Monosaccharides — Structural Aspects

→ Structural aspects of monosaccharides include

1. Stereoisomerism
2. Optical activity
3. Racemic mixture
4. Epimers
5. Enantiomers.

1. Stereoisomerism

→ Stereoisomerism is an important character of monosaccharides

→ Stereoisomers are the compounds that have the same structural formula

but differ in their spatial configuration.

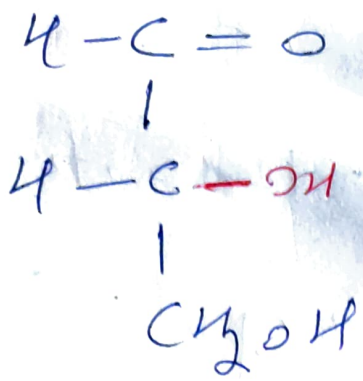
→ A carbon is said to be asymmetric when it is attached to four different atoms or groups

→ The number of asymmetric carbon atoms (n) determines the possible isomers of a given compound which is equal to 2^n.

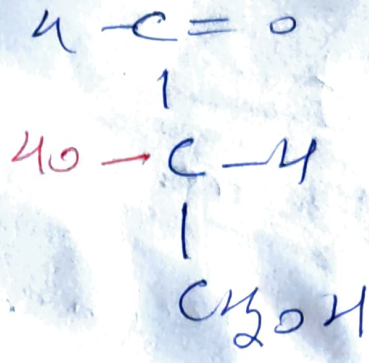
→ Glucose contains 4 asymmetric carbons, and thus has 16 isomers

→ Glyceraldehyde (Triose) is the simplest monosaccharide with one asymmetric carbon atom

→ It exists as two ~~D~~ - stereoisomers and has been chosen as the reference carbohydrate



D- Glyceraldehyde



L- Glyceraldehyde

→ The D- and L- isomers are mirror images of each other.

→ The spatial ~~arrang~~ orientation of -H and -OH groups on the carbon atom that is adjacent to the terminal primary alcohol carbon determines whether the sugar is -D- or L- isomer.

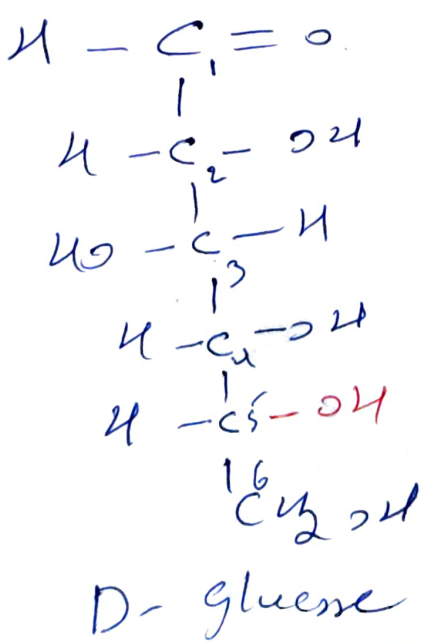
→ If OH group on the right side it belongs to D-series and if on the left side, it belongs to L-series.

→ It may be noted that, the naturally occuring monosaccharides in the mammalian tissues are mostly of D-Configuration.

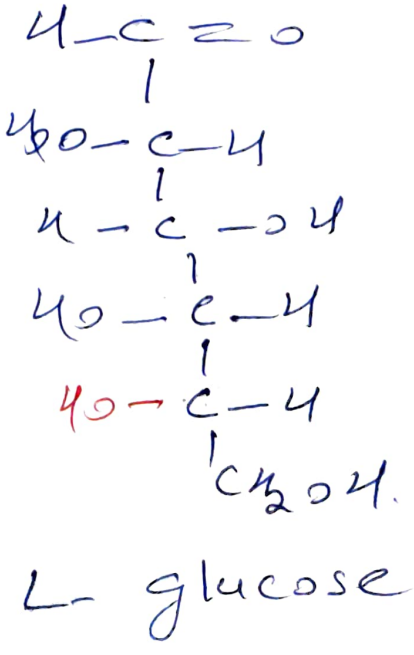
→ The enzyme machinery of cell is specific to metabolite D-series of monosaccharides

→ The term dextrose is used for glucose in solution

→ This is because of the dextrorotatory nature of glucose.



