Science & Technology Concepts

STC/MS™

for Middle Schools™

Human Body Systems
Changes to the Teacher's Guide
and
Human Body Systems
Changes to the Student Guide and Source Book

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PART 2 THE RESPIRATORY AND CIRCULATORY SYSTEMS

Lesson 9 introduces the *Human Body Systems* Anchor Activity, which is entitled Diseases and Health Careers. The Anchor Activity is a research project during which students work in pairs to gather information about a disease or health care career, organize their findings, and display them in poster form. When their work is complete, each pair shares its poster with the class in a brief oral presentation. Students are encouraged to use a variety of print, audiovisual, and on-line resources to research the topic they have selected for their Anchor Activity.

By this point in the module, students have become familiar with the processes of digestion. They are aware that digested nutrients pass through the walls of the small intestine into the bloodstream, which transports them to body cells. In Lessons 10 and 11, students explore how their bodies obtain another substance needed by the cells—oxygen. They explore the mechanisms of breathing and gas exchange as well as the capacity of the lungs to hold large quantities of air.

The logical next step is to explore what happens to oxygen and digested nutrients when they reach the body cells. Thus, in Lesson 12, students explore cellular respiration, the process whereby oxygen reacts with nutrients to release energy for life activities. First, students explore combustion by observing the burning of a candle. This experience familiarizes them with the raw materials and end products of oxidation. Students then perform a series of short inquiries during which they examine the raw materials and waste products of cellular respiration. When these investigations are complete, students compare and contrast the processes of combustion and cellular respiration.

In Lesson 13, students explore the nature of calories by comparing the relative amounts of heat released by two different foods—marshmallows (representing carbohydrates) and sunflower seeds (representing proteins and fats). This inquiry vividly illustrates the energy potential in various foods.

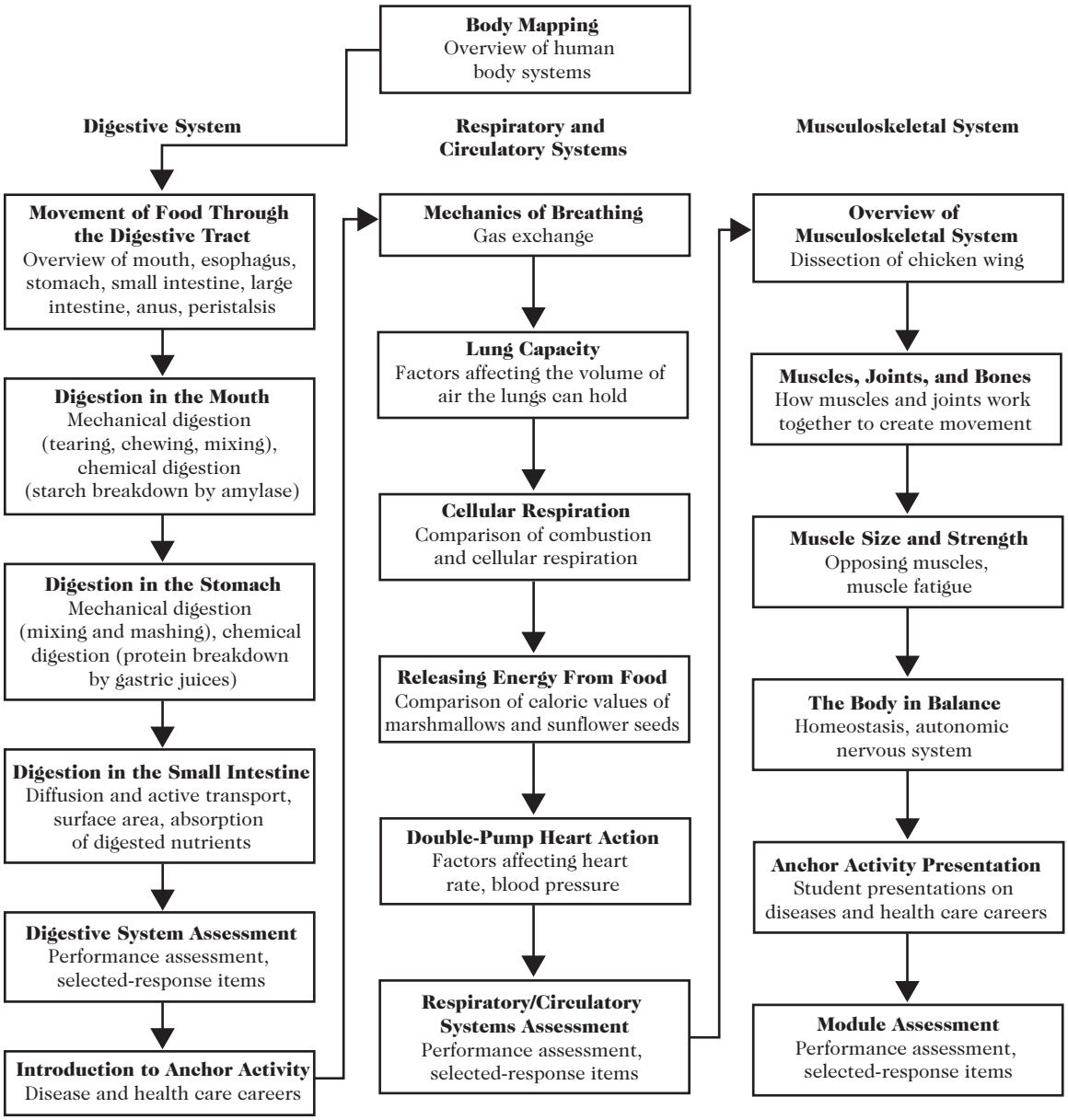
Lessons 14 through 16 concern the heart and the circulatory system. These lessons focus on how oxygen and nutrients are transported to the body cells and how wastes are carried away for eventual elimination. In Lesson 14, students use a siphon-pump to explore the double-pump action of the heart. Heart rate and the factors that affect it are investigated in Lesson 15. Narrowed arteries and the burden they place on the heart are investigated in Lesson 16.

