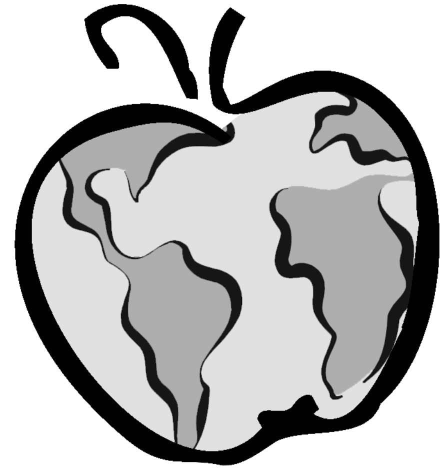
Lesson 19



Passing the Sugar

Balanced Diet Theme

This lesson integrates chemistry, physiology, math, and health concepts. Students estimate the number of sodas and sport drinks they drink in a week and calculate and measure out the grams and teaspoons of sugar contained in these drinks. Through a reading, they learn that drinking sugar-sweetened beverages provide “empty calories” and that excessive intake has been linked to an increased risk for developing health problems such as type 2 diabetes. Therefore, they need to choose beverages without added sugars. They are also introduced to the chemical structure and function of simple sugars and learn how the digestive, cardiorespiratory, and endocrine systems interact to deliver fuel to muscles. Optional role plays and movement activities offer students opportunities to visualize some of the abstract concepts presented. Finally, students investigate the sugar content of foods found in their homes.

This lesson is best suited for eighth-graders and advanced seventh-graders. However, most sixth- and seventh-graders are able to complete activities 19.1 and 19.3. See the lesson procedure for ideas on modifying activities for sixth- and seventh-graders.

Behavioral Objective

For students to choose beverages without added sugars or artificial sweeteners

Learning Objectives

Students will be able to do the following:

1. Use a triple beam balance to accurately weigh material
2. Use formulas to convert between volume and mass measurement units
3. Recognize that the measurement of volume and mass requires an understanding of the sensitivity of measurement tools and knowledge of which sensitivity is necessary for a particular task
4. Describe the chemical structure and function of simple sugars and give examples of sugars added to foods

5. Describe how the digestive, cardiorespiratory, and endocrine systems interact to deliver fuel to working muscles
6. Recognize that the consumption of excessive amounts of sugar-sweetened beverages can increase a person's risk of developing type 2 diabetes
7. Distinguish between situations in which to drink water and situations in which to drink sport beverages
8. Use food labels to compare and contrast the sugar content of foods

Materials

Activity 19.1

- Activity 19.1, Soda and Sport Drinks: How Many Do You Drink?
- Two 5 lb (2.3 kg) bags of sugar (can be saved and reused)
- Each group of four students will need the following:
  - Four empty 20 oz (600 ml) plastic soda bottles
  - Two small beakers
  - Four large beakers
  - Two teaspoons (measuring spoon if possible)
  - Triple beam balance

Activity 19.2

Activity 19.2, Sugary Sport Drinks?

Optional

- Activity 19.3, Added Sugar Sleuth
- Student resource 19.1, Organ and Cell Name Tags

Procedure

This lesson is best suited for eighth-graders and advanced seventh-graders. However, most sixth- and seventh-graders are able to complete activities 19.1 and 19.3. Teachers working with sixth-graders should do the activity 19.2 reading as a group, stopping to discuss the words students are not familiar or reviewing them prior to beginning the activity. Before doing activity 19.3, sixth-graders may also need a quick review of how to read a nutrition label and a review of the various names for sugar (see step 6 of the procedure).

ENGAGE

1. Ask students to think about and reflect on the following questions:
   - How many sodas and sport drinks did you drink over the past seven days?
   - What's the main ingredient in these drinks?
   - How many teaspoons (ml) of sugar do you think are in a 12-ounce (375 ml) can of coke? A 20-ounce (600 ml) bottle of Gatorade?
   - What happens to the sugar from these drinks once it enters your body? Where does it go? What effect does it have on the chemistry of your body? What effect does it have on your performance in school or sports?

   Listen to their answers, but don't provide them with answers to the questions. Tell that they will explore the answers to these questions during this lesson.