D- glucose



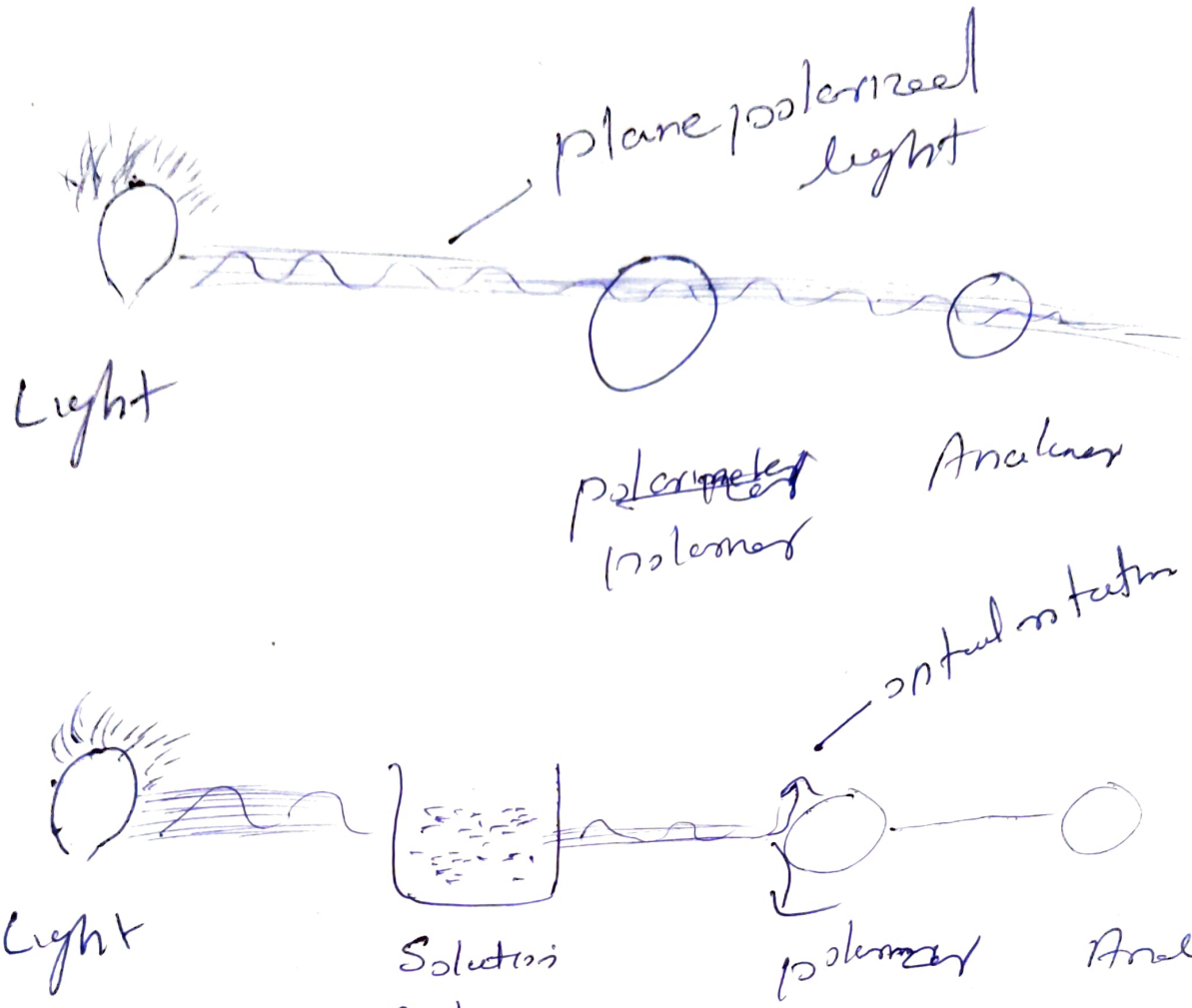
L- glucose

(2) optical activity

→ Optical activity is a characteristic feature of compounds with asymmetric carbon atom.

→ When a beam of polarised light is passed through a solution of an optical isomer, it will be rotated either to the right or left

→ The term dextrorotatory (+) and levorotatory (−) are used to compounds that respectively rotate the plane of polarised light to the right or to the left.



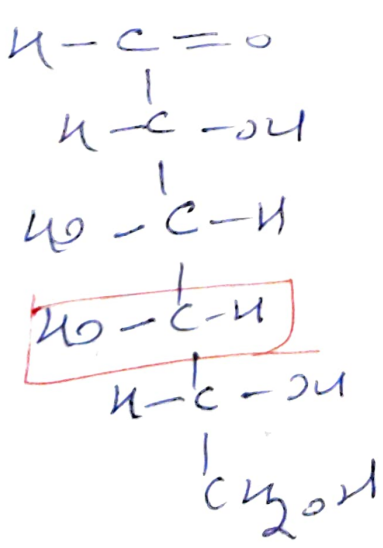
Racemic Mixtures

→ of D- and L- isomers are present in equal concentration, it is known as racemic mixture or DL mixture

→ Racemic mixture doesn't exhibit any optical activity, since the dextro and levorotatory activities cancel each other.

