



# FOOD CHEMISTRY

Course No.-DTC-321, Credit Hours – 3 (2+1)



## CARBOHYDRATES



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# ***CARBOHYDRATES***

- ❖ **Carbohydrate, an organic molecule** is one of 3 basic macronutrients needed to sustain life.
- ❖ They are found in a **wide range of foods** that bring a variety of other imp nutrients to the diet– vitamins and minerals, phytochemicals, antioxidants and dietary fiber.
- ❖ The basic molecular formula  $(C \cdot H_2O)_n$  , where  $n \geq 3$
- ❖ Sugar  $\rightarrow$  heat  $\rightarrow$  C + H<sub>2</sub>O  $\rightarrow$  Hydrate of C  $\rightarrow$  Carbohydrate

❖ Carbohydrates are **polyhydroxy aldehydes or ketones**

❖ Classified into **three** categories:

**1. Monosaccharides-** **single** polyhydroxy aldehyde or ketone unit w/c cannot be hydrolysed further, e.g., **Glucose, Fructose, Galactose.**

**2. Oligosaccharides-** **2-10 monosaccharides** linked together by **glycosidic bonds**. Example – **Sucrose, Maltose, Lactose.**

**3. Polysaccharides-** made up of **more than ten monosaccharides.**  
Example- **Starch, Glycogen, Cellulose.**

## Major Functions

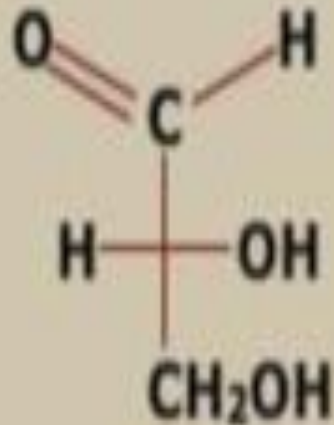
- ❖ form **major organic matter** on earth → extensive roles in all forms of life.
- ❖ serve as **energy stores** (**starch** and **glycogen**), **fuels**, and **metabolic intermediates**.
- ❖ **Ribose** and **deoxyribose** sugars → **component of RNA** and **DNA**.
- ❖ **structural elements** → **cell walls** of bacteria and plants.
- ❖ linked to many **proteins** and **lipids** → play **key roles** in mediating interactions among cells and interactions between cells and other elements in the cellular environment.

# Structure of Important Carbohydrates

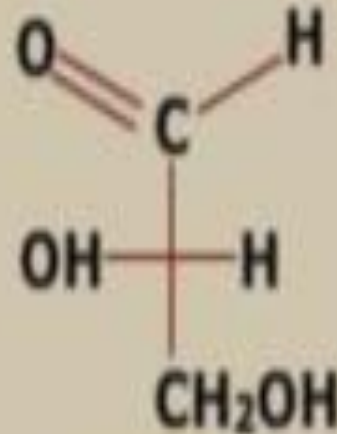
## Monosaccharides

- ❖ Monosaccharides with **three, four, five, six, and seven carbon atoms** in their backbones → **triose, tetroses, pentoses, hexoses, and heptoses** respectively.
- ❖ **carbons** of sugar are **numbered** beginning at the **end of the chain nearest the carbonyl group**.
- ❖ **All the monosaccharides** except **dihydroxyacetone** contain **one or more asymmetric (chiral) carbon atoms** and thus occur in
- ❖ **optically active isomeric forms**.

