Where Did the Sugar Go?

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Name: _____

Today we'll be learning all about carbohydrates and how they move around to different parts of the body. Carbohydrates are sugar molecules, and they come in all shapes and sizes. Some carbohydrates are monosaccharides, a simple sugar composed of only one molecule, like glucose. Some sugars are known as disaccharides because they are composed of two simple sugars. Some common disaccharides are lactose, a sugar found in milk, and sucrose, a sugar commonly found in fruits and vegetables. Some sugars are called polysaccharides. These can be made of thousands of sugar molecules bonded together. One of the most common polysaccharides is starch, the molecule found in potatoes, bread, and pasta.

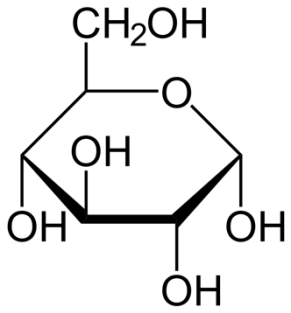


Figure 1: Glucose molecular structure

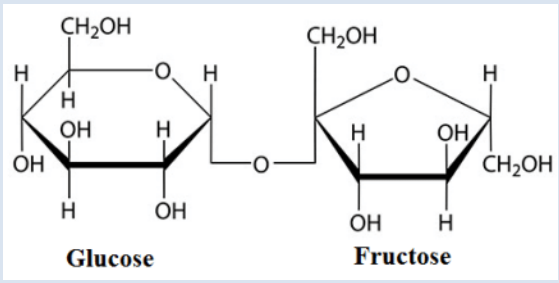


Figure 2: Sucrose molecular structure

We'll be focusing on all of these sweet molecules and foods to help us learn a little more about diabetes. Diabetes is a disorder where a person can't properly regulate the amount of sugar, specifically glucose, in their blood. People with diabetes often have higher levels of sugar in their blood than nondiabetics, and this can lead to many issues. With more sugar in the blood, the blood pressure increases as well. This high pressure can put strain on your heart and lead to heart issues. Sometimes this high blood pressure can cause damage to large and small blood vessels and can cause issues in other parts of the body. If the damaged vessel is in the eyes, it can lead to problems seeing, and if the damaged vessel is in the brain, it can lead to a stroke.

In this activity and its stations, you are going to learn about three important parts of a diabetic's life: meal planning, monitoring, and motion. All three are necessary to maintain healthy blood glucose levels and reduce the long-term effects of diabetes. As you learn some of the common considerations diabetics make, you'll also learn about the foods that have high carbohydrates and how the body utilizes that sugar for energy.

Quick start: What is glucose and how does it relate to diabetes?

STATION 1: MEAL PLANNING

Goal: Your goal is to craft a meal for a Type 1 diabetic patient to eat and to calculate the insulin needed to accompany the meal.

Main Meal Options	Price	Carbohydrates (g)
Buffalo Vegan Chicken Nuggets with Roll	$4.00	57
Cheese Enchiladas	$4.50	29
Rotini with Meat Sauce and Roll	$3.00	43
Veggie Burger on Bun	$3.50	37

Beverage Options	Price	Carbohydrates (g)
Juice	$2.00	16
Milk	$2.00	13
Water	$0.00	0

Side Dish Options	Price	Carbohydrates (g)
Baby Carrots with Ranch	$0.75	11
Baked Fries	$1.50	17
Chili Soup	$2.00	27
Garlic and Herb Broccoli	$1.00	5

1. Select a meal for the diabetic patient includes the following:
    - 1 main meal component
    - 1 beverage
    - At least 1 side dish
    - Costs less than $9.00 total

    Write your selections below and calculate the total carbohydrates in the meal.

		Price	Carbohydrates (g)
Main Meal Selection			
Beverage Selection			
Side Dish 1			
Side Dish 2 (optional)			
Side Dish 3 (optional)			
Side Dish 4 (optional)			
	Totals		

2. Calculate the insulin dose needed for the meal you've selected using the following equation:

   Insulin dose = Total carbohydrates (g) x Insulin:CHO Ratio

   *The insulin:CHO ratio describes how many carbohydrates are removed when insulin is taken. Our patient has an **Insulin: CHO ratio of 1/10**, meaning that for 1 unit of insulin, 10 grams of carbohydrates will be removed.*

Insulin dose =	

3. The patient only brought **7 insulin** units for lunch. Calculate how many carbohydrates will be removed with 7 insulin units.