   Optional: In preparation for activity 19.1, Soda and Sport Drinks: How Many Do You Drink?, you may want to have students keep a "beverage diary" because some students have difficulty remembering what they drink.

Day	Beverage type (milk, soda, juice, sport drink, water, etc.)	Serving size (6 oz, 8 oz, 12 oz, 20 oz, etc.)
1	Milk	8 oz
1	Juice	6 oz

2. Hand out activity 19.1, Soda and Sport Drinks: How Many Do You Drink? Have students work individually to complete part I. Explain that this activity will give them the opportunity to reflect on how many high-sugar drinks they consumed last week and calculate how much sugar they ingested. You may need to review how to read a nutrition label with students. (See lesson 22, Smart Snacks, for instructions and an overhead transparency of a food label.)
3. Review students' responses to questions 1 through 6 to make sure they calculated the answers correctly. Discuss question 6, highlighting the fact that 20-ounce (600-milliliter) bottles of sport drinks have about the same amount of sugar as most 12-ounce (375-milliliter) sodas.
4. Assign activity 19.3 for homework. This is especially appropriate if you will not be doing activity 19.2. Explain that you want students to explore their cupboards looking for foods with added sugars. Instruct them to write down the names of foods that have added sugar as one of the first three ingredients. *(Optional:* Begin the lesson with this activity. You will need to review how to read a food label [see lesson 22, Smart Snacks] and the names of common sugars [see step 6 of this lesson procedure].)

EXPLORE

5. Assign partners or groups of four, depending on equipment availability. Review the instructions for activity 19.1, part II. Explain that they will measure out the amount of sugar in 20-ounce (600-milliliter) sodas and the total amount of sugar from sodas and sport drinks they consumed last week. They will use two measurement tools—teaspoons and triple beam balances—allowing them to compare the accuracy and sensitivity of the two and how each tool is suited for different measurement tasks. (Note: Using balances gives students experience with scientific equipment and a better working understanding of grams. On the other hand, students' practical experience with teaspoons may make it easier for them to understand just how much sugar they are consuming in these drinks.) Instruct students to collect their materials and complete the investigation.
6. Have students examine a display of the sugar-filled soda bottles. Invite students to discuss their observations by asking the following:
   - Were you surprised at how much sugar you're consuming?
   - Why don't we see the sugar in soda? Is soda a solution, a mixture, or a suspension of sugar? What's the difference?
   - Why do you suppose doctors and scientists encourage us to limit our consumption of soda and other sugary drinks?
7. Hand out activity 19.2, Sugary Sport Drinks? Preview the reading by explaining the following:
   - There are lots of different kinds of sugars. Sucrose is the scientific name for table sugar. Fructose is found naturally in fruit and is added to sweeten many kinds of manufactured foods. Lactose is found naturally in milk. To identify added sugars in the foods you eat, look for words ending with the suffix *–ose* in the ingredients list found on food labels. List some sugars on the board.

- As you read activity 19.2, Sugary Sport Drinks?, you will learn how sugary drinks such as sport drinks, sodas, and fruit punches affect your body chemistry and can increase your risk of developing type 2 diabetes.

8. Direct students to read and complete the questions in activity 19.2, Sugary Sport Drinks? This can be finished for homework. To improve comprehension, have students locate the names of the digestive organs mentioned in the reading on a diagram in the classroom or their textbook. Arrange the class in small groups to discuss their answers to the questions in activity 19.2. Review the main points as a group. Remind the class of the following:
    - Sugar is a carbohydrate, and some sugar is found naturally in foods. We need to eat carbohydrate because it provides us with energy to move and grow. However, it's important to choose foods such as milk, yogurt, fruits, vegetables, whole grains breads, vitamins, minerals, and other nutrients we need. Sugar-sweetened beverages have only sugar, and this only adds "empty calories." Making healthy choices means choosing drinks and foods without added sugar.
    - Drinking and eating foods with lots of added sugar increases your risk for becoming overweight, developing dental cavities, and developing diabetes. (Review healthy drink options discussed in the Teacher Resources under Specific Background Materials.)
    - It's best to avoid diet soft drinks. They contain artificial sweeteners such as NutraSweet, Splenda, and sucralose, that condition you to expect "sweetness" in drinks and foods. Also, their long-term safety is not fully understood.

