# Chapter 8: Photosynthesis: An Overview

## Lesson Objectives

1. Describe the role of light and pigments in photosynthesis.
2. Explain the role of electron carrier molecules in photosynthesis.
3. State the overall equation for photosynthesis.

## BUILD Vocabulary

### A. The chart below shows key terms from the lesson with their definitions.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary pigment in plants</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Reactions in photosynthesis that require light and light-absorbing pigments</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Reactions in photosynthesis in which carbon dioxide and energy-carrying molecules are used to produce high-energy sugars</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Carrier molecule that transports high-energy electrons</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Light-absorbing molecule</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fluid portion of the chloroplast that surrounds the thylakoid membrane</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Photosynthetic membrane sac found inside chloroplasts</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Section 8.3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Enzyme that converts ADP and a phosphate group to ATP</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Another name for the light-independent reactions in which carbohydrates are produced</strong></td>
<td></td>
</tr>
</tbody>
</table>
Chlorophyll and Chloroplasts

In addition to water and carbon dioxide, photosynthesis requires light and chlorophyll. Inside chloroplasts are thylakoids. The region outside the thylakoid is the stroma. A model of a chloroplast is shown below.

Follow the directions.

1. Color the stroma blue. Label it.
2. Color each thylakoid green. Label one.
3. Circle the granum in red. Label it.

Answer the questions.

   thylakoids  stroma
5. Where do the light-independent reactions occur? Circle the correct answer.
   thylakoids  stroma
6. Is the following statement true or false? In plants, photosynthesis takes place in the chloroplasts.__________
7. The function of chlorophyll is
   A. to protect a plant from losing water.
   B. to help plants absorb oxygen.
   C. to protect the plant cell.
   D. to capture energy from the sun.
Chlorophyll and Chloroplasts

Photosynthesis in plants takes place in organelles called chloroplasts. Within each chloroplast is a fluid-filled area called the stroma. Also inside each chloroplast are many saclike membranes called thylakoids. Thylakoids are connected to each other in stacks. Each stack is a granum.

Complete the Venn diagram to compare the stroma and a granum in a chloroplast. Use the phrases below. One has been done for you.

Answer the questions. Circle the correct answer(s).

1. Which reactions change the energy of sunlight to energy-rich carriers?
   - light-dependent reactions
   - light-independent reactions

2. Which two reactants are needed for light-dependent reactions?
   - carbon dioxide
   - light
   - oxygen
   - water

3. Which two reactants are needed for light-independent reactions?
   - carbon dioxide
   - energy-rich compounds
   - oxygen
   - stroma
8.3 The Process of Photosynthesis

Light-Dependent and Light-Independent Reactions

Photosynthesis involves two sets of reactions. The light-dependent reactions need sunlight. They use energy from this sunlight to produce energy-rich compounds, like ATP. The light-independent reactions use these energy-rich compounds to produce sugars from carbon dioxide.

*Complete the T-chart. Write the phrases in the box that belong in each side of the chart.*

<table>
<thead>
<tr>
<th>Light-dependent Reactions</th>
<th>Light-independent Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use energy from the sun</td>
<td>Take place in the stroma</td>
</tr>
<tr>
<td>Use carbon dioxide</td>
<td>Take place in thylakoids</td>
</tr>
<tr>
<td>Produce oxygen</td>
<td>Require water</td>
</tr>
<tr>
<td>Produce sugars</td>
<td>Also called Calvin cycle</td>
</tr>
<tr>
<td>Convert ADP into ATP</td>
<td></td>
</tr>
</tbody>
</table>
The Light-Independent Reactions: Producing Sugars

Both ATP and NADPH are produced by the light-dependent reactions of photosynthesis. The Calvin cycle uses the energy in ATP and NADPH to produce high-energy sugars. A model of the Calvin cycle is shown below.

Follow the directions.

1. Circle the places where ATP and NADPH are used.

2. Draw an X over the two 3-carbon molecules that are removed from the cycle to produce sugars, lipids, and other compounds.

Answer the questions.

3. Circle the letter of each statement that is true about the Calvin cycle.
   
   A. The main products of the Calvin cycle are six carbon dioxide molecules.
   B. Carbon dioxide molecules enter the Calvin cycle from the atmosphere.
   C. Energy from ATP and high-energy electrons from NADPH are used to convert 3-carbon molecules into higher-energy forms.
   D. The Calvin cycle uses 6 molecules of carbon dioxide to produce a single 6-carbon sugar molecule.

4. Why are the reactions of the Calvin cycle also called the light-independent reactions?
Chapter 9: Overview of Cellular Respiration

Cellular respiration is the process that uses oxygen to release energy from food.

*Use the terms in the box below to label the diagram of cellular respiration.*

<table>
<thead>
<tr>
<th>electron transport</th>
<th>Krebs cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>glycolysis</td>
<td>mitochondrion</td>
</tr>
</tbody>
</table>

---

**Answer the questions.**

1. Where does glycolysis take place?
   A. mitochondrion  
   B. cytoplasm  
   C. cell membrane  
   D. nucleus

2. Where do the Krebs cycle and the electron transport chain take place?
   A. ribosome  
   B. nucleus  
   C. mitochondrion  
   D. cytoplasm

3. Which reactant is used in the electron transport chain?
   A. water  
   B. carbon dioxide  
   C. oxygen  
   D. sugar

4. Which stage(s) of cellular respiration are aerobic?
   A. glycolysis  
   B. Krebs cycle  
   C. electron transport  
   D. both B and C
Comparing Photosynthesis and Cellular Respiration

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.

