Chapter 8: Sugar

SUGAR SOLUTIONS

Did you know that there are many types of sugar?

Carbohydrate	Digestive Enzyme	Common Food Source
Sucrose	Sucrase	Table Sugar
Fructose	None	Fruit, Corn Syrup
Glucose	None	Fruits, Vegetables, Grains

Sugar is considered a ***simple carbohydrate***, or simple sugar. Simple carbohydrates provide our bodies with a quick energy source. Once in our body, they are broken down or converted to glucose to burn as an energy source. Glucose is converted to energy through ***cellular respiration***. Cellular respiration is essential for survival. It needs glucose and oxygen to form the energy our cells need to grow and divide. However, if our bodies do not need the glucose at that time, it is then converted into a storage form (body fat).

Carbohydrates are small chains of one to three units of sugar linked together. ***Glucose***, also called dextrose, is the most common carbohydrate present in food today. It can be found in all fruits and vegetables. The body uses glucose for energy. ***Fructose*** is the sweetest of all naturally occurring sugars. It is found primarily in fruits and is also called fruit sugar. Common table sugar is ***sucrose***. It is typically used as an added sweetener for many recipes. One molecule of glucose and one molecule of fructose are linked together to make sucrose. In order to break

Drinking 20oz of regular soda is the same as eating 16tsp of table sugar!

sucrose down into glucose and fructose, the digestive enzyme sucrase is needed. Glucose and fructose do not need to be broken down further to be absorbed by the body. You will learn more about glucose, fructose, and sucrose in *Food Explorations Lab I* of this chapter.

Solubility is one of the many properties of sugar. Solubility is the ability of a substance (solute) to dissolve in another substance (solvent). When you add sugar to water, the sugar dissolves and the mixture becomes a solution. In this example, sugar is the solvent and water is the solution. However, you can't continue to add an endless amount of sugar to the water. Once you reach the water's capacity for sugar, the solution is considered saturated, meaning any added sugar will not be dissolved. The saturation point varies at different temperatures; the higher the temperature of water, the more sugar the solution can hold. You will learn more about solubility in *Food Explorations Lab II* of this chapter.

We see sugar solutions every day. Sugary drinks like soda and energy drinks are considered sugar solutions. Some of these drinks can contain as many as 16 teaspoons (almost 80 grams) of sugar in a 20-ounce bottle. That is a lot of sugar! The American Heart Association indicated that we should not consume much more than 5-6 teaspoons of added sugar per day. This example contains three times that amount!

Think About It

Food Explorations Lab I

1. Two sugars found in fruit are _____glucose_____ and _____fructose_____.

2. The most common sugar found in food is _____glucose_____.

3. Table sugar is the simple sugar _____sucrose_____.

Food Explorations Lab II

1. The ability of one substance to dissolve in another substance is _____solubility_____.

2. When no more of a substance can be dissolved in another the solution is called

_____saturated_____.

3. How does temperature affect the amount of sugar that can dissolve in water?

The higher the temperature of water, the more sugar the solution can hold.

Food Explorations Lab I:
Sweet Saccharide

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, your group will test sugar solutions to determine their glucose content and to determine the solutions' identities. You will also calculate the calories contained in the sugar solutions and consider how a person's sugar intake can be reduced.

Lab Objectives

In this lab, you will learn how to…

1. Determine the glucose concentration of unknown sugar solutions.
2. Determine the identity of three unknown liquid substances based on their glucose concentration.
3. Identify foods containing glucose, fructose, and sucrose.
4. Calculate calories in food due to simple sugars.
5. Describe how a diet can be modified to reduce sugar intake.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

Which of the following substances do you think will have the greatest concentration of glucose? (Circle your answer.)

Apple Juice Grape Juice Table Sugar/Water Solution

Predictions: I predict _____ will have the greatest concentration of glucose because…

Will the glucose concentration be high or low in each liquid solution? Provide an explanation for your response. (Circle your answer.)

APPLE JUICE:

HIGH **LOW**

There is glucose present in the juice.

GRAPE JUICE:

HIGH **LOW**

There is glucose present in the juice.

SUGAR CANE (SUGAR WATER):

HIGH **LOW**

Glucose is not present in sucrose, which is the sugar used in this solution.