   Carbohydrates Removed = Insulin Units/ Insulin:CHO Ratio

Carbohydrates Removed =	

4. Knowing how many carbohydrates the patient will be able to remove, build a meal where the total carbohydrates is equal to or less than the Carbohydrates Removed number above while also maintaining the same rules as above.

		Price	Carbohydrates (g)
Main Meal Selection			
Beverage Selection			
Side Dish 1			
Side Dish 2 optional			
Side Dish 3 optional			
Side Dish 4 optional			
	Totals		

Quick Check:
People with diabetes go through this process to ensure their body will be able to utilize or store carbohydrates (sugars) properly. What factors do you consider when deciding what to eat?

Bonus: Complete the following, if time allows.

The patient needs to eat but also took their blood sugar and realized their blood sugar is already too high. Use the equations and information below to determine the new **target carbohydrates for the meal** and **select a new meal.**

Patient's Current Blood Glucose: 170mg/dL
Patient's Target Blood Glucose: 120mg/dL
Insulin Units Available: 7 units
Insulin:CHO Ratio: 1/10

Blood Sugar Correction Dose = (Current Blood Glucose – target blood glucose)/ 50
Blood Sugar Correction Dose =

CHO Insulin Dose = Insulin Units Available – High Blood Sugar Correction Dose
CHO Insulin Dose =

Total Carbohydrates in Meal= CHO Insulin Dose/ Insulin:CHO Ratio
Total Carbohydrates in Meal=

		Price	Carbohydrates (g)
Main Meal Selection			
Beverage Selection			
Side Dish 1			
Side Dish 2 optional			
Side Dish 3 optional			
Side Dish 4 optional			
	Totals		

STATION 2: MONITORING

Goal: Your goal is to determine what happens to food, specifically sugar, after it is eaten.

Background: Two patients have come into the lab to have their blood sugar tested. Blood sugar tests can be conducted 2 ways: (1) a small vial of blood is taken and then tested in a diagnostics lab or (2) the patient's finger is pricked with a small needle and the blood is tested with special strips and a tool called a glucometer. Today we've collected small vials for the blood samples, but you will be testing them with a glucometer.

To better understand how the patient's blood sugar changes over time, we have collected multiple blood samples.

Sample Number	When Was the Sample Taken?
1	On an empty stomach
2	1 hour after drinking a very sugary beverage

Protocol:

1. Familiarize yourself with your station materials. You will need the following materials:
    a. Two labeled plastic slides (one Patient A, one for Patient B)
    b. Patient A blood samples (A1, A2)
    c. Patient B blood samples (B1, B2)
    d. Glucometer
    e. Glucometer test strips
2. Add 1 drop of sample A1 (Patient A's first sample) to the labeled plastic slide.
3. Place a new test strip into the glucometer. Wait until it shows the following symbol.

4. Place the end of the strip to the edge of sample A1 to draw the sample into the strip. The device will beep when it has received the sample.
5. Wait a moment for the glucose reading to appear. Record this number in the table 1 below.
6. Remove the test strip and place it in the waste container.
7. Add 1 drop of sample A2 (Patient A's second sample) to the labeled plastic slide.
8. Repeat steps 3-6.
9. Once finished, use one of the tissues to clean the slide and place the tissue in the waste container.

Table 1: Patient A		
Sample	**A1**	**A2**
Time Since Sugary Drink	0 min	60 min
Blood Sugar Concentration (mg/dL)		

Quick Check:
What body system did the sugary drink go through to enter the body of the patient? (Circle your response)

Immune System **Digestive System** **Muscular System** **Nervous System** **Circulatory System**

Quick Check:
Based on the blood sugar test that you conducted, after the first body system breaks down the drink, what system does the sugar travel to next?

Immune System **Digestive System** **Muscular System** **Nervous System** **Circulatory System**

Follow the same protocol for Patient B's samples. You can record Patient B's data in the table below.

Table 2: Patient B		
Sample	**B1**	**B2**
Time Since Sugary Drink	0 min	60 min
Blood Sugar Concentration (mg/dL)		

Quick Check:
What differences do you notice between Patient A and Patient B?

