

Introduction:

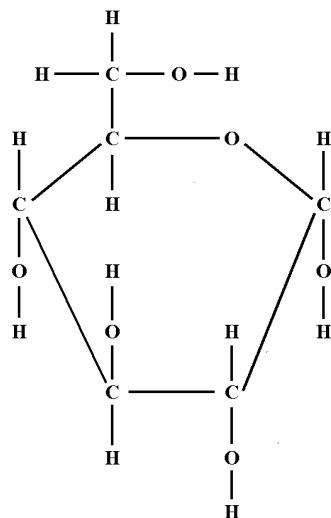
Biologists today depend upon chemists for much of their understanding of life and life processes. Therefore, an understanding of some chemical concepts important to living things is necessary. Carbohydrates make up a large group of chemical compounds found in cells. Carbohydrates are used for **energy** during cellular respiration and **cell structures**, such as cell walls.

An important group of biological compounds are the **saccharides**, or more commonly, the simple sugars. Carbohydrates contain carbon, hydrogen, and oxygen atoms in a ratio of 1:2:1 respectively. The many different types of sugars have been grouped into three main categories, depending on the number of simple sugars that form their basic structure. They are **monosaccharides**, **disaccharides**, and **polysaccharides**.

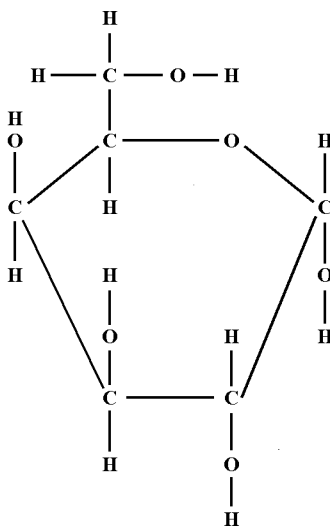
Directions: Follow the steps and answer the questions as you proceed. When you have finished, you should have a general understanding of what carbohydrates are all about and the differences between the main categories of carbohydrates.

I. Monosaccharides or Simple Sugars

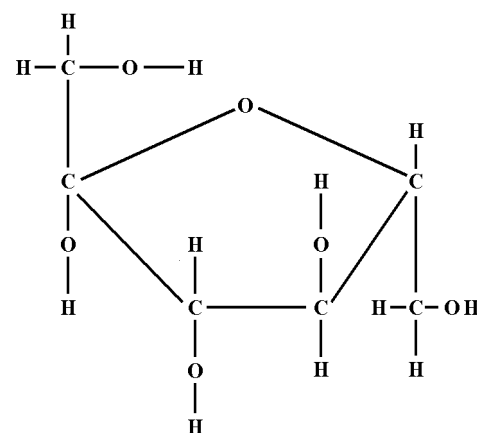
Examine the corresponding models for the three different monosaccharides. They will be found at the end of this worksheet. The three most common simple sugars are glucose, galactose, and fructose. The paper models do not represent the true three dimensional shapes of the molecules. They are to be used to illustrate that individual molecules of carbohydrates do differ from one another in their physical shape. Also, they show how it is possible for molecules to join together to form larger carbohydrates.

Structural Formulas for the three types of **Monosaccharides**:

Glucose



Galactose



Fructose

Questions:

1. What three different types of atoms, or elements, are present in monosaccharides?
2. How many atoms of carbon are there in each molecule of glucose, fructose, and galactose?
3. Write the molecular formulas for glucose, fructose, and galactose. Add the proper subscripts to the following:
glucose, C H O fructose, C H O galactose, C H O

4. Compare the number of hydrogen atoms to the number of oxygen atoms in each sugar. What is the ratio of hydrogen to oxygen atoms (that is, how many hydrogen atoms are there for each oxygen atom)?
5.
 - a) How do the ratios of hydrogen to oxygen atoms compare in galactose, glucose, and fructose?
 - b) How do they compare to the ratio in water?
6. The structural arrangement of the C, H, and O atoms in glucose, fructose, and galactose differ. Does this difference help to explain why different cut out shapes are used for each monosaccharide?
7. Molecules of monosaccharides may have the same molecular formula but differ in their three dimensional shape. This is called isomerism and each of the simple sugars are called isomers. Describe isomerism in your own words using the cut out models and structural formulas as a guide.

II. Disaccharides or Double Sugars

Two monosaccharide sugar molecules can join together chemically to form a larger carbohydrate molecule called a double sugar, or disaccharide. By chemically joining a glucose molecule with a fructose molecule, a different double sugar called sucrose is produced. Use the paper cut out models to illustrate this process.

Cut out a glucose and a fructose paper model molecule. Cut along the solid lines only. Try to join the two molecules together to form a sucrose molecule.

8. Will the two cut out molecules stay together to form one molecule of sucrose?

In order to join the two molecules together, you must remove an OH end from one molecule and an H end from the other. Cut along the dotted lines. Do not lose the small cut outs; you will use them later to form a new compound.

9. Does this aid in joining the two sugar molecules to form sucrose?

Attach the sucrose molecule in the space below and title it. Attach the H and OH ends together and title it. You have chemically bonded two monosaccharides together and created one disaccharide and one molecule of water. In order for glucose and fructose to bond together, it is necessary to create bonding sites. By removing an H from one of the oxygen atoms in one sugar and an OH from a carbon in the other sugar, this allows the two sugars to chemically bond forming sucrose.

