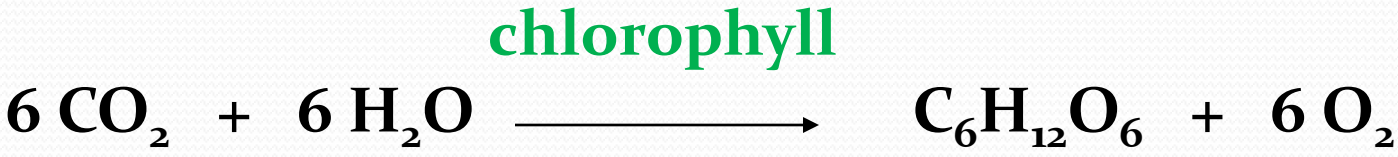
UNIT-2

Carbohydrates

What are Carbohydrates?

- Carbohydrates are organic biomolecules abundantly present in the nature.
- Found in the cells of plants and animals.
- Carbohydrates are predominantly biosynthesized by plants through **photosynthesis**
- Glucose is synthesized in plants from CO_2, H_2O, and solar energy from the sun.



(Complex Carbohydrates Of Plants)

- Animals and **Human beings cannot biosynthesize Carbohydrates** predominantly.

- Carbohydrates serve as the **primary source of energy/Fuel for the body.**

- Carbohydrates **are chief constituents** of **human food**.

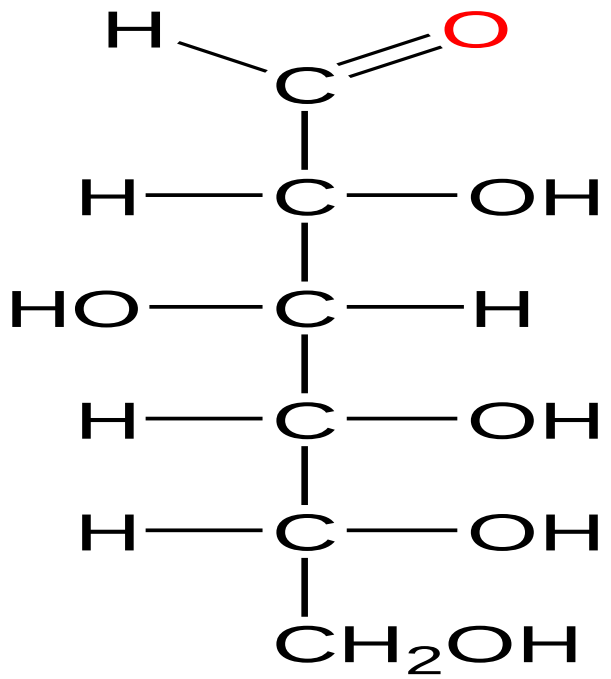
- **Carbohydrate** (Glucose) is **oxidized** in living cells of the human body to **produce** **CO_2, H_2O,** and **energy(ATP).**

- However, in **a critical condition** when cells are deprived of Glucose. Human body biosynthesizes Glucose using the **non carbohydrate precursors** present in body via **Gluconeogenesis**.

- Empirical formula/General formula for simple carbohydrates: $\mathbf{C_n (H_2O)_n}$
- Where ***n* = the number of carbon atoms** present in carbohydrate structure.
- Simple Carbohydrates have **many Hydroxyl groups (Polyhydroxy).**
- The hydroxyl groups may be free or substituted by any other groups.
- Simple Carbohydrates have **carbonyl/ functional** groups such as **Aldehyde or Ketone.**
- Simple Carbohydrates(Glucose/Fructose) are **r**epeatedly linked to form its **condensed complex** carbohydrates for example **Starch, Inulin.**

Aldose

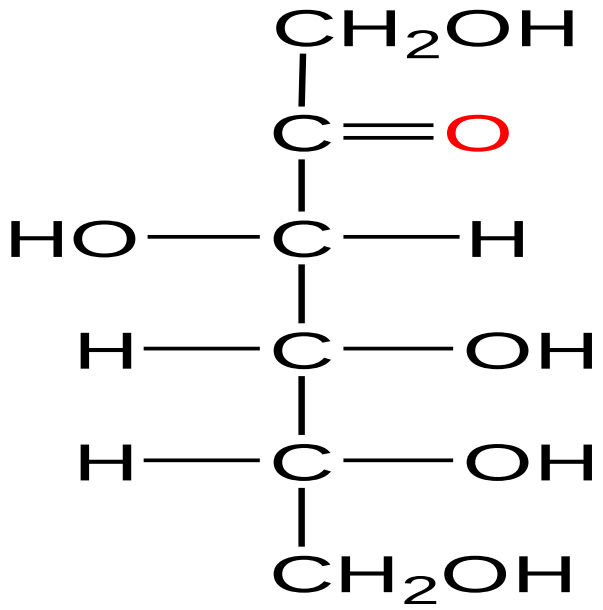
(e.g., Glucose) have an aldehyde group at one end.



