Biochemistry \ Lectures

Biology \ First class

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Biochemistry

Biochemistry:Is the branch of science that explores chemical processes within and related to living organisms. It is a laboratory-based science that brings together Biology and Chemistry.

Biochemistry focuses on processes happening at a molecular level. It focuses on what is happening inside our cells, studying components like proteins, Lipids…etc. Biochemists need to understand how the structure of a molecule relates to its function, allowing to predict how molecules will interact.

Carbohydrates

Carbohydrates: also called (Saccharides) which means sugars, are the most abundant biological molecules on earth. Carbohydrates including simple monomeric sugars and their polymers, they are play several important roles in living organisms.

Carbohydrates are major source of energy from our diet and composed of the elements C, H and O. The bulk of plant's carbohydrates is produced by photosynthesis such as glucose are synthesized in plants from CO_2 and H_2O and energy from the sun.

In animals and plants, carbohydrates polymers act as energy-storage molecules.

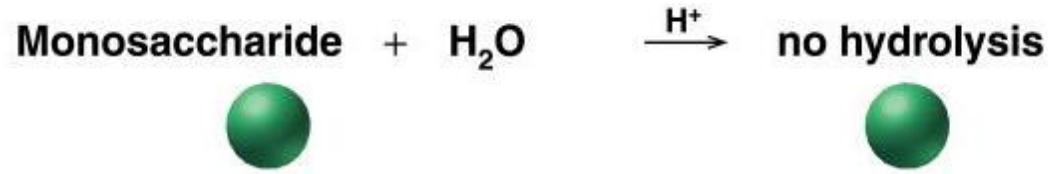
Carbohydrates are defined as: Polyhydroxyaldehydes or Polyhydroxyketones of formula $C_n(H_2O)_n$, or compounds that can be hydrolyzed to them (sugars or Saccharides).

Types of Carbohydrates

1. **Monosaccharides**

Are the smallest units of carbohydrate structure that cannot be hydrolyzed to simpler carbohydrates, eg. Glucose or fructose

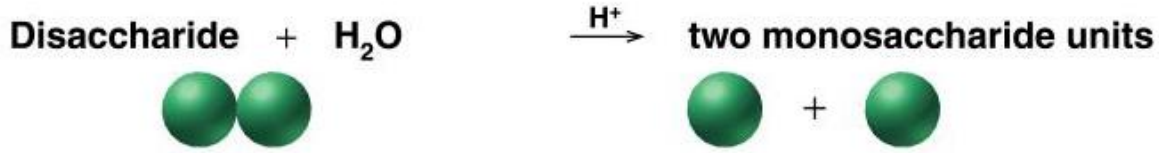
$$\text{Monosaccharides} + H_2O \xrightarrow{H^+} \text{no hydrolysis}$$



2. Disaccharides

Are carbohydrates that can be hydrolyzed into two monosaccharides units .e.g Sucrose, which is hydrolyzed into glucose and fructose.

$$\text{Disaccharide} + H_2O \xrightarrow{H^+} \text{two monosaccharides}$$



3. Oligosaccharides

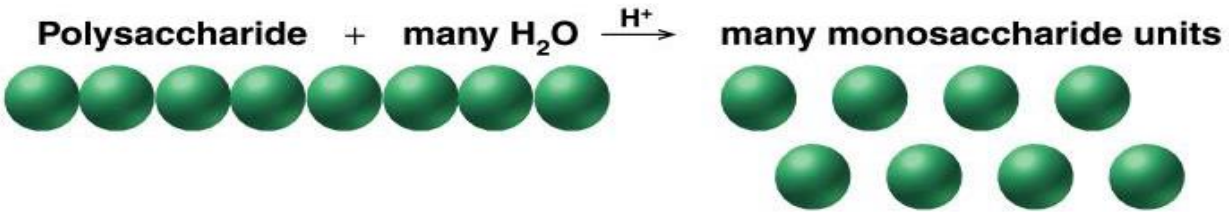
Are polymers of 2 to about 10 monosaccharides residues ,the most common oligosaccharides are the disaccharides.

Oligosaccharides can be hydrolyzed into a few monosaccharides units.

