

CARBOHYDRATES



CARBOHYDRATES



- Are the most abundant in nature e.g. **Cellulose** of wood, cotton and paper
- **Starches** in cereals, roots and tubers
- **Glycogen** in animal tissues and include the
- **Sugars** e.g. cane sugar, milk sugar and glucose in body fluids.
- **Chemically** they have the elements C, H and O.
- General formula for carbohydrates is **(CH₂O)_n** , where ration of C, H, and O is **1:2:1**

Many structures of sugars differ only in the orientation of the hydroxyl groups (-OH).

- This slight structural difference makes a big difference in properties of sugars e.g.
 - biochemical properties,
 - organoleptic properties (e.g., taste),
 - physical properties such as melting point and specific rotation (i.e. how plane of polarized light is rotated).

A chain-form monosaccharide with an aldehyde group ($-CHO$) at an end-carbon is classified as an **aldose**.

- When a ketone ($-C=O$) group is on an internal carbon, it is classified as a **Ketose**

Naming of sugars

- **Triose** - contain 3 carbon atoms
- **Tetrose**- contain 4 carbon atoms
- **Pentose** - contain 5 carbon atoms
- **Hexose** - contain 6 carbon atoms
- **Heptose** - contain 7 carbon atoms

Sugar containing aldehyde function groups are called **aldoses** or aldose sugars.

- Those containing ketone groups are called **ketoses** or ketose sugars.

NOMENCLATURE

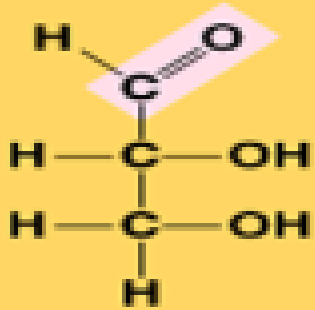
Functional group

Number of carbons

	Ketone	Aldehyde
4	Tetrose	Tetrulose
5	Pentose	Pentulose
6	Hexose	Hexulose
7	Heptose	Heptulose
8	Octose	Octulose