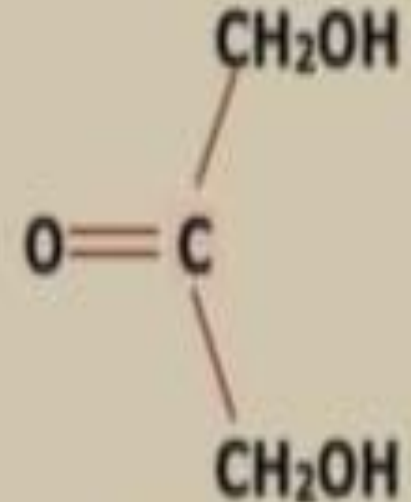
# Basic structures of monosaccharides



D-Glyceraldehyde



L-Glyceraldehyde

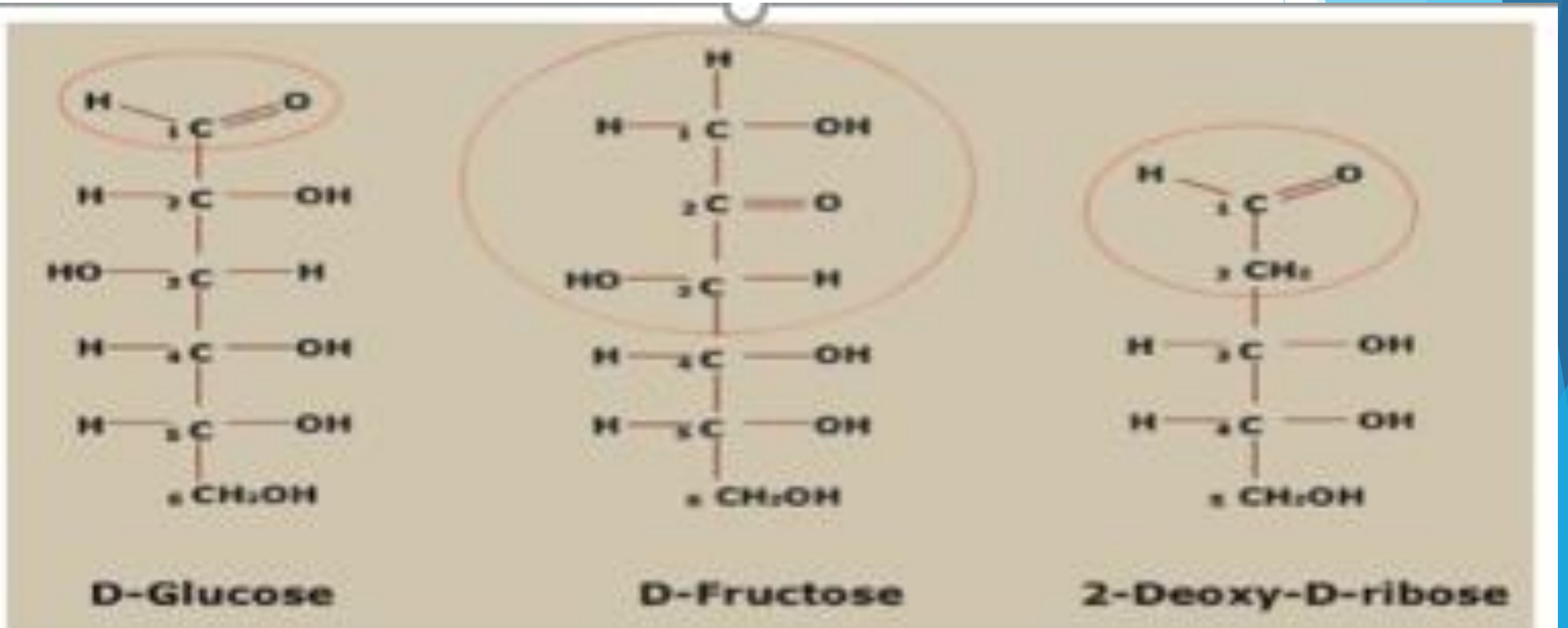


Dihydroxyacetone

**Aldotriose**

**Ketotriose**

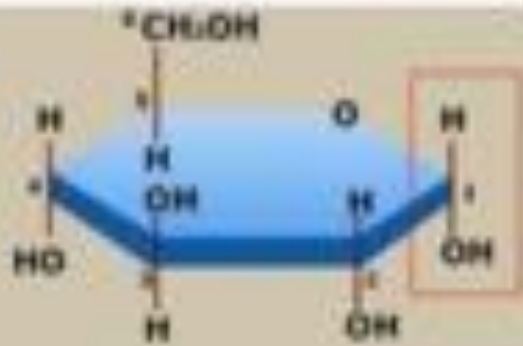
# Representative monosaccharides



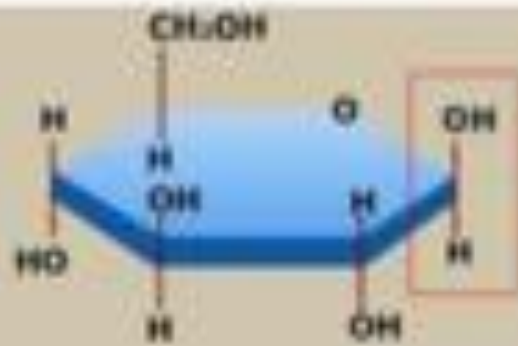


- ❖ In **aqueous solution**, **all monosaccharides** occur → as **cyclic (ring) structures** → in w/c **carbonyl group** forms a **covalent bond** with **oxygen** of a hydroxyl group along the chain.
- ❖ The formation of these ring structures is the **result of** a general **reaction** between **alcohols** and **aldehydes** or **ketones** to form → **hemiacetals** or **hemiketals** which contain an additional asymmetric carbon atom and thus can exist in **two stereoisomeric forms**.
