BIOCHEMISTY

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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 $(C. H_2O)n$, where $n \geq 3$

- Sugar → heat → C ✚ H2O → Hydrate of C → 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

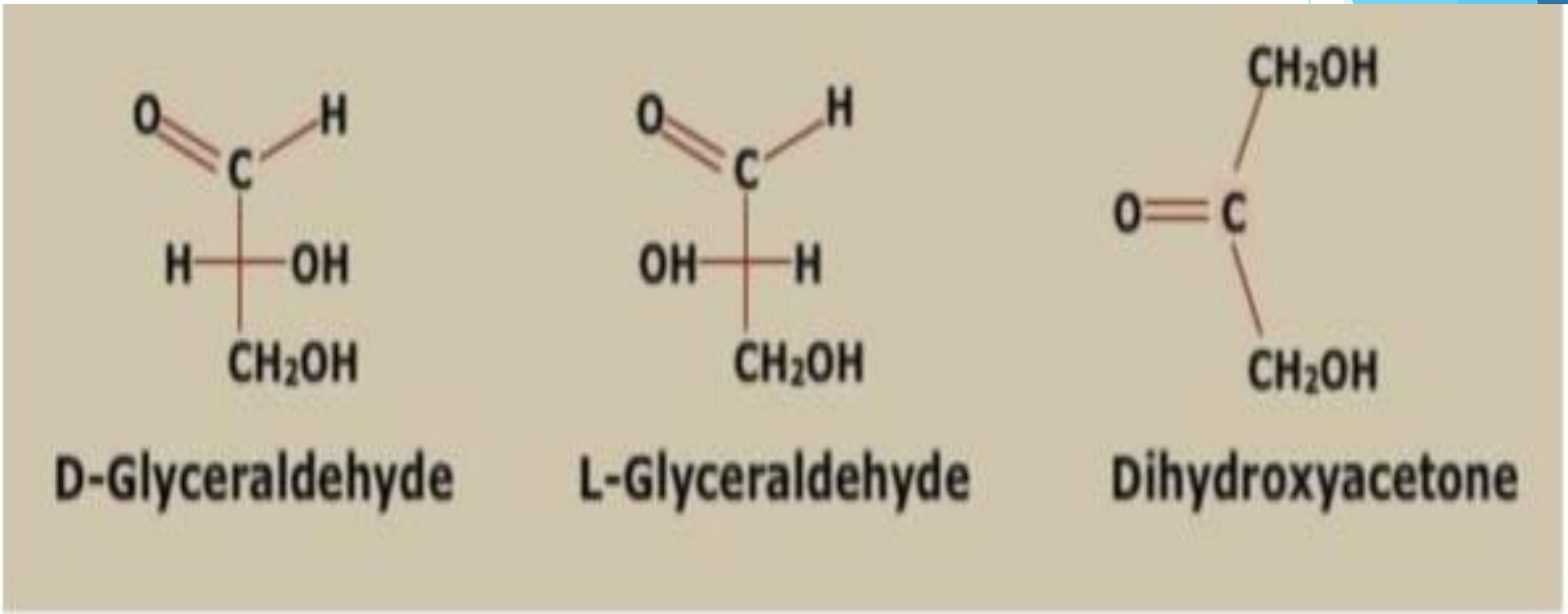
Monosaccharides

- 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**.