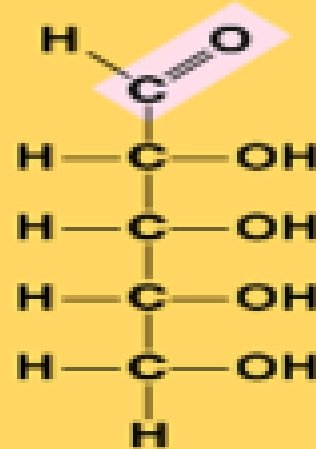
Common Aldoses and Ketoses

**Triose sugars
(C₃H₆O₃)**



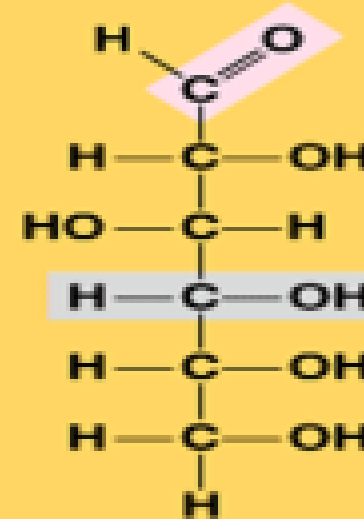
Glyceraldehyde

**Pentose sugars
(C₅H₁₀O₅)**

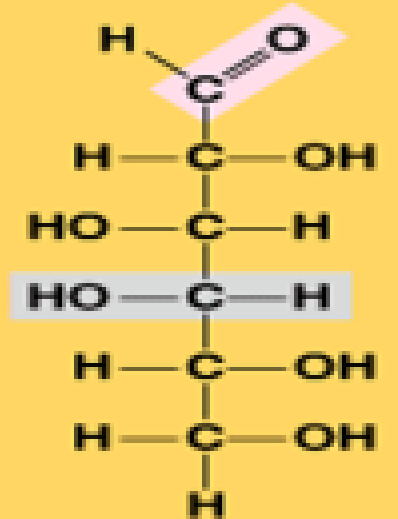


Ribose

**Hexose sugars
(C₆H₁₂O₆)**



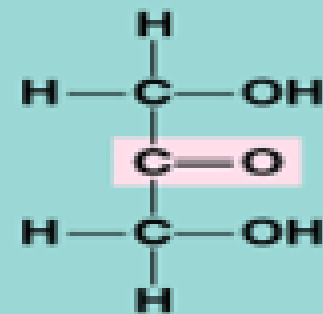
Glucose



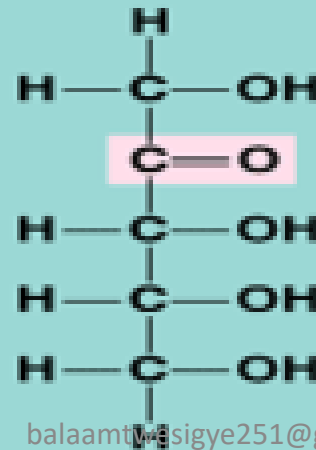
Galactose

Aldoses

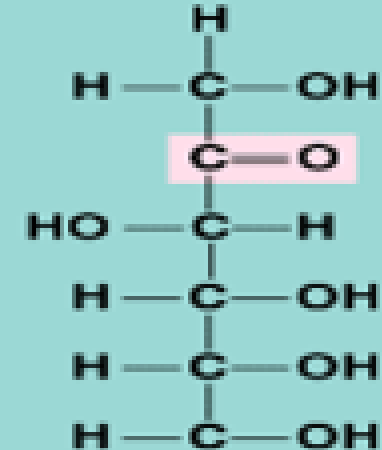
Ketoses



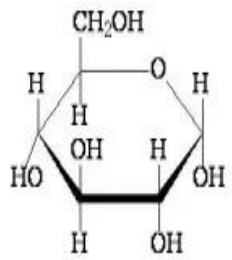
Dihydroxyacetone



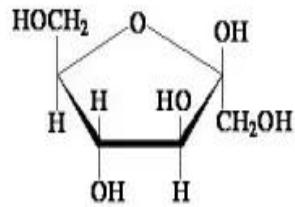
balaamt@sigye251@gmail.com



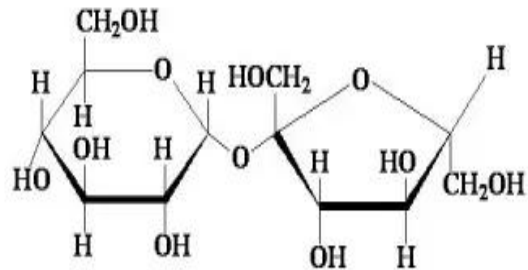
Structural isomerism



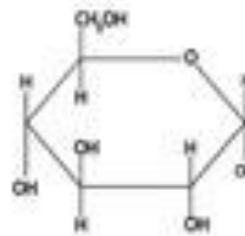
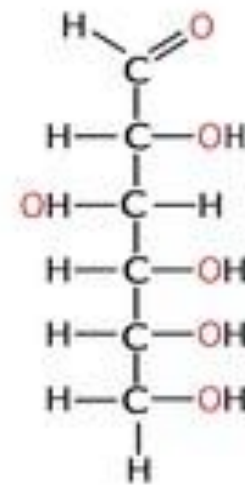
glucose



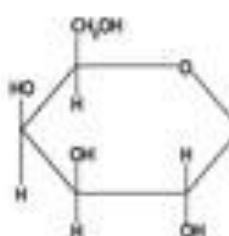
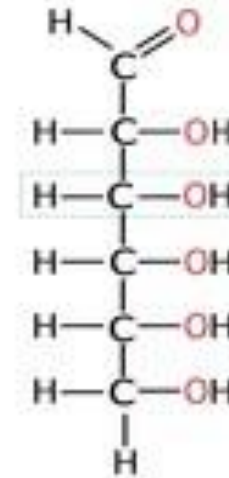
fructose



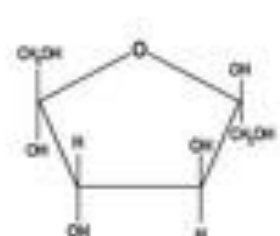
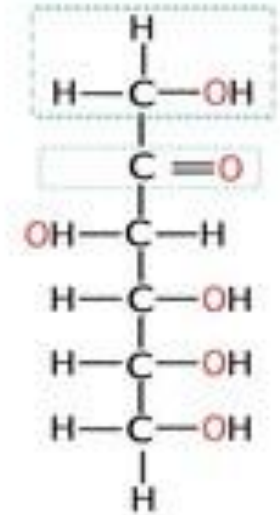
sucrose



