

## 8.1 & 9.1 Energy and Life

**Chemical Energy and ATP** Energy is the ability to do work. Organisms need energy to stay alive.

- ▶ **Adenosine triphosphate (ATP)** is a chemical compound cells use to store and release energy.
  - An ATP molecule consists of adenine, the sugar ribose, and three phosphate groups.
  - Cells store energy by adding a phosphate group to adenosine diphosphate (ADP) molecules.
  - Cells release energy from ATP molecules by subtracting a phosphate group.
- ▶ Energy provided by ATP is used in active transport, to contract muscles, to make proteins, and in many other ways.
- ▶ Cells contain only a small amount of ATP at any one time. They regenerate it from ADP as they need it, using energy stored in food.

**Heterotrophs and Autotrophs** The energy to make ATP from ADP comes from food. Organisms get food in one of two ways.

- ▶ **Heterotrophs** get food by consuming (eating) other organisms.
- ▶ **Autotrophs** use the energy in sunlight to make their own food.
- ▶ **Photosynthesis** is the process that uses light energy to produce food molecules.

**Chemical Energy and Food** Chemical energy is stored in food molecules.

- ▶ Energy is released when chemical bonds in food molecules are broken.
- ▶ Energy is measured in a unit called a **calorie**, the amount of energy needed to raise the temperature of 1 gram of water 1 degree Celsius.
- ▶ Fats store more energy per gram than do carbohydrates and proteins.

**Comparing Photosynthesis and Cellular Respiration** The energy in photosynthesis and cellular respiration flows in opposite directions. Their equations are the reverse of each other.

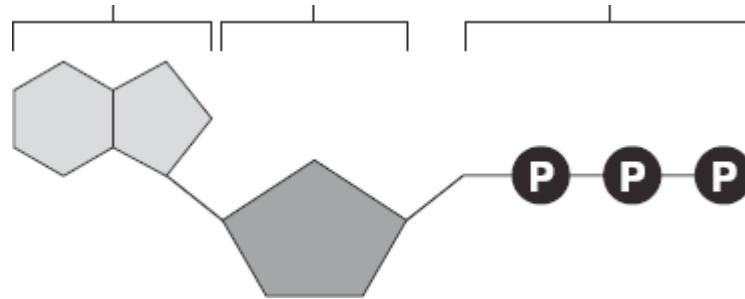
- ▶ Photosynthesis removes carbon dioxide from the atmosphere, and cellular respiration puts it back.
- ▶ Photosynthesis releases oxygen into the atmosphere, and cellular respiration uses oxygen to release energy from food.

## Chemical Energy and ATP

*For Questions 1–6, complete each statement by writing the correct word or words.*

1. \_\_\_\_\_ is the ability to do work.
2. The main chemical compound cells use for energy is \_\_\_\_\_ (ATP).
3. \_\_\_\_\_ is a 5-carbon sugar molecule that is part of an ATP molecule.
4. The \_\_\_\_\_ of ATP are the key to its ability to store and supply energy.

- ATP releases energy when it \_\_\_\_\_ bonds between its phosphate groups.
- Most cells only store enough ATP for \_\_\_\_\_ of activity.
- THINK VISUALLY** Label each part of the diagram of an ATP molecule below.



For Questions 8–10, refer to the Visual Analogy comparing ATP to a charged battery.

- VISUAL ANALOGY** In the visual analogy, what chemical is represented by the low battery?

\_\_\_\_\_

\_\_\_\_\_

- What are two ways in which the diagram shows an increase in energy?

\_\_\_\_\_

\_\_\_\_\_

- Describe the concepts shown in the diagram.

