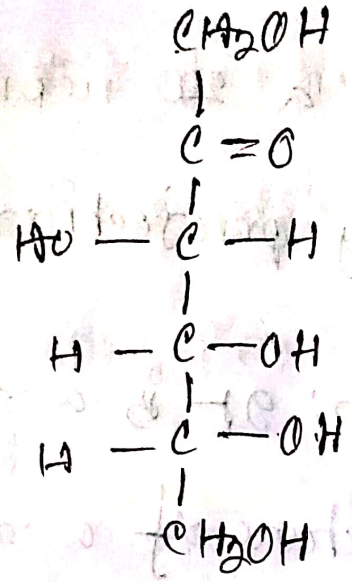
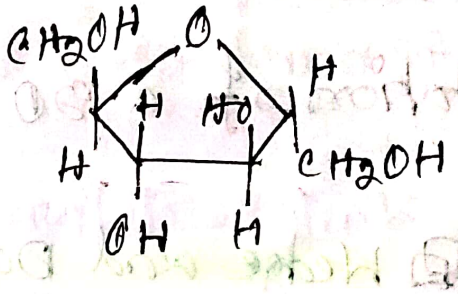
(i) Boat form:



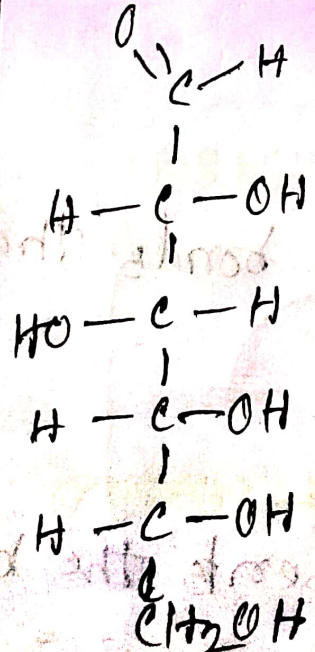
D-fructose

Boat → form

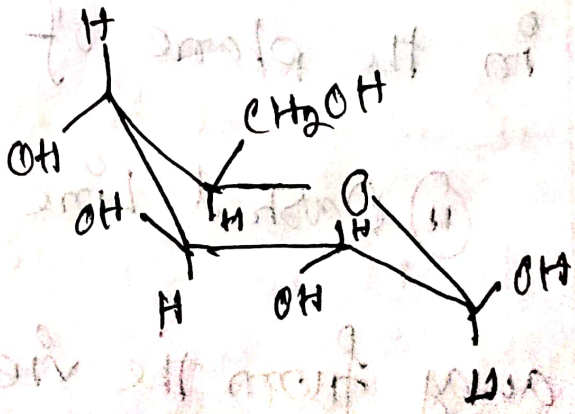


α-D-fructose

(ii) Chain form:

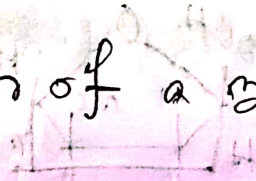


Chain → form



α-D-Glucose.

Fischer Projection: It is devised by Emil Fischer in 1901, it is actually a 2D representation of a 3D structure by projection.



Wedge and Dash Projection: It is a method of representating the 3D structure of a molecule using three types of line.

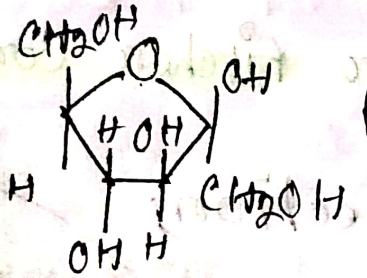
(i) Solid line represents the bonds that are in the plane of paper/image

(ii) Dashed Line represents the bonds that extend away from the viewer.

(iii) Wedge-shaped line represents the bonds oriented towards the viewer.

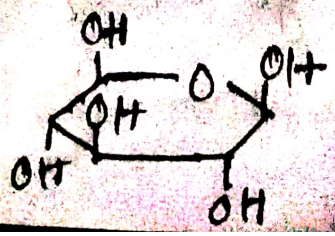
Haworth Projection: It is used to draw the cyclic structure in cyclic form. For carbohydrate, this projection is made using furanose and pyranose ring.

Furanose: It is a chemical structure that includes a five membered ring system, consisting of four carbon atoms and one oxygen atom. It is a collective term.



β-D-fructofuranose.

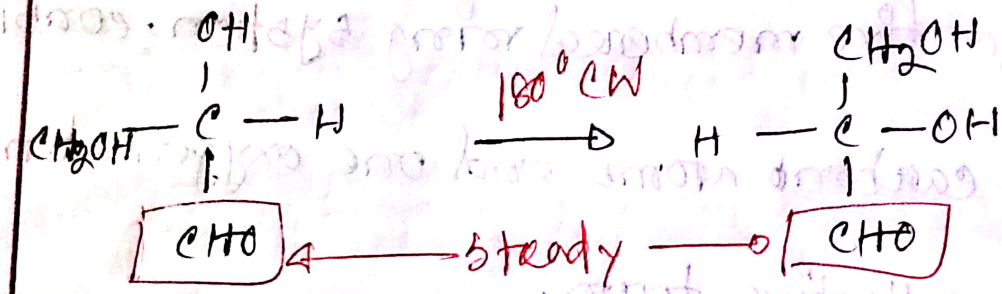
Pyranose: It is also a collective term containing a six-membered ring, includes 5 carbon atoms and one oxygen atom.



β-D-Glucopyranose.

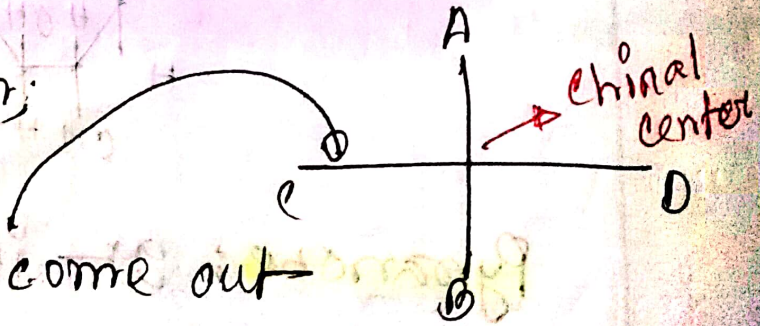
Manipulation of fisher Projection:

* The projection can be rotated at 180° but can not be rotated at 90° angle.
* While rotating ACW or CW, 1 side chain of 4 should be kept steady.



Wedge-Dash to fischer Conversion:

In fischer projection;



*** Horizontal line come out of the plane towards the viewer.

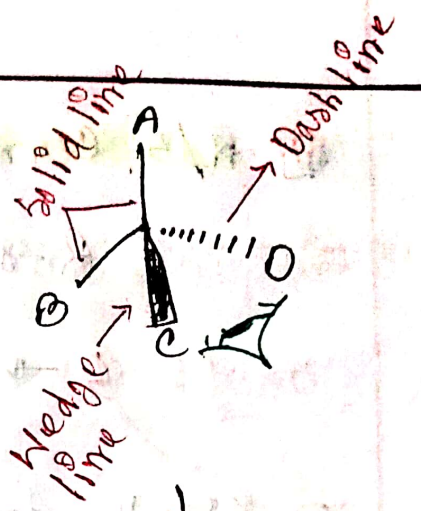
*** Vertical Line go away from the plane, from the ~~few~~ viewer.

