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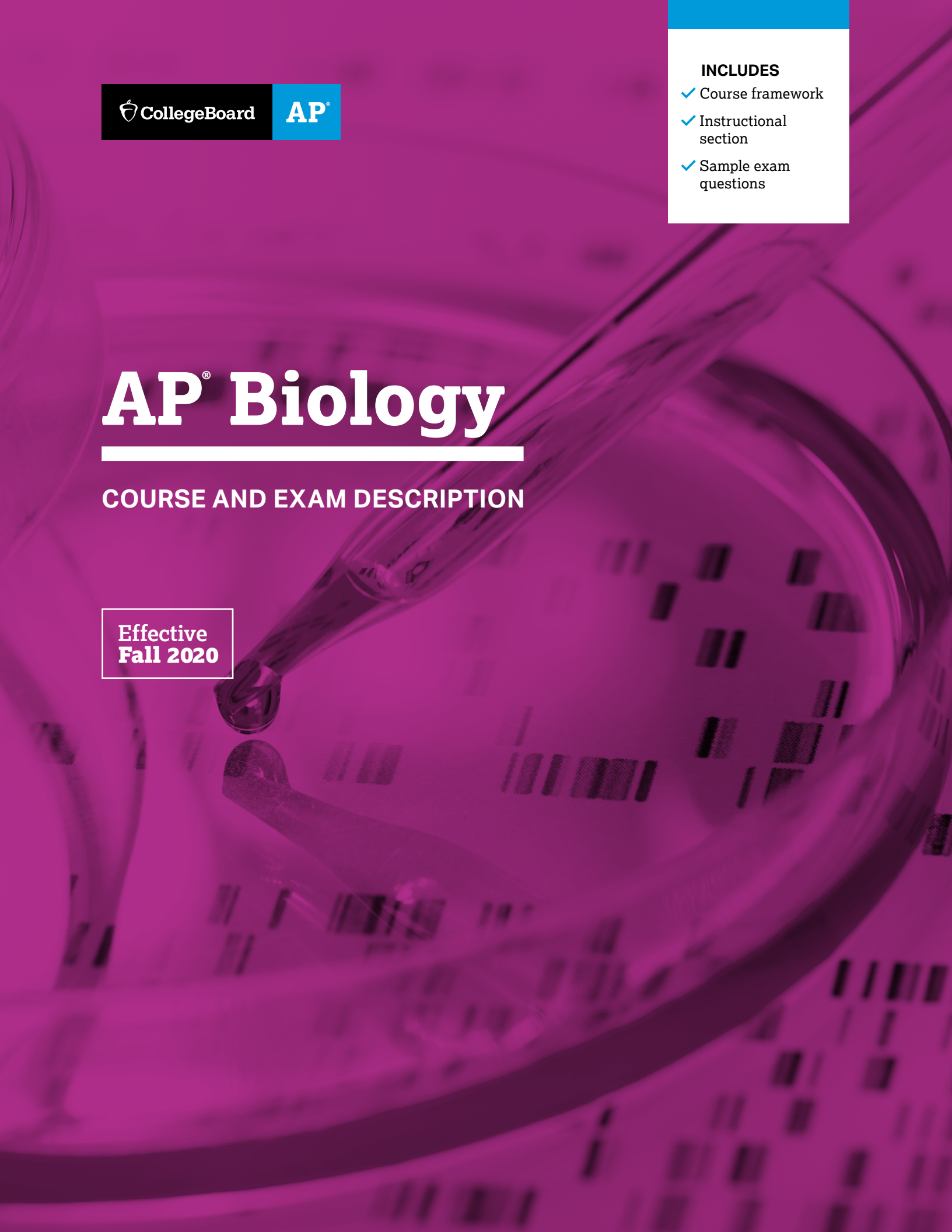
INCLUDES
- Course framework
- Instructional section
- Sample exam questions

AP® Biology

COURSE AND EXAM DESCRIPTION

Effective
Fall 2020



AP® Biology

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AP COURSE AND EXAM DESCRIPTIONS ARE UPDATED PERIODICALLY

Please visit AP Central (apcentral.collegeboard.org) to determine whether a more recent course and exam description is available.

