



INCLUDES

- ✓ Course framework
- ✓ Instructional section
- ✓ Sample exam questions

AP[®] Biology

COURSE AND EXAM DESCRIPTION

Effective
Fall 2025



About the AP Biology Course

AP Biology is an introductory college-level biology course. Students cultivate their understanding of biology through inquiry-based investigations as they explore the following topics: evolution, cellular processes, energy and communication, genetic information transfer, ecology, and interactions.

College Course Equivalent

The AP Biology course is equivalent to a two-semester college introductory biology course for biology majors.

Prerequisites

Students should have successfully completed high school courses in biology and chemistry.

Laboratory Requirement

This course requires that 25 percent of the instructional time will be spent in hands-on laboratory work, with an emphasis on inquiry-based investigations that provide students with opportunities to apply the science practices.

Inquiry-based laboratory experiences support the AP Biology course and AP Course Audit curricular requirements by providing opportunities for students to engage in the science practices as they design plans for experiments, make predictions, collect and analyze data, apply mathematical routines, develop explanations, and communicate about their work.

Colleges may require students to present their laboratory materials from AP science courses before granting college credit for laboratory work, so students should be encouraged to retain their laboratory notebooks, reports, and other materials.

Introduction

Given the speed with which scientific discoveries and research continuously expand scientific knowledge, 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 essential, 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 and depth of content in the AP Biology course defines concepts, science practices, and

understandings required by representative colleges and universities for granting college credit and/or placement. Illustrative examples are provided to offer a variety of optional instructional contexts to help students achieve deeper understanding. Content that is outside the scope of the course and exam is also identified within the exclusion statements in the framework.

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. The framework specifies what students should know, be able to do, and understand to qualify for college credit and/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 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 be proficient in 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.

1**AP BIOLOGY**

Science Practices

The table that follows presents the science practices that students should develop during the AP Biology course. These practices and skills form the basis of the tasks on the AP Biology Exam. While many different skills can be applied to any one content topic, the framework supplies skill focus recommendations for each topic to help assure skill distribution and repetition throughout the course.

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 apply those skills when taking the AP Biology Exam.

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



Science Practices

Science Practice 1

Concept Explanation **1**

Explain biological concepts and processes presented in written format.

Science Practice 2

Visual Representations **2**

Analyze visual representations of biological concepts and processes.

Science Practice 3

Questions and Methods **3**

Determine scientific questions and methods.

SKILLS

1.A Describe biological concepts and processes.

1.B Explain biological concepts and processes.

1.C Explain biological concepts and processes in applied contexts.

2.A Describe characteristics of visual representations of biological concepts and processes.

2.B Explain relationships between characteristics of biological models in both theoretical and applied contexts.

2.C Explain how biological models relate to larger principles, concepts, processes, systems, or theories.

2.D Represent relationships within biological models, including mathematical models, diagrams, flowcharts, and systems.

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

3.B State the null hypothesis or predict the results of an experiment.

3.C Identify experimental procedures that align with the question, including:

- i. identifying dependent and independent variables
- ii. identifying appropriate controls
- iii. justifying appropriate controls

3.D Propose a new investigation based on an evaluation of the experimental design or evidence.

**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 to represent the data, including: x-y graphs (bar, histogram, line, log scale, dual y), scatter plot, box and whisker plot, and pie chart. The graph should include the following components:

- i. type of graph appropriate for the data
- ii. axis labeling, including appropriate units and legend
- iii. scaling
- iv. accurately plotted data (including error bars when appropriate)
- v. trend line (when appropriate)

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

- i. identifying specific data points
- ii. describing trends and patterns in the data
- iii. describing relationships between variables

5.A Perform mathematical calculations, including:

- i. mathematical equations in the curriculum
- ii. means
- iii. rates
- iv. ratios
- v. percentages and percent changes

5.B Use confidence intervals and error bars to estimate whether sample means are statistically different.

5.C Perform chi-square hypothesis testing.

5.D Use data to evaluate a hypothesis or prediction, including rejecting or failing to reject the null hypothesis.

6.A Make a scientific claim.

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

Course Content

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 coursework in biology and its integration into a wide variety of STEM fields.

Big Ideas

The big ideas, often, are abstract concepts or themes that allow students to create meaningful connections among course concepts. 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

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.

BIG IDEA 2: ENERGETICS

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

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

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 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 a Glance provide suggestions for how to teach the required course content and administer the 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, adjust the pacing based on the needs of your students, alternate schedules (e.g., block scheduling), or your school's academic calendar.


TOPICS

Each unit is divided into teachable segments called topics. The topic pages (starting on p. 32) contain all required content for each topic.

Units	Exam Weighting
Unit 1: Chemistry of Life	8–11%
Unit 2: Cells	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 throughout the course by showing the units in which each big idea appears.

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
Big Ideas 	<i>Chemistry of Life</i>	<i>Cells</i>	<i>Cellular Energetics</i>	<i>Cell Communication and Cell Cycle</i>	<i>Heredity</i>	<i>Gene Expression and Regulation</i>	<i>Natural Selection</i>	<i>Ecology</i>
Evolution	✓	✓	✓	✓	✓	✓	✓	✓
Energetics	✓	✓	✓	✓	✓	✓	✓	✓
Information Storage and Transmission	✓	✓	✓	✓	✓	✓	✓	✓
Systems Interactions	✓	✓	✓	✓	✓	✓	✓	✓

Course at a Glance

Plan

The course at a glance provides a useful visual organization of the AP Biology 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 spiral throughout the course.