- ❖ For example, D glucose exists in solution as an **intramolecular hemiacetal** in which the **free hydroxyl group** at **C-5** has reacted with the aldehydic **C-1**, rendering the latter carbon **asymmetric** and producing **two stereoisomers** ⇒ **α and β**.

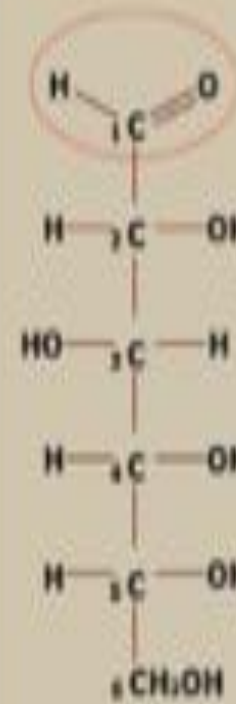
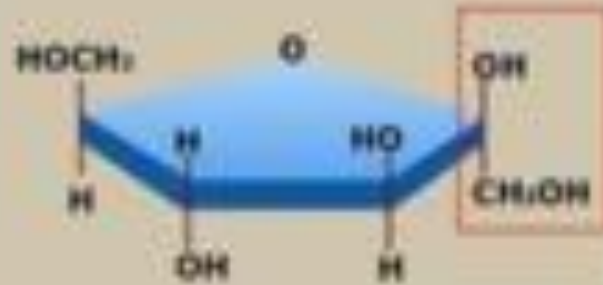
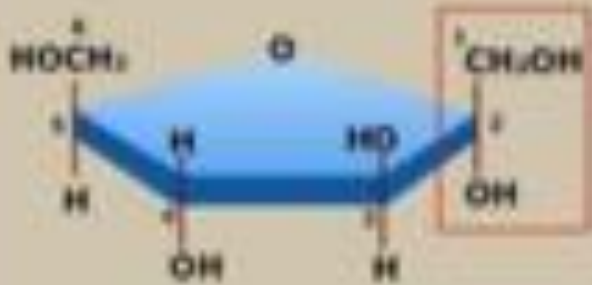
- ❖ **Isomeric forms** of monosaccharides (differ only in configuration about hemiacetal or hemiketal C atom) → **anomers**.
- ❖ The **hemiacetal** (or carbonyl) carbon atom → **anomeric** carbon.
- ❖ The  **$\alpha$  and  $\beta$  anomers** of D-glucose **interconvert** in aqueous solution by a process called **mutarotation**.



