

CARBOHYDRATES: CHEMISTRY AND IDENTIFICATION

6

In this investigation, you will identify the three main types of carbohydrates by using chemical tests.

Materials

~~paper~~
~~test tubes~~
 test tubes
 test tube holder
~~glucose, fructose, and galactose~~
 Benedict's solution
 iodine solution

droppers
 hot plate
 water
 beaker (Pyrex)
 monosaccharide solution
 disaccharide solution
 Goggles

polysaccharide solution

~~_____~~
~~_____~~
~~_____~~
~~_____~~
~~_____~~

There are three different groups of carbohydrates. They are called monosaccharides, disaccharides, and polysaccharides. "Saccharide" means sugar.

Group 1. Monosaccharides (single molecule sugars)

A single molecule sugar is called a monosaccharide. The prefix "mono-" means one. However, the one molecule can have different shapes due to a different arrangement of atoms. Three monosaccharides are glucose, fructose, and galactose.

Group 2. Disaccharides (double molecule sugars)

Two monosaccharide sugar molecules can join chemically to form a larger carbohydrate molecule called a double sugar, or disaccharide. The prefix "di-" means two. By chemically joining a glucose molecule with a fructose molecule, a double sugar called sucrose is produced.

Group 3. Polysaccharides (many molecule sugars)

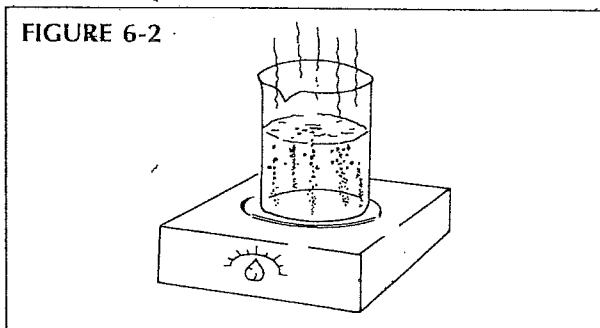
Just as double sugars were formed from two single sugar molecules, polysaccharides are formed when many single sugars are joined chemically. The prefix "poly-" means many. Starch, glycogen, and cellulose are the three most common polysaccharides in biology. They consist of long chains of glucose molecules joined.

Part C. Identification of Carbohydrates

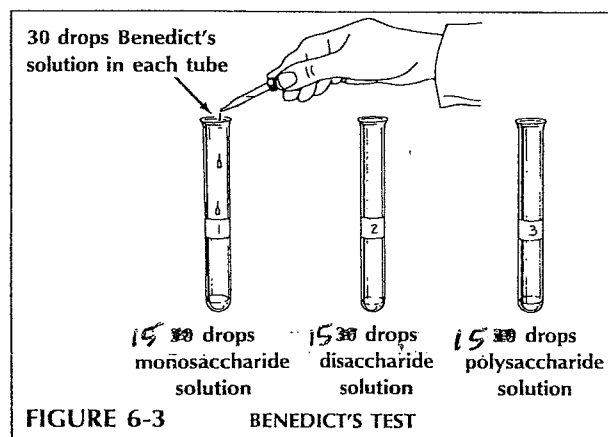
I. Chemical Tests on Known Carbohydrates

Benedict's Test

- Fill a 500 mL beaker half full of water. Bring the water to a boil on a hot plate. The boiling water is called a hot water bath (Figure 6-2). **CAUTION:** *Water is very hot.*



- Number three clean test tubes one to three. Using Figure 6-3 as a guide and a clean dropper for each tube, add the following:
 Tube 1—15 drops of monosaccharide solution
 Tube 2—15 drops of disaccharide solution
 Tube 3—15 drops of polysaccharide solution



- Add 30 drops of Benedict's solution to each tube.
- CAUTION:** If Benedict's solution spillage occurs, rinse with water and call your teacher.
- Place the three test tubes into the hot water bath for five minutes.
 - Use a test tube holder to remove the tubes from the hot water bath.

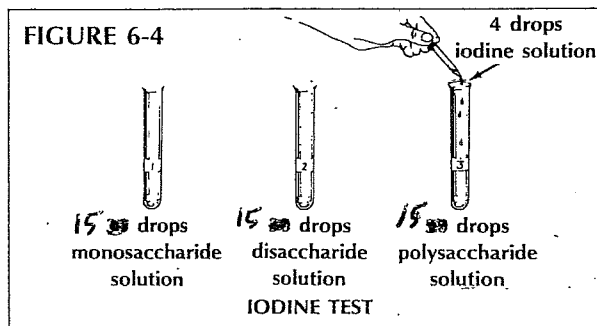
CAUTION: Water and test tubes are very hot. Handle test tubes only with a test tube holder.

- Observe any color changes in the solutions. NOTE: A color change may or may not occur when Benedict's solution is added to a carbohydrate and then heated. A change from blue to green, yellow, orange, or red occurs if a monosaccharide is present. The original blue color will remain after heating if a disaccharide or polysaccharide is present.

- Record in Table 6-1 the color of the solutions in the tubes in the column marked "Benedict's Color After Heating."

Iodine Test

- Number three clean test tubes one to three. Using Figure 6-4 as a guide and a clean dropper for each tube, add the following:
 Tube 1—30 drops of monosaccharide solution
 Tube 2—30 drops of disaccharide solution
 Tube 3—30 drops of polysaccharide solution



- Add 4 drops of iodine solution to each tube. **CAUTION:** If iodine spillage occurs, rinse with water and call your teacher immediately.
- Mix the contents of each tube by gently swirling.
- Record in Table 6-1 the color of the solutions in the three tubes in the column marked "Iodine color." NOTE: A color change may or may not occur when iodine solution is added to a carbohydrate. A change from its original rust color to deep blue-black occurs if a polysaccharide is present. The original color of the carbohydrate remains if a disaccharide or monosaccharide sugar is present.

TABLE 6-1. RESULTS OF TESTS WITH KNOWN CARBOHYDRATES

TUBE NUMBER	CARBOHYDRATE TYPE	BENEDICT'S COLOR AFTER HEATING	IODINE COLOR
1	Monosaccharide		
2	Disaccharide		
3	Polysaccharide		

Analysis

Use your results from Parts A and B to answer questions 1 to 5.

1. Name the three categories of carbohydrates studied in this investigation. _____

2. What three elements are present in all carbohydrates?

3. Give two examples each of sugars that are
 - (a) monosaccharides. _____
 - (b) disaccharides. _____
 - (c) polysaccharides. _____
4. (a) How many times larger is the number of hydrogen atoms than oxygen atoms in all carbohydrates?

- (b) In water? _____
5. "Mono-" means one, "di-" means two, and "poly-" means many. Why are these terms used in describing the three types of sugars? _____

Use your results from Part C to answer questions 6 to 9.

6. How can you tell by using Benedict's and iodine solutions if a sugar is a
 - (a) monosaccharide? _____
 - (b) disaccharide? _____
 - (c) polysaccharide? _____
7. A certain sugar has no change in color when tested with Benedict's solution.
 - (a) Can you tell what type of saccharide it is? _____
 - (b) Explain: _____

8. A certain sugar has a color change in Benedict's solution.
 - (a) Can you tell what type of saccharide it is? _____
 - (b) Explain: _____

9. Give an example of a food that is a
 - (a) monosaccharide. _____
 - (b) disaccharide. _____
 - (c) polysaccharide. _____

