Chapter 9

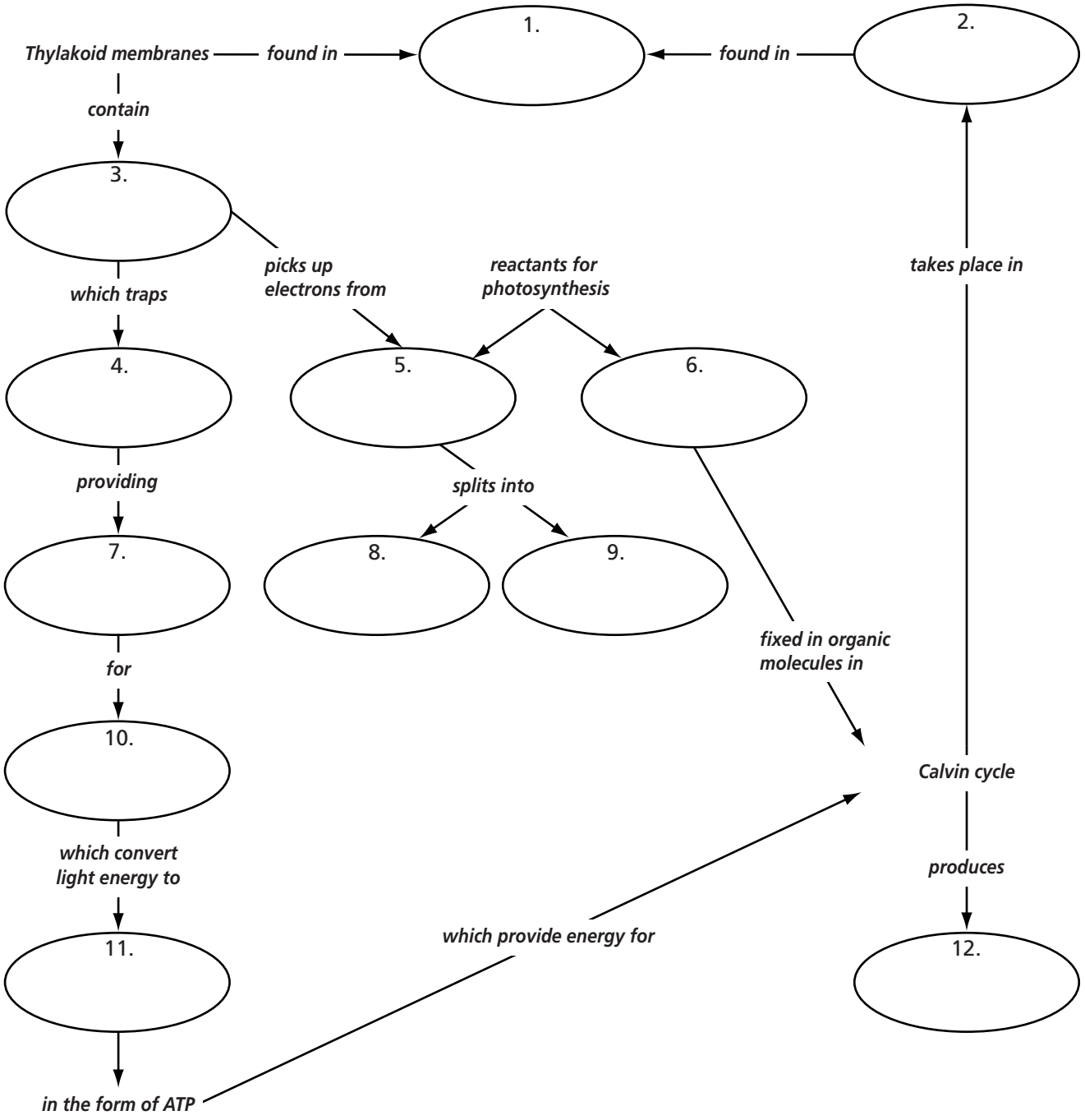
Energy in a Cell

Concept Mapping

Use with Chapter 9, Section 9.2

Photosynthesis: Trapping the Sun's Energy

Complete the concept map describing photosynthesis. Use these words or phrases once: *chemical energy*, *oxygen*, *light-dependent reactions*, *chlorophyll*, *stroma*, *glucose*, *water*, *sunlight*, *oxygen*, *carbon dioxide*, *hydrogen ions*, *chloroplasts*.



Chapter 9

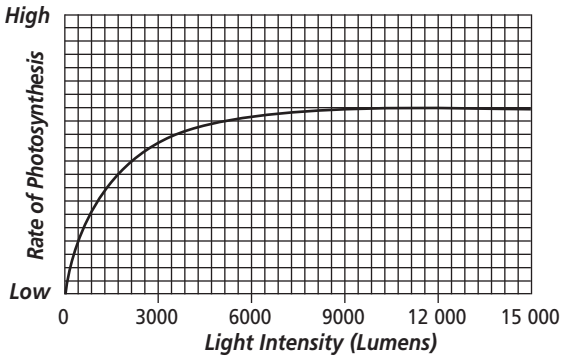
Energy in a Cell

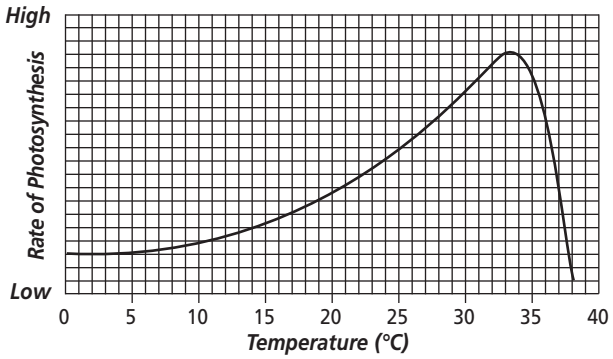
Problem Solving

Use with Chapter 9, Section 9.2

Two Factors Affecting Photosynthesis

The rate at which photosynthesis occurs is not always the same. The intensity of light, temperature, supply of carbon dioxide, supply of water, and availability of minerals are important factors that affect the rate of photosynthesis in land plants. The rate also varies by species and a plant's health and maturity. The two graphs below show the effects of light intensity and temperature on the rate of photosynthesis in land plants. These two factors affect many enzymes that control photosynthetic reactions. Study the graphs and answer the questions that follow. (Light intensity is measured in lumens, the SI unit of light flow.)





