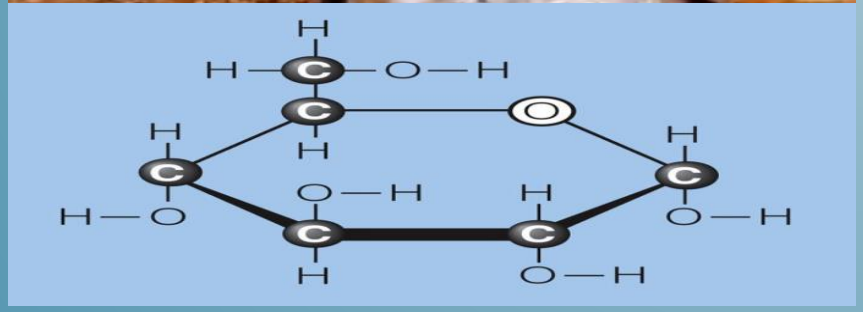
Biochemistry – Year 2



Lecture 1

By

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Objectives

- ✓ Definition
- ✓ Biological importance
- ✓ Classification
- ✓ The chemistry of monosaccharide
- ✓ Type of isomerism
- ✓ Reaction of monosaccharide
- ✓ Type of glycosidic bond
- ✓ Disaccharides
- ✓ Oligosaccharides
- ✓ Polysaccharides
- ✓ Glycoproteins and proteoglycans

Carbohydrates

Definition

Carbohydrates (CHO) are polyhydrxy aldehydes or ketones or substances that yield such compounds on hydrolysis .

Many but not all carbohydrates have empirical formula $C_n(H_2O)_n$ some also contain nitrogen , phosphorus or sulfur.

They are also called saccharides or sugar due to the sweet taste of the simplest member of the family.

Biologically important

1. Chief source of energy (glucose) and for storage energy (starch and glycogen).

2. Constituents of compound lipids(glycolipids) and conjugated proteins (glycoproteins).

3. Their degradation products are utilized for the synthesis of other substances such as fatty acids, cholesterol , amino acids.

Classification

Carbohydrates are classified as follows :

1. Monosaccharide (simple sugar):The sugars that cannot be hydrolyzed into simpler carbohydrates .

2.Disaccharides:sugars that yield 2 molecules of the same or different Monosaccharides on hydrolysis.

3. Oligosaccharide: which yield 3-10 molecules on hydrolysis.

4. Polysaccharides: yield more than 10 molecules of Monosaccharides on hydrolysis. The can be subdivided further:

A. Homopolysaccharides: polymer of the same Monosaccharides unites ex: Starch , glycogen.

B.Heterpolysaccharides: : polymer of the different Monosaccharides or their derivatives unites ex: Mucopolysaccharides

1. Monosaccharide (simple sugar)

The sugars that cannot be hydrolyzed into simpler carbohydrates . They may be subdivided depending on :

A. The number of carbon atoms that they contain

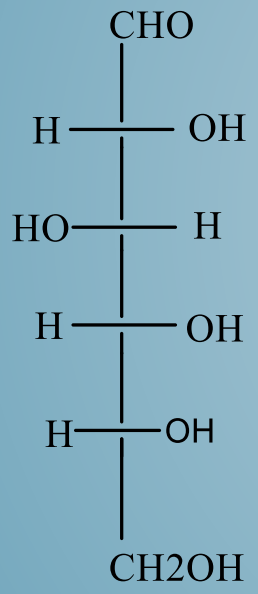
$C_3H_6O_3$ tri ose $C_4H_8O_4$ tetr ose

$C_5H_{10}O_5$ pent ose $C_6H_{12}O_6$ hex ose

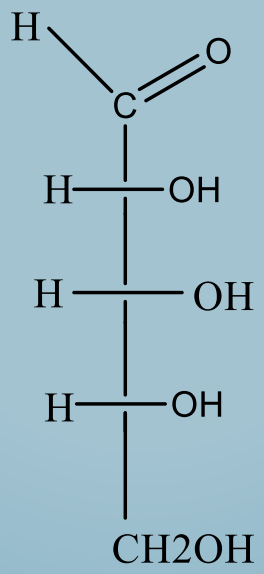
B. The kind of carbonyl group in monosaccharide or the site of carbonyl group :

- Monosaccharide that is contain an aldehyde group or terminal carbonyl group is called aldose .
- Whereas Monosaccharide that is contain a ketone group or non-terminal carbonyl group is called ketose .