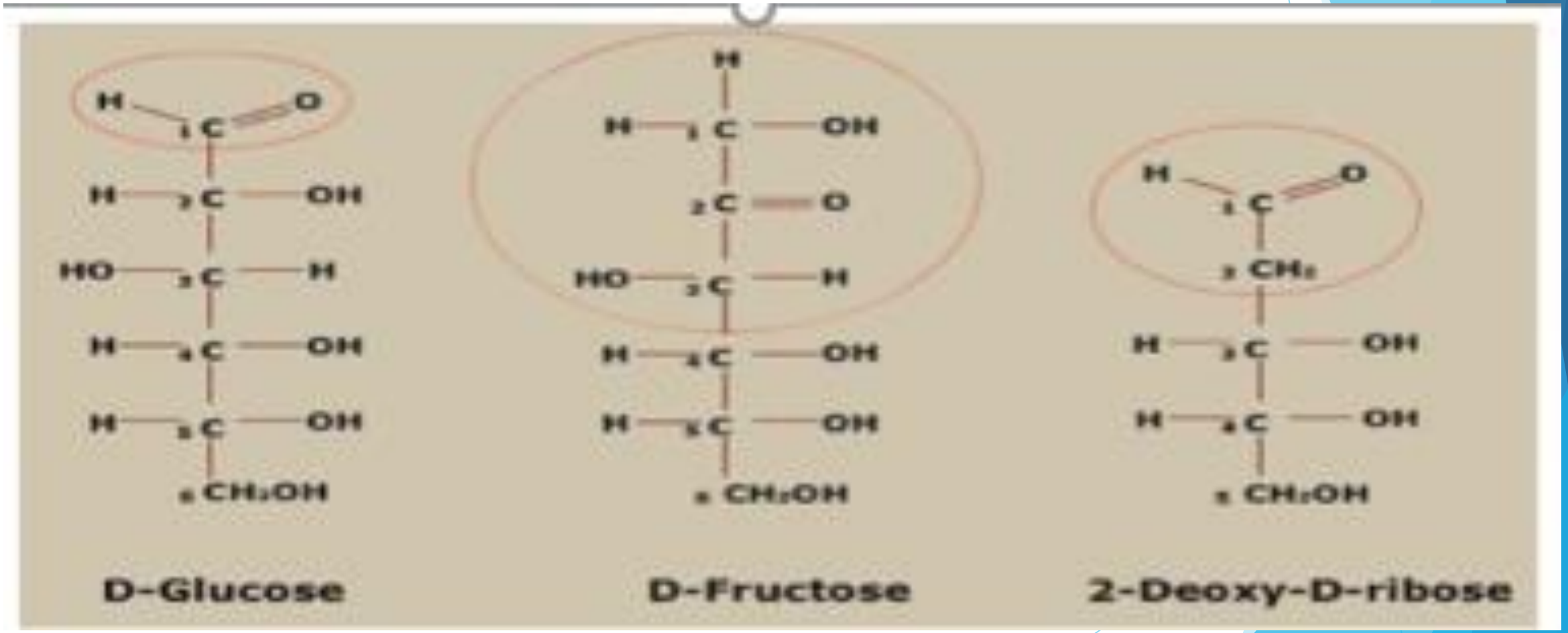
Basic structures of monosaccharides



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.

