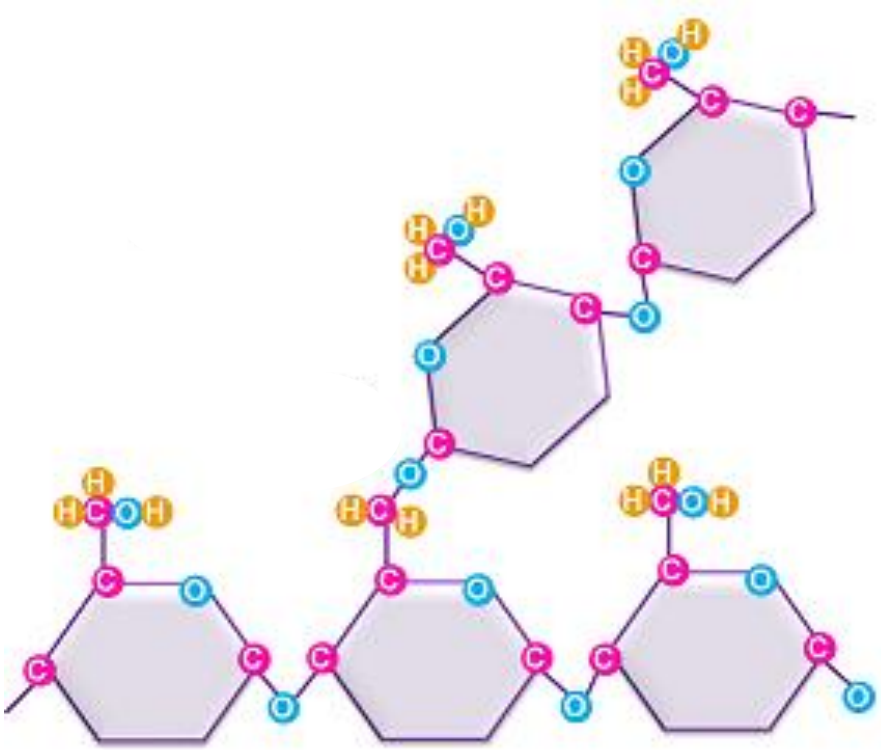
Carbohydrate



The term "carbohydrate" was proposed by K.G. Shmidt in 1844.

A carbohydrate also called saccharides is macromolecule, consisting of carbon, hydrogen, and oxygen atoms, usually with a hydrogen : oxygen atom ratio of 2:1 (as in water) with the empirical formula $C_m(H_2O)_n$.

Structurally they are polyhydroxy aldehydes and ketones.

$C_n(H_2O)_m$ (n=3-9)

Carbohydrate is produced by photosynthesis in plant such as glucose which synthesized in plants from CO_2, H_2O, and energy from the sun. Carbohydrate is oxidized in living cells (respiration) to produce CO_2, H_2O, and energy.

Each sugar was ended with "ose"

carbohydrates classification

1- Monosaccharides - simple sugars with multiple OH groups. Based on number of carbons (3, 4, 5, 6), a monosaccharide is a triose, tetrose, pentose or hexose, cannot be hydrolyzed to simpler carbohydrates; eg. Glucose or fructose.

A- Aldoses: - in which the carbonyl group on the first carbon is an aldehyde.

B- Ketoses: - which contain a ketone carbonyl group on the second carbon.

2- Disaccharides – Two monosaccharides covalently linked can be hydrolyzed into two monosaccharide units; eg. Sucrose, which is hydrolyzed into glucose and fructose.

3- Oligosaccharides - a few monosaccharides (3 - 10) covalently linked.

4- Polysaccharides- have more than 10.

A- Homopolysaccharides: - consist of the same monosaccharide residues (starch, cellulose, etc.).

B- Heteropolysaccharides: - of different monosaccharide residues (hyaluronic acid, etc.).