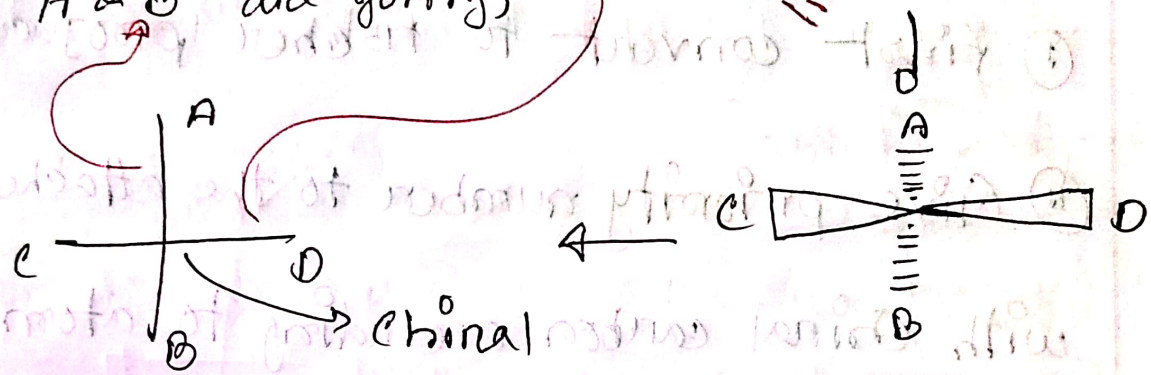
To convert,

① Look between wedge & Dash

② C & D are coming,

A & B are going,





D-L Configuration :

① The projection should be in fischer

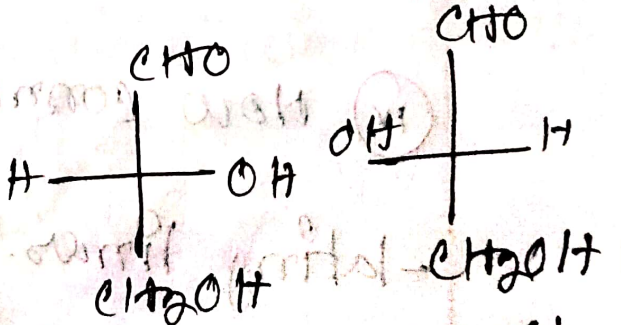
if

② Lowest chiral carbon (highest number) has —OH group on,

Right → D

Left → L

other than —OH, think of highest priority group instead of —OH



R/S Convention:

R → Rectus (Towards right, CW)

S → Sinister (Towards Left, ACW)

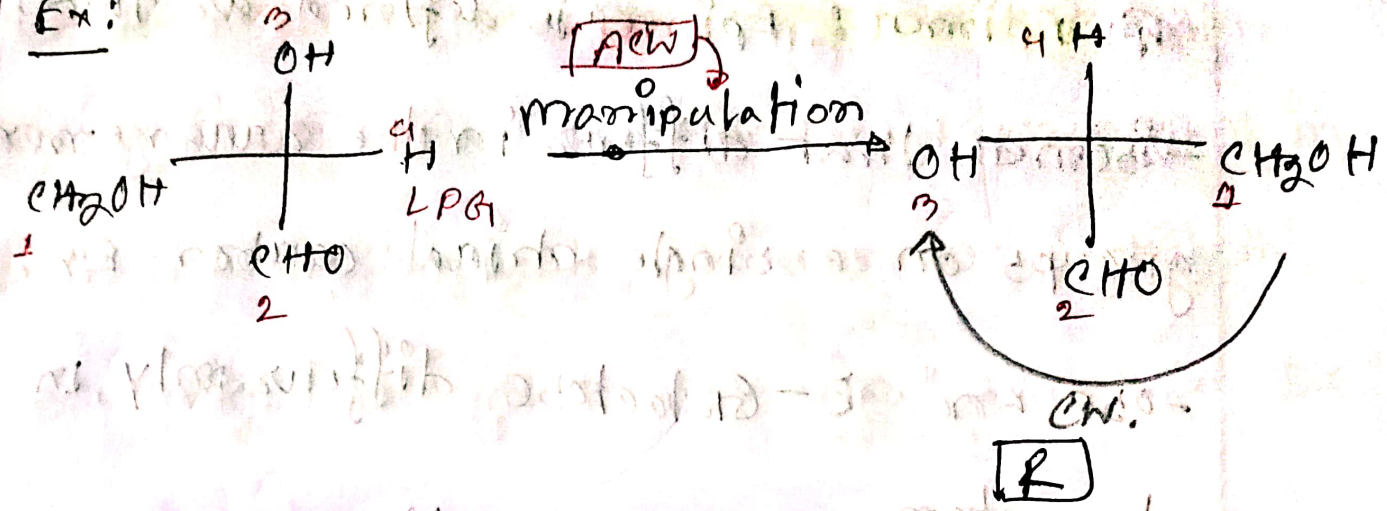
(i) First convert to fischer projection.

(ii) Give priority number to the attached group with chiral carbon according to atomic mass.

(iii) Lowest priority group (LPG) should be at top position: If not then manipulate the projection to do so:

(iv) Now connect the priority group by circulating lines. If connection is in clockwise direction, it is R (+), if Anti clockwise it is S(−)

Ex:



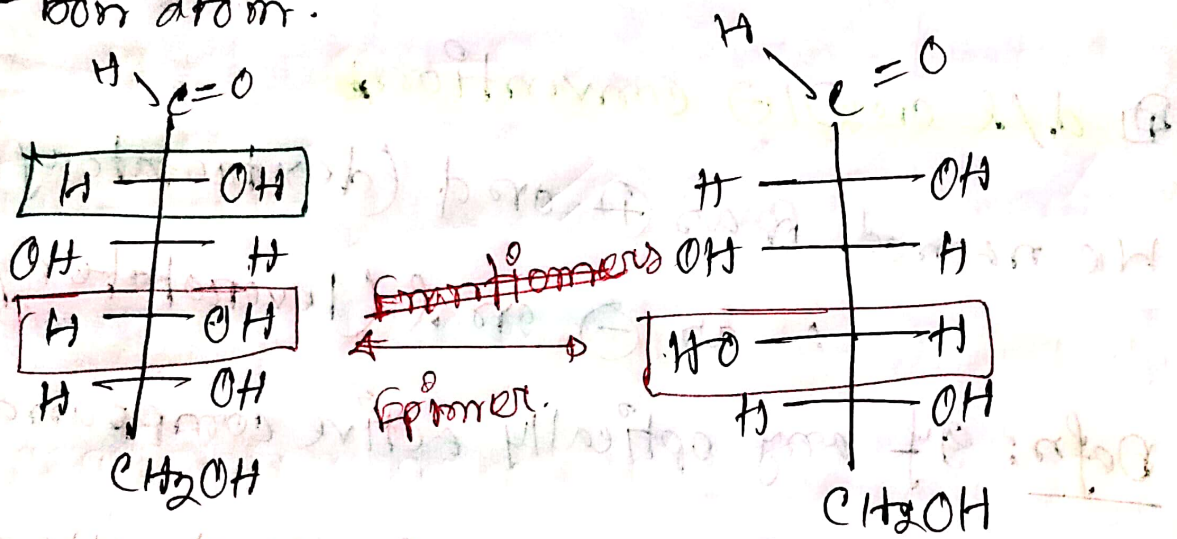
d/l or ⊕/⊖ convention:

We named R as ⊕ or d (dextrotatory)

S as ⊖ or l (levorotatory)

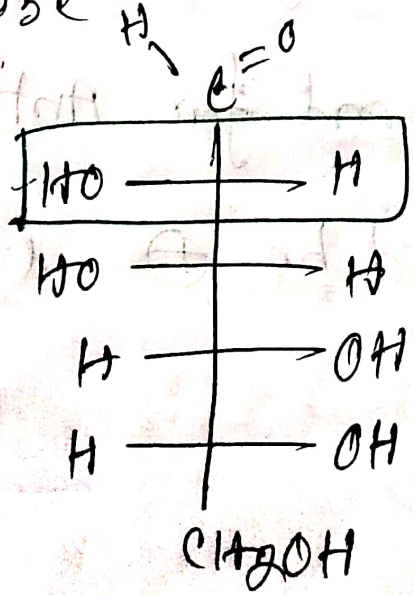
Defn: If any optically active compound rotate a plane polarized light in clockwise direction it is called d and for Anticlockwise direction, it is l. d be ⊕ l be ⊖.

