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Biochemistry & Clinical Pathology
Chapter 2 : Carbohydrates

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Chapter 2
Carbohydrates

- → Carbohydrates are Organic Compound with general formula $Cn(H_2O)n$
- → They are Composed of Carbon, Hydrogen, Oxygen,
- → Carbohydrates are polyhydroxy aldehydre or ketone compound derived from hydrolysis.
- → They are the Major source of chemical energy for the living organisms.
- → Ex : Sugar & Starch.
- → Starch & Cellulose are the two common carbohydrates.

Classification of Carbohydrates

Carbohydrates

- → On the basis of Complexity / Compound
- → On the basis of reactivity
- → On the basis of Functional Group

Classification on the basic of complexity

1. **Monosaccharides (Simple sugar)**
    - Carbohydrates that can't be hydrolysis to simple compound are called monosaccharides.
    - These are single unit carbohydrates (have the one sugar molecules).
    - Example : Glucose, Fructose, Galactose,
2. **Oligosaccharides**
    - These are made up of 2-10 units of monosaccharides/ simple sugar
        - **Disaccharides :** These oligosaccharides consists of two monosaccharides units
            - Example : Sucrose Glucose + Fructose
        - **Trisaccharides :** These oligosaccharides consists of 3 monosaccharides units
            - Example : Raffinose. Glucose + Fructose + Galactose
3. **Polysaccharides**
    - A single molecules of a polysaccharides sugar is formed by polymerization of more than 10 monosaccharides units
    - Example : Starch or Cellulose

Classification on the basic of Reactivity

- **Reducing sugar :** These sugar act as reducing agent & these reduce fehlings & Tollens reagents.
- **Non Reducing Sugar :** These sugar do not reduce fehlings & Tollens reagents.

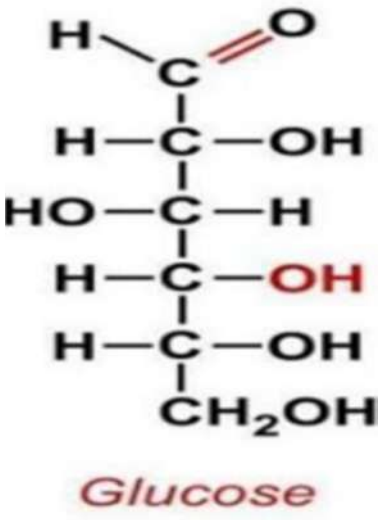
Classification on the basic of functional groups

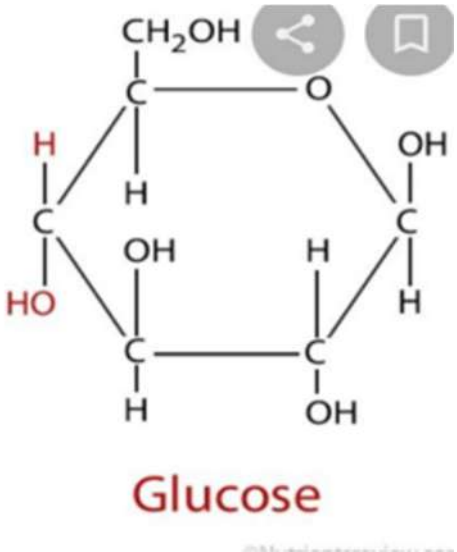
- **Aldose :** These sugar have an aldehyde functional groups
  - **Example :** D-glucose
- **Ketose :** These sugar have an ketone functional group
  - **Example :** D-fructose