4. Polysaccharides

Are polymers of monosaccharides that contain more than 20 monosaccharides units, e.g starch and cellulose .

$$\text{Polysaccharides} + \text{many } H_2O \xrightarrow{H^+} \text{many monosaccharide units}$$



Functions of carbohydrates

1.Serve as energy stores in the living system such as: glycogen and starch.

2.As principal components of a number of bio molecules like ribose and deoxyribose in nucleic acids.

3.As structural and protective elements in the cell walls of bacteria and plants (like cellulose) and in connective tissues of animals.

Classification of monosaccharides

Monosaccharides: Are Polyhydroxy aldehydes or ketones. They are classified by the type of carbonyl group and the number of carbon atoms they contain. All monosaccharides contain at least three carbon atoms, one of these is the carbonyl carbon, and each of the remaining carbon atoms bears a hydroxyl group.

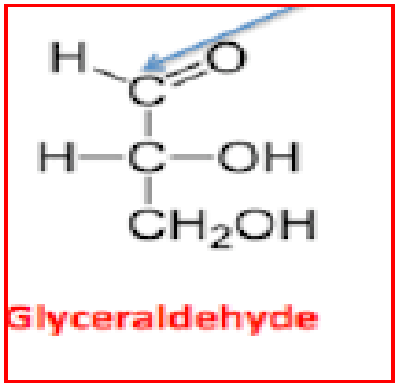
The two general classes of monosaccharides are :

-**Aldose**: Polyhydroxyaldehyde, e.g **Glucose .**

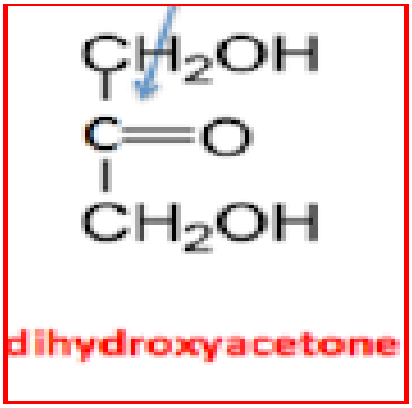
-**Ketose**: Polyhyroxyketone,e.g **Fructose**.

Triose, tetrose, Pentose, hexose, etc are carbohydrates that contain three, four, five, six, etc carbons per molecules (usually five or six); e.g aldohexose, ketohexose.

The aldehydictriose, or aldotriose, is glyceraldehyde is chiral–its central carbon, C-2, has four different groups attached to it.



Dihydroxyacetone is a chiral ,it has no a symmetric carbon atom.



Monosaccharides

Monosaccharides consist of:

- 3 to 6 carbon atoms, typically
- A carbonyl group (aldehyde or ketone)
- Several hydroxyl groups
- Also known as simple sugars.
- Classified by 1the number of carbons and 2. whether aldoses or ketoses
- Most (99%), are straight chain compounds.
- D-glyceraldehyde is the simplest of aldoses (aldotriose)
- All other sugars have the ending ose (glucose , galactose, ribose, Lactose, etc).