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

Assess

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

UNIT 1 Chemistry of Life

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

- 2** 1.1 Structure of Water and Hydrogen Bonding
- 2** 1.2 Elements of Life
- 2** 1.3 Introduction to Macromolecules
- 1** 1.4 Carbohydrates
- 6** 1.5 Lipids
- 2** 1.6 Nucleic Acids
- 6** 1.7 Proteins

UNIT 2 Cells

~14-16 Class Periods **10-13%** AP Exam Weighting

- 1** **6** 2.1 Cell Structure and Function
- 2** **5** 2.2 Cell Size
- 2** 2.3 Plasma Membrane
- 5** 2.4 Membrane Permeability
- 3** 2.5 Membrane Transport
- 6** 2.6 Facilitated Diffusion
- 4** 2.7 Tonicity and Osmoregulation
- 1** 2.8 Mechanisms of Transport
- 6** 2.9 Cell Compartmentalization
- 6** 2.10 Origins of Cell Compartmentalization

Progress Check 1

Multiple-Choice: ~24 questions

Free-Response: 2 questions

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

Progress Check 2

Multiple-Choice: ~33 questions (2 parts)

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

~12-14 Class Periods

12-16% AP Exam Weighting

- 1**
3 3.1 Enzymes
- 6** 3.2 Environmental Impacts on Enzyme Function
- 6** 3.3 Cellular Energy
- 6** 3.4 Photosynthesis
- 4** 3.5 Cellular Respiration

Progress Check 3

Multiple-Choice: ~19 questions

Free-Response: 2 questions

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

UNIT
4

Cell Communication and Cell Cycle

~12-14 Class Periods

10-15% AP Exam Weighting

- 1** 4.1 Cell Communication
- 1** 4.2 Introduction to Signal Transduction
- 6** 4.3 Signal Transduction Pathways
- 6** 4.4 Feedback
- 4**
5 4.5 Cell Cycle
- 6** 4.6 Regulation of Cell Cycle

Progress Check 4

Multiple-Choice: ~24 questions

Free-Response: 2 questions

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

UNIT
5

Heredity

~8-10 Class Periods

8-11% AP Exam Weighting

- 1** 5.1 Meiosis
- 3** 5.2 Meiosis and Genetic Diversity
- 5**
6 5.3 Mendelian Genetics
- 5** 5.4 Non-Mendelian Genetics
- 1** 5.5 Environmental Effects on Phenotype

Progress Check 5

Multiple-Choice: ~23 questions

Free-Response: 2 questions

- Interpreting and Evaluating Experimental Results with Graphing
- Conceptual Analysis

**UNIT
6****Gene Expression
and Regulation****~18-20**Class
Periods**12-16%**AP Exam
Weighting

- 1** 6.1 DNA and RNA Structure

- 2** 6.2 DNA Replication

- 2** 6.3 Transcription and RNA Processing

- 2**
6 6.4 Translation

- 6** 6.5 Regulation of Gene Expression

- 6** 6.6 Gene Expression and Cell Specialization

- 2** 6.7 Mutations

- 6** 6.8 Biotechnology

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****~19-21**Class
Periods**13-20%**AP Exam
Weighting

- 2** 7.1 Introduction to Natural Selection

- 1** 7.2 Natural Selection

- 4** 7.3 Artificial Selection

- 3** 7.4 Population Genetics

- 1**
5 7.5 Hardy-Weinberg Equilibrium

- 4** 7.6 Evidence of Evolution

- 6** 7.7 Common Ancestry

- 3** 7.8 Continuing Evolution

- 2** 7.9 Phylogeny

- 2**
6 7.10 Speciation

- 6** 7.11 Variations in Populations

- 3** 7.12 Origins of Life on Earth

Progress Check 7**Multiple-Choice: ~48 questions (2 parts)****Free-Response: 2 questions**

- Interpreting and Evaluating Experimental Results with Graphing
- Analyze Data

**UNIT
8****Ecology****~19-21**Class
Periods**10-15%**AP Exam
Weighting

- 3** 8.1 Responses to the Environment

- 6** 8.2 Energy Flow Through Ecosystems

- 4** 8.3 Population Ecology

- 5** 8.4 Effect of Density on Populations

- 5** 8.5 Community Ecology

- 6** 8.6 Biodiversity

- 5** 8.7 Disruptions in Ecosystems

Progress Check 8**Multiple-Choice: ~24 questions****Free-Response: 2 questions**

- Interpreting and Evaluating Experimental Results with Graphing
- Scientific Investigation

AP BIOLOGY

Laboratory Investigations

Lab Experiments

The AP Biology Exam directly assesses the learning objectives of the course framework, which means the inclusion of appropriate experiments aligned with those learning objectives is important for student success. Selecting experiments that provide students with the broadest laboratory experience possible is important when designing the course. You should devote 25 percent of instructional time to lab investigations and have students conduct at least two investigations per Big Idea.

We encourage you to be creative in designing a lab program while ensuring students explore and develop understandings of core techniques. After completion, students should be able to explain how to collect data, use data to form conclusions, and apply their conclusions to larger biological concepts. Students should report recorded data and quantitative conclusions drawn from the data with appropriate precision and significant figures. Students should also develop an understanding of how changes in the design of the experiments would impact the validity and accuracy of their results. Many questions on the AP Biology Exam are written in an experimental context, so these skills will prove invaluable for both concept comprehension and exam performance.