Epimer: Epimer is defined as two stereo-isomer that differs in the arrangement of groups on a single chiral carbon. Ex: D-Glucose and D-Galactose differs only in 4th Carbon atom.



D-Glucose

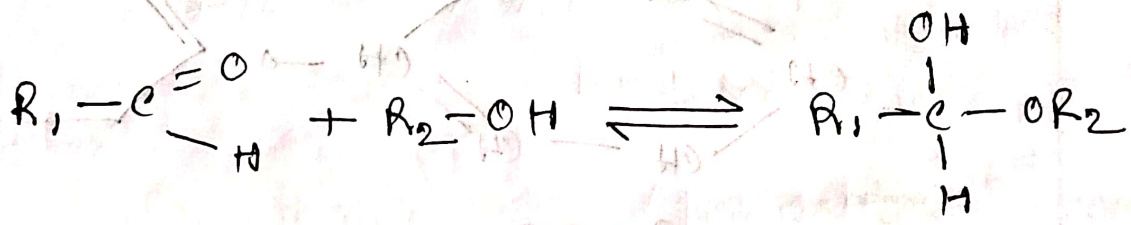
D-Galactose



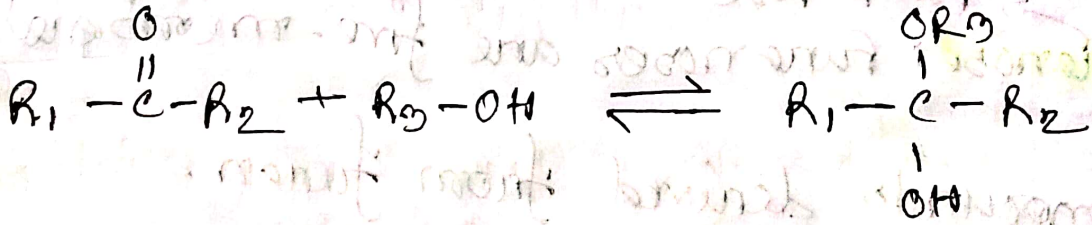
D-Mannose

D-Glucose & D-mannose are epimer at C_2

Formation of Hemiacetals & Hemiketals: An Aldehyde or ketone can react with an alcohol in a 1:1 ratio to yield a hemiacetal or hemiketal, respectively, creating a new chiral center at the carbonyl carbon.

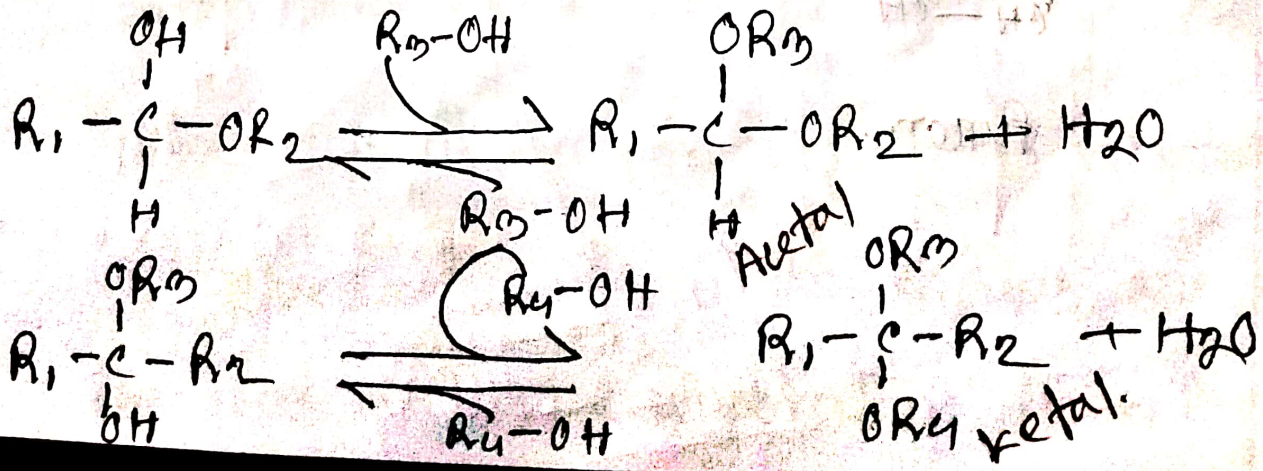


Hemiacetal



Hemiketal.

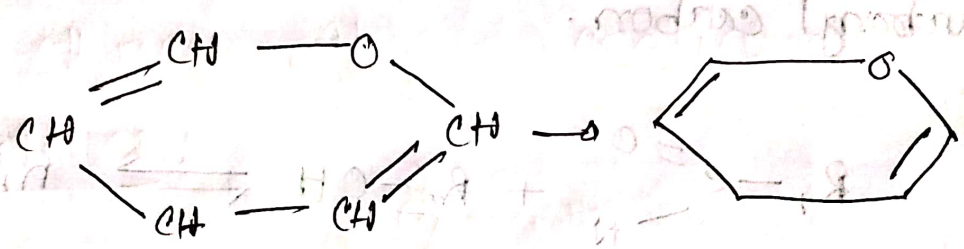
Substitution of a second alcohol molecule produces an acetal or ketal.



N.B:

→ for aldose

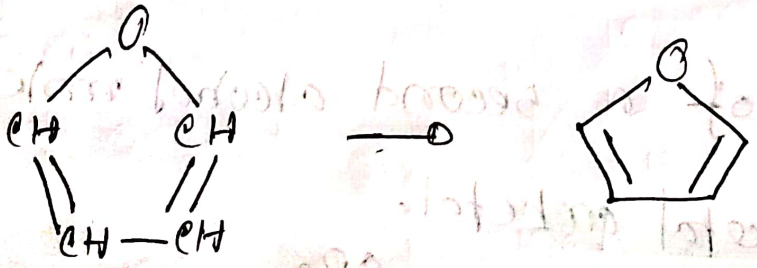
Pyranose: six-membered ring compounds are called pyranoses because they resemble the ~~six~~ six membered ring compound pyran.



Pyran.

→ for ketose

furanose: furanoses are five-membered ring compounds derived from furan.



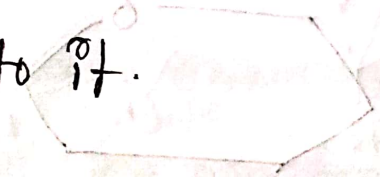
furan.

Fischer Projection to Haworth Perspective:

(i) Draw pyranose ring (for aldose) or furanose ring (for ketose)

(ii) Number the carbons in clockwise direction beginning with the anomeric carbon or,

Think the downward horizontal line as C_2 and C_3; then number other carbons according to it.



(iii) Place the -OH group as which are on right side of the fischer projection, ~~it~~ they are placed pointing down and which are on left side, they are placed pointing up. or,

Think the fischer projection is rotated at 90° clockwise. Now the groups are below the line will placed pointing down & vice-versa.

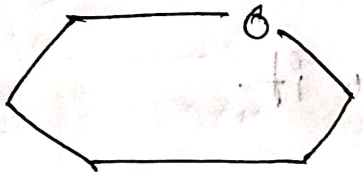
(iv) The terminal $-CH_2OH$ group is upward for D-enantiomers and downward for L-enantiomers.

(v) The $-OH$ group can be both upward or downward. If upward, it is called Beta (β) config. or otherwise Alpha (α) configuration.

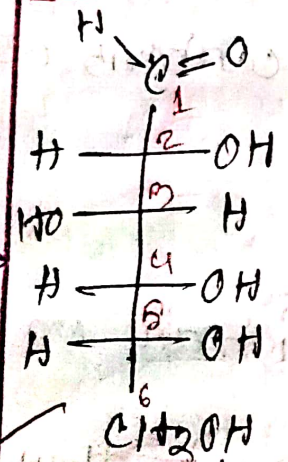
Example 01 :

(i) Pyranose as aldose.

