FOOD CHEMISTRY

BINITA RANI
ASSOCIATE PROFESSOR (DAIRY CHEMISTRY)
FACULTY OF DAIRY TECHNOLOGY
S.G.I.D.T., BVC CAMPUS,
P.O.- BVC, DIST.-PATNA-800014

BIOCHEMISTRY

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CARBOHYDRATES

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- **Carbohydrates** are **polyhydroxy aldehydes or ketones**
- Classified into **three** categories

1. **Monosaccharides**- a **single** polyhydroxy aldehyde or ketone unit w/c **cannot** be hydrolysed further into monomers. Example – Glucose (Dextrose)
2. **Oligosaccharides**- made up of **2-6 monosaccharides** linked together by **glycosidic bonds**. Example – Sucrose
3. **Polysaccharides** – made up of **more than six monosaccharides** Example- **Starch, Glycogen, Cellulose**

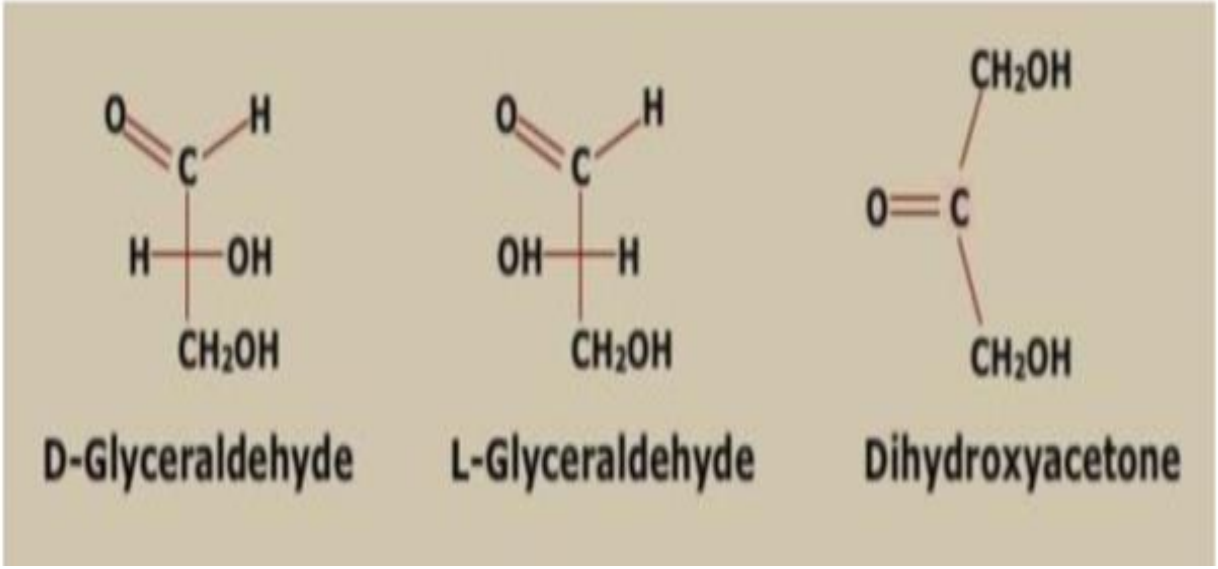
Major Functions

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

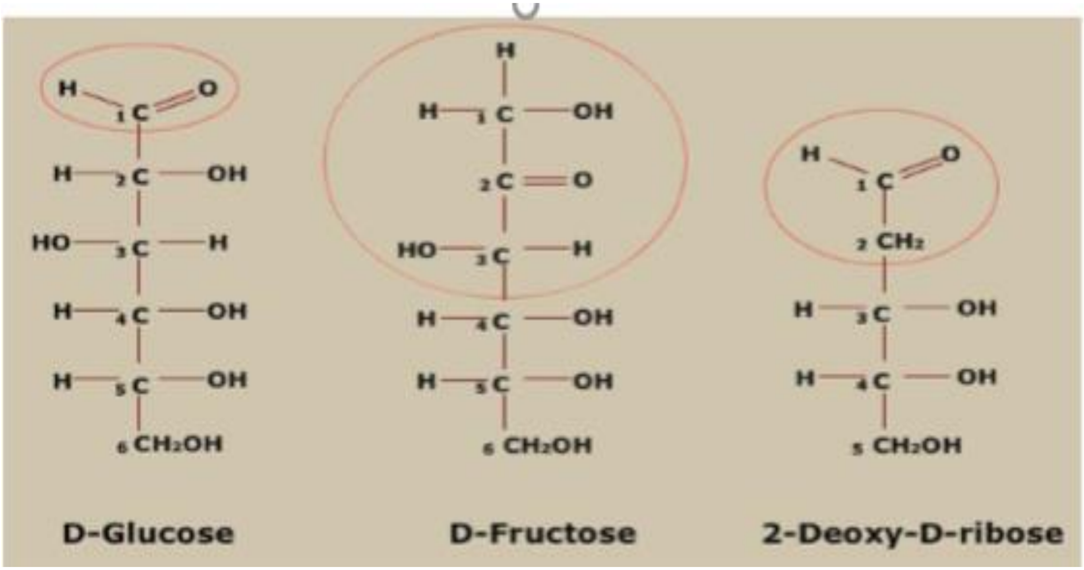
Structure of Important Carbohydrates

Monosaccharides

- Monosaccharides with **three, four, five, six, and seven carbon atoms** in their backbones are called, **triose, tetroses, pentoses, hexoses, and heptoses** respectively.
- The **carbons** of a 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 Structure of Monosaccharides