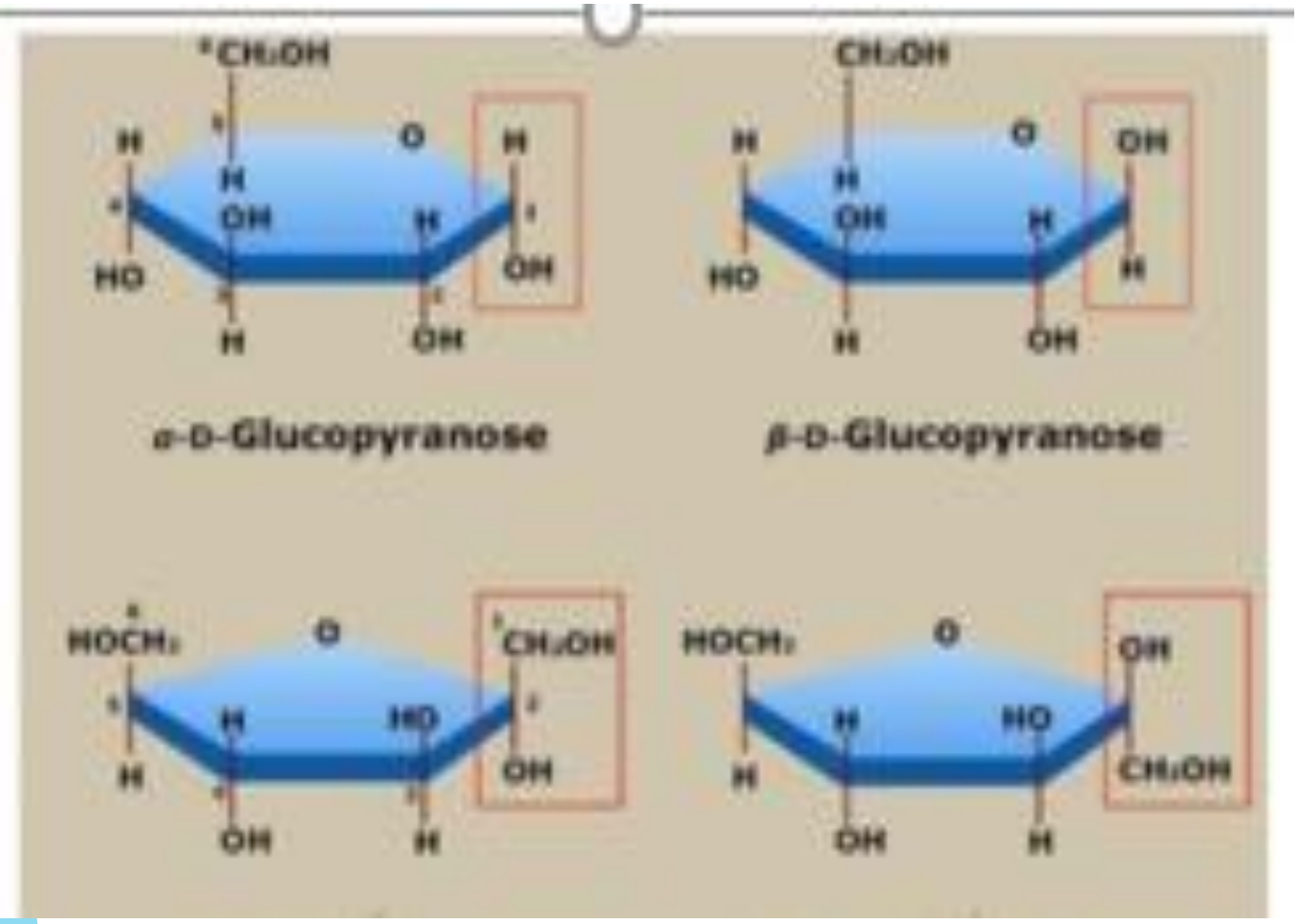
- The formation of these ring structures is the result of a general **reaction** between **alcohols** and **aldehydes** or **ketones** to form → **hemiacetals** or **hemiketals** which contain an additional asymmetric carbon atom and thus can exist in **two stereoisomeric forms**.