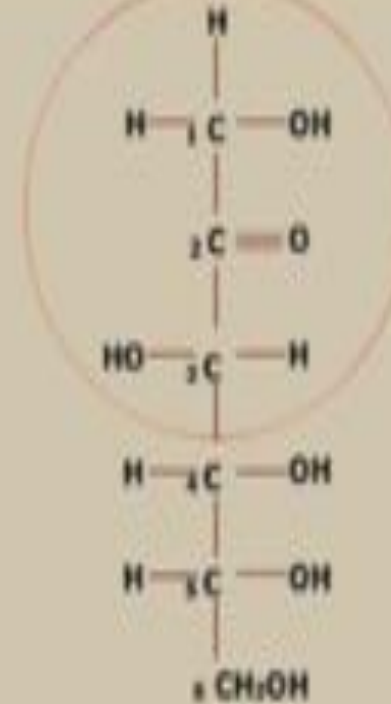
$\alpha$ -D-Glucopyranose



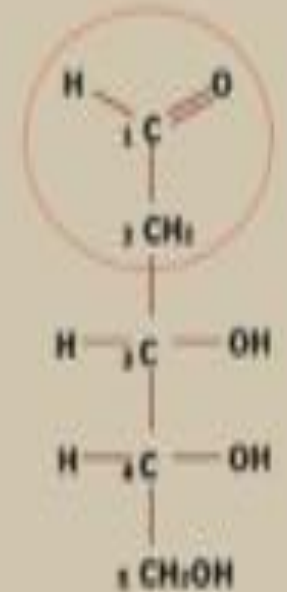
$\beta$ -D-Glucopyranose



D-Glucose



D-Fructose



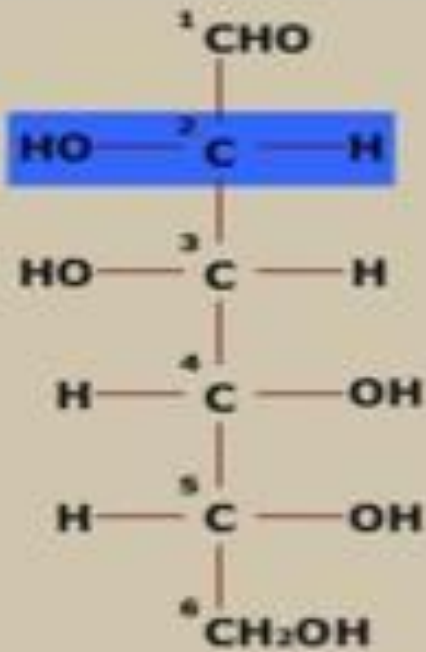
2-Deoxy-D-ribose

## Pyranoses and Furanoses

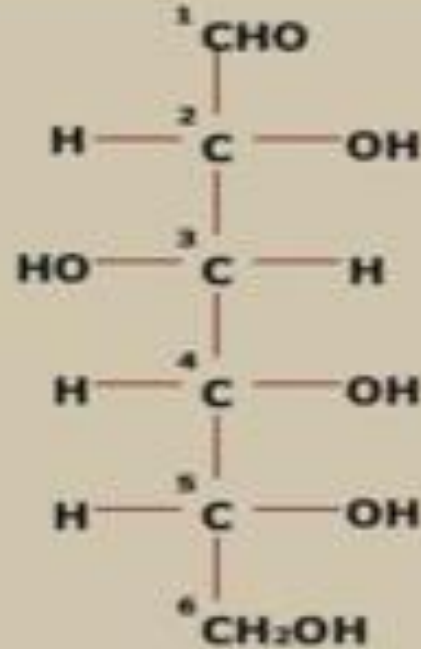
D glucose exists in solution as **intramolecular hemiacetal** in which the **free hydroxyl group** at **C-5** has reacted with the aldehydic **C-1**, rendering the latter carbon **asymmetric** and producing **two stereoisomers -  $\alpha$  and  $\beta$**

