

Lesson C3–4

Understanding Respiration

Unit C. Plant and Soil Science

Problem Area 3. Seed Germination, Growth, and Development

Lesson 4. Understanding Respiration

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: II: Address taxonomic or other classifications to explain basic plant anatomy and physiology.

Benchmark: II-A. Examine unique plant properties to identify/describe functional difference in plant structures including roots, stems, flowers, leaf and fruit.

Performance Standard: 4. Explain the processes of photosynthesis and respiration.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Define cellular respiration.
2. Describe the processes of cellular respiration.
3. Identify factors that affect cellular respiration.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Parker, Rich. *Introduction to Plant Science*. Albany, New York: Delmar. 2000

Other Resources. The following resources will be useful to students and teachers:

Biondo, Ronald J. and Dianne A. Noland. *Floriculture: From Greenhouse Production to Floral Design*. Danville, IL: Interstate Publishers, Inc. 2000

Walker, Pam and Elaine Wood. *Biology in Our Lives*. Danville, IL: Interstate Publishers, Inc. 2001

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Laboratory materials

Terms. The following terms are presented in this lesson (shown in bold italics):

Aerobic respiration
Anaerobic respiration
Cellular respiration
Cytosol
Electron transport system (ETS)
Fermentation
Glycolysis
Mitochondria
Oxidation
Redox reactions
Reduction
Tricarboxylic acid (TCA) cycle

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Hand out penny candy to the students. Inquire as to what is in the candy. The students will identify sugar. Ask them if candy gives them an energy boost. If yes, ask them to explain how that happens. They will probably say that they digest the sugar. Shift the discussion to plants. Ask how plants get their energy.

They might know about the production of food through photosynthesis, but not how manufactured food is used.

Summary of Content and Teaching Strategies

Objective 1: Define cellular respiration.

Anticipated Problem: What is cellular respiration?

- I. The cells that make up organisms are at constant work producing materials for growth, reproduction, movement, and maintenance of the internal environment. In order for the cells to keep functioning, they must convert substances to make ATP.
 - A. **Cellular respiration** is the process in which chemical energy stored in certain foods is converted to ATP, high-energy compounds. The process of respiration takes place in complex organelles known as **mitochondria**.
 - B. Where oxygen is plentiful, organisms use a highly efficient method of cellular respiration known as **aerobic respiration**. Where oxygen is in short supply some organisms have evolved to obtain their energy through **anaerobic respiration**. Humans and most plants rely on aerobic respiration.

Begin the lesson with an interest approach. Identify the objectives of the lesson and key terms related to cellular respiration. Have the students read the appropriate sections from reference materials. As they read the material during supervised study or as homework require them to take notes on the key points. Lead a class discussion on cellular respiration. Require the students to take notes during the discussion. Determine the level of student understanding of the topic through questions asked during the discussion. Use transparency masters TM: C3-4A—An Equation for Respiration, TM: C3-4B—A Plant Cell, and TM: C3-4C—A Comparison of Photosynthesis and Respiration, to illustrate concepts.

Objective 2: Describe the processes of cellular respiration.

Anticipated Problem: What are the processes of cellular respiration?

- II. Aerobic respiration is the opposite of photosynthesis.
 - A. During aerobic respiration glucose or other forms of carbohydrates are broken down in the presence of water and oxygen. The products are energy in the form of ATP, carbon dioxide, and water.
 - B. There are four main stages to aerobic respiration. The first stage is glycolysis. **Glycolysis** is the conversion of six-carbon glucose molecules to three-carbon molecules of pyruvate. A product is the formation of ATP and release of hydrogen. Glycolysis takes place in the **cytosol** or fluid of a cell in which organelles are suspended.
 - C. Pyruvate molecules enter the mitochondria in the second stage. Pyruvate is converted to acetyl coenzyme A and carbon dioxide and hydrogen are released.