Lesson 17 is the second formal assessment in the module. It concerns the respiratory and circulatory systems. In the first part of this assessment, students design and carry out an inquiry that explores the effect of exercise on breathing rate. In the second part, they respond to a series of selected-response items and put the finishing touches on their human body systems posters.

PART 3 THE MUSCULOSKELETAL SYSTEM

Part 3 of *Human Body Systems*, The Musculoskeletal System, deals with how the body uses the energy released by cellular respiration. Lesson 18, during which students dissect a chicken wing, serves as an overview of the musculoskeletal system. In Lesson 19, students explore the nature of joints, with an emphasis on how muscles, bones, and nerves work together to produce movement. Students examine the relationship between muscle size and strength in Lesson 20, and in Lesson 21, they focus on muscle fatigue. In the culminating inquiry in Lesson 22, students investigate homeostasis as they try to maintain a small quantity of water at average human body temperature for a short period of time.

Conceptual Sequence for *Human Body Systems*



Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Set of colored pencils	Colored pencil set	B	8	12 (16), 14 (8), 21 (8)
Siphon-pump	Siphon pump	B	16	14 (16), 16 (16)
Spinal column model, assembled	Spine model, assembled	B	1	19 (1)
Spinal column model kit, unassembled	Spine models, unassembled	B	8	19 (8)
Student timer	Student timer	B	18	15 (16), 16 (16), 17 (16), 21 (16)
Sugar solution	Sugar solution	R	8	3 (8), 6 (16)
Dispensing bottle, 125 mL	Dispensing bottle, 125mL	B	16	3 (8), 6 (16), 8 (16)
Pint of corn syrup (light)	Corn syrup, pint	R	1	3 (1), 6 (1), 8 (1)
Sugar solution label	Labels	R	16	3 (16)
Sunflower seed	Sunflower seeds	R	32	13 (32)
Syringe with end removed	Syringes with ends removed, 60mL	B	16	10 (16)
Tea candle	Tea candle	R	16	12 (8), 13 (10), 22 (16)
Tennis ball	Tennis balls	R	8	2 (8)
Test tube (medium), 20 × 150 mm	Test tubes, 20×150mm	B	100	3 (16), 4 (16), 5 (28), 6 (8), 8 (16), 12 (16)
Test tube (large), 25 × 150 mm	Test tubes, 25×150mm	B	16	6 (16), 12 (16), 13 (16), 22 (16)
Test tube brush	Test tube brush	B	4	3 (4), 4 (4), 6 (4), 8 (4)
Test tube clamp	Test tube clamp	B	16	3 (16), 4 (16), 6 (8), 8 (16), 13 (16), 21 (16), 22 (16)
Test tube rack, 6-hole	Test tube rack, 6-hole	B	9	3 (8), 4 (8), 5 (9), 6 (8), 8 (8), 12 (8), 13 (8)
Test tube rack, round	Test tube rack, round (for 20-mm tubes)	B	2	3 (2), 4 (2), 5 (2), 6 (2), 8 (2)
Thermometer	Thermometer, alcohol	B	16	5 (2), 12 (16), 13 (16), 22 (16)
Trash bag (large)	Trash bags	R	4	2 (1), 12 (1), 18 (2)
Tubing cutter	Cutter, plastic tubing	B	1	14 (1)
Wooden block	Wooden blocks, 1-in. cubes	B	8	12 (8)