Introduction

Given the speed with which scientific discoveries and research continuously expand scientific knowledge, many educators are faced with the challenge of balancing breadth of content coverage with depth of understanding. The AP Biology course outlined in this framework embraces this challenge by deemphasizing a traditional "content coverage" model of instruction in favor of one that focuses on enduring, conceptual understandings and the content that supports them. This approach enables students to spend less time on factual recall and more time on inquiry-based learning of essential concepts, helping them develop the reasoning skills necessary to engage in the science practices used throughout their study of AP Biology.

To foster this deeper level of learning, the breadth of content coverage in AP Biology is defined in a way that distinguishes content essential to support the enduring understandings from the many examples or applications that can overburden the course. Illustrative examples are provided that offer you a variety of optional instructional contexts to help your students achieve deeper understanding. Content that is outside the scope of the course and exam is also identified.

This framework encourages student development of inquiry and reasoning skills, such as designing a plan for collecting data, analyzing data, applying mathematical routines, and justifying arguments using evidence. The result will be readiness for the study of advanced topics in subsequent college courses—a goal of every AP course.

Course Framework Components

Overview

This course framework provides a clear and detailed description of the course requirements necessary for student success; it specifies what students must know, be able to do, and understand to qualify for college credit or placement.

The course framework includes two essential components:

1 SCIENCE PRACTICES

The science practices are central to the study and practice of biology. Students should develop and apply develop and apply the described practices on a regular basis over the span of the course.

2 COURSE CONTENT

The course content is organized into commonly taught units of study that provide a suggested sequence for the course. These units comprise the content and skills colleges and universities typically expect students to master to qualify for college credit and/or placement. This content is grounded in big ideas, which are crosscutting concepts that build conceptual understanding and spiral throughout the course.

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Science Practices

The table that follows presents the science practices that students should develop during the AP Biology course. These practices form the basis of many tasks on the AP Biology Exam.

The unit guides that follow embed and spiral these practices throughout the course, providing teachers with one way to integrate the practices into the course content with sufficient repetition to prepare students to transfer those skills when taking the AP Biology Exam.

More detailed information about the teaching of the science practices can be found in the Instructional Approaches section of this publication.

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Science Practices

Science Practice 1	Science Practice 2	Science Practice 3
Concept Explanation 1 Explain biological concepts, processes, and models presented in written format.	***Visual Representations*** 2 Analyze visual representations of biological concepts and processes.	***Questions and Methods*** 3 Determine scientific questions and methods.

SKILLS

1.A Describe biological concepts and/or processes.

1.B Explain biological concepts and/or processes.

1.C Explain biological concepts, processes, and/or models in applied contexts.

2.A Describe characteristics of a biological concept, process, or model represented visually.

2.B Explain relationships between different characteristics of biological concepts, processes, or models represented visually

a. In theoretical contexts.

b. In applied contexts.

2.C Explain how biological concepts or processes represented visually relate to larger biological principles, concepts, processes, or theories.

2.D Represent relationships within biological models, including

a. Mathematical models.

b. Diagrams.

c. Flow charts.

3.A Identify or pose a testable question based on an observation, data, or a model.

3.B State the null or alternative hypotheses, or predict the results of an experiment.

3.C Identify experimental procedures that are aligned to the question, including

a. Identifying dependent and independent variables.

b. Identifying appropriate controls.

c. Justifying appropriate controls.

3.D Make observations, or collect data from representations of laboratory setups or results. (Lab only; not assessed)

3.E Propose a new/next investigation based on

a. An evaluation of the evidence from an experiment.

b. An evaluation of the design/methods.

Science Practices *(cont'd)*

Science Practice 4

Representing and Describing Data 4

Represent and describe data.

Science Practice 5

Statistical Tests and Data Analysis 5

Perform statistical tests and mathematical calculations to analyze and interpret data.

Science Practice 6

Argumentation 6

Develop and justify scientific arguments using evidence.

SKILLS

4.A Construct a graph, plot, or chart (*X,Y; Log Y; Bar; Histogram; Line, Dual Y; Box and Whisker; Pie*).

a. Orientation
b. Labeling
c. Units
d. Scaling
e. Plotting
f. Type
g. Trend line

4.B Describe data from a table or graph, including

a. Identifying specific data points.
b. Describing trends and/or patterns in the data.
c. Describing relationships between variables.

