Honey as a Biomolecule

Name _____

Part 1: Introduction

In order to stay healthy, people need to eat a variety of nutritious foods. Food contains six nutrients that are necessary for good health. These nutrients include carbohydrates, proteins, lipids, minerals, vitamins, and water.

Carbohydrates, lipids, and proteins are called organic molecules. These molecules are called organic molecules because they are carbon based and should not be confused with certified organic products. The USDA defines organic agriculture as using methods that preserve the environment and avoid most synthetic material as pesticides and antibiotics.

Read each statement and check the appropriate box indicating if you think that the statement is true or false.

True	False	Statement
	X	A teaspoon of honey and a teaspoon of sugar have the same number of calories.
	X	A teaspoon of honey and a teaspoon of sugar have the same number of carbohydrates.
	X	A teaspoon of honey and a teaspoon of sugar have the same effect on a person's glycemic index (GI). GI is a measure of how carbohydrates affect a person's blood sugar level. High GI foods "spike" a person's blood sugar level which may increase a person's risk of coronary heart disease and Type 2 diabetes.
X		Honey is added to certain baked goods to extend shelf life.
X		Honey is not recommended for infants under one year of age.

Divide into groups of 2-3 students. Read the following articles. Discuss with your group if you learned anything new about honey or table sugar.

- "Carbohydrates and the Sweetness of Honey"
- "Is Honey the Same as Sugar?"

Part 2: Comparing Carbs

Carbohydrates are the main source of energy for living organisms. Glucose, fructose, and galactose are the three **monosaccharides** or single sugar molecules. **Disaccharides** are formed by two monosaccharides bonded together and include sucrose, also known as table sugar, and lactose, the sugar found in milk. **Polysaccharides** are large molecules formed by many monosaccharides bonded together. Animals store carbohydrates in the polysaccharide glycogen. Plants store carbohydrates in polysaccharides, starch and cellulose, the latter of which is used for structure and support. Whether simple or complex, all carbohydrates are made of sugar, but not all sugars are equally sweet.
Food scientists have rated the relative sweetness of carbohydrates as seen in the table.

Relative Sweetness Scale	
Carbohydrate	***Rating***
Glucose	70-80
Galactose	35
Fructose	140
Sucrose (glucose + fructose)	100
Lactose (glucose + galactose)	20
High Fructose Corn Syrup	120-160

1. Which monosaccharide is the sweetest?

   Fructose

When a disaccharide breaks down into its component monosaccharides, the sweetness changes as well. The resulting sweetness can be determined by averaging the sweetness of the two monosaccharides.

Lactose is the disaccharide found in milk. Before lactose can be used by the body, it must be broken down into monosaccharides. The enzyme, lactase, breaks down lactose into the monosaccharides, glucose and galactose. When lactose is digested its sweetness changes too. The new sweetness can be calculated by averaging the sweetness rating of the two monosaccharides; glucose (75) and galactose (35). Note: The average value for glucose is used in the example.

Example: $\frac{75+35}{2} = \frac{110}{2} = 55$

2. How does the sweetness of milk compare to the sweetness of milk that has been digested by lactase?
   Undigested milk, lactose, is less sweet than digested milk, made of glucose and galactose. Compare the sweetness of lactose, 20, to the average sweetness of glucose and galactose, $\frac{75+35}{2} = \frac{110}{2} = 55$.

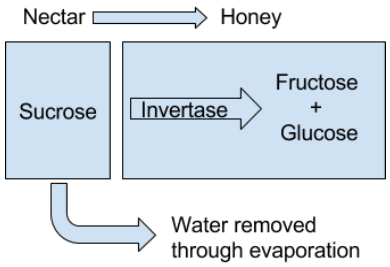
3. Sucrose or table sugar is also a disaccharide. What two monosaccharides compose sucrose?
   Fructose and glucose compose sucrose.

4. Using the average value for glucose, calculate the sweetness of sucrose after it has been broken down into its component monosaccharides.
   Sucrose = $\frac{75+140}{2} = \frac{215}{2} = 107.5$

5. How does the sweetness of sucrose compare to the sweetness of sucrose that has been digested by enzymes?
   Sucrose without digestion (100) is less sweet than digested sucrose (107.5).