EXPAND AND EVALUATE

9. Allow students to clarify their understanding and show you what they have learned by using one or more of the following activities:
    - **Pass the sugar.** Assign students the following roles and distribute student resource 19.1, Organ and Cell Name Tags included in the lesson. Instruct students to act out the movement of sugar from the mouth to various cells in the body. Assign a student "director" to help them work together to pass sugar molecules (tennis balls) through the correct sequence of organs and cells.

      Roles

Mouth	Esophagus	Stomach	Small intestine	Heart
Blood	Muscle cell	Brain cell	Liver cell	Director

      Students need to understand the roles of these organs before they can do the activity. Consider preparing them for the role play by assigning one organ to a group of students (give each group a label), have them look up the functions, and then have groups cooperatively piece together a flow chart on poster board using their labels. This shouldn't take the place of the role play. Some students learn through movement.
    - **Do the wave.** Divide the class into two groups. Direct them to sit in two parallel lines facing each other. Tell line 1 to "do the wave" (i.e., alternate standing up and sitting down). After a very slight delay, instruct line 2 to do the wave. Repeat this several times. Tell students that they just demonstrated what happens to blood glucose and blood insulin after we consume refined starchy food (such as white bread). Ask them if they know which line represents blood glucose? Which line represents blood insulin? Ask them to explain what's happening (see activity 19.2).
    - **Demonstrate insulin's role in the body.** Assign four students to play the role of sugar molecules. Assign one student to play an insulin molecule. Explain that the

classroom represents a cell. The hallway is a blood capillary, or small blood vessel. Instruct the sugar molecule students to go out into the hallway ("blood"), shut the door, and demonstrate how insulin increases the permeability of the cell to sugar. (The insulin student will open the door, allowing the sugar molecules to come in.)

- **Acting out verbs.** Select a group of six to eight students to act out the following:
  a. **Digestion of a starch molecule into sugar molecules.** You may need to give them a reminder (starch molecules are long chains of sugar molecules) and a tip (each student should represent one sugar molecule).
  b. **Dissolving sugar into water.** Divide the class in half. Instruct students to stand on opposite sides of the room. Assign students on one side to be sugar molecules (solute) and those on the other side to be water molecules (solvent). To demonstrate the intermolecular bonds that exist within each substance, have students place their hands on neighboring students' shoulders. On your command, have the sugar "dissolve" into the water and form a solution. Students will need to break their links with neighbors and form new bonds with students from the other group. You may choose to talk about the energy needed to break bonds and how increases in temperature can speed up this reaction.

Extension Activities

1. Instruct students to make a poster, advertisement, or public service announcement that encourages kids to choose water, milk, or 100 percent juice over soda and sport drinks.
2. Have students work together to develop and teach a short lesson that encourages younger kids to choose healthy drinks.
3. Have students use model kits to build the chemical structures of simple sugars and demonstrate how linking sugars together to form chains forms complex carbohydrate. (This is appropriate for eighth-graders who have been introduced to organic chemistry.)

SCHOOLWIDE PROMOTION OR FUNDRAISER

Teach this lesson as a precursor to one of the following schoolwide promotions:

- **Soda Tax Fundraiser.** Raise funds for your school *and* awareness of soda consumption and its connection to health problems. Families are asked to keep track of the number of sodas and other sugary drinks they consume in a week and to donate 10 cents for each one they drink. They can get a "tax credit" of 5 cents for each bottle of water they drink. Include information on the importance of limiting sugar-sweetened beverage consumption (see the Carbohydrate Parent Sheet on the CD-ROM that accompanies this book) and healthy beverage alternatives (see the Quenchers Parent Resource on the CD-ROM) with a description of the promotion.
- **Healthy Beverage Options: Parent Night Promotion.** Offer parents samples and recipes of healthy beverage options. Possibilities could include seltzer and fruit slices, or a seltzer and fruit juice spritzer. Hand out information on the importance of limiting sugar-sweetened beverage consumption (see the Carbohydrate Parent Sheet on the CD-ROM) and healthy beverage alternatives (see the Quenchers Parent Resource on the CD-ROM).

Teacher Resources

GENERAL BACKGROUND MATERIALS

Visit www.hsph.harvard.edu/nutritionsource.

