BIOLOGY
Section II
8 Free-Response Questions
Time—80 minutes

Directions: Questions 1 and 2 are long free-response questions that should require about 20 minutes each to answer. Questions 3 through 8 are short free-response questions that should require about 6 minutes each to answer. Read each question carefully and write your response in the space provided following each question. Only material written in this space will be scored. Answers must be written out. Outline form is not acceptable. It is important that you read each question completely before you begin to write.

1. In a certain prairie community, a dominant prairie grass species has recently been infected with a virus that disrupts one of the electron transport proteins in the chloroplasts of infected cells.

   (a) **Describe** the most likely effects on cellular processes (be specific as to which processes and molecules are most likely to be directly affected).

   (b) **Describe** and **explain** the most likely effects on individual infected plants.

   (c) **Predict** the short-term effects (within a year of infection) on the infected plant populations and their communities. **Justify** your prediction.

   (d) **Predict** the long-term effects (years to decades after infection) on the infected plant populations and their communities. **Justify** your prediction.

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Questions 33-37

Students investigated the effect of light on the carbon cycle in aquatic ecosystems by performing the controlled experiment summarized below. The students placed equal amounts of water (pH 7.0) from a large aquarium in glass beakers. The students transferred aquatic plants from the aquarium to several of the beakers, and then they placed equal numbers of the beakers in the light or the dark (Figure 1: groups I and II). Similarly, the students transferred goldfish from the same aquarium to other beakers, and then they placed equal numbers of those beakers in the light or dark (Figure 1: groups III and IV). Finally, the students placed an equal number of beakers containing water only in the light or dark (Figure 1: groups V and VI).

After exposing the samples to light or dark for one hour, the students recorded the pH of the water in each beaker. Carbon dioxide dissolved in water will lower the pH of an aqueous solution. In the experiment, the students used changes in pH to monitor changes in the amount of carbon dioxide in the water. For each treatment group, the students calculated the mean pH and standard error, as documented in the table below.

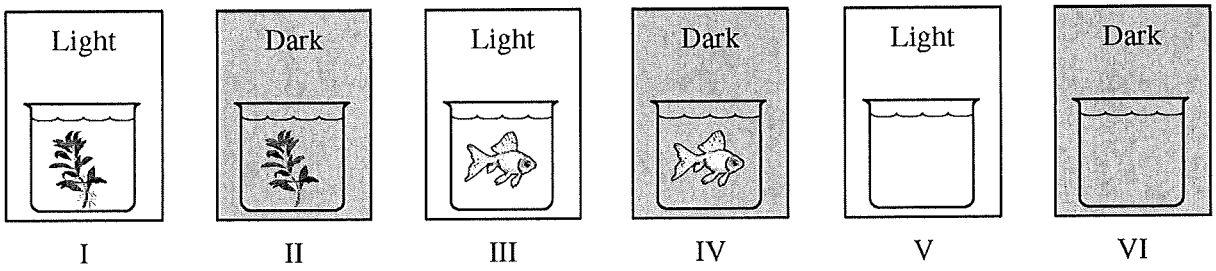

Figure 1. Treatment groups

MEAN pH OF TREATMENT GROUPS AFTER 1 HOUR

Treatment group (n = 10)	I	II	III	IV	V	VI
Mean pH	8.2	6.4	5.9	5.6	7.3	6.8
Standard error of the mean	0.3	0.3	0.2	0.3	0.5	0.4

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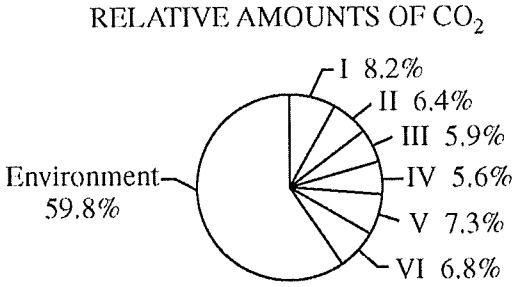
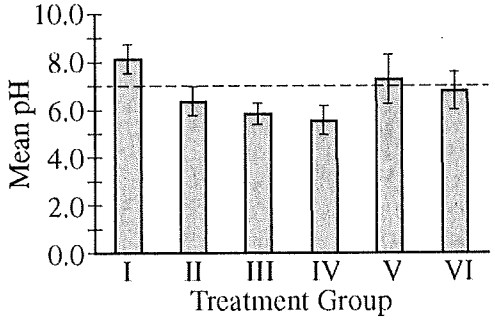
33. Which of the following graphs is the most appropriate representation of the experimental results documented in the table?