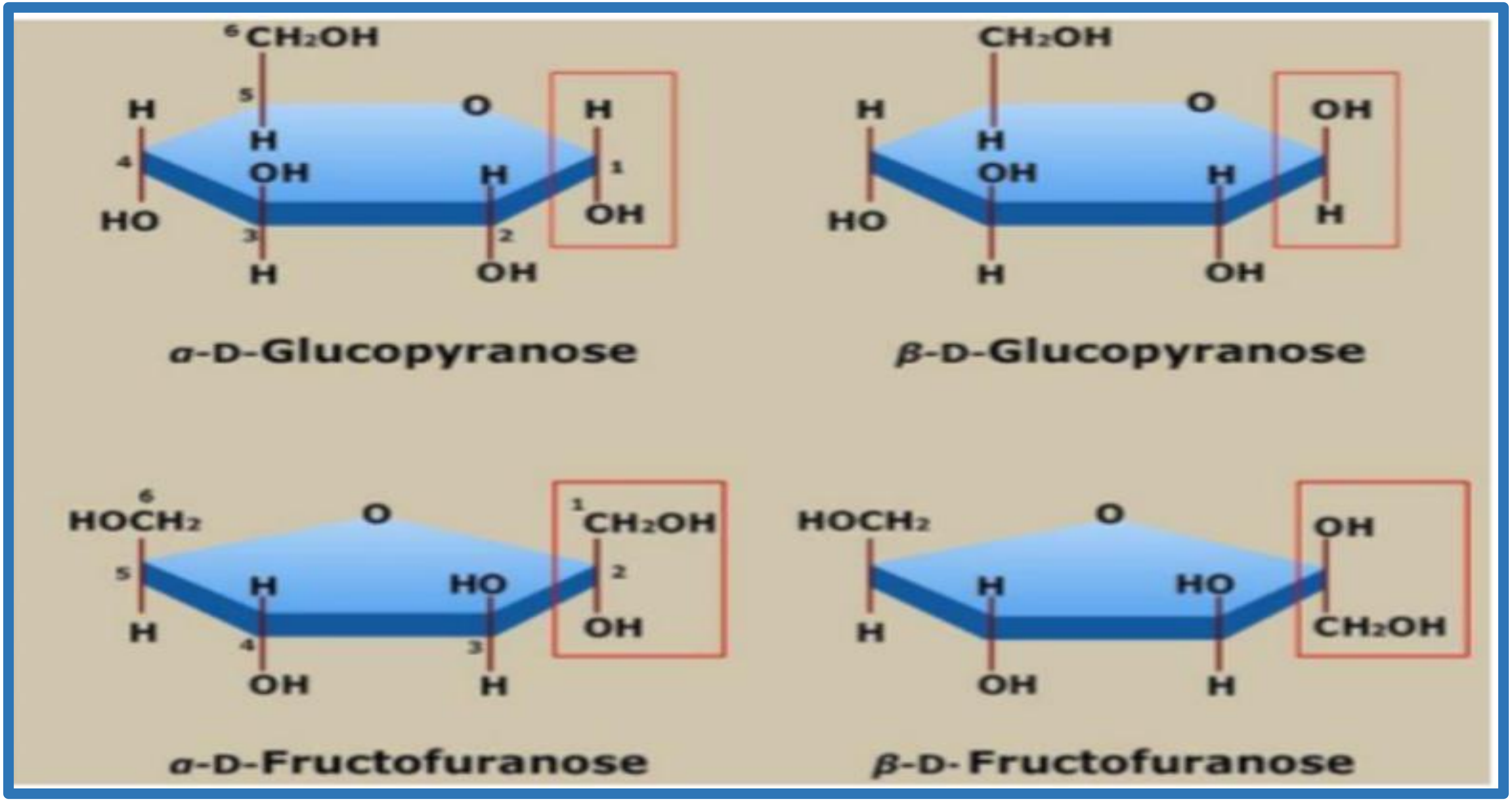


Representative Monosaccharides

- In **aqueous solution**, **aldotetroses** and **all monosaccharides** with five or more carbon atoms occur predominantly as **cyclic (ring) structures** in which the **carbonyl group** has formed a **covalent bond** with the **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 derivatives called **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, **designated α and β**.

- **Isomeric forms** of monosaccharides that differ only in their configuration about the hemiacetal or hemiketal carbon atom are called **anomers**. The hemiacetal (or carbonyl) carbon atom is called the anomeric carbon. The **α and β anomers** of D- glucose **interconvert** in aqueous solution by a process called **mutarotation**.