Lab Materials

AP Biology is a college-level course, but the equipment and chemicals needed for the labs are comparable to those required for a high school-level biology course. A list of instruments, equipment, and chemicals for AP Biology can be found at the beginning of each investigation in the *AP Biology Investigative Labs: An Inquiry-Based Approach* lab manual. Most lab manuals provide a list of materials and equipment needed for each lab investigation. Before purchasing materials, consult your lab manual and calculate how much of a substance or material may be needed for the number of students you have.

Students will need access to basic lab equipment and glassware (e.g., beakers, graduated cylinders, and balances). Access to some specialized equipment, such as spectrophotometers, gel electrophoresis equipment and pH meters, may be needed to complete

some of the investigations in the lab manual. None of the investigations in the lab manual require the use of probes or computer sensors for data collection, though they can be used if available. It is recommended to have a computer and projector to show computer-based animations and simulations for prelab activities or postlab discussions. However, a paper-based alternative can easily be provided if the equipment is unavailable. Students may use computers or graphing calculators to analyze data and present their findings, but they do not need to do so.

It is important that the AP Biology laboratory program be adapted to local conditions and funding even while it aims to offer students a well-rounded experience with experimental biology. Adequate lab facilities should be provided so that each student has a work space where equipment and materials can be left overnight if necessary. Sufficient lab glassware for the anticipated enrollment and appropriate instruments (balances and pH meters) should be provided.

Students in AP Biology will find it helpful to have access to computers with software appropriate for processing lab data and writing reports. A lab assistant in the form of a paid or unpaid aide may also be helpful; previous students may be able to earn credit by serving as assistants in the lab.

There are avenues you can explore as a means of obtaining access to more expensive equipment, such as computers, spectrophotometers, gel electrophoresis equipment, and probes. Spectrophotometers can often be rented for short periods of time from instrument suppliers. Chemical companies often have equipment that can be borrowed; company representatives should have this information. Alternatively, local colleges or universities may allow high school students to complete a lab as a field trip on their campus, or they may allow you to borrow their equipment. They may even donate their old equipment to your school. Some schools have partnerships with local businesses that can help with lab equipment and materials. It never hurts to ask for equipment and/or make your laboratory needs known. There are many grant programs that biology teachers can apply to for funds to purchase equipment and supplies, and you can also use online donation sites such as DonorsChoose and AdoptAClassroom.org.

Lab Time

It is critical that lab work be part of an AP Biology course so that it is comparable to a college-level course for biology majors. Data show that increased lab time is correlated with higher AP scores. Flexible or modular scheduling may be implemented to meet the time requirements identified in the course outline for laboratory experiences. You may find that at minimum, one double period a week is needed to allow adequate time for authentic lab experiences.

Lab Manuals

College Board publishes *AP Biology Investigative Labs: An Inquiry-Based Approach*, a manual that meets the curriculum requirement for inquiry-based laboratory experiences for students.

Both the teacher and the student manuals are free and available on the College Board website. Though this lab manual isn't required, it includes laboratory investigations that you can choose from to satisfy the guided inquiry lab component for the course. Some textbook publishers may provide a lab manual as an ancillary to the textbook, and most science classroom supply companies also offer lab manuals.

Lab Notebooks and Student Workbooks

Many publishers and science classroom material distributors offer affordable lab notebooks and student workbooks with associated practice problems and solutions. Students can use any type of notebook, even an online document, to fulfill the lab notebook requirement.

AP BIOLOGY

Exam Information

Exam Overview

The AP Biology Exam assesses student understanding of the science practices and learning objectives outlined in the course framework. The exam is 3 hours long and includes 60 multiple-choice questions and 6 free-response questions. A four-function, scientific, or graphing calculator is allowed on both sections of the exam. The details of the exam, including exam weighting and timing, can be found below.

Section	Question Type	Number of Questions	Exam Weighting	Timing
I	Multiple-choice questions	60	50%	90 minutes
II	Free-response questions	6	50%	90 minutes

Question 1: Interpreting and Evaluating Experimental Results (9 pts)
Question 2: Interpreting and Evaluating Experimental Results with Graphing (9 pts)
Question 3: Scientific Investigation (4 pts)
Question 4: Conceptual Analysis (4 pts)
Question 5: Analyze Model or Visual Representation (4 pts)
Question 6: Analyze Data (4 pts)

The exam assesses content from each of four big ideas for the course:

1. Evolution
2. Energetics
3. Information Storage and Transmission
4. Systems Interactions

The exam also assesses each of the eight units of the course with the following exam weightings on the multiple-choice section of the AP Exam:

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

Section I: Multiple-Choice

The first section of the AP Biology Exam includes 60 multiple-choice questions appearing either as individual questions or in sets of typically 4–5 questions each. All six AP Biology science practices are assessed in the multiple-choice section with the following exam weightings:

Science Practice	Exam Weighting
1: Concept Explanation	25–33%
2: Visual Representations	16–24%
3: Questions and Methods	8–14%
4: Representing and Describing Data	8–14%
5: Statistical Tests and Data Analysis	8–14%
6: Argumentation	20–26%

Section II: Free-Response

The second section of the AP Biology Exam includes two long questions and four short-answer questions. Each of the four short-answer questions will focus on a different big idea and a different unit of instruction.

