**BIOLOGY**
Section II
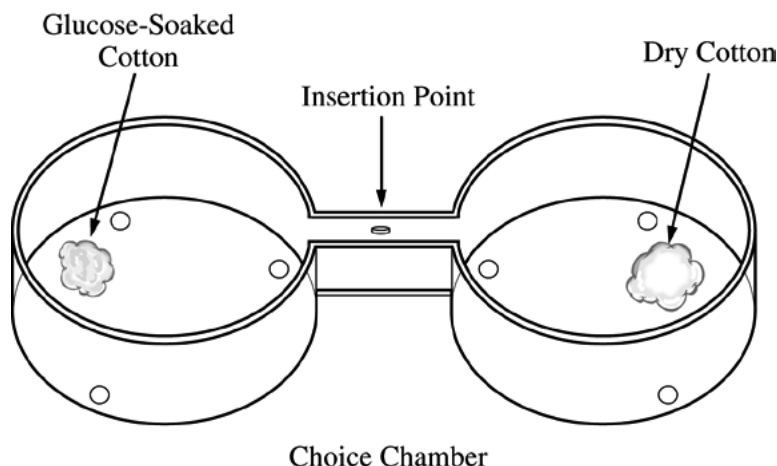**8 Free-Response Questions**
Time—90 minutes

Directions: Questions 1 and 2 are long free-response questions that should require about 22 minutes each to answer and are worth 10 points each. Questions 3 through 8 are short free-response questions that should require about 6 minutes each to answer. Questions 3 through 5 are worth 4 points each, and questions 6 through 8 are worth 3 points each. Read each question carefully and completely. Write your response in the space provided following each question. Only material written in the space provided will be scored. Answers must be written out in paragraph form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but unless specifically called for by the question, a diagram alone will not receive credit.
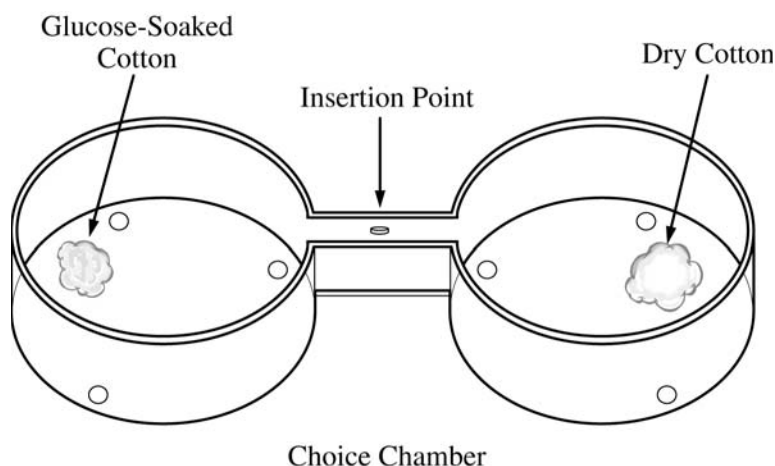
1. In an investigation of fruit-fly behavior, a covered choice chamber is used to test whether the spatial distribution of flies is affected by the presence of a substance placed at one end of the chamber. To test the flies' preference for glucose, 60 flies are introduced into the middle of the choice chamber at the insertion point indicated by the arrow in the figure above. A cotton ball soaked with a 10% glucose solution is placed at one end of the chamber, and a dry cotton ball with no solution is placed at the other end. The positions of flies are observed and recorded every minute for 10 minutes.

    (a) **Predict** the distribution of flies in the chamber after 10 minutes and **justify** your prediction.

    (b) **Propose** ONE specific improvement to each of the following parts of the experimental design and **explain** how the modification will affect the experiment.

    - Experimental control
    - Environmental factors

    (c) The experiment described above is repeated with ripe bananas at one end and unripe bananas at the other end. Once again the positions of the flies are observed and recorded every minute for 10 minutes. The positions of flies after 1 minute and after 10 minutes are shown in the table below.

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Question 1

Glucose-Soaked Cotton — Insertion Point — Dry Cotton

Choice Chamber

In an investigation of fruit-fly behavior, a covered choice chamber is used to test whether the spatial distribution of flies is affected by the presence of a substance placed at one end of the chamber. To test the flies' preference for glucose, 60 flies are introduced into the middle of the choice chamber at the insertion point indicated by the arrow in the figure above. A cotton ball soaked with a 10 percent glucose solution is placed at one end of the chamber, and a dry cotton ball with no solution is placed at the other end. The positions of flies are observed and recorded every minute for 10 minutes.

(a) **Predict** the distribution of flies in the chamber after 10 minutes and **justify** your prediction. (**2 points maximum**)
- 1 point for predicting the location of the flies in the choice chamber
- 1 point for justifying the prediction

(b) **Propose** ONE specific improvement to each of the following parts of the experimental design and **explain** how the modification will affect the experiment. (**4 points maximum**)
- Experimental control
- Environmental factors

	Proposed Improvement (includes but not limited to) (**1 point maximum**)	Explanation (**1 point maximum**)
Experimental control	Replace the dry cotton ball with a water-soaked cotton ball.	Ensures that glucose is the attractant
	Constant light or temperature or duration of experiment or time of day, etc.	Other variables must be held constant

	Proposed Improvement (includes but not limited to) (**1 point maximum**)	Explanation (**1 point maximum**)
Environmental factors	• Use different concentrations of glucose • Use different temperature(s) • Use different light levels • Use a different choice chamber (size/shape) • Vary duration of the experiment • Vary time of day when experiment is performed	Attributes movement of flies only to glucose preference

(c) The experiment described above is repeated with ripe bananas at one end and unripe bananas at the other end. Once again the positions of the flies are observed and recorded every minute for 10 minutes. The positions of flies after 1 minute and after 10 minutes are shown in the table below.

DISTRIBUTION OF FLIES IN CHOICE CHAMBER

Time (minutes)	Position in Chamber		
	End with Ripe Banana	Middle	End with Unripe Banana
1	21	18	21
10	45	3	12

Perform a chi-square test on the data for the 10-minute time point in the banana experiment. **Specify** the null hypothesis that you are testing and **enter** the values from your calculations in the table below. (**2 points maximum**)

PART (c): CHI-SQUARE CALCULATION

Null Hypothesis: (**1 point**) The flies will be evenly distributed across the three different parts of the choice chamber.			
	Observed (o)	Expected (e)* (**1 point**)	$(o - e)^2/e$
End with ripe banana	45	20	31.25
Middle	3	20	14.45
End with unripe banana	12	20	3.2
Total	60	60	48.9
*Expected values must be those predicted by the null hypothesis provided in the student response, add up to 60, and include no cells equal to 0.			

(d) **Explain** whether your hypothesis is supported by the chi-square test and **justify** your explanation. (**1 point maximum**)
- Correct explanation with justification of why the stated null hypothesis is rejected or not rejected. Response must clarify each of the following:
  o degrees of freedom (df) = 2 and p = 0.05 (critical value = 5.99)
    OR
    degrees of freedom (df) = 2 and p = 0.01 (critical value = 9.21)
  o how the calculated test statistic compares to the selected critical value
  o whether the null hypothesis should be rejected

(e) Briefly **propose** a model that describes how environmental cues affect the behavior of the flies in the choice chamber. (**1 point maximum**)
- Stimulus → Response
- Input →(possible integration) →Output