- ❖ Monosaccharides can be **oxidized** by  $\rightarrow$  **mild oxidizing agents**  $\rightarrow$  **ferric ( $\text{Fe}^{3+}$ ) or cupric ( $\text{Cu}^{2+}$ ) ion.**
- ❖ **carbonyl carbon is oxidized  $\rightarrow$  carboxyl group.**
- ❖ **Glucose and other sugars** capable of  $\rightarrow$  reducing ferric or cupric ion  $\rightarrow$  **reducing sugars.**
- ❖ This property is  $\rightarrow$  **basis of Fehling's reaction**  $\rightarrow$  a **qualitative test** for presence of reducing sugar.
- ❖ amount of oxidizing agent **reduced** by sugar soln  $\rightarrow$  conc. of sugar.

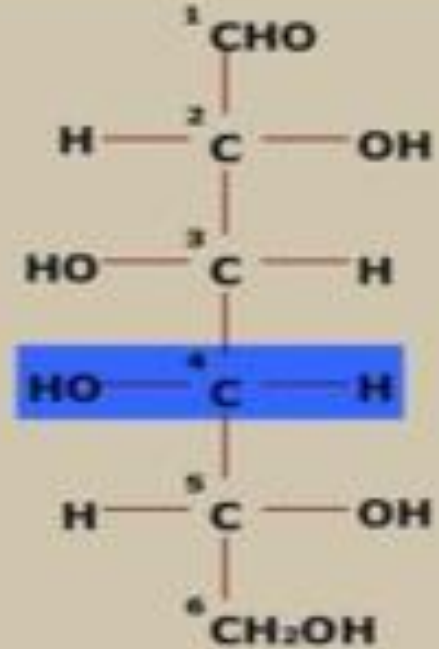
- ❖ Two sugars that **differ** => in configuration around **one carbon atom** => **epimers**.
- ❖ D Mannose differs from D glucose => in its configuration around **carbon 2**.
- ❖ D-Galactose differs from D-glucose => in its configuration around **carbon 4** .
- ❖ **D-Galactose and D-Mannose are not epimers.**