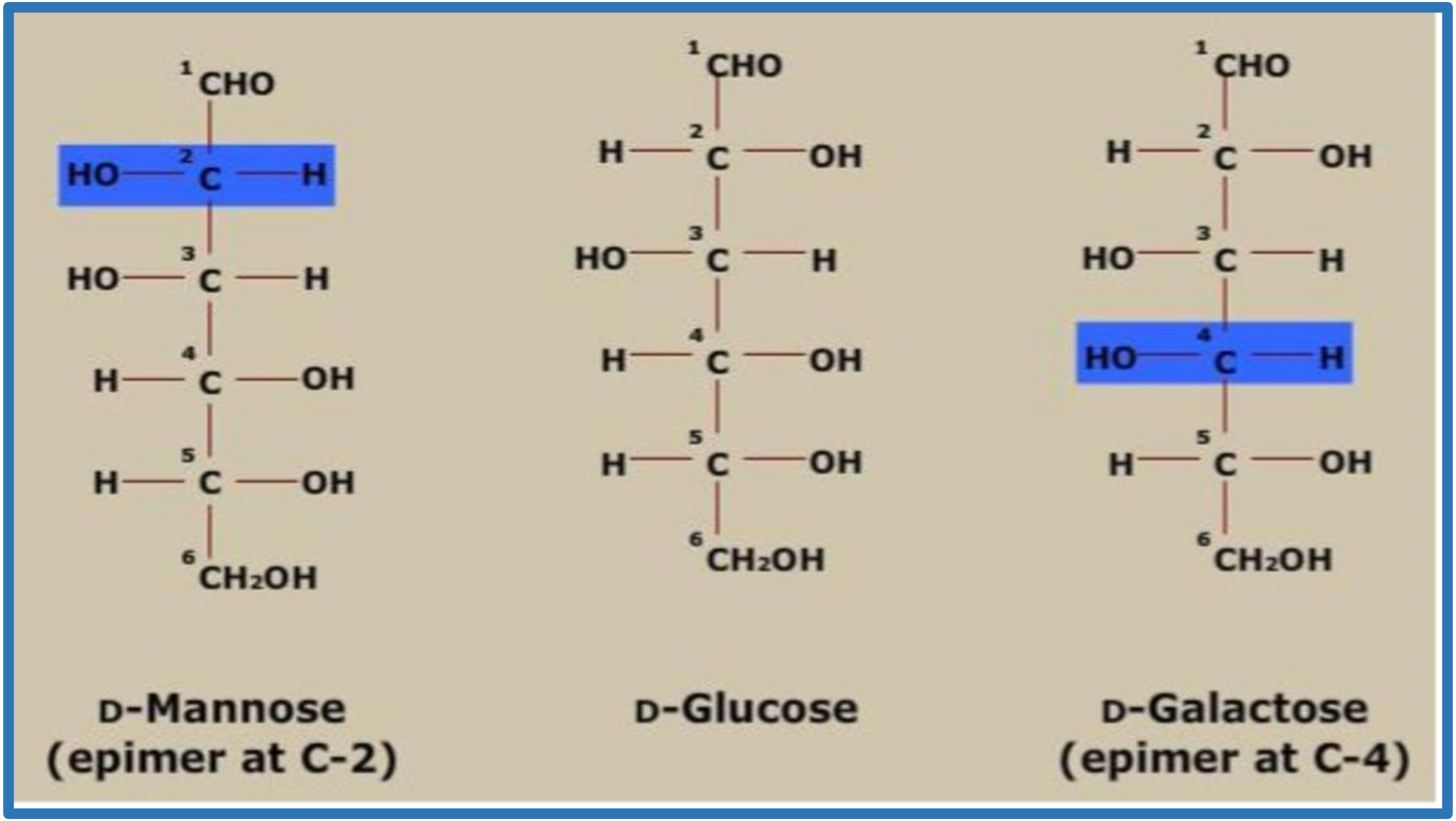


Pyranoses and Furanoses

- • Monosaccharides can be **oxidized** by relatively **mild oxidizing agents** such as **ferric (Fe^{3+}) or cupric (Cu^{2+}) ion**. The carbonyl carbon is oxidized to a carboxyl group.

- **Glucose and other sugars** capable of reducing ferric or cupric ion are called **reducing sugars**. This property is the basis of Fehling's reaction, a qualitative test for the presence of reducing sugar. By measuring the amount of oxidizing agent reduced by a solution of a sugar, it is also possible to estimate the concentration of that sugar.

- •**Two sugars** that **differ** only in the configuration around **one carbon atom** are called **epimers**. DMannose differs from D-glucose only in its configuration around carbon 2. D-Galactose differs from D-glucose only in its configuration around carbon 4 . **D-Galactose and D-Mannose are not epimers**.



1 CHO
HO 2 C H
HO 3 C H
H 4 C OH
H 5 C OH
6 CH₂OH
D-Mannose
(epimer at C-2)
1 CHO
H 2 C OH
HO 3 C H
H 4 C OH
H 5 C OH
6 CH₂OH
D-Glucose
1 CHO
H 2 C OH
HO 3 C H
HO 4 C H
H 5 C OH
6 CH₂OH
D-Galactose
(epimer at C-4)