D-glucose

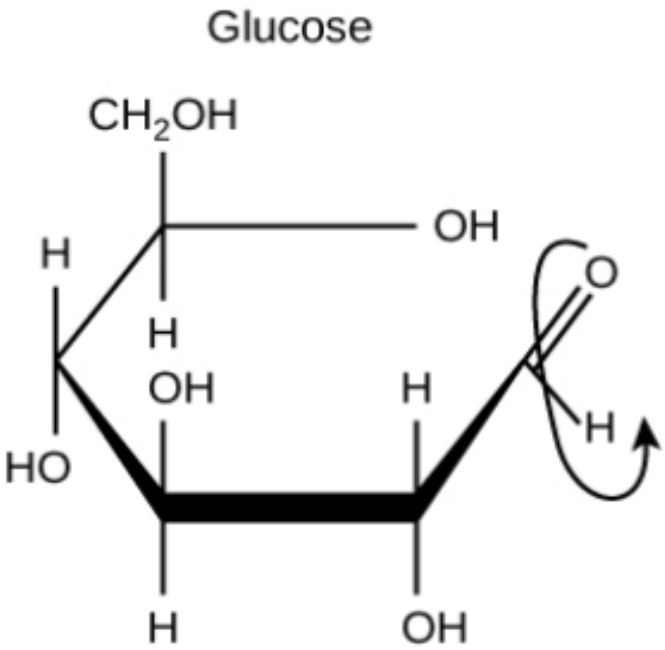
Ketose

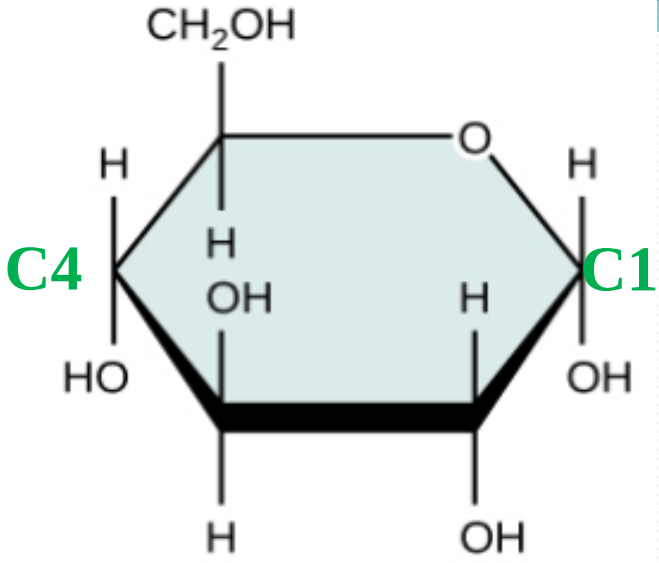
(e.g., Fructose) have a ketone group, usually at C2.