Bonus: Complete the following, if time allows:

People with diabetes are characterized by higher resting blood sugar levels and increased blood sugar responses to sugary foods and drinks. Use the table below of healthy blood sugar levels and your data above to determine if either patient is diabetic.

Healthy Blood Sugar Levels for Adults	
Time before Sugary Drink	**Blood Sugar Concentration (mg/dL)**
0 min	< 100
60 min	< 180
120 min	< 180

Please circle your response for each patient.

Patient A Diagnosis: Diabetic Nondiabetic

Patient B Diagnosis: Diabetic Nondiabetic

STATION 3: MOTION

Goal: Your goal is to determine what happens to sugar in the body during exercise.

Background: Two patients (Patient C and D) have come into the lab to learn how their blood sugar is affected by exercise. For this test, patients had blood samples taken before and after a 30 minute workout. The workout consisted of a moderate run/jog on a treadmill. The collected blood samples were centrifuged so we can test their blood plasma- only the liquid portion of the blood.

Protocol:

1. Familiarize yourself with your station materials. You will need the following materials:
    a. Patient C plasma samples (C1, C2)
    b. Patient D plasma samples (D1, D2)
    c. Glucose test strips
    d. Glucose Strip color chart
2. Take two glucose test strips out of the black lidded container. Label one "C1" and the other "C2".
3. Take the strip labeled "C1" and dip it into the bottle labeled C1 and immediately remove it from the solution.
4. Start a timer for 1 minute then compare the color of the strip to the glucose color chart.
5. Record your result in the table 3 below by circling the number that matches. Throw away the used strip into the waste container.
6. Take the strip labeled "C2" and dip it into your test tube labeled C2 and immediately remove it from the solution.
7. Start a timer for 1 minute then compare the color of the strip to the glucose color chart.
8. Record your result in the table below by circling the number that matches. Throw away the used strip into the waste container.

Table 3: Patient C												
Sample	**C1 (before exercising)**						**C2 (after exercising)**					
Glucose concentration (mg/100mL)	80	90	100	110	120	130	80	90	100	110	120	130

9. Take two glucose test strips out of the black lidded container. Label one "D1" and the other "D2".
10. Take the strip labeled "D1" and dip it into the bottle labeled D1 and immediately remove it from the solution.
11. Start a timer for 1 minute then compare the color of the strip to the glucose color chart.
12. Record your result in the table below by circling the number that matches. Throw away the used strip into the waste container.
13. Take the strip labeled "D2" and dip it into your test tube labeled D2 and immediately remove it from the solution.
14. Start a timer for 1 minute then compare the color of the strip to the glucose color chart.
15. Record your result in the table below by circling the number that matches. Throw away the used strip into the waste container.

Table 4: Patient D												
Sample	**D1 (before exercising)**						**D2 (after exercising)**					
Glucose concentration (mg/100mL)	80	90	100	110	120	130	80	90	100	110	120	130

Quick Check:
For both patients, what happened to the blood sugar (glucose) level after exercising?

Quick Check:
What body system does the sugar move to when you are exercising?
(*Hint: Remember that when you exercise, your muscles need to make energy to move. Through cellular respiration, glucose and oxygen can be transformed into energy, water, and carbon dioxide.)*

