# AP® Biology
# 1999 Scoring Guidelines



These materials were produced by Educational Testing Service (ETS), which develops and administers the examinations of the Advanced Placement Program for the College Board. The College Board and Educational Testing Service (ETS) are dedicated to the principle of equal opportunity, and their programs, services, and employment policies are guided by that principle.

The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 3,900 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 22,000 high schools, and 3,500 colleges, through major programs and services in college admission, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT™, the Advanced Placement Program® (AP®), and Pacesetter®. The College Board is committed to the principles of equity and excellence, and that commitment is embodied in all of its programs, services, activities, and concerns.

# AP® BIOLOGY
# 1999 SCORING GUIDELINES

## Question 1

A. **Experimental Design:** The following experimental characteristics may earn 1 point each. (Max 7 points)

| |
|---|
| • Score only the **1st** independent variable (temperature, wavelength, intensity) manipulated, and the **1st** factor used by the student to measure photosynthetic rate ($O_2$, $CO_2$, etc.).<br>• A 3 point maximum in Section A if the experiment will not work biologically. Examples: using an organism that is not photosynthetic, or using an apparatus that biologically will not measure photosynthesis as designed (i.e. potometer or respirometer). Not intended to mean a technical design flaw. |

- State **hypothesis** (clear statement of a hypothesis, identifies it as a hypothesis, uses "If/then" statement
- Specify a **control group** for comparison
- Identify and **hold constant at least one experimental factor** that can affect photosynthetic rate
- **Manipulate the independent variable** (change the temperature, wavelength of light, intensity of light)
- Describe **what is being measured** to determine rate ($CO_2$ or $H_2O$ consumption, $O_2$ or carbohydrate production, growth, $e^-$ flow measured with dye reduction, production of an intermediate product, etc.)
- **Quantify** the measurement of the variable (method **&** time frame of measurement)
- **Rate** calculation or definition
- **Verify** results through sample size (>1) or repetition
- Utilize **statistical application** of data (mean, t-test, ANOVA, etc.)
- Design an **exemplary** experiment

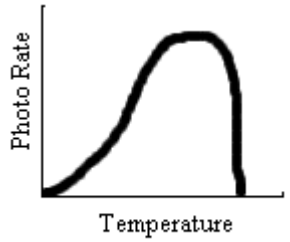
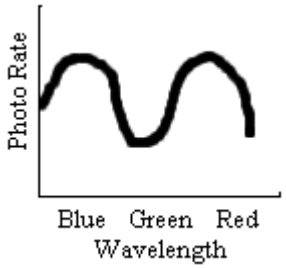
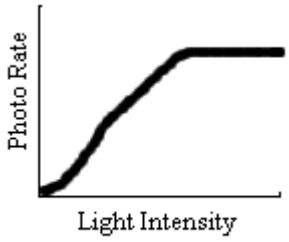
B. **Describe expected experimental results** (Max 2 points)

- Verbal or graphic description of expected experimental results (1 point)

## Question 1 (cont.)

- Verbal or graphic description of expected results across the entire range of biological activity (1 point)

- The graphs below represent 2-point graphs, but to earn **any** points, graphs must be accurately labeled

| Temperature | Wavelength | Intensity |
|---|---|---|
| Rate rises with temperature to an optimum and then falls | An "action spectrum" with highest rates in the blue and red regions of the spectrum | Rate increases steadily to a maximum and levels off |
|   |   |   |

C. **Biological explanation of results** (Max 3 points)

Temperature

- Enzyme kinetics or metabolic changes
- Enzyme denatures
- Photorespiration
- Stomatal closing w/high temp, limits $CO_2$ & lowers rate
- Excessive water loss, less reactant available for reaction
- Elaboration

## Question 1 (cont.)

Wavelength

- Absorption/reflection of light by chlorophyll
- Accessory pigments absorbing green light
- Relation between wavelength & energy
- Elaboration

Intensity

- More photons hit photosystems
- More $e^-$ flow in the electron transport system/time
- Plateau caused by limiting factors
- Elaboration

# AP® BIOLOGY
# 1999 SCORING GUIDELINES

## Question 2

**Overview of point distribution:**

Communication between two plant cells (4 pts. max)

Source (1 pt. max.)

Hormone-producing cell (generic)

Plasmodesmata (elab. pt. for good description)

Signal (1 pt. max.)

A specific plant hormone

Responses/Elab. (2 pts. max.)