Observation of Unknown Samples

MATERIALS

4-8 Glucose Test Strips
Unknown Sample A
Unknown Sample B
Unknown Sample C
Control (water)
Stopwatch or kitchen timer
Glucose Color Chart
Paper towels or napkins
safety goggles
aprons (optional)

PROCEDURE

1. Obtain your 3 unknown samples from your teacher and the control (water).

2. Observe each sample. Record observations in Table A under the column labeled "Liquid Appearance."

3. Start with the control. Measure the glucose concentration of the control by dipping 1 glucose strip into the cup. After dipping, blot each side of the strip on a paper towel or napkin to remove the excess fluid. Not removing the extra fluid from your strip through blotting can result in an incorrect measurement.

4. Wait 30 seconds for the color of the strip to develop; then compare the color of the strip to the *Glucose Reference Color Chart*. Be sure to read your test strip at **exactly** 30 seconds. Record your answer in Table A under the column labeled "Test Strip Color at 30 Seconds."

5. One at a time, repeat steps 3-4 with all three unknown samples. Be sure to use a new strip each time, wait exactly 30 seconds, and record your data in Table A under the column labeled "Test Strip Color at 30 Seconds."

Table A: Unknown Sample Observations and Glucose Testing

	Liquid Appearance	Test Strip Color at 30 Seconds
Control (Water)	Clear, no color	Negative (Teal)
Sample A	Yellow, clear	Positive (Light brown)
Sample B	Yellow, clear	Positive (Dark brown)
Sample C	Yellow, clear	Negative (Teal)

Conclusion:

1. Using the *Glucose Reference Color Chart* provided, record the glucose concentration for each of your samples in Table B.

TABLE B: Glucose Concentrations and Substance Identification

	Glucose Concentration (At 30 seconds)	Identity of Substance	Explanation
Control	0mmoL/L	Water	Water does not contain glucose.
Sample A	30mmoL/L	Apple	Apple has a lower glucose concentration compared to grape juice.
Sample B	60mmoL/L	Grape	Grape juice has a higher glucose concentration.
Sample C	0mmoL/L	Sugar Water	Sugar is composed of sucrose. Sucrase would be needed to breakdown sucrose before glucose could be detected.

2. Using the data presented in Table C, calculate the % glucose for each food item.

Food Item	Total Sugar	Free Fructose	Free Glucose	Sucrose	% Glucose
Example Juice	18g	7g	3g	1g	16.7%

$$\frac{\text{3g Free Glucose}}{\text{18g Total Sugar}} = 0.167$$

0.167 x 100 = 16.7% glucose

Table C: Calculating % Glucose in Food Items

Food Item	Total Sugar	Free Fructose	Free Glucose	Sucrose	% Glucose
Apple Juice	10g	6g	2g	2g	20%
Grape Juice	15g	8g	7g	0g	46.7%
Sugar Water	16g	1g	1g	14g	6.25%

Apple:

$$\frac{\text{2g Free Glucose}}{\text{10g Total Sugar}} = 0.20$$

$$0.20 \times 100 = 20\%$$

Grape:

$$\frac{\text{7g Free Glucose}}{\text{15g Total Sugar}} = 0.4667$$

$$0.4667 \times 100 = 46.7\%$$

Table Sugar Water:

$$\frac{\text{1g Free Glucose}}{\text{16g Total Sugar}} = 0.0625$$

$$0.0625 \times 100 = 6.25\%$$

3. Compare and contrast your results in Tables A and B to your original responses to the lab question. Describe similarities and differences.

Answers will vary based on responses in Table A and B.

4. Complete Table B on page 210. The sugar solutions used in this investigation were grape juice, apple juice, and sugar water. Match the sugar solution to each unknown and provide an explanation to support your answer.

5. The table sugar water and grape juice solutions have similar sugar concentrations, but the glucose concentrations were different. Explain why this is possible.

The sugar water solution only contained sucrose, which is composed of linked glucose and fructose. Grape juice contained fructose and glucose separated, so the glucose indicator strip could detect the glucose.

6. What types of foods are naturally high in fructose? Glucose? Sucrose?

Fructose: Honey and most fruit

Glucose: Whole grain products, legumes, potatoes, dairy, vegetables, and grapes

Sucrose: Dates, sugar beets, sweet peas, and dried fruit

7. Fructose, glucose, and sucrose are types of carbohydrates in the diet that can provide energy for the body in the form of calories. Calculate how many calories from total sugar each beverage contains. (HINT: To find total calories multiply Total Sugar in Table C by 4 grams/calorie.)