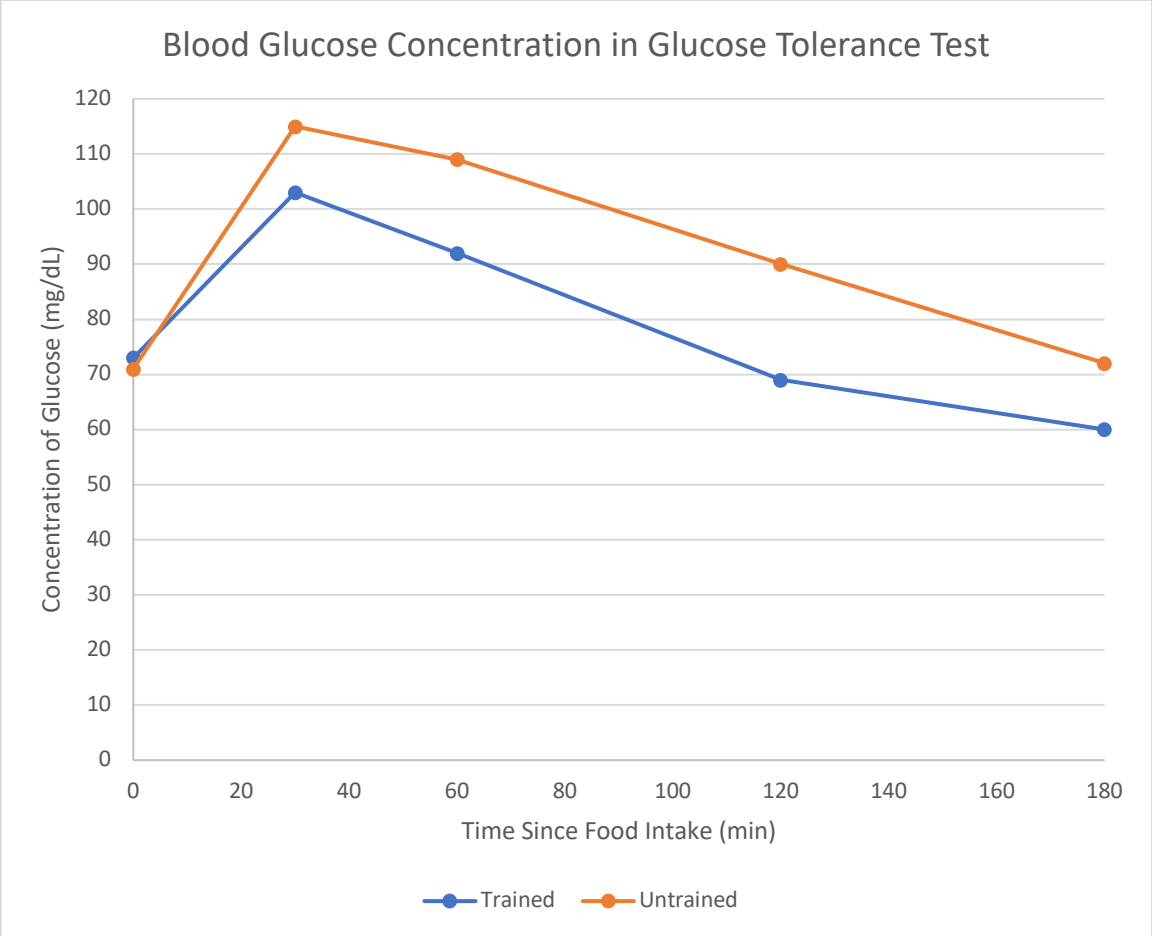
Immune System **Digestive System** **Muscular System** **Nervous System** **Circulatory System**

Bonus: Complete the following, if time allows.

Patient C has diabetes, a disorder that makes it harder to regulate how glucose travels from body system to body system. Doctors have asked patient C to incorporate regular exercise into their weekly schedule to lower their glucose levels, but patient C is skeptical.

To help make their argument, the doctor provided the following graph to help convince Patient C of the importance of exercise.

Use the graph and information below to complete the claim, evidence, reasoning chart to form a strong argument in favor of exercise. This argument will use data and scientific knowledge to present a convincing claim.



***Background**: In this experiment, healthy adults were split into two groups: one group that had been exercising vigorously 5-7 days/week for 6 months and one group that had done no exercise training for at least 12 months. To collect the data, the participants had blood glucose (blood sugar) measured before and after consuming a sugary drink.*

When making an argument, you want to include these three components: a claim, any relevant evidence, and reasoning. Use the graphic organizer below and circle the information you would like to include in your argument for each component.

Claim	
I agree with the doctor that it would be good for Patient C to exercise regularly.	I disagree with the doctor that it would be good for Patient C to exercise regularly.

Evidence		
The graph shows that the untrained group had overall lower blood sugar levels than the trained group.	The graph shows no difference in blood sugar levels between both groups.	The graph shows that the trained group had overall lower blood sugar levels than the untrained group.

Reasoning		
People who train have a lower glucose (sugar) tolerance and their bodies respond to sugar quickly to keep blood sugar levels low.	Exercise has no effect on glucose (sugar) tolerance and therefore should not change from an untrained group to a trained group.	People who train have a higher glucose (sugar) tolerance and their bodies respond to sugar slowly to keep blood sugar levels high.