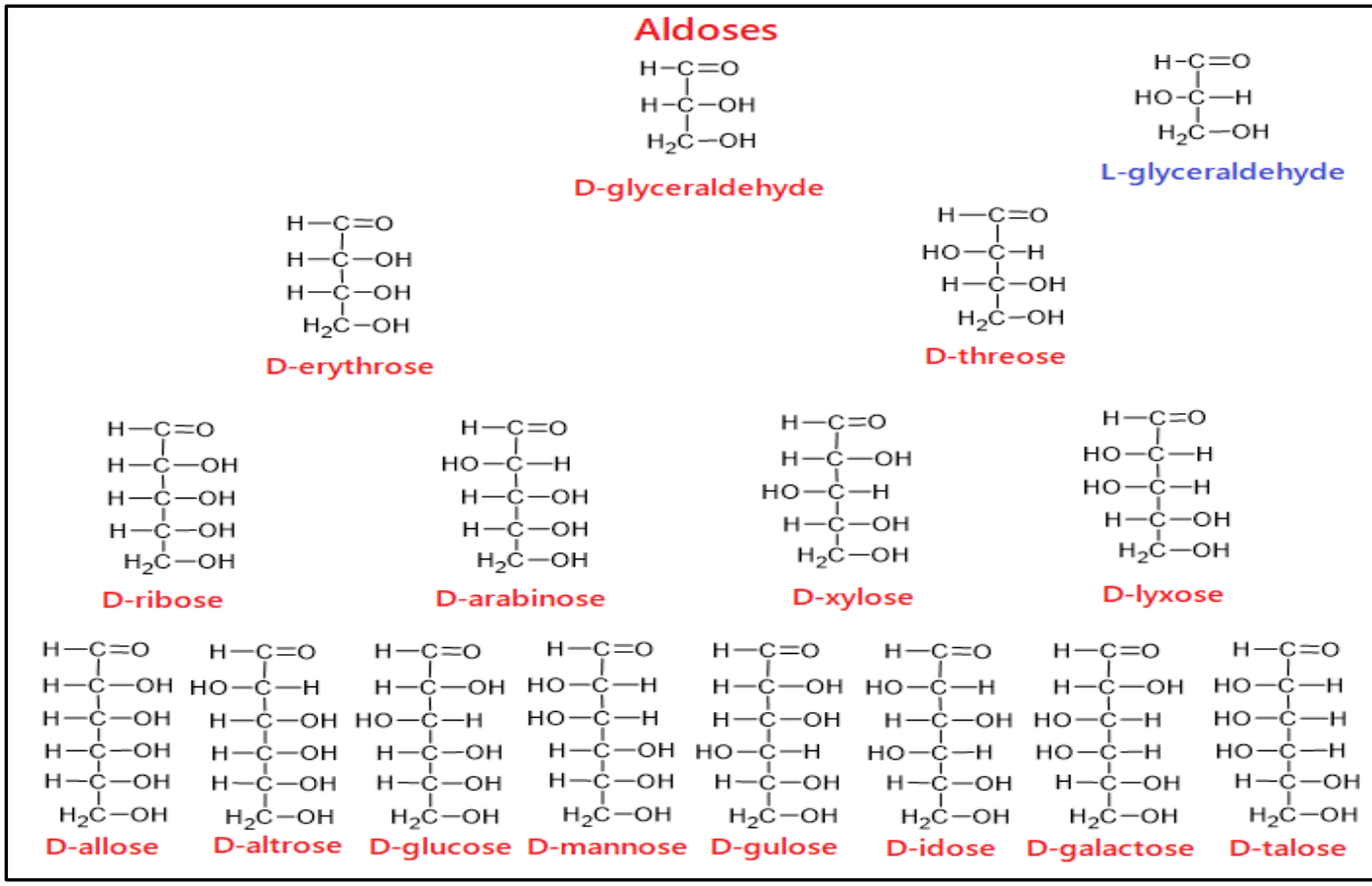
1. Aldoses

Aldoses: Are monosaccharides with an aldehyde group and many hydroxyl (-OH) groups such as:
Triose (3 Catoms)

Tetrose (4C atoms)

pentose (5 C atoms)