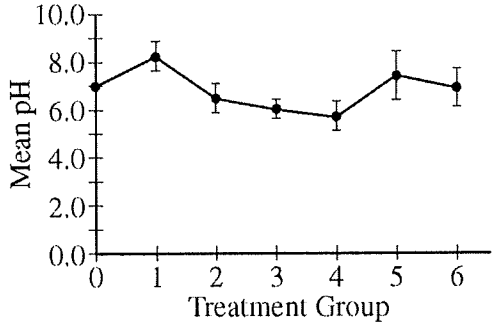
(A)



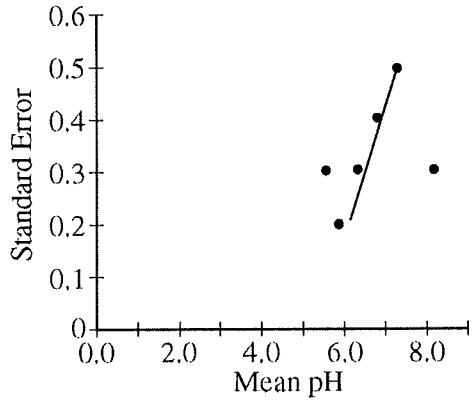
(B)



(C)



(D)



34. Which of the following observations provides the best evidence that photosynthesis occurred in treatment group I?

(A) The specimens in the beakers were aquatic plants from a large aquarium.
(B) The beakers were placed in the light.
(C) The mean pH of the samples increased after one hour.
(D) The standard error of the mean was smaller than that for treatment group V.

35. To investigate whether an organism in the study is capable of both photosynthesis and respiration, a comparison of which treatment groups is most appropriate?

(A) I and II
(B) II and IV
(C) III and V
(D) IV and VI

36. The results for treatment groups V and VI could suggest which of the following questions about the design of the experiment?

(A) Do the glass beakers prevent light from reaching the test samples?
(B) Is the method used for measuring pH harmful to aquatic organisms?
(C) Is the availability of carbon dioxide a limiting factor in aquatic ecosystems?
(D) Does the aquarium water contain living microorganisms?

37. Which of the following modifications to the experimental design will best help reduce the standard errors of the means?

(A) Using pond water instead of aquarium water
(B) Exposing samples to light for a greater amount of time
(C) Increasing the sample size of each treatment group
(D) Collecting organisms from a natural water source instead of an aquarium

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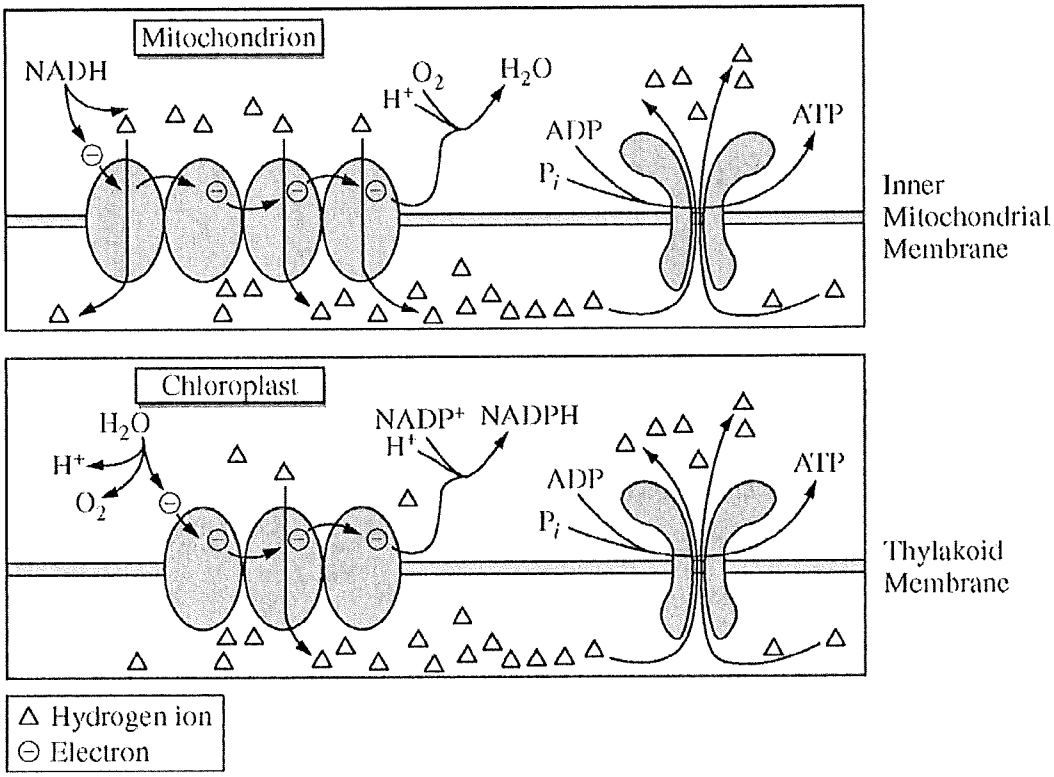
62. The figures below illustrate the similarities between ATP synthesis in mitochondria and chloroplasts.



