جامعة المستقبل
AL MUSTAQBAL UNIVERSITY

كلية العلوم
قسم الادلة الجنائية

المحاضرة التاسعة

Carbohydrates

المادة : عضوية
المرحلة : الاولى
اسم الاستاذ: م.د. كرار مجيد عبيد

Structure, Classification, and Functions of Carbohydrates

Introduction

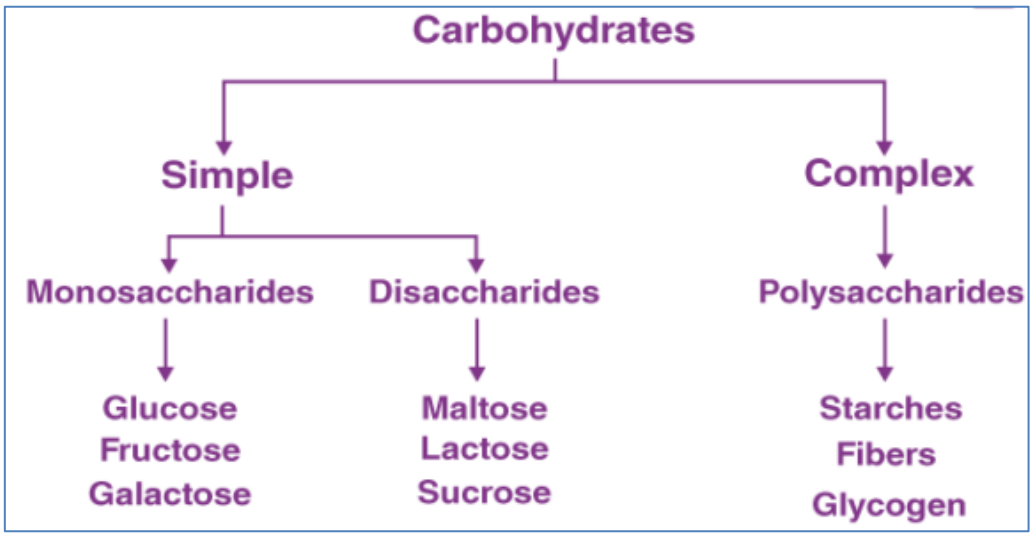
Carbohydrates are necessary for all living things, including people, plants, and microbes. They are essential to our diet and may be found in many different foods, such as fruits, grains, vegetables including potatoes, milk, honey, and table sugar. Out of the four macromolecules—proteins, fats, and nucleic acids—carbohydrates were the last to catch scientists' interest for investigation and further study.

What are Carbohydrates?

Carbohydrates are defined as biomolecules containing a group of naturally occurring carbonyl compounds (aldehydes or ketones) and several hydroxyl groups. It consists of carbon (C), hydrogen (H), and oxygen (O) atoms, usually with a hydrogen-oxygen atom ratio of 2:1 (as in water). It's represented with the empirical formula Cm(H2O)n (where m and n may or may not be different) or (CH2O)n.

But some compounds do not follow this precise stoichiometric definition, such as uronic acids. And there are others that, despite having groups similar to carbohydrates, are not classified as one of them, e.g., formaldehyde and acetic acid.

Classification of Carbohydrates



Carbohydrates are divided into four major groups based on the degree of polymerization: monosaccharides, disaccharides, oligosaccharides, and polysaccharides.

Given below is a brief account of the structure and functions of carbohydrate groups.

1. Monosaccharides

Monosaccharides are the simplest carbohydrates and cannot be hydrolyzed into other smaller carbohydrates. The “mono” in monosaccharides means one, which shows the presence of only one sugar unit.

They are the building blocks of disaccharides and polysaccharides. For this reason, they are also known as simple sugars. These simple sugars are colorless, crystalline solids that are soluble in water and insoluble in a nonpolar solvent.

The general formula representing monosaccharide structure is $Cn(H2O)n$ or $CnH2nOn$. Dihydroxyacetone and D- and L-glyceraldehydes are the smallest monosaccharides – here, n=3.