   Apple: 10g Total Sugar x 4cal = 40 calories

   Grape: 15g Total Sugar x 4cal = 60 calories

   Table Sugar Water: 16g Total Sugar x 4cal = 64 calories

8. Based on the reading "Sugar Solutions", what does the body do with sugar that is consumed but not needed for the body's current energy needs?

   The sugar is converted to fat for storage.

9. Identify two sources of added sugar you regularly eat or drink. Name one way you can decrease your intake of extra sugar.

   Sports drink – zero calorie option

   Regular soda – water or diet soda

Food Explorations Lab II:
Super Solutions

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, sugar will be dissolved to make two saturated solutions. One solution will be made using heated water, while the other will be made using cold water. The amount of sugar used in each solution and the amount of sugar in natural fruit juice will be compared.

Lab Objectives:

In this lab, you will learn how to…

1. Explain how temperature affects the amount of carbohydrate (sugar) in a solution.
2. Identify common sources of sugar in the human diet.
3. Identify the solute and solvent in a solution.
4. Calculate the calories in a food or drink due to its sugar content.
5. Identify foods and drinks with lower sugar content.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Questions

Which of the following solutions will contain the greatest concentration of sugar? (Circle your answer.)

Heated Sugar Solution Cold Sugar Solution Natural Fruit Juice

Predictions: I predict _____ will have the greatest concentration of sugar because…

Observation of Sugar Saturation

MATERIALS

100mL graduated cylinder
Beaker containing water
1 - 9 oz. plastic cup
1 small bag white sugar (25g)
1 plastic spoon
1 plastic knife
1 paper plate
1 medium bowl
1 hand juicer
1 triple beam balance
6 Styrofoam cups (1 per student)
4-5 oranges

PROCEDURE

Heated Solution

You teacher will demonstrate how to create a solution using heat.

1. On high heat, your teacher will quickly heat 100mL of water.
2. While the water heats, your teacher will measure out 250 grams of sugar.
3. Once the water is hot (simmering, but not boiling), your teacher will add 50-100 grams of sugar at a time. Your teacher will allow the sugar to dissolve before adding more sugar.
4. Your teacher will continue to add sugar until additional sugar will not dissolve. If your teacher has to add additional sugar beyond the initial 250 grams, he/she will measure and add sugar in 50-gram increments.
5. Record the amount of carbohydrate (sugar) your teacher needed to create a supersaturated heated solution in Table A under the column labeled "Heated Solution."
6. Your teacher will divide the hot solution into separate Styrofoam cups (1 per group of students) and set aside. The heated solutions will cool for later observation.

Cold Solution

1. Measure 100mL of cold water and pour into the 9 oz. plastic cup.

2. Add the 25g of sugar a little at a time to the cup of water and mix until the sugar dissolves.

3.Continue to add sugar until it will no longer dissolve.

4. If you have to add additional sugar beyond the initial 25g, be sure to measure the gram amount of each new addition of sugar using the triple balance beam.

STEP 1: Place a clean Styrofoam cup on your balance. Mass the cup using the triple beam balance.

Mass of Empty Cup =	_____ **g**

STEP 2: Pour additional sugar into the cup. Mass the cup and sugar.

Mass of Cup and Sugar =	_____ **g**

STEP 3: Subtract the mass of the empty cup from the mass of the cup and sugar.

_____**g** – _____**g** = **Mass of Cup and Sugar – Mass of Empty Cup =**	_____ **g** **Mass of Additional Sugar**

5. If you used less than the provided 25g, measure any remaining sugar and subtract the mass from the original 25g.

STEP 1: Place a second clean Styrofoam cup on your balance. Mass the cup using the triple beam balance.

Mass of Empty Cup =	_____ **g**

STEP 2: Pour remaining sugar into the cup. Mass the cup and sugar.

Mass of Cup and Sugar =	_____ **g**

STEP 3: Subtract the mass of the empty cup from the mass of the cup and remaining sugar.

_____g – _____g = **Mass of Cup and Sugar – Mass of Empty Cup =**	_____ g **Mass of Remaining Sugar**

6. Record the amount of carbohydrate (sugar) used to make the cold solution in Table A under the column labeled "Cold Solution."