SPECIFIC BACKGROUND MATERIALS

For an overview of the types of carbohydrate, their function in the body, dietary recommendations, and examples of foods high in healthy carbohydrate (whole grains), see Teacher Resources in lesson 4, Carbohydrate: Energy Food (page 92) and the activity 19.2 reading in this lesson. Also see the Quenchers Parent Sheet and the Carbohydrate Parent Sheet on the accompanying CD-ROM.

Why do we need to limit our consumption of sugar-sweetened beverages?

Eating a diet high in added sugar (or refined flour) can raise the risk for heart disease and diabetes over time. During the past 20 years, the amount of sugar-sweetened beverages (soda, fruit drinks, sport drinks, and so on) that people drink has increased dramatically. Youth who drink excessive amounts of sugary beverages (two or more 8-ounce, or 250-milliliter, servings per day) are more at risk for becoming overweight, for getting inadequate calcium and other vitamins and minerals (because they drink less milk and juice), and for developing dental cavities. The following facts illustrate just how many soft drinks teens are consuming:

- Teenagers who drink soft drinks get 15 percent of their calories from carbonated and noncarbonated soft drinks. Teen boys who drink soft drinks consume on average three 12-ounce (375-milliliter) cans per day, and girls drink more than two cans per day.
- One in 10 boys consumes the equivalent of five and a half 12-ounce (375-milliliter) cans per day, or 800 calories per day. One out of every 20 boys consumes the equivalent of seven cans per day, or about 1,000 calories.

Research findings indicate a strong link between sugar-sweetened beverage (SSB) consumption and childhood obesity. A recent study found that middle school students who increased their consumption of soft drinks also increased their chance of becoming obese over the 18-month study. For each additional serving consumed per day over the baseline intake, the odds of obesity increased 60 percent. A school-based randomized controlled trial found that reducing the intake of SSB reduced overweight among youth. SSB consumption has also been linked to weight gain and diabetes incidence in adult women.

What beverage options do nutrition experts recommend?

- Offer water and low-fat or skim milk as the primary beverage choices during meals and snack time. When serving fruit juice, select only 100 percent juice products, and limit them to no more than 12 ounces (375 milliliters) per day (4-6 ounces, or 125-175 milliliters, per day for children ages six and under).
- Do not serve sugar-sweetened beverages (soda, fruit drinks, iced tea, and sport drinks) at school or after-school functions. Encourage parents to limit sugar-sweetened beverages to two 8-ounce (250-milliliter) servings per week at home. Also encourage them to keep no soda in the house, and to discourage children from “super-sizing it” when out at a restaurant.
- Sport drinks are recommended only for highly intense activity that lasts longer than one hour, when the ability to keep going is required for competition. In normal play, stopping for a healthy snack and a cold drink of water is a better way to refuel the body.

- Read nutrition labels to avoid added sugars and artificial sweeteners. Watch out for "punches," "drinks," and "cocktails"—these often contain sugar or artificial sweeteners, with partial or no fruit juice. Choose drinks that do not list sucrose, fructose, high fructose corn syrup, or rice syrup as the first ingredients. Also, look for fruit juice as one of the first ingredients. Artificial sweeteners, such as NutraSweet, Splenda, and sucralose, condition kids to expect "sweetness" in drinks and foods. Because their long-term safety is not fully understood, it is best to avoid them.
- Healthy beverage alternatives include the following:
  - Water (plain, or flavored with fruit slices or frozen fruit juice ice cubes)
  - Sodium-free seltzer water (examples: Zazz, Polar, and Schweppe's seltzer waters)
  - Diluted 100 percent juice (4 ounces of water and 4 ounces of juice, or 12 milliliters of each)
  - Juice spritzers (juice and seltzer water)

What is diabetes? Why is type 2 diabetes on the rise in children?

The Centers for Disease Control (CDC) define diabetes mellitus as a group of diseases characterized by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Most of the carbohydrate we eat is broken down into glucose, a monosaccharide and major source of energy. After a meal, blood glucose levels rise, and in healthy people this stimulates the beta cells in the pancreas to release insulin, a hormone that facilitates the uptake of glucose into liver, muscle, and fat cells. Diabetics either don't make enough insulin or are resistant to the insulin they make. As a result, blood glucose builds up in their blood. With glucose unavailable to the cells, the body breaks down fat, producing ketones and other metabolites that lower blood pH, which can be fatal. Chronic high blood sugar can cause heart disease, blindness, kidney disease, and lower-extremity amputations.

