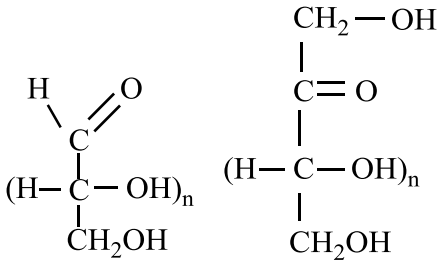
Carbohydrates

Carbohydrates are defined chemically as aldehyde or ketone derivatives of the higher polyhydric alcohols,



Aldose

Ketose

Classification of the carbohydrates

Monosaccharaides which are simple sugars that cannot be broken down into smaller molecules by hydrolysis.
$(C_nH_{2n}O_n)$
Glucose, fructose

Disaccharides which can be hydrolyzed to give two monosaccharaides.
$(C_n(H_2O)_{n-1})$
Sucrose, lactose

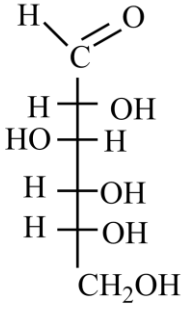
Oligosaccharides which are made of two to ten monosaccharide units.
N-glycoproteins

Polysaccharides which are polymers consisting of many (hundreds and thousands) monosaccharide units
$(C_6H_{10}O_5)_n$
Starch, glycogen

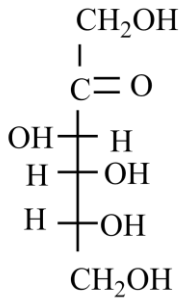
Monosaccharaides

According to the number of carbon atoms they are trioses, tetroses, pentoses, hexoses.
$C_3H_6O_3$ – Glyceraldehyde
$C_5H_{10}O_5$ – Ribose
$C_6H_{12}O_6$ – Glucose, fructose

Depending on the presence of the aldehyde or the ketone group, the sugar is called aldose or ketose.



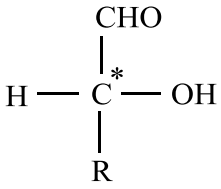
D-glucose

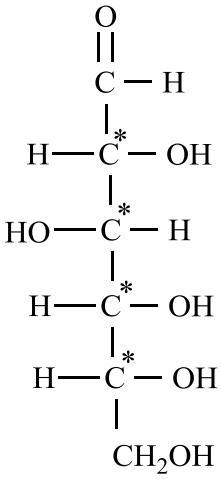


D-fructose

Stereoisomerism

Asymmetric Carbon: A carbon atom to which four different atoms or groups of atoms are attached is said to be asymmetric.

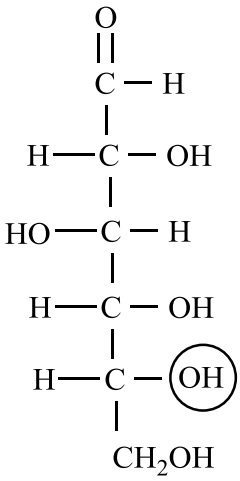




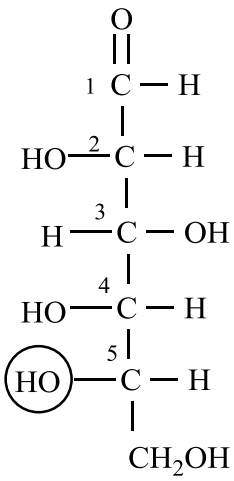
D-glucose have 4 assymmetric (chiral) carbon atom.

The presence of asymmetric carbon atoms in a compound gives rise to the formation of isomers of that compound. Such compounds which are identical in composition and differs only in spatial configuration are called "stereoisomers".

Two such isomers of glucose – D – Glucose and L – Glucose are mirror image of each other.