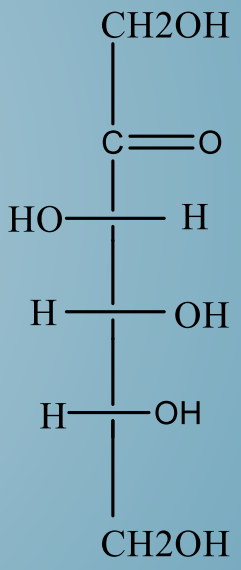
- We can combine these two terms into one word when we need to explain the number of the carbon atoms and the kind of carbonyl group such as aldohexose , aldopentose and ketohexose.



Glucose ,an aldohexose



Ribose, aldopentose

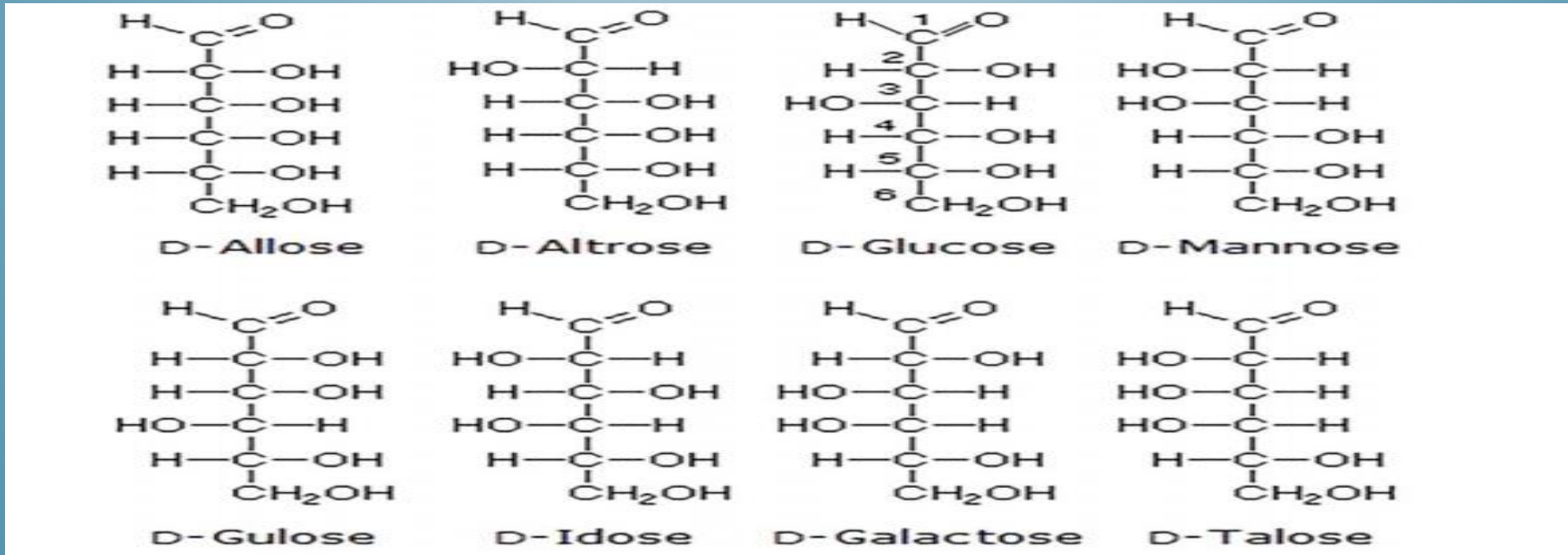


Fructose, a ketohexose

Sugars show various forms of isomers (compounds that are identical in composition (same chemical formula) but differ in spatial configuration).