About 90 to 95 percent of diabetes cases are classified as type 2 diabetes. At the onset of this form of the disease, the pancreas is capable of producing insulin, but the body's cells are insensitive or resistant to the effects of the hormone. Although the causes of the disease are not completely understood, extra fat tissue seems to put an increased demand on the body to make insulin, which in turn diminishes the number or sensitivity of insulin receptor sites on the target cells plasma membranes. Because the cells do not respond properly, glucose levels stay elevated, stimulating the pancreas to release even more insulin, further exacerbating the problem. Eventually, high blood glucose levels destroy the insulin-producing beta cells. Many people with type 2 diabetes can control their blood glucose by following a careful diet and exercise program, losing excess weight, and taking oral medication. More advanced stages may require insulin injection.

Because it was once rare in children, type 2 diabetes was previously called adult-onset diabetes. Between 1988 and 1994, the incidence of type 2 diabetes in children increased tenfold. This type of diabetes is associated with obesity, inactivity, and old age and has a strong genetic component. African Americans, Hispanic/Latino Americans, American Indians, and some Asian Americans and Native Hawaiians or other Pacific Islanders are at particularly high risk for type 2 diabetes. The increase in type 2 diabetes in children seems to be the consequence of an increase in childhood obesity. Unless obesity trends are reversed, the CDC predicts that 40 percent of boys and 30 percent of girls born in 2000 will develop diabetes in their lives. Experts fear that children with type 2 diabetes may face complications at an earlier age, because longer duration seems to increase the complications.

About 5 to 10 percent of all diabetes cases are classified as type 1, or "juvenile," diabetes. This form of diabetes develops when the body's immune system destroys pancreatic beta cells and typically begins in children or young adults, although it can strike at any age. Type 1 diabetics do not produce insulin, so they must receive insulin injections (or pump) to survive, which explains why this form of the disease was previously called insulin-dependent diabetes. The cause of type 1 diabetes is unknown, but it is suspected to be triggered by exposure to environmental factors, possibly an unknown virus, in genetically predisposed people.

The symptoms of diabetes include frequent urination, excessive thirst, unexplained weight loss, extreme hunger, sudden vision changes, tingling or numbness in hands or feet, feeling tired most of the time, very dry skin, sores that are slow to heal, more infections than usual, and halitosis (exhaled ketones that are strong smelling). Elevated blood sugar levels can often go undetected.

For more information, see the CDC's National Diabetes Fact Sheet at www.cdc.gov/diabetes/pubs/factsheet.htm or www.cdc.gov/diabetes/faq/basics.htm.

REFERENCES

Ludwig, D., Peterson, K., Gortmaker, S. 2001. Relation between consumption of sugar-sweetened drinks and childhood obesity: A prospective, observational analysis. *Lancet* 357: 505-508.

Schulze, M.B., Manson, J.E., Ludwig, D.S., et al. 2004. Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA* 292: 927-934.

Answer Key

ACTIVITY 19.2, SUGAR SPORTS DRINKS?

1. Water, water, sports drink, water, sports drink, sports drink
2. Blood sugar levels increase, stimulating insulin release from the pancreas, which promotes sugar absorption by cells, thereby bringing blood sugar levels back to normal.
3. Diabetics either do not produce enough insulin, or their cells are resistant to insulin.
4. Limit sugar in the diet, exercise, keep a healthy weight, know your family history.
5. Sugar molecules are small, hexagon-shaped molecules containing carbon, hydrogen, and oxygen. They supply energy to cells.

Name ___________________________________

Activity 19.1

Soda and Sport Drinks: How Many Do You Drink?

Part I

1. How many sodas and sport drinks have you consumed in the past seven days? Record your estimates in column 2 of the following table.
2. Examine the food labels on the next page. How many grams of sugar are in each serving? Record your answers in column 3 of the table.
3. How many grams of sugar are in the entire bottle? (Note: Some bottles contain more than one serving.) Total grams = number of servings × grams per serving. Record in column 4.
4. Calculate the total number of grams of sugar you consumed in each beverage category by multiplying the number of drinks (column 2) by the grams per container. (Total grams = number of drinks × grams per bottle.) Record your answers in column 5. Sum the total of all the categories.
5. Calculate the number of teaspoons of sugar you consumed. One teaspoon contains 4 grams of sugar (1 tsp = 4 g).