Epimers

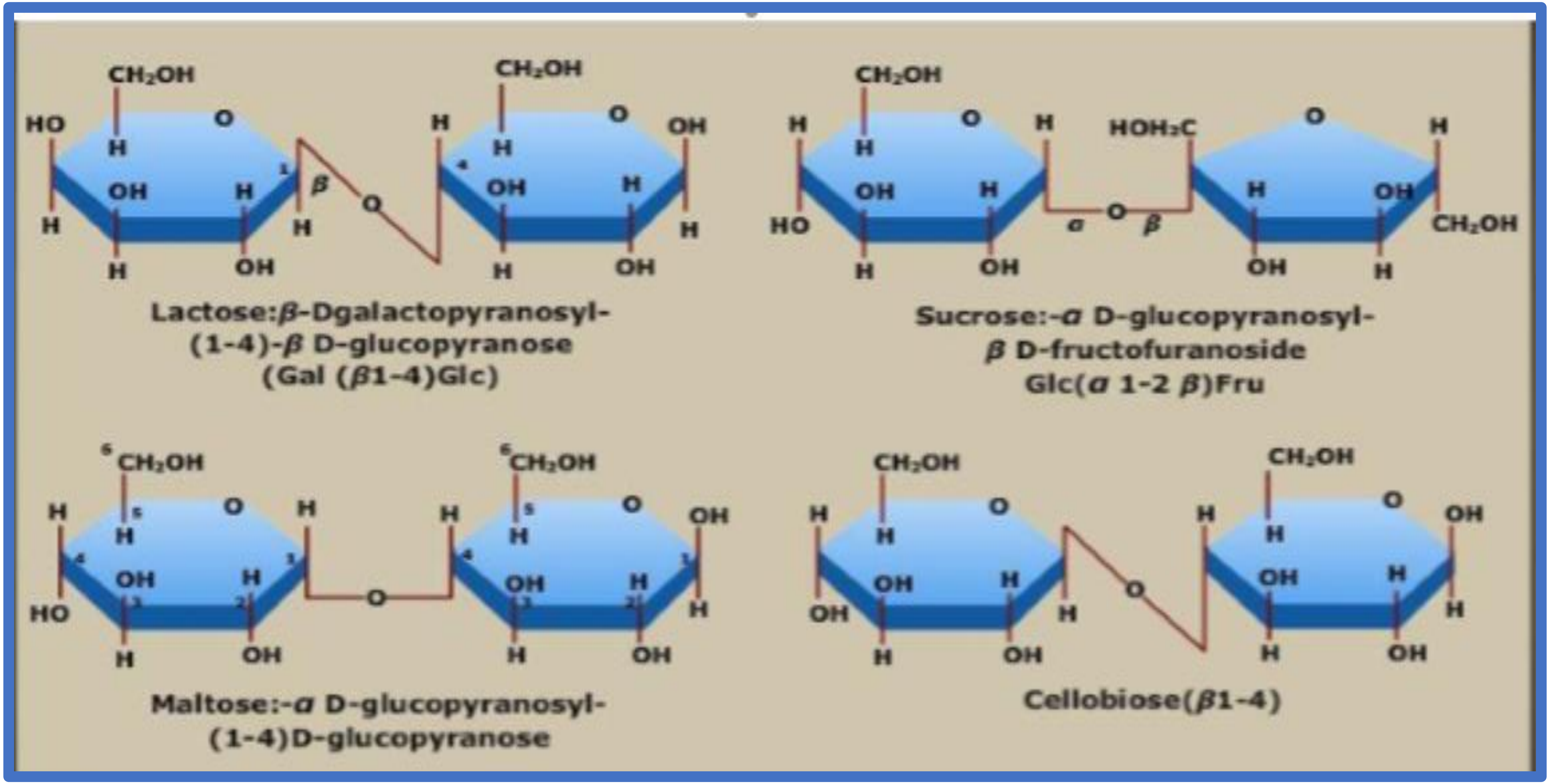
Disaccharides

- Disaccharides (such as maltose, lactose, and sucrose) consist of two monosaccharides joined covalently by an **O-glycosidic** bond, which is formed when a **hydroxyl group** of one sugar reacts with the **anomeric carbon** of the other.

- The oxidation of a sugar's anomeric carbon by cupric or ferric ion (the reaction that defines a reducing sugar) occurs only with the linear form, which exists in equilibrium with the cyclic form(s).

- When the anomeric carbon is involved in a glycosidic bond, that sugar residue cannot take the linear form and therefore becomes a **nonreducing sugar**.

- In describing disaccharides or polysaccharides, the end of a chain with a **free anomeric carbon** (one not involved in a glycosidic bond) is commonly called the **reducing end**.



