.
3.D.1: Cell communication processes share common features that reflect a shared evolutionary history.
3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling
3.D.3: Signal transduction pathways link signal reception with cellular response
3.D.4: Changes in signal transduction pathways can alter cellular response
Enduring understanding 3.E: Transmission of information results in changes within and between biological systems.
3.E.1: Individuals can act on information and communicate it to others.
3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.

Big Idea 4: System: Biological systems interact, and these systems and their interactions possess complex properties.

Enduring understanding 4.A: Interactions within biological systems lead to complex properties.
4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.
4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.
4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.
4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.
4.A.5: Communities are composed of populations of organisms that interact in complex ways.
4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.
Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems.
4.B.1: Interactions between molecules affect their structure and function.
4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.
4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.
4.B.4: Distribution of local and global ecosystems changes over time.
Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.
4.C.1: Variation in molecular units provides cells with a wider range of functions.
4.C.2: Environmental factors influence the expression of the genotype in an organism.
4.C.3: The level of variation in a population affects population dynamics.
4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.