   Number of teaspoons = number of grams × 1 teaspoon / 4 grams

6. Which container has more sugar, a 12-ounce (375-milliliter) soda or a 20-ounce (600-milliliter) sport drink?
7. What other nutrients (vitamins, minerals, protein, fat, salts) are found in these drinks?

	Number in last seven days	**Grams per serving**	**Grams per container**	**Total grams**	**Total teaspoons**
Example: 12 oz soda	*3*	*41*	*41*	*123*	*30.75*
12 oz (375 ml) soda					
20 oz (600 ml) soda					
20 oz (600 ml) sport drink					
Bottled water					
Other					
			Total		

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From J. Carter, J. Wiecha, K. Peterson, S. Nobrega, and S. Gortmaker, 2007, *Planet Health,* 2nd ed. (Champaign, IL: Human Kinetics).

Soda and Sport Drinks: How Many Do You Drink? *(continued)*

Bottle of water
Nutrition Facts
Serving Size 1 Bottle
Amount Per Serving
Calories 0
% Daily Value
Total Fat 0 g 0%
Sodium 10 mg 0%
Total Carb. 0 g 0%
Sugars 0 g
Protein 0 g
*Percent Daily Values are based on 2,000-calorie diet.

12 oz (375 ml) soda
Nutrition Facts
Serving Size 1 Can
Amount Per Serving
Calories 150
% Daily Value
Total Fat 0 g 0%
Sodium 35 mg 1%
Total Carb. 41 g 14%
Sugars 41 g
Protein 0 g
*Percent Daily Values are based on 2,000-calorie diet.

20 oz (600 ml) soda
Nutrition Facts
Serving Size 8 fl oz (240 ml) Servings Per Container 2.5
Amount Per Serving
Calories 100
% Daily Value
Total Fat 0 g 0%
Sodium 25 mg 1%
Total Carb. 27 g 9%
Sugars 27 g
Protein 0 g
*Percent Daily Values are based on 2,000 calorie diet.

20 oz (600 ml) sport drink
Nutrition Facts
Serving Size 8 fl oz (240 ml) Servings Per Container 2.5
Amount Per Serving
Calories 50
% Daily Value
Total Fat 0 g 0%
Sodium 110 mg 5%
Potassium 30 mg !%
Total Carb. 14 g 5%
Sugars 14 g
Protein 0 g
*Percent Daily Values are based on 2,000 calorie diet.

Part II

Work with your group to collect the following materials:

- Two plastic funnels (you can make these with paper and tape)
- Four empty 20-ounce (600-milliliter) plastic soda bottles
- Two small beakers
- One triple beam balance

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From J. Carter, J. Wiecha, K. Peterson, S. Nobrega, and S. Gortmaker, 2007, *Planet Health,* 2nd ed. (Champaign, IL: Human Kinetics).

- Four large beakers
- Two teaspoons
- Sugar

Complete the following measurement activities.

1. Refer to the table on the previous page to determine how much sugar is contained in 20-ounce (600-milliliter) sodas. Record here:

   _____ grams of sugar in 20 oz (600 ml) soda (column 4)

   _____ teaspoons of sugar in 20 oz (600 ml) soda (column 6)

2. Use a triple beam balance to weigh out the grams of sugar in a 20-ounce (600-milliliter) soda. Be precise with your measurements. Set the sugar aside.
3. Use a teaspoon to carefully measure out the teaspoons of sugar in a 20-ounce (600-milliliter) soda. Set the sugar aside.
4. Carefully measure out the total amount of sugar each person consumed in sodas and sport drinks during the last seven days. Half of your group should use a triple beam balance to measure their total sugar, and the others should use a teaspoon. Each person should carefully pour or spoon the sugar into an empty 20-ounce (600-milliliter) soda bottle. Cap the bottle and display it in the front of the room.