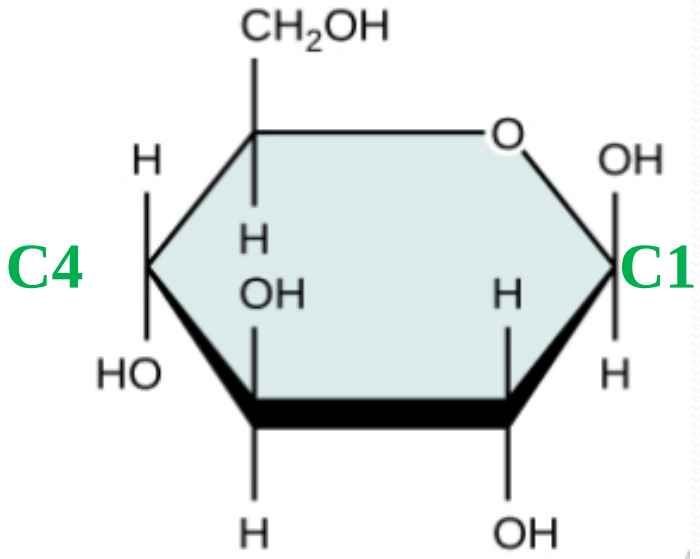
D-fructose

Monosaccharide
e.g. Glucose



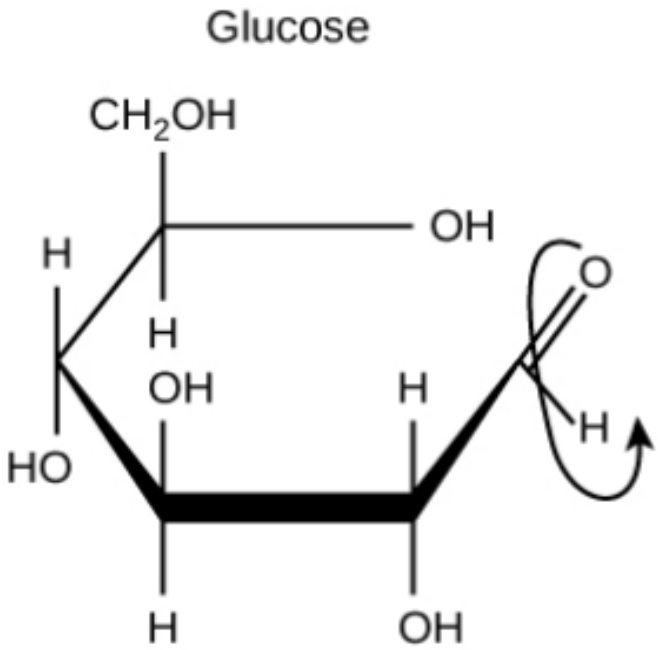


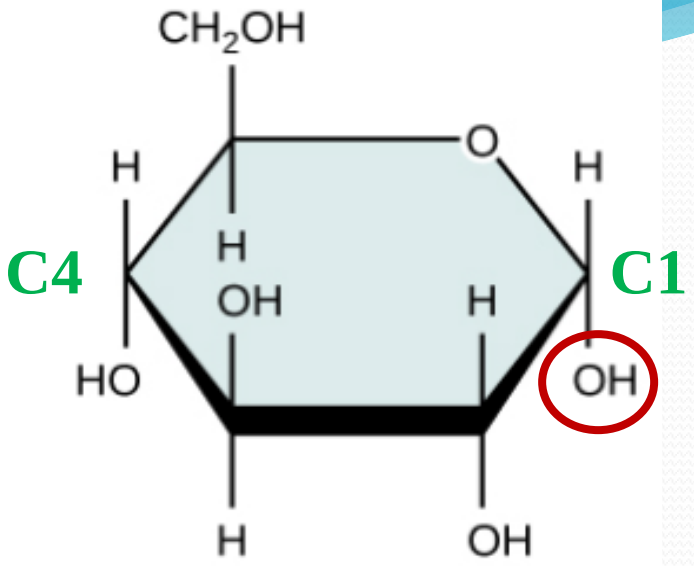
α Glucose

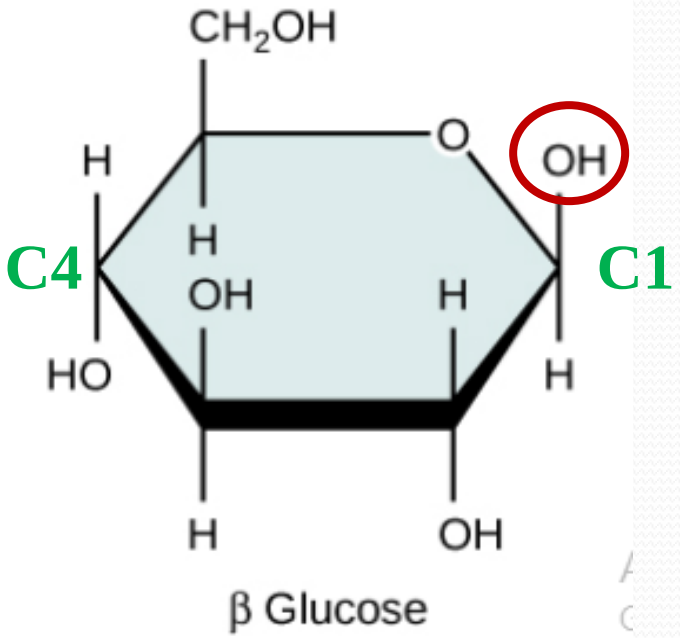


β Glucose