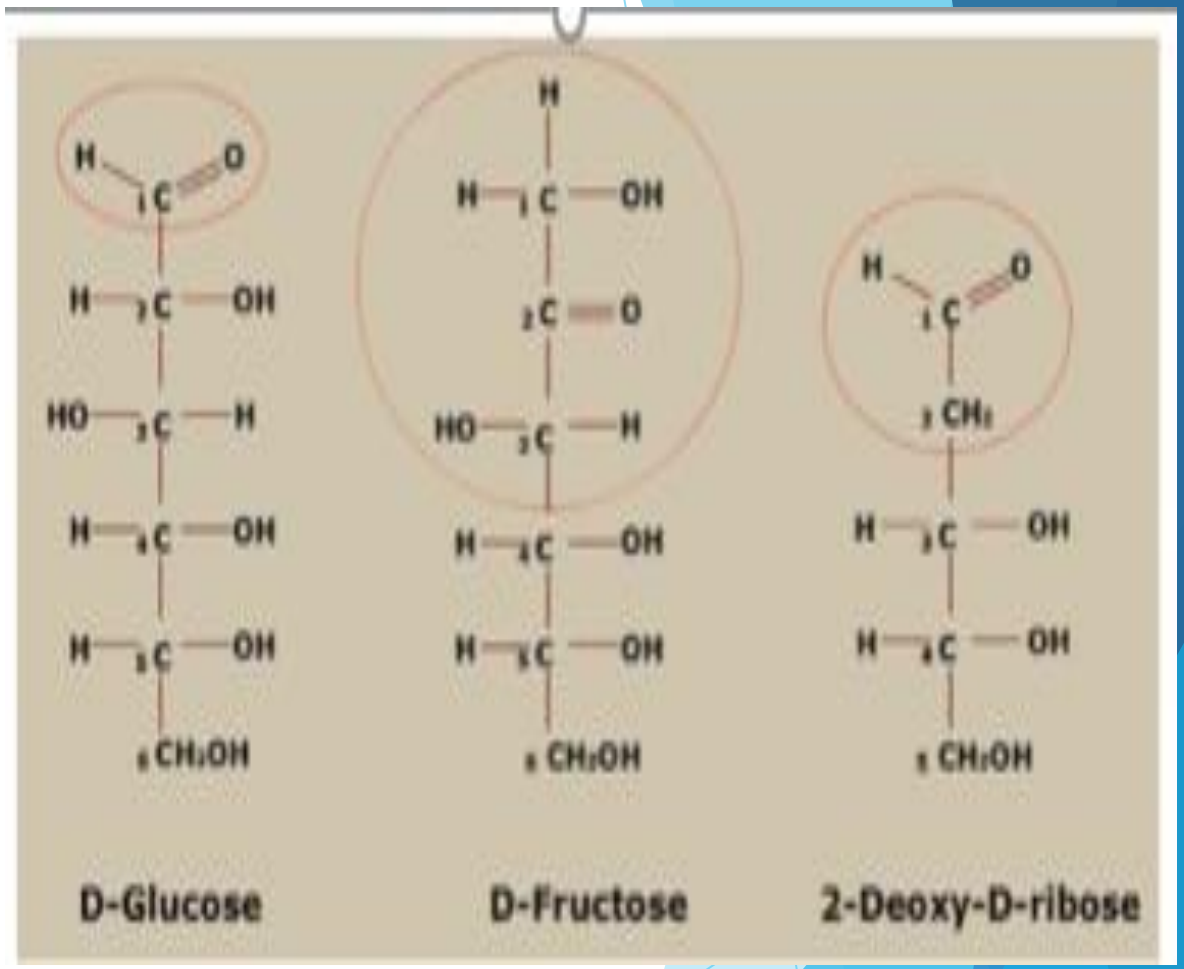
- For example, D glucose exists in solution as an intramolecular hemiacetal in which the free hydroxyl group at C-5 has reacted with the aldehydic C-1, rendering the latter carbon asymmetric and producing two **stereoisomers** => **α and β**.

- **Isomeric forms** of monosaccharides (differ only in configuration about hemiacetal or hemiketal C atom) → **anomers**.

- The hemiacetal (or carbonyl) carbon atom → **anomeric** carbon.

- The **α and β anomers** of D-glucose **interconvert** in aqueous solution by a process called **mutarotation**.





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 - α and β

- Monosaccharides can be **oxidized** by → **mild oxidizing agents** → **ferric (Fe3+) or cupric (Cu2+) ion**.

- carbonyl carbon is oxidized → carboxyl group.

- **Glucose and other sugars** capable of → reducing ferric or cupric ion → **reducing sugars**.

- This property is → **basis of Fehling's reaction** → a qualitative test for presence of reducing sugar.