- D. The aerobic respiration process enters the third stage known as the **tricarboxylic acid (TCA) cycle**. It takes place in the mitochondria and consists of eight steps. Carbon dioxide and hydrogen are released during TCA.
- E. In the fourth stage, the **electron transport system (ETS)**, electrons of the hydrogen molecules released in the earlier stages are passed through a series of acceptors. As they travel, they go through chemical reactions in which **oxidation** (the combining with oxygen) and **reduction** (the removing of oxygen) occur. Reactions in which substances are oxidized and reduced are referred to as **redox reactions**. During this pathway ATP is synthesized and water is released.
- F. **Fermentation** is carried out by some fungi and bacteria, since it is a third type of cellular respiration and is anaerobic. Fermentation produces ethyl alcohol or lactic acid. Humans recognize the value of fermentation in the making of silage, beer, and wine.

Have the students read text selections related to the process of cellular respiration. Enhance the lesson with hands-on laboratory activities. Lab activity, LS: C3–4A—The Effects of Oxygen on Seed Germination, demonstrates how oxygen is required for cellular respiration. Lab activity, LS: C3–4B—Fermentation, demonstrates a gas (carbon dioxide) as a product of fermentation.

Objective 3: Identify factors that affect cellular respiration.

Anticipated Problem: What factors affect cellular respiration?

- III. Nearly all energy used to maintain life originates from the sun. Plants convert the solar energy through photosynthesis to chemical energy. Plants and animals then release the chemical energy for their use through respiration. Various factors influence respiration.
 - A. Respiration increases as temperatures rise.
 - B. Oxygen is required for aerobic respiration to occur. If levels of oxygen are reduced in the atmosphere, respiration slows.
 - C. Soils saturated with water lack oxygen. In the absence of oxygen respiration does not occur. This explains why root cells and ultimately root systems die in waterlogged soil.
 - D. Under low light conditions less carbohydrates are produced by plants. Low levels of carbohydrates, in turn, mean low rates of respiration.
 - E. The stage of growth and the age of the plant influences the rate of respiration needed to maintain the life processes. Young actively growing plants tend to have a higher rate of respiration.

Have the students read sections of texts related to factors influencing cellular respiration. Discuss the content with the students. Highlight key points that should be included in their notes. Review the material presented and evaluate student mastery of the material.

Review/Summary. Base review and summary of the lesson content on the learning objectives. It is beneficial to review material addressing an objective before moving on with instruc-

tion on the next objective. Have students explain terms, processes outlined in the lesson, and the content associated with each objective. Student responses can be used in determining which objectives require greater review or whether further instruction is necessary. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application.

LS: C3-4A—The Effects of Oxygen on Seed Germination

LS: C3-4B—Fermentation

TM: C3-4A—An Equation for Respiration

TM: C3-4B—A Plant Cell

TM: C3-4C—A Comparison of Photosynthesis and Respiration

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance during oral review of the material, application of skills in the laboratory, and a written exam.

Answers to Sample Test:

Part One: Matching

1 = g, 2 = h, 3 = a, 4 = i, 5 = j, 6 = b, 7 = f, 8 = e, 9 = d, 10 = c

Part Two: Completion

1. electron transport system (ETS)
2. redox reactions
3. tricarboxylic acid (TCA) cycle
4. ATP
5. aerobic
6. photosynthesis
7. ATP, carbon dioxide, water
8. increases
9. slows
10. higher

Part Three: Short Answer

1. The first stage is glycolysis. Glycolysis is the conversion of six-carbon glucose molecules to three-carbon molecules of pyruvate. A product is the formation of ATP and release of hydrogen. Glycolysis takes place in the cytosol or fluid of a cell in which organelles are suspended. Pyruvate molecules enter the mitochondria in the second stage. Pyruvate is converted to acetyl coenzyme A. Carbon dioxide and hydrogen are released. The pro-

cess enters the third stage known as the tricarboxylic acid (TCA) cycle. It takes place in the mitochondria and consists of eight steps. Carbon dioxide and hydrogen are released during TCA. In the fourth stage, the electron transport system (ETS), electrons of the hydrogen molecules released in the earlier stages are passed through a series of acceptors. As they travel, they go through chemical reactions in which oxidation (the combining with oxygen) and reduction (the removing of oxygen) occur. Reactions in which substances are oxidized and reduced are referred to as redox reactions. During this pathway ATP is synthesized and water is released.