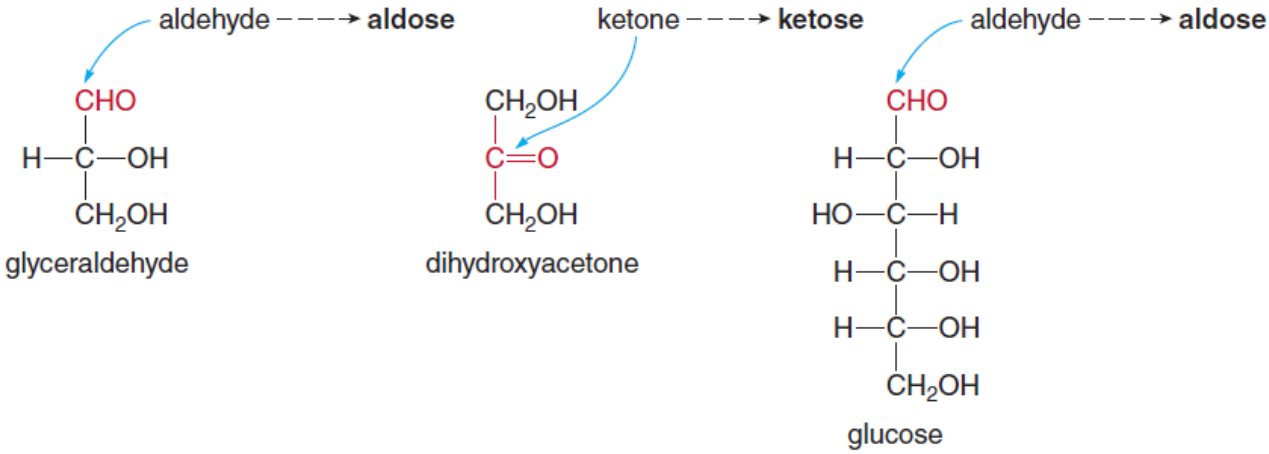
Monosaccharides

Aldoses are monosaccharides

- with an **aldehyde group**.
- with many hydroxyl (–OH) groups.

Ketoses are monosaccharides

- with a ketone group .
- with many hydroxyl (–OH) groups.



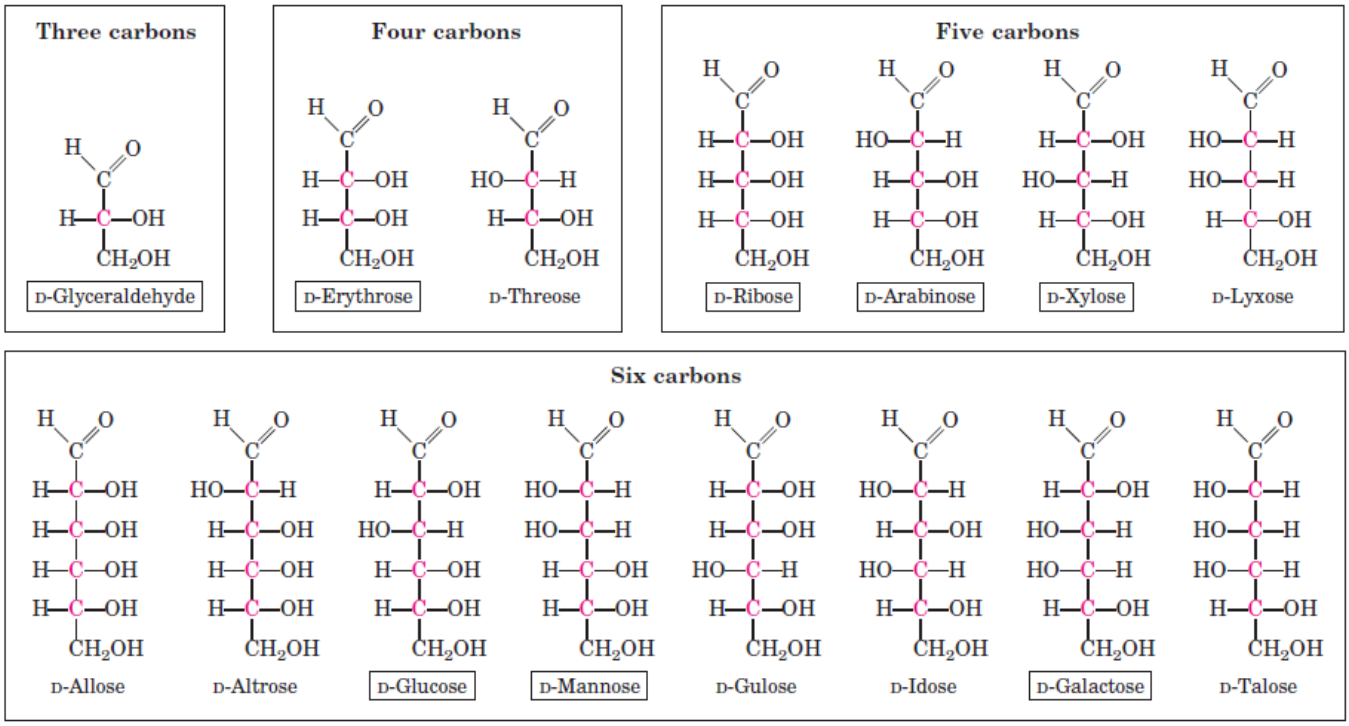
A monosaccharide is characterized by the number of carbons in its chain.:

- aldotriose (3 C atoms)
- aldotetrose (4 C atoms)
- aldopentose (5 C atoms)
- aldohexose (6 C atoms)

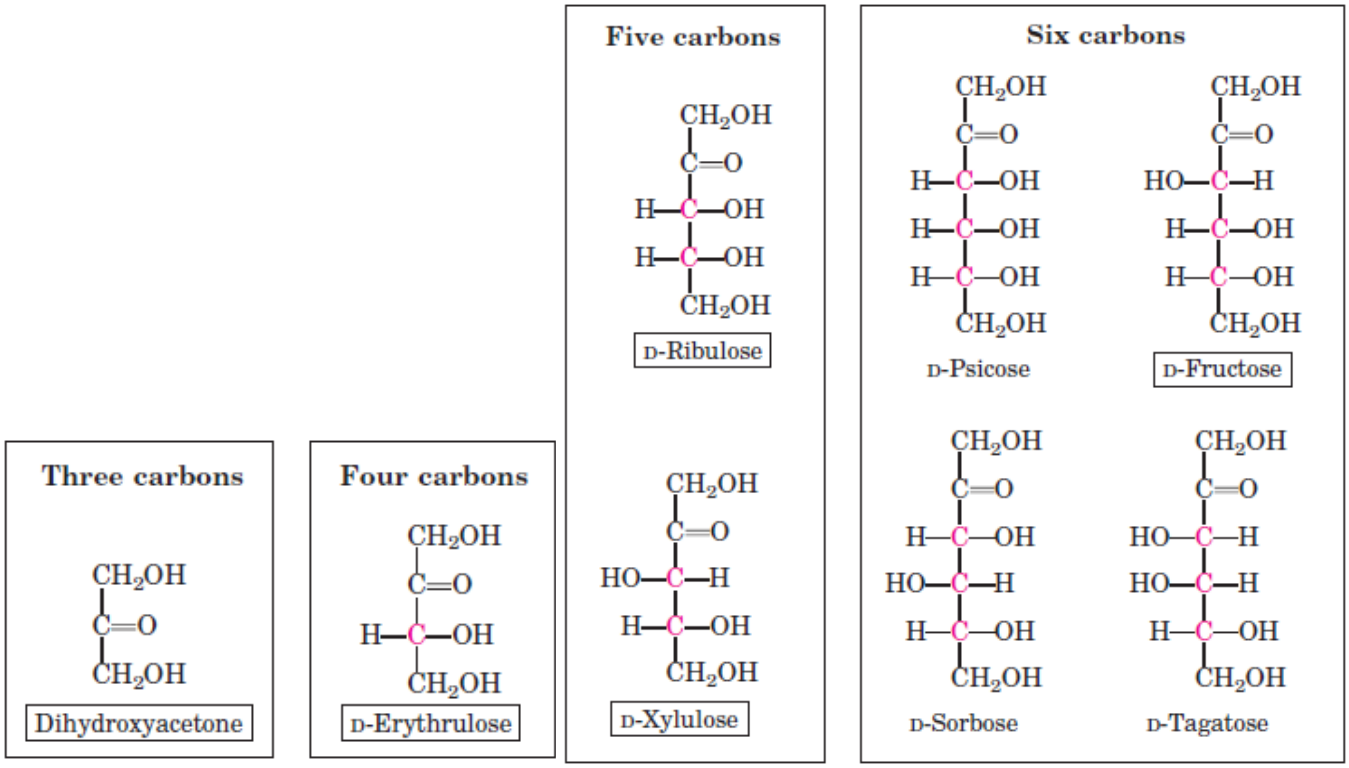
- ketotriose (3 C atoms)
- ketotetrose (4 C atoms)
- ketopentose (5 C atoms)
- ketohexose (6 C atoms)