Free-response question 1: Interpreting and Evaluating Experimental Results is a 9-point question that provides students with an authentic scenario and accompanying data, presented in a table, graph, or both. This question assesses student ability to do the following in four question parts:

- Part A (1 point): Describe biological concepts, processes, or models.
- Part B (3 points): Identify experimental methods or describe data.
- Part C (3 points): Identify experimental methods, analyze data, or perform calculations.
- Part D (2 points): Make and justify predictions.

Free-response question 2: Interpreting and Evaluating Experimental Results with Graphing is a 9-point question that presents students with an authentic scenario accompanied by data in a table. This question assesses students' ability to do the following in four question parts:

- Part A (1 point): Describe biological concepts, processes, or models.
- Part B (4 points): Construct the appropriate graph from the data provided.
- Part C (2 points): Analyze data, perform calculations, state a null hypothesis, or predict results of an experiment.
- Part D (2 points): Make and justify predictions.

Free-response question 3: Scientific Investigation is a 4-point question that presents students with a description of a lab investigation scenario. This question assesses students' ability to do the following in four question parts:

- Part A (1 point): Describe biological concepts or processes.
- Part B (1 point): Identify experimental procedures.
- Part C (1 point): State the null hypothesis or predict the results of an experiment.
- Part D (1 point): Justify predictions.

Free-response question 4: Conceptual Analysis is a 4-point question that presents students with an authentic scenario describing a biological phenomenon with a disruption. This question assesses students' ability to do the following in four question parts:

- Part A (1 point): Describe biological concepts or processes.
- Part B (1 point): Explain biological concepts or processes.
- Part C (1 point): Predict the causes or effects of a change in a biological system.
- Part D (1 point): Justify predictions.

Free-response question 5: Analyze Model or Visual Representation is a 4-point question that presents students with a description of an authentic scenario accompanied by a visual model or representation. This question assesses students' ability to do the following in four question parts:

- Part A (1 point): Describe characteristics of a biological concept, process, or model represented visually.
- Part B (1 point): Explain relationships between different characteristics of a biological concept or process represented visually.
- Part C (1 point): Represent relationships within a biological model.
- Part D (1 point): Explain how a biological concept or process represented visually relates to a larger biological principle, concept, process, or theory.

Free-response question 6: Analyze Data is a 4-point question that presents students with data in a graph, table, or other visual representation. This question assesses students' ability to do the following in four question parts:

- Part A (1 point): Describe data.
- Part B (1 point): Describe data.
- Part C (1 point): Use data to evaluate a hypothesis or prediction.
- Part D (1 point): Explain how experimental results relate to biological principles, concepts, processes, or theories.

Task Verbs Used in Free-Response Questions

The following **task verbs** are commonly used in the free-response questions:

Calculate: Perform mathematical steps to arrive at a final answer, including algebraic expressions, properly substituted numbers, and correct labeling of units and significant figures.

Construct/Draw: Create a diagram, graph, representation, or model that illustrates or explains relationships or phenomena. Labels may or may not be required.

Describe: Provide relevant characteristic(s) of a specified topic.

Determine: Decide or conclude after reasoning, observation, or applying mathematical routines (calculations).

Evaluate: Judge or determine the significance or importance of information, or the quality or accuracy of a claim.

Explain: Provide information about how or why a relationship, process, pattern, position, situation, or outcome occurs, using evidence and/or reasoning to support or qualify a claim.

Explain “how” typically requires analyzing the relationship, process, pattern, position, situation, or outcome.

Explain “why” typically requires analysis of motivations or reasons for the relationship, process, pattern, position, situation, or outcome.

Identify: Indicate or provide information about a specified topic, without elaboration.

Justify: Provide evidence to support, qualify, or defend a claim, and provide reasoning to explain how that evidence supports or qualifies the claim.

Make a claim: Make an assertion that is based on evidence or knowledge.

Predict/Make a prediction: Predict the causes or effects of a change in, or disruption to, one or more components in a relationship, pattern, process, or system.

Represent: Use appropriate graphs, symbols, words, illustrations, and tables of numerical values to describe biological concepts, characteristics, and/or relationships.

State (the null hypothesis): Indicate or provide a hypothesis to support or defend a claim about a scientifically testable question related to the experimental variables.

Support a claim: Provide reasoning to explain how evidence supports or qualifies a claim

Sample Exam Questions

The sample exam questions that follow illustrate the relationship between the course framework and the AP Biology Exam and serve as examples of the types of questions that appear on the exam. After the sample questions you will find a table that shows which skill, learning objective(s), and unit each question relates to. The table also provides the answers to the multiple-choice questions.

Section I: Multiple-Choice Questions

The following are examples of the kinds of multiple-choice questions found on the exam.

1. Insulin is a protein hormone that is secreted in response to elevated blood glucose levels. When insulin binds to its receptors on liver cells, the activated receptors stimulate phosphorylation cascades that cause the translocation of glucose transporters to the plasma membrane.

Based on the information provided, which of the following best explains the role of insulin in this liver cell signal transduction pathway?

- (A) It acts as a ligand.
 - (B) It acts as a receptor.
 - (C) It acts as a secondary messenger.
 - (D) It acts as a protein kinase.
2. Humans have 23 pairs of chromosomes. Which of the following statements best predicts the consequence if correct chromosome separation did not occur during meiosis II?
 - (A) The gametes would get larger from one generation to the next.
 - (B) The chromosome number would double with each generation.
 - (C) The chromosome number would be halved with each generation.
 - (D) The chromosome number would triple with each generation.