2. Respiration increases as temperatures rise. Oxygen is required for respiration to occur. If levels of oxygen are reduced in the atmosphere, respiration slows. Soils saturated with water lack oxygen. In the absence of oxygen, respiration does not occur. This explains why root cells and ultimately root systems die in waterlogged soil. Under low light conditions less carbohydrates are produced by plants. Low levels of carbohydrates, in turn, mean low rates of respiration. The stage of growth and the age of the plant influences the rate of respiration needed to maintain the life processes. Young actively growing plants tend to have a higher rate of respiration.

Test

Lesson C3–4: Understanding Respiration

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | |
|--------------------------|--------------------|
| a. Aerobic respiration | f. Glycolysis |
| b. Anaerobic respiration | g. Mitochondria |
| c. Cellular respiration | h. Oxidation |
| d. Cytosol | i. Redox reactions |
| e. Fermentation | j. Reduction |

- _____ 1. Complex organelles in which the process of respiration takes place.
- _____ 2. The combining with oxygen.
- _____ 3. A highly efficient method of cellular respiration in the presence of oxygen.
- _____ 4. Reactions in which substances are oxidized and reduced.
- _____ 5. The removing of oxygen.
- _____ 6. Cellular respiration in the absence of oxygen.
- _____ 7. The conversion of six-carbon glucose molecules to three-carbon molecules of pyruvate..
- _____ 8. Carried out by some fungi and bacteria.
- _____ 9. Fluid of a cell in which organelles are suspended.
- _____ 10. The process in which chemical energy stored in certain foods is converted to ATP.

Part Two: Completion

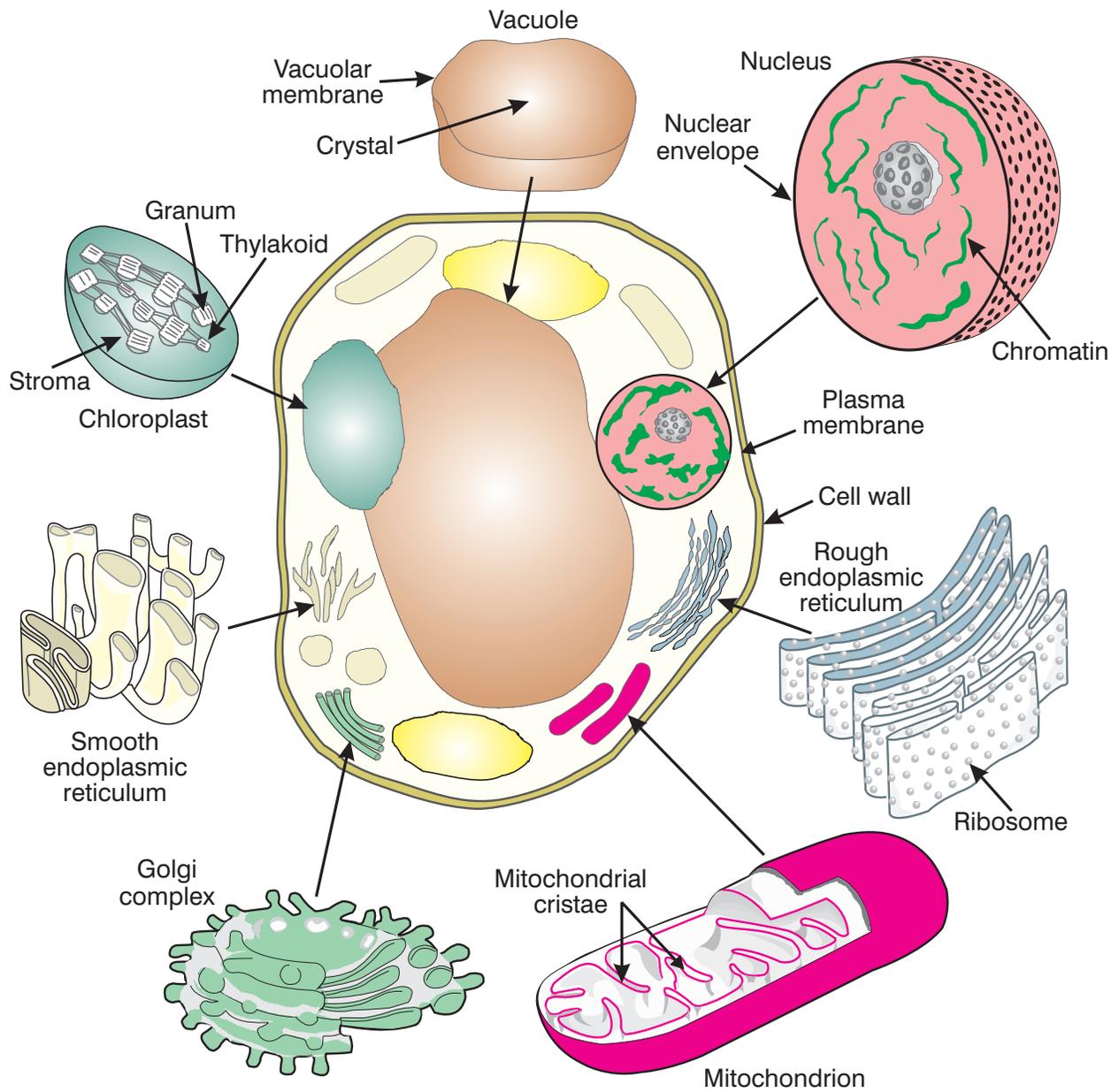
Instructions. Provide the word or words to complete the following statements.