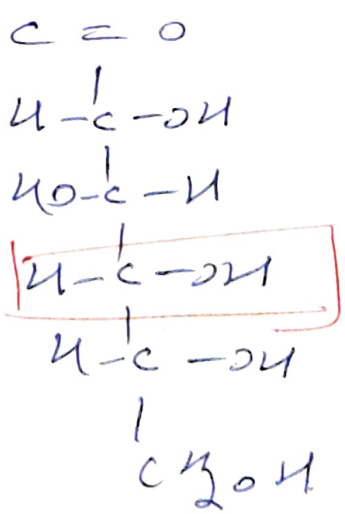
Epimers

→ of two monosaccharides differ from each other in their configuration around a single specific carbon (other than anomeric carbon) are. They are referred to as epimers to each other

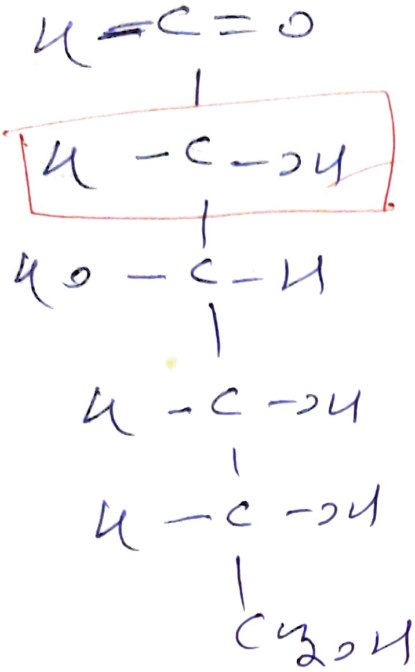


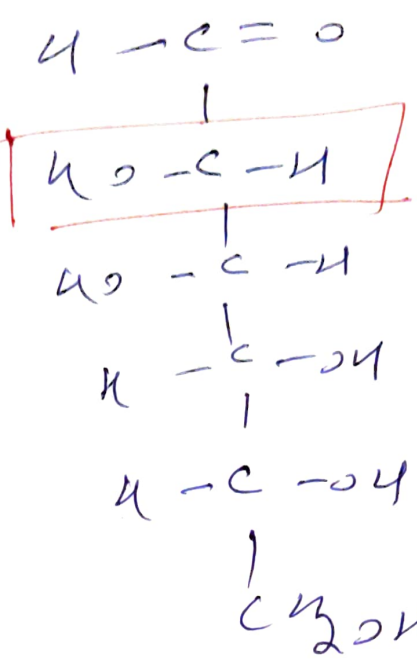
D-galactose

(C4 epimer of glucose)



D-glucose (C4 epimer of galactose)

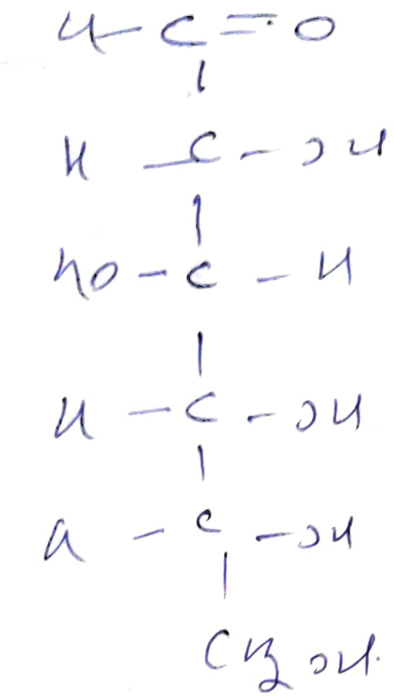




D-glucose
(C_2 epimer of mannose)

D-mannose
(C_2 epimer of glucose)

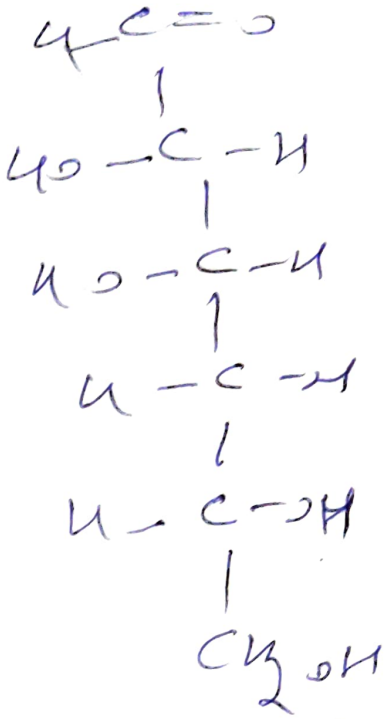
The inter conversion of epimers e.g glucose to galactose and vice versa is known as epimerization and a group of enzymes namely epimerases catalyse this reaction



