

PUC 1ST YEAR –SEMESTER-2

UNIT II: Chemical constituents of living cells

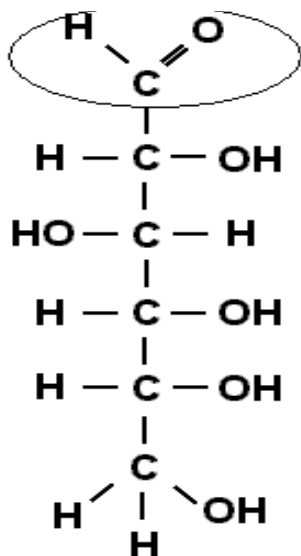
Module no 8 : Carbo hydrates –Structure classification and functions

Carbohydrates may be defined as polyhydroxy aldehydes or ketones or as substances that yield one of these compounds on hydrolysis.

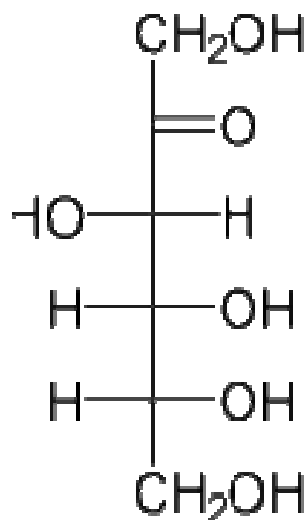
Carbohydrates are the organic compounds consisting of carbon, hydrogen and oxygen, the last two in a 2:1 ratio as in water. Carbohydrates are a group of universally occurring compounds having the general formula $(CH_2O)_n$, in which 'n' is 3 or greater. Carbohydrates serve as the chief source of energy in the food of many animals. The carbohydrates are widely distributed both in animal and plant tissues. In animal cells they occur chiefly in the form of glucose and glycogen, where as in plants cellulose and starch are the main representatives. Carbohydrates are also important structural components.

Structure:

Carbohydrates are aldehydes and ketone derivatives of Polyhydroxy alcohols. Each carbohydrate therefore contains an aldehyde or a ketonic group and is known as aldose or a ketose.



Glucose (aldose)



Fructose (ketose)

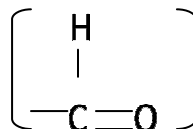
Classification:

Carbohydrates are classified into three groups.

1. Mono Saccharides
2. Oligo Saccharides and
3. Poly Saccharides

1. Mono Saccharides(simple sugars):

Monosaccharides are the simplest carbohydrates which cannot be hydrolyzed to smaller molecules. The monosaccharides are divided into two categories, based on the functional group and the number of carbon atoms. When the functional group in monosaccharides is an aldehyde.

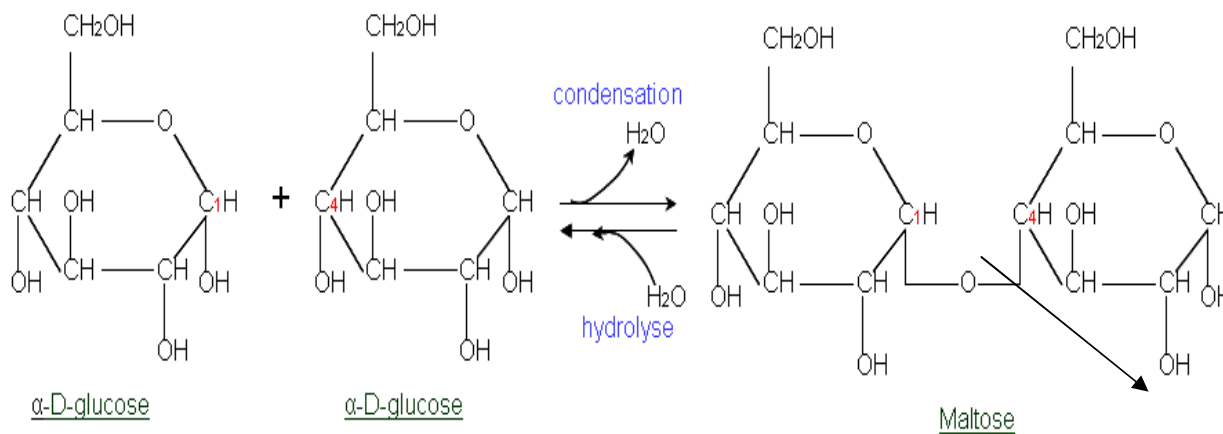


they are known as aldoses Ex: glyceraldehyde, glucose. When the functional group is a keto ($-C=O$) group, they are referred as ketoses ex: Fructose.