1. What does the graph on the left tell about the effect of light intensity on the rate of photosynthesis?

2. What happens when light intensity rises above 9000 lumens?

3. What adaptive advantages would a plant have if its photosynthetic rate kept increasing with light intensity above 9000 lumens?

4. What does the graph on the right tell about the effect of temperature on the rate of photosynthesis?

5. What happens when the temperature rises above 33°C?

6. What might cause this change?

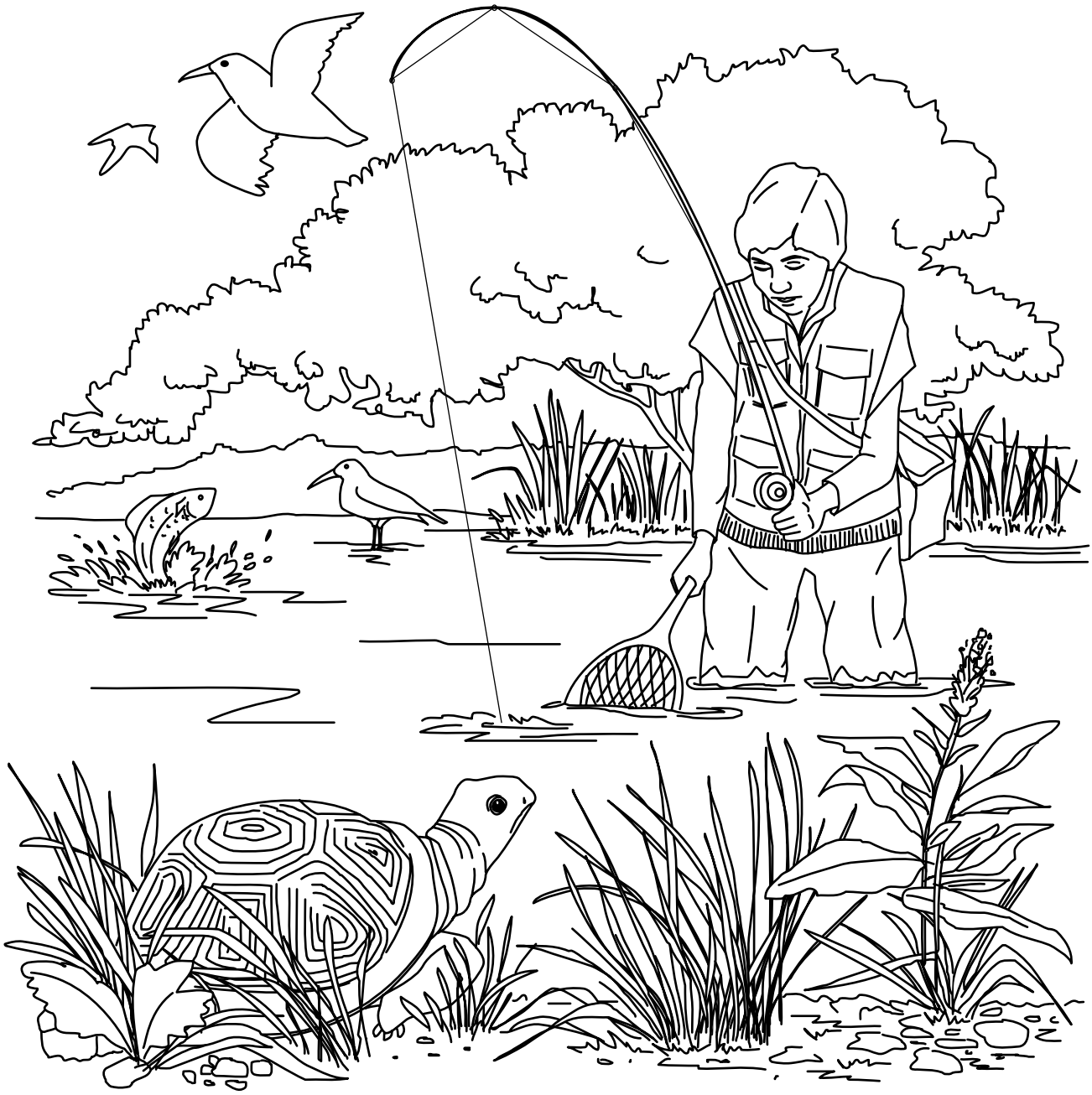
7. What light intensity and temperature levels allow the highest photosynthesis rate?