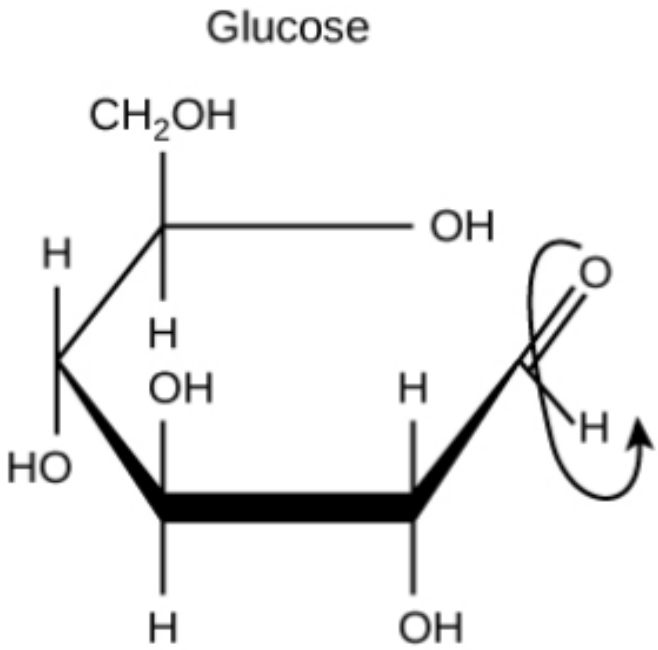
Monosaccharide
e.g. Glucose

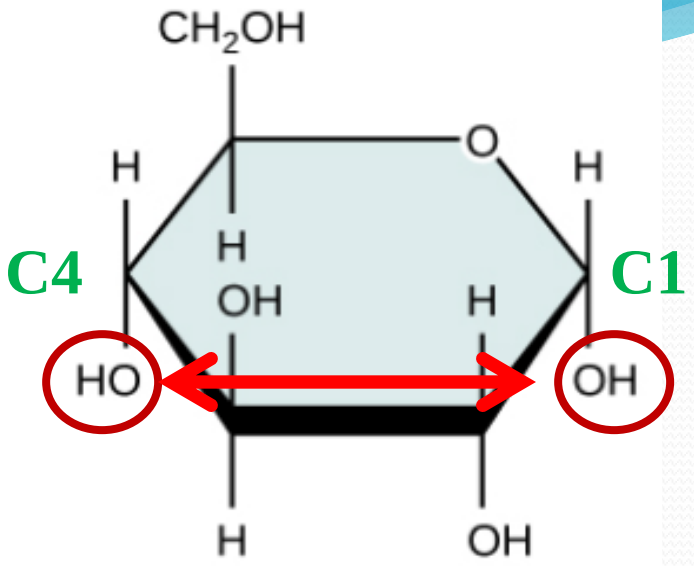


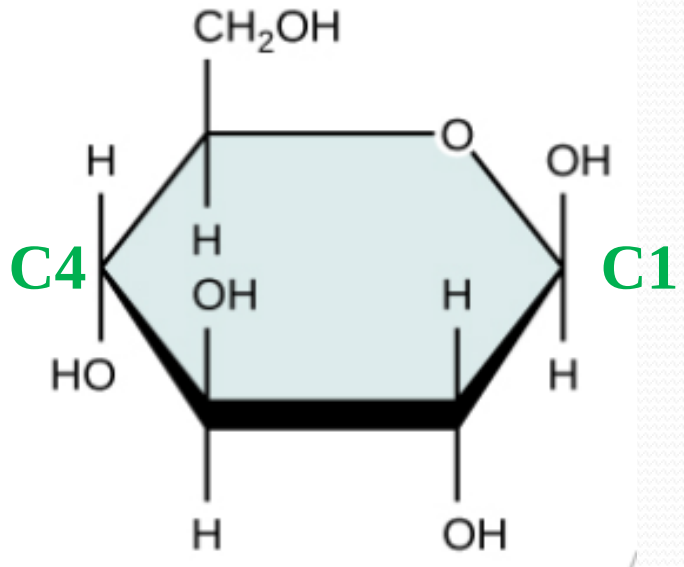




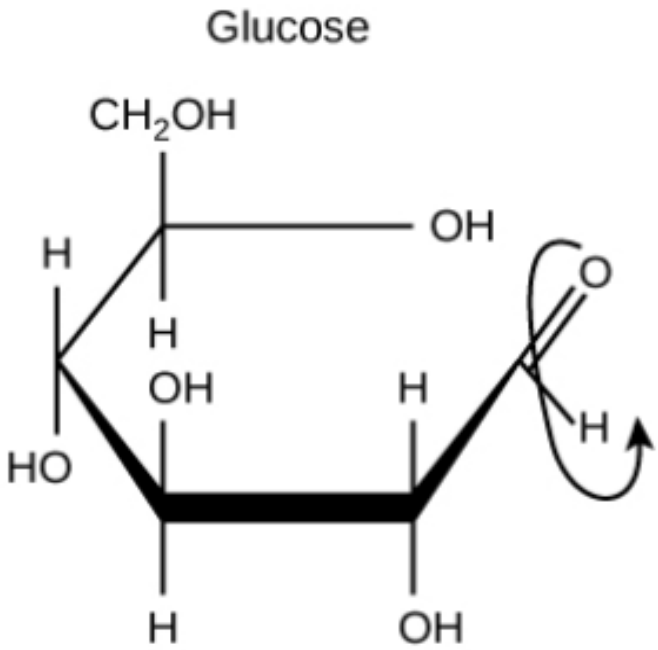
Monosaccharide
e.g. Glucose