PART 2 The Respiratory and Circulatory Systems

Health

3. Ask students to explore and write a paragraph about what happens when a person hyperventilates.

Science

4. Challenge students to use the Internet to research the "bends," a condition sometimes suffered by deep-sea divers. Ask students to write a paragraph explaining this phenomenon.

Applied Science

5. Tell students that restaurant owners and movie theater managers often cool their facilities to 16 °C before their patrons arrive, even though most people are most comfortable indoors when the temperature is around 22 °C. Ask why these managers and owners do not set the temperature higher.

ASSESSMENT

Assessment for this inquiry should be based on the following:

1. The student's participation in the inquiry and adherence to directions:
   A. Did the student use the equipment in an appropriate manner?
   B. Did the student do his or her share of the work?
2. The student's ability to determine the substances released from the body during exhalation:
   A. Did the student deduce that carbon dioxide was in exhaled air?
   B. Did the student surmise that heat was released in exhaled air?
3. The student's understanding of the breathing apparatus:
   A. Did the student accurately color code the paths of inhaled and exhaled air?
   B. Did the student draw enough arrows to show clearly the path of inhaled and exhaled air through the apparatus?
   C. Did the student demonstrate understanding of the mechanics of the model?
4. The student's ability to determine whether inhaled or exhaled air contains a greater percentage of carbon dioxide.
5. The student's ability to write a basic equation for cellular respiration.
6. Evidence that the student's responses to the written questions in this lesson are consistent with your knowledge of his or her ability level.

PREPARATION FOR LESSON 13

1. Students will explore the energy content of foods in Lesson 13 by burning a marshmallow and a sunflower seed. If your room is not well ventilated, you may want to obtain a fan to help circulate the air. It is possible to activate a smoke alarm.

2. Clean a 1/2-gallon plastic container and fill it with tap water.

PREPARATION FOR LESSON 15

For Lesson 15, you will need 16 clean, 1/2-gallon plastic containers with screw-on tops. Consider having student and staff volunteers help you obtain them. Fill the containers with water and replace the tops. You may want to consider tying thick string around the neck of each bottle and creating a loop that will make it easier for students to carry.

LESSON 13

Releasing Energy From Food

Inquiries 1
Periods 1–1½

CONCEPTS

A calorie is a unit of measure of heat energy.

Oxidation is the process during which a substance combines with oxygen.

One phase of cellular respiration is the oxidation of nutrients in cells to release energy.

Different foods have different caloric values.

STUDENT OBJECTIVES

Compare the relative amounts of energy in similar amounts of marshmallows and sunflower seeds.

Determine that a calorie is a unit of measurement of heat energy.

Construct a definition for the word "calorie."

OVERVIEW

Students have now explored the breathing mechanism, vital capacity, and cellular respiration. In this inquiry, they have an opportunity to experience what happens to the nutrients they ingest and the oxygen they breathe in a dramatic way—by burning two foods and comparing how much energy is released during each process. This activity is designed to help students understand that food is a source of energy and that different foods have different amounts of energy. Students apply the information they gather, along with the process they used to obtain that information, to develop a basic understanding of the meaning of the word "calorie."