Master 21

Using Energy

Section Focus

Use with Chapter 9, Section 9.1



1. How is each of these organisms using energy?

2. In what other ways do organisms use energy?

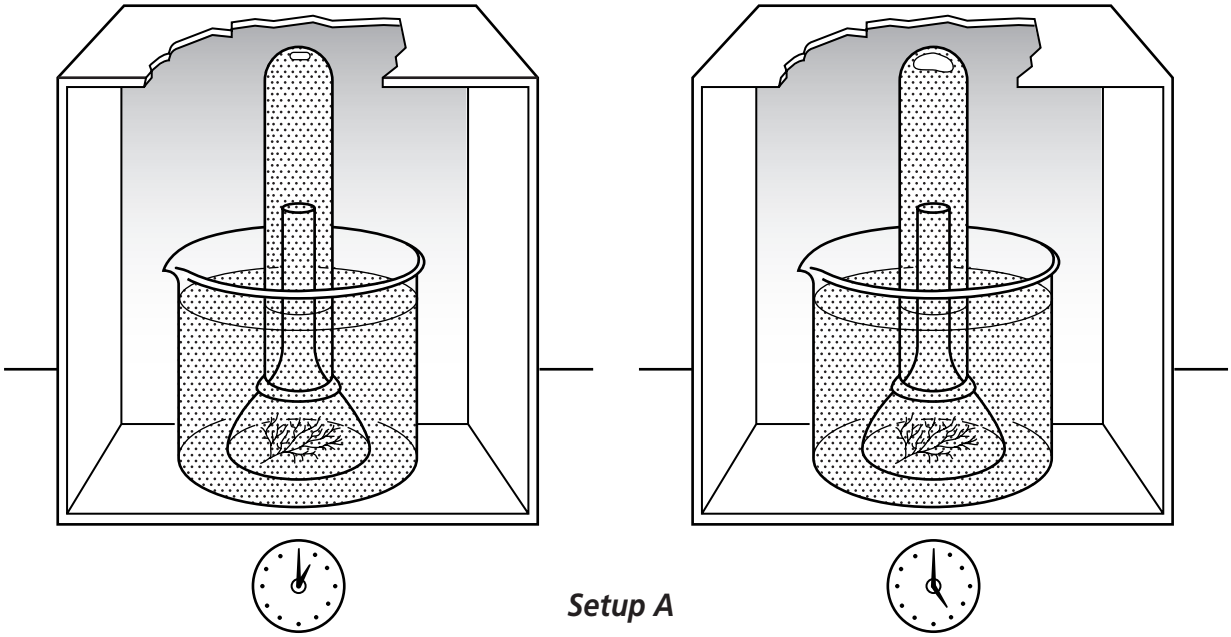
Name Date Class

Master 22

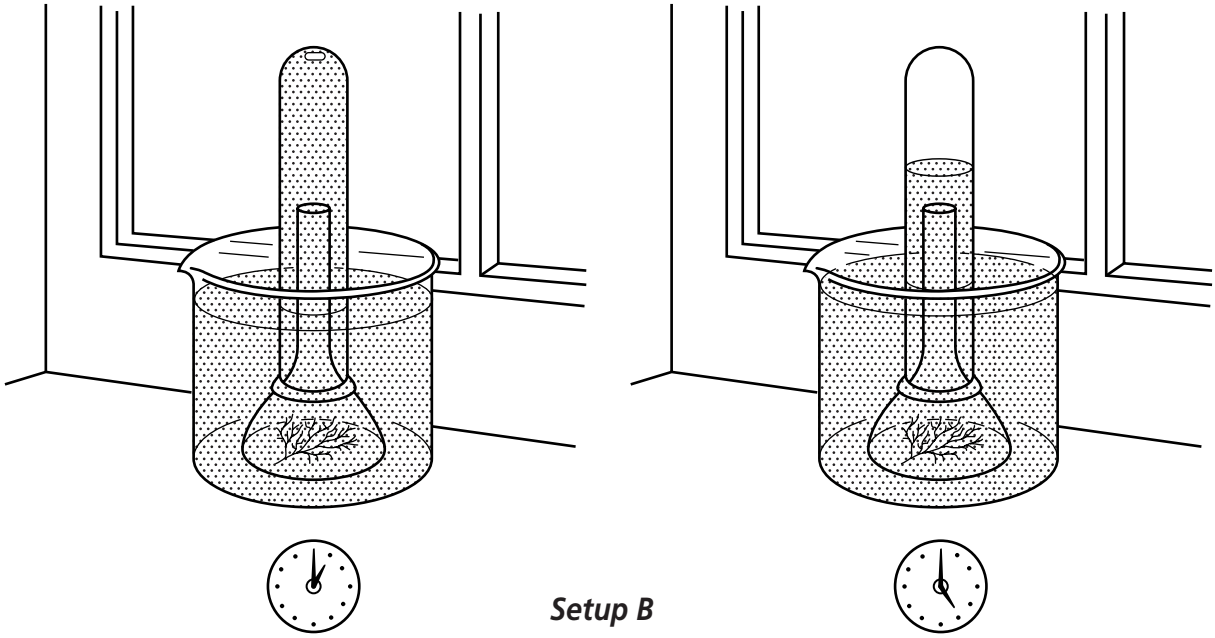
Photosynthesis

Section Focus

Use with Chapter 9, Section 9.2



Setup A



Setup B

1. How does the amount of gas in each test tube differ?

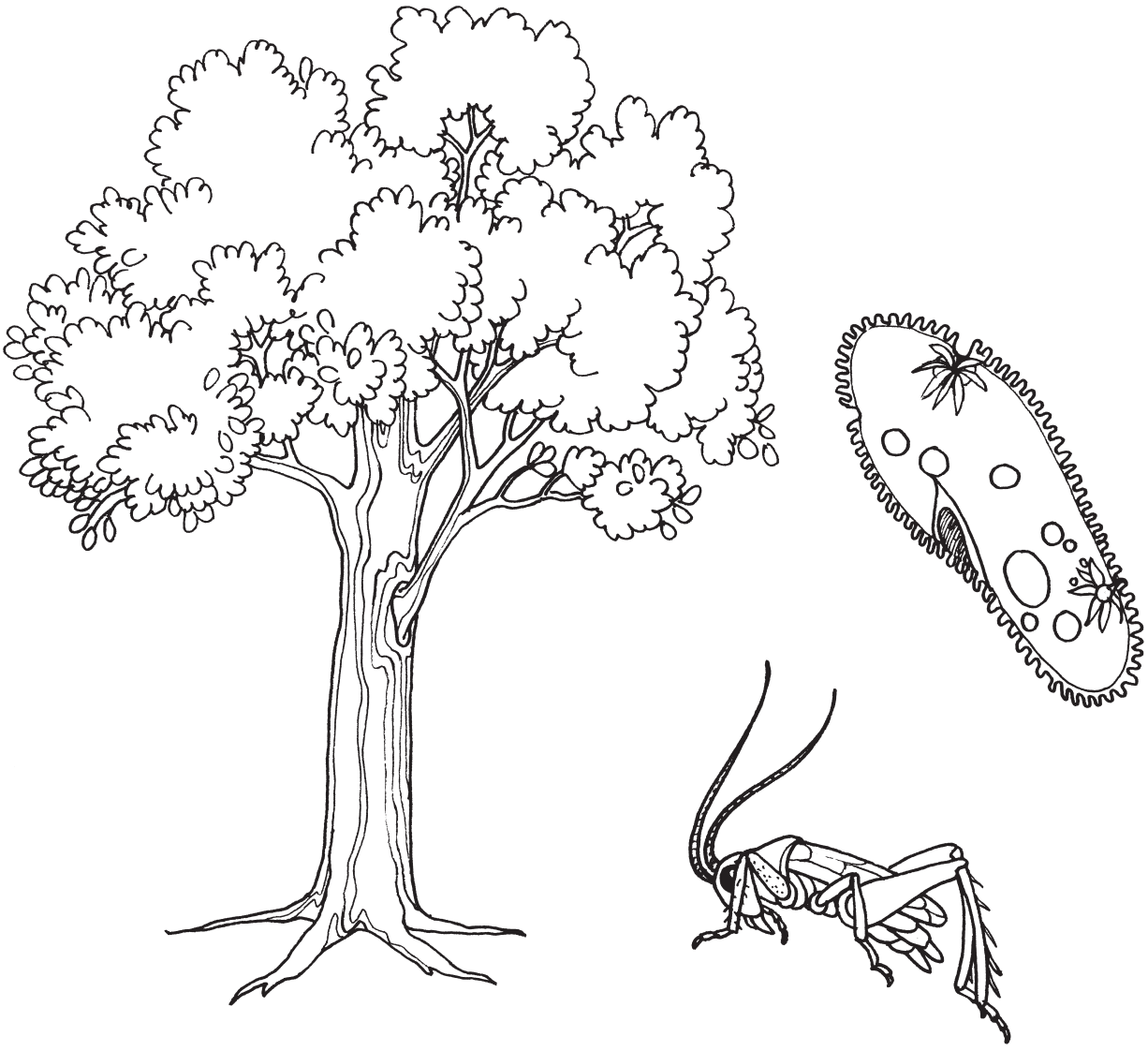
2. Oxygen is a product of a process called photosynthesis, which occurs in plants. Based on the results shown, what is required for photosynthesis to occur?

