Name: _____ Date: _____

Student Exploration: Dehydration Synthesis

Vocabulary: carbohydrate, chemical formula, dehydration synthesis, disaccharide, glucose, hydrolysis, monosaccharide, polysaccharide, valence

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

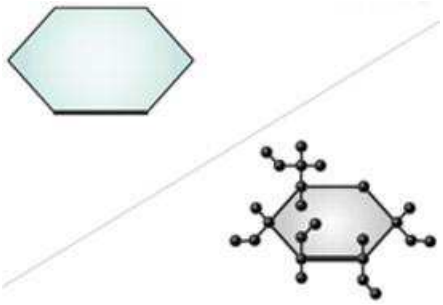
1. If you exercise on a hot day, you need to worry about dehydration. In this context, what do you think *dehydration* means? _____

   _____

2. Astronauts and backpackers often bring dehydrated food. What do you think dehydrated food is? _____

Gizmo Warm-up

What do rice, potatoes, and sugar have in common? They are all foods rich in **carbohydrates**. Carbohydrates are an important energy source for your body. The basic building block of most carbohydrate compounds is the molecule **glucose**. Using the *Dehydration Synthesis* Gizmo™, you will learn about the structure of a glucose molecule and how glucose molecules can be joined together to make larger carbohydrate molecules.



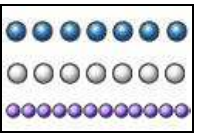
To begin, select the CREATE GLUCOSE tab.

1. Look at the **chemical formula** for glucose. How many carbon (C), hydrogen (H), and oxygen (O) atoms are found in a molecule of glucose? C:_____ H:_____ O:_____

2. Turn on **Show chemical structure**. Each black sphere represents a carbon, hydrogen, or oxygen atom. The lines connecting the spheres represent chemical bonds.

   A. How many black spheres are in the diagram? _____

   B. How does this relate to the number of carbon, hydrogen, and oxygen atoms in the chemical formula for glucose? _____

Activity A: **Build a glucose molecule**	Get the Gizmo ready: • Be sure the CREATE GLUCOSE tab is still selected.	

Introduction: Each element tends to form a certain number of chemical bonds. This value is the **valence** of the element. For example, a carbon atom has a valence of four.

Goal: Construct a molecule of glucose.

1. Identify: The structure of a water molecule (H_2O) can be written as H-O-H, with each dash representing a chemical bond. Count the number of bonds the oxygen and hydrogen atoms form in a water molecule.

   A. What is the valence of oxygen? _____

   B. What is the valence of hydrogen? _____

2. Build a model: Use the carbon, oxygen, and hydrogen atoms from the **Atoms box** to build a glucose molecule on the empty hexagon in the building region. Use the chemical structure in the lower right as a guide, and pay attention to the valence of each atom as you build.

   Once you think you have correctly constructed the glucose molecule, click **Check**. If necessary, continue to modify your molecule until it is correct.

3. Make a diagram: Congratulations, you have completed a molecule of glucose! Click the COPY SCREEN button to take a snapshot of your completed molecule. Paste the image into a blank document and label the image “Glucose.”

4. Explain: How did the valence of each element help you determine the structure of the

   glucose molecule? _____

   _____

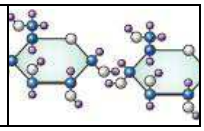
   _____

5. Make connections: Carbon forms the backbone of every major type of biological molecule, including carbohydrates, fats, proteins, and nucleic acids. How does carbon’s high valence relate to its ability to form these large and complex biomolecules?

   _____

   _____

   _____

Activity B: **Dehydration synthesis**	Get the Gizmo ready: • Select the DEHYDRATION tab.	

Question: What occurs when two glucose molecules bond?

1. Infer: Glucose is an example of a **monosaccharide**, the simplest type of carbohydrate. A **disaccharide** is made from bonding two monosaccharides together.

   What do you think the prefixes *mono-* and *di-* mean? *Mono-*: _____ *Di-*: _____

2. Predict: Turn on **Show description**. Drag both glucose molecules into the building region. Observe the highlighted region. What do you think will happen to the atoms in this region when the glucose molecules bond?

   _____

   _____

3. Run Gizmo: Click **Continue** and watch the animation.

   A. What happened? _____

   B. What was removed from the glucose molecules when they bonded to form maltose?

   _____

4. Infer: Based on what you have seen, create a balanced equation for the dehydration synthesis reaction. (Recall that the formula for glucose is $C_6H_{12}O_6$.) You will have to determine the formula of maltose yourself.