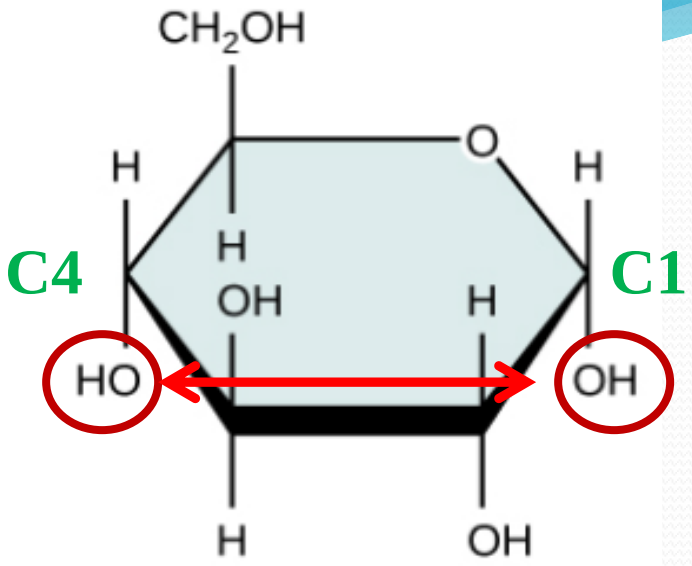


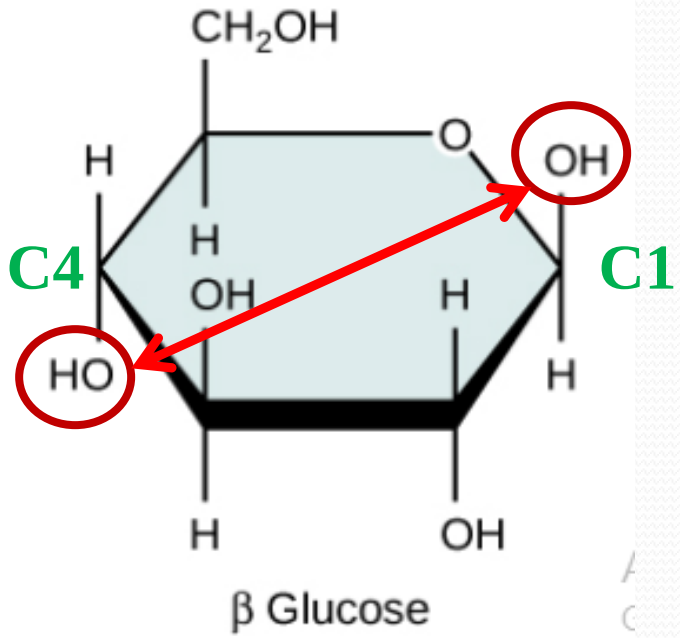




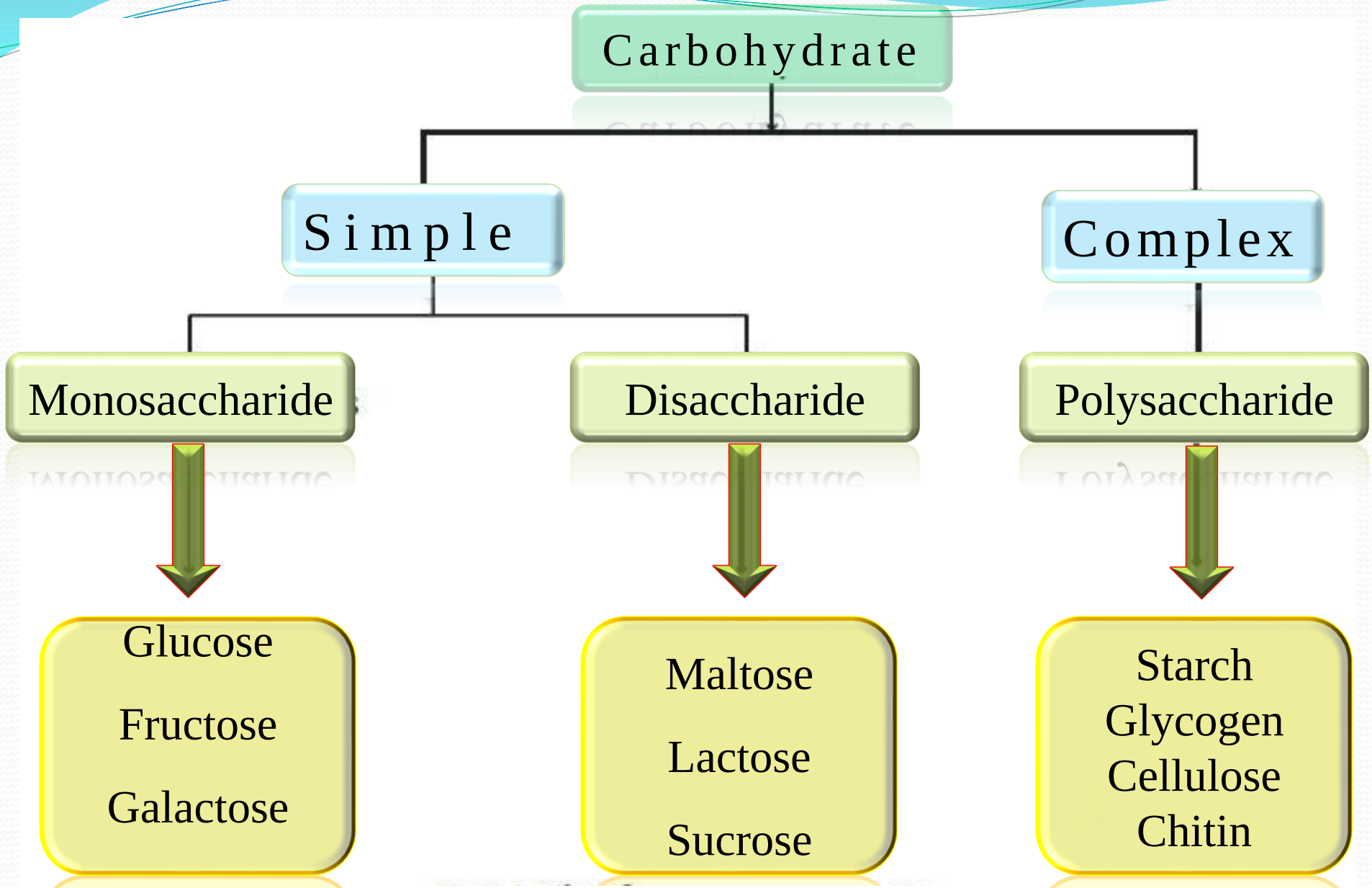
Monosaccharide
e.g. Glucose

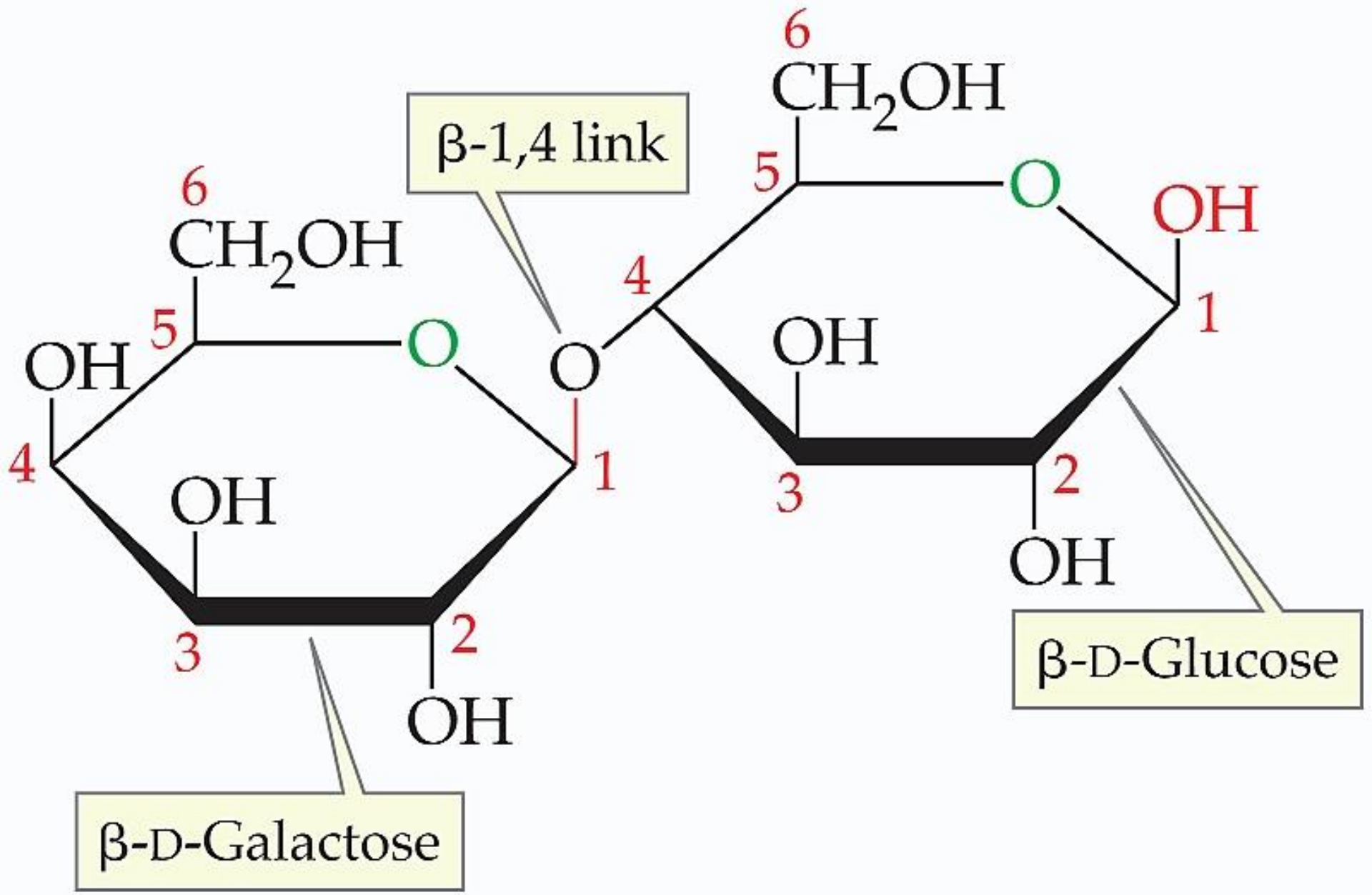




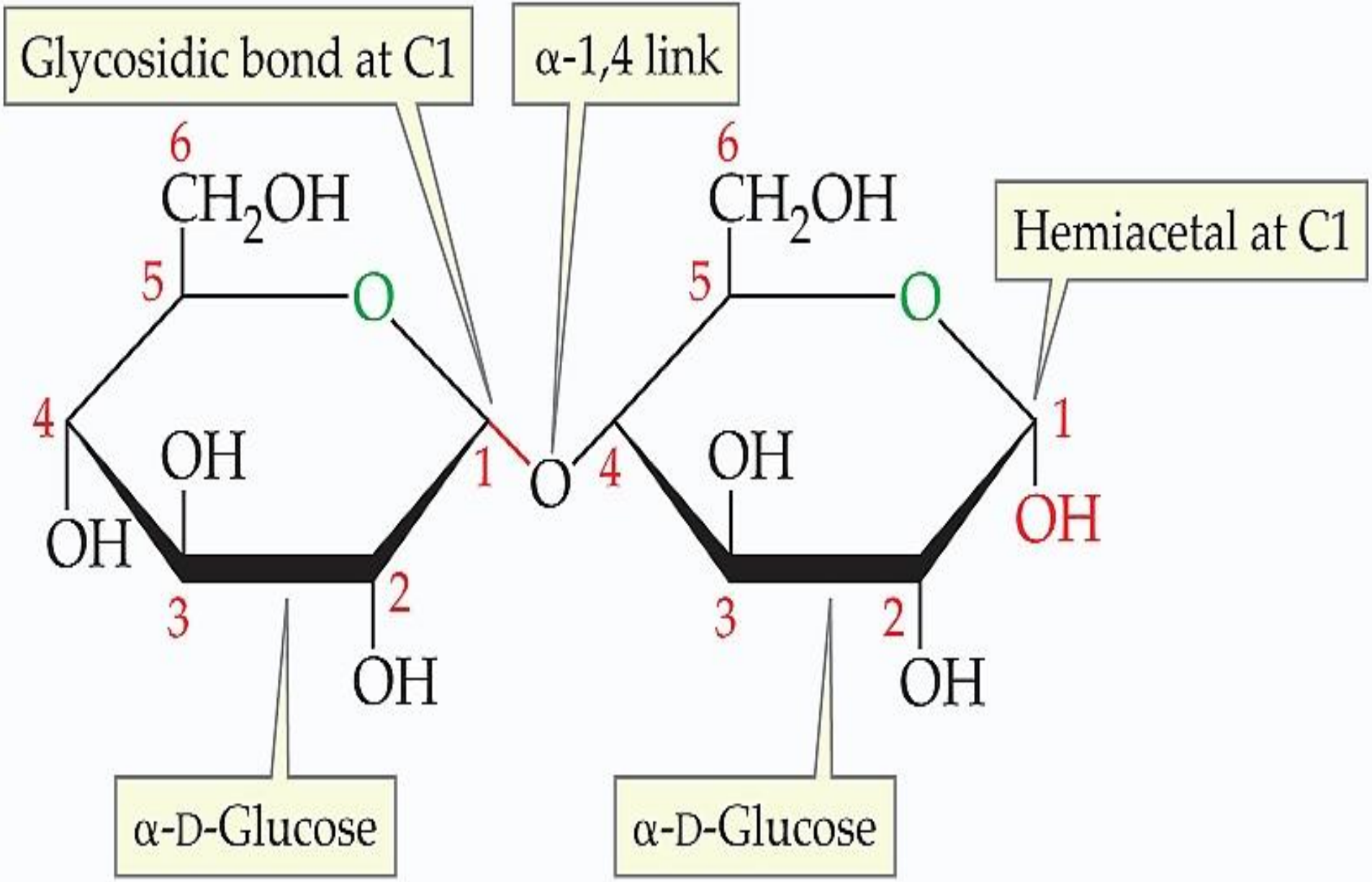