BACKGROUND

Our bodies constantly strive to maintain a balance between energy intake and energy output. **Energy intake** is determined by measuring the energy stored in the chemical bonds of the nutrients we ingest. **Energy output** is the sum of the energy lost during oxidation, the energy used for life processes, and the energy stored in the body as fat or glycogen. Because adolescents are still growing, they have higher energy needs than adults do. Often a person's eating habits do not change when energy needs decrease. The body converts the excess energy to fat and stores it.

The energy value of food is expressed in terms of calories. A **calorie** is the amount of heat energy needed to raise the temperature of 1 gram of water 1 °C. This quantity is quite small; therefore, measurements of the energy in food are usually expressed in kilocalories (also called large calories or Calories). A **Calorie** is the amount of heat energy needed to raise the temperature of 1000 g of water 1 °C. The word "calorie" is commonly

used to refer to a kilocalorie. For purposes of this lesson, no distinction need be made between the two terms. (To prevent confusion, however, point out to students that the calorie counts on Nutrition Facts labels refer to kilocalories.)

Determining the caloric value of foods requires sophisticated laboratory equipment. In this lesson, students will conduct a simple experiment that provides convincing evidence of the relative caloric content of two foods—a sunflower seed and a marshmallow. (The adjective "relative" is used because much of the energy from the burning foods escapes into the environment.) Students light each food with a candle and hold the food under a test tube filled with water. They observe that the burning sunflower seed causes a greater increase in the temperature of the water than the burning marshmallow does.

Students may note that neither the volume nor the mass of the two foods that they burn in this lesson is identical. Assure them that volume and mass would be among the variables that would need to be controlled if they were performing a more rigorous investigation.

Students may be confused about the meaning of **energy,** which can be defined as the ability to perform work. Energy is most evident when it changes from one form to another. Electrical energy can be changed to light energy; this happens, for example, when a person turns on a light switch. Chemical energy from batteries is used to produce sound in a compact disc player or light in a flashlight. Human body systems are fueled by the energy stored in chemical bonds. Release of this energy enables us to do many things—dance, sing, swim, and—yes—even think!

Although this lesson produces dramatic results and is enjoyable for students to perform, it is based on some complex and important scientific phenomena. Increasing students' awareness of the energy value of the nutrients they ingest and the differences among them is just one purpose of the lesson. A second purpose is to enable students to appreciate the relationship between the burning of food and the oxidation of glucose in their cells. You may wish to re-emphasize that, as noted in Lesson 12, the burning of the foods that they see in this inquiry is far more intense and dramatic than the oxidation of nutrients in their cells.

Two reading selections, "Counting Calories: Bombs Away!" and "Go for the Burn," appear in this lesson in the Student Guide. "Counting Calories," which is near the beginning of the lesson (SG page 111) and is accompanied by a sidebar about calories entitled "Large or Small?" (SG page 112), discusses how scientists measure the caloric value of foods using a bomb calorimeter. "Go for the Burn" discusses the relationship between caloric intake, good nutrition, and weight. It appears at the end of Lesson 13 in the Student Guide (page 116).

Student Misconception

Many students believe that calories are solid "things" in food that make people fat. Students may think that high-calorie foods have more of these "things" than low-calorie foods do. By the end of this lesson, students should recognize that a calorie, like a kilogram or a pound, is a unit of measure. Calories measure heat energy.

MATERIALS FOR LESSON 13

For the teacher

1 butane lighter
1 1-gallon plastic container (empty and clean)*
2 tea candles
1 piece of newsprint*
1 black marker
Electric fan (optional)*

For each student

1 pair of safety goggles*

For each group of 4 students

1 plastic box with lid
4 miniature marshmallows
4 sunflower seeds
1 tea candle
2 dissecting needles
2 thermometers
2 test tubes (large), 25 × 150 mm
1 test tube rack, 6-hole
2 test tube clamps
2 graduated cylinders, 50 mL
1 beaker (400 mL), filled with water
1 beaker (250 mL), filled with water
4 paper towels*
1 aluminum pie pan
Water (or access to a sink)*

*Needed, but not supplied

PREPARATION

1. Have two extra tea candles available for each class.
2. Write the word "Calories" on a sheet of newsprint and post it in a prominent location.
3. Fill the 1-gallon container with tap water and allow it to adjust to room temperature. Use this water to fill the beakers that students will use for filling the test tubes and cooling the burnt food samples. You will need to refill this container before every class.
4. If your room is not well ventilated, you may want to turn on an electric fan to circulate the air after students have burned their foods.
5. If you have access to probeware and a temperature probe, you may wish to have your class perform this activity as it is described in *The Guide to Probeware and Computer Applications for STC/MS™*, available online at www.nsrconline.org.