3. Mutations in the *MYO6* and *POU4F3* genes have been associated with a form of hereditary hearing loss in humans. Researchers studying the genes have proposed that *POU4F3* encodes a transcription factor that influences the regulation of *MYO6*.

Which of the following questions will best help guide the researchers toward a direct test of their proposal?

- (A) Have mutations in other genes also been associated with hearing loss?
- (B) In what types of cells are the mutant forms of the *POU4F3* gene expressed?
- (C) Are mutations in the *MYO6* and *POU4F3* genes also found in mice?
- (D) Do mutations in the *POU4F3* gene affect *MYO6* mRNA levels in cells?

Questions 4–7 refer to the following information.

In the early 1970s, researchers hypothesized that carbon was the limiting nutrient in many aquatic ecosystems. To test this hypothesis, the researchers divided a small lake in two roughly equal halves with an impermeable curtain that was fastened and sealed to the bedrock of the lake (Figure 1). Beginning in 1971 the researchers treated one side of the lake with sucrose and the other side with both sucrose and phosphate. From 1971 to 1983 the researchers monitored the phytoplankton biomass in both parts of the lake. The results are shown in Figure 2.

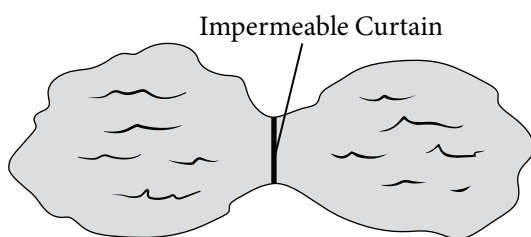


Figure 1. Lake with an impermeable curtain

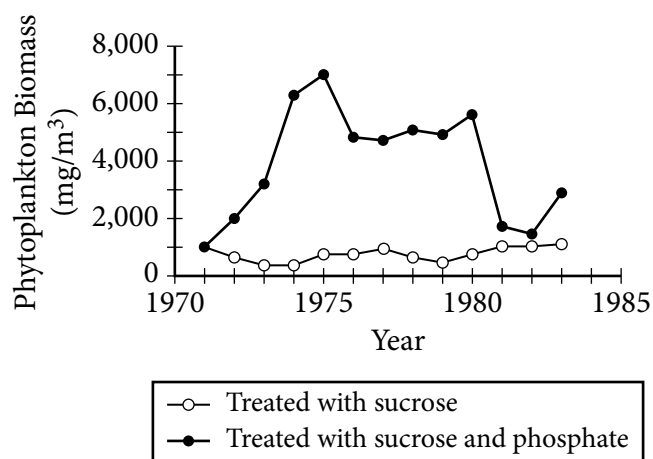


Figure 2. Phytoplankton biomass in two sides of a small lake that is divided by an impermeable curtain

- Which of the following claims is best supported by the data?
 - Carbon was a limiting factor for phytoplankton in the lake.
 - Phosphate was a limiting factor for phytoplankton in the lake.
 - Both carbon and phosphate were limiting factors for phytoplankton in the lake.
 - Neither carbon nor phosphate was a limiting factor for phytoplankton in the lake.
- The average growth rate of the phytoplankton population from 1971 to 1975 in the side of the lake treated with sucrose and phosphate is closest to which of the following?
 - 125 (mg/m³)/year
 - 1,000 (mg/m³)/year
 - 1,500 (mg/m³)/year
 - 6,000 (mg/m³)/year

6. Which of the following treatments would have been the best control treatment for the experiment?
- (A) An untreated section of the lake
 - (B) A section of the lake that was treated with phosphate but not sucrose
 - (C) A different lake that was treated with sucrose and phosphate
 - (D) A small pool of the lake water maintained in a controlled laboratory environment
7. Which of the following was most likely a direct consequence of the addition of phosphate to the lake?
- (A) The amount of biomass in the first trophic level decreased.
 - (B) The amount of biomass in the second trophic level decreased.
 - (C) The amount of energy available to producers in the lake increased.
 - (D) The amount of energy available to consumers in the lake increased.
8. The enzyme trypsin aids in protein digestion in the small intestine. The relative activity of trypsin at different pH values is shown in Figure 1.

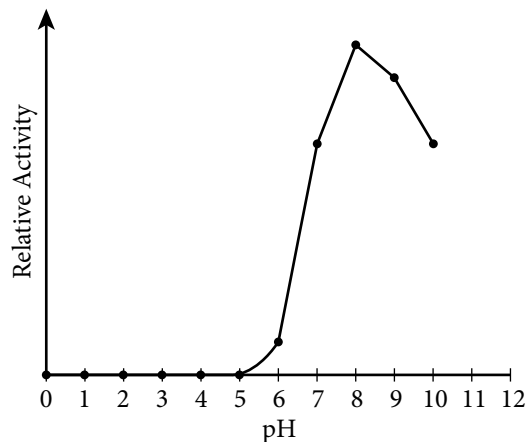


Figure 1. Effect of pH on the activity of trypsin

Which of the following statements best explains the activity levels of trypsin shown in Figure 1?

- (A) The small intestine releases inhibitor molecules that block the activity of trypsin unless it is at its optimum pH.
- (B) The number of effective collisions between trypsin and its substrate increases at higher pH values.
- (C) As pH values increase, the substrate concentration decreases, leading to an eventual decline in the rate of the trypsin-catalyzed reaction.
- (D) At extremely low pH values, trypsin is denatured and cannot function efficiently.