Monosaccharides

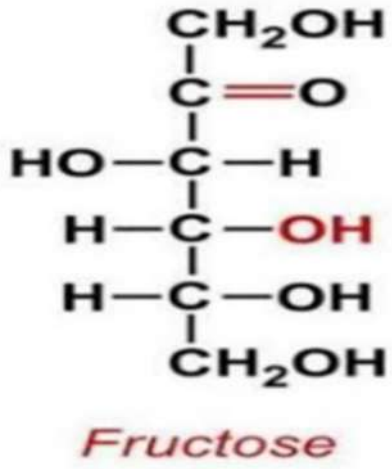
- Monosaccharides are derived from the Greek word mono which means single & saccharide which means sugar.
- Monosaccharides can't be hydrolysed further to provide simple sugar.
- Simple sugar are known as monosaccharides.
- They have a sweet flavour.
- They are water soluble.
- They have a Crystalline appearance.
- They have
- 3-10 carbon atom
- 2 or more hydroxyl (OH) groups
- One aldehyde (CHO) or Ketone (CO) groups
- There general formula is $C_nH_{2n}O_n$

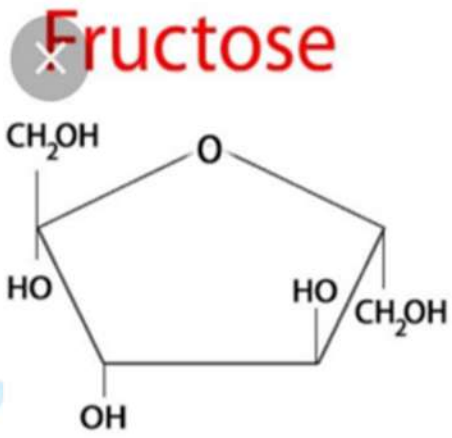
Structure of Glucose



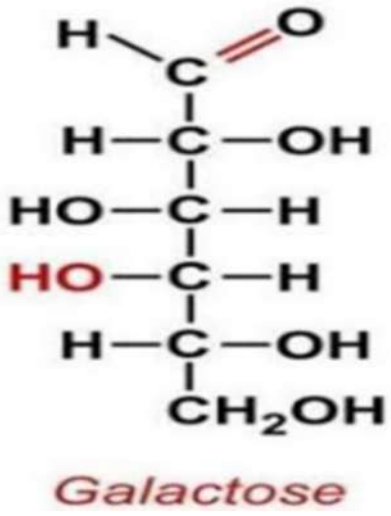


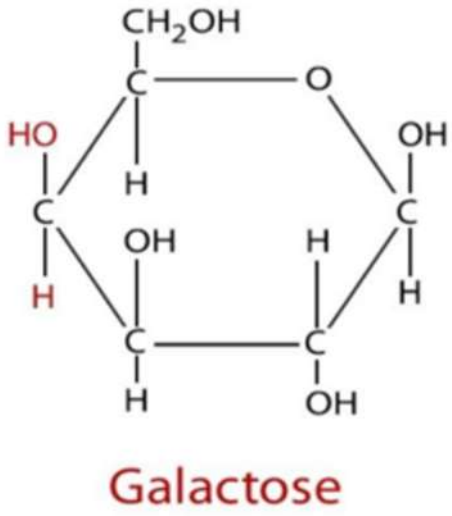
Structure of Fructose





Structure of Galactose

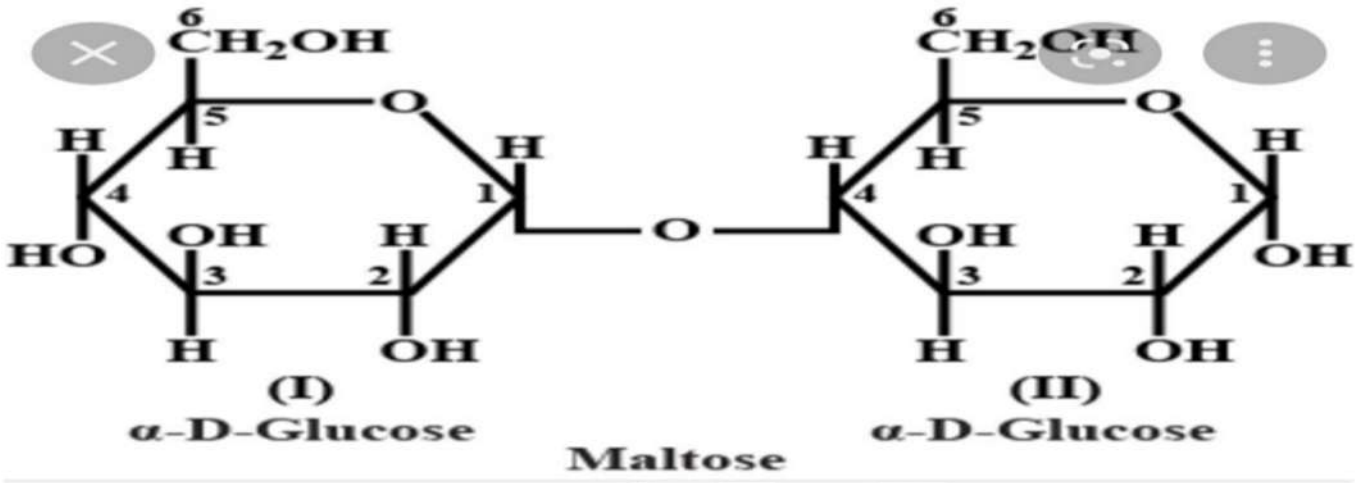




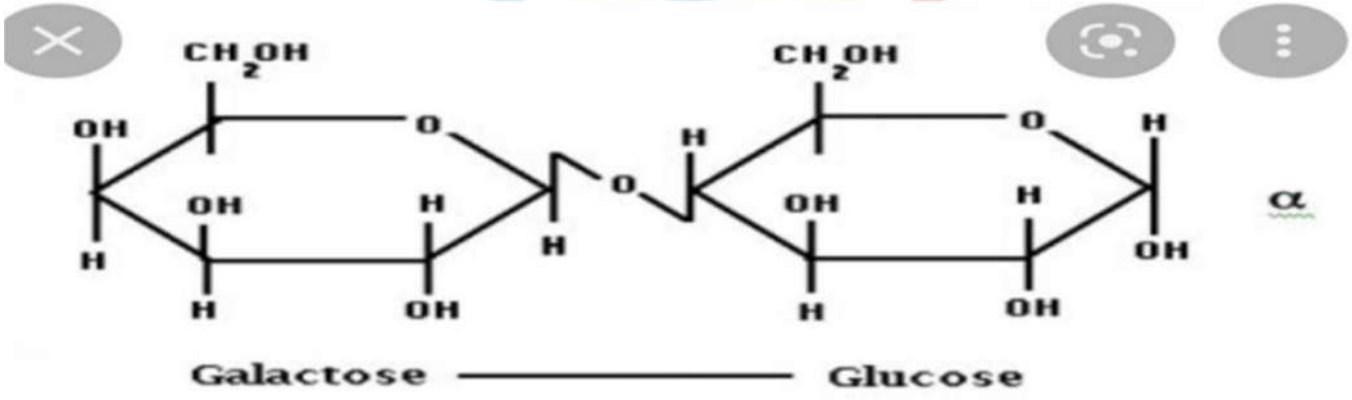
Disaccharides

- → Disaccharides are those carbohydrates which are made up of two monosaccharides units
- → They can be reducing sugar. Lactose
- → They can be non reducing sugar Sucrose