Master 23

Cellular Respiration

Section Focus

Use with Chapter 9, Section 9.3



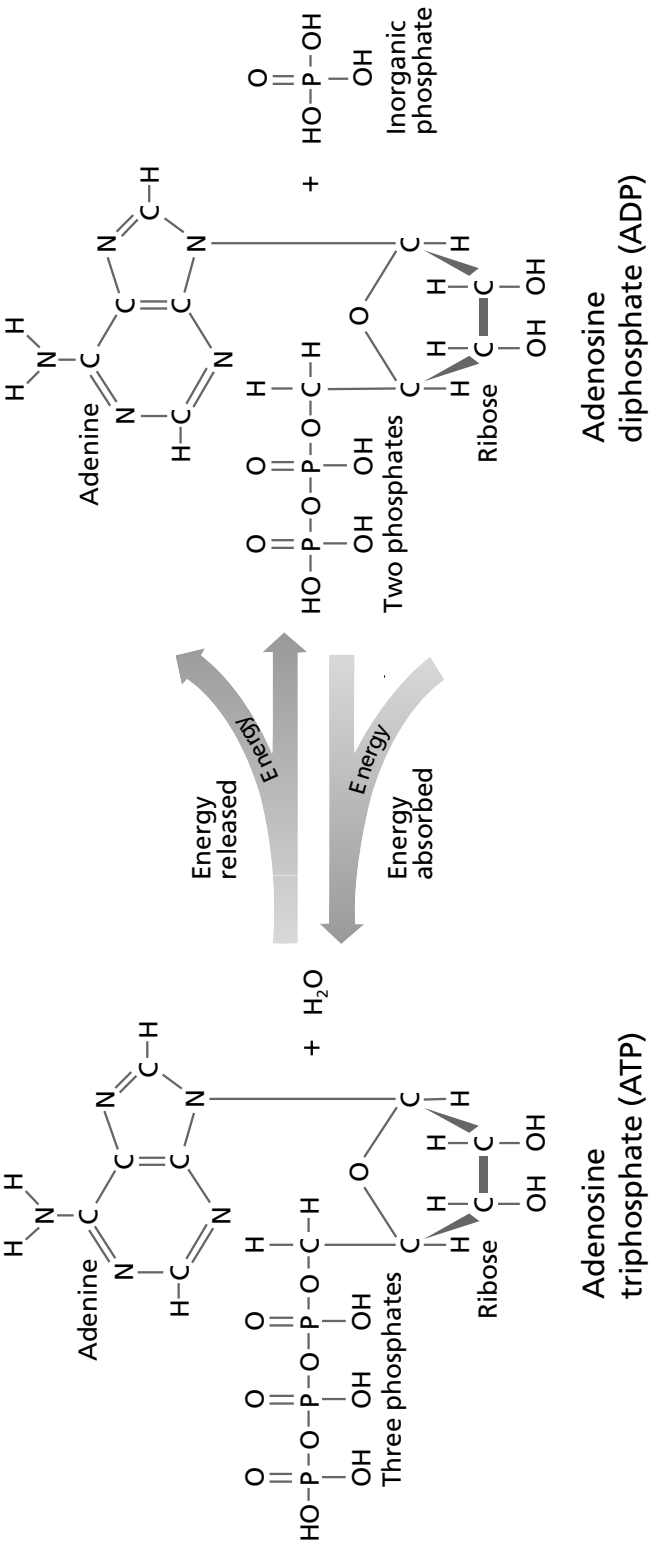
1. Which of these organisms require energy?
2. How does the manner in which these organisms get energy differ?