9. Different photosynthetic organisms have different types of chlorophyll molecules. The distribution of chlorophylls in several different groups of organisms is shown in Table 1. A plus sign (+) in the table indicates the presence of a chlorophyll, while a minus sign (–) indicates its absence.

Table 1. The distribution of chlorophylls in several groups of organisms

	Chlorophyll <i>a</i>	Chlorophyll <i>b</i>	Chlorophyll <i>c</i>	Chlorophyll <i>d</i>
Flowering plants	+	+	–	–
Green algae	+	+	–	–
Brown algae	+	–	+	–
Red algae	+	–	–	+
Cyanobacteria	+	–	–	–

Based on the data, which of the following most likely describes the evolutionary relationship among the organisms?

- (A) Because brown algae, red algae, and cyanobacteria lack chlorophyll *b*, they evolved before green algae and flowering plants did.
- (B) Because green algae and flowering plants contain chloroplasts, they evolved more recently than brown algae, red algae, and cyanobacteria did.
- (C) Because increasingly complex forms of chlorophyll are found in red algae, brown algae, green algae, and flowering plants, the evolutionary relationship among these organisms can be seen over time.
- (D) Because all of the organisms contain chlorophyll *a*, the organisms share a common ancestor.
10. A student used a microscope to observe a slide of red onion cells that were suspended in a 1% NaCl solution. The student then added a 15% NaCl solution to the slide and observed the changes that occurred. The student's observations are represented in Figure 1.

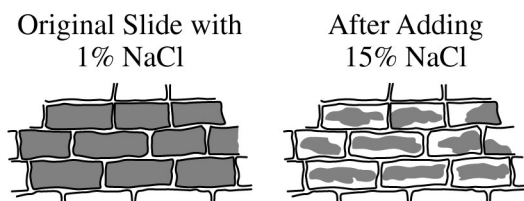


Figure 1. Student's observations of onion cells

Which of the following most directly explains the changes in the cells?

- (A) The degradation of DNA in the nuclei of the cells
- (B) The lysis of chloroplasts in the cells
- (C) The movement of water from the central vacuoles of the cells into the solution
- (D) The movement of NaCl from the solution into the cytoplasm of the cells

11. The human *TPM1* gene encodes members of the tropomyosin family of cytoskeletal proteins. Which of the following best explains how different proteins can be made in different cell types from the one *TPM1* gene?
- (A) Different introns are selectively converted to exons.
 - (B) Different exons are retained or spliced out of the primary transcript.
 - (C) The GTP cap is selectively added to and activates different exons.
 - (D) Different portions of the primary transcript remain bound to the template DNA.
12. Scientists examined the folded structure of a purified protein resuspended in water and found that amino acids with nonpolar R groups were primarily buried in the middle of the protein, whereas amino acids with polar R groups were primarily on the surface of the protein.

Which of the following best explains the location of the amino acids in the folded protein?

- (A) Polar R groups on the surface of the protein can form ionic bonds with the charged ends of the water molecules.
 - (B) Polar R groups are too bulky to fit in the middle of the protein and are pushed toward the protein's surface.
 - (C) Nonpolar R groups that cannot form hydrogen bonds with water are pushed into the middle of the protein.
 - (D) Nonpolar R groups from different parts of the protein form covalent bonds with each other to maintain the protein's structure.
13. The apple maggot fly, *Rhagoletis pomonella*, is native to North America and originally fed on fruit of the wild hawthorn. Since the mid-1800s, a population of flies has emerged that instead feed on domesticated apples. Apple maggot flies typically mate on or near the fruit of their host plants. Many varieties of apples ripen several weeks before the hawthorn fruits do.

The different fruit preferences of the two fly populations will most likely have which of the following effects?

- (A) The flies that eat hawthorn fruit will increase in number, while the flies that eat apples will decrease in number because of the use of insecticides on apple trees.
- (B) The single fly species will evolve into two distinct species because of the lack of gene flow between the two populations.
- (C) The ability to survive on a diet of two different fruits will help the flies learn to eat many more types of fruit.
- (D) The flies that eat hawthorn fruit will lay some of their eggs on the earlier-ripening apples to minimize competition among the larvae.

14. Platelets are fragments of larger cells and normally circulate in the blood without adhering to blood vessel walls. When the wall of a blood vessel is damaged, collagen fibers in the wall are exposed to the interior of the blood vessel. The exposed fibers and chemicals released from the endothelial cells that line the blood vessel attract platelets, which start to form a plug and release other chemicals (Figure 1).

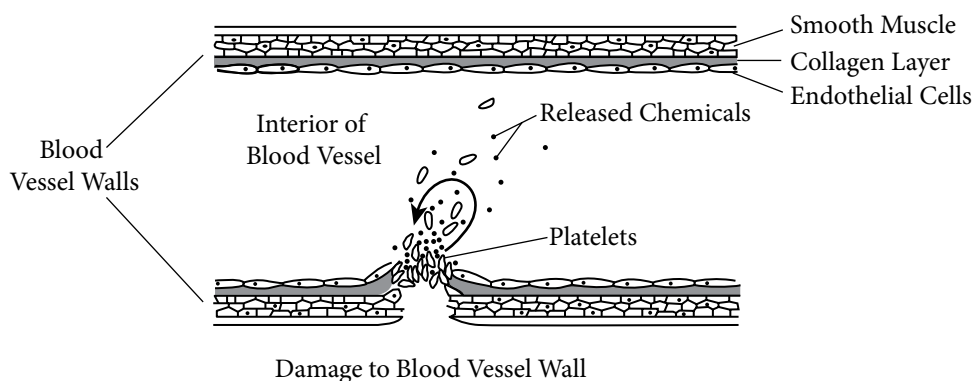


Figure 1. Formation of a platelet plug in a damaged blood vessel wall

Which of the following best explains the feedback mechanism illustrated in Figure 1?