Glucose

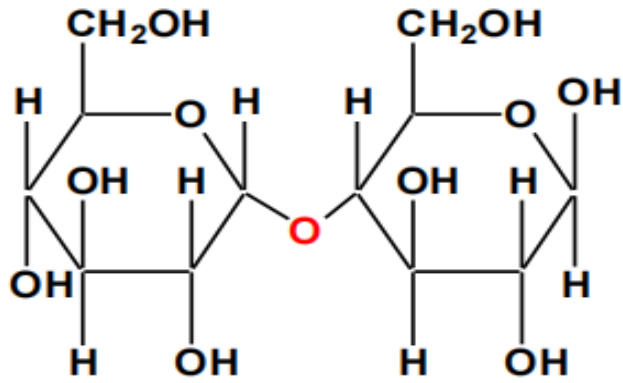


Galactose



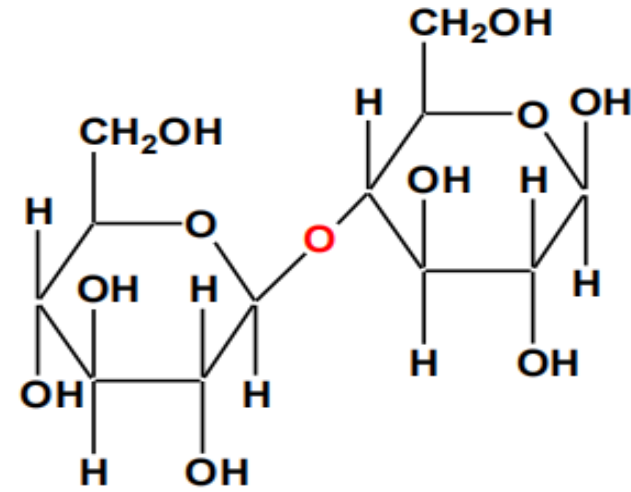
Fructose

Some Disaccharides



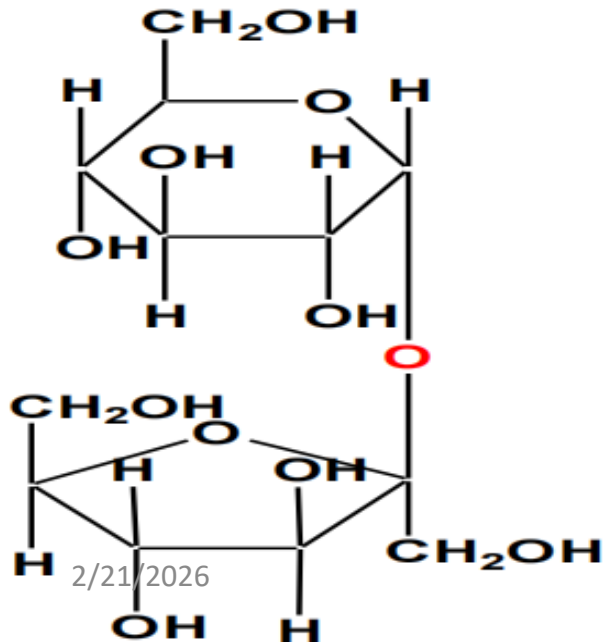
maltose

(α -D-glucosyl-(1 - >4)- β -D-glucopyranose)

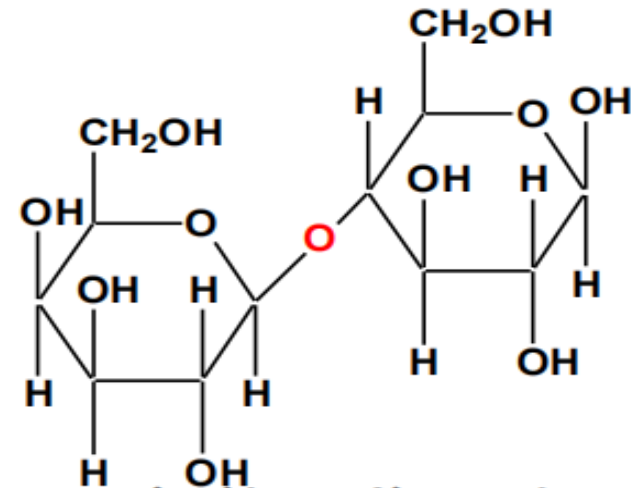


cellobiose

(β -D-glucosyl-(1 - >4)- β -D-glucopyranose)



sucrose



lactose

(β -D-galactosyl-(1 - >4)- β -D-glucopyranose)

Biological significance of carbohydrates

students take some notes

Biochemical properties

Digestion of Carbohydrates

lets watch the video and take some notes please



Functions of carbohydrates

Primary Energy Source – Carbohydrates provide energy through glucose, which is the body's preferred fuel source for cells, especially the brain and muscles.

