

2010 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS

## BIOLOGY

## SECTION II

Time—1 hour and 30 minutes

**Directions:** Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in the pink booklet.

- Homeostatic maintenance of optimal blood glucose levels has been intensively studied in vertebrate organisms.
    - Pancreatic hormones regulate blood glucose levels. **Identify** TWO pancreatic hormones and **describe** the effect of each hormone on blood glucose levels.
    - For ONE of the hormones you identified in (a), **identify** ONE target cell and **discuss** the mechanism by which the hormone can alter activity in that target cell. **Include** in your discussion a description of reception, cellular transduction, and response.
    - Compare** the cell-signaling mechanisms of steroid hormones and protein hormones.
- 
- An experiment was conducted to measure the reaction rate of the human salivary enzyme  $\alpha$ -amylase. Ten mL of a concentrated starch solution and 1.0 mL of  $\alpha$ -amylase solution were placed in a test tube. The test tube was inverted several times to mix the solution and then incubated at 25°C. The amount of product (maltose) present was measured every 10 minutes for an hour. The results are given in the table below.

Time (minutes)	Maltose Concentration ( $\mu$ M)
0	0
10	5.1
20	8.6
30	10.4
40	11.1
50	11.2
60	11.5

- Graph** the data on the axes provided and **calculate** the rate of the reaction for the time period 0 to 30 minutes.
- Explain** why a change in the reaction rate was observed after 30 minutes.
- Draw and label** another line on the graph to predict the results if the concentration of  $\alpha$ -amylase was doubled. **Explain** your predicted results.
- Identify** TWO environmental factors that can change the rate of an enzyme-mediated reaction. **Discuss** how each of those two factors would affect the reaction rate of an enzyme.

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3. A new species of fly was discovered on an island in the South Pacific. Several different crosses were performed, each using 100 females and 100 males. The phenotypes of the parents and the resulting offspring were recorded.

Cross I: True-breeding bronze-eyed males were crossed with true-breeding red-eyed females. All the  $F_1$  offspring had bronze eyes.  $F_1$  flies were crossed, and the data for the resulting  $F_2$  flies are given in the table below.

<b>F<sub>2</sub> Phenotype</b>	<b>Male</b>	<b>Female</b>
Bronze eyes	3,720	3,800
Red eyes	1,260	1,320

Cross II: True-breeding normal-winged males were crossed with true-breeding stunted-winged females. All the  $F_1$  offspring had stunted wings.  $F_1$  flies were crossed, and the data for the resulting  $F_2$  flies are given in the table below.

<b>F<sub>2</sub> Phenotype</b>	<b>Male</b>	<b>Female</b>
Normal wings	1,160	1,320
Stunted wings	3,600	3,820

Cross III: True-breeding bronze-eyed, stunted-winged males were crossed with true-breeding red-eyed, normal-winged females. All the  $F_1$  offspring had bronze eyes and stunted wings. The  $F_1$  flies were crossed with true-breeding red-eyed, normal-winged flies, and the results are shown in the table below.

<b>Phenotype</b>	<b>Male</b>	<b>Female</b>
Bronze eyes, stunted wings	2,360	2,220
Bronze eyes, normal wings	220	300
Red eyes, stunted wings	260	220
Red eyes, normal wings	2,240	2,180

- What conclusions can be drawn from cross I and cross II? **Explain** how the data support your conclusions for each cross.
- What conclusions can be drawn from the data from cross III? **Explain** how the data support your conclusions.
- Identify** and **discuss** TWO different factors that would affect whether the island's fly population is in Hardy-Weinberg equilibrium for the traits above.

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## BIOLOGY

### SECTION II

Time—1 hour and 30 minutes

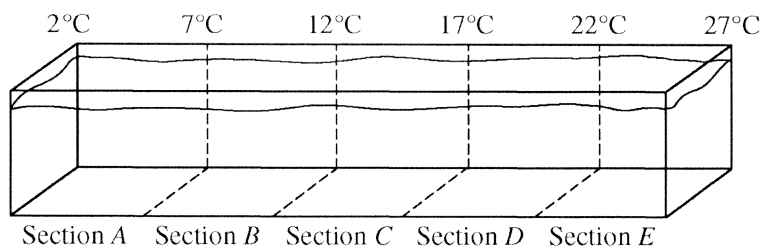
**Directions:** Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in the pink booklet.