❖ Classification



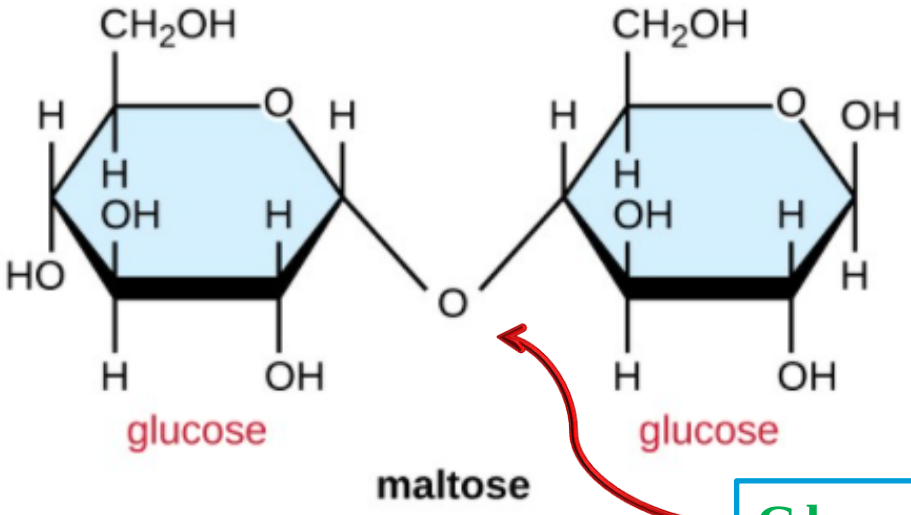


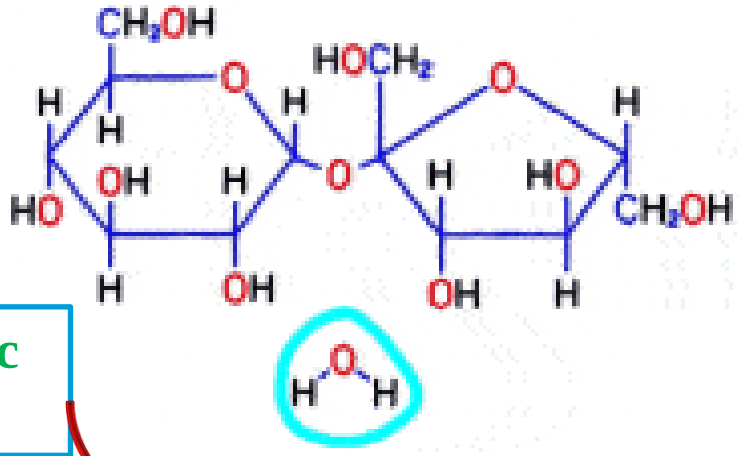
Lactose



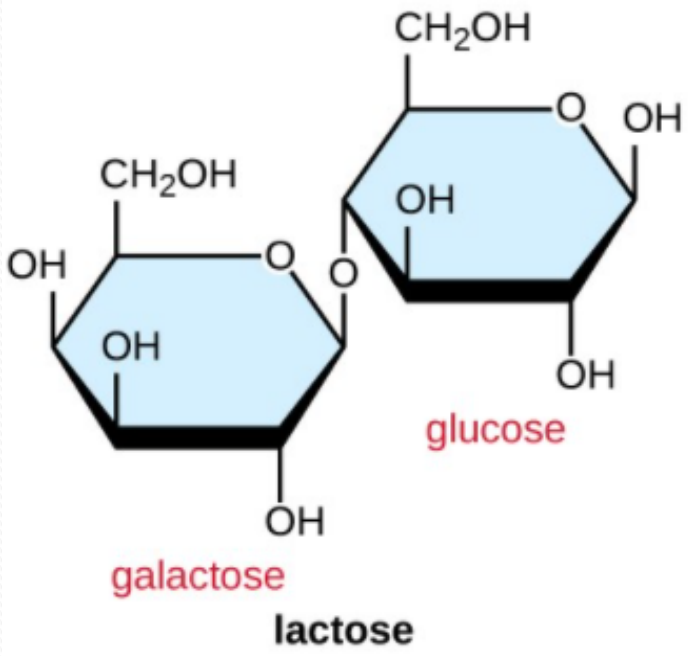
Maltose

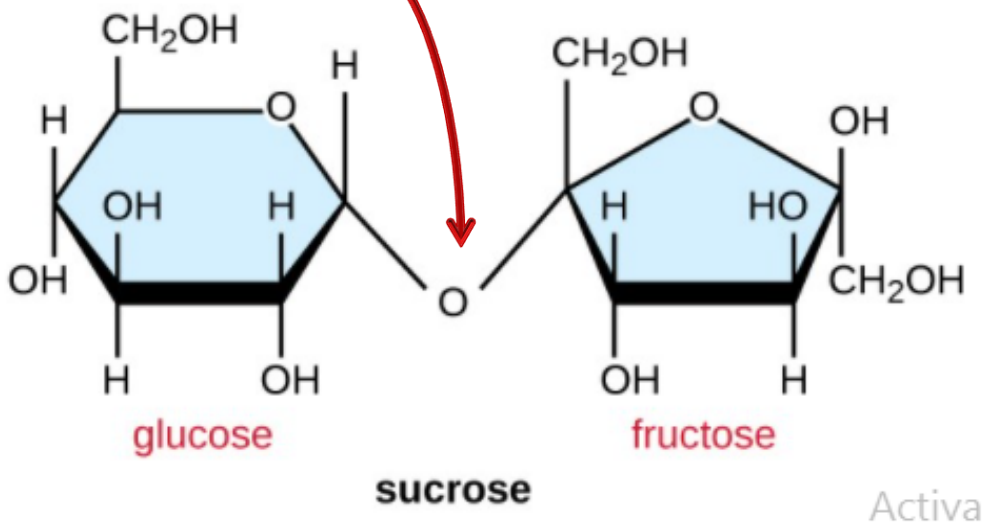
Disaccharides