These terms are then combined with the words *aldose* and *ketose* to indicate both the number of carbon atoms in the monosaccharide and whether it contains an aldehyde or ketone. Thus, glyceraldehyde is an aldotriose (three carbons and an aldehyde), dihydroxyacetone is a ketotriose (three carbons and a ketone), and glucose is an aldohexose (six carbons and an aldehyde).

The series of **(a)** D-aldoses and **(b)** D-ketoses having from three to six carbon atoms, shown as projection formulas. The carbon atoms in red are chiral centers. In all these D isomers, the chiral carbon *most distant from the carbonyl carbon* has the same configuration as the chiral carbon in D-glyceraldehyde. The sugars named in boxes are the most common in nature.



D-Aldoses
(a)

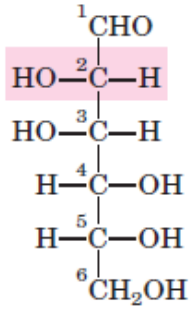


D-Ketoses
(b)

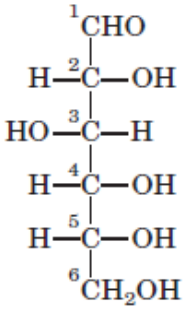
In general, a molecule with *n* chiral centers can have 2^n stereoisomers. Glyceraldehyde has $2^1 = 2$; the aldohexoses, with four chiral centers, have $2^4 = 16$ stereoisomers.

The stereoisomers of monosaccharides of each carbon-chain length can be divided into two groups that differ in the configuration about the chiral center *most distant* from the carbonyl carbon. Those in which the configuration at this reference carbon is the same as that of D-glyceraldehyde are designated D isomers, and those with the same configuration as L-glyceraldehyde are L isomers. When the hydroxyl group on the reference carbon is on the right in the projection formula, the sugar is the D isomer; when on the left, it is the L isomer. Of the 16 possible aldohexoses, eight are D forms and eight are L. Most of the hexoses of living organisms are D isomers

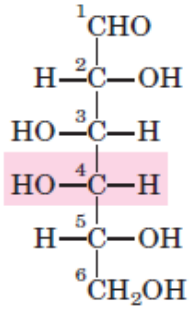
Epimers: -Two sugars that differ only in the configuration around one carbon atom. D-glucose and D-mannose, which differ only in the stereochemistry at C-2, are epimers, as are D-glucose and D-galactose



D-Mannose
(epimer at C-2)



D-Glucose



D-Galactose
(epimer at C-4)