Getting Started

1. Work with students to develop a list of what they already know about calories. Record their responses on newsprint.
2. Ask students to read "Counting Calories: Bombs Away!" and "Large or Small?" Both appear directly after the "Getting Started" section of the Student Guide.
3. Discuss the articles with the class and answer any questions. Then have students revise their lists on the basis of the reading and discussion.

NOTE Students will have different ideas about the meaning of the word "calorie." As they discuss this issue, try to elicit the concept that a calorie is a unit of measure of energy. Even though they may not fully comprehend this concept at this point, it will help them understand the outcome of the investigation they will perform.

Inquiry 13.1
Comparing the Energy Released by Marshmallows and Sunflower Seeds

PROCEDURE

1. Have a volunteer from each group pick up a plastic box.

2. Go over the steps of the Procedure for this inquiry. Tell students to design a data table in their science notebooks before beginning the inquiry.

3. With the class, review the Safety Tips.

SAFETY TIPS

Wear safety goggles while performing this inquiry.

Students should consider the foods used in this lesson as laboratory chemicals. They should not eat them or put them in their mouths.

Keep the end of the needle with the burning food facing upward.

Students should keep the test tube pointed away from themselves and their classmates when heating the water.

Place the candle on the pie pan so that the pan will catch bits of burning food that may fall off the needle.

When students have finished burning a marshmallow or sunflower seed, they should dip it into the small beaker of water to cool it, then remove the food from the needle with a paper towel.

Be careful with the candle. Students should let it cool for a while before they pick it up again.

4. Light a candle for each group and have students conduct the inquiry as described in the Procedure.

NOTE Keep the lighter handy. You will need to relight the candles between each trial.

5. Tell students to rinse the test tubes after each trial and add fresh water before they begin a new one.

SAFETY TIP

Make sure students are aware that the candle will remain hot for a while after the flame goes out. They should be particularly careful about the melted wax. Tell them when it is safe to return the candle to the tray. Also instruct them to leave the candle on the pie pan when they return their materials to the distribution center.

6. For cleanup, students should do the following:

A. Empty the water from the test tube. Wipe the outside of the test tube with a paper towel and return it to the plastic box.

B. Dispose of the paper towels and the burned food samples.

C. Replace the paper towels in the plastic box.

D. Return the plastic boxes to the materials distribution center.

REFLECTIONS

1. Discuss the results of the inquiry and the questions that appear in Step 1 of "Reflecting on What You've Done" in the Student Guide.

   A. Which of the two foods has a higher energy content? What evidence do you have for this? (Students should conclude that the sunflower seed has considerably more energy per unit of volume than the marshmallow does. This is demonstrated by the fact that the average increase in the temperature of the water heated by the sunflower seed was considerably greater than that of the water heated by the marshmallow.)

   B. What do you think the process you observed during this inquiry might have to do with calories? (The difference in the amount by which the water temperature rose is an indication of the relative caloric value of the foods.)

   C. How is the process you observed during the inquiry similar to cellular respiration? (In both cases, foods were oxidized.)

   D. How is the process you observed in this lesson different from the process of cellular respiration? (The burning of the sunflower seeds and marshmallows differs from cellular respiration in several ways. In the inquiry, the oxidation was initiated by an outside source [that is, lighting the food with a candle]. The oxidation occurred very rapidly, and it created a flame. Most of the energy was released rather than stored. Reinforce the idea that although glucose is often the cell's first choice for fuel, amino acids and digested fats are also usable sources of energy.)

2. Have students take another look at the list they developed during "Getting Started" and determine whether anything should be revised. At this point, they should realize that a calorie is a measure of the energy released as a result of the oxidation of foods that they eat.

HOMEWORK

Ask students to read "Dr. William Harvey Closes the Loop" in Lesson 14 of the Student Guide (page 121).