- (A) This is an example of positive feedback, because the few platelets that initially bind attract more platelets to the damaged area.
 - (B) This is an example of positive feedback, because it results from the interactions among collagen, endothelial cells, and platelets.
 - (C) This is an example of negative feedback, because a large clump of platelets can block the blood vessel and prevent blood flow through it.
 - (D) This is an example of negative feedback, because the accumulation of platelets returns the open blood vessel wall to a closed state.
15. It is estimated that oxygen production first evolved in photosynthetic prokaryotes approximately 2.7 billion years ago. The first photosynthetic prokaryotes are presumed to be similar to today's cyanobacteria.

Which of the following best supports the claim that photosynthetic prokaryotes were responsible for the oxygen in Earth's atmosphere?

- (A) The light reactions of photosynthesis split carbon dioxide into carbon and oxygen.
- (B) The light reactions of photosynthesis split water into hydrogen ions and oxygen.
- (C) The Calvin cycle splits glucose into carbon, hydrogen, and oxygen.
- (D) The Calvin cycle splits water into hydrogen ions and oxygen.

Section II: Free-Response Questions

The following are examples of the kinds of free-response questions found on the exam. Note that on the actual AP Exam, there will be two long questions and four short-answer questions.

Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

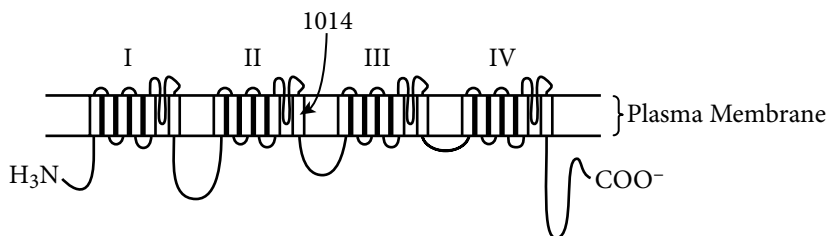
Interpreting and Evaluating Experimental Results (Question 1 on the AP Exam)

In many countries, *Anopheles gambiae* mosquitoes are responsible for transmitting the parasite that causes malaria to people through their bites. A primary tool for mosquito control is the use of insecticidal nets sprayed with chemicals known as pyrethroids, which are relatively safe for people but toxic to mosquitoes. However, mosquito resistance to pyrethroids has now become widespread. Pyrethroids interfere with the function of a transmembrane sodium channel found in cells of the mosquitoes (Figure 1). In one common mutation to the channel protein, a phenylalanine is substituted for a leucine at amino acid position 1014.

- A. **Describe** the most likely cause of the amino acid substitution in the sodium channel protein.

Scientists hypothesize that this mutation is responsible for some cases of pyrethroid resistance.

Figure 1. Schematic drawing of the transmembrane sodium channel targeted by pyrethroids and other insecticides. The arrow points to the position of amino acid 1014.

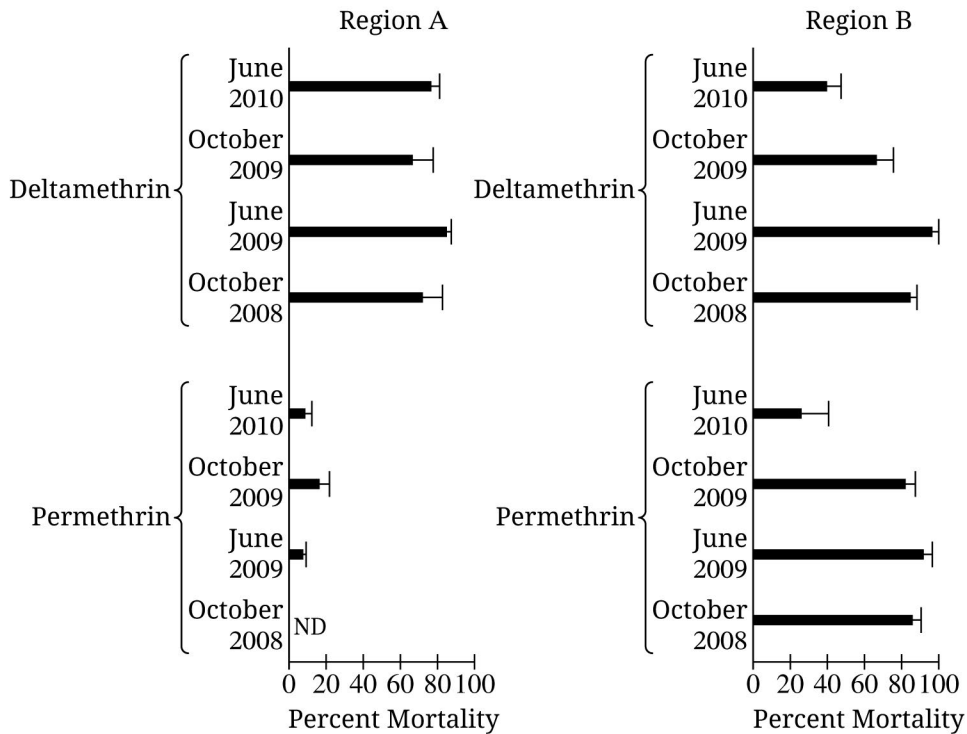


To investigate pyrethroid resistance, mosquitoes were collected four times over a two-year period from the following two regions.