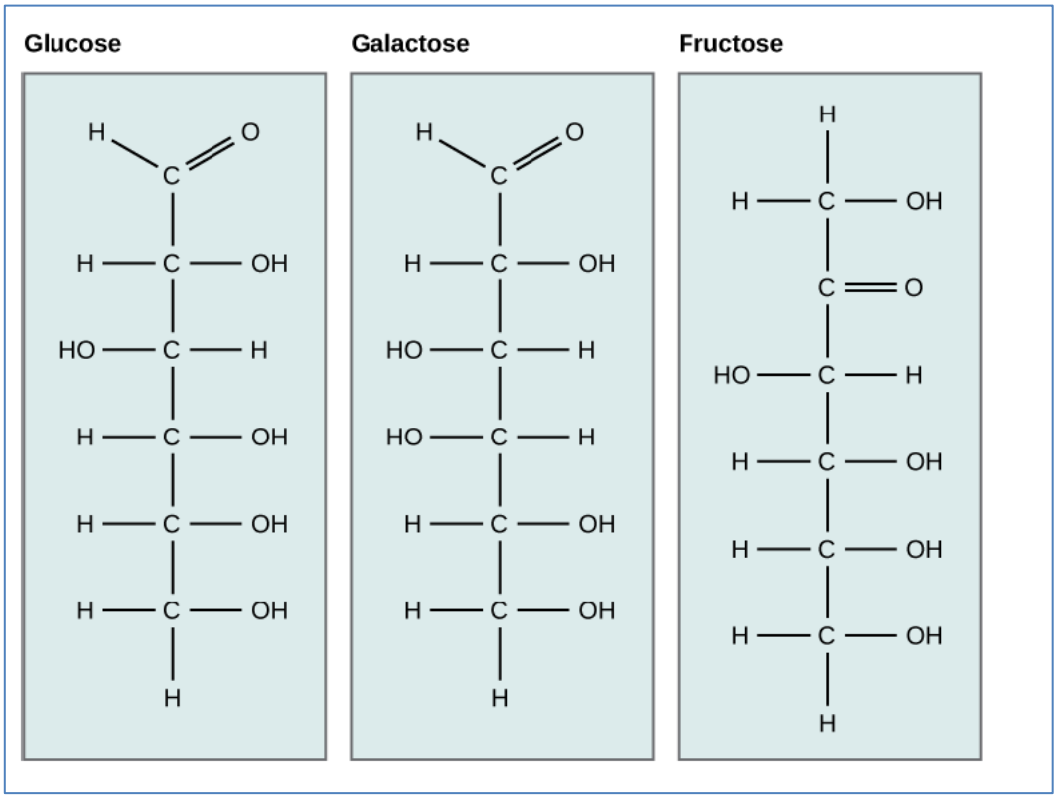
The monosaccharides containing the aldehyde group (the functional group with the structure, R-CHO) are known as aldolases and the one containing ketone groups is called ketoses (the functional group with the structure $RC(=O)R'$). Some examples of monosaccharides are glucose, fructose, erythrulose, and ribulose.

D-glucose is the most common, widely distributed, and abundant carbohydrate. It’s commonly known as dextrose and it’s an aldehyde containing six carbon atoms, called

aldohexose. It's present in both, open-chain and cyclic structures.

Most monosaccharide names end with the suffix -ose. And based on the number of carbons, which typically ranges from three to seven, they may be known as trioses (three carbons), tetroses (four carbons), pentoses (five carbons), hexoses (six carbons), and heptoses (seven carbons)

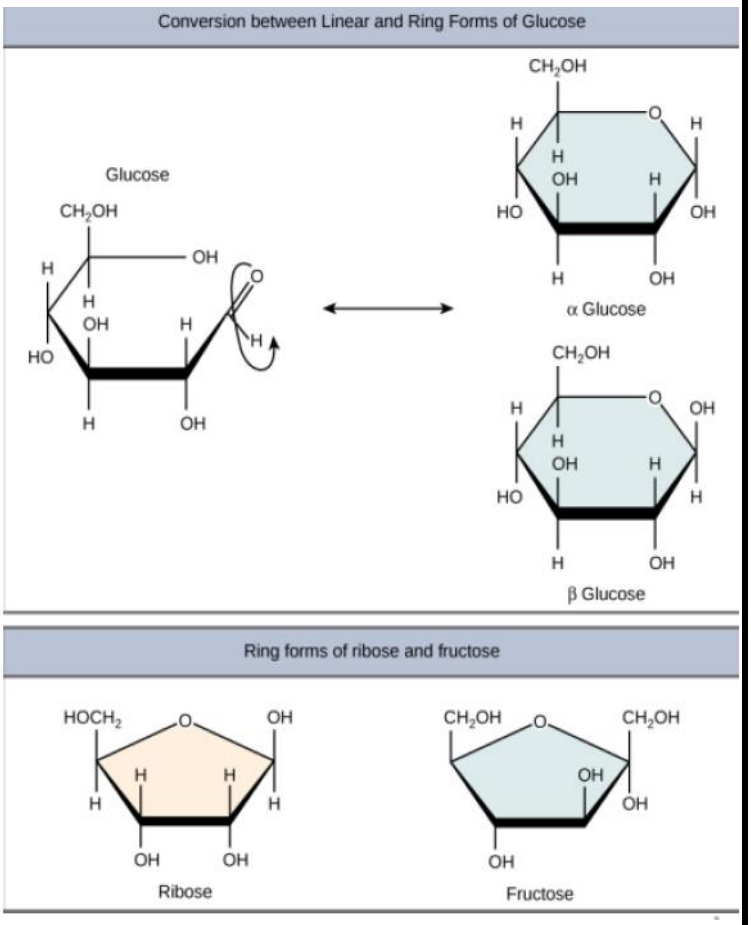
Although glucose, galactose, and fructose all have the chemical formula of C6H12O6, they differ at the structural and chemical levels because of the different arrangement of functional groups around their asymmetric carbon.



Structure of Monosaccharides

Monosaccharides are either present as linear chains or ring-shaped molecules. In a ring form, glucose's hydroxyl group (-OH) can have two different arrangements around the anomeric carbon (carbon-1 that becomes asymmetric in the process of ring formation).

If the hydroxyl group is below carbon number 1 in the sugar, it is said to be in the alpha (α) position, and if it is above the plane, it is said to be in the beta (β) position.



Functions of Monosaccharides

• Glucose ($C_6H_{12}O_6$) is an important source of energy in humans and plants. Plants synthesize glucose using carbon dioxide and water, which in turn is used for their energy requirements. They store the excess glucose as starch which humans and herbivores consume.

• The presence of galactose is in milk sugar (lactose), and fructose in fruits and honey makes these foods sweet.

• Ribose is a structural element of nucleic acids and some coenzymes.

• Mannose is a constituent of mucoproteins and glycoproteins required for the proper functioning of the body.