5.A Perform mathematical calculations, including

a. Mathematical equations in the curriculum.
b. Means.
c. Rates.
d. Ratios.
e. Percentages.

5.B Use confidence intervals and/or error bars (both determined using standard errors) to determine whether sample means are statistically different.

5.C Perform chi-square hypothesis testing.

5.D Use data to evaluate a hypothesis (or prediction), including

a. Rejecting or failing to reject the null hypothesis.
b. Supporting or refuting the alternative hypothesis.

6.A Make a scientific claim.

6.B Support a claim with evidence from biological principles, concepts, processes, and/or data.

6.C Provide reasoning to justify a claim by connecting evidence to biological theories.

6.D Explain the relationship between experimental results and larger biological concepts, processes, or theories.

6.E Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on

a. Biological concepts or processes.
b. A visual representation of a biological concept, process, or model.
c. Data.

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Course Content

Based on the Understanding by Design® (Wiggins and McTighe) model, this course framework provides a clear and detailed description of the course requirements necessary for student success. The framework specifies what students must know, be able to do, and understand, with a focus on the big ideas that encompass core principles, theories, and processes of the discipline. The framework also encourages instruction that prepares students for advanced work in STEM and life science–related majors.

Big Ideas

The big ideas serve as the foundation of the course and allow students to create meaningful connections among course concepts. Often, they are abstract concepts or themes that become threads that run throughout the course. Revisiting the big ideas and applying them in a variety of contexts allow students to develop deeper conceptual understandings. Following are the big ideas of the course and a brief description of each:

BIG IDEA 1: EVOLUTION (EVO)

The process of evolution drives the diversity and unity of life. Evolution is a change in the genetic makeup of a population over time, with natural selection as its major driving mechanism. Darwin's theory, which is supported by evidence from many scientific disciplines, states that inheritable variations occur in individuals in a population. Due to competition for limited resources, individuals with more favorable genetic variations are more likely to survive and produce more offspring, thus passing traits to future generations. A diverse gene pool is vital for the survival of species because environmental conditions change. The process of evolution explains the diversity and unity of life, but an explanation about the *origin* of life is less clear.

In addition to the process of natural selection, naturally occurring catastrophic and human-induced events as well as random environmental changes can result in alteration in the gene pools of populations. Scientific evidence supports that speciation and extinction have occurred throughout Earth's history and that life continues to evolve within a changing environment, thus explaining the diversity of life.

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BIG IDEA 2: ENERGETICS (ENE)

Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis. Cells and organisms must exchange matter with the environment. Organisms respond to changes in their environment at the molecular, cellular, physiological, and behavioral levels. Living systems require energy and matter to maintain order, grow, and reproduce. Organisms employ various strategies to capture, use, and store energy and other vital resources. Energy deficiencies are not only detrimental to individual organisms but they can cause disruptions at the population and ecosystem levels. Homeostatic mechanisms that are conserved or divergent across related organisms reflect either continuity due to common ancestry or evolutionary change in response to distinct selective pressures.

BIG IDEA 3: INFORMATION STORAGE AND TRANSMISSION (IST)

Living systems store, retrieve, transmit, and respond to information essential to life processes. Genetic information provides for continuity of life, and, in most cases, this information is passed from parent to offspring via DNA. Nonheritable information transmission influences behavior within and between cells, organisms, and populations. These behaviors are directed by underlying genetic information, and responses to information are vital to natural selection and evolution. Genetic information is a repository of instructions necessary for the survival, growth, and reproduction of the organism. Genetic variation can be advantageous for the long-term survival and evolution of a species.

BIG IDEA 4: SYSTEMS INTERACTIONS (SYI)

Biological systems interact, and these systems and their interactions exhibit complex properties. All biological systems comprise parts that interact with one another. These interactions result in characteristics and emergent properties not found in the individual parts alone. All biological systems from the molecular level to the ecosystem level exhibit properties of biocomplexity and diversity. These two properties provide robustness to biological systems, enabling greater resiliency and flexibility to tolerate and respond to changes in the environment.

UNITS

The course content is organized into commonly taught units. The units have been arranged in a common sequence frequently found in many college courses and textbooks.

The eight units in AP Biology, and their weightings on the multiple-choice section of the AP Exam, are listed below.