Example :

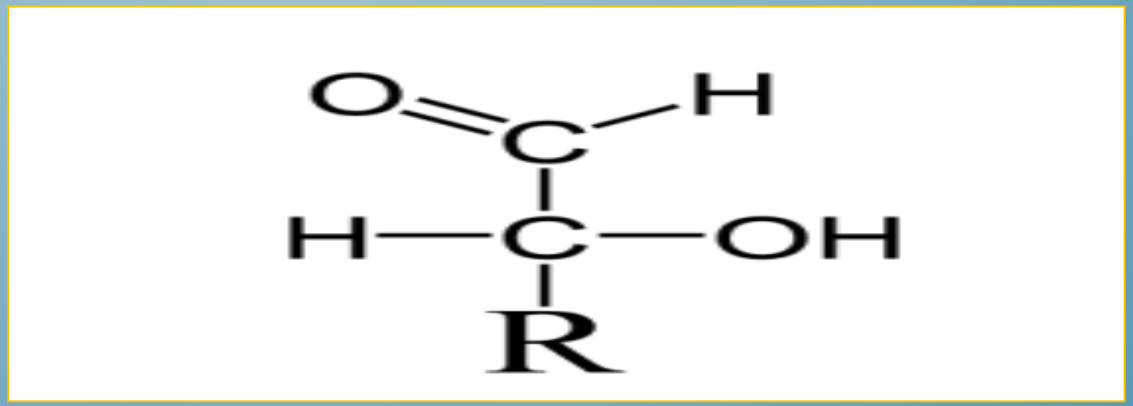
Glucose , Fructose , Mannose , and Galactose have the same chemical formula ($C_6H_{12}O_6$).



The structure of monosaccharide

Sugars exhibit various forms of isomerism (compounds that have the same structural formula but differ in spatial configuration) .

The presence of asymmetric carbon atoms or chiral center (carbon atoms attached to 4 different atoms or groups) allows the formation of isomers.



Types of isomerism

1.D and L isomerism :

the orientation of H and OH around the carbon atom adjacent to the terminal primary alcohol carbon atom determinate the series , ex: C5 in glucose .

When- OH group on this carbon in the right → D-isomer
When- OH group on this carbon in the lift → L-isomer

The vast majority of sugars in human are D-sugars.


Any
Question
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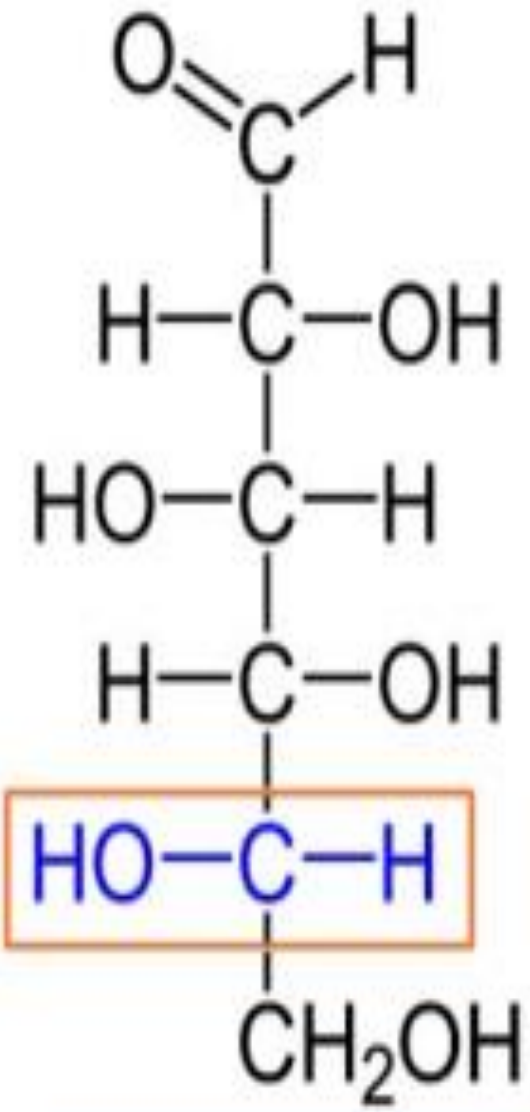
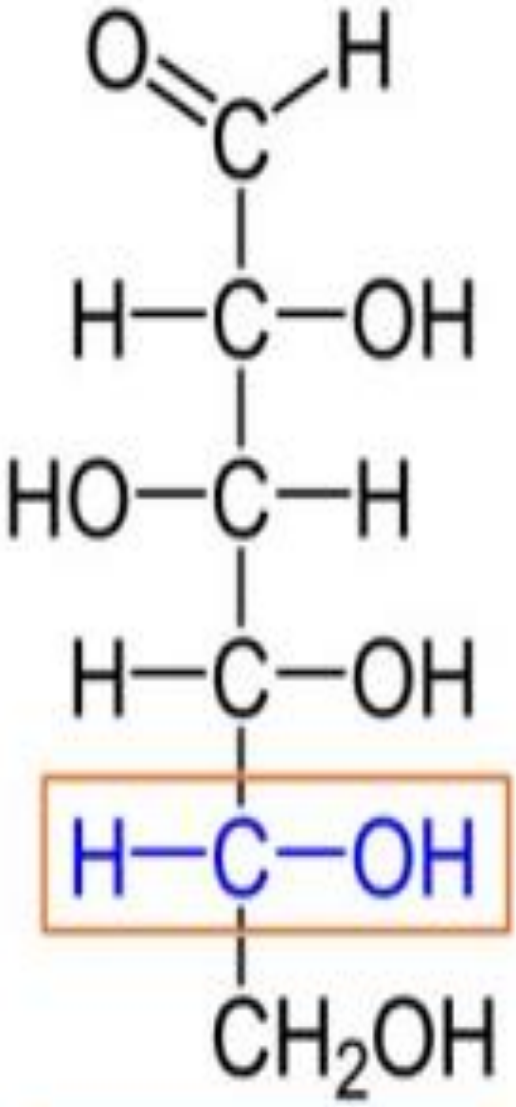