D-Glucose



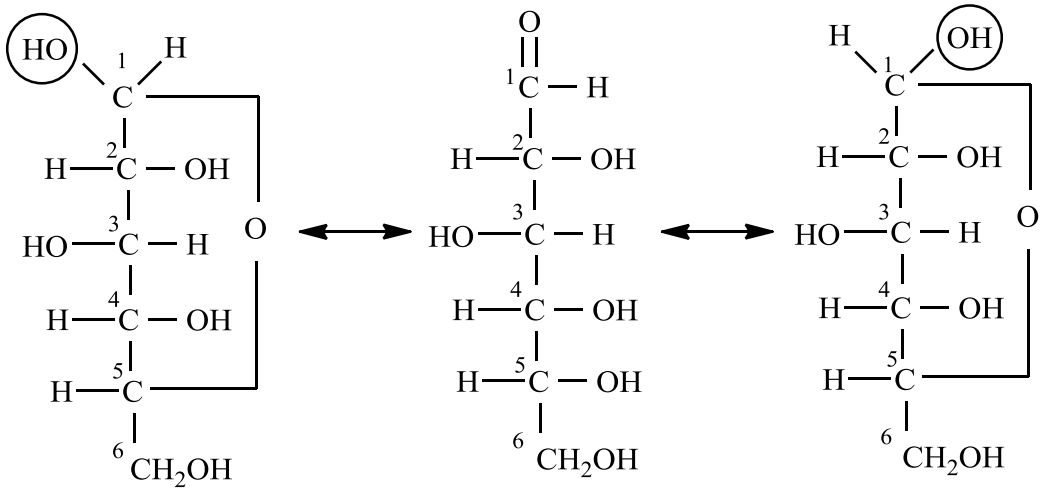
L-Glucose

(Stereoisomers of glucose)

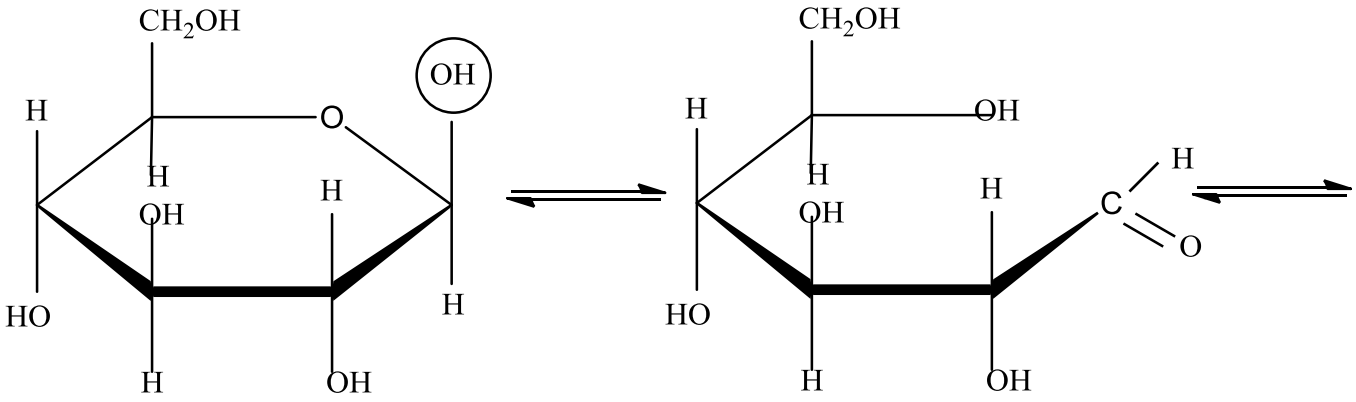
D – series (families) and **L – series**: The orientation of the H and OH group around the carbon atom 5 in glucose determines the series. When the –OH group on this carbon is on the right, it belongs to D – series, when the –OH group is on the left, it is a member of L – series.