Glycosidic bond

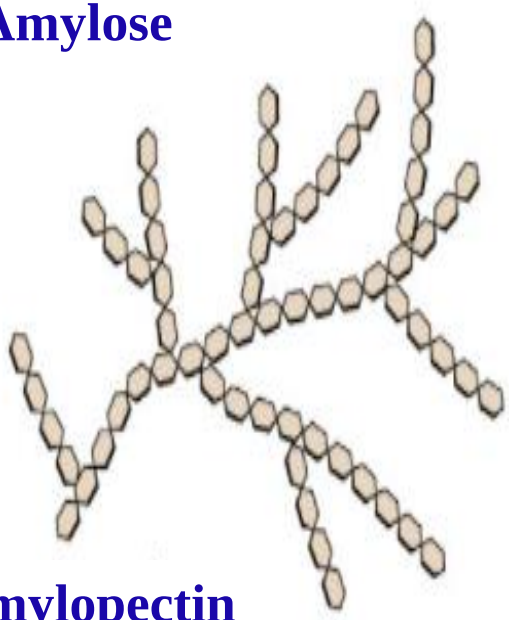




Polysaccharides:

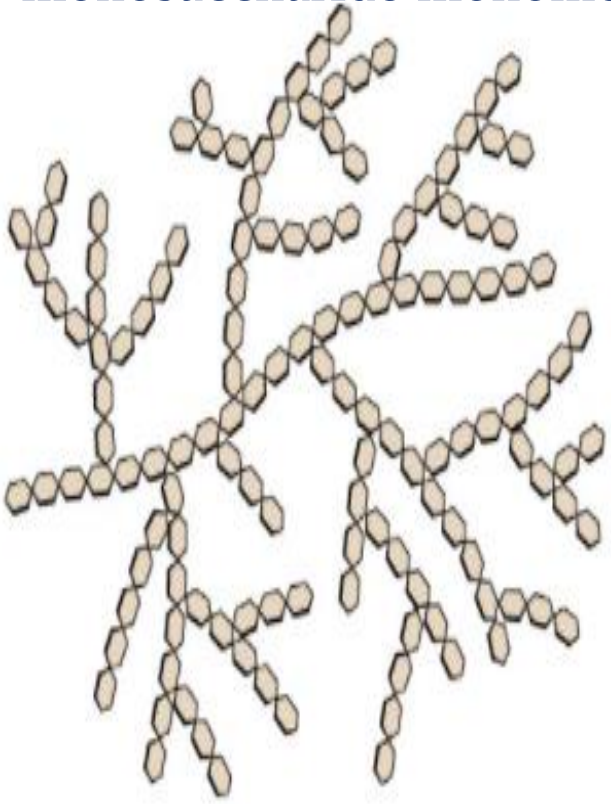
Polysaccharides, also called **glycans**, are large polymers composed of hundreds of monosaccharide monomers.