1. An experiment on a species of small freshwater fish recorded their behavioral responses to different temperatures. Ten fish were each tested once, one at a time.

To begin the experiment, a fish was removed from a stock tank (maintained at 22°C) and placed in the temperature-gradient tank drawn below. After the fish had spent 30 minutes in the temperature-gradient tank, the section where the fish was located was recorded. Additional observations were recorded every 5 minutes, for a total of 7 observations per fish. A summary of the combined data for all 10 fish appears below.

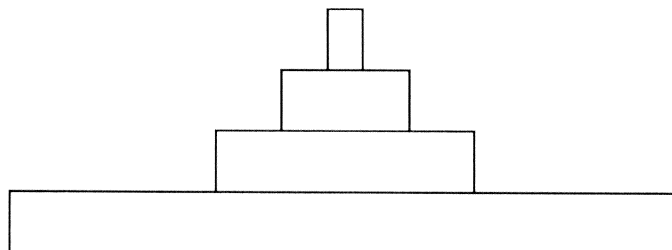
- (a) On the axes provided, **construct** the appropriate type of labeled graph showing the relationship between water temperature and fish distribution. **Summarize** the outcome of the experiment.
- (b) **Identify** TWO variables that were not specifically controlled in the experimental design, and **describe** how these variables might have affected the outcome of the experiment.
- (c) **Discuss** TWO ways that water temperature could affect the physiology of the fish in this experiment.



Section	Fish/Section
A	9
B	11
C	34
D	12
E	4

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2. ATP and GTP are primary sources of energy for biochemical reactions.
- (a) **Describe** the structure of the ATP or the GTP molecule.
  - (b) **Explain** how chemiosmosis produces ATP.
  - (c) **Describe** TWO specific cell processes that require ATP and explain how ATP is used in each process.
  - (d) An energy pyramid for a marine ecosystem is shown below. **Label** each trophic level of the pyramid and provide an example of a marine organism found at each level of this pyramid. **Explain** why the energy available at the top layer of the pyramid is a small percentage of the energy present at the bottom of the pyramid.



3. Phylogeny is the evolutionary history of a species.
- (a) The evolution of a species is dependent on changes in the genome of the species. **Identify** TWO mechanisms of genetic change, and **explain** how each affects genetic variation.
  - (b) Based on the data in the table below, **draw** a phylogenetic tree that reflects the evolutionary relationships of the organisms based on the differences in their cytochrome *c* amino-acid sequences and **explain** the relationships of the organisms. Based on the data, **identify** which organism is most closely related to the chicken and **explain** your choice.
  - (c) **Describe** TWO types of evidence—other than the comparison of proteins—that can be used to determine the phylogeny of organisms. **Discuss** one strength of each type of evidence you described.

THE NUMBER OF AMINO ACID DIFFERENCES IN CYTOCHROME *c* AMONG VARIOUS ORGANISMS

	Horse	Donkey	Chicken	Penguin	Snake
Horse	0	1	11	13	21
Donkey		0	10	12	20
Chicken			0	3	18
Penguin				0	17
Snake					0

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4. The flow of genetic information from DNA to protein in eukaryotic cells is called the central dogma of biology.
- (a) **Explain** the role of each of the following in protein synthesis in eukaryotic cells.
- RNA polymerase
  - Spliceosomes (snRNPs)
  - Codons
  - Ribosomes
  - tRNA
- (b) Cells regulate both protein synthesis and protein activity. **Discuss** TWO specific mechanisms of protein regulation in eukaryotic cells.
- (c) The central dogma does not apply to some viruses. **Select** a specific virus or type of virus and **explain** how it deviates from the central dogma.

**END OF EXAM**

**2008 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS (Form B)**

**BIOLOGY**

**SECTION II**

**Time—1 hour and 30 minutes**

**Directions:** Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in the goldenrod booklet.

1. Measurements of dissolved oxygen (DO) are used to determine primary productivity in bodies of water.
  - Explain the relationship of dissolved oxygen to primary productivity.
  - How would the predicted levels of DO differ in each of the following pairs of water samples? Provide support for your prediction. Be sure to include a discussion of net productivity and gross productivity in your answer.
    - I. Pond water at 25°C vs. pond water at 15°C
    - II. Pond water placed in the dark for 24 hours vs. pond water placed in light for 24 hours
2. Many biological structures are composed of smaller units assembled into more complex structures having functions based on their structural organization.