Fruit Juice Solution

1. Wash your hands.
2. Slice each orange in half. Over the medium bowl, use the hand juicer to remove the juice from each orange half.
3. Measure 100mL of fresh orange juice (no pulp) and pour into a cup.
4. You have made fresh orange juice! Repeat steps 2 and 3 with each orange putting the juice in the Styrofoam cups. Allow every group member to taste the orange juice.
5. Record the amount of carbohydrate present in the orange juice solution in Table A under the column labeled "Natural Fruit Juice Solution." On average, 1 orange contains about 9g of natural sugar (carbohydrate).

Table A:

Heated Solution (gram/mL)	Cold Solution (gram/mL)	Natural Fruit Juice Solution (gram/mL)
250g/100mL	25g/100mL	9g/100mL

Conclusion:

1. Order the solutions (heated, cold, or natural juice) from the most sugar content to the least. Explain how this compares to your original response to the lab question.

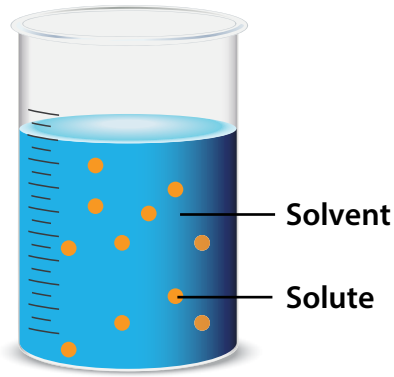
   The heated solution contained the most sugar and the natural solution contained the least.

2. Obtain a heated solution sample from your teacher. Compare and contrast the appearance of the heated solution to the cold solution.

   The heated solution is thicker and opaque; it contains more sugar particles. The cold solution is think and cloudy.

3. In a solution, the solvent is present in the greatest amount. The solute is dissolved within the solvent. Explain which component (water or sugar) is classified as the solvent and which is the solute. Use the diagram to help guide your answer.

   Water is the solvent and sugar is the solute.



4. Explain why there are differences in the solubility of sugar molecules when added to hot water versus cold water.

   Hot water molecules move more rapidly than cold water molecules, allowing the sugar to dissolve more easily.

5. Using you results in Table A, how many calories from carbohydrate would each solution provide per 100mL? There are 4 calories in 1g of carbohydrate.

   Heated Solution:

   250g x 4cal = 1000cal per 100mL

   Cold Solution:

   25g x 4cal = 100cal/100mL

   Natural Fruit Juice: ★

   9g x 4cal = 36cal/100ml orange juice

6. Circle the solution under question 5 that provided the most calories. Place a star by the solution that provided the least amount of calories.

   Students should circle the heated solution, indicating it provides the most calories and place a star by the natural fruit juice, indicating it provides the least amount of calories.

7. Provide an example of a saturated sugar solution that you drink on a regular basis.

   Any drink with added sugar like sports drinks, soda, and energy drinks.

8. Based on the reading "Sugar Solutions", what does your body do with the sugar you eat or drink when it is not needed for energy?

   The sugar is converted to fat for storage.

9. Considering the higher calorie content of sweetened beverages, name two alternatives you can drink.

   You can choose diet drinks, zero calorie alternatives, or water.

Investigating Your Health:
Surprising Sugar

Name: _____

Objective: Investigate sugar by comparing the nutrition facts of a soda and 100% juice. Determine how much added sugar you are consuming and describe ways you can reduce your intake in your diet.

Added sugars in the diet are one major source of extra calories. They are sugars added to food or drinks during preparation or processing. Some sugars are found naturally in foods like fruit and milk products. However, the majority of sugars in our diet are added to make food taste better or to make the food last longer. Unlike sugars naturally found in foods, many of the foods with added sugars provide additional calories in your diet, but no essential nutrients or fiber. This can put you at risk for becoming overweight and developing weight related diseases like diabetes. Added sugars can be found in soda, energy drinks, sports drinks, and desserts. Consuming too much sugar, either natural or added, increases your risk for dental cavities. You can drink water or milk instead of drinking soda. You can also choose fresh fruit for dessert. In general, girls should have no more than 80-240 calories a day from added sugars and fats, while boys should have no more than 90-270 calories a day from added sugars and fats. The exact amount depends on your energy needs. Use the *Try This at Home* recipe to make a healthy juice with fruit!

