Advanced Placement Biology

Grade 11 or 12

Prerequisite: None

Credit Value: 5

ABSTRACT

Advanced Placement (AP) Biology is designed as the equivalent of an introductory course usually taken by biology majors in college. Topics and laboratories include molecules and cells, genetics and evolution, and organisms and populations. Emphasis is placed on providing the conceptual framework, factual knowledge, and analytical skills necessary to deal critically with the rapidly-changing science of biology. Students are encouraged to take the AP Biology examination in May. Students will complete a summer ecology project on which they will be tested in September. Benchmark assessments are employed to track individual student progress.

Adopted by the Somerville Board of Education on July 25, 2017
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**Essential Question:**
- How are living things distributed according to the presence of natural resources?
- How do the structures of biological molecules account for their functions?
- What similarities and differences between prokaryotic and eukaryotic cells account for their evolutionary relationships?
- How do the laws of thermodynamics relate to processes by which energy is provided to living systems?

**Content:**
- Population Dynamics, Communities and Ecosystems, and Global Issues
- The Properties of the Water Molecule
  - Carbohydrates, Lipids, Proteins,
- Structural Organization of Membranes and Compartmentalization
- Entropy, Enthalpy, and Enzymes

**Skills and Topics:**
- compare the effect abiotic and biotic factors have on population size and community structure
- trace energy flow through an ecosystem related to trophic structure
- review how carbon, nitrogen, and water cycle through ecosystems
- describe the effects human populations have on ecosystems
- discuss the models that are used to describe population growth
- list the chemical and physical properties of the water molecule and provide real-world examples:
  - capillarity
  - surface tension
  - cohesion
  - pH
  - high boiling point
  - low freezing point
  - density
- discuss the structure and function of the major molecules of life
- join the monomer units of each group of biological molecules using dehydration synthesis
- break down the polymers using hydrolysis
- compare and contrast the characteristics of prokaryotic and eukaryotic cells
- explain the fluid-mosaic model structure of membranes
- discuss the permeability of membranes to substances according to their properties
- describe sub-cellular organization in terms of the division of labor within the organelles (e.g., the endomembrane system)
- discuss the first two laws of thermodynamics
- relate the concept of entropy (disorder in a system) to free energy
- discuss enzymes as specialized proteins that regulate the rate of chemical reactions
- describe the specificity between an enzyme and its substrate
- use graphical analysis to determine the end point of an enzyme-catalyzed reaction
- design a controlled experiment to test the effect of varying pH or temperature on enzyme activity
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<td>Integration of Technology:</td>
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<td>Laboratory reports:</td>
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<td>o Dissolved oxygen and primary aquatic productivity</td>
<td>o pH of common solutions</td>
<td>o Inquiry Osmosis exploration</td>
<td>o Enzyme catalysis</td>
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<td>o Summer project</td>
<td>o Amylase bubble gum lab</td>
<td>o Cell analogy project</td>
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# AP Biology
## Grade 11 or 12

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*2016 NJSLS:*

RST: Reading in Science and Technical Subjects  
WHST: Writing in History, Science, and Technical Subjects  
SL: Speaking and Listening  
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N: Real Number System  
A: Algebra  
F: Functions  
G: Geometry  
S: Statistics and Probability  
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S-ID: Interpreting Categorical and Quantitative Data  
S-IC: Making Inferences and Justifying Conclusions  
S-MD: Using Probability to Make Decisions
## Essential Question:

- **How does the cell cycle ensure genetic continuity?**
- **What is the role of ATP in coupling on cells’ anabolic and catabolic processes?**
- **What features of meiosis are important to heredity?**
- **How do the structure of nucleic acids relate to their functions of information storage and protein synthesis?**

## Content:

- **Gap**₁ or **Growth**₁, **Synthesis**, **Gap**₂, **Mitosis**, **Meiosis**, and **Cytokinesis**
- **Photosynthesis**, **Cellular Respiration**, **Glycolysis**, and **Fermentation**
- **Inheritance Patterns and Linkage**
- **Mutations**, **Replication**, **Transcription**, **Translation**, **Gene Regulation**, and **Nucleic**