10. The H and OH ends removed from the glucose and fructose can join to form what familiar compound?

Construct a lactose molecule by joining together a glucose and galactose paper model molecule. Remember to remove the H and OH ends to ensure proper joining. Attach the molecules in the area below and title them. There should be one disaccharide molecule and one water molecule attached to the paper when you are finished with this task.



11. Write the molecular formula for lactose by adding the correct subscripts. Use the structural formulas as a guide and remember that a H₂O molecule was lost. C H O

12. Write the molecular formula for sucrose by adding the correct subscripts. C H O

13. Determine the ratios of hydrogen atoms to oxygen atoms for both molecules.

- a) How does the ratio of H to O atoms compare in sucrose and lactose?
- b) How does the ratio of H to O atoms compare in glucose and fructose?
- c) How does the ratio of H to O atoms compare in water?

14. Do isomers exist in double sugars? Compare your model of sucrose to your model of lactose. Explain your answer.

15. How many monosaccharide molecules are needed to construct a disaccharide molecule?

III. Polysaccharides or Complex Sugars

Just as double sugars were formed from two monosaccharide sugar molecules, complex sugars are formed when many single sugars are joined together chemically. The exact number of glucose molecules attached together to form these polysaccharides is not known. Starch and cellulose are the two most common polysaccharides in biology. They consist of long chains of glucose molecules joined together.

Construct a starch molecule by joining three glucose molecules. This will represent only a small part of a starch molecules. Attach the molecules in the area below and title them. There should be one polysaccharide molecule and two water molecule

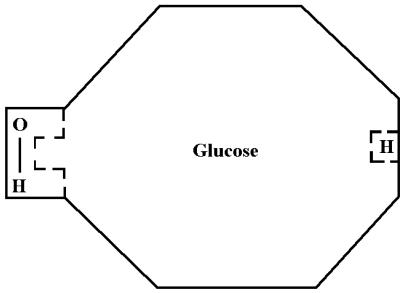
attached to the paper when you are finished with this task.



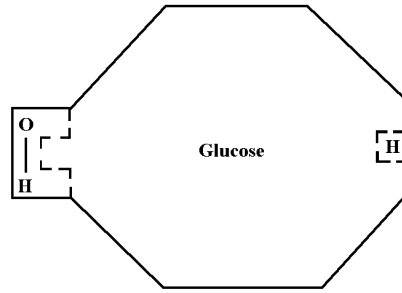
16. What must be removed from some of the glucose molecules in order to join them?
17. Using the middle “glucose” molecule of your model., determine the molecular formula of starch. Remember that a molecule of water has been lost from the middle glucose molecule when it joined with the other two. Add the correct subscripts (C H O) .
18. a) How does the ratio of H to O atoms in starch compare with the ratio in double sugars?
b) How does the ratio of H to O atoms in starch compare with the ratio in simple sugars?
c) How does the ratio of H to O atoms in starch compare with the ratio in water?
19. What three elements make up all carbohydrates?
20. What is the ratio between H and O atoms in carbohydrates and water?
21. What smaller molecules join to make up disaccharides?
22. What small molecules make up all polysaccharides?
23. When a disaccharide molecule is produced, what other common molecule is always formed?
24. “Mono” means one, “di” means two, and “poly” means many. Why are these prefixes used in describing the three main types of carbohydrates?
25. Synthesis means “putting together”. Dehydration means “loss of water”. Explain why chemists refer to the joining of monosaccharide molecules forming disaccharides as a dehydration synthesis, or condensation, reaction .

Cut Out Models for the Carbohydrate Worksheet

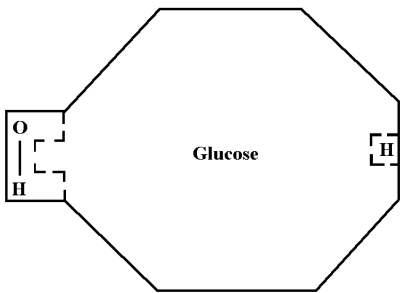
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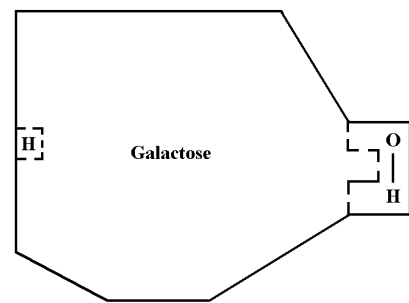
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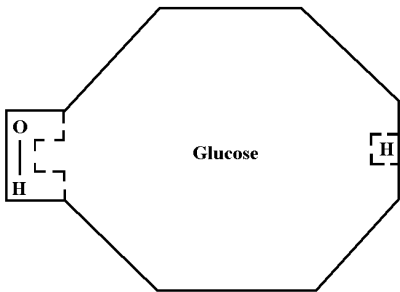
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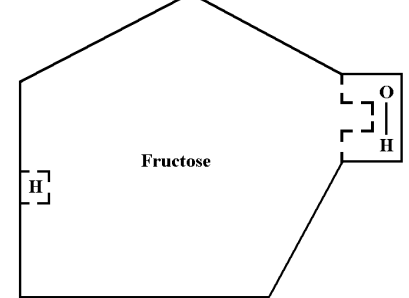
Blue



Red



Yellow



Red