(ii) Numbering

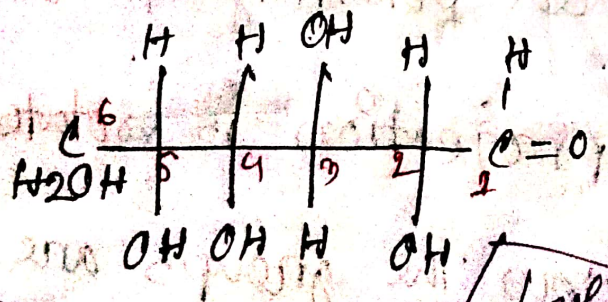


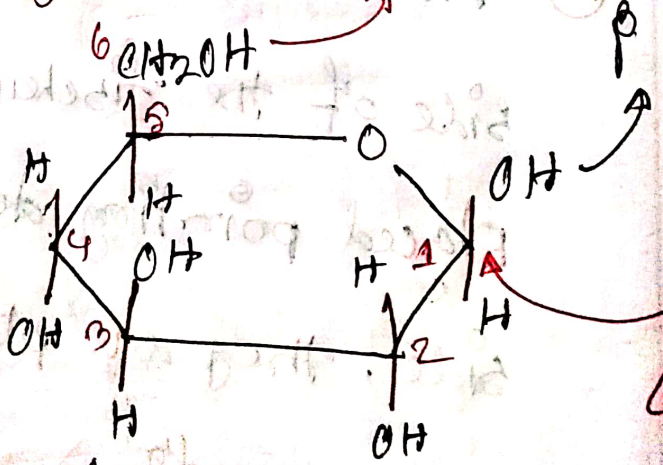
(iii) Place groups



α-D Glucose

rotate 90° CW.





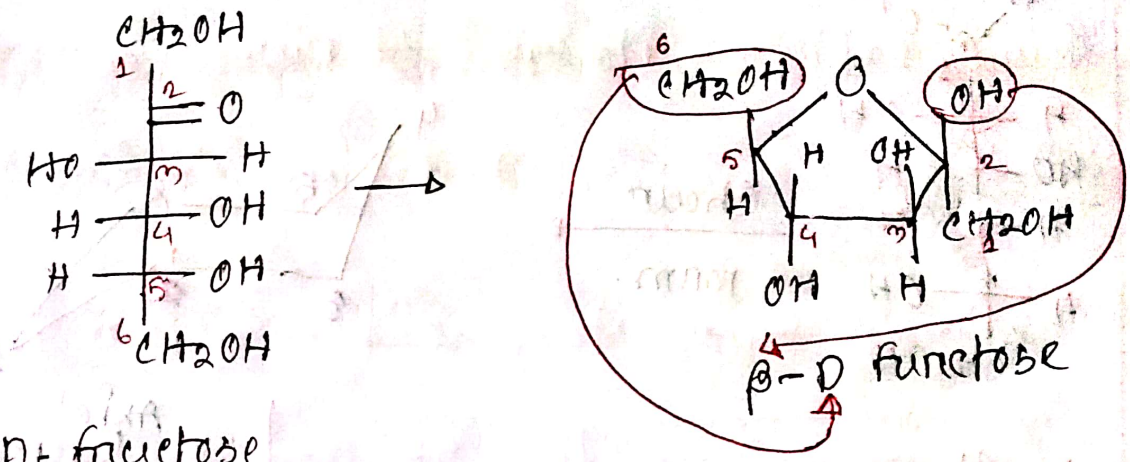
Anomeric Carbon

β-D Glucose

left → up

Right → Down

Example 02:



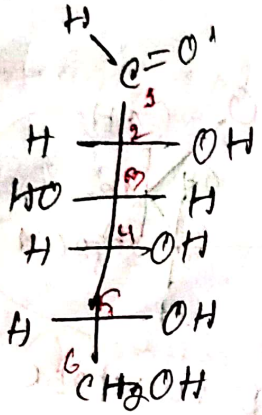
Fischer to Chair:

(i) Draw chair and number the carbon taking the horizontal line as C_2 & C_3.

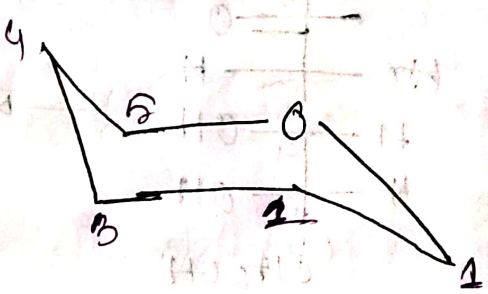
(ii) Draw the axial and equatorial bonds as up-down-up from C_1 and down-up-down from C_1 for axial & equatorial respectively.

(iii) Put the side chain as we did in the Fischer to Boat (Haworth) i.e. Right → down
Left → up.

Example 01:

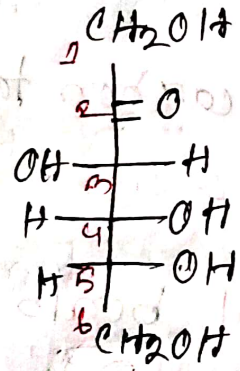


D-Glucose

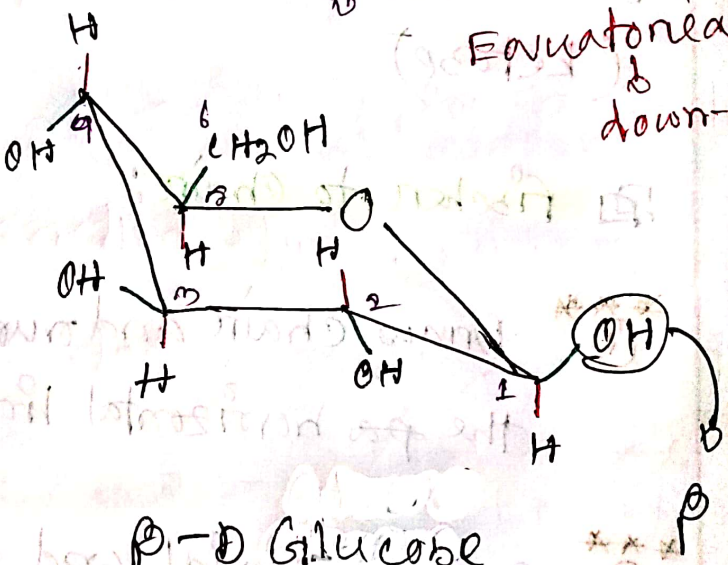


Axial
↳ up-down-up
Equatorial
↳ down-up-down

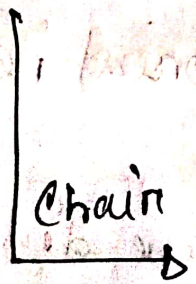
Example 02:

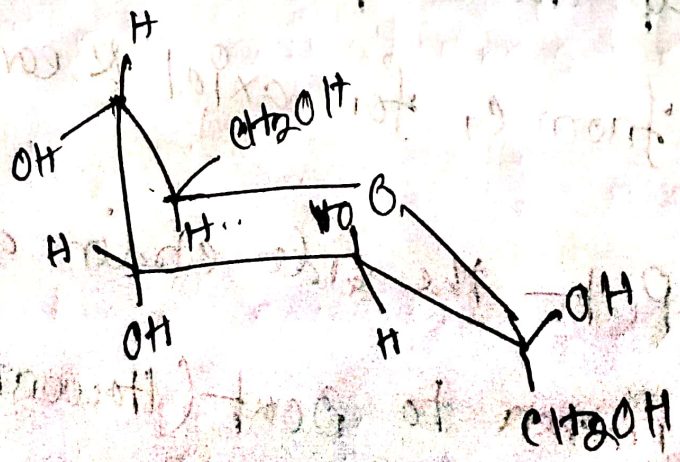


D-Fructose



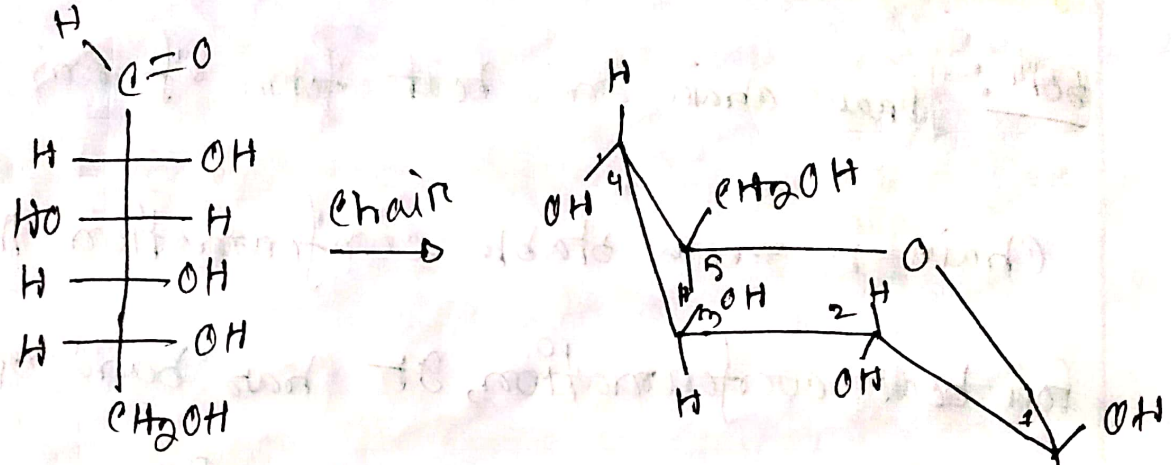
β-D Glucose





β D Fructose.

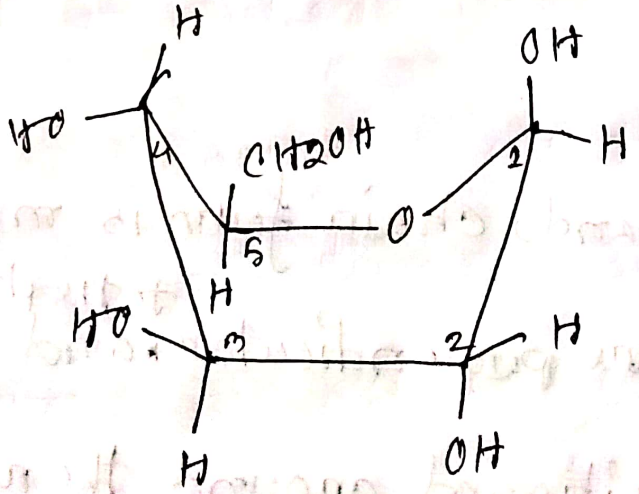
Chain to Boat : It is just some rearrangement on chain structure.



D-Glucose

β-D-Glucose

Boat



Q. Why chair form is more stable than the Boat form? Explain with neat sketch.

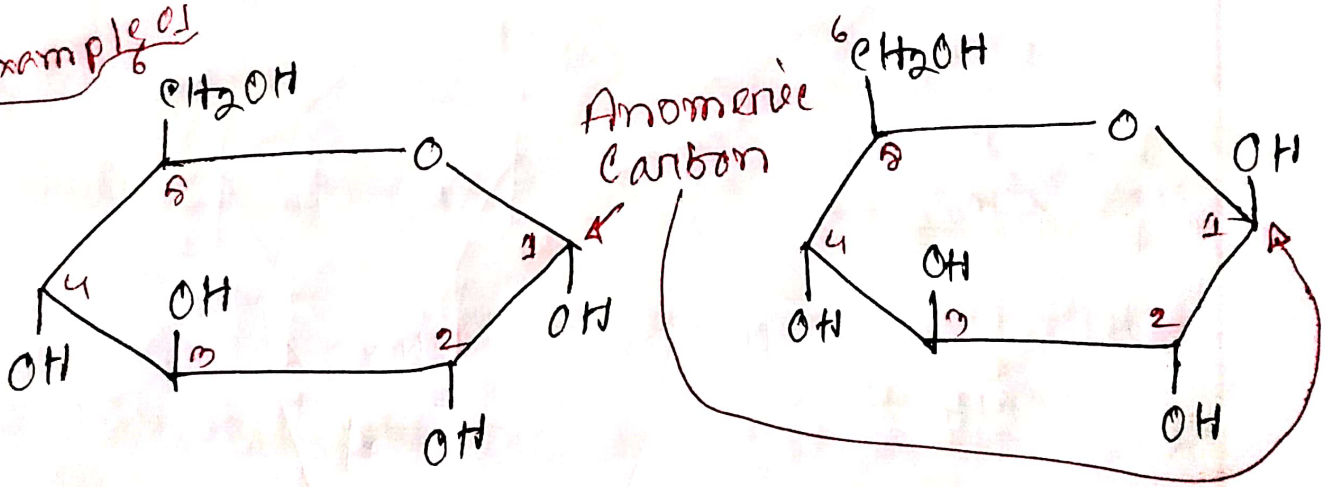
Soln: Draw chair and boat form of any comp. first.

Chair is more stable conformation than boat. For boat conformation, it has bond opposition strain as C–H bonds on the sides are eclipsed. And there is also another strain present within H atoms. These two strains make ~~chair~~ boat form unstable.

On the other hand, chair form is more stable. The axial bonds are perpendicular to the plane and equatorial bonds are positioned around the ring. Thus the groups on axial and equatorial position avoid strain making the chair form more stable.

Anomer: It is a cyclic stereoisomer of a carbohydrate with isomerism involving only the arrangement of atoms or groups at the aldehyde or ketone position. Aldoses are different at first carbon and ketoses are different at second carbon. The epimeric carbon (C_1 or C_2) are known as anomeric carbon center.

Example of

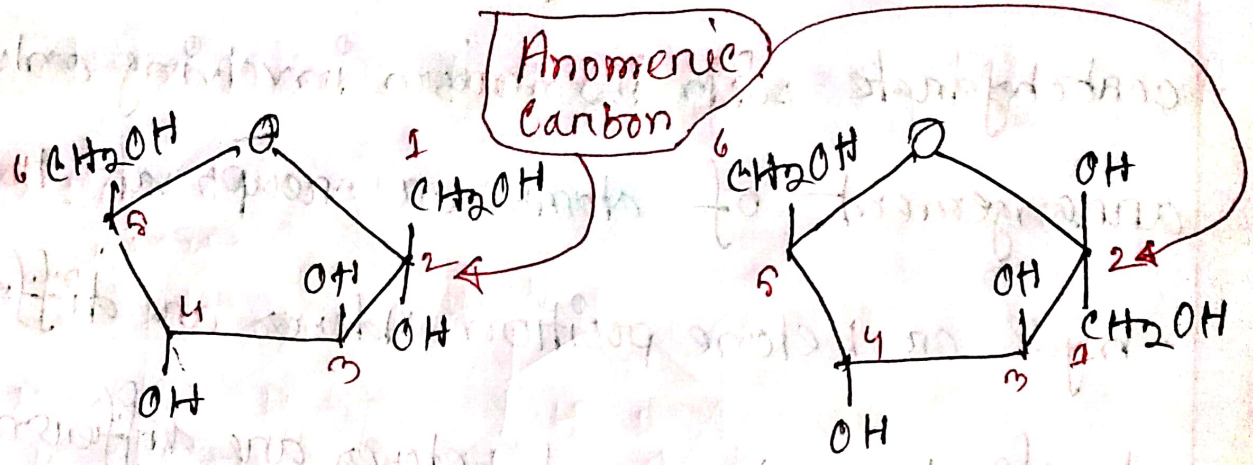


α-D Glucopyranose

β-D Glucopyranose

Anomeric carbon is C_1 as aldose.