\_\_\_\_\_

\_\_\_\_\_

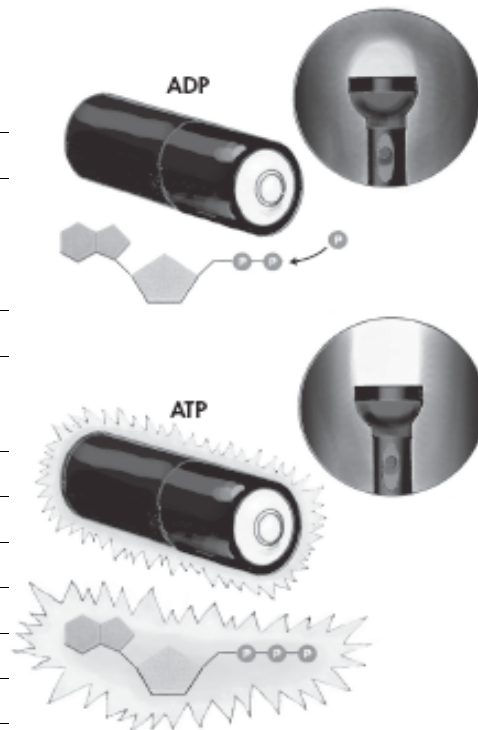
\_\_\_\_\_

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- What are two ways in which cells use the energy temporarily stored in ATP?

\_\_\_\_\_

\_\_\_\_\_

- Energy is needed to add a third phosphate group to ADP to make ATP. What is a cell's source of this energy?

\_\_\_\_\_

\_\_\_\_\_

**ATP as a Charged Battery** An analogy takes two things that seem to be different and shows how they can be similar.



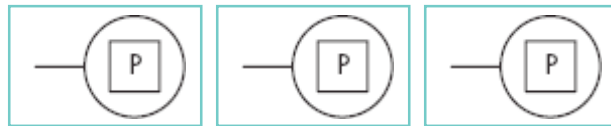
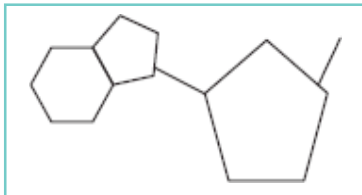
13. How is a partially charged battery like ADP? \_\_\_\_\_  
\_\_\_\_\_

14. Why do cells contain only a small amount of ATP?
- A. ATP cannot store large amounts of energy for a long time.
  - B. ATP releases energy too quickly.
  - C. ATP cannot carry out active transport.
  - D. ATP has only two phosphate groups.

**Chemical Energy** Living things use chemical fuels. One of the most important compounds that cells use to store and release energy is ATP.

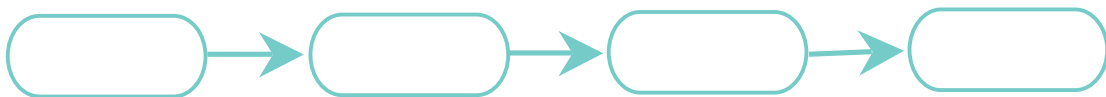
Follow the directions. Then answer the questions.

- 15. Trace the outlines of the adenosine molecule and the three phosphate groups.
- 16. Cut out each phosphate group.
- 17. Arrange the phosphate groups on the adenosine molecule to form a molecule of ATP.



- 18. When ATP is changed to ADP, it releases energy. Change your ATP molecule so that it forms ADP. What change did you make? \_\_\_\_\_
- 19. ADP can be converted into ATP. Change your ADP molecule into ATP. What change did you make? \_\_\_\_\_
- 20. Fill in the blanks with *two* or *three*. The primary difference in the structures of ATP and ADP is that ATP has \_\_\_\_\_ phosphate groups and ADP has \_\_\_\_\_ phosphate groups.
- 21. The organisms listed in the box belong to a food chain. Use the words in the box to fill in the food chain in the correct order.

bear                      insect                      salmon                      grass



22. Explain how top-level consumers such as hawks depend on sunlight for their food.

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## Heterotrophs and Autotrophs

For Questions 23–27, write *True* if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- \_\_\_\_\_ 23. All heterotrophs must eat food to get energy.
- \_\_\_\_\_ 24. Autotrophs do not need to eat food because they make food.
- \_\_\_\_\_ 25. The energy in food originally came from ATP.
- \_\_\_\_\_ 26. The term photosynthesis means “pulling apart with light” in Greek.
- \_\_\_\_\_ 27. The energy of sunlight is stored in the chemical bonds of carbohydrates.