6. Breaking down disaccharides into monosaccharides is necessary for digestion but food scientists see another benefit. Of what advantage is producing sucrose that has already been broken down by enzymes?
   Sucrose that has been broken down by enzymes will be perceived as more sweet than sucrose that has not been broken down. This extra sweetness is more palatable to a consumer and makes a product more desirable.

Bees make honey by gathering nectar from certain flowering plants. Nectar is sucrose. Foraging bees carry the nectar to their hive where receiving bees unload the nectar load and begin to process the nectar into honey. During the processing, bees add invertase, an enzyme that breaks down sucrose.



7. How do you think sweetness of honey compares to the sweetness of nectar? Explain your thinking.
   Honey is sweeter than nectar. Honey is glucose and fructose ($\frac{75+140}{2} = \frac{215}{2} = 107.5$*) while nectar is sucrose (100).*

Examine the ingredients on the label for Junior Mints to answer the questions below.

Junior Mints

Ingredients: Sugar, Semi-Sweet Chocolate (Sugar, Chocolate Processed with Alkali, Cocoa Butter, Soy Lecithin-An Emulsifier, Vanillin-An Artificial Flavor), Corn Syrup, Confectioner's Glaze, Modified Food Starch, Peppermint Oil, Invertase (An Enzyme).

8. What carbohydrates have been used?
   Sucrose (sugar), corn syrup, confectioner's glaze (likely sugar and water), and modified food starch

9. What enzyme has been added and how will that affect the sweetness of the carbohydrates?
   Invertase has been added and this will increase the sweetness of the sucrose by breaking it down into fructose and glucose with higher sweetness ratings.

Part 3: Developing a Food Product with Honey

Food scientists use their knowledge of biology, chemistry, and chemical engineering to better understand food processes and to improve food products for consumers. Imagine you are a food scientist developing a new food product using honey as an ingredient.

10. What is the name of your product?

    Answers will vary.

11. Who is the core audience for your product?

    Answers will vary.

12. What will your packaging look like?

    Answers will vary.

13. What ingredients will be used in your product?

    Answers will vary.

14. Draw a quick sketch of what your product will look like?

    Answers will vary.

15. List three reasons why a food scientist might use honey instead of sugar in this recipe.

    (You may want to refer to Honey: A Reference Guide to Nature's Sweetener found here: https://honey.com/files/general/refguide.pdf to read about some of the applications for honey in food products.)

		Applications								
Characteristics	**Functions**	**Bakery**	**Beverages**	**Cereals**	**Confections**	**Dairy**	**Meats**	**Sauces**	**Snacks**	**Spreads**
Antimicrobial Properties	Delays Spoilage	x				x	x	x	x	x
Carbohydrate Composition	Flavor Enhancement		x				x	x	x	x
Color	Coloring Agent	x				x	x			
Composition	Decrease Burn Perception						x	x	x	
Crystallization	Texture				x					x
Flavor	Flavoring Agent	x	x	x	x	x	x	x	x	x
Humectancy	Adds Moisture	x						x		x
Hygroscopic	Retains Moisture		x					x		
Lower Freezing Point	Freezing Point Depression		x			x				
Low Glycemic Index	Reduces Rebound Hypoglycemia		x						x	
Miscibility	Water Soluble	x				x		x		x
Maillard Reaction Precursors	Antioxidation						x			
Nutrition	Healthy Appeal	x	x	x	x	x			x	x
pH Balance	Inhibits Bacterial Growth		x			x				
Preservation	Slows Staling	x								
Pro-biotic	Enhances Bifidobacteria					x				
Proteins	Clarification		x							
Pumpable	Extrudable	x			x			x		x
Reducing Sugars	Enhances Browning	x		x			x	x	x	
Spreadability	Improves Reduced-fat Products	x		x	x		x			x
Viscosity	Binding Agent		x	x			x	x	x	x
Water Activity	Extends Shelf-life	x		x				x		