

Name \_\_\_\_\_

Date \_\_\_\_\_

## Chemistry of Carbohydrates

### Procedure:

#### Part A: Carbohydrates

An important group of biological compounds are the saccharides, or more commonly, the sugars of carbohydrates. Carbohydrates contain carbon, hydrogen and oxygen. The many different types of sugars have been grouped into three main categories: monosaccharides, disaccharides and polysaccharides.

#### Monosaccharides or simple sugars

Examine the structural formulas and the corresponding models for the three monosaccharides that you have been given.

The paper models do not represent the true three-dimensional shapes of the molecules. They are used to illustrate that the individual molecules of carbohydrates do differ from one another in general structural shape. Also, they show how it is possible for molecules to join together to form different carbohydrates.

1. What three 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? \_\_\_\_\_
5. How does the ratio of hydrogen to oxygen atoms compare in the three sugars?  
\_\_\_\_\_  
How do they compare to the ratio in water?  
\_\_\_\_\_
6. The structural arrangement of C, H, and O in glucose, fructose and galactose differs. Does this difference help to explain why different model shapes are used for each monosaccharide?  
\_\_\_\_\_
7. Molecules of monosaccharides may have the same molecular formula but differ in three-dimensional structure. This is called isomerism. Describe isomerism in your own words using the models and structural formulas as a guide.  
\_\_\_\_\_  
\_\_\_\_\_

#### Disaccharides or double sugars

Two monosaccharide sugar molecules can join together to form a larger carbohydrate molecule called a double sugar, or disaccharide. By chemically joining a glucose molecule with another glucose molecule a double sugar is formed called maltose. By joining a glucose and a fructose molecule, a different molecule is formed called sucrose.

- Cut out a glucose and fructose paper model molecule. Cut along the solid lines only. Attempt to join these models together.

8. Will the sucrose molecule stay together? \_\_\_\_\_
- In order to join the molecules together, remove an -OH end from one molecule and an -H end from another. Cut along the dotted lines.
9. Does this aid in joining the two molecules? \_\_\_\_\_
10. The +H and -OH ends removed from the glucose and fructose can join to form what familiar compound? \_\_\_\_\_
- Construct a maltose molecule by joining together two glucose molecules. Remember to remove the +H and -OH ends to ensure proper joining.
11. Write the molecular formula for maltose by adding the correct subscripts. C H O .
12. Write the molecular formula for sucrose by adding the correct subscripts. C H O .
13. Determine the ratio of H atoms to O atoms in both molecules. How does the ratio of H to O compare in sucrose and maltose?
- \_\_\_\_\_
14. Does isomerism exist in double sugars? \_\_\_\_\_
15. How many monosaccharide molecules are needed to construct a disaccharide molecule? \_\_\_\_\_

### Polysaccharides or complex sugars

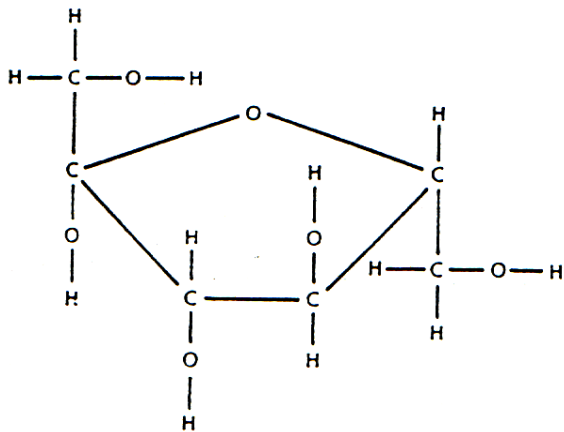
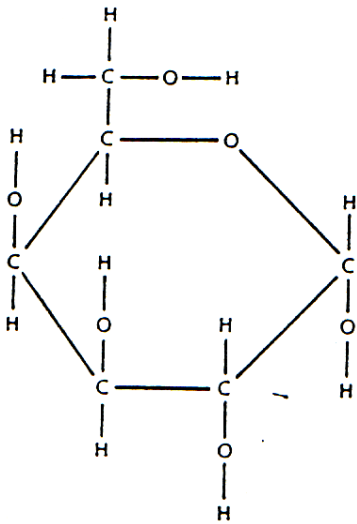
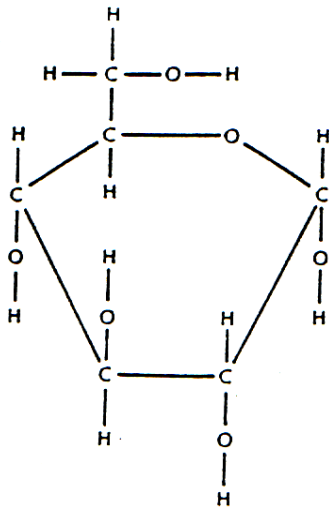
Just as double sugars were formed from two monosaccharide sugar molecules, complex sugars are formed when many single sugars are joined together chemically. The exact number of glucose molecules attached together to form these polysaccharides is not known. Starch and cellulose are the two most common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

- Construct a starch molecule by joining three glucose molecules. This will only represent a small part of a starch molecule because starch consists of hundreds of glucose molecules.
16. What must be removed from some of the glucose molecules in order to join them?
- \_\_\_\_\_
17. Using only the middle glucose molecule of your model, determine the molecular formula of starch. Add the correct subscripts, C H O .
18. How does the ratio of H to O atoms in starch compare to the double sugars? \_\_\_\_\_
- In single sugars? \_\_\_\_\_
- In water? \_\_\_\_\_

### Analysis

1. What three elements make up carbohydrates? \_\_\_\_\_
  2. What is the ratio between H and O atoms in carbohydrates and water? \_\_\_\_\_
  3. What small molecules make up all disaccharides? \_\_\_\_\_
  4. What small molecules make up all polysaccharides? \_\_\_\_\_
  5. What common molecule is formed when monosaccharide molecules are joined? \_\_\_\_\_
  6. Mono means one, di means two and poly means many. Why are these types of terms used to describe these three types of sugars? \_\_\_\_\_
  7. Synthesis means putting together. Dehydration means loss of water. Explain why chemists refer to the joining of monosaccharide molecules to form disaccharides as a dehydration synthesis reaction? \_\_\_\_\_
- \_\_\_\_\_
8. Why is the joining of three glucose molecules in forming a polysaccharide an example of dehydration synthesis? \_\_\_\_\_
  9. The word carbohydrate is derived from carbon and water (hydrate). Explain why this combination correctly describes this chemical group? \_\_\_\_\_
- \_\_\_\_\_

Structural formulas



Models