Various physiological changes

Ion movement; $H_2O$ movement; RNA movement

Communication between two immune system cells (4 pts. max)

Source (1 pt. max.)

Any two immune system cells interacting or

An immune system cell interacting with the product of another immune system cell

Signal (1 pt. max.)

Tc/APC docking

Antibody

Histamine

Interferon

Responses/Elab. (2 pts. max.)

Discharge of perforin; phagocytosis of pathogen; inflammatory response; phagocyte activation; Ab secretion; clonal selection

Communication between two neurons OR between a neuron and a muscle cell (4 pts. max)

Source (1 pt. max.)

## Question 2 (cont.)

Sending neuron

Signal (1 pt. max.)

Neurotransmitter

Responses/Elab. (2 pts. max.)

Neuron-neuron: Chemical gating; depolarization of postsynaptic membrane; EPSP, IPSP, or both

Neuron-muscle: Action potential to T tubules; Ca ++ release from sarcoplasmic reticulum; Ca ++ binding to troponin; cross-bridge formation

Communication between a specific endocrine-gland cell and its target cell (4 pts. max)

Source (1 pt. max.)

Specific gland

(elaboration point for peptide vs. steroid hormone pathways)

Signal (1 pt. max.)

Specific hormone

Responses/Elab. (2 pts. max.)

Specific effect

# AP® BIOLOGY
# 1999 SCORING GUIDELINES

## Question 3

For full credit, a student must receive at least one point from each section I, II, and III.

**Section I**
**Describe** how this classification system presents different conclusions about the relationships among living organisms than those presented by the previous five-kingdom system of classification.

**Maximum of 4 points from this section**

(1) Not all prokaryotes are closely related (not monophyletic).
(1) Prokaryotes split early in the history of living things (not all in one lineage).
(1) Archaea are more closely related to Eukarya than to Bacteria.
(1) Eukarya are not directly related to Eubacteria.
(1) There was a common ancestor for all extant organisms (monophyletic).
(1) Eukaryotes are more closely related to each other (than Prokaryotes are to each other)
(1) Correct description of the five-kingdom system.

**Section II**
**Describe** three kinds of evidence that were used to develop the taxonomic scheme above, and **explain** how this evidence was used. The evidence may be structural, physiological, molecular, and/or genetic.

**Maximum of 6 points, 3 points from the first three descriptions of evidence mentioned and 3 from the explanations. The explanations must differentiate between at least two of the groups.**

| **Descriptions** | **Explanations** | | |
|---|---|---|---|
| Differences | Eukaryotes | Archaea | Eubacteria |
| Habitat - mostly extreme (halophilic, thermophilic, acidic) | - | + | - |
| Reproduction | Mitosis/meiosis | Binary fission | Binary fission |
| Multicellularity exists | + | - | - |
| Nucleus | + | - | - |
| Membrane-bound organelles | + | - | - |
| Microtubules/ microfilaments | + | - | - |
| Cell walls with peptidoglycan | - | - | + |

## Question 3 (cont.)

| | | | |
|---|---|---|---|
| Chromosomes:<br>Shape<br>Number<br>Histones present | Linear<br>More than one<br>+ | Circular<br>One<br>+ | Circular<br>One<br>- |
| Ribosomes: Size<br>Base sequence of rRNA | Large<br>Similar | Small<br>Similar | Small<br>Unique |
| Structure of tRNA | Similar | Unique | Similar |
| RNA polymerase | Multiple types | Multiple types | Single type |
| Introns | Present | Some | None |
| Operon organization of genes | - | + | + |
| Initiator amino acid in protein formation | Methionine | Methionine | formyl-methionine |
| Phospholipids: Bonds<br>Hydrocarbon structure | Ester<br>Unbranched | Ether<br>Branched | Ester<br>Unbranched |
| Can be pathogens | + | - | + |
| Response to antibiotics such as streptomycin or chloramphenicol | - | - | + |
| Response to diphtheria toxins | + | - | - |
| Metabolism Can be methanogens | - | + | - |
| Enzymatic make-up differs<br>Enzyme location differs<br>Photosynthetic pigments differ | Must correctly describe what the difference is. | | |
| Differences in gene sequences of DNA | Must correctly describe what the difference is. | | |
| Differences in whole genome sequences | Must correctly describe what the difference is. | | |

## Question 3 (cont.)

**Section III**
**Describe** four of the characteristics of the universal ancestor.

**Maximum of 4 points for this section. Described characteristics can earn one point each OR one point may be earned for a list of the first four correct characteristics.**