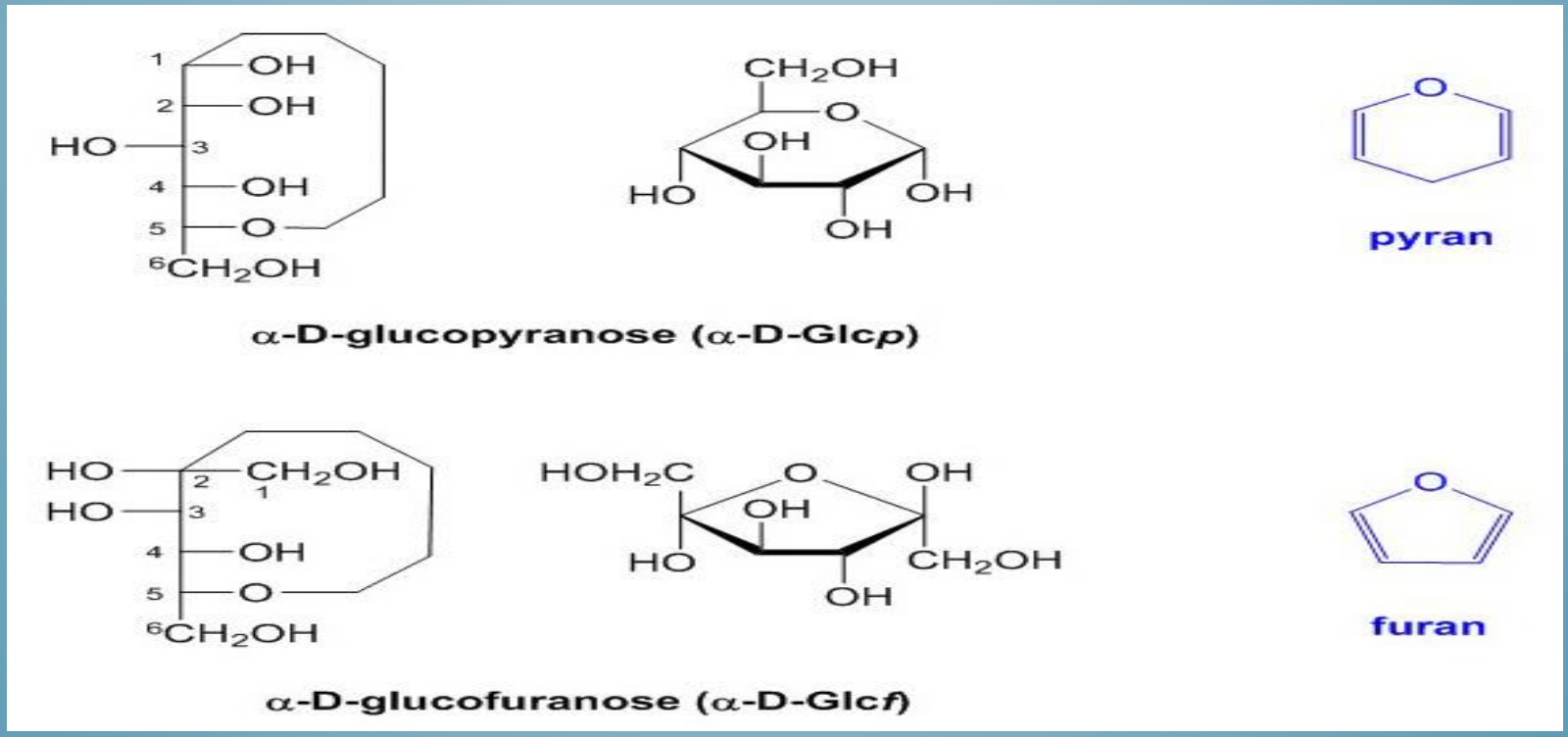
L- Glucose



D- Glucose

2. Pyranose and furanose ring structures

The ring structures of monosaccharides are similar to the ring structures of either pyrane (a six – membered ring) or furan (a five – membered ring) .

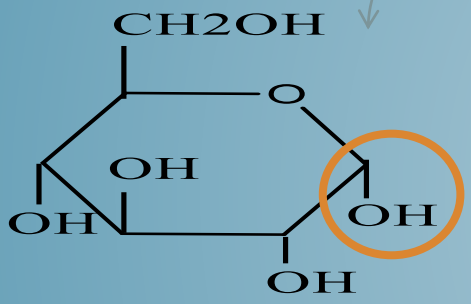


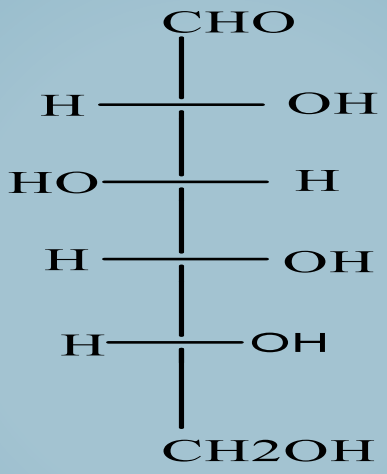
3.Alpha (α) and (β) anomers :

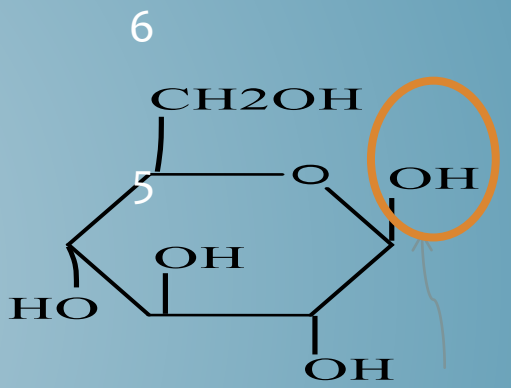
most monosaccharaides exist in cyclic form as they contain 2 functional groups (carbonyl and hydroxyl groups). Ex : in case of glucose , the different form of glucose are formed .

The straight – chain structure of monosaccharides allow many of the reaction . All monosaccharides have a cyclic structure because the intermolecular reaction of the hydroxyl group at C-5 of monosaccharides with the carbonyl group at C-1 or anomeric (chiral) carbon atom to form a cyclic with a six member ring contain one oxygen and five carbon atoms .

