

Study Tip

Divide the class into pairs and have students quiz each other about the Vocabulary words and Key Concepts.

Thinking Visually

1. Light
2. Light-dependent reactions
3. NADPH
4. Carbon dioxide
5. Sugars

Chapter 8 Assessment**Reviewing Content**

1. b
2. b
3. b
4. d
5. c
6. a
7. d
8. a
9. b
10. a

Understanding Concepts

11. Autotrophs are able to obtain energy by making their own food. Heterotrophs obtain their energy by consuming food.
12. An ATP molecule consists of a nitrogen-containing compound called adenine, a sugar called ribose, and three phosphate groups.
13. ATP resembles a fully charged battery because it can yield energy when the third phosphate group is removed, also forming ADP. ADP is like a partially charged battery that can be recharged when energy is added to link a third phosphate group, reforming ATP.
14. A single molecule of glucose stores more than 90 times the energy stored by ATP. However, ATP, which transfers energy quickly, is used by the cell as an immediate source of energy.
15. Priestley discovered that plants produce a substance needed to burn candles, now known to be oxygen. Ingenhousz found that plants produce oxygen only when exposed to light.
16. Carbon dioxide + water → sugars + oxygen
17. Plant pigments absorb energy from light and transfer it to electrons involved in photosynthesis.

8-1 Energy and Life**Key Concepts**

- Plants and some other types of organisms are able to use light energy from the sun to produce food.
- The characteristics of ATP make it exceptionally useful as the basic energy source of all cells.

Vocabulary

autotroph, p. 201
heterotroph, p. 201
adenosine triphosphate (ATP), p. 202

8-2 Photosynthesis: An Overview**Key Concepts**

- The experiments performed by van Helmont, Priestley, and Ingenhousz led to work by other scientists who finally discovered that in the presence of light, plants transform carbon dioxide and water into carbohydrates, and they also release oxygen.
- Photosynthesis uses the energy of sunlight to convert water and carbon dioxide into high-energy sugars and oxygen.
- In addition to water and carbon dioxide, photosynthesis requires light and chlorophyll, a molecule found in chloroplasts.

Vocabulary

photosynthesis, p. 204
pigment, p. 207
chlorophyll, p. 207

**8-3 The Reactions of Photosynthesis****Key Concepts**

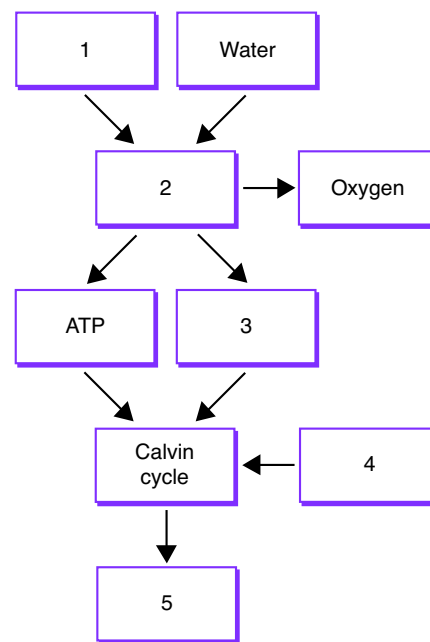
- The process of photosynthesis includes the light-dependent reactions as well as the Calvin cycle.
- The light-dependent reactions produce oxygen gas and convert ADP and NADP⁺ into ATP and NADPH. The light-dependent reactions occur in the thylakoid.
- The Calvin cycle uses ATP and NADPH from the light-dependent reactions to produce high-energy sugars. The Calvin cycle is also known as the light-independent reactions.

Vocabulary

thylakoid, p. 208
photosystem, p. 208
stroma, p. 208
NADP⁺, p. 209
light-dependent reactions, p. 210
ATP synthase, p. 210
Calvin cycle, p. 212

Thinking Visually

Using the information in this chapter, complete the following flowchart about photosynthesis:

**CHAPTER RESOURCES****Print:**

- **Teaching Resources**, Chapter Vocabulary Review, Graphic Organizer
- **Chapter Tests: Levels A and B**, Chapter 8 Test

Technology:

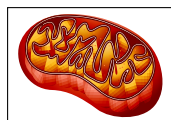
- **Computer Test Bank**, Chapter 8 Test
- **iText**, Chapter 8 Assessment

Chapter 8 Assessment

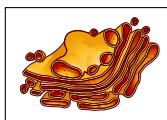
Reviewing Content

Choose the letter that best answers the question or completes the statement.