Master 11

ATP–ADP Cycle

Basic Concepts

Use with Chapter 9, Section 9.1



Name Date Class

Worksheet 11

ATP–ADP Cycle

Basic Concepts

Use with Chapter 9, Section 9.1

1. What is the structural difference between ATP and ADP?

2. Which molecules are contained in both ATP and ADP?

3. In which structure, ATP or ADP, is more energy stored? Where is the energy stored?

4. Describe what takes place in the process of converting ADP to ATP.

5. Describe what happens in the process of converting ATP to ADP.

6. Explain why the reactions shown in the transparency are considered to be part of a cycle.

7. Describe the role of proteins in the release of energy stored in ATP.

8. What are two ways that cells use energy released from the breakdown of ATP?

Master 12

Photosynthesis

Basic Concepts

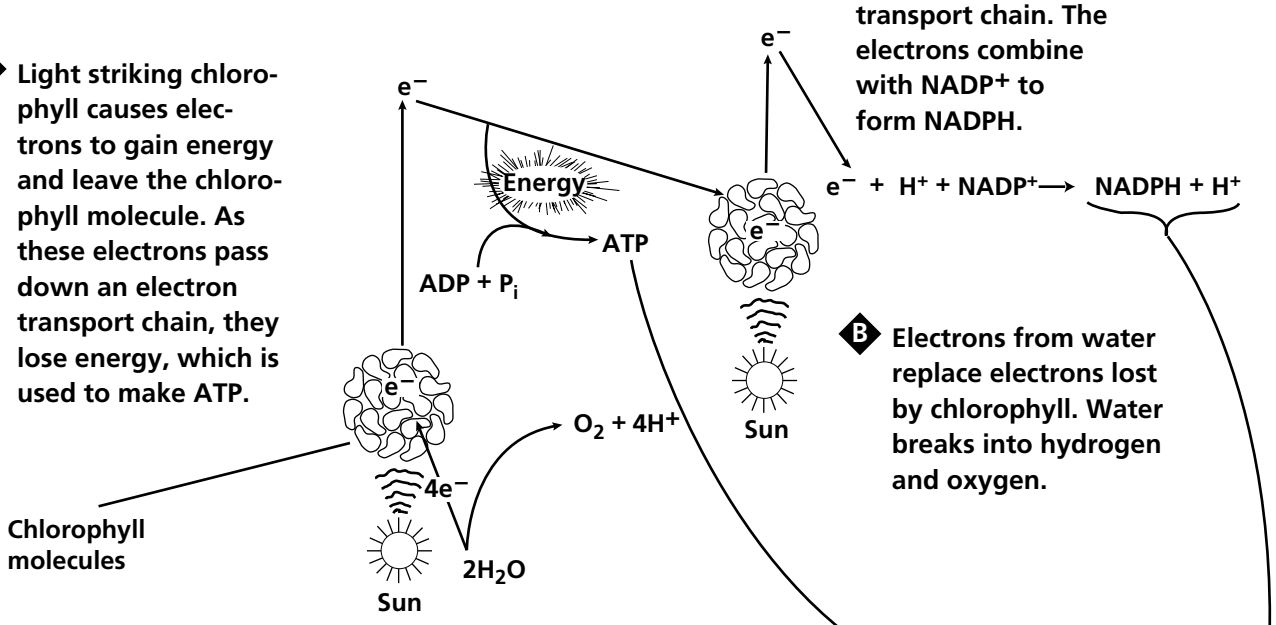
Use with Chapter 9, Section 9.2

Light-Dependent Reactions

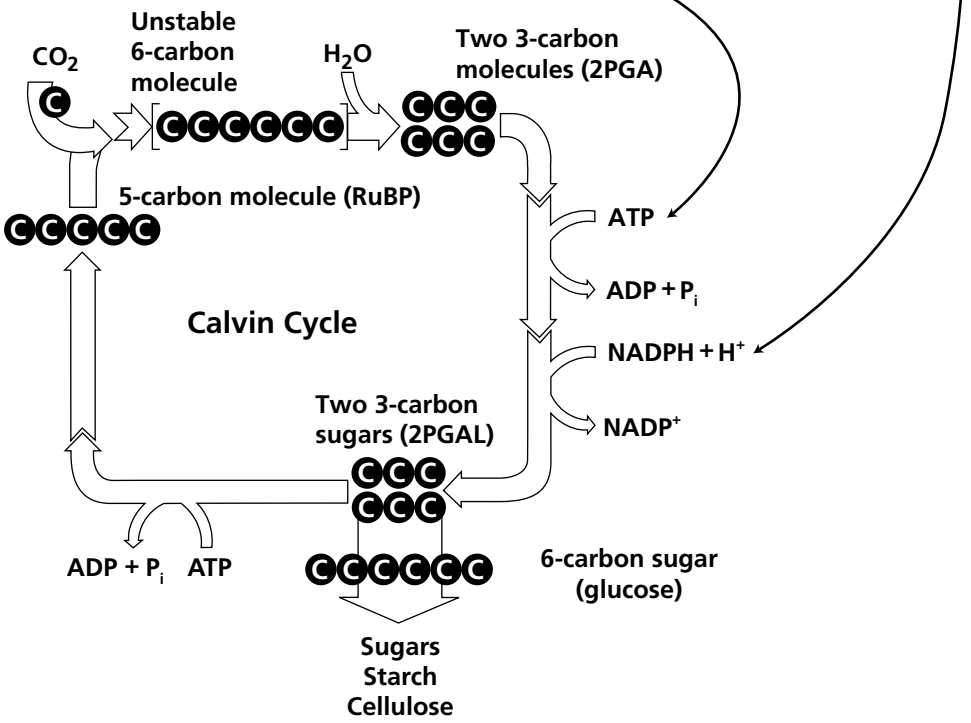
A Light striking chlorophyll causes electrons to gain energy and leave the chlorophyll molecule. As these electrons pass down an electron transport chain, they lose energy, which is used to make ATP.

C Electrons move down another electron transport chain. The electrons combine with $NADP^+$ to form NADPH.

B Electrons from water replace electrons lost by chlorophyll. Water breaks into hydrogen and oxygen.