28. Complete the table comparing two types of organisms.

Autotrophs and Heterotrophs		
Type	Description	Examples
Autotrophs		
Heterotrophs		

29. Suppose that you ate a hamburger on a wheat roll with lettuce, tomatoes, and onions for lunch. As you ate, you took in food molecules from plants and animals. Explain why all the energy in the food molecules of this hamburger could be traced back to the sun.

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30. A calorie is a unit of \_\_\_\_\_.
31. The Calorie used on food labels is equal to \_\_\_\_\_ calories.
32. A Calorie is also referred to as a \_\_\_\_\_.
33. Cells use the energy stored in chemical bonds of foods to produce compounds that directly power the cell’s activities, such as \_\_\_\_\_.

# Overview of Cellular Respiration

For Questions 5–10, complete each statement by writing the correct word or words.

34. The equation that summarizes cellular respiration, using chemical formulas, is \_\_\_\_\_.
35. If cellular respiration took place in just one step, most of the \_\_\_\_\_ would be lost in the form of light and \_\_\_\_\_.
36. Cellular respiration begins with a pathway called \_\_\_\_\_, which takes place in the \_\_\_\_\_ of the cell.
37. At the end of glycolysis, about \_\_\_\_\_ percent of the chemical energy is locked in the bonds of the \_\_\_\_\_ molecule.
38. Cellular respiration continues in the \_\_\_\_\_ of the cell with the \_\_\_\_\_ and electron transport chain.
39. The pathways of cellular respiration that require oxygen are said to be \_\_\_\_\_. Pathways that do not require oxygen are said to be \_\_\_\_\_.

## Comparing Photosynthesis and Respiration

For Questions 12–15, write *True* if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- \_\_\_\_\_ 40. The energy flow in photosynthesis and cellular respiration occurs in the same direction.
- \_\_\_\_\_ 41. Photosynthesis deposits energy in Earth’s “savings account” for living organisms.
- \_\_\_\_\_ 42. Cellular respiration removes carbon dioxide from the air.
- \_\_\_\_\_ 43. Photosynthesis takes place in nearly all life.

Cellular respiration and photosynthesis can be thought of as opposite processes. Energy flows in opposite directions in the two processes.

Complete the table using the words below. Some words may be used more than once. You will use more than one term in some of the spaces.

**carbon dioxide      energy release      mitochondria      water**

	<b>Photosynthesis</b>	<b>Cellular Respiration</b>
Function	<b><i>energy capture</i></b>	
Location	<b><i>chloroplasts</i></b>	
Reactants		<b><i>glucose and oxygen</i></b>
Products	<b><i>oxygen and glucose</i></b>	

*Answer the questions*

44. Circle the correct answer. Which process releases energy for the cell?

cellular respiration                      photosynthesis

45. Circle the correct answer. For which reaction is  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$  the correct equation?

cellular respiration                      photosynthesis

46. Which statement about cellular respiration is true?

- A. Cellular respiration does not use energy.
- B. The total amount of energy is constant.
- C. Energy is destroyed during the reaction.
- D. Energy is created during the reaction.

47. How are the processes of photosynthesis and cellular respiration connected?

- A. The products of both processes are the same.
- B. The reactants for one process are the same as the reactants for the other process.
- C. Each process provides the materials needed in the other process.
- D. There is no direct relationship.

48. How does an understanding of the process of cellular respiration support the theory that the cell is the basic functional unit of life?

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49. List and define 10 new or unusual vocabulary words

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2 \_\_\_\_\_

3 \_\_\_\_\_

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5 \_\_\_\_\_

6 \_\_\_\_\_

7 \_\_\_\_\_

8 \_\_\_\_\_

9 \_\_\_\_\_

10 \_\_\_\_\_