## Skills and Topics:

- List and describe the regulation of the stages of the cell cycle
- Compare and contrast the steps of the processes Mitosis and Meiosis
- Delineate the process of gametogenesis
- Explain the importance of reduction division of genetic material by two divisions
- Determine the cross-over rate between two strains of mold
- Discuss the biological basis of cancer
- Describe the anatomy of the mitochondria (crisatae, matrix) and chloroplast (stoma, thylakoid membranes)
- Explain the movement of electrons across the inner and outer membranes of the mitochondria (respiration) and the chloroplast (photosynthesis)
- Discuss the process of catabolically breaking down organic molecules
- Compare and contrast aerobic and anaerobic respiration in terms of net yield of energy
- Trace the number of ATP molecules released through the Krebs cycle
- Explain the mechanism of the principle patterns of inheritance:
  - Single allele
  - Double allele
  - Incomplete codominance
  - Multiple alleles
  - Sex-linkage
- Create family pedigrees to track a trait through generations
- Use cross-over rates to determine linkage groups
- Use linkage groups to map chromosomes
- Explore the inheritance patterns in a real-world organism
- Compare and contrast the structure and function of RNA with DNA
- Explain the processes of DNA replication and RNA/protein synthesis
- Explore and investigate DNA technology:
  - Cloning
  - Plasmid transformation
  - Gel-electrophoresis
- Discuss eukaryotic gene regulation
- Discuss prokaryotic gene regulation (e.g., Lac-operon, Trp-operon)
- Discuss viral structure and replication (e.g., lytic, lysogenic cycles)
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<td><strong>Skills and Topics:</strong></td>
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<td>• delineate the steps of glycolysis, the Krebs cycle, and the electron transport chain</td>
<td>• use technological systems and equipment to generate and analyze useful data dominance</td>
<td>• describe how reverse transcriptase allows versatility among the retroviruses</td>
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<td>• describe the role of oxaloacetate in the Citric acid cycle</td>
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<td>• use restriction enzymes to cut DNA into bands and separate using gel electrophoresis</td>
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<td>• apply PV=nRT to measure the rate of cellular respiration experimentally</td>
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<td>• insert a gene into a bacteria allowing antibiotic resistance</td>
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<td>• explain the steps of the light-dependent and light-independent reactions of photosynthesis</td>
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<td>• use a spectrophotometer to measure photosynthetic rate at different light intensities</td>
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<td>• separate plant pigments chromatographically and calculate the Rf values</td>
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<td>• discuss the adaptations that have evolved in response to different environmental conditions (e.g., stomates, location of chloroplasts, day storage, night production of carbohydrates)</td>
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- Open-ended responses, conclusions and analysis of exploratory activities

**Formative Assessments:**

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○ Mitosis (slide preparation and stage identification)  
○ Karyotype preparation  
○ Meiosis: cross-over in Sordaria fimicola  
○ Chromosome modeling and mapping | Laboratory reports:  
○ Cell respiration  
○ Plant pigments  
○ λ Spectrophotometry  
○ Photosynthetic rate of spinach treatments | Laboratory reports:  
○ Genetics of Drosophila melanogaster (virtual)  
○ Chi-square analysis of maze dihybrid  
○ Case study: Pompeii disease | Laboratory reports:  
○ Bacterial transformation  
○ Restriction enzyme cleavage of DNA  
○ Human DNA extraction |
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#### Essential Question:
- What role does natural selection play in the process of evolution?
- How does the organization of cells, tissues, and organs determine the structures and functions in plant systems?
- How does the organization of cells, tissues, and organs determine the structures and functions in animal systems?
- How are scientists limited through societal bioethical controls?

#### Content:
- Early Evolution of Life, Evidence of Evolution, and Evolutionary Mechanisms
- Structure, Transport, Reproduction, and Response in Plants
- Patterns of Reproduction, Development, and Regulation Interdependency of Organ Systems and Adaptive Features
- Bioethics, Use of Technology for Research, Disease, Pathogens, and Vectors