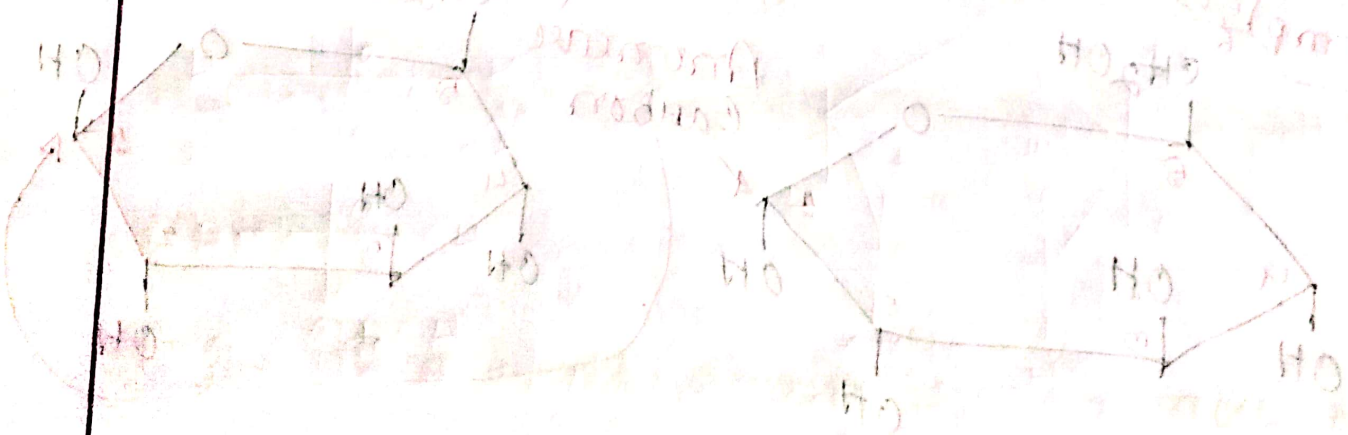
Example 02: For Ketose



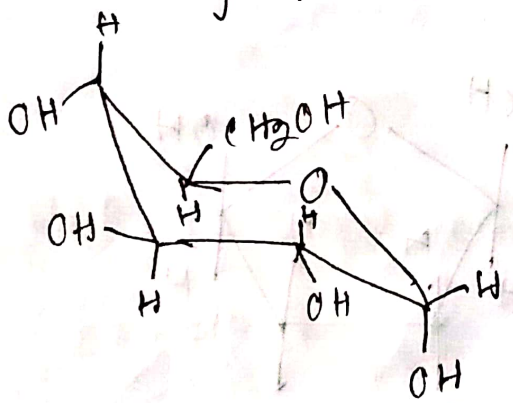
α-D fructofuranose

β-D fructofuranose.

Anomeric carbon is C_2.



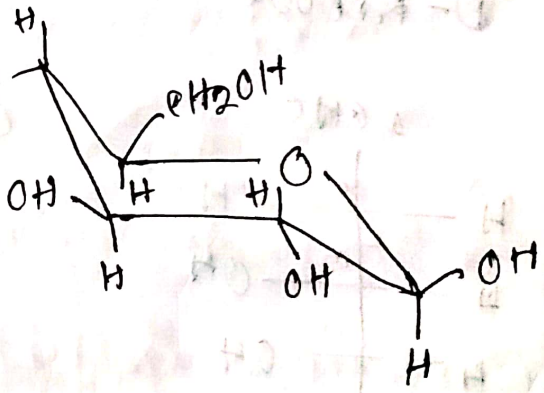
Mutarotation: The spontaneous change in specific rotation of an optically active compound in solution with time, to an equilibrium value is called mutarotation. When the pure anomers are dissolved in water they undergo mutarotation, the process by which they return to an equilibrium mixture of the anomer. Ex:



α-D Glucose

36%

+112.2°



β-D Glucose

64%

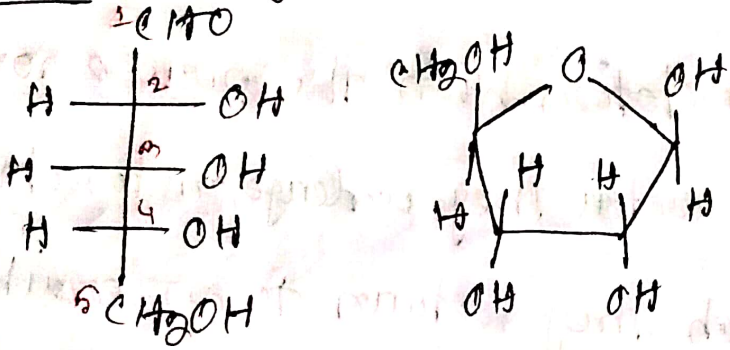
+18.7°

Specific rotation = 0.36×112.2 + 0.64×18.7

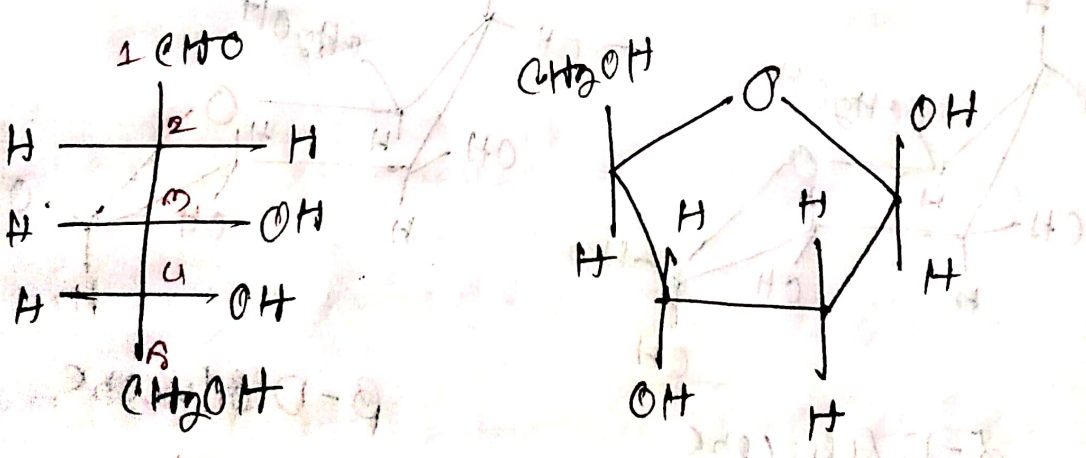
= 52.3°

Deoxy sugar: These sugars have the hydroxyl group replaced by a hydrogen atom.

Ex: ① Deoxyribose.



D-Ribose

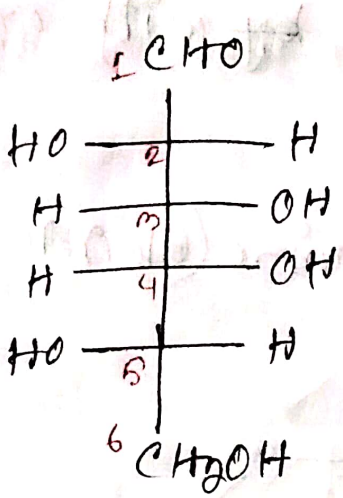


2-Deoxy-D-ribose

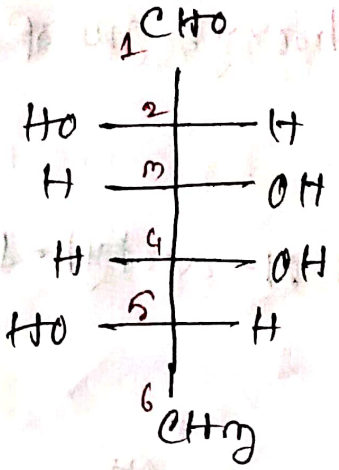
↳ Deoxyribose

it is a constituent of DNA.