1. In the fourth stage, the _____, _____, _____, electrons of the hydrogen molecules released in the earlier stages are passed through a series of acceptors.
2. Reactions in which substances are oxidized and reduced are referred to as _____.
3. The third stage of cellular respiration, known as the _____, _____, takes place in the mitochondria and consists of eight steps.
4. In order for the cells to keep functioning, they must convert substances to make _____.

A CHEMICAL EQUATION FOR RESPIRATION



A PLANT CELL



A COMPARISON OF PHOTOSYNTHESIS AND RESPIRATION

Photosynthesis	Respiration
<p>CO₂ and H₂O are used.</p> <p>Food and O₂ are produced.</p> <p>Energy from light is trapped by chlorophyll and food.</p> <p>ATP is produced through photophosphorylation.</p> <p>Only cells containing chlorophyll carry out photosynthesis.</p> <p>Photosynthesis occurs only in light.</p>	<p>O₂ and food are used.</p> <p>CO₂ and H₂O are produced.</p> <p>Every living cell carries out respiration.</p> <p>ATP is produced through oxidative phosphorylation.</p> <p>Respiration occurs in both light and dark.</p>

Lab Sheet

The Effects of Oxygen on Seed Germination

Purpose:

Explain the importance of oxygen in cellular respiration and why it is essential for seed germination.

Materials:

2 jars of the same size with tight fitting lids
paper towels
20 corn seeds
steel wool pad
water

Procedure:

1. Soak the corn seeds overnight in water.
2. Line the inside walls of both jars with paper towels.
3. Stuff paper towels in one jar to keep the lining pressed to the sides.
4. Stuff a steel wool pad and some paper towels if necessary in the other jar to keep the lining pressed to the sides.
5. Evenly space 10 corn seeds between the glass and the paper towels about one inch below the lip of the jar.
6. Wet the paper towels and steel wool. Pour off excess water.
7. Tightly seal each jar.
8. Observe the corn seeds over the next two weeks.
9. Record your observations.

Anticipated findings:

The steel wool in the jar will rust, depleting the oxygen supply in the jar. Without oxygen the germination process will stall. Seeds in the other jar will germinate at a normal rate.

Lab Sheet

Fermentation

Purpose:

Students will see that fermentation produces a gas.

Materials:

Flasks
Sugar or corn syrup
Water
Yeast
Balloon

Instructions:

1. Mix $\frac{1}{8}$ cup of sugar or corn syrup with 200 ml water in a flask.
2. Add a packet of fresh baker's yeast.
3. Place a deflated balloon over the mouth of the flask.
4. Products of fermentation include carbon dioxide and ethyl alcohol. What do you expect to happen?