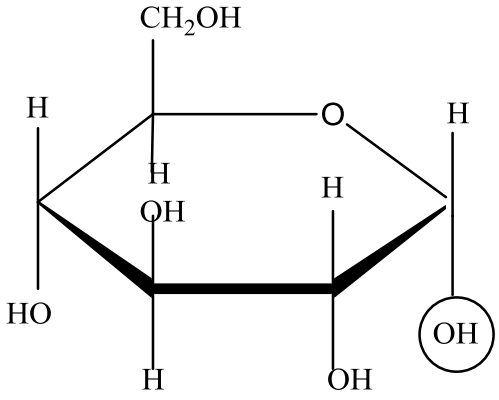
Cyclic structures: As the two reacting groups aldehyde and alcoholic group belong to the same molecule, a cyclic structure takes place.

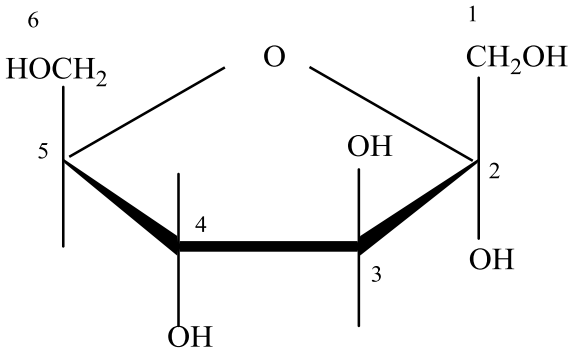
C_1 after cyclization becomes asymmetric – it is called "anomeric" carbon and α–D–glucose and β–D–glucose are "anomers".