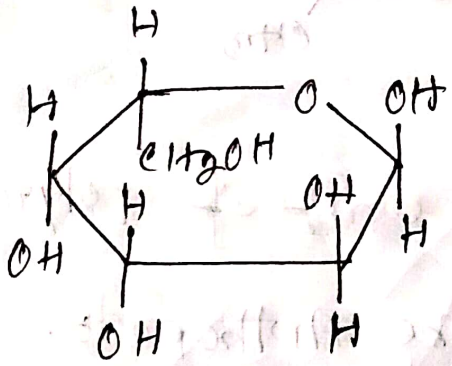
(11) Fucose or 6-deoxy-L-galactose

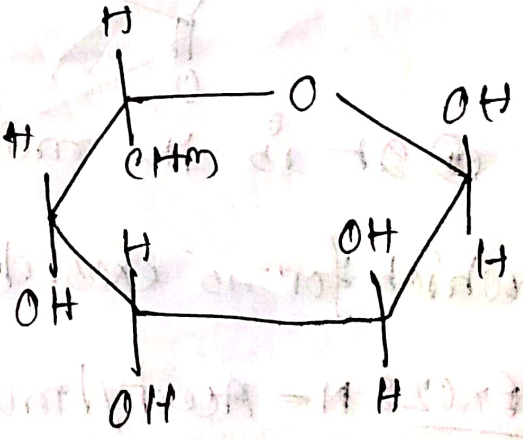


L-Galactose



6-deoxy-L-galactose
(Fucose)

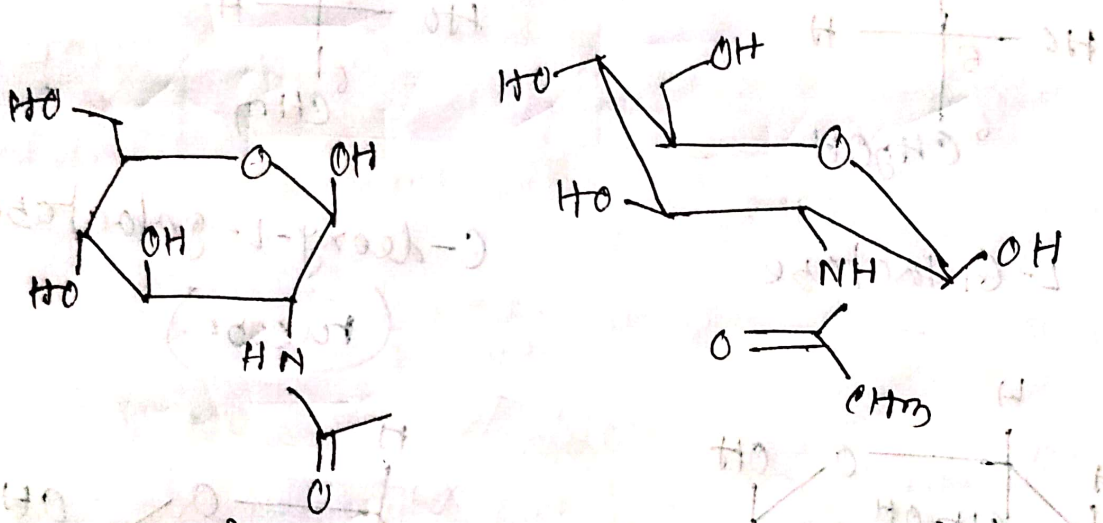




Fucose is the main component of fucodian of brown Algae, and present in N-linked glycans.

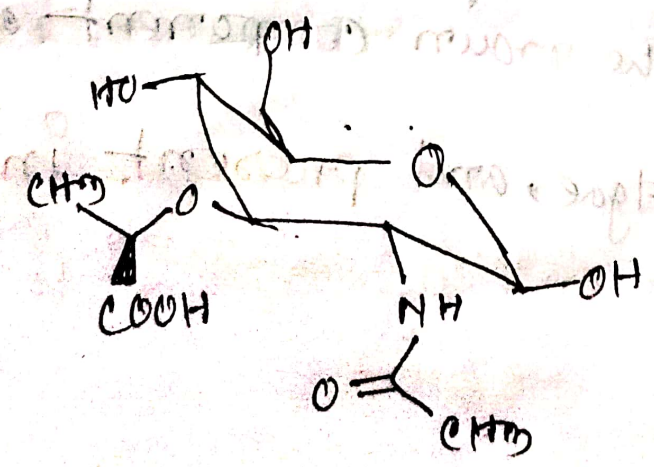
Amino Sugars: They are carbohydrates in which a hydroxyl group is replaced by with an amino group.

Ex 01 : N-acetyl-D-Glucosamine (GlcNAc or NAG)

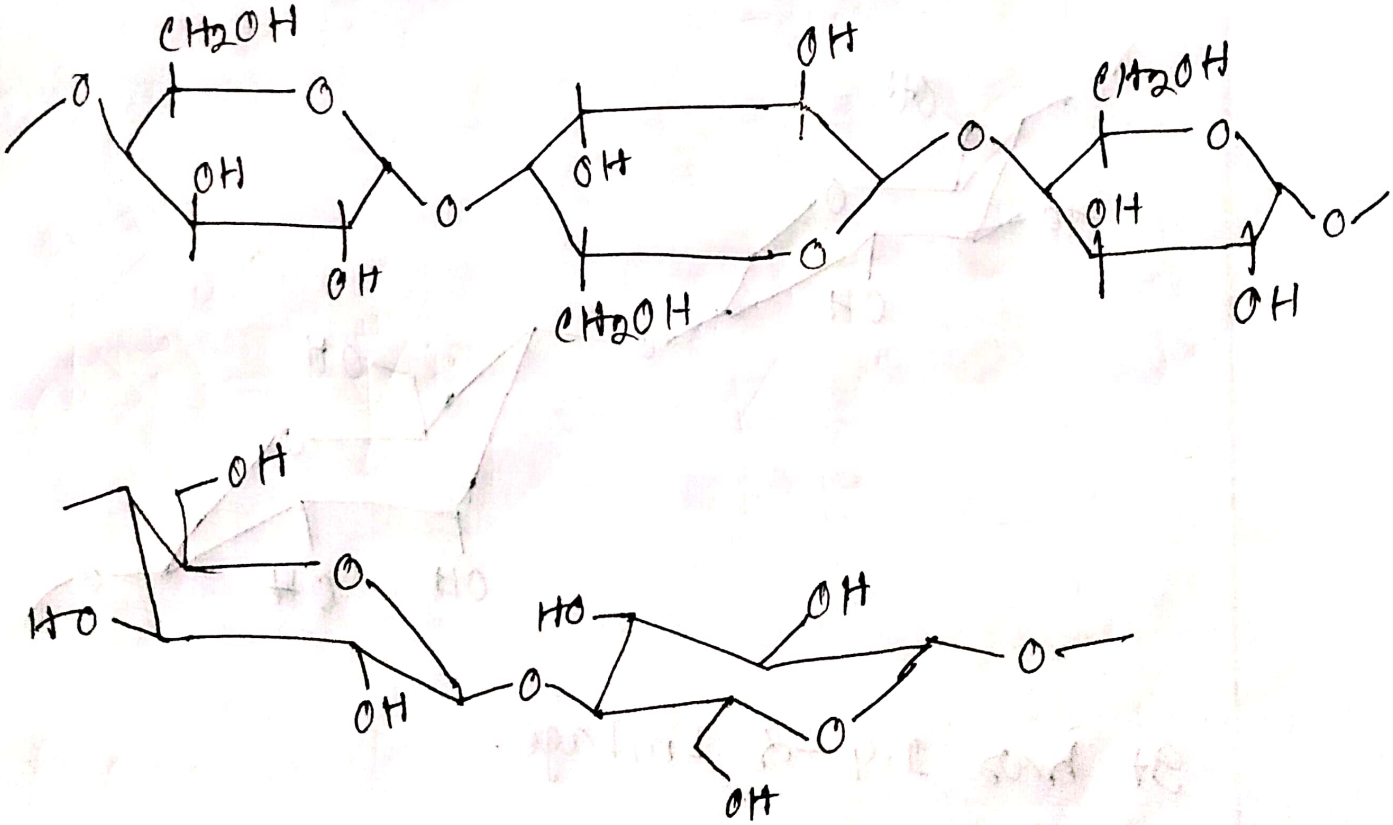


⊛ It is the monomer unit of polymer Chitin, which forms exoskeletons like Arthropods.