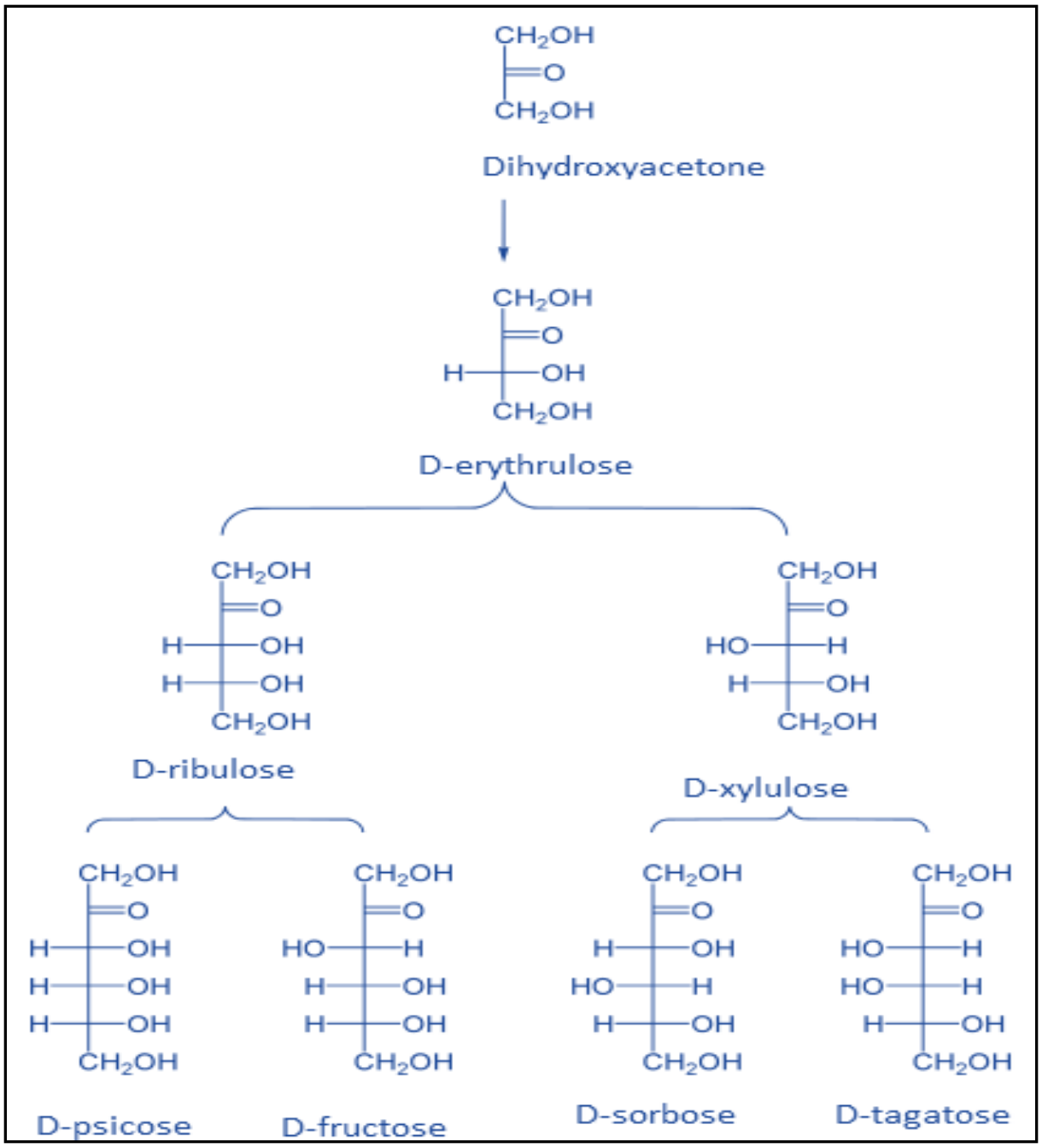
hexose (6C atoms)



(Fig- A)

2. Ketoses

Ketoses: Are monosaccharides with a ketone group and many hydroxyl (-OH) groups such as:
Triose (3 C atoms)
Tetrose (4C atoms)
pentose (5C atoms)



Stereochemistry of monosaccharides

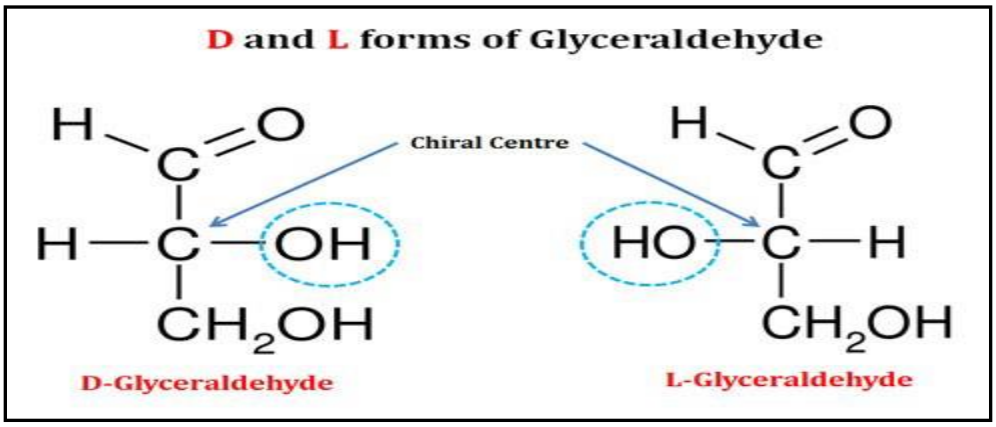
- **Asymmetric** Carbons (Chiral)
- **Symmetric** Carbons (A chiral)

Aldotriose

Glyceraldehyde which has a single chiral carbon atom, there are two stereoisomers (D and L)glyceraldehydes. Atoms attached to chiral center can exist two spatial arrangements. A molecule with (n) chiral centers can have 2^n stereoisomers.