For **THREE** of the following complex structures, describe the smaller units, their assembly into the larger structures, and one major function of these larger, organized structures.

  - (a) A eukaryotic chromosome
  - (b) A mature angiosperm root
  - (c) A colony of bees
  - (d) An inner membrane of a mitochondrion
  - (e) An enzyme

**2008 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS (Form B)**

3. Evolution is one of the unifying themes of biology. Evolution involves change in the frequencies of alleles in a population. For a particular genetic locus in a population, the frequency of the recessive allele ( $a$ ) is 0.4 and the frequency of the dominant allele ( $A$ ) is 0.6.
- (a) What is the frequency of each genotype ( $AA$ ,  $Aa$ ,  $aa$ ) in this population? What is the frequency of the dominant phenotype?
  - (b) How can the Hardy-Weinberg principle of genetic equilibrium be used to determine whether this population is evolving?
  - (c) Identify a particular environmental change and describe how it might alter allelic frequencies in this population. Explain which condition of the Hardy-Weinberg principle would not be met.
4. Scientists use the concept of homology in identifying evolutionary relationships among organisms. Features shared by two groups of organisms are said to be homologous if the similarities reflect shared ancestry. Homology is found in comparisons of structural, molecular, biochemical, developmental, physiological, and behavioral characteristics of organisms. Select THREE of the following hypotheses and explain TWO examples of homology that support each hypothesis.
- (a) Chloroplasts are related to photosynthetic prokaryotes.
  - (b) Spiders and insects are closely related.
  - (c) Echinoderms (sea stars and their relatives) are closely related to the chordates (the phylum that includes vertebrates).
  - (d) Reptiles and birds are closely related.
  - (e) Humans and chimpanzees are closely related primates.

**STOP**

**END OF EXAM**

# 2005 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS (Form B)

## BIOLOGY

### SECTION II

Planning Time—10 minutes

Writing Time—90 minutes

**Directions:** Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in the goldenrod booklet.

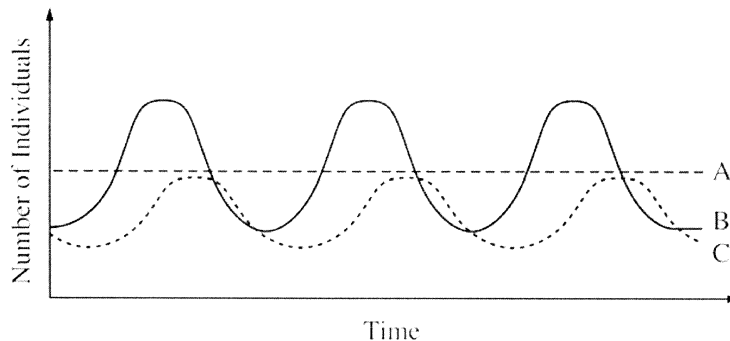
1. Survival of organisms depends on adaptive behavior and species interactions.

(a) Behaviors of organisms may be influenced by environmental factors. Select two of the following types of behavior. For each type, explain

- (i) how the environment affects the behavior, and
- (ii) why this behavior increases the survivorship of individuals of a species.

- Taxis/Kinesis
- Migration
- Courtship

(b) Interactions among populations may have an effect on densities of the species that interact. Predation represents an important interaction among populations. The curves below depict the population densities of three species: a small herbivore, a larger herbivore, and a carnivore.



**Identify** which curve represents which of the species listed, and **justify** your answer by describing the changes in the population densities of these three species over time.

2. In the evolution of organisms, major adaptations arose in certain groups, opening new evolutionary possibilities. For **two** of the following types of organisms, discuss the evolutionary significance of the features listed.