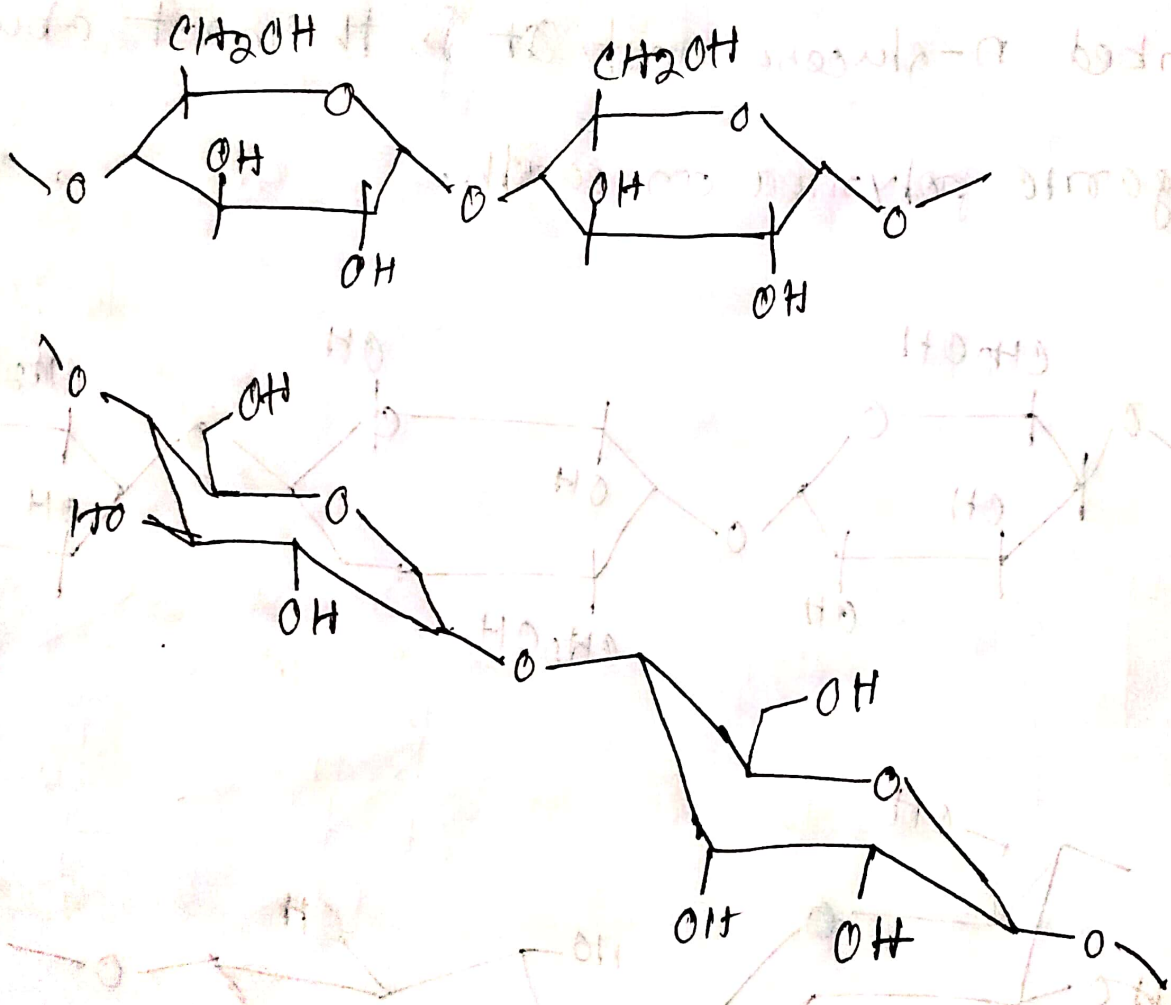
Ex 02: N-Acetylmuramic Acid (MurNAc)



Cellulose: It has the formula $(C_6H_{10}O_5)_n$. It is a polysaccharide consist of a linear chain of hundred to thousands of $\beta(1\rightarrow4)$ linked D-glucose unit. It is the most abundant organic polymer on earth.



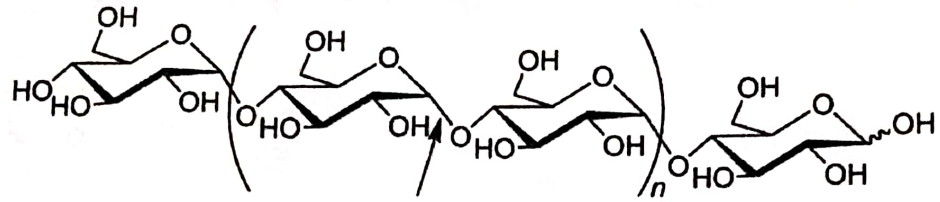
Starch: Starch or Amylum is a polymeric carbohydrate consist of numerous glucose units joined by glycosidic bonds.



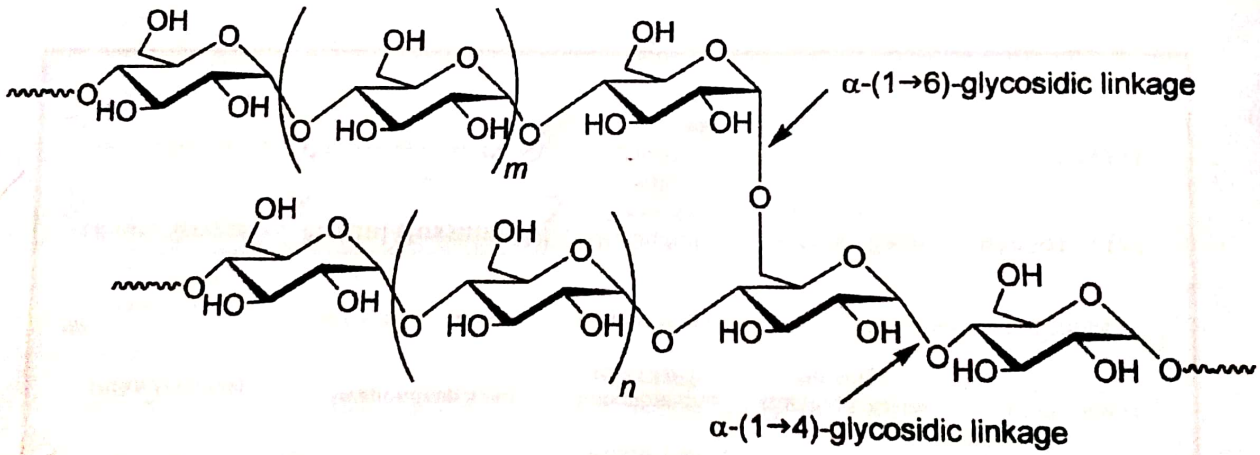
It has 1,4-α Linkage.

Amylopectin: It is a water insoluble polysaccharide and highly branched polymer of α-glucose.

Amylose



Amylopectin



Amylopectin