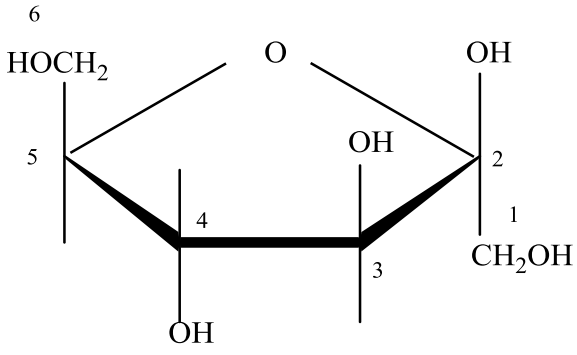
Haworth Projection





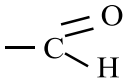


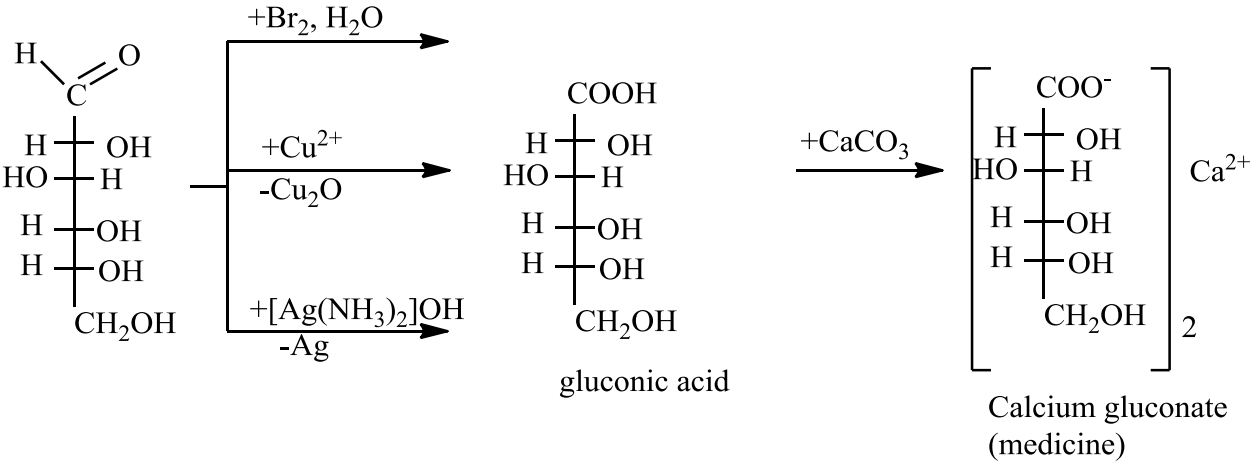
α-D-fructofuranose



β-D-fructofuranose

Chemical properties

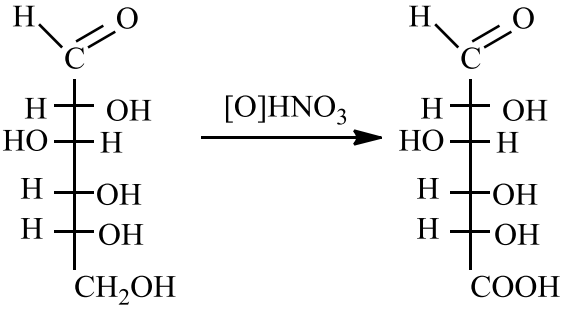
1) Oxidation of the  group. When the aldehyde carbon is oxidized, the **aldonic** acids form.



gluconic acid

Calcium gluconate (medicine)

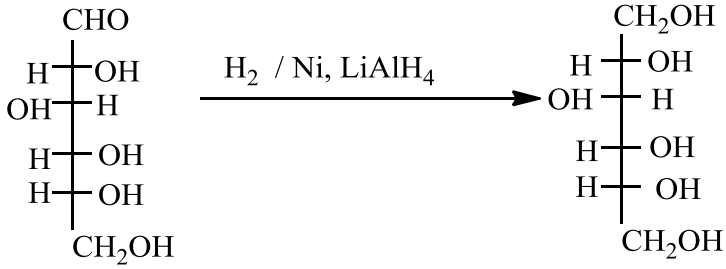
2) Oxidation of the alcohol group (-OH) at carbon – 6 produces an uronic acid.

