

2009 AP[®] BIOLOGY FREE-RESPONSE QUESTIONS

BIOLOGY

SECTION II

Time—1 hour and 30 minutes

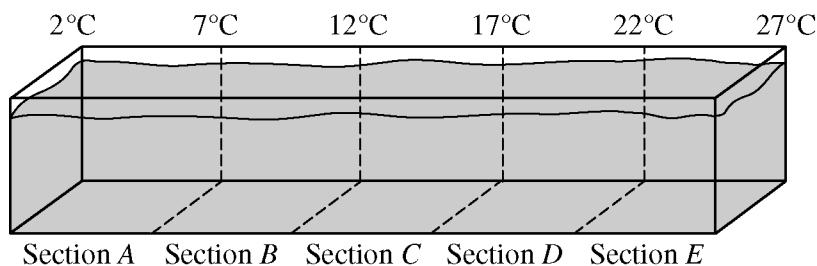
Directions: Answer all questions.

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. 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

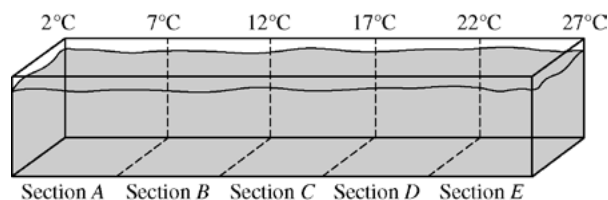
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Question 1

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.



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A	9
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- (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. **(4 points maximum)**

Graph (1 point each; 3 points maximum for graph)	Summarize (1 point maximum for summary)
<ul style="list-style-type: none"> Correctly labeled and scaled axis <ul style="list-style-type: none"> Temperature range may be indicated by section with legend Correct orientation: x-axis = temp; y-axis = # fish observed Correct bar graph/scatter plot <ul style="list-style-type: none"> Discrete data points only if range is indicated NO point for line graph 	<ul style="list-style-type: none"> Fish were distributed by temperature, e.g., most fish were observed at moderate temperature range, or 12–17°C

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Question 1 (continued)

- (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. **(4 points maximum)**

Variable* (1 point each; 2 points maximum)	Describe (1 point each; 2 points maximum)
Fish characteristics, e.g., age, size, sex, schooling, health	Age/mating behavior/sex, SA:V ratio, tendency to school may affect activity levels/distribution of fish
Tank characteristics, e.g., depth, shape, size, gravel, plants, sections/ends	Depth/shape/size/pressure/ends of tank may affect distribution of fish “control” tank at constant temperature
Water quality, e.g., pH, salt, chemicals, microbes	Attraction/avoidance influences fish response to temperature
Placement of fish, time in stock tank	Tendency of fish to remain where placed, effect of shock on fish
External stimuli, e.g., light, noise	Attraction/avoidance influences fish response to temperature
Oxygen concentration	Attraction/avoidance influences fish response to temperature
Time of day/biological rhythms or when observations recorded	Temperature preference or activity of fish differs with time of day, e.g., diurnal vs. nocturnal
Other acceptable variables**	Other acceptable descriptions

* 1 point for **each** variable, may include two from same category

** NOT type of fish, NOT temperature, since these were set by experimenters

- (c) **Discuss** TWO ways that water temperature could affect the physiology of the fish in this experiment. **(4 points maximum)**

Effect (directional) (1 point each; 2 points maximum)	Explanation of effect (1 point each; 2 points maximum)
Metabolic rate/activity increase with temperature increase	Related to kinetic energy, enzyme activity (NOT denaturation)
Heart rate/circulation/blood flow increase with temperature increase	Related to kinetic energy, blood vessel constriction/dilation, etc.
Respiration rate, operculum movement, “breathing rate” increase with temperature increase	Related to diffusion rates, metabolic rates
Shock/stress prevent normal activity	Nervous system impairment alters fish movements
Gas exchange (O ₂ or CO ₂) altered at different temperatures	Dissolved oxygen increases at lower temperatures