**D-Mannose**  
(epimer at C-2)



**D-Glucose**

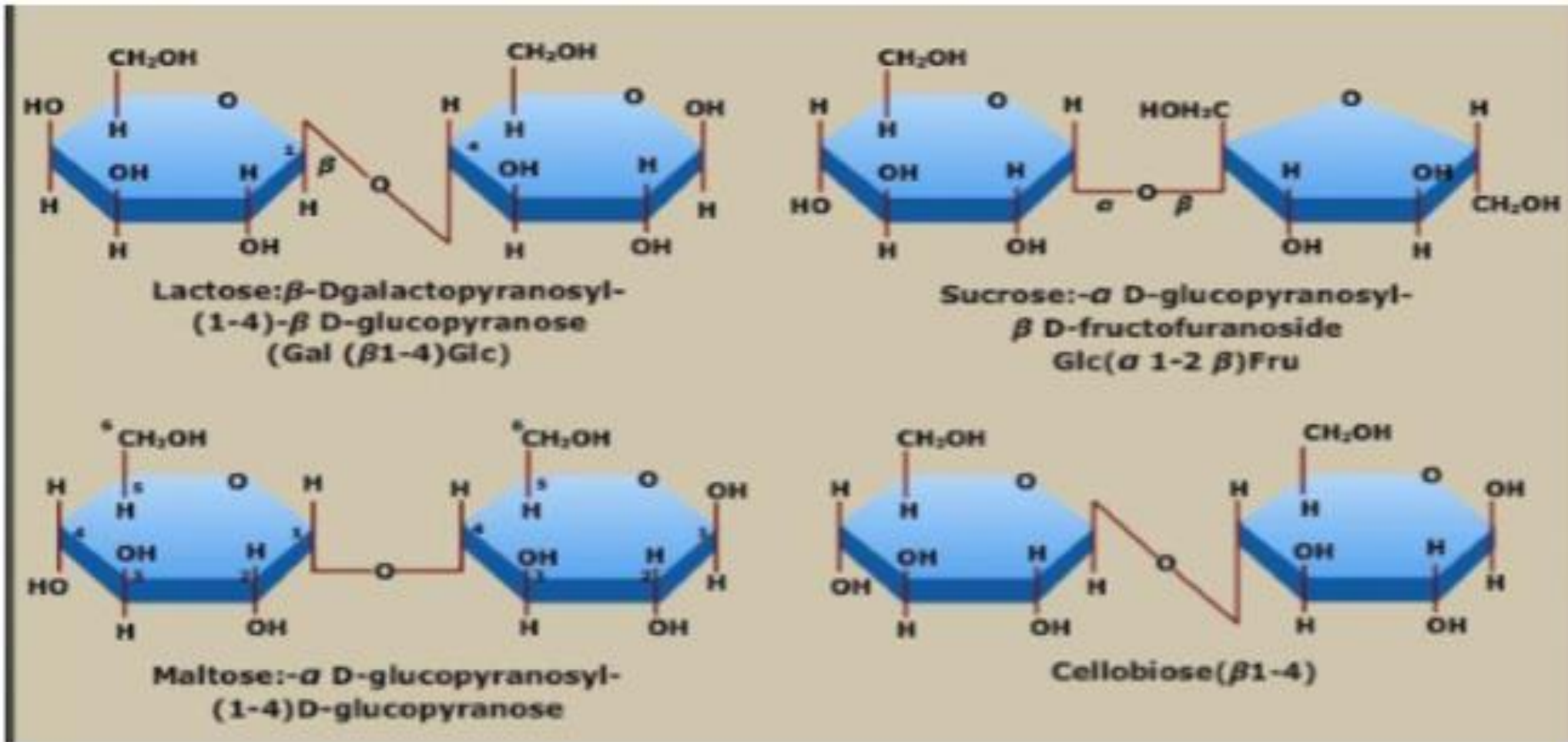


**D-Galactose**  
(epimer at C-4)

# Epimers

# Disaccharides

two monosaccharides **join covalently** by an **O-glycosidic bond** => formed when a **hydroxyl group** of one sugar reacts with the **anomeric carbon** of the other.