PART A: Sugary Liquids

1. Find and look at the Nutrition Facts labels for a soft drink (e.g. pop, soda) and juice. Choose a regular soft drink (not diet), and a regular 100% juice. If you are unable to find Nutrition Facts labels, use the handout provided by your teacher or access the nutrient database on USDA's website: http://ndb.nal.usda.gov/ndb/search/list. Complete the Nutrition Facts labels and calculate the number of calories per fluid ounce for each and record below.

Soft Drink:

Dr. Peppy

Calories ÷ Fluid Ounce = 12.5

100% Juice:

Orange Juice

Calories ÷ Fluid Ounce = 13.75

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____%	Vitamin C ____%
Vitamin E ____%	Calcium ____%
Iron ____%	Thiamin ____%
Niacin ____%	Folate ____%
Vitamin B_{12} ____%	Zinc ____%
Magnesium ____%	

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____%	Vitamin C ____%
Vitamin E ____%	Calcium ____%
Iron ____%	Thiamin ____%
Niacin ____%	Folate ____%
Vitamin B_{12} ____%	Zinc ____%
Magnesium ____%	

2. Complete the nutrition facts label below for your favorite non-diet drink and calculate the number of calories per fluid ounce for each and record below.

Answers to some questions may vary.

Favorite Drink: _____

Calories ÷ Fluid Ounce = _____

Nutrition Facts

Serving Size _____

Calories _____

Total Fat _____

Sodium _____

Total Carbohydrates _____

Dietary Fiber _____

Sugars _____

Protein _____

Vitamin A ____%	Vitamin C ____%
Vitamin E ____%	Calcium ____%
Iron ____%	Thiamin ____%
Niacin ____%	Folate ____%
Vitamin B_{12} ____%	Zinc ____%
Magnesium ____%	

3. Calculate the calorie amounts and % Daily Value of the listed nutrients for drinking each drink 3 times a week. Compare calorie amounts and % Daily Value of the listed nutrients in each drink. Multiply the calories and nutrients in each drink by 3.

Soft Drink: 150 calories x 3 times/week = 450 calories/week; 0% Daily Value for all nutrients

100% Juice: 110 calories x 3 times/week = 330 calories/week; 12% Vitamin A, 6% Iron, 9% Niacin, 21% Magnesium, 411% Vitamin C, 105% Calcium, 54% Thiamin, and 45% Folate

Favorite Drink: (Sweetened Tea) 70 calories x 3 times/week = 210 calories/week; 0% Daily Value for all nutrients

4. Which drink is the best option? Why?

Juice has more vitamins and minerals than both soda and sweetened iced tea; it is the best option.

PART B: Consuming Sugar

5. Over the next week, record how many times you drink a sugar sweetened drink (e.g. soft drink, juice, sweet tea). Be sure to record the name of the beverage and how much you consumed (in ounces).

BEVERAGES CONSUMED				
DAY	Breakfast	Lunch	Dinner	Snack

6. Determine how many added calories you are drinking each week by consuming these beverages. (*HINT*: Determine how many fluid ounces you consumed in one week for each beverage. Multiply your intake by the calories/fluid ounce determined in question 1).

   Assume I drank 2 Dr. Peppy's and 2 sweetened iced teas this week.

   Dr. Peppy: 150 calories x 2 = 300 calories

   Sweetened Tea: 70 x 2 = 140 calories

   300 calories + 140 calories = 440 total added calories

7. Determine how many added calories you are drinking each day by consuming these beverages. (*HINT:* Divide your total added calories by 7 to get your daily average.)

   440 calories ÷ 7 days = 63 calories/day

8. Identify 3 healthier drink options and explain why they are a better choice.

   Water because it doesn't have any added calories. Water because it is the simplest form of hydration for our body. Milk because it has calcium, which is good for me. No sugar added green tea because it provides antioxidants. 100% fruit juice because it has beneficial vitamins. No sugar added 100% juice because it provides hydration as well as vitamins and minerals (moderate amounts). Note, you can consume all the necessary vitamins and minerals from a healthy diet without needing to add No-Sugar Added 100% Juice to your diet.

TRY THIS AT HOME:

Fresh Fruit Juice

Makes 1 serving

You will need:

½ cup orange juice
1 banana
½ cup pineapple chunks

INSTRUCTIONS:

1. Pour orange juice into the blender.

2. Cut up the banana and add it to the blender.

3. Add pineapple chunks to blender.

4. Blend until smooth

5. Refrigerate for 15 minutes and enjoy!