Based on the number of carbon atoms, the mono saccharides are regarded as trioses (3c), tetroses (4c), pentoses (5c), hexoses (6c), heptoses (7c) and octoses (8c). Pentose sugars (ex. Ribose, deoxy ribose) are important constituents of nucleic acids. Hexoses are physiologically the most important of the monosaccharides. The important hexoses are Glucose, fructose and galactose. Glucose is the principal sugar in blood, serving the tissue as a major metabolite fuel.

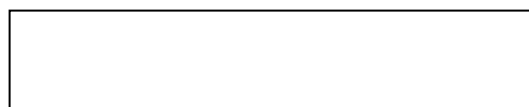
2. Oligo Saccharides:

The Oligo saccharides are those Carbohydrates which on hydrolysis give two to ten simple mono saccharide molecules. During union of monosaccharide units water molecule is eliminated and the units are linked through an oxygen bridge known as glycosidic linkage.



Glycosidic

bond



Formation of Maltose

The oligo saccharides are further classified depending upon the number of monosaccharide units formed on hydrolysis into Disaccharides, tri-, tetra-, and penta saccharides, respectively.

Disacharieds on hydrolysis produce two molecules of the same or different mono saccharides.

Maltose \longrightarrow Glucose + Glucose

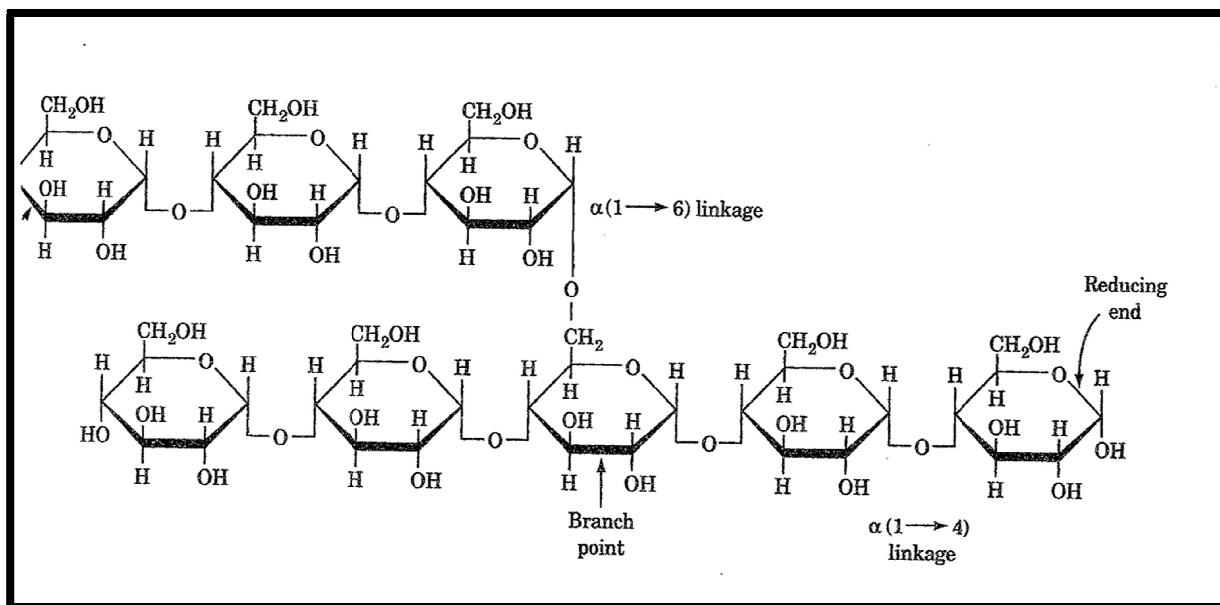
Sucrose \longrightarrow Glucose + Fructose

Lactose \longrightarrow Glucose + Galactose

Tri, tetra and penta saccharides on hydrolysis produce, three, four and five mono saccharide units respectively. The natural source of oligo saccharides are green plants.

3. Poly saccharides:

Majority of the carbohydrates found in nature occur as polysaccharides of high molecular weight. Polysaccharides yield more than 10 molecules of monosaccharides on hydrolysis. Some Polysaccharides are linear polymers and others are highly branched. In all cases the linkage that unites the monosaccharide units is the glycosidic bond. They are tasteless, colourless and insoluble in water. Because of insolubility and large size they form colloidal solutions and will not pass across natural animal membranes. They are represented by a general formula $(C_6H_{10}O_5)_n$.



Structure of amylopectin (Branched Starch)

Polysaccharides are of two types

- Homo polysaccharides(Homoglycans):** They contain mono saccharide units of a single type.
Ex: starch, inulin, cellulose, glycogen
- Hetero polysaccharides (Hetroglycans):** They possess two or more different types of mono saccharide units of their derivatives.
Ex: chitin, heparin, chondroitin sulfate etc.

Function of Carbohydrates:

Carbohydrates participate in a wide range of functions.

- They are the most abundant dietary source of energy (4 cal/g) for all organisms. About 60% of the total energy requirement of man is provided by the break down of carbohydrates.