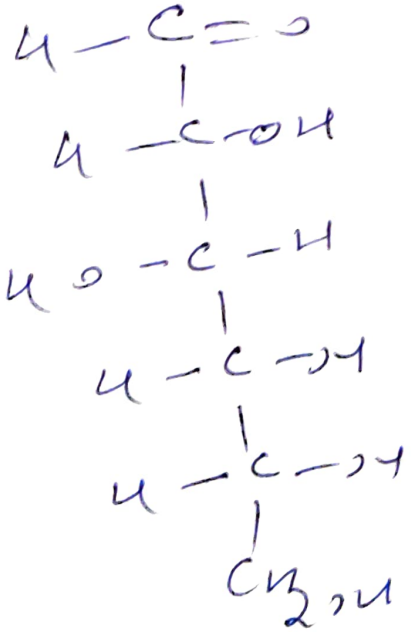
D-glucose

Carbon shift

Epimerase



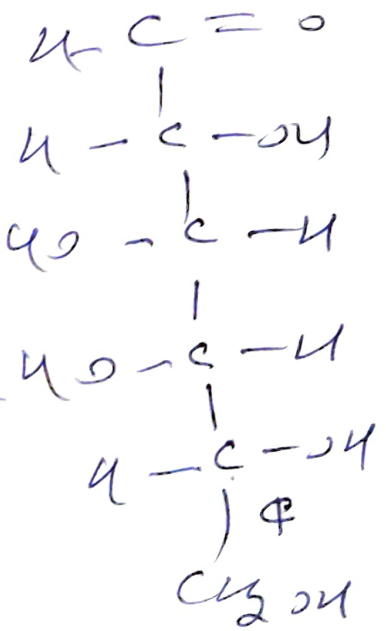
D-mannose



D-glucose

Carbon shift

Epimerase



D-galactose

In medicine

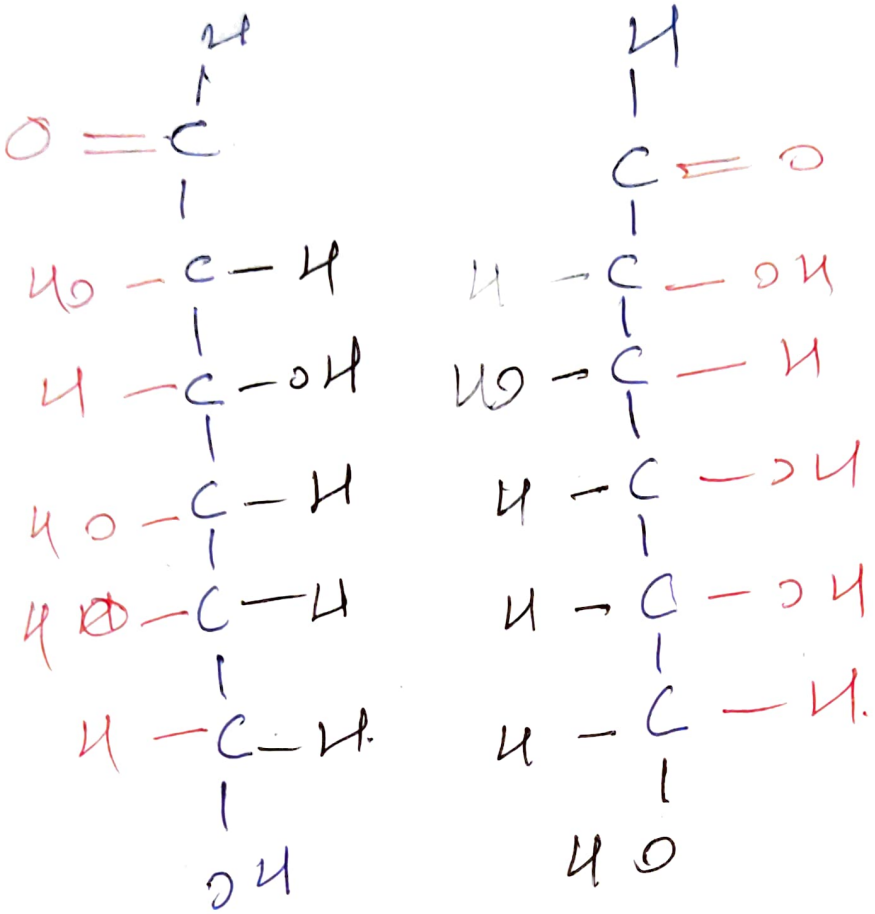
Doxorubicin and Epirubicin are epimers of each other.

Enantiomers

→ Enantiomers are a special type of ~~steric~~ stereoisomers that are mirror images of each other

→ The two members are designated as D and L sugars

→ Majority of the sugars in the higher animals including man are of D-type



L-glucose. D-glucose.

→ ~~Ther~~ The term diastereoisomers is used to represent the stereoisomers that are not mirror images of one another.