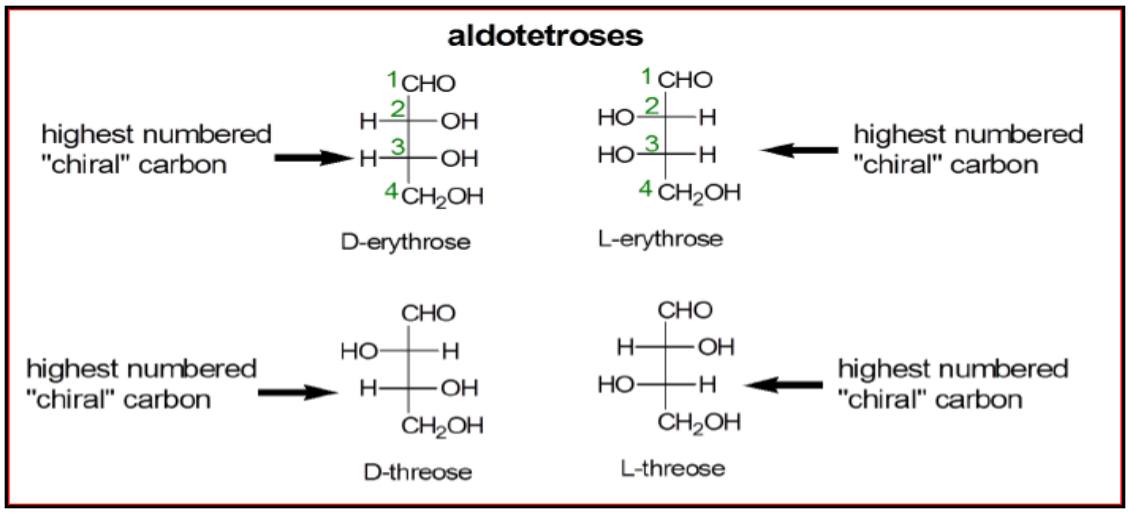
For example

Glyceraldehyde has $2^1 = 2$ stereoisomers



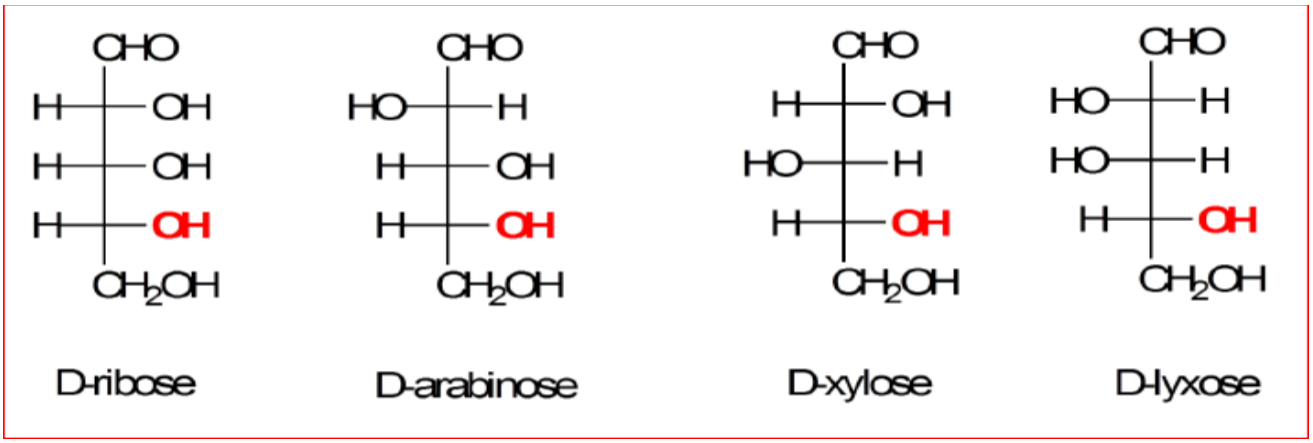
Aldotetrose

There are four stereoisomers for aldotetroses (D and L –erythrose D, L-threose) because erythrose and threose each process two chiral carbon atoms.



