CollegeBoard
Advanced Placement Program

AP® Biology
2009 Free-Response Questions

The College Board

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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.

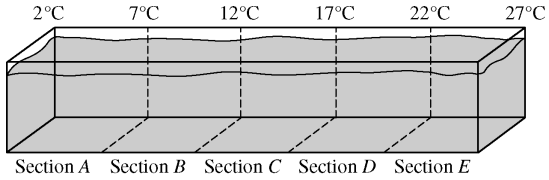
1. An experiment on a species of small freshwater fish recorded their behavioral responses to different temperatures. Ten fish were each tested once, one at a time.

   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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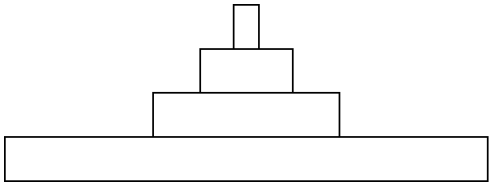
2. ATP and GTP are primary sources of energy for biochemical reactions.

   (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.



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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

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