   ________ = Total amount of sugar from sodas and sport drinks in seven days

Reflecting on Your Observations

1. Were you surprised by the amount of sugar you consumed? Explain.
2. Why isn't the sugar in drinks visible?
3. Compare the sugar you weighed out in step 2 with the sugar you measured out with the teaspoon in step 3. Do they appear to be about the same? How might you more accurately compare them?
4. Scientists typically use balances to weigh out solid ingredients. Cooks typically use measuring spoons and cups. Explain why each of the measuring tools is best suited for those functions.
5. Which tool—the balance or the teaspoon—do you think was the better tool to use for this activity? Explain your position.

Name ___________________________________

Sugary Sport Drinks?

As you read the following essay, circle any words that are new to you and underline at least five key points.

In 1971 water bottles and sport drinks had not been invented yet, so when 14-year-old Lynne Cox and her teammates prepared for their 26-mile (41.6-kilometer) swim across the Catalina Channel in California, they had to figure out how to get the fluids and energy they needed during their 12 1/2 hours in the water. To complicate matters, the water temperature was 55 to 60 °F (13 to 16 °C), so they had to worry about how to maintain their body temperature as well. "We . . . filled plastic ketchup bottles with hot tea with sugar, warm orange juice, beef broth, hot apple cider, hot chocolate, and coffee loaded with sugar. We were trying to figure out what we could use on the Catalina crossing to boost our blood sugar and replace lost heat. With salt water in our mouths from swimming in the sea, the orange juice was absolutely disgusting, beef broth was bad, and hot chocolate was a real mistake because it contained milk solids, which were known to make swimmers nauseated. We narrowed our choices to coffee, tea, and hot cider." A year later, when Lynne broke the world record for crossing the English Channel, she drank hot apple juice and ate oatmeal cookies that were tossed to her.

Today long-distances athletes and others working for long periods in the heat are lucky; they can go to any corner store and purchase sport drinks that are specially formulated to quickly deliver sugar to working muscles and replenish the water lost through sweating. The American College of Sports Medicine recommends drinking sport drinks when you exercise strenuously for more than 60 minutes. They recommend drinking water during shorter bouts of exercise or at times when you are physically active at more moderate intensities, such as playing baseball or riding your bike for fun. Sport drinks do not improve your performance in these situations. You don't need the sugar; your body has enough stored energy. During recreational activities that last several hours, it's best to stop for a healthy snack to refuel your body.

As sport drinks have become more plentiful, many children and adults are drinking when they don't need them. They are also drinking more of other kinds of sugar-sweetened beverages, such as soda and fruit punches. Youth currently drink twice as much soda as milk. The excess sugar in these drinks is creating health problems in children and teens that used to show up only in older adults.

Sugar and Body Chemistry

Glucose, fructose, maltose, and sucrose are examples of sugars commonly found in the foods and drinks we consume. They are added in large quantities to soda, sport drinks, cookies, and candies, but occur naturally in dairy foods, fruits, vegetables, and other foods made from plants. Sugars are simple carbohydrates. They are composed of one or two small molecules that contain carbon, oxygen, and hydrogen.

Because of their small size and shape, sugar molecules are easily transported through the cells lining the small intestines and into the blood. Complex carbohydrate, such as the starch found in grains and vegetables, is made up of long chains of simple sugars linked together. These large molecules must be broken down into simple sugars by digestive enzymes in the small intestines before they can enter the blood. Sugars dissolve in blood and are pumped throughout the body. After a meal, blood sugar levels rise, and this stimulates cells in the pancreas to release a hormone called insulin into the blood. Insulin binds to cells in muscle, liver, and many other tissues, making their membranes more permeable to sugar. It acts like a doorman helping sugar get out

(continued)

From J. Carter, J. Wiecha, K. Peterson, S. Nobrega, and S. Gortmaker, 2007, *Planet Health,* 2nd ed. (Champaign, IL: Human Kinetics).
From L. Cox, 2004, *Swimming to Antarctica: Tales of a long-distance swimmer* (New York: Alfred A. Knopf).

of the blood and go inside the cells. Cells break down the sugar molecules and use the energy released to grow, to reproduce, and for many other functions. The brain uses sugar molecules exclusively for energy. During exercise, sugar supplies muscle cells with most of the energy they need for contraction.