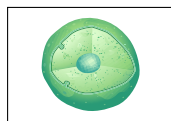
- Which of the following are autotrophs?
 - impalas
 - plants
 - leopards
 - mushrooms
- One of the principal chemical compounds that living things use to store energy is
 - DNA.
 - ATP.
 - H_2O .
 - CO_2 .
- Which scientist concluded that most of a growing plant's mass comes from water?
 - Priestley
 - van Helmont
 - Ingenhousz
 - Calvin
- In addition to light and chlorophyll, photosynthesis requires
 - water and oxygen.
 - water and sugars.
 - oxygen and carbon dioxide.
 - water and carbon dioxide.
- The leaves of a plant appear green because chlorophyll
 - reflects blue light.
 - absorbs blue light.
 - reflects green light.
 - absorbs green light.
- The products of photosynthesis are
 - sugars and oxygen.
 - sugars and carbon dioxide.
 - water and carbon dioxide.
 - hydrogen and oxygen.
- Which organelle contains chlorophyll?



a.



c.



b.



d.

- The first process in the light-dependent reactions of photosynthesis is
 - light absorption.
 - electron transport.
 - oxygen production.
 - ATP formation.

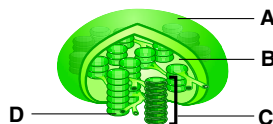
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- Which substance from the light-dependent reactions of photosynthesis is a source of energy for the Calvin cycle?
 - ADP
 - NADPH
 - H_2O
 - pyruvic acid
- The light-independent reactions of photosynthesis are also known as the
 - Calvin cycle.
 - Priestley cycle.
 - Ingenhousz cycle.
 - van Helmont cycle.

Understanding Concepts

- How do heterotrophs and autotrophs differ in the way they obtain energy?
- Describe the three parts of an ATP molecule.
- Use the analogy of a battery to explain how energy is stored in and released from ATP.
- Compare the amounts of energy stored by ATP and glucose. Which compound is used by the cell as an immediate source of energy?
- How were Priestley's and Ingenhousz's discoveries about photosynthesis related?
- Write the basic equation for photosynthesis using the names of the starting and final substances of the process.
- What role do plant pigments play in the process of photosynthesis?
- Identify the structures labeled A, B, C, and D. In which structure(s) do the light-dependent reactions occur? In which structure(s) does the Calvin cycle take place?



- Explain the role of $NADP^+$ as an energy carrier in photosynthesis.
- What is the role of ATP synthase? How does it work?
- Summarize what happens during the Calvin cycle.
- How do the events in the Calvin cycle depend on the light-dependent reactions?
- Describe three factors that affect the rate at which photosynthesis occurs.



If your class subscribes to the iText, your students can go online to access an interactive version of the Student Edition and a self-test.

(Continued from page 216)

- A: chloroplast; B: stroma; C: granum; D: thylakoid. The light-dependent reactions take place in the thylakoids. The Calvin cycle takes place in the stroma.
- $NADP^+$ carries energy by holding two electrons and a hydrogen ion. It carries the stored energy to other reactions that help build sugar molecules.
- ATP synthase is a protein found in the thylakoid membrane that allows H^+ ions to pass through it. As H^+ ions pass through this protein, it rotates and binds ADP and a phosphate group together to produce ATP.
- During the Calvin cycle, plants use the energy that ATP and NADPH contain to build high-energy compounds that can be stored for a long time. The Calvin cycle uses six molecules of carbon dioxide to produce a single 6-carbon sugar molecule.
- The Calvin cycle uses the ATP and NADPH produced during the light-dependent reactions to produce high-energy sugars.
- Factors that affect the rate of photosynthesis include the temperature, the amount of available water, and the intensity of light.



HOMEWORK GUIDE

Section:	Questions:
Section 8-1	1, 2, 11-14, 27, 32
Section 8-2	3-6, 15-17, 24, 30
Section 8-3	7-10, 18-23, 25, 26, 28, 29, 31

Critical Thinking

24. The chlorophyll may be broken down by the cooling temperatures or the changing light, so the green color disappears. The leaf then shows the color of its remaining pigment(s).