- (a) Flowering plants: flowers, fruits and seeds, and broad leaves
- (b) Flatworms: three germ layers, bilateral symmetry, and cephalization
- (c) Segmented worms: segmentation, coelom, and digestive system
- (d) Reptiles: amniotic eggs, waterproof skin, and well-developed lungs

**2005 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS (Form B)**

3. Protein synthesis is vital for cell growth and metabolism.
- (a) Describe transcription and translation.
  - (b) Identify similarities between transcription and translation.
  - (c) Identify differences between transcription and translation.
  - (d) Describe structural changes that can occur to a protein after translation to make it function properly.
4. Water potential in potato cells was determined in the following manner. The initial masses of six groups of potato cores were measured. The potato cores were placed in sucrose solutions of various molarities. The masses of the cores were measured again after 24 hours. Percent changes in mass were calculated. The results are shown below.

Molarity of Sucrose in Beaker	Percent Change in Mass
0.0 <i>M</i>	18.0
0.2	5.0
0.4	-8.0
0.6	-16.0
0.8	-23.5
1.0	-24.0

- (a) Graph these data on the axes provided. From your graph, find the apparent molar concentration (osmolarity) of the potato core cells.
- (b) What are the components of water potential, and why is water potential important for the movement of water in plants?
- (c) Predict what would happen to typical animal cells placed in 0.0 *M* and 1.0 *M* sucrose solutions, and explain your prediction.

**2005 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS (Form B)**

A large rectangular grid of graph paper, consisting of 20 columns and 20 rows of small squares, intended for students to write their free-response answers.

**END OF EXAMINATION**

# 2004 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS

## BIOLOGY

### SECTION II

Time—1 hour and 30 minutes

**Directions:** Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in the pink booklet.

1. Meiosis reduces chromosome number and rearranges genetic information.
  - (a) **Explain** how the reduction and rearrangement are accomplished in meiosis.
  - (b) Several human disorders occur as a result of defects in the meiotic process. **Identify** ONE such chromosomal abnormality; what effects does it have on the phenotype of people with the disorder? **Describe** how this abnormality could result from a defect in meiosis.
  - (c) Production of offspring by parthenogenesis or cloning bypasses the typical meiotic process. **Describe** either parthenogenesis or cloning and **compare** the genomes of the offspring with those of the parents.
2. Darwin is considered the “father of evolutionary biology.” Four of his contributions to the field of evolutionary biology are listed below.
  - The nonconstancy of species
  - Branching evolution, which implies the common descent of all species
  - Occurrence of gradual changes in species
  - Natural selection as the mechanism for evolution
  - (a) For EACH of the four contributions listed above, **discuss** one example of supporting evidence.
  - (b) Darwin’s ideas have been enhanced and modified as new knowledge and technologies have become available. **Discuss** how TWO of the following have modified biologists’ interpretation of Darwin’s original contributions.
    - Hardy-Weinberg equilibrium
    - Punctuated equilibrium
    - Genetic engineering

## 2004 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS

3. A controlled experiment was conducted to analyze the effects of darkness and boiling on the photosynthetic rate of incubated chloroplast suspensions. The dye reduction technique was used. Each chloroplast suspension was mixed with DPIP, an electron acceptor that changes from blue to clear when it is reduced. Each sample was placed individually in a spectrophotometer and the percent transmittance was recorded. The three samples used were prepared as follows.

- Sample 1 – chloroplast suspension + DPIP
- Sample 2 – chloroplast suspension surrounded by foil wrap to provide a dark environment + DPIP
- Sample 3 – chloroplast suspension that has been boiled + DPIP

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Percent Transmittance in Three Samples

Time (min)	Light, Unboiled % Transmittance	Dark, Unboiled % Transmittance	Light, Boiled % Transmittance
	Sample 1	Sample 2	Sample 3
0	28.8	29.2	28.8
5	48.7	30.1	29.2
10	57.8	31.2	29.4
15	62.5	32.4	28.7
20	66.7	31.8	28.5

- (a) On the axes provided, **construct** and **label** a graph showing the results for the three samples.
- (b) **Identify** and **explain** the control or controls for this experiment.
- (c) The differences in the curves of the graphed data indicate that there were differences in the number of electrons produced in the three samples during the experiment. **Discuss** how electrons are generated in photosynthesis and why the three samples gave different transmittance results.

**2004 AP<sup>®</sup> BIOLOGY FREE-RESPONSE QUESTIONS**