   _____

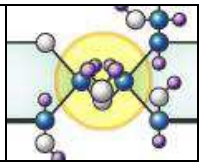
   Turn on **Show current formula/equation** to check your answer.

5. Summarize: Use what you have observed to explain what occurs during a **dehydration synthesis** reaction. _____

   _____

6. Apply: A *trisaccharide* is a carbohydrate made of three monosaccharides. What do you think would be the chemical formula of a trisaccharide made of three bonded glucose molecules?

   _____

Activity C: **Hydrolysis**	Get the Gizmo ready: • Select the Hydrolysis tab. • Turn on **Show description** and **Show current formula/equation**.	

Introduction: Carbohydrates made up of three or more bonded monosaccharides are known as **polysaccharides**. In a reaction known as **hydrolysis**, your body breaks down polysaccharides into individual monosaccharides that can be used by your cells for energy.

Question: What occurs when polysaccharides break up into monosaccharides?

1. Predict: Examine the polysaccharide in the building region and its chemical formula.
   A. How many monosaccharides can form if this polysaccharide breaks up? _____
   B. Recall the formula of glucose is $C_6H_{12}O_6$. How many carbon, oxygen, and hydrogen atoms will you need for three glucose molecules? _____
      _____
   C. What must be added to the polysaccharide in the Gizmo to get three glucose molecules? _____

2. Observe: Turn off **Show current formula/equation**. Drag a water molecule into the building region. Click **Continue**. What happened? _____
   _____

3. Infer: Create a balanced equation for the hydrolysis reaction that just occurred.
   _____
   Turn on **Show current formula/equation** to check your answer.

4. Observe: Turn off **Show current formula/equation**. Drag the second water molecule into the building region. Click **Continue**. What happened? _____
   _____

(Activity C continued on next page)

Activity C (continued from previous page)

5. Summarize: Now create a balanced equation for that shows the entire hydrolysis reaction. (In other words, the equation should show how the polysaccharide broke up into three separate glucose molecules.)

   _____

   Turn on **Show current formula/equation** to check your answer.

6. Compare: How do hydrolysis reactions compare to dehydration synthesis reactions?

   _____

   _____

   _____

7. Apply: Amylose is a polysaccharide made from the synthesis of four glucose molecules.

   A. How many water molecules are produced when amylose forms? _____

   B. What do you think is the chemical formula for amylose? _____

   C. How many water molecules would be needed to break amylase down into four glucose molecules? _____

8. Extend your thinking: Hydrolysis of the carbohydrates you eat begins in your mouth as you chew. How do you think this process might be affected if a person's salivary glands were unable to produce saliva, which is mostly composed of water?

   _____

   _____

   _____

Vocabulary: Dehydration Synthesis

Vocabulary

- Carbohydrate – an organic molecule made up of carbon, hydrogen, and oxygen.
  - Carbohydrates are the main energy source for most types of cells.
  - Carbohydrates are initially formed by plants through the processes of photosynthesis and *dehydration synthesis*.
  - Foods rich in carbohydrates include grains, fruits, and sugars.
- Chemical formula – a symbolic representation of an element or compound.
  - Chemical formulas use subscripts and parentheses to denote the number of atoms in a molecule of the substance.
  - Examples of chemical formulas include NaCl (table salt), H_2O (water), and $Ca(OH)_2$ (calcium hydroxide).
- Dehydration synthesis – a chemical reaction in which two or more molecules bond by losing one or more water molecules.
  - Plants build starches through dehydration synthesis.
- Disaccharide – a carbohydrate made of two *monosaccharides*.
  - Examples of disaccharides include maltose (two glucose molecules) and sucrose (one glucose molecule and one fructose molecule).
- Glucose – a monosaccharide with the chemical formula $C_6H_{12}O_6$.
  - Glucose is the primary molecule used during cellular respiration reactions.
- Hydrolysis – a chemical reaction in which the interaction of water and a compound result in the breaking up of that compound.
  - Your digestive system breaks down starches through hydrolysis.
- Monosaccharide – the simplest type of carbohydrate.
  - Examples of monosaccharides include glucose and fructose.
- Polysaccharide – a carbohydrate made of three or more monosaccharides.
  - Examples of polysaccharides include starch and cellulose.
- Valence – the number of chemical bonds an element is capable of forming.
  - The valence of an element is equal to the number of electrons that an atom of that element gains, loses, or shares while forming chemical bonds.