Aldopentoses

Aldopentoses , which pentose three chiral carbon , eight stereoisomers



Aldohexoses

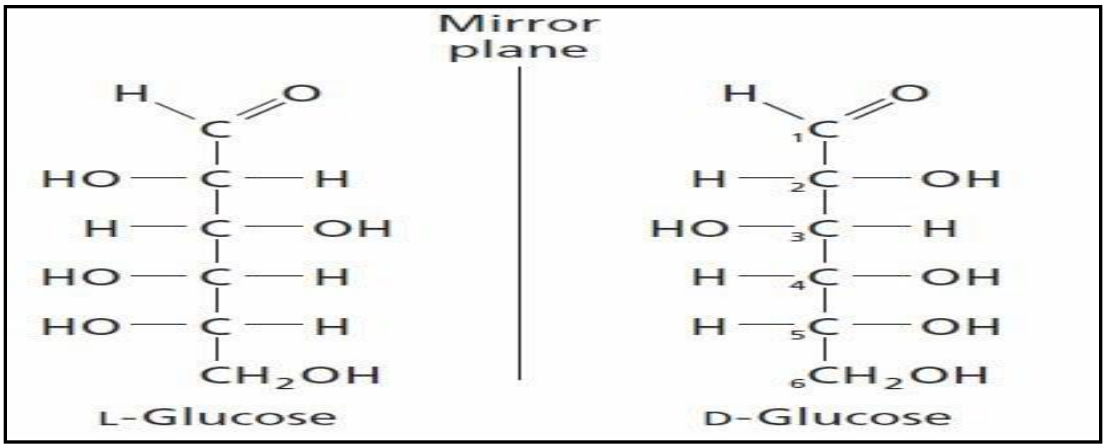
Aldohexoses, which possess four chiral carbons, have a total of 2^4 or 16 stereoisomers the (eight D and eight L) enantiomers (Fig-A).

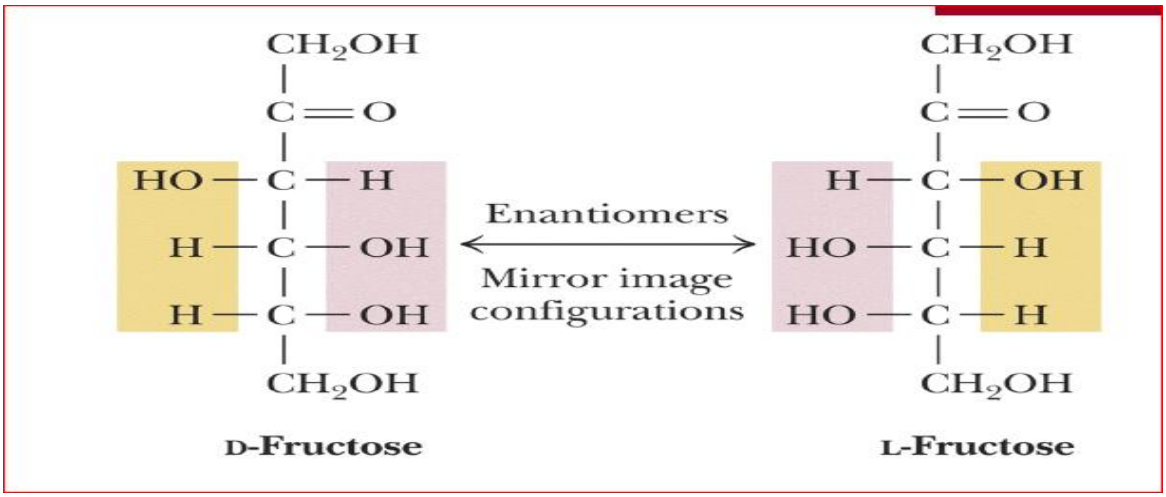
Enantiomers (D and L sugars)

Enantiomers: Pairs of stereoisomers that are mirror images of one another.