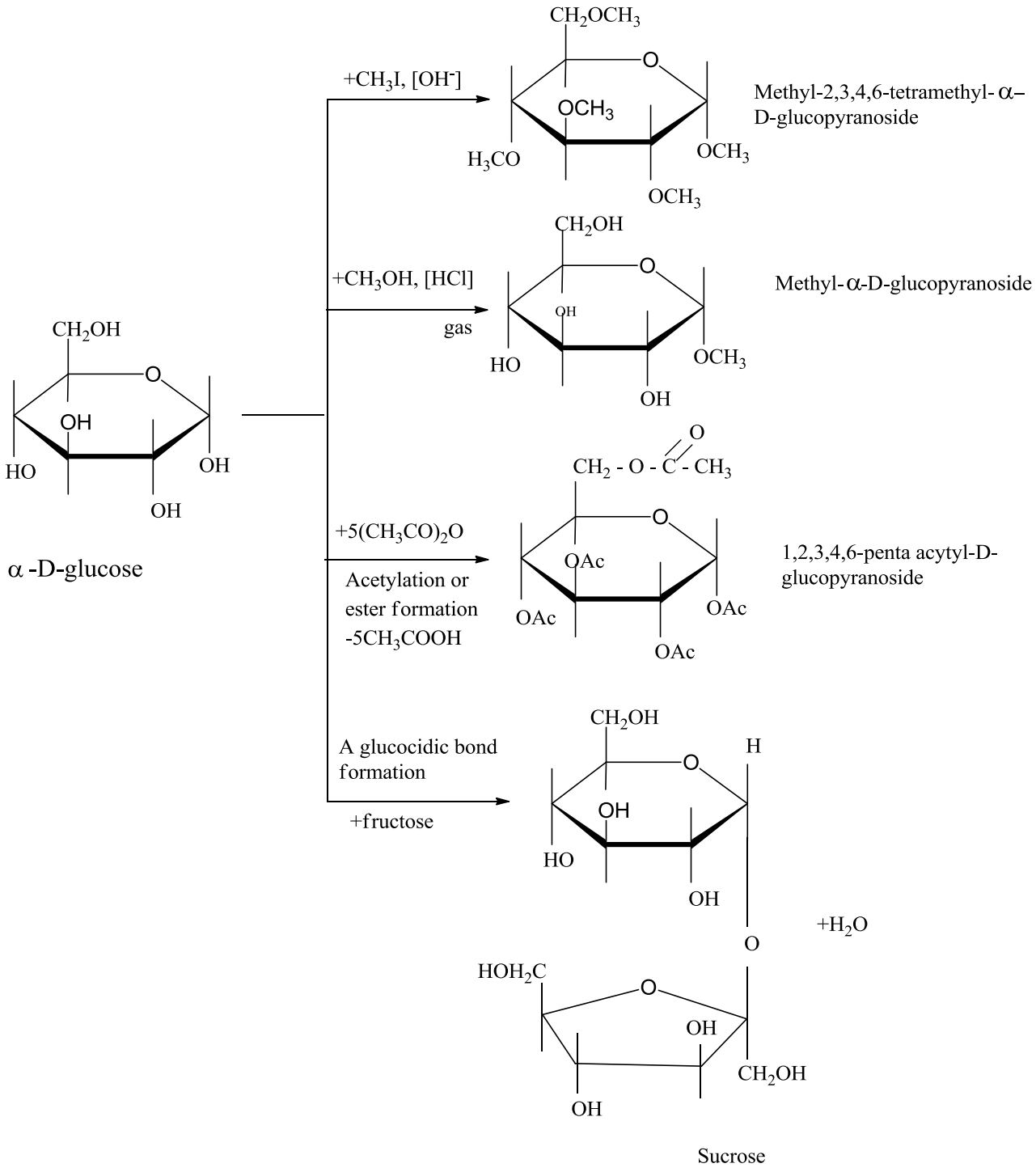


D-glucose

glucuronic acid

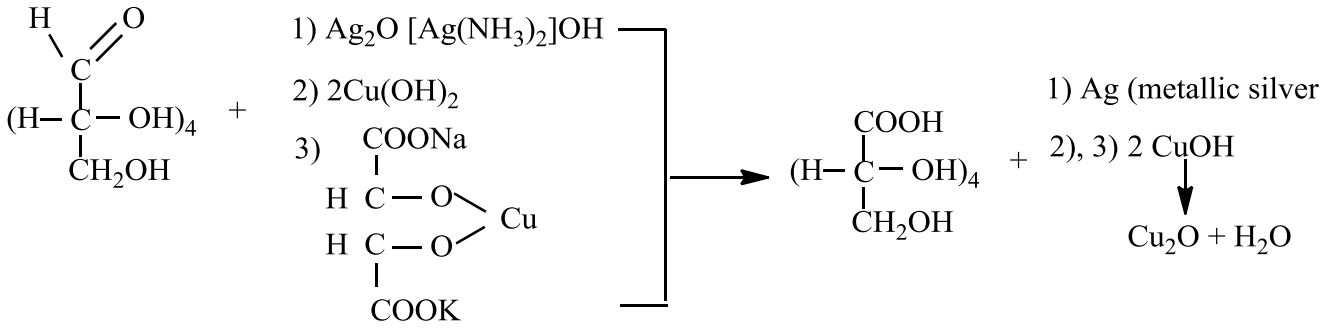
3) Reduction of the carbonyl carbon produces a new alcohol group. Such compounds are called polyols. Glucose is reduced to sorbitol.





The level of glucose in human blood plasma considerably increases in patients suffering from severe disease **Deabetes** mellitus, which makes essential the development of specific analytical tests of glucose concentration determination. The presence in the aqueous solution of D-glucose of its open-chain aldehyde form which is the reducing sugar can be detected by special analytical tests.

D-glucose present in aqueous solution or biological (blood, urine or liquor) gives positive tests with Fehling's, Benedict's and Tollen's reagents.


1) Ag_2O $[Ag(NH_3)_2]OH$
2) $2Cu(OH)_2$
3)
COONa
Cu
COOK
COOH
1) Ag (metallic silver
2), 3) 2 CuOH
$Cu_2O + H_2O$