The figures can best assist in answering which of the following questions?

(A) Do electron transport chains create a gradient so that ATP synthase can generate ATP molecules?
(B) What are the sources of energy that drive mitochondrial and chloroplast electron transport systems?
(C) What is the optimal temperature at which ATP synthase chemically converts ADP and a phosphate group into one molecule of ATP?
(D) What is the evolutionary relationship between the ATP synthase in mitochondria and the ATP synthase in chloroplasts?

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Answers to Multiple-Choice Questions

1 – C	17 – A	33 – B	49 – A
2 – C	18 – A	34 – A	50 – D
3 – A	19 – C	35 – D	51 – C
4 – A	20 – C	36 – A	52 – A
5 – C	21 – B	37 – D	53 – D
6 – D	22 – B	38 – B	54 – A
7 – C	23 – C	39 – A	55 – B
8 – A	24 – D	40 – C	56 – B
9 – B	25 – B	41 – A	57 – B
10 – B	26 – A	42 – A	58 – B
11 – A	27 – B	43 – B	59 – A
12 – B	28 – D	44 – C	60 – D
13 – C	29 – C	45 – B	61 – C
14 – C	30 – A	46 – A	62 – A
15 – A	31 – B	47 – C	63 – C
16 – D	32 – C	48 – D	

Answers to Grid-In Questions

1 – 340–360	4 – 0.34–0.35
2 – 5.3–5.4	5 – 1.4–1.7
3 – 26 or 25	6 – 60

Scoring Guidelines for Free-Response Question 1

10 points maximum; 1 point for each specific prediction. A maximum of 3 points can be earned in any one section.

(Part a) 1 point for each reasonable resulting change to a cellular process.
Effects may include:

- Less ATP produced.
- Less NADPH produced.
- Inability to fix carbon via Calvin cycle without products of electron transport chain.
- Decrease in O_2 production.

(Part b) 1 point for each reasonable expected change to an individual plant, with explanation.
Explanations may include:

- Plant cannot produce glucose due to decrease in photosynthetic product (G3P).
- Stunted growth due to lack of energy for building molecules.
- Plant becomes weakened and may die due to lack of ability to capture energy.
- Plant uses up pre-infection energy stores.
- Cannot perform growth/repair/reproduction due to lack of usable energy.

(Part c) 1 point for each reasonable predicted short-term change to the plant population or the prairie community, with justification.
Predictions may include:

- Reduction in population size of affected prairie grass due to death of infected members.
- Decrease in consumer population size as less energy available for the higher trophic levels.
- Smaller herbivore population size due to increased competition for limited resources.
- Unaffected plant species gain resources due to loss of infected plants.
- Uninfected plants have increased offspring due to more available resources.

(Part d) 1 point for each reasonable predicted long-term change to the plant population or the prairie community, with justification.
Predictions may include:

- Plant species becomes locally extinct.
- Reduction in genetic variability due to loss of infected plants.
- Change in allele frequencies for the affected species.
- Loss of consumer species dependent on affected prairie grass species.
- Members of the affected species with a genotype conferring resistance become more common, leading to no long-term effects to the population or community.
- Grass is replaced by other species — community is stabilized, or some changes in members of the food chain.
- Increased erosion due to lack of grass leading to degradation of abiotic environment, further limiting the ability of the environment to support the community.