Quadrant II – Transcript and Related Materials

Programme : Bachelor of Science (Third year)

Subject : BOTANY

Course Code : BOC - 106

Course Title : Cell biology and plant biochemistry

Unit : 04

Module Name : Structure and Properties of Monosaccharides (Glucose and Fructose)

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Notes:

MONOSACCHARIDES

- In Greek *monos:* single and *Sacchar:* Sugar
- They are the most basic units of carbohydrates.
- With few exception (e.g. deoxyribose), monosaccharides have chemical formula: $C_x(H_2O)n$.
- These are also refered as simple sugar. The term sugar is applied to carbohydrate that are soluble in water and sweet to test.
- They consist of single polyhydroxy aldehyde and ketone units and thus cannot be hydrolysed into a simpler form.

Properties of monosaccharides

- The important monosaccharide - Glucose (Hexose).
- They are simple form of sugars and are usually colorless, water soluble, crystalline solids.
- Some monosaccharides have a sweet taste.
- Monosaccharides are the building blocks of Diasaccharides (Sucrose and Lactose) and Polysaccharides (Cellulose and Starch).

- Each carbon atom that supports a hydroxyl group is chiral (all of the C except for the fist and terminal), giving rise to number of isomeric forms, all with the same chemical formula.
- For instance, Galactose and Glucose are both Aldohexoses, but have different physical structure and chemical properties.
- Carbohydrates can be represented in a linear chain form or cyclic form.
- Cyclic form is formed of either 5C or 6C: 5 C ring- Furanose and 6 C ring- Pyranose.

Depending on the number of carbon atoms they possess, monosaccharides are classified as:

1. Trioses
2. Tetroses
3. Pentoses
4. Hexoses
5. Heptoses

Depending upon the functional aldehyde (CHO) or ketone(C=O) group present:

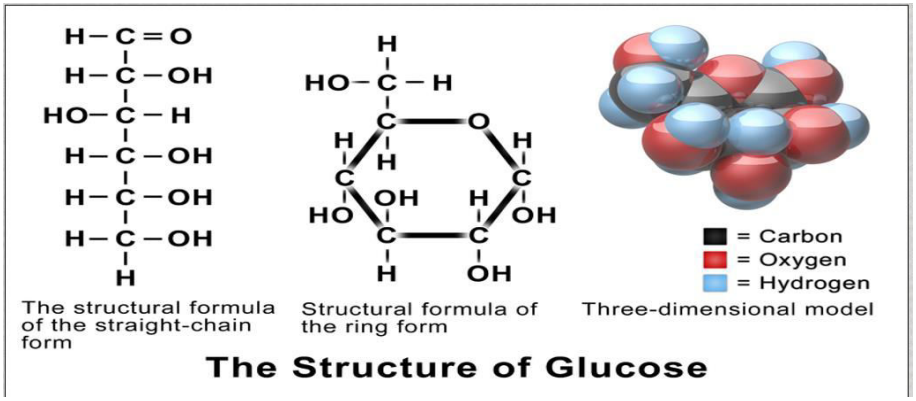
1. Aldoses
2. Ketoses

Properties of glucose

Chemical name	**Glucose**
Chemical Formula	$C_6H_{12}O_6$
Density	1.54 g/cm^3
Molecular Weight	180.16 g/mol
Melting Point	146 °C
Taste	Sweet

Structure of glucose

- The common monosaccharides have cyclic structure. For simplicity the structure of aldoses and ketoses are represented as straight chain molecule.
- In solution, aldehyde or ketone group of monosaccharide react with a hydroxyl group of the same molecule forming a bond hemiacetal or hemiketal.



OPEN CHAIN STRUCTURE OF GLUCOSE COULD NOT EXPLAIN FOLLOWING FACTS AND REACTIONS:

1. In spite of having aldehyde group, it doesn't give results for Schiff's test and doesn't form - hydrogen sulphate addition product with NaHSO3.
2. The penta-acetate of glucose doesn't react with NH2-OH indicating absence of free CHO group.
3. Glucose is found to exist in 2 different crystalline forms – alpha and beta.

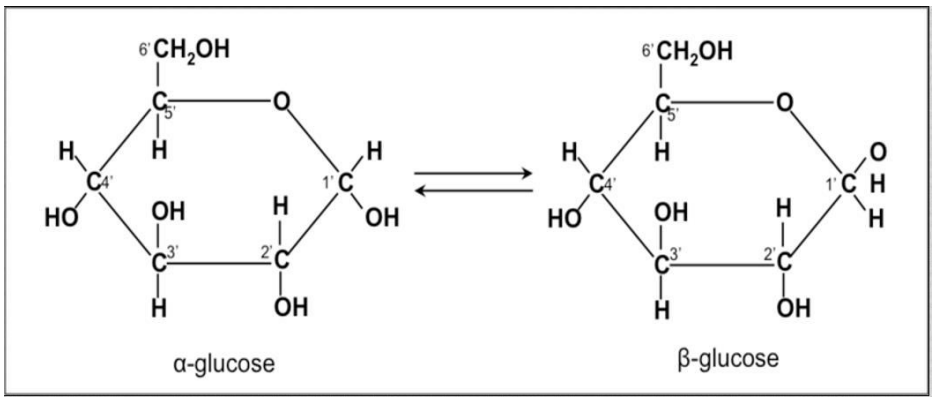
Alpha and beta form of glucose:

The designation of alpha means that the hydroxyl group attached to C-1 is below the plane of the ring. Beta means that it is above the plane of the ring. The carbon is the anomeric carbon atom and so alpha and beta forms are anomers.

The Alpha form of glucose – CYCLIC is obtained by crystallization from concentrated solution of glucose at 303 K.

The Beta form of glucose - CYCLIC is obtained by crystallization from hot and saturated aqueous solution at 371 K.

The cyclic structure of Glucose is represented by Haworth structure.



Properties of fructose

Chemical name	**Fructose**
Chemical Formula	$C_6H_{12}O_6$
Solubility	Soluble in water.
Molecular Weight	180.156 g/mol
Melting Point	103℃
Taste	Sweet

- Fructose is an important ketohexose which is obtained by hydrolysis of disaccharide sucrose.
- It is white crystalline solid at room temperature.
- It is an odorless sugar.
- It absorbs moisture quickly and becomes sticky.
- Fructose can be fermented anaerobically by yeast and bacteria. Yeast converts sugar to ethanol and carbon dioxide.

Open chain structure of fructose

In open chain, an arrangement of atoms is represented in a structural formula by a chain whose ends are not joined to form a ring.

Cyclic structure of fructose

- The ring formed is a 5C ring and is named as Furanose with analogy to the compound Furan.
- In free state Fructose is present in the Pyranose ring form and in the combined state, it is present in the Furanose form.

Alpha fructose