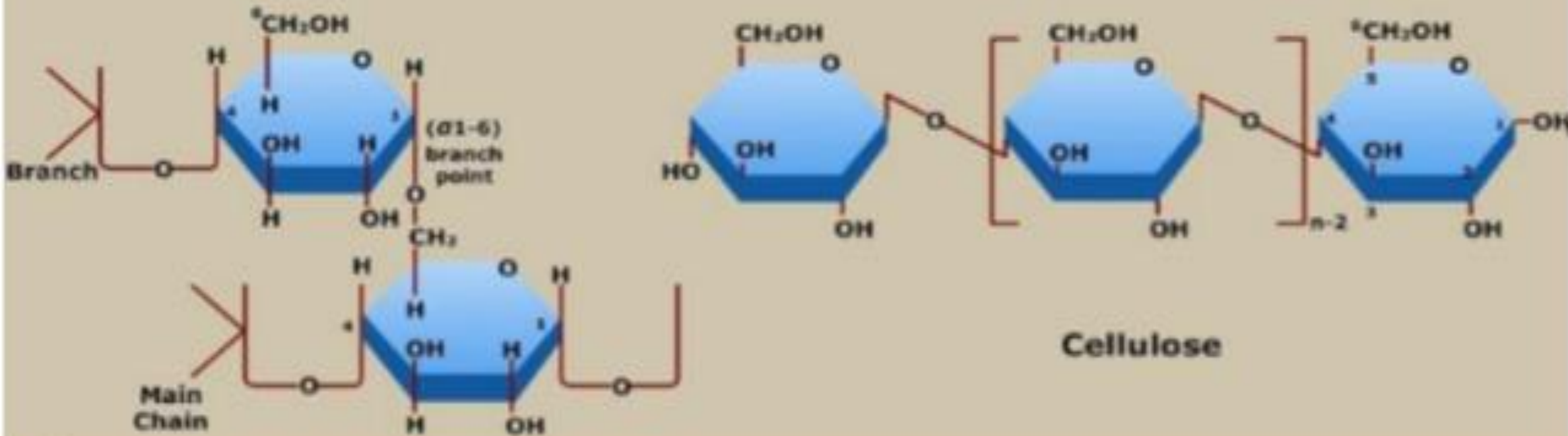
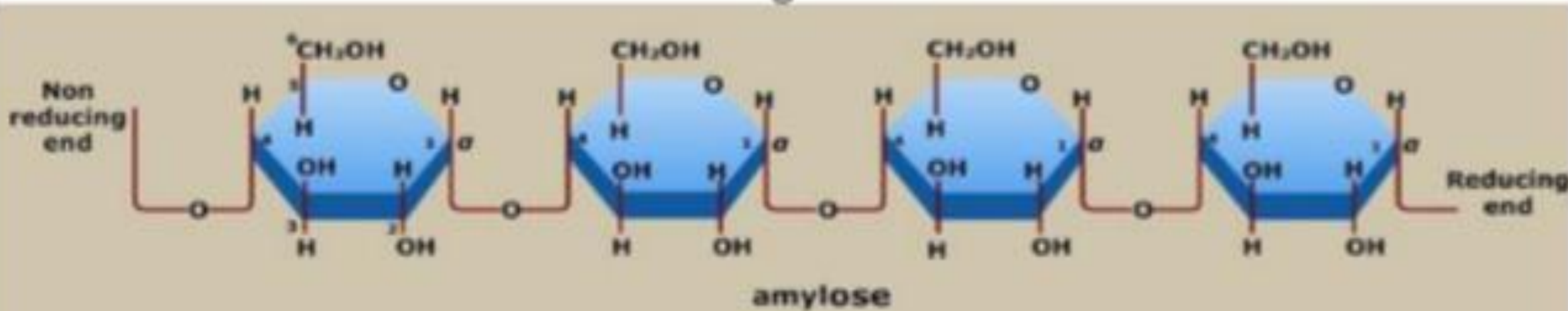
- ❖ The **oxidation** of sugar's anomeric carbon by **cupric or ferric ion** occurs only with the **linear form**, which exists in equilibrium with the cyclic form (s).
- ❖ When anomeric carbon is involved in a **glycosidic bond** => that sugar residue cannot take the linear form => becomes a **nonreducing sugar**.
- ❖ In disaccharides or polysaccharides => the **end** of a chain with a **free anomeric carbon** => **reducing end**.



## Polysaccharides

- ❖ **Homopolysaccharides** => single type of monomer
- ❖ **Heteropolysaccharides** => two or more different kinds
- ❖ Some homopolysaccharides serve as **storage forms** of monosaccharides => used as fuels => **starch** and **glycogen**
- ❖ Other homopolysaccharides serve as **structural elements** => **cellulose** (plant cell walls) and **chitin** (animal exoskeletons)

- ❖ **Heteropolysaccharides** provide **extracellular support** for organisms of all kingdoms, e.g., glycosaminoglycan, glycoprotein etc.
- ❖ in **animal** tissues => extracellular space is occupied by several types of heteropolysaccharides => which form a **matrix** that holds individual cells together and provides **protection, shape, and support to cells, tissues, and organs.**
- ❖ **rigid layer of the bacterial cell envelope** (the peptidoglycan) is composed in part of a **heteropolysaccharide** (built from two **alternating monosaccharide** units).



# Polysaccharides

**THANKS**

The background features abstract, overlapping geometric shapes in various shades of blue, ranging from light sky blue to deep navy blue. These shapes are primarily located on the right side of the frame, creating a modern, layered effect against the white background.