EXTENSIONS

■ Science ■ Mathematics

1. Have students determine the relative caloric value of marshmallows and sunflower seeds more precisely. They can do this by multiplying 20 grams of water by the change in temperature (in °C) after heating the water with the burning foods. Then have them devise a way to reduce the amount of heat lost into the air from the burning foods. Have them present their ideas in paragraph form.

■ Science

2. What are "empty" calories? Ask students to write a brief paragraph explaining this phrase and giving examples.

■ Health

3. Ask students to record everything they eat and drink in a 24-hour period and to determine their total caloric intake during that period. They can find the caloric values of packaged foods on the Nutrition Facts labels. They can also perform a search on the Internet using "calorie" as a key word. Make sure that students pay attention to portion size when they record their intake and consult the references. Have them read "Go for the Burn" at the end of this lesson (SG page 116) to find the average caloric intake per day for persons of their age. Have them compare that figure with their own total intake.

■ Mathematics

4. Challenge students to answer the following mathematical problem: If you weigh approximately 40 kilograms, you can burn about 12.5 calories per minute by shoveling snow. How long would you have to shovel snow to burn 175 calories, which is the amount in an average slice of pizza? How long would you have to shovel snow to burn 2500 calories, which is the average daily calorie intake for a boy of middle school age?

ASSESSMENT

Assessment for this inquiry should be based on the following:

1. The student's participation in the inquiry and adherence to directions:
   A. Did the student use the equipment appropriately?
   B. Did the student do his or her share of the work?
2. The student's ability to follow the procedure to determine the relative energy value of the two foods:
   A. Did the student construct an appropriate data collection chart?
   B. Did the student follow directions and perform the inquiry without assistance?
   C. Did the student obtain realistic data for the energy value of the two foods?
3. The student's understanding of the word "calorie":
   A. Was the student able to determine that a calorie is a unit of measure of heat energy?
   B. Did the student deduce that different foods have different energy values?
4. Evidence that the student's responses to the questions in this lesson are consistent with your knowledge of his or her ability level.

PREPARATION FOR LESSON 14

Obtain three clear, 2-liter soda bottles with screw-on tops. Fill two bottles with water; pour water into the third bottle until it is two-thirds full. Add red food coloring to all three bottles. This will simulate blood and will be used as a means of introducing students to the circulatory system. Replace the tops.

Name:_____

Class:_____ Date:_____

Student Sheet 16.1
Study Guide—Respiration and Circulation

Directions In Lesson 17, you will be assessed on what you learned in Lessons 10 through 16. The following is a list of things you may expect to see or do during the assessment.

1. Describe the steps involved in inhalation and exhalation.

2. Explain the difference between total lung capacity, vital capacity, and residual volume.

3. Explain the process of cellular respiration. List the raw materials and the products of this process. Tell how the body eliminates the waste products of cellular respiration.

4. Define the word "calorie." Explain how you measured the relative caloric value of sunflower seeds and marshmallows.

5. Explain what blood pressure is and list at least four factors that can influence it.

6. Describe the differences between arteries, veins, and capillaries.

7. List five factors that could affect a person's heart rate. Tell whether each factor would be more likely to raise or lower heart rate, and why.

8. List the four main components of blood and the major function of each component.

9. Explain the function of valves in the circulatory system. Where are they likely to be found?

10. Explain why the heart can be called a double pump.

(continued)

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PART 2 The Respiratory and Circulatory Systems

LESSON 13

Releasing Energy From Food

Which has more calories—a toasted marshmallow or an untoasted one? By the end of this lesson, you should be able to answer this question.

INTRODUCTION

In Lesson 12, you explored how oxygen and nutrients react chemically in your cells to release energy. But do all foods release the same amount of energy? Do you get the same amount of energy from a 4-ounce hamburger patty as you do from 4 ounces of spaghetti or of chocolate fudge ice cream? How is the energy in food measured?

In this lesson, you will explore and compare the energy value of two different foods. You'll read about how scientists measure the energy in food and about the units in which the energy in food is measured.

By the time you are finished, "counting calories" may have a new meaning!

OBJECTIVES FOR THIS LESSON

Compare the energy value of marshmallows and sunflower seeds.

Read about and discuss how the energy in food is measured.