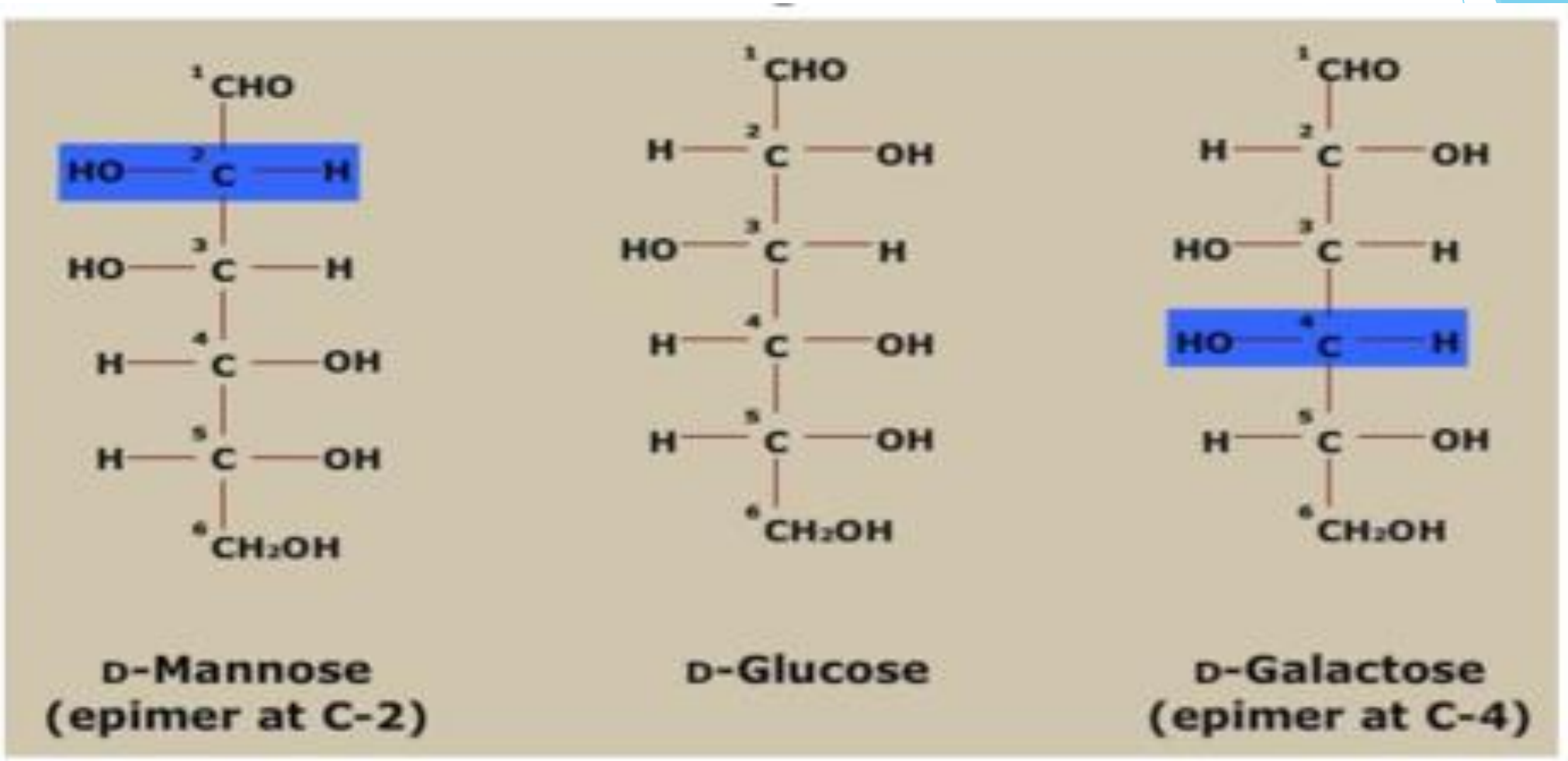
- amount of oxidizing agent reduced by sugar soln → conc. of sugar.

- **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** .