Light-Independent Reactions



Name Date Class

Worksheet 12

Photosynthesis

Basic Concepts

Use with Chapter 9, Section 9.2

1. Describe what happens when sunlight strikes chlorophyll.

2. What happens as an electron moves down an electron transport chain?

3. What is produced from the splitting of water during the light-dependent reactions? What is this process called?

4. What is the importance of the oxygen produced during the light-dependent reactions?

5. What products of the light-dependent reactions are used in the light-independent reactions?

6. When does carbon fixation occur?

7. What is the source of energy for converting PGA into PGAL during the light-dependent reactions?

8. What is the final product of the light-dependent reactions? What kinds of substances are formed from it?

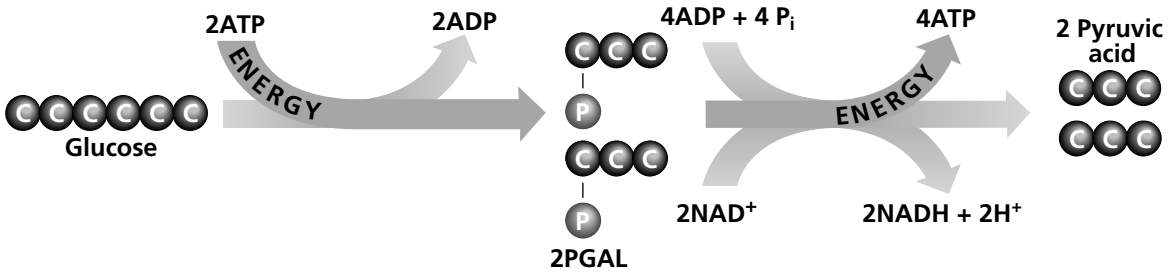
Master 13

Cellular Respiration

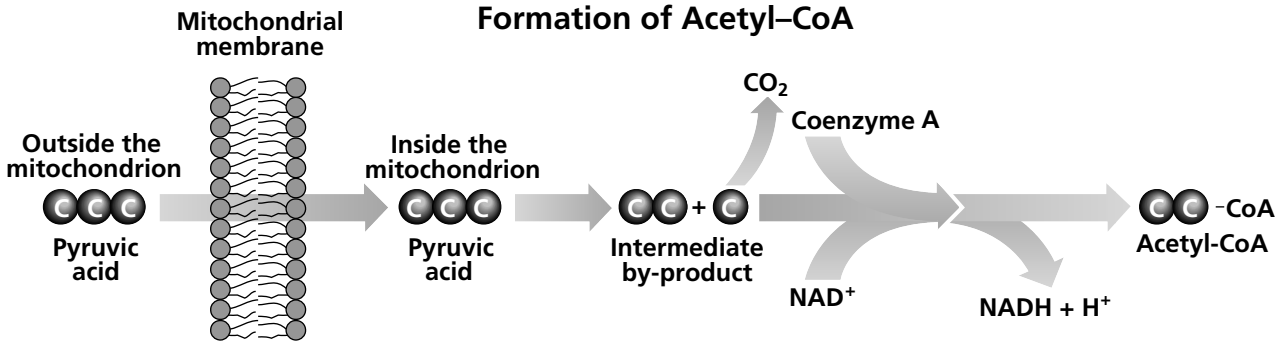
Basic Concepts

Use with Chapter 9, Section 9.3

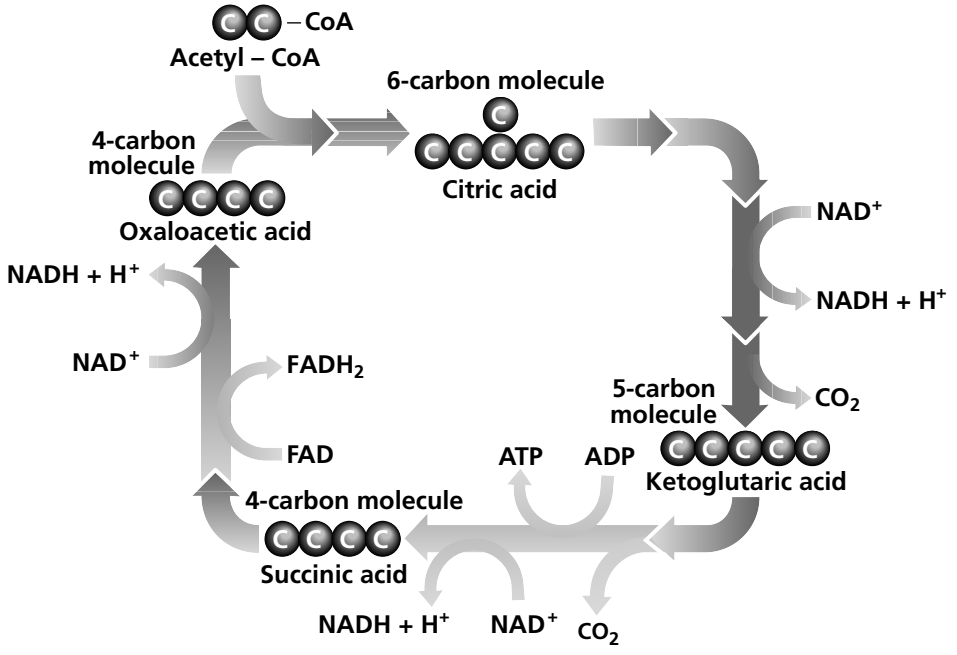
Glycosis



Formation of Acetyl–CoA



Citric Acid Cycle



Name Date Class

Worksheet 13

Cellular Respiration

Basic Concepts

Use with Chapter 9, Section 9.3

1. What is the source of energy for the first step of glycolysis?

2. In glycolysis, what carbon compound is broken down? What carbon compound is the end product?

3. In glycolysis, what is the ratio of glucose molecules to the net number of ATP molecules at the end of the process? Explain your response.