Energy Storage – Excess glucose is stored as glycogen in the liver and muscles for later use.

Sparing Protein – When sufficient carbohydrates are available, the body spares proteins from being broken down for energy, allowing them to be used for growth and repair.

Aiding Digestion – Dietary fiber, a type of carbohydrate, promotes digestive health by supporting bowel movements and gut microbiota.

Supporting Brain Function – Glucose is the primary energy source for the brain, essential for cognitive functions like memory and concentration.

Structural Role – Some carbohydrates, such as ribose in RNA and DNA, play a structural role in cells and genetic material.

Cell Communication and Recognition – Certain carbohydrates contribute to cell signaling and immune system function by forming glycoproteins and glycolipids.

Oxidation Reactions

(a) Mild oxidation (Aldonic acid formation) Aldoses are oxidized at the aldehyde (-CHO) group to form aldonic acids.

Example: Oxidation of glucose to gluconic acid:



(Glucose → Gluconic acid)

(b) Strong oxidation (Aldaric acid formation) Both the aldehyde and primary alcohol (-CH₂OH) groups are oxidized to form dicarboxylic acids (aldaric acids).

Example: Glucose oxidation to glucaric acid:



(Glucose → Glucaric acid)

(c) Enzyme-catalyzed oxidation (Uronic acid formation)

The primary alcohol (-CH₂OH) group of aldoses is oxidized to a carboxyl group, forming uronic acids.

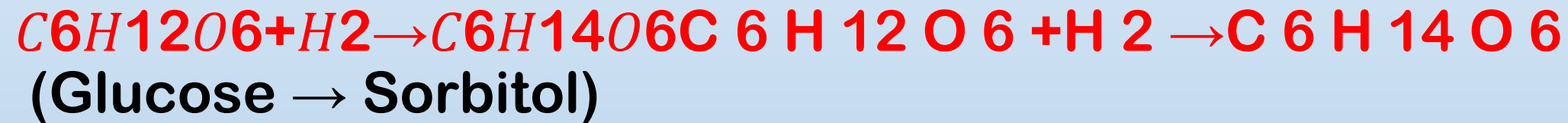
Example: Glucose to glucuronic acid:



(Glucose → Glucuronic acid)

2. Reduction Reactions (Formation of Sugar Alcohols) Aldoses and ketoses can be reduced to sugar alcohols (polyols).

Example: Reduction of glucose to sorbitol:

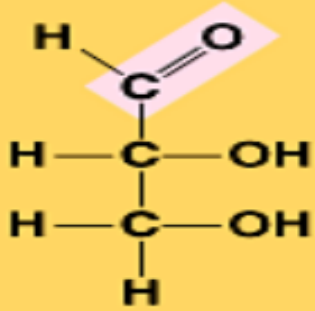


Example: Reduction of mannose to mannitol:



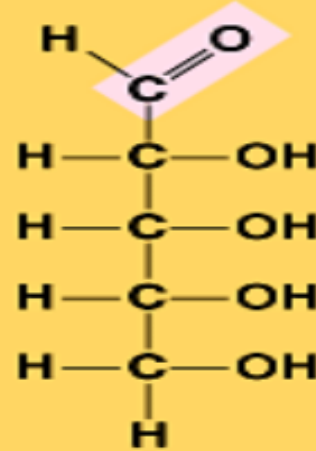
Common Aldoses and Ketoses

**Triose sugars
(C₃H₆O₃)**



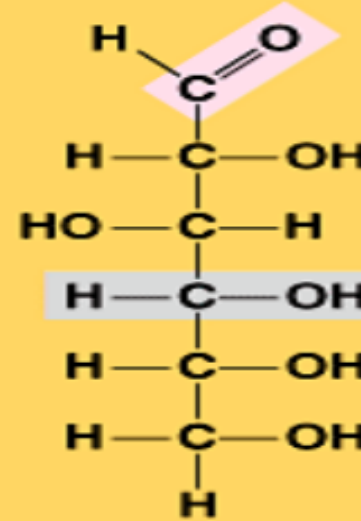
Glyceraldehyde

**Pentose sugars
(C₅H₁₀O₅)**

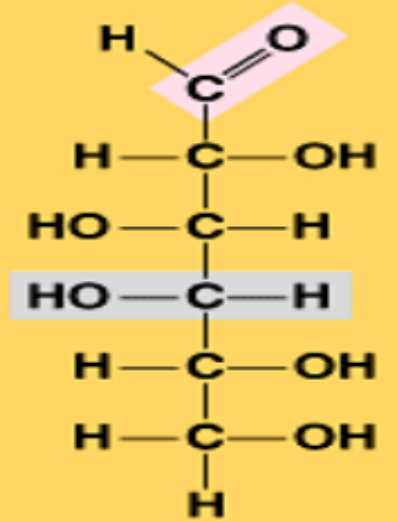


Ribose

**Hexose sugars
(C₆H₁₂O₆)**



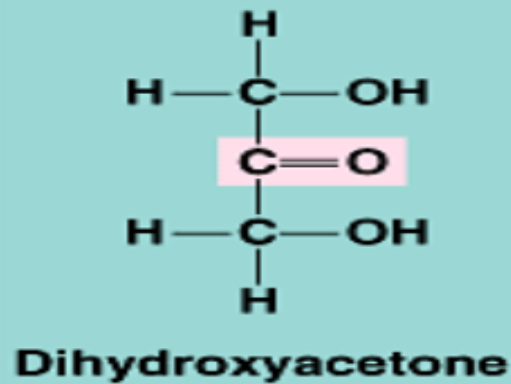
Glucose



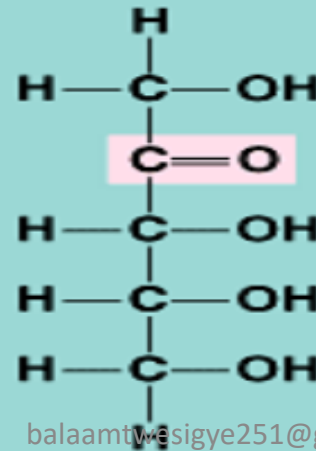
Galactose

Aldoses

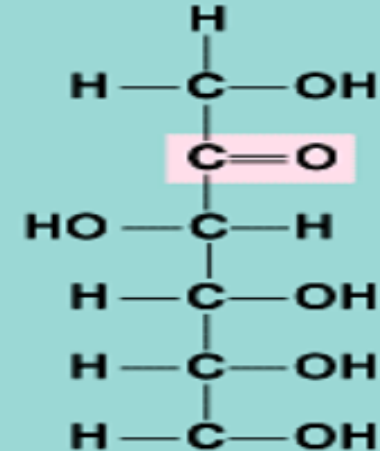
Ketoses



Dihydroxyacetone



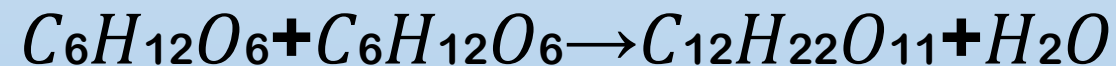
Ribulose



Glycosidic Bond Formation (Condensation Reaction)

When two monosaccharides react, they form a glycosidic bond, releasing water.

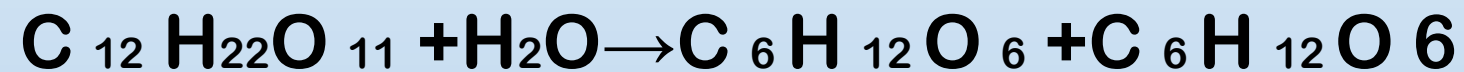
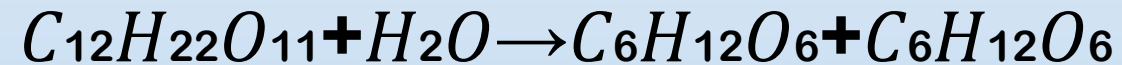
Example: Glucose + Fructose → Sucrose + Water



Hydrolysis of Disaccharides and Polysaccharides

Hydrolysis breaks glycosidic bonds with the addition of water.

Example: Hydrolysis of sucrose:



(Sucrose → Glucose + Fructose)

Example: Hydrolysis of starch to maltose:



(Starch → Maltose)