- Region A: a southern vegetable-growing region where large amounts of insecticide are applied for crop protection
- Region B: a northern rice-growing region where very little insecticide is applied for rice protection

Scientists exposed the collected mosquitoes to filter papers soaked in two different pyrethroid insecticides, deltamethrin and permethrin, and the percent mortality of the mosquitoes was determined after 24 hours (Figure 2). The scientists simultaneously determined whether leucine or phenylalanine was encoded at position 1014 by each of the two copies of the sodium channel gene (Table 1).

Figure 2. Susceptibility of *A. gambiae* mosquitoes from two regions to the pyrethroids deltamethrin and permethrin. A mosquito strain that is susceptible to the insecticides displayed at least 95% mortality in all experiments, and mosquitoes exposed to untreated filter paper displayed less than 10% mortality. Error bars represent standard deviation. “ND” means no data are available.



B.

- i. **Identify** the dependent variable in the experiment whose data are graphed in Figure 2.
- ii. **Identify** the positive control in the experiment.
- iii. **Justify** exposing some mosquitoes to untreated filter paper each time the experiment was performed.

Table 1. Frequencies of leucine and phenylalanine at position 1014 of the sodium channel

Region	Date	Total Mosquitoes Tested	Homozygous for Leucine	Heterozygous for Leucine and Phenylalanine	Homozygous for Phenylalanine
A	October 2008	39	3	5	31
A	June 2009	29	-	5	24
A	October 2009	28	-	1	27
A	June 2010	46	-	9	37
B	October 2008	27	20	5	2
B	June 2009	26	18	7	1
B	October 2009	34	20	8	6
B	June 2010	44	12	20	12

C.

- i. Based on the data in Figure 2, **describe** whether mosquitoes from region A or from region B are more likely to exhibit greater evolutionary fitness if exposed to permethrin in their native environment over the time period of the experiment.
- ii. Based on the data in Figure 2, **describe** any significant change in the susceptibility of mosquitoes from region B to each of the two insecticides over the two-year period.
- iii. Use the data in Table 1 to **calculate** the frequency of the allele coding for phenylalanine in each population of mosquitoes in October 2008. Round your answers to two decimal places.

Using mosquitoes from insecticide-free areas, the scientists developed mosquito strains with amino acid substitutions at other positions in the sodium channel protein. They exposed the mosquito strains to nonpyrethroid insecticides.

D.

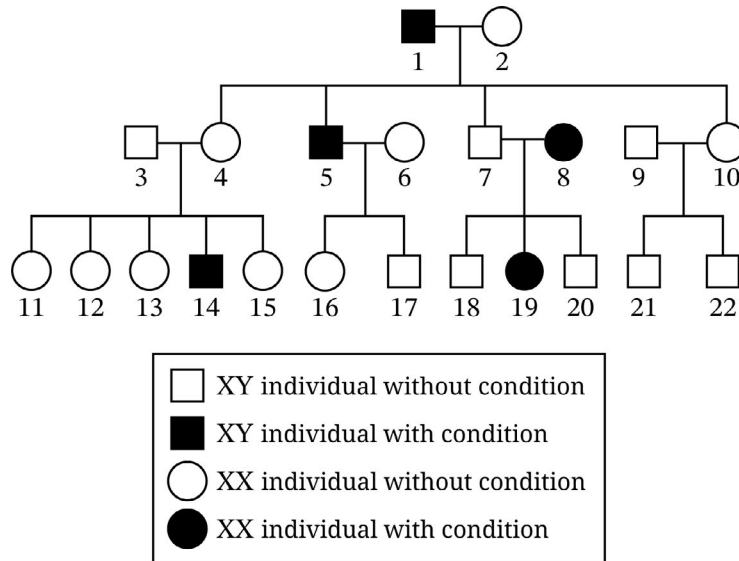
- i. **Predict** the susceptibility of the mosquitoes to the insecticides. The scientists claim that the mosquito population of region B evolved resistance over the period of the experiment and that resistance arose as a result of the immigration of resistant mosquitoes from other regions.
- ii. Based on the data in Table 1 and the information provided, provide evidence to **support** the scientists' claim.

Analyze Model or Visual Representation (Question 5 on AP Exam)

In humans, the gene that determines a particular condition has only two alleles, one of which (B) is completely dominant to the other (b).

- A. **Describe** the process in eukaryotes that ensures that the number of chromosomes will not double from parent to offspring when gametes fuse during fertilization.

Figure 1. The phenotypes of three generations of a family with respect to a particular inherited condition are shown in the pedigree. Individuals are numbered.



- B. **Explain** how any one chromosome in individual 16 contains DNA that came from both individuals 1 and 2.
- C. Based on the pedigree provided, use the allele designations B and b to **identify** the genotype of individual 2.
- D. Based on the pedigree, **explain** whether the inheritance pattern of the condition is sex-linked or autosomal and dominant or recessive.