Construct a definition for the word "calorie."

Getting Started

1. With your teacher, develop a list of things that you already know about calories.

2. Read "Counting Calories: Bombs Away!" and "Large or Small?" (on page 112) Discuss these reading selections with the class. On the basis of your reading and discussion, revise your list.

COUNTING CALORIES: BOMBS AWAY!

You may have heard that food contains calories. You can't see them or taste them. What are calories, and how do scientists measure them?

A calorie is not a "thing." It is a unit of measure, just like a kilogram or a meter. Kilograms measure mass; meters measure length. Calories measure heat energy. One calorie is the amount of heat energy needed to raise the temperature of 1 gram of water 1 °C.

To find out how much energy is in food, scientists measure how much heat the food produces when it is burned.

Most foods won't burn if you try to light them with a match. But they will burn in a bomb calorimeter! A bomb calorimeter is a device that scientists use to measure calories in food.

First, the food is ground up and dried. A carefully weighed sample is placed inside a strong steel container about the size of a coffee mug (the "bomb"). The container is sealed. Oxygen is pumped in until the pressure is extremely high.

(continued)

MATERIALS FOR LESSON 13

For you

1 pair of safety goggles

For your group

1 plastic box
4 miniature marshmallows
4 sunflower seeds
1 tea candle
2 dissecting needles
2 thermometers
2 large test tubes
1 test tube rack
2 test tube clamps
2 50-mL graduated cylinders
1 400-mL beaker of water
1 250-mL beaker of water
4 paper towels
1 aluminum pie pan
Water (or access to a sink)

Inquiry 13.1
Comparing the Energy Released by Marshmallows and Sunflower Seeds

PROCEDURE

1. Have one member from your group pick up a plastic box. You will work in pairs for this activity.

2. After you have read the Procedure for this inquiry with the class, design a data table in your science notebook on which to record your results. After you do, record your answers to the following two questions in your notebook:

A. Which food do you think will raise the water temperature more—marshmallows or sunflower seeds?

B. Why do you think one food might raise the temperature more than the other?

3. With your teacher, review the Safety Tips for this activity.

4. Follow these directions to determine the relative energy value of a marshmallow.

A. Pour exactly 20 mL of water from the 400-mL beaker into the graduated cylinder. Then pour the 20 mL of water from the cylinder into the test tube. Put the test tube clamp securely around the test tube.

SAFETY TIPS

Wear safety goggles while performing this inquiry.

Consider the foods you will use in this lesson as laboratory chemicals. Do not eat them or put them in your mouth.

Keep the end of the needle with the burning food facing upward.

Keep the test tube pointed away from you and classmates while you are heating the water.

Place the candle on the pie pan so that it will catch bits of burning food that may fall off the needle.

When you have finished burning a marshmallow or sunflower seed, dip it into the small beaker of water to cool it. Then remove the food from the needle with a paper towel.

Be careful with the candle. Let it cool for a while before you pick it up again.

B. Insert the thermometer into the test tube. Allow it to rest in the water for 30 seconds. Read the temperature and record it on your data table (see Figure 13.1).

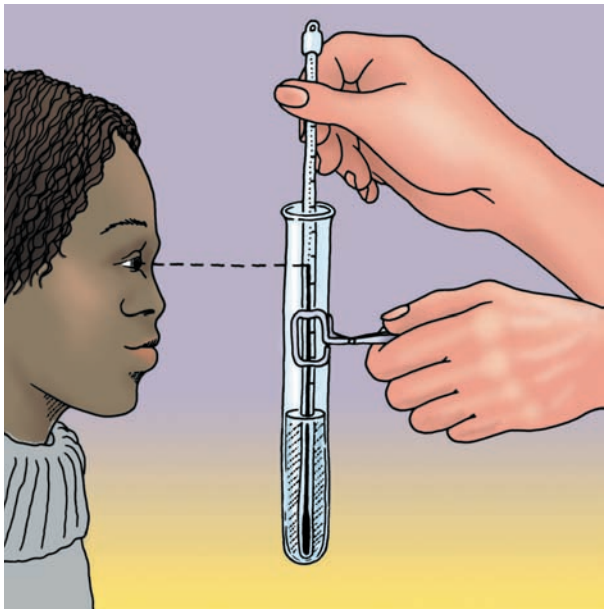

Figure 13.1 *Read the thermometer at eye level.*

C. Place a candle in a pie pan. Your teacher will light a candle for your group.

D. Tear off approximately one-fourth of the marshmallow. The piece of marshmallow should be close in size to the shelled sunflower seed. Stick the needle into a marshmallow and hold it over the flame until the marshmallow ignites (see Figure 13.2). As soon as the marshmallow ignites, have your partner extinguish the candle flame and move the candle to the side of the pie pan.

