

Lesson 8.1

UNDERSTAND KEY CONCEPTS

1. b
2. b
3. b
4. c
5. Heterotrophs obtain energy by consuming other organisms; autotrophs obtain energy by consuming the food they make.
6. An ATP molecule consists of a nitrogen-containing compound called adenine, a 5-carbon sugar called ribose, and three phosphate groups.
7. A single molecule of glucose stores more than 90 times the energy stored by ATP. ATP, though, transfers energy quickly and is used by the cell as an immediate source of energy.

THINK CRITICALLY

8. Answers should include an understanding that ATP stores only a small amount of energy and, thus, is efficient for only short-term storage. Answers should also acknowledge that energy in ATP is stored as chemical bonds, and energy is released when bonds are broken to form ADP and stored when bonds are added to re-form ATP (energy transfer).
9. The Indian pipe plant appears to have no chlorophyll or any other pigment. Without a pigment, this organism cannot carry out photosynthesis to make its own food. Therefore, it must be a heterotroph, which obtains food by consuming other living things.

Lesson 8.2

UNDERSTAND KEY CONCEPTS

10. d 11. c
12. carbon dioxide + water $\xrightarrow{\text{light}}$ sugars + oxygen
13. Plant pigments absorb sunlight—the energy source for photosynthesis.
14. A=stroma; B=granum; C=thylakoid; the light-dependent reactions take place within the thylakoids that make up grana (C and/or B); the light-independent reactions take place in the stroma (A).

THINK CRITICALLY

15. The chlorophyll molecules break down first as temperatures drop in the fall, leaving the yellow and red light reflected by the accessory pigments for all to see.
16. Sample answer: Start with two samples of the same type of algae, and place equal amounts of the algae samples in the same amount of pond water. Put one sample in a dark place and the other in a location that receives sunlight daily. Temperatures should be kept the same in both places. After two weeks, compare the two samples to determine the growth and health of the two samples of algae.
17. Sample answer: The plant would grow normally for a short period of time, and then the rate of photosynthesis would drop because of a lack of CO_2 , which is necessary for carrying out photosynthesis. Eventually, the plant might die, because without the CO_2 necessary to carry out photosynthesis, the plant would not have the energy-storing sugars needed to carry out cell activities.

Lesson 8.3

UNDERSTAND KEY CONCEPTS

18. a 19. b 20. a

21. c 22. c

23. NADP⁺ molecules pick up high-energy electrons along with H⁺ ions in the light-dependent reactions to become NADPH. This NADPH is used in the light-independent reactions to produce high-energy sugars.

24. ATP synthase is a protein that spans the thylakoid membrane and allows H⁺ ions to pass through. As

H⁺ ions from the thylakoid space pass through the ATP synthase and into the stroma, the ATP synthase molecule rotates and the energy produced is used to convert ADP to ATP.

25. The Calvin cycle uses 6 molecules of carbon dioxide to produce a single 6-carbon sugar molecule. The energy for the reactions that make this possible is supplied by ATP and NADPH, which are produced in the light-dependent reactions. The Calvin cycle works steadily, removing carbon dioxide from the atmosphere and turning out energy-rich sugars.

26. Sample answer: Because the enzymes that make photosynthesis possible work best between 0°C and 35°C, temperatures above or below this range may slow down the rate of photosynthesis. High light intensity increases the rate of photosynthesis, though after the light intensity reaches a certain level the plant reaches its maximum rate. A shortage of water can slow or even stop photosynthesis.

THINK CRITICALLY

27. No step in the Calvin cycle depends on the presence of light. Instead, the cycle uses energy stored in ATP and NADPH.

28. The energy used in the Calvin cycle comes from ATP and NADPH produced in the light-dependent reactions.


29. Sample answer: If enough of the sun's rays are blocked, the rate of photosynthesis would slow down. In the short term, plants and other photosynthetic organisms may not grow normally. In the long run, some plants, and organisms that depend on plants, may not survive.

Connecting Concepts

USE SCIENCE GRAPHICS

30. Students' graphs should show Distance From Light (cm) on the x-axis and Bubbles Produced per Minute on the y-axis. The line should show a curve that descends from left to right.
31. The number of bubbles decreases as the light is placed further away. There would be fewer than 5 bubbles if the light were 50 cm away.
32. The farther the light is from the plant, the fewer the number of bubbles produced. The reason is that a decrease in light intensity results in a decrease in the rate of photosynthesis—and therefore a decrease in oxygen produced.
33. because that is where light intensity is greatest

WRITE ABOUT SCIENCE

34. Stories and illustrations will vary. Students should recognize that both the oxygen atom and the hydrogen atoms enter a chloroplast together as a water molecule, H_2O . The oxygen atom is split from the hydrogen atoms in the light-dependent stage of photosynthesis and leaves the plant as oxygen gas. The hydrogen atoms become involved in the formation of NADPH, the production of ATP, and the production of high-energy sugars in the Calvin cycle.
35.  The chloroplasts are specialized to produce sugars such as glucose, but this process cannot occur without an input of energy. The sun's rays provide that energy, and chlorophyll captures the sun's rays.

Analyzing Data

PURPOSE Students will analyze data to understand how varying concentrations of CO_2 affect rates of photosynthesis and that different plants respond to CO_2 concentration in different ways.

PLANNING Review with students factors that affect photosynthesis. Also remind students that a line graph shows how a variable plotted on the vertical axis changes in response to changes in the variable plotted on the horizontal

axis. Tell students that understanding the unit of measure for the rate of photosynthesis is not as important as recognizing that the rate increases in units of 20 along the vertical axis. Finally, you may wish to ask students which of the two plants is a C_4 plant and how they know. (*Corn is C_4 ; it has a higher rate of photosynthesis, even at very low CO_2 concentrations.*)

ANSWERS

36. c

37. b

Answers

1. D
2. A
3. B
4. A
5. C
6. D
7. C
8. D
9. B
10. D
11. Light is absorbed by electrons in pigments, increasing the electrons' energy level. These high-energy electrons are used in the light-dependent reactions to convert ADP and NADP^+ into the molecules ATP and NADPH. In the light-independent reactions, ATP and NADPH are then used to produce high-energy sugars.