Pacing recommendations at the unit level and on the Course at Glance provide suggestions for how you can teach the required course content and administer the Personal Progress Checks. The suggested class periods are based on a schedule in which the class meets five days a week for 45 minutes each day. While these recommendations have been made to aid in planning, teachers should of course adjust the pacing based on the needs of their students, alternate schedules (e.g., block scheduling), or their school's academic calendar.

TOPICS

Each unit is broken down into teachable segments called topics. The topic pages (starting on p. 34) contain all required content for each topic. Although most topics can be taught in one or two class periods, teachers should pace the course to suit the needs of their students and school.

Units	Exam Weighting
Unit 1: Chemistry of Life	**8–11%**
Unit 2: Cell Structure and Function	**10–13%**
Unit 3: Cellular Energetics	**12–16%**
Unit 4: Cell Communication and Cell Cycle	**10–15%**
Unit 5: Heredity	**8–11%**
Unit 6: Gene Expression and Regulation	**12–16%**
Unit 7: Natural Selection	**13–20%**
Unit 8: Ecology	**10–15%**

Spiraling the Big Ideas

The following table shows how the big ideas spiral across units by showing the units in which each big idea appears.

Big Ideas	Unit 1 *Chemistry of Life*	Unit 2 *Cell Structure and Function*	Unit 3 *Cellular Energetics*	Unit 4 *Cell Communication and Cell Cycle*	Unit 5 *Heredity*	Unit 6 *Gene Expression and Regulation*	Unit 7 *Natural Selection*	Unit 8 *Ecology*
Evolution EVO		✓			✓		✓	✓
Energetics ENE	✓	✓	✓	✓				✓
Information Storage and Transmission IST	✓			✓	✓	✓		✓
Systems Interactions SYI	✓	✓	✓		✓		✓	✓

Course at a Glance

Plan

The course at a glance provides a useful visual organization of the AP Biology curricular components, including:

- Sequence of units, along with approximate weighting and suggested pacing. Please note, pacing is based on 45-minute class periods, meeting five days each week for a full academic year
- Progression of topics within each unit
- Spiraling of the big ideas and science practices across units

Teach

SCIENCE PRACTICES

Science practices are spiralled throughout the course:

1 Concept Explanation
2 Visual Representations
3 Questions and Methods
4 Representing and Describing Data
5 Statistical Tests and Data Analysis
6 Argumentation

BIG IDEAS

The big ideas spiral across topics and units:

EVO Evolution
IST Information Storage and Transfer
ENE Energetics
SYI Systems Interactions

Assess

Assign the Personal Progress Checks—either as homework or in class—for each unit. Each Personal Progress Check contains formative multiple-choice and free-response questions. The feedback from the Personal Progress Checks shows students the areas where they need to focus.

UNIT 1 Chemistry of Life

~5-7 Class Periods | **8-11%** AP Exam Weighting

SYI 2	1.1 Structure of Water and Hydrogen Bonding
ENE 2	1.2 Elements of Life
SYI 2	1.3 Introduction to Biological Macromolecules
SYI 1	1.4 Properties of Biological Macromolecules
SYI 6	1.5 Structure and Function of Biological Macromolecules
IST 2	1.6 Nucleic Acids

Personal Progress Check 1

Multiple-Choice: ~20 questions
Free-Response: 2 questions

- Conceptual Analysis (partial)
- Analyze Model or Visual Representation (partial)

UNIT 2 Cell Structure and Function

~11-13 Class Periods | **10-13%** AP Exam Weighting

SYI 1	2.1 Cell Structure: Subcellular Components
SYI 6	2.2 Cell Structure and Function
ENE 5 2	2.3 Cell Size
ENE 2	2.4 Plasma Membranes
ENE 3	2.5 Membrane Permeability
ENE 3	2.6 Membrane Transport
ENE 6	2.7 Facilitated Diffusion
ENE 4	2.8 Tonicity and Osmoregulation
ENE 1	2.9 Mechanisms of Transport
ENE 6	2.10 Cell Compartmentalization
EVO 6	2.11 Origins of Cell Compartmentalization

Personal Progress Check 2

Multiple-Choice: ~30 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results (partial)
- Analyze Model or Visual Representation (partial)

NOTE: Partial versions of the free-response questions are provided to prepare students for more complex, full questions that they will encounter on the AP Exam.