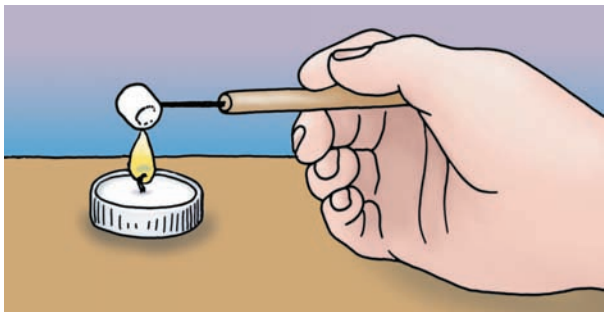

Figure 13.2 *Toasted marshmallow!*

E. Immediately place the marshmallow so that the tip of the flame is touching the bottom of the test tube. Hold it there until the flame goes out (see Figure 13.3).

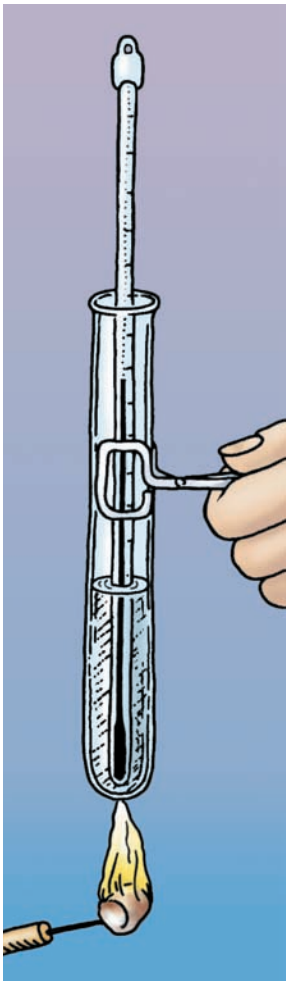

Figure 13.3 *Hold the marshmallow under the test tube.*

F. Wait 25 seconds. Read the temperature of the thermometer in the test tube. Record the temperature on your data table.

G. Dip the food in the 250-mL beaker of water for a moment to allow it to cool. Remove the remains of the marshmallow from the needle with a paper towel.

H. Rinse the test tube and refill it with 20 mL of fresh water from the 400-mL beaker. Repeat Steps B through G. Record your data. Calculate the average temperature rise of the water.

5. Now determine the relative energy value of a shelled sunflower seed.

A. Press on the side of the sunflower seed to crack open the shell. Remove the seed from the shell. Stick the dissecting needle into the sunflower seed by gently twisting the wooden handle of the needle back and forth with your thumb and forefinger until the point of the needle is securely fixed in the sunflower seed.

B. As shown in Figure 13.4, follow the same procedure that you carried out with the marshmallow. Record your data in your science notebook.

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Figure 13.4 *The pie pan will catch any residue that falls from the burning sunflower seed.*

SAFETY TIP

The candle will remain hot for a while after the flame goes out. Be especially careful with the melted wax. Keep the candle on the pie tin when you return it to the tote tray.

6. Follow your teacher's directions for cleanup.

REFLECTING ON WHAT YOU'VE DONE

1. On the basis of what you discovered in this inquiry, answer the following questions in your science notebook:

A. Which of the two foods has a higher energy content? What evidence do you have for this?

B. What do you think the process you observed during this inquiry might have to do with calories?

C. How is the process you observed during the inquiry similar to cellular respiration?

D. How is the process you observed in this lesson different from the process of cellular respiration? (Refer to the Venn diagram that you drew in Lesson 12 if necessary.)

2. With your teacher, take another look at the list your class developed at the beginning of this lesson. Revise the list as necessary.