Anomeric carbon







Anomeric carbon

Haworth formula
α-D-Glucose

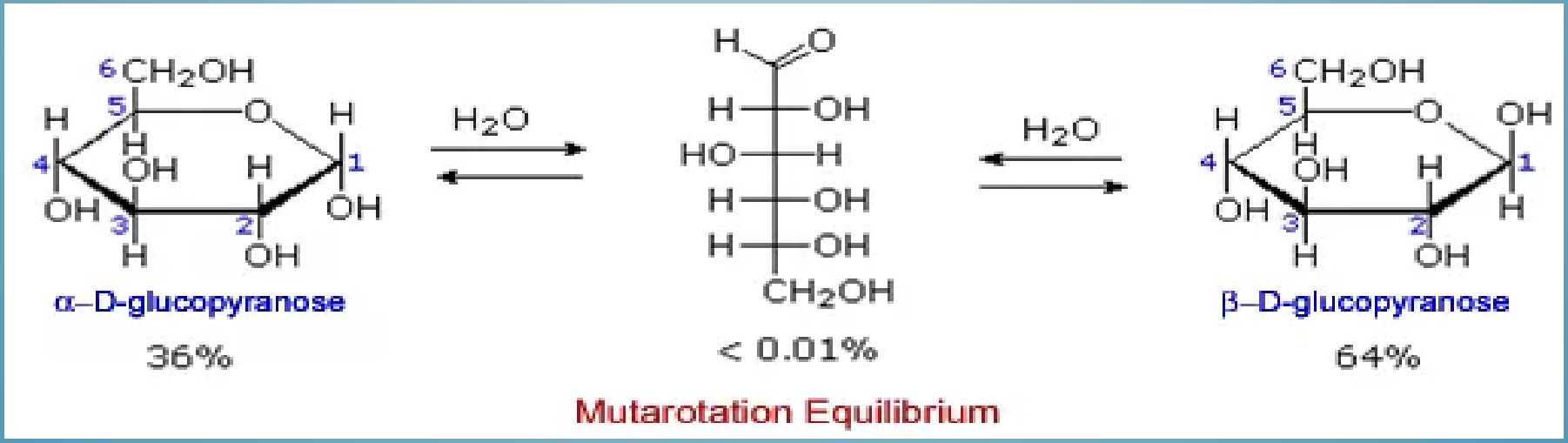
Fischer projection formula

Haworth formula
β-D-Glucose

Mutarotation

This phenomenone is caused by the interconversion of one anomer to another in solution through the open – chain aldehyde form as intermediate and two cyclic anomer α and β anomer in equilibrium.

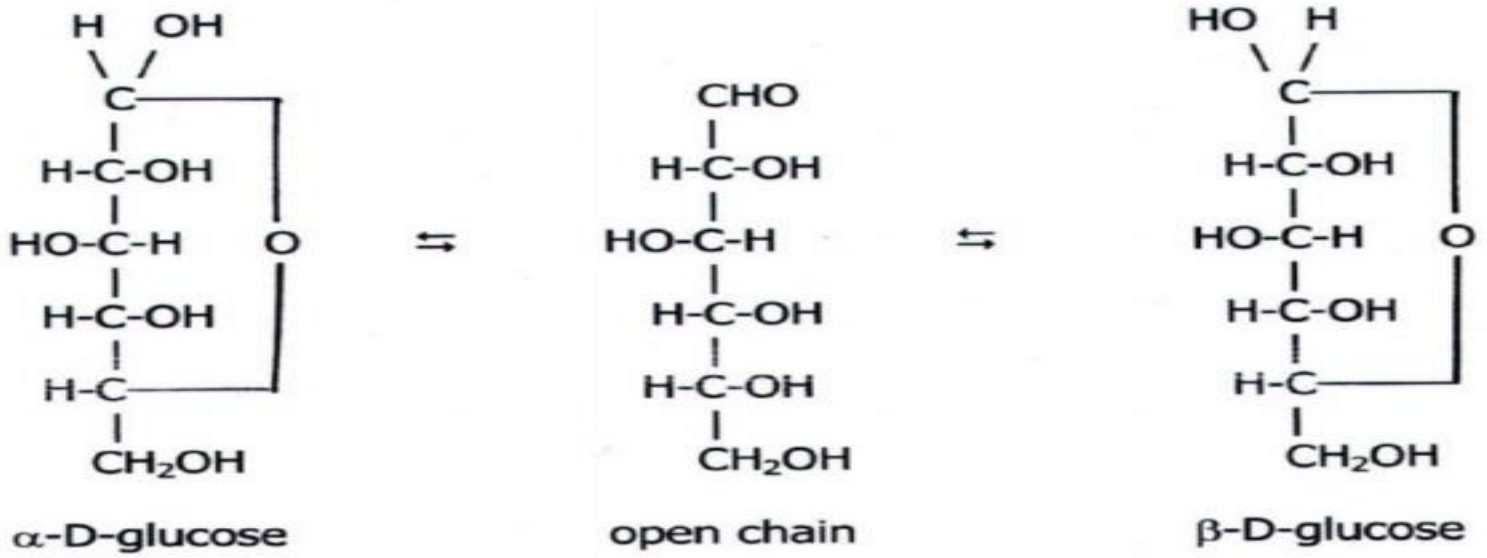
The change probably take place via a hydrated straight – chain acyclic molecule.



Glucose exist as two isomers because a new chiral center is created at C-1 by formation of cyclic structure.

The **α- isomer** is defined as the one in which the hydroxy group at the anomeric carbon is below the plane of the ring .

the isomer with the hydroxy group above the ring at the anomeric carbon is the **β- isomer**.



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