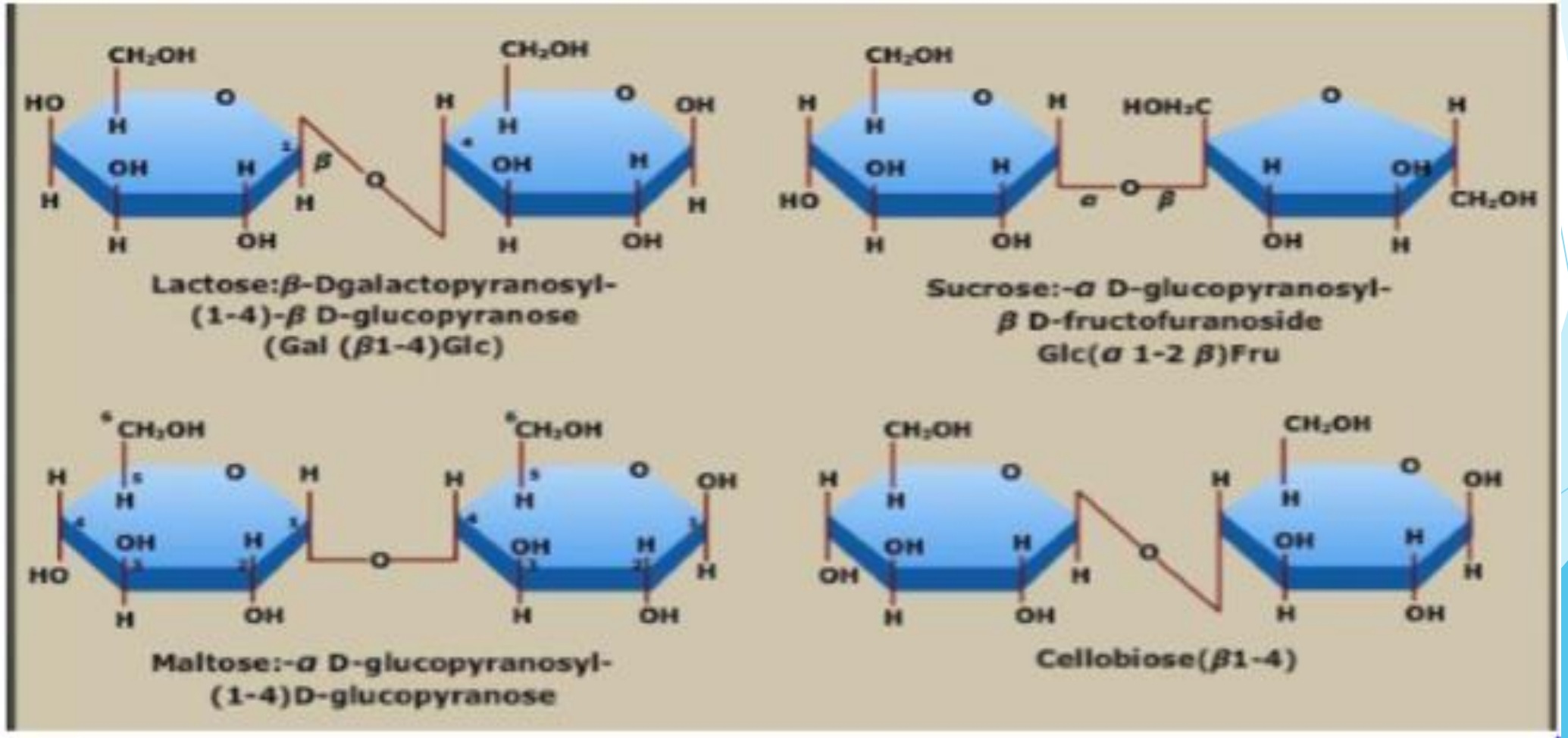
- **D-Galactose and D-Mannose are not epimers**.



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**.