UNIT 3 Cellular Energetics

~14-17 Class Periods | **12-16%** AP Exam Weighting

- ENE 1 — 3.1 Enzyme Structure
- ENE 3 — 3.2 Enzyme Catalysis
- ENE 6 — 3.3 Environmental Impacts on Enzyme Function
- ENE 6 — 3.4 Cellular Energy
- ENE 6 — 3.5 Photosynthesis
- ENE 4 — 3.6 Cellular Respiration
- SYI 6 — 3.7 Fitness

Personal Progress Check 3

Multiple-Choice: ~20 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results with Graphing (partial)
- Scientific Investigation (partial)

UNIT 4 Cell Communication and Cell Cycle

~9-11 Class Periods | **10-15%** AP Exam Weighting

- IST 1 — 4.1 Cell Communication
- IST 1 — 4.2 Introduction to Signal Transduction
- IST 6 — 4.3 Signal Transduction
- IST 6 — 4.4 Changes in Signal Transduction Pathways
- ENE 6 — 4.5 Feedback
- IST 4 5 — 4.6 Cell Cycle
- IST 6 — 4.7 Regulation of Cell Cycle

Personal Progress Check 4

Multiple-Choice: ~25 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results (partial)
- Analyze Data

UNIT 5 Heredity

~9-11 Class Periods | **8-11%** AP Exam Weighting

- IST 1 — 5.1 Meiosis
- IST 3 — 5.2 Meiosis and Genetic Diversity
- EVO IST 6 5 — 5.3 Mendelian Genetics
- IST 5 — 5.4 Non-Mendelian Genetics
- SYI 1 — 5.5 Environmental Effects on Phenotype
- SYI 6 — 5.6 Chromosomal Inheritance

Personal Progress Check 5

Multiple-Choice: ~25 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results with Graphing
- Conceptual Analysis

NOTE: Partial versions of the free-response questions are provided to prepare students for more complex, full questions that they will encounter on the AP Exam.

UNIT 6 Gene Expression and Regulation

~18-21 Class Periods | **12-16%** AP Exam Weighting

- IST 1 — 6.1 DNA and RNA Structure
- IST 2 — 6.2 Replication
- IST 2 — 6.3 Transcription and RNA Processing
- IST 6 2 — 6.4 Translation
- IST 6 — 6.5 Regulation of Gene Expression
- IST 6 — 6.6 Gene Expression and Cell Specialization
- IST 2 3 — 6.7 Mutations
- IST 6 — 6.8 Biotechnology

Personal Progress Check 6

Multiple-Choice: ~25 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results
- Analyze Model or Visual Representation

UNIT 7 Natural Selection

~20-23 Class Periods | **13-20%** AP Exam Weighting

- EVO 2 — 7.1 Introduction to Natural Selection
- EVO 1 — 7.2 Natural Selection
- EVO 4 — 7.3 Artificial Selection
- EVO 3 — 7.4 Population Genetics
- EVO 5 1 — 7.5 Hardy-Weinberg Equilibrium
- EVO 4 — 7.6 Evidence of Evolution
- EVO 6 — 7.7 Common Ancestry
- EVO 3 — 7.8 Continuing Evolution
- EVO 2 — 7.9 Phylogeny
- EVO 6 2 — 7.10 Speciation
- EVO 3 — 7.11 Extinction
- SYI 6 — 7.12 Variations in Populations
- SYI 3 — 7.13 Origin of Life on Earth

Personal Progress Check 7

Multiple-Choice: ~40 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results with Graphing
- Analyze Data

UNIT 8 Ecology

~18-21 Class Periods | **10-15%** AP Exam Weighting

- ENE IST 3 — 8.1 Responses to the Environment
- ENE 6 — 8.2 Energy Flow Through Ecosystems
- SYI 4 — 8.3 Population Ecology
- SYI 5 — 8.4 Effect of Density of Populations
- ENE 5 — 8.5 Community Ecology
- SYI 6 — 8.6 Biodiversity
- EVO SYI 5 — 8.7 Disruptions to Ecosystems

Personal Progress Check 8

Multiple-Choice: ~20 questions
Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results with Graphing
- Scientific Investigation