<table>
<thead>
<tr>
<th>carbon dioxide</th>
<th>energy release</th>
<th>mitochondria</th>
<th>water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosynthesis</td>
<td>Cellular Respiration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>energy capture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>chloroplasts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactants</td>
<td>glucose and oxygen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Products</td>
<td>oxygen and glucose</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answer the questions

1. Circle the correct answer. Which process releases energy for the cell?
   - cellular respiration
   - photosynthesis

2. 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

3. 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.

4. 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.
9.2 The Process of Cellular Respiration

Lesson Objectives
- Describe what happens during glycolysis.
- Describe what happens during the Krebs cycle.
- Explain how high-energy electrons are used by the electron transport chain.
- Identify how much ATP cellular respiration generates.

BUILD Vocabulary

A. The chart below shows key terms for the lesson with their definitions.

<table>
<thead>
<tr>
<th>Term 9.1</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Process that requires oxygen</td>
</tr>
<tr>
<td></td>
<td>Process that does not require oxygen</td>
</tr>
<tr>
<td></td>
<td>Amount of energy needed to raise the temperature of 1 gram of water 1 degree Celsius</td>
</tr>
<tr>
<td></td>
<td>Process that uses oxygen to release energy from food</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Term 9.2</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part of cellular respiration in which glucose is changed to pyruvic acid</td>
</tr>
<tr>
<td></td>
<td>Part of cellular respiration in which pyruvic acid is used to make carbon dioxide, NADH, ATP, and FADH_2</td>
</tr>
<tr>
<td></td>
<td>The innermost space of the mitochondrion and the site of the Krebs cycle</td>
</tr>
<tr>
<td></td>
<td>A high-energy electron carrier</td>
</tr>
</tbody>
</table>
**Compare/Contrast Table** Use a compare/contrast table when you want to see the similarities and differences between two or more objects or processes. Look at the table below. The three stages of cellular respiration are shown across the top. The topics being compared are listed in the first column.

As you read about the process of cellular respiration, complete the table. The first one has been done for you. Use the completed chart as a study aid.

<table>
<thead>
<tr>
<th>Steps of Cellular Respiration</th>
<th>Glycolysis</th>
<th>Krebs cycle</th>
<th>Electron transport chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where in cell it occurs</td>
<td>cytoplasm</td>
<td>matrix of mitochondria</td>
<td>inner membrane of mitochondria</td>
</tr>
<tr>
<td>Starting reactants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ending products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of ATP molecules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is oxygen required?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Answer the questions.**

1. Where do the reactants for the Krebs cycle come from? ____________________________

2. What is the name of the protein spheres that spin as hydrogen ions pass through them?

   ____________________________________
The Krebs Cycle

Pyruvic acid is formed during glycolysis. If oxygen is present, the pyruvic acid moves into the Krebs cycle. In the Krebs cycle, pyruvic acid is changed into carbon dioxide. High-energy electrons are accepted by NAD\(^+\) and FAD. This results in the formation of NADH and FADH\(_2\). NADH and FADH\(_2\) are used in another process to make ATP. A model of the Krebs cycle is shown below.

1. Fill in the details missing from the concept map below.

![Concept Map of the Krebs Cycle]

2. Why is it incorrect to say that a 4-carbon molecule is produced at the end of the Krebs cycle?

3. What happens to the carbon dioxide that results from the Krebs cycle?

---

**2.** Why is it incorrect to say that a 4-carbon molecule is produced at the end of the Krebs cycle?

---

**3.** What happens to the carbon dioxide that results from the Krebs cycle?

---
Electron Transport and ATP Synthesis

The electron transport chain uses the high-energy electrons produced by the Krebs cycle to move hydrogen ions from one side of the inner membrane to the other.

*Complete the flowchart about electron transport. Use the terms in the box.*

<table>
<thead>
<tr>
<th>intermembrane positively</th>
<th>electron transport chain inner membrane</th>
<th>ATP synthase ATP</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-energy electrons from NADH and FADH$_2$ are passed into and along the _________________.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The energy from the electrons moving down the chain is used to move H$^+$ ions across the ______.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H$^+$ ions build up in the ____________________ space, making it ____________________ charged and making the matrix negatively charged.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H$^+$ ions move through channels of ____________________ in the inner membrane.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ATP synthase uses the energy from the moving ions to combine ADP and a phosphate, forming high-energy _____________________.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BUILD Understanding**

**Venn Diagram** A Venn diagram is made up of overlapping circles. It is a useful tool for comparing two or even three topics. As you read about the two forms of fermentation in Lesson 3, complete the Venn diagram below.
Fermentation

Fermentation is respiration without oxygen. In fermentation, energy is released from food molecules by producing ATP. There are two forms of fermentation: alcoholic fermentation and lactic acid fermentation. Alcoholic fermentation is what makes bread rise. It is also used in alcoholic beverages. Lactic acid fermentation is used to produce foods such as cheese, yogurt, pickles, and kimchi. The diagram below shows the two types of fermentation.

Follow the directions.

1. Label the process that shows alcoholic fermentation.

2. Label the process that shows lactic acid fermentation.

Circle the correct answer. Questions may have more than one correct answer.

3. Alcoholic fermentation is used to make which product?
   - bread
   - cheese
   - yogurt
   - pickles

4. What kind of taste do lactic acid bacteria give foods?
   - sweet
   - salty
   - sour
   - spicy

5. What are some milk products made from lactic acid fermentation?
   - milk
   - sour cream
   - yogurt
   - cheese

6. What is one main difference between fermentation and aerobic respiration?
   - ____________________________
   - ____________________________
   - ____________________________