2. Carbohydrates play a key role in the metabolism of amino acids and fatty acids.
3. Carbohydrates serve as an important structural material in some animals and in all plants, where they constitute the cellulose framework, Monosaccharides are important constituents of nucleic acids, co-enzymes, Flavoproteins etc. Heparin prevents the clotting of blood. Chondroitin sulphates are found in cornea, cartilage tendons, skin, heart valves and saliva. Glycosides are components of steroid hormones.
4. Some carbohydrates are essential for normal oxidation of fats.
5. Carbohydrates are utilized as raw materials for several industries.
EX: paper, plastic, textiles, alcohol etc.

Carbohydrates of Physiologic Importance:

1. **Ribose:** It is a structural element of ATP, nucleic acids(RNA) and coenzymes (NAD, NADP, Flavoproteins)
2. **Deoxy Ribose:** It is a structural element of Nucleosides, Nucleotides and DNA
3. **Glucose:** Glucose is the sugar of the body. It is the principal sugar in blood, serving the tissue as a major metabolic fuel. Structural unit of cellulose in plants.
4. **Fructose:** It occurs naturally in fruit juices and honey.
5. **Galactose:** It is synthesized in mammary glands and hydrolysed to make the lactose of milk.
6. **Sucrose:** Most commonly used table sugar.
7. **Lactose:** Major sugar in milk.
8. **Maltose:** Product of starch hydrolysis.
9. **Cellulose:** It is the chief constituent of plant cell wall. It is absent in animal body.

10. **Starch:** Starch is the carbohydrate reserve of plants which is the most important dietary source for higher animals, including man. It is found in cereals, potatoes, legumes, roots, tubers, vegetables etc.
11. **Glycogen:** Glycogen is the carbohydrate reserve in animals, hence often referred to as animal starch. It is present in high concentration in liver, followed by muscle, brain etc. Glycogen is a readily mobilized storage form of glucose.
12. **Chitin:** It is an important structural Polysaccharide in invertebrates. Ex: The exoskeleton of insects and crustaceans.
13. **Inulin:** It is a polymer of fructose found in dahlia bulbs, garlic, onion etc. It is used for assessing kidney function through measurement of glomerular filtration rate (GFR).

CHECK POINTS:

- Carbohydrates are the polyhydroxy aldehydes or ketones or compounds which produce them on hydrolysis.
- Carbohydrates are the major dietary energy sources.
- Carbohydrates are classified into 3 groups namely mono saccharides, oligo saccharides and Polysaccharides.
- Monosaccharides are further classified on the basis of presence of functional groups(into aldoses and ketoses) and the number of carbon atoms (trioses, tetroses, pentoses, hexoses and heptoses)
- Oligo saccharides on hydrolysis give 2 to 10 mono saccharide units.
- Among the oligosaccharides, disaccharides are the most common. These include lactose (milk sugar), maltose (malt sugar) and sucrose (table sugar/ cane sugar).
- Polysaccharides are the polymers of monosaccharids or their derivatives , held together by glycosidic bonds.

- Homopolysaccharides are composed of a single type of monosaccharide units (e.g., starch, Glycogen etc)
- Hetero polysaccherides contain a mixture of few monosaccharide units or their derivatives (e.g., chitin, heparin etc).

Object type Questions:

- The sugar present in the blood
A. **Glucose** B. Fructose C. Galactose D. Manose
- Carbohydrates which are not found in plants
A. Inulin B. Cellulose C. Starch **D. Galactose**
- Major metabolic fuel of the tissue is
A. Galactose B. Sucrose C. Fructose **D. Glucose**
- Monosaccharide units are linked with each other with the help of
A. Hydrogen bonds B. Covalent linkages C. Ionic bonds
D. Glycosidic linkages
- Maltose is a
A. **Disaccharide** B. Monosaccharide C. Oligosaccharide
D. Polysaccharide
- One of the following statement is not correct with regards to polysaccharides
A. They are represented by a general formula $(C_6H_{10}O_5)_n$
B. They are tasteless, colourless and insoluble in water
C. They form colloidal solutions
D. On hydrolysis they give 2 to 10 monosaccharide units
- Animal starch is
A. Glucose **B. Glycogen** C. Chitin D. None

8. Important structural polysaccharide present in the exoskeleton of some invertebrates is

A. Inulin B. Glycogen **C. Chitin** D. Cellulose

Short Answer Questions:

1. Define carbohydrates
2. Explain the significance of carbohydrates
3. Write notes on disaccharides
4. Write short notes on monosaccharides
5. Explain polysaccharides
6. List out some important functions of carbohydrates

Long answer Questions:

1. Describe the classification of carbohydrates
2. What are mono and oligo saccharides. Describe the important monosaccharides and disaccharides of physiological importance?