4. Which of the processes shown in the transparency is anaerobic? Which of the processes is aerobic?

5. Where does the breakdown of pyruvic acid occur?

6. What is the end product of the breakdown of pyruvic acid?

7. How is the breakdown of pyruvic acid related to the citric acid cycle?

8. As citric acid breaks down, what substance is released?

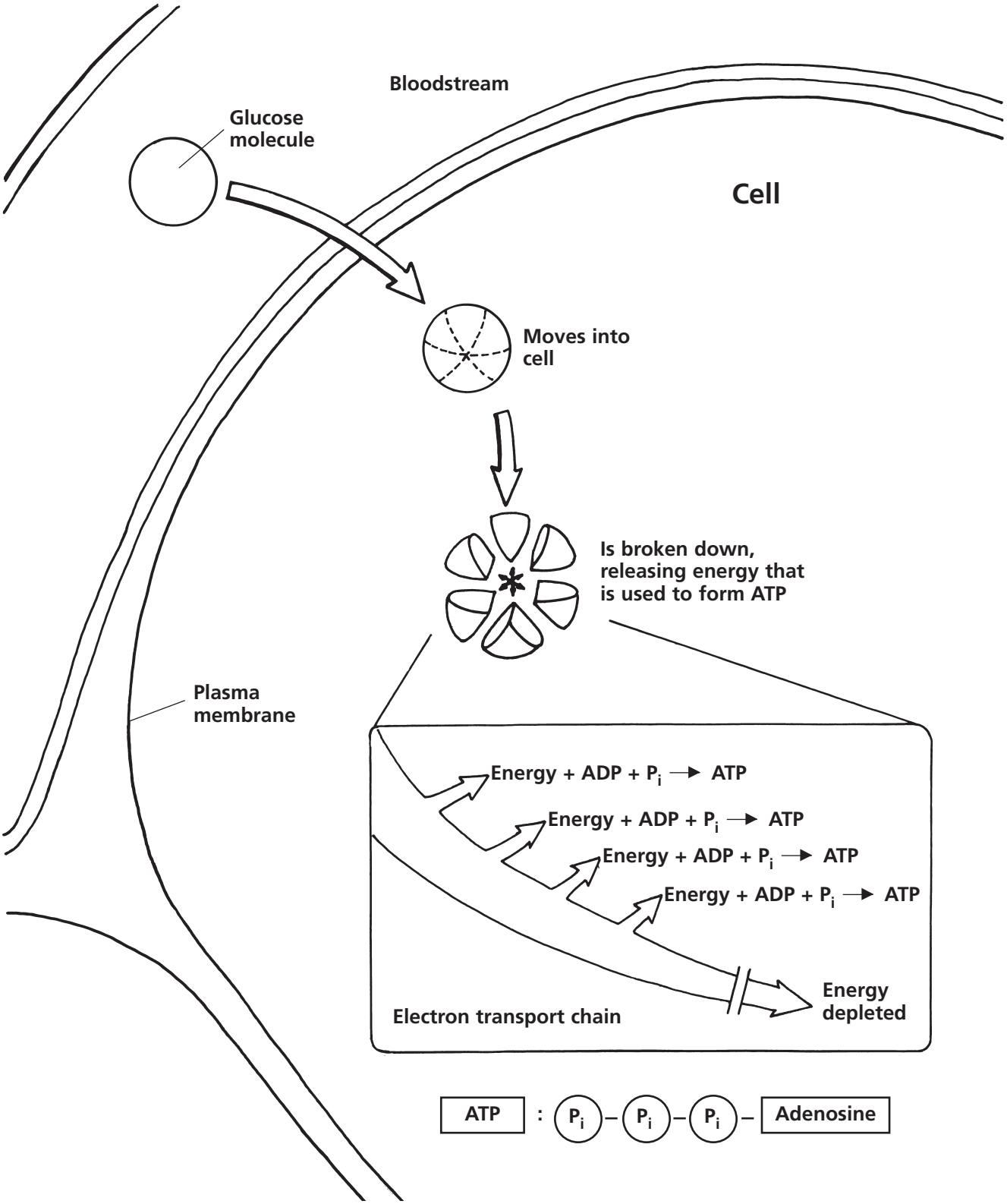
9. What happens to the NADH and $FADH_2$ molecules produced during cellular respiration?

Master 14

Electron Transport Chain

Reteaching Skills

Use with Chapter 9, Section 9.3



Name Date Class

Worksheet 14

Electron Transport Chain

Reteaching Skills

Use with Chapter 9, Section 9.3

1. How does a plant get glucose molecules?

2. How does an animal get glucose molecules?

3. What is the structure of ATP?

4. How does the structure of ATP help a cell perform its functions?

5. Why is it necessary to release the energy stored in glucose in small amounts?

6. Where in a cell is the electron transport chain shown in the transparency found?

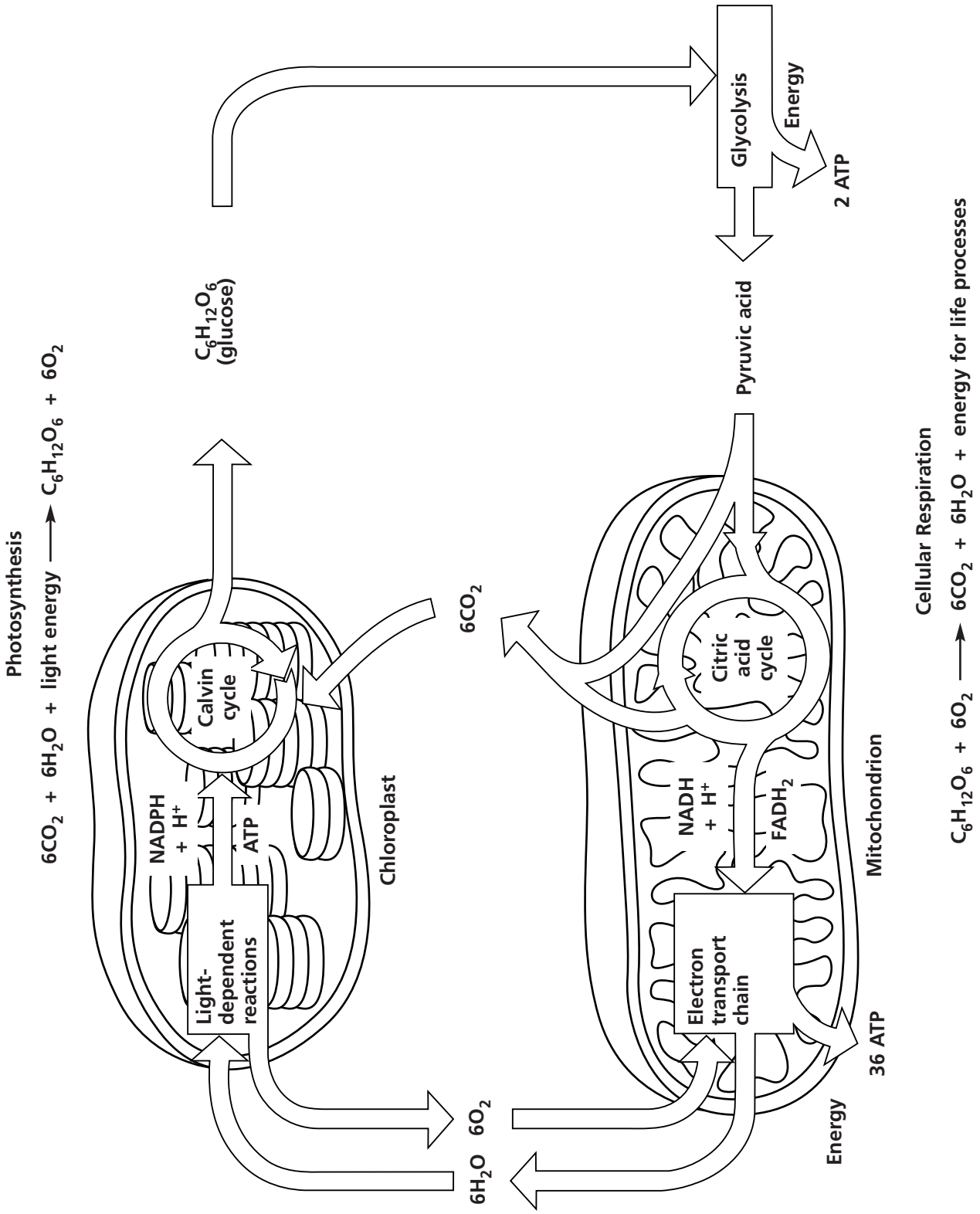
7. Describe at least ten ways that your body is using energy as you work on this worksheet.