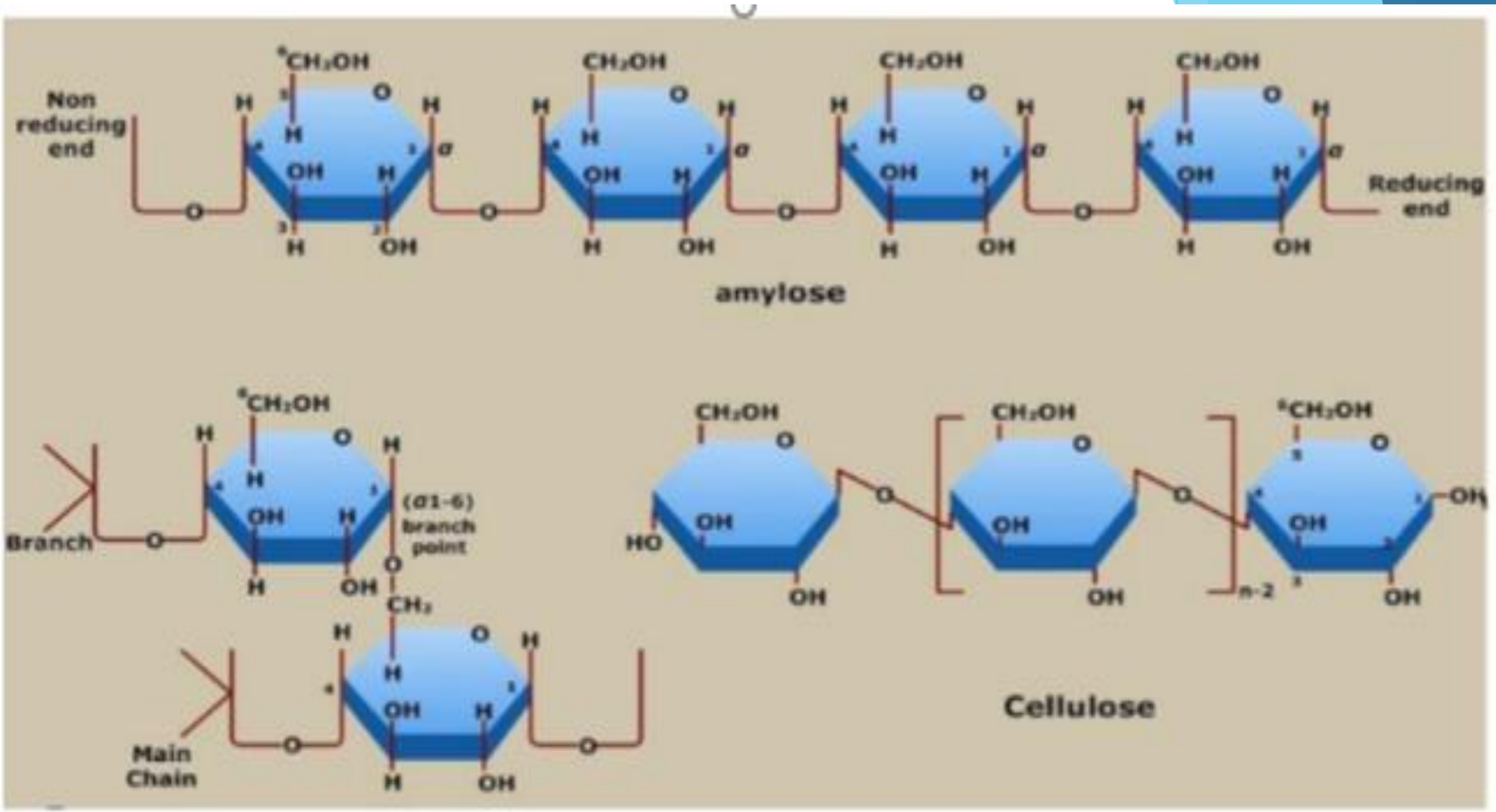
Polysaccharides

- **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