Characteristic (possible explanations)
(1) Small (surface to volume ratio, no internal transport system)
(1) Unicellular (all functions self-contained)
(1) Prokaryote (no membrane-bound organelles).
(1) Had cell membrane (containment, protection, semipermeable)
(1) cell membrane made of a phospholipid bilayer (barrier).
(1) cytoplasm (different from external environment)
(1) DNA for the genetic material (**or** nucleic acid **or** RNA)
(1) mRNA for information transfer (common to all organisms)
(1) tRNA to carry amino acids and/or aminoacylsynthetase (common to all organisms)
(1) ability to reproduce (asexual)
(1) ability to mutate, adapt, or evolve through natural selection
(1) ability to make proteins **or** had ribosomes on which proteins could be constructed
(1) metabolism: carbon-based **or** organic; Energy transformations, ATP as energy molecule
(1) enzymes for amino acid, nucleotide, and coenzyme synthesis as well as enzymes for glycolysis and the Krebs cycle (common to all organisms)
(1) Heterotrophic/Autotrophic* with explanation (* not photosynthetic)
(1) Anaerobic/aerobic with explanation
(1) Aquatic with explanation

# AP® BIOLOGY
# 1999 SCORING GUIDELINES

## Question 4

**Explain** how DNA meets each of the three criteria stated above

Select **one** of the criteria stated above and describe experimental evidence used to determine that DNA is the hereditary material

**Note: Part A can earn a maximum of 8 points. Part B can earn a maximum of 2 points.**

D. Explain how DNA meets each of the three criteria stated above [**8 max**]

1. Molecular Properties for Precise COPYING [**3 max**]

- ☐ Template concept (semi-conservative replication)
- ☐ Molecular structure[ e.g. complementary base pairing; A:T,C:G; purine-pyrimidine pairing; antiparallel]
- ☐ DNA polymerase function in copying
- ☐ Separation concept
- ☐ Elaboration of replication [e.g. specific roles of other replication enzymes, proper sequence of steps]

2. Molecular Properties that make it STABLE but ABLE to change [**3 max**]

**Stable**

- ☐ Energetically favorable arrangement; stable because of shape of molecule [ e.g. double helix; bases in the interior of the helix]
- ☐ Energetically favorable arrangement; stable because of bonding [ e.g. multiple H bonds; phosphodiester bonds]
- ☐ Silent errors [e.g. "junk" DNA; introns; redundancy of the genetic code]
- ☐ Able to be repaired [e.g. proofreading]

## Question 4 (cont.)

**Able**

- ☐ Description of a mutation [e.g. substitution; deletion; insertion; inversion; translocation]
- ☐ Crossing over [e.g. during meiosis]
- ☐ Base changes [e.g. depurination; deamination; tautomerism]
- ☐ Gene rearrangements [e.g. antibody genes in stem cells; transposons]
- ☐ Sensitive to mutagens [e.g. UV; X-ray]
- ☐ Restriction enzyme recognition sequences

**Stable or Able** (with justification)

- ☐ Methylation
- ☐ Telomeres protect ends

3. **Molecular Properties that make it COMPLEX enough to determine PHENOTYPE [3 max]**

- ☐ Colinearity of gene and protein [i.e., base sequence determines aa sequence]
- ☐ Infinite base sequence combinations lead to protein variety
- ☐ Variable numbers of base pairs per gene lead to different sizes of polypeptides
- ☐ Proteins are responsible for phenotype
- ☐ Description of transcription and translation
- ☐ Chromosome structure as it relates to function [e.g. supercoiling; chromosome or gene inactivation; interaction with histones; etc.]

## Question 4 (cont.)

E. Select **one** of the criteria stated above and describe experimental evidence used to determine that DNA is the hereditary material [**2 max**]

Identification of experiment with valid link to any one of the criteria [**1 max**]:

1) precise copying, 2) stable but able to change, 3) complex enough to determine phenotype, 4) DNA is the hereditary material]

May include but need not be limited to experiments that show:

- DNA can transform bacteria
- viral DNA can re-program cells
- equivalence of A:T and C:G
- double helix structure, [e.g. x-ray crystallography]
- replication is semiconservative
- hereditary enzyme deficiency disorders have genetic links
- DNA codes for protein
- changes in DNA quantities during the cell cycle (mitosis/meiosis)
- chromosome markers linked to disorders
- measurement of mutation rates
- changes in DNA [biotechnology]

Description of EVIDENCE [**1 max**]

- Evidence provided in the context of an experiment