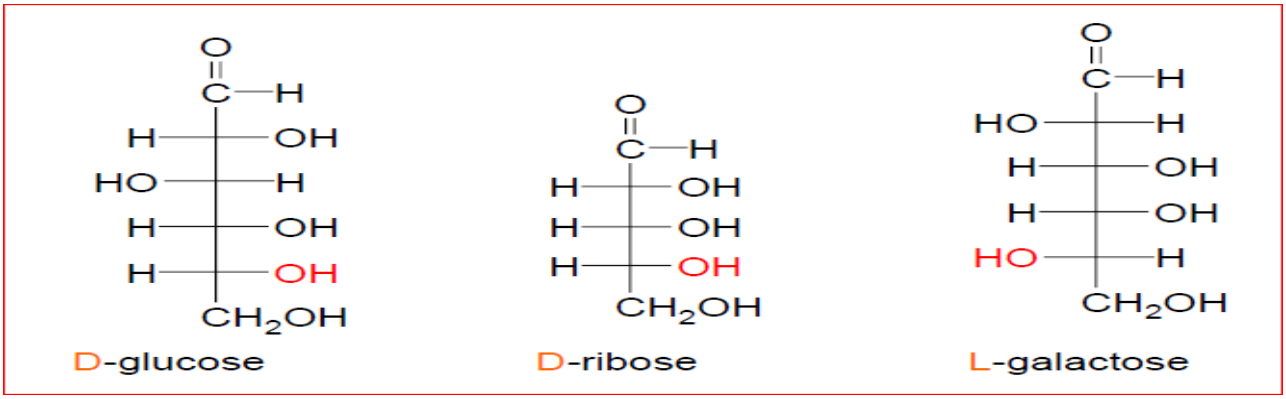
For sugar drawn in the **fischer Projection** with the most oxidized carbon at the top:

- If the OH on the bottom chiral center points to the right, the sugar is **D**.
- If the OH on the bottom chiral center points to the left, the sugar is **L.**





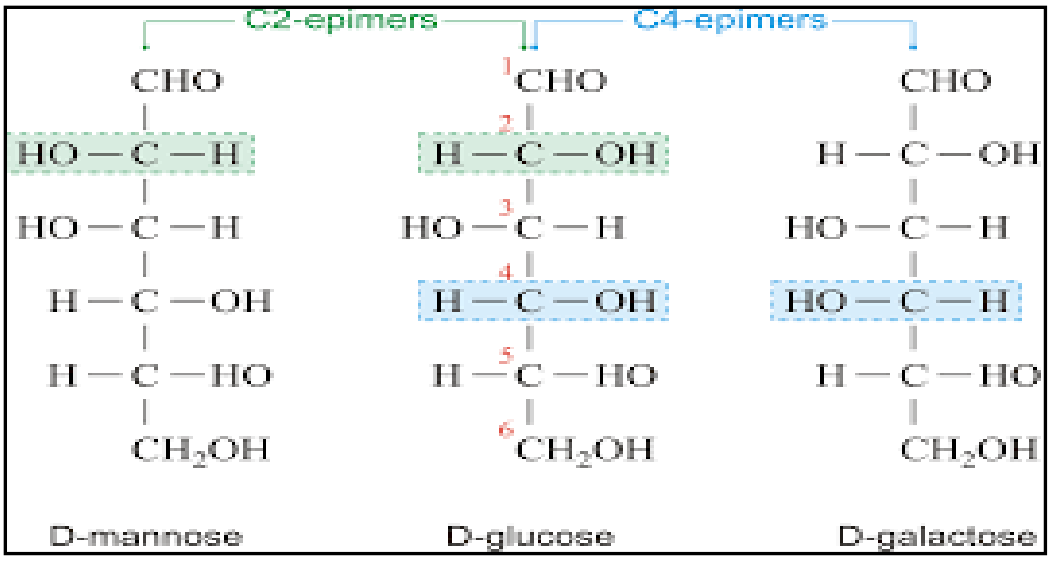
Eaxmples of D and L isomers of monosaccharides



Epimers

Pairs of monosaccharide's that have the same molecular formula and bonding but differ in the configuration about one chrial center.

For example, D-mannose and D-galactose are epimers of D-glucose (at C-2 and C-4), respectively.



***Note:**

- In nature D-glucose is commonly occurs.

– In large biological molecules D-glyceraldehyde, D-ribose, D-mannose and D- galactose are important components.

- D-Sugars are biological more abundant than L-sugar