Health Risks

Maintaining normal blood sugar is vital to health; eating sugar is not. Scientists have discovered that regularly drinking sugar-sweetened beverages increases the risk of gaining excess weight and developing type 2 diabetes, a chronic disease that used to be called adult-onset diabetes, but is now showing up in youth. This type of diabetes is associated with obesity, lack of exercise, and old age and it tends to run in families. It should not be confused with another form of diabetes called type 1, or juvenile, diabetes. Type 1 diabetes typically shows up in children or young adults and is thought to be triggered by exposure to environmental factors, possibly an unknown virus.

Diabetics have difficulty keeping their blood sugar at a healthy level. After a meal or drink that contains carbohydrate, blood sugar levels rise. In healthy people, this stimulates the pancreas to release insulin into the blood, which in turn helps sugar enter cells and returns blood sugar back to premeal levels. Diabetics either don't make enough insulin or are resistant to the insulin they make. As a result, sugar builds up in their blood. With sugar unavailable to the cells, the body breaks down fat for energy, producing chemicals that make the blood more acidic, which can be fatal. Chronic high blood sugar can cause heart disease, blindness, kidney disease, and lower-extremity amputations.

To help prevent type 2 diabetes, do the following:

- Eat a healthy diet, including plenty of whole grains, vegetables, and fruits. Limit foods that are high in added sugars to small quantities, and don't have them every day.
- Get plenty of exercise.
- Keep a healthy weight. If you're overweight, ask for help from your parents and your doctor to get to a healthier weight.
- Know your family history. If diabetes is in your family, be sure to get your blood checked periodically as you get older to monitor your blood glucose levels.

Sport drinks were plentiful when Lynne Cox swam the first Antarctic mile in 2002, but she didn't need them. The meal she ate before the swim provided her with all the energy she needed during her 25-minute swim in water that was 32 °F (0 °C). Sport drinks are only recommended for strenuous exercise lasting longer than 60 minutes.

Nutrition Tips for Improving Your Fitness and Performance

- Drink plenty of water before, during, and after physical activity.
- Eat foods from each of the five food groups at every meal.
- Choose whole grains over processed grains.
- Choose plant oils over animal fat.
- Time your meals so that you eat 90 minutes or more before a competition.

(continued)

From J. Carter, J. Wiecha, K. Peterson, S. Nobrega, and S. Gortmaker, 2007, *Planet Health,* 2nd ed. (Champaign, IL: Human Kinetics).
From L. Cox, 2004, *Swimming to Antarctica: Tales of a long-distance swimmer* (New York: Alfred A. Knopf).

Sugary Sport Drinks? *(continued)*

Check What You Learned

1. In which of the following situations should you drink water? In which would a sport drink be a good choice? Write a W (water) or S (sport drink) in the blank to indicate your response.

   ______ Shooting baskets for a few hours after school

   ______ 60-minute soccer or basketball game

   ______ Seven-mile hike

   ______ Riding your bike around town with friends

   ______ Six-hour sports camp held outside in the hot summer sun

   ______ Two-hour bike race

2. Describe what happens to blood sugar and blood insulin levels immediately after drinking a sugary drink. How does insulin help to maintain blood sugar at a healthy level?

3. Why do diabetics have trouble maintaining their blood sugar at a healthy level?

4. List four things you can do to prevent developing type 2 diabetes.

5. List four or more characteristics of sugar molecules. Include information about their size, shape, chemical structure, and function in the body.

Making Connections

Interview your extended family. Does anyone have type 2 diabetes? Why is this important for you to know?

Name ___________________________________

Activity 19.3

Added-Sugar Sleuth

1. Find eight foods in your refrigerator or cupboards that list a sugar as one of the first three ingredients. Remember to look for words ending with the suffix -ose in the ingredients list.
2. Use the information on the nutrition label to complete columns 1 through 3 in the following chart.
3. Four grams of sugar equal 1 teaspoon of sugar. Calculate how many teaspoons of sugar per serving are in each food and write the corresponding number of teaspoons in column 4. (Number of teaspoons = number of grams x 1 teaspoon / 4 grams)

Food	Name of sugars in ingredients	Grams of sugar (g)	Teaspoons of sugar (tsp) per serving

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Student Resource 19.1

Name ________________________________

Organ and Cell Name Tags

Mouth	Esophagus
Stomach	Small intestine
Heart	Blood
Muscle cell	Brain cell
Liver cell	Director