#### Skills and Topics:
- describe current models for the origin of prokaryotic and eukaryotic cells
- explain the types of evidence supporting the evolutionary view of life
- account for speciation and macroevolution
- explain how heredity and natural selection are involved in the process of evolution
- contrast between domains and kingdoms of living things
- construct a cladogram and analyze
- determine the frequency of alleles and genotypes in the gene pool of a population using the Hardy-Weinberg Law of Genetic Equilibrium
- distinguish among the major tissue types of vascular plants (e.g., ground, dermal, vascular)
- trace transport of nutrients and water throughout a vascular plant
- trace the reproductive process of plants (e.g., angiosperm: double fertilization – seed [embryo + endosperm], germination, development)
- identify and explain the biochemical structure and function of plant hormones
- provide examples of plant response to stimuli (tropisms)
- explain the concept of photoperiodism
- investigate animal communication and defense processes
- explain how does cell-signaling lead to the maintenance of homeostasis and differentiation in development
- explore the evolution, organization, and structure and function of the constituent tissues and organs of the following systems:
  - nervous
  - endocrine
  - immune
- investigate animal behavior patterns
- use scientific journals and the Internet to research a bioethical challenge
- research the structure and function of a disease (e.g., genetic or infectious) and the mode of transmission
- prepare, rehearse, and deliver a formal presentation in logical or sequential order using clear, precise, and organized language appropriate to the topic via voice-thread
- use visuals, such as charts, graphs, and/or props when presenting for clarification
- develop nutrition portfolio
- create voice-thread debating a bioethical issue
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  o Gene BLAST lab  
  o Mathematical modeling of Hardy-Weinberg lab  
  Various Natural Selection simulations | Laboratory reports:  
  o Transpiration lab  
  o Comparison of monocot and dicot tissues  
  o Stomata peels  
  Spring Break Project | Laboratory reports:  
  o Physiology of the Circulatory System  
  o Animal behavior: taxis and kinesis in isopods  
  Presentations: research of animal system interactions  
  Advanced Placement examination | Laboratory report |
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- **S-CP**: Conditional Probability and the Rules of Probability
- **S-MD**: Using Probability to Make Decisions
AP Biology
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Grade: 11 or 12
Prerequisite: None
Length of Course: Academic Year
Credit Value: 5

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This course will consist of the following units of study:

- Population Dynamics, Communities and Ecosystems, and Global Issues
- The Properties of the Water Molecule and Carbohydrates, Lipids, Proteins, and Nucleic Acids
- Structural Organization of Membranes and Compartmentalization
- Entropy, Enthalpy, and Enzymes
- Gap1 or Growth1, Synthesis, Gap2, Mitosis, Meiosis, and Cytokinesis
- Photosynthesis, Cellular Respiration, Glycolysis, and Fermentation
- Inheritance Patterns and Linkage
- Mutations, Replication, Transcription, Translation, Gene Regulation, and Nucleic Acid Technology
- Early Evolution of Life, Evidence of Evolution, and Evolutionary Mechanisms
- Structure, Transport, Reproduction, and Response in Plants
- Patterns of Reproduction, Development, and Regulation and Interdependency of Organ Systems and Adaptive Features
- Bioethics, use of Technology for Research, Disease, Pathogens, and Vectors
Course Objectives

The student will demonstrate the ability to answer in detail the following essential questions:

- How are living things distributed according to the presence of natural resources?
- How do the structures of biological molecules account for their functions?
- What similarities and differences between prokaryotic and eukaryotic cells account for their evolutionary relationships?
- How do the laws of thermodynamics relate to processes by which energy is provided to living systems?
- How does the cell cycle ensure genetic continuity?
- What is the role of ATP in coupling on cells’ anabolic and catabolic processes?
- What features of meiosis are important to heredity?
- How do the structure of nucleic acids relate to their functions of information storage and protein synthesis?
- What role does natural selection play in the process of evolution?
- How does the organization of cells, tissues, and organs determine the structures and functions in plant systems?
- How does the organization of cells, tissues, and organs determine the structures and functions in animal systems?
- How are scientists limited through societal bioethical controls?
- What are the post-graduation and/or career options that apply to the course content?

Evaluation Process

A final average of 65% or better is required to be awarded course credit. Throughout the length of this course, students may be evaluated on the basis of, but not limited to:

- Formative Assessments, such as writing prompts, journals, and portfolios
- Summative Assessments, such as quizzes, tests, and midterm and final examinations
- Performance Assessments, such as projects and presentations
- Technology-based Applications, such as electronic portfolios, Web Quests, ThinkQuest, and podcasting
- Class Participation
- Homework

Specific weights will be determined by course and level.
AP Biology
Student Agreement

STUDENT NAME: ____________________________________________

Last Name                                      First Name

GRADE: ______________

My signature below indicates that I have received a copy of the Somerville Public Schools Course Requirements for AP Biology.

I acknowledge my responsibility to read and understand all of the information contained in the AP Biology Course Requirements information and syllabus packet.

__________________________    ____________________
Student Signature                  Date

Note: Please share the course requirements for AP Biology with your parents.