Master 15

Photosynthesis and Cellular Respiration

Reteaching Skills

Use with Chapter 9, Section 9.3



Name Date Class

Worksheet 15

Photosynthesis and Cellular Respiration

Reteaching Skills

Use with Chapter 9, Section 9.3

1. In what organelles do photosynthesis and cellular respiration take place?

2. Trace the path of oxygen, water, carbon dioxide, and glucose in the transparency.

3. Which organelle requires sunlight to function?

4. In what ways are photosynthesis and cellular respiration alike?

5. In what ways are photosynthesis and cellular respiration different?

6. What is the source of energy used by mitochondria?

7. Which two cycles are linked by the production and utilization of carbon dioxide? Where do these cycles occur?

8. Explain how the equations for photosynthesis and cellular respiration compare.

Chapter 9

Energy in a Cell

Chapter Assessment

Reviewing Vocabulary

Complete each statement.

1. The reactions in photosynthesis in which light energy from the sun is converted to chemical energy are called _____ .
2. The process by which plants trap the sun's energy to build carbohydrates is called _____ .
3. The transfer of electrons along a series of proteins, releasing energy as they pass, is known as an _____ .
4. _____ is a plant pigment that absorbs most wavelengths of light except green.
5. The splitting of water during photosynthesis is _____ .
6. The anaerobic process of breaking down glucose to form pyruvic acid is called _____ .
7. In photosynthesis, the cycle of reactions that uses carbon dioxide to synthesize glucose is known as the _____ .
8. A cycle of reactions in aerobic respiration that begins and ends with the same 4-carbon compound is the _____ .

Compare and contrast each pair of related terms.

9. aerobic process : anaerobic process

_____

_____

10. photosynthesis : cellular respiration

_____

_____

_____

_____

_____

_____

Understanding Main Ideas (Part A)

In the space at the left, write the letter of the word or phrase that best completes the statement or answers the question.

_____ **1.** Which of the following is *not* a part of adenosine diphosphate?

a. glucose **b.** adenine
c. ribose **d.** two phosphate groups

_____ **2.** The light-independent reactions of photosynthesis take place in the

a. thylakoids. **b.** stroma. **c.** mitochondria. **d.** cytoplasm.

_____ **3.** The energy in glucose *cannot* be released by

a. glycolysis. **b.** the citric acid cycle.
c. cellular respiration. **d.** photosynthesis.

_____ **4.** Cells store energy when

a. the third phosphate group breaks off from an ATP molecule.
b. they break down sucrose to glucose and fructose.
c. a third phosphate group is bonded to an ADP molecule.
d. ions are released into the bloodstream.

_____ **5.** Leaves appear green because the green portion of the light that strikes them is

a. changed to heat. **b.** absorbed. **c.** destroyed. **d.** reflected.

_____ **6.** Which of the following equations best represents photosynthesis?

a. $C + O_2 + H_2O \rightarrow CO_2 + HOH$ **b.** $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
c. $6C + 6H_2O \rightarrow C_6H_{12}O_6$ **d.** $C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O$

_____ **7.** Kidneys use energy to move molecules and ions in order to keep the blood chemically balanced. This process is an example of cells using energy to

a. carry on chemosynthesis. **b.** control body temperature.
c. transmit impulses. **d.** maintain homeostasis.

_____ **8.** In respiration, the final electron acceptor in the electron transport chain is

a. oxygen. **b.** ATP. **c.** hydrogen ions. **d.** water.

_____ **9.** In glycolysis, ____ molecules of ATP are used in the first step and ____ molecules of ATP are produced in the second step.

a. four, two **b.** two, four **c.** two, two **d.** four, four

_____ **10.** In the process of photosynthesis, the

a. Calvin cycle yields CO_2. **b.** light-dependent reactions release oxygen.
c. Calvin cycle breaks down H_2O. **d.** light-dependent reactions produce $NADP^+$.

Understanding Main Ideas (Part B)

Answer the following questions.

1. Synthesis of molecules, transmission of nerve impulses, movement of cilia, and bioluminescence are various activities of organisms.

a. What requirement do these activities have in common?

b. Why is ATP important in each activity?

2. Both the wine industry and the bread industry use the process of alcoholic fermentation.

a. In what way is the use of alcoholic fermentation by these industries similar?

b. In what way does their use of alcoholic fermentation differ?

3. In cellular respiration, the steps following glycolysis depend on whether oxygen is present. Explain.

4. Explain what is meant by carbon fixation. During which stage of photosynthesis does this process take place?

5. If you run as fast as you can, your muscles may begin to feel weak and have a burning sensation. Explain what is occurring in your muscle cells that accounts for this muscle fatigue.

Thinking Critically

Answer the following questions.

The table below shows the average yield of ATP molecules from the oxidation of glucose in eukaryotic cells.

Reaction	ATP Produced	ATP Used
Glycolysis	2	4
Citric acid cycle	2	
Electron transport chain	32	

1. What is the net production of ATP molecules by *each* of the four reactions?

2. What is the total net gain of ATP molecules per glucose molecule?

3. The combination of glycolysis and fermentation yields a net gain of 2 ATP molecules. How many molecules of ATP does fermentation yield? Explain.

In an experiment conducted to determine whether green plants take in CO_2, a biologist filled a large beaker with aquarium water to which she added bromothymol blue. She exhaled CO_2 into the solution of bromothymol blue, which made the solution turn yellow. Then she placed a sprig of *Elodea* into two test tubes. She left a third test tube without *Elodea* to serve as a control. She added the yellow bromothymol solution to all three test tubes and placed a stopper in each. Next, she placed all the test tubes in sunlight. After several hours in sunlight, the bromothymol solution in the test tubes with the *Elodea* turned blue. The bromothymol solution in the control remained yellow.

4. What conclusion can be drawn from the experiment? Explain.