Disaccharides

Polysaccharides

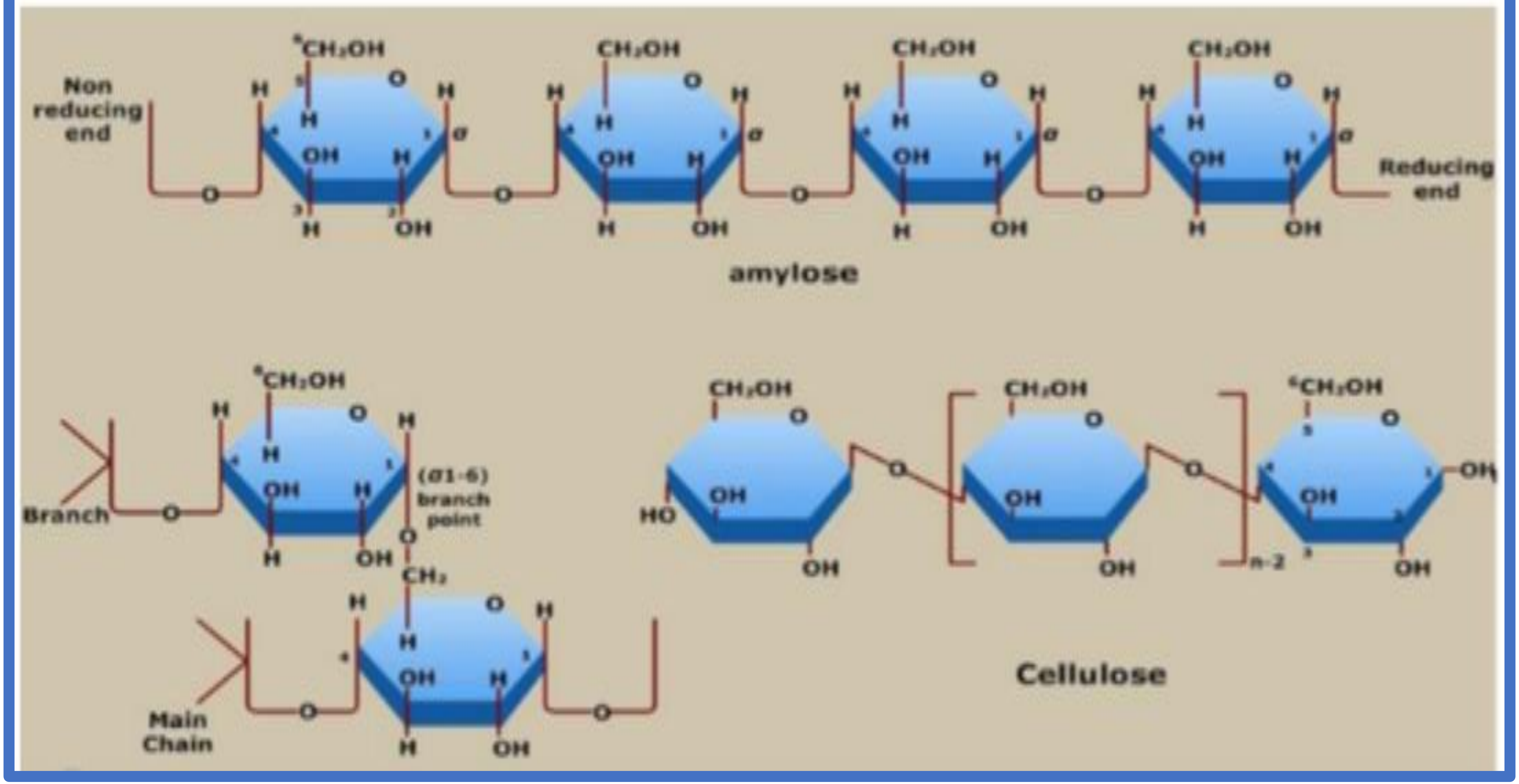
- **Homopolysaccharides** contain only a single type of monomer; **heteropolysaccharides** contain two or more different kinds.

- Some homopolysaccharides serve as **storage forms** of monosaccharides that are used as fuels; **starch** and **glycogen** are homopolysaccharides of this type.

- Other homopolysaccharides (**cellulose** and **chitin** for example) serve as **structural elements** in plant cell walls and animal exoskeletons.

- **Heteropolysaccharides** provide **extracellular support** for organisms of all kingdoms. For example, the rigid layer of the bacterial cell envelope (the peptidoglycan) is composed in part of a heteropolysaccharide built from two alternating monosaccharide units.

- In animal tissues, the 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.



Polysaccharides