25. Some students may build on the analogy of the battery from the chapter. Others may develop a new analogy. For example, ADP is like a ball at the bottom of the hill. Moving the ball to the top of the hill is like adding a phosphate group and making ATP. The ball now has the energy to roll downhill and move other objects in its path. ATP has energy to help change molecules.

26. No step of the Calvin cycle depends directly on light. Instead, it uses energy stored in the molecules ATP and NADPH.

27. Students' answers may include: Start with two samples of the same amount and type of pond algae in water. Put one sample in the dark and the other in a location that receives daylight, keeping the temperatures the same. After two weeks, compare the two samples to determine the amount and health of the algae.

28. a. The graph shows a curve that descends from left to right. The farther the light is from the plant, the fewer bubbles are produced.

b. 10 cm. c. The closer the plant is to the light, the more oxygen is produced. This occurs because more light energy is reaching the algae cells and thus is available for photosynthesis.

29. At first, photosynthesis would take place during daylight, but it would stop when the water was used up. If no more water was added, the plant might die.

30. Because the Indian pipe plant has no chlorophyll or other pigment involved in photosynthesis, it probably cannot make its own food. Therefore, it must obtain food from other sources the way a heterotroph does. Perhaps it absorbs partly decayed food in the soil.

31. Short-term effects: Less light will reach photosynthetic organisms, so less photosynthesis will occur, and those organisms may grow more

Critical Thinking

24. **Formulating Hypotheses** Some plant leaves contain yellow and red pigments as well as chlorophyll. In the fall, those leaves may become red or yellow. Suggest an explanation for those color changes.

25. **Using Analogies** Develop an analogy to explain ATP and energy transfer to a classmate who does not understand the concept.

26. **Interpreting Graphics** The Calvin cycle is sometimes described as the light-independent reactions. Study **Figure 8-11** on page 212 and give evidence to support the idea that the Calvin cycle does not depend on light.

27. **Designing Experiments** Design an experiment that uses pond water and algae to demonstrate the importance of light energy to pond life. Be sure to identify the variables you will control and the variable you will change.

28. **Using Tables and Graphs** A water plant placed in a bright light gives off bubbles of oxygen. In the laboratory, you notice that if the light is placed at different distances from the plant, the rate at which the plant produces bubbles changes. Your data are shown in the following table.

Oxygen Production	
Distance From Light (cm)	Bubbles Produced per Minute
10	39
20	22
30	8
40	5

- On graph paper, plot the data on a line graph. Describe the trend. When the light was farther from the plant, did the number of bubbles produced increase or decrease? Explain.
- At what distance is gas production at its highest?
- What relationship exists between the distance from the plant to the light and the number of bubbles produced? Explain your answer.

29. **Predicting** Suppose you water a potted plant and place it by a window in an airtight jar. Predict when photosynthesis might occur over the next few days. Would you expect the pattern to change if the plant were left there for several weeks? Explain.

slowly. Long-term effects: Some autotrophs could die because they lack the food and energy they need; then, heterotrophs that depend on those autotrophs could experience starvation and death.

32. In autotrophs, the process of photosynthesis captures energy from sunlight and uses it to produce high-energy sugars. This energy passes from one organism to another in an ecosystem as organisms eat and are eaten.

30. **Inferring** Examine the photograph of the Indian pipe plant shown below. What can you conclude about the ability of the Indian pipe plant to make its own food? Explain your answer.



31. **Formulating Hypotheses** Many of the sun's rays may be blocked by dust or clouds formed by volcanic eruptions or pollution. What are some possible short-term and long-term effects of this on photosynthesis?

32. **Connecting Concepts** Recall what you learned about the flow of energy through an ecosystem. Explain how photosynthesis relates to that flow.

Writing in Science

Imagine that you are an oxygen atom and two of your friends are hydrogen atoms. Together, you make up a water molecule. Describe the events and changes that happen to you and your friends as you journey through the light-dependent reactions and Calvin cycle of photosynthesis. Include illustrations with your description.

Performance-Based Assessment

Making Models Construct a two- or three-dimensional model of an ATP molecule. Label the various parts of the molecule. Use the model to explain how ATP is broken down into ADP and AMP. (AMP contains one phosphate group.) How does your model change?

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