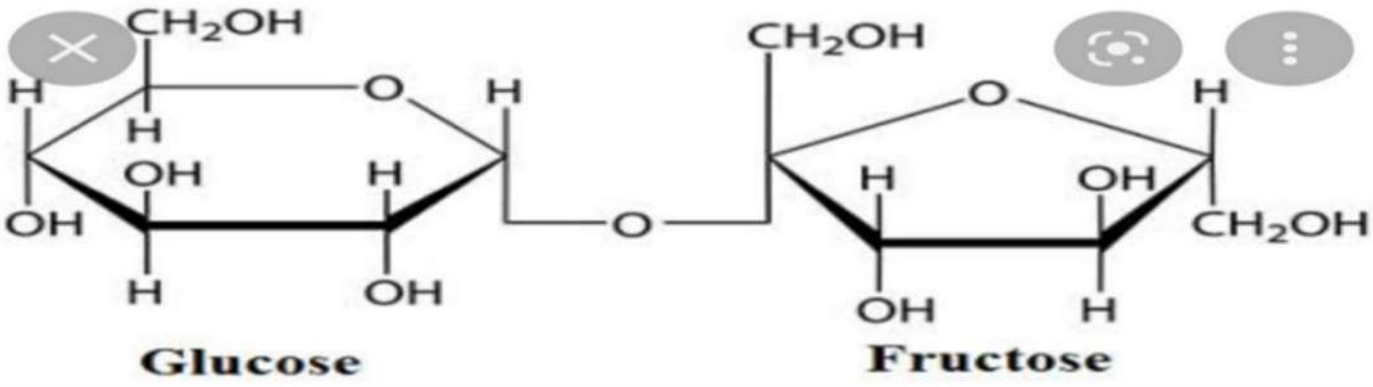
Structure of Maltose



Structure of Lactose



Structure of Sucrose



Polysaccharides

- → They are composed of long carbohydrates molecules chain constituted of numerous simple monosaccharides
- → Polysaccharides are considered to be the major class of biomolecules
- → This complex Biomolecules function as a important source of energy in animals and form a structural components in plant cells
- → They do not have a sweet flavour
- → Many are water insoluble
- → They are naturally hydrophobic
- → They are carbohydrates with a high molecular weight
- → They are made up of 3 elements hydrogen, carbon, oxygen,

Classification of Polysaccharides

1. **Homopolysaccharides :**
   • The monomeric units are arranged in the form of long chain either unbranched or branched. • Eg: Starch, Glycogen, Cellulose etc.
2. **Hetrropolysaccharides :**
   • Hemicellulose is a polymer containing D-xylose, L-arabinoc, D-Galactose, LRhamnose, D-Monnose and D-Glucoronic acid • Eg. : Heparin

Chemical Nature of Starch

- Glucose is stored in plants in the form of starch.
- It is composed of two components " Amylose "and " Amylopectin"
- Amylose is made up of 250 - 300 glucose , that are joined together by α -1 , 4 glycosidic bond.
- Amylose chains are unbranched and coiled.
- Amylose are consist about 15 - 20 %
- Amylopectin is a glucose polymer with α 1, 4 glycosidic linkage.
- Side chains with about 12 glucose are linked to the main chain with α -1,6 glycosidic linkage.

Chemical Nature of Glycogen

- Glucose is stored in the form of glycogen in animals.
- It is found mostly in liver and muscles.
- It is often called animal starch.
- It converted in to glucose and provide energy in short term requirement.
- It is a polymer which is highly branched , and 8 - 10 glucose units present per branch.
- The chain of glycogen are joined together by α 1, 4 glycosidic link.
- and branches are joined to the main chain by α 1, 6 glycosidic bond.
- The structure of glycogen is similar to amylopectin but it is more highly branched.

Qualitative Test

The qualitative tests are performed for identification of carbohydrates are following :

1) **Fehling's Test :** In this test , 1-2 ml each of the Fehling's solution A and B are added to few drops of the test solution and boiled for a few minutes . A Yellowish red colour appears that confirms the presence of reducing sugar (carbohydrate).
2) **Tollen's test :** In this test , 2-3ml of Tollen's reagent is added to 2-3 ml of aqueous solution of carbohydrate , and boiled in a water bath for 10 minutes . A shining silver mirror indicates the presence of reducing carbohydrates.

Biological role of Carbohydrates

- They are source of energy for living organism.
- They are used as dietary fibers like cellulose.
- They are used as flavouring and sweating agent.
- They are stored in our body in the form of glycogen in liver and muscles and converted into glucose to provide energy according to need.
- They are important component of brain cells.
- They are important component of DNA & RNA (Deoxyribose and Ribose sugar)
- They act as an anticoagulant in the form of Heparin.
- They are major component of cartilage , tendon and bones.
- They are used in clearance test in the form of Inulin.
- They are used in the treatment of heart diseases in the form of Glycosides.