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**Photosynthesis: The Making of Sugar and Starches**

Please answer in your lab notebook, CSIQ!

**Introduction:**

 Biologist today depend upon their knowledge of chemistry for much of their understanding of life and its processes. Therefore, the knowledge of some chemical concepts important to living things is necessary for a complete understanding of biology.

 Carbohydrates (also known as sugars and starches) make up a large group of chemical compounds found in cells. They are manufactured by plants in a process called **photosynthesis.** These carbohydrates are then used by the plants as a food source to provide energy for cell processes. When an animal like you eats a plant, the carbohydrates are used by animal as an energy source for their own cells.

 In this exercise , you will first investigate the structure of water and carbon dioxide molecules. Then you will investigate what happens to those two types of molecule during photosynthesis to produce a simple sugar molecule know as monosaccharides. Finally, you will learn how simple sugar molecules are then put together in chains to produce double sugars (disaccharides) and complex carbohydrates or starches (polysaccharides).

**Procedure:**

**Part A: Water and Carbon Dioxide Molecules**

 Your group will receive a set of colored balls that represent atoms, and springs and wooden sticks that represent covalent bonds (shared electrons). Like in a real covalent bond, the sticks and springs will hold the atoms together to form molecules.

**PLEASE MAKE SURE BEFORE YOU BEGIN THAT YOU HAVE THE FOLLWING ITEMS IN YOUR MODEL KIT!**

**Materials:** (12) Yellow (Hydrogen atoms), (6) Black (Carbon atoms), (18) Red (Oxygen atoms), (24) sticks, (24) springs

1. Find the element hydrogen on your periodic table. How many electrons does it have in its outermost orbit?
2. In an atom, the first orbit becomes stable when it has 2 electrons, the second when it has 8 and the third also when it has 8. When atoms form bonds with other atoms, they seek to obtain a stable outer orbit by either sharing electrons (covalent bond) or gaining/losing electrons (ionic bond). How many more electrons would hydrogen need to fill its outermost orbit?
3. Look at one of the yellow hydrogen atom models. How many holes does it have?
4. What is the relationship between the number of bonds hydrogen atoms can form and the number of holes in the model of the atom?
5. Use a periodic table to see how many electrons are in the outermost orbit of an oxygen atom. How many additional electrons will it need in order to have a stable outermost orbit?
6. How many holes are in the model of the oxygen atom?
7. How many more electrons does a carbon atom need to fill its outer orbit?
8. What is the maximum number of bonds each carbon atom can form?

The chemical formula for water is H2O. This means that each water molecule consists of one oxygen and two hydrogen atoms bonded together by covalent bonds. Construct a model molecule using the correct model atoms and sticks for bonds. In any complete model of a molecule, all the holes of all atoms must be filled. Save this model for later. Next, build a model of a carbon dioxide (CO2) molecule using carbon and oxygen atoms and springs to represent bonds. Again, all the holes of all the atoms must be filled.

1. Take the H2O and CO2 molecules to your teacher plus your lab notebook to get a signature.
	1. Now, construct five more of each of the H2O and CO2 molecules.
2. Why do you need five more of each H2O and CO2 molecules?

**Part B: Monosaccharides**

 During photosynthesis, a plant uses the energy from the sun to break the bonds of six H2O and six CO2 molecules. The plant then re-forms the C, H and O atoms into a sugar (monosaccharide) molecule with the molecular formula C6H12O6. Break apart the H2O molecules and the CO2 molecules and using only sticks build C6H12O6 (glucose). **Use the model below as a guide.**

**Glucose**



1. When you have created a monosaccharide model, how many type(s) of atoms do you have left over?
2. Combine the left over atoms with each other in (two’s). What type of molecule have you built?
3. Write the chemical equations for the entire photosynthesis process. Remember, in a chemical equation, the atoms/molecules you started with (the reactants) are on the left side of the arrow and the atoms/molecules you ended up with (the products) are on the right side. Both sides of the equation must have the same total number of each kind of atom. **Matter can neither be created nor destroyed!**

**Part C: Disaccharides**

1. Plants put two monosaccharide units together to form a disaccharide (double sugar). In order for you to simulate this, combine your monosaccharide with that from another group. To combine them, you will need to remove an OH from one molecule and an H from the other and combine the two large molecules in the spots where the OH and H were removed. What is the chemical formula for the disaccharide you just made?
2. What atoms are left over after creating the disaccharide?
3. Join the left over atoms together. What familiar compound did you just make?
4. This process of putting together two monosaccharides (simple sugars) to form one disaccharide (double sugar) is called **dehydration synthesis.** Look up the meaning of “dehydration” and “synthesis” and then explain why the process has this name.

**Part D: Polysaccharides**

1. The same process of dehydration synthesis is used to build large polysaccharide chains (three or more monosaccharides hooked togher). If you were to make a polysaccharide that is three monosaccharides long, what would be the chemical formula?
2. How many molecules of water would be left over?
3. Picture what would happen if you continued to add monosaccharides to the polysaccharide chain, with water molecules left over each time. State the general rule that relates the number of monosaccharides hooked together to the number of water molecules that would be left over.
4. Suppose you were able to make a polysaccharide what was ten monosaccharides long. In your lab notebook, show how you would determine the chemical formula for the polysaccharide.
5. Write the chemical formula for the polysaccharide from question #21

Now, you have an understanding of the process called photosynthesis which supplies most the living thing on this planet with their food!

**PLEASE DISMANTLE YOUR MODELS COMPLETELY! MAKE SURE YOU HAVE THE CORRECT ATOMS, STICKS AND SPRINGS IN YOUR KIT BEFORE YOU CHECK IT BACK IN!**

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