Carbohydrates

Carbohydrates are a class of organic compounds such as sugar, starch, glycogen, cellulose. Carbohydrates were considered to be hydrates of carbon because they contain hydrogen and oxygen in the ratio of 2:1 just as in water and the general formula of carbohydrates is $C_n(H_2O)_n$.

Carbohydrates are defined as aldehydes or ketones of polyhydroxy alcohols.

Carbohydrates are divided into three major categories:

1- Monosaccharides are simple sugars, that can't be changed into simpler sugars upon hydrolysis (reaction with H_2O) e.g. glucose, fructose, galactose, arabinose and xylose.

2- Disaccharides are double monosaccharides: on hydrolysis they yield two simple sugars. e.g. maltose, sucrose and lactose.

3- Polysaccharides are complex saccharides: on hydrolysis a polysaccharide yields many simple sugars.

Sugars which contain free aldehyde or ketone group have a reducing ability and are known as an aldoses or ketoses respectively.

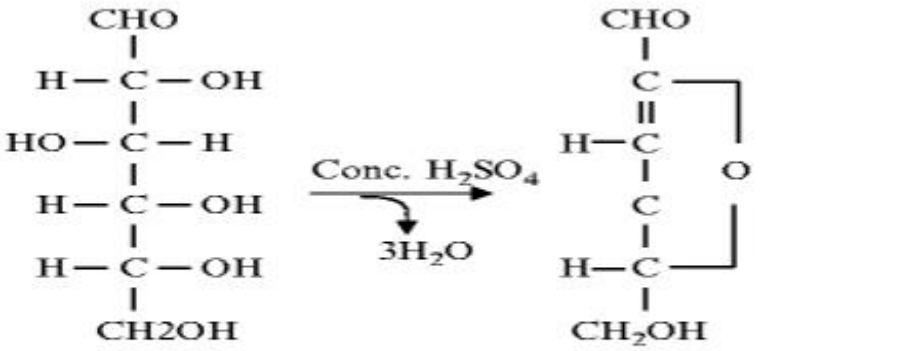
Carbohydrates form first by photosynthesis in plants from CO_2 and H_2O.

Carbohydrates can be a source of energy, stores of energy, structural units in the living body or are part of function molecule such as antibodies and certain hormones.

Qualitative Tests for Carbohydrates:

Molisch test:

Concentrated sulphuric acid H_2SO_4 hydrolyse glycosidic bonds to give monosaccharides which are then dehydrated to give furfural (from pentoses) or its derivative (hydroxy-methyl furfural) from hexoses, which in turn combine with sulphonated naphthol to give purple ring.



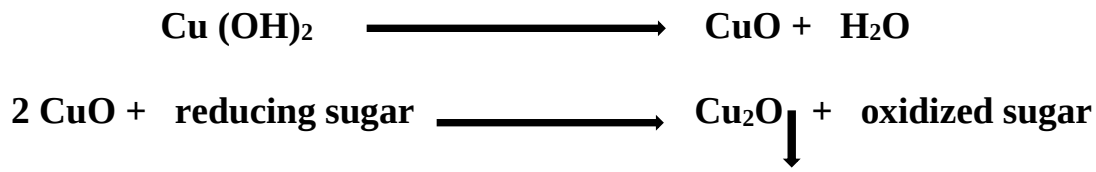
D-Glucose Hydroxymethyl furfural

Procedure:

1) Add 2 drops of α- Naphthol to10 drops of sugar solution in a test tube.
2) Carefully add about 20 drops of conc. H_2SO_4 down the side of the tube, two layers will be formed, observe the purple ring at the junction of the two layers.

Benedict's test:

Carbohydrates with a free aldehyde or ketone group have reducing properties in alkaline solution of copper (II) hydroxide Cu $(OH)_2$, forming rust-brown cuprous oxide precipitate.



Procedure:

1) Add 10 drops of the sugar solution to 15 drops of Benedict's reagent in a test tube.
2) Place the tube in a boiling water bath, observe any change in color or precipitate.

Barfoed's test:

This test is used to distinguish reducing monosaccharides from reducing disaccharides. Since the monosaccharides reduce cupric ions (Cu^{+2}) faster than disaccharides even in slightly acidic solution. The rate of reduction depends upon the concentration of cupric ions and the time of heating.

Procedure:

1) Add 5 drops of the sugar solution to 15 drops of Barfoed's reagent in a test tube.
2) Boil for 3 minutes, and allow to stand. Report your observations.

Seliwanoff's test:

This test is used to distinguish an aldohexose from ketohexose. Heating with HCL dehydrates hexoses to hydroxymethyl furfural (HMF). Ketohexoses yield large amount of HMF and at faster rate than do aldohexoses. HMF form red condensation product with resorcinol.

Procedure:

1) To 15 drops of Seliwanoff's reagent add 10 drops of sugar solution (fructose or glucose).
2) Place the tube in boiling water bath, record the time needed for your result for each sugar used. A red color develops with fructose (a ketohexose) and no such color with glucose (an aldohexose).

Notes:

1) Sucrose also gives a positive test because it is readily hydrolysed during the course of the test yielding fructose as one of the products.
2) The time factor in Seliwanoff's test is very important.

Bial's test:

This is specific for pentoses.

Procedure:

1) To 15 drops of Bial's reagent add 5 drops of pentose solution (Xylose or arabinose) and heat in boiling water bath for 3-4 minutes, to get a blue-green color.

Reagents:

1) **Benedict's reagent:** Dissolve 173 gm of sodium citrate, 100 gm sodium carbonate in 800 ml warm water. filter into a 1000 ml measuring cylinder and make up to 850 ml with distilled water. Meanwhile, Dissolve 17.3 gm of copper sulfate in about 100 ml H_2O and make up to 150 ml pour the first solution into a 2 L beaker and slowly add the copper sulphate solution with stirring.
2) **Barfoed's reagent:** Consists of 6.5% copper acetate in 1% acetic acid.
3) **Bial's reagent:** Is made by dissolving 0.3 g orcinol in 100 ml conc. HCL and then adding 5 drops of 1% solution of ferric chloride.
4) **Seliwanoff's reagent:** Is made by dissolving 0.05 g of resorcinol in 100 ml of dilute (1:2) HCL.