Amylose

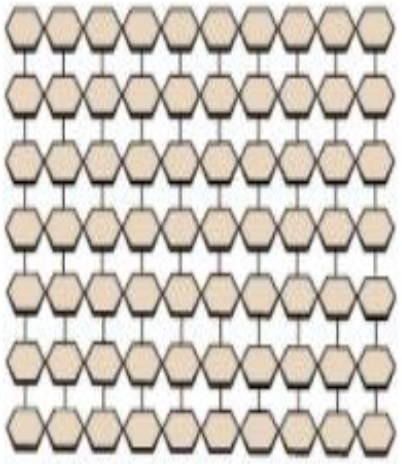


Amylopectin

Starch



Glycogen

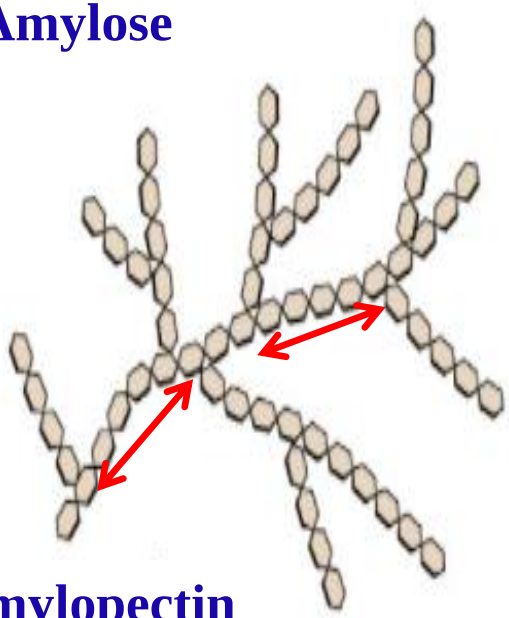


Cellulose (fibre)

Polysaccharides:

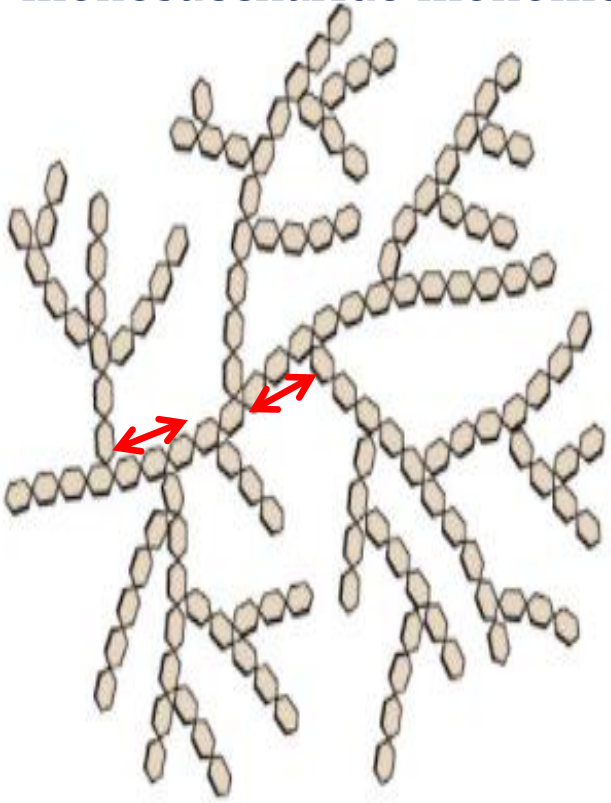
Polysaccharides, also called **glycans**, are large polymers composed of hundreds of monosaccharide monomers.

Amylose



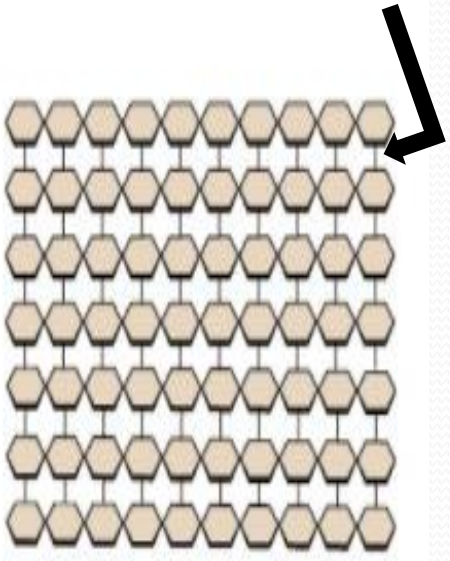
Amylopectin

Starch



Glycogen

β-1-4 Linkage



Cellulose (fibre)

- **Reducing end**- End with free anomeric carbon, not involved in formation of glycosidic bond.
- **Non reducing end**- End with no free anomeric carbon, since involved in formation of Glycosidic bond.

Amylopectin

- Amylopectin is 80-85 %
- Branched structure
- Branching point appears after every 25-30 Glucose units.
- It has α (1-6) glycosidic bond at branching point.
- α(1-4) glycosidic bonds in linear structure.

Amylose
(20%)

Glucose monomers

Amylopectin
(80%)

α-1, 4-Glycosidic bond

α-1, 6-Glycosidic
bond to branch

α-1, 4-Glycosidic bond

(a) Unbranched chain of amylose

(b) Branched-chain of amylopectin

Four Main Classes of Carbohydrates

Depending Upon Number of Saccharide (glucose) Units

Monosaccharides (1 Saccharide Unit)

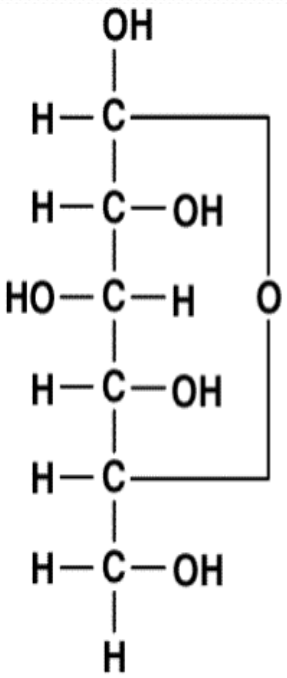
Disaccharides (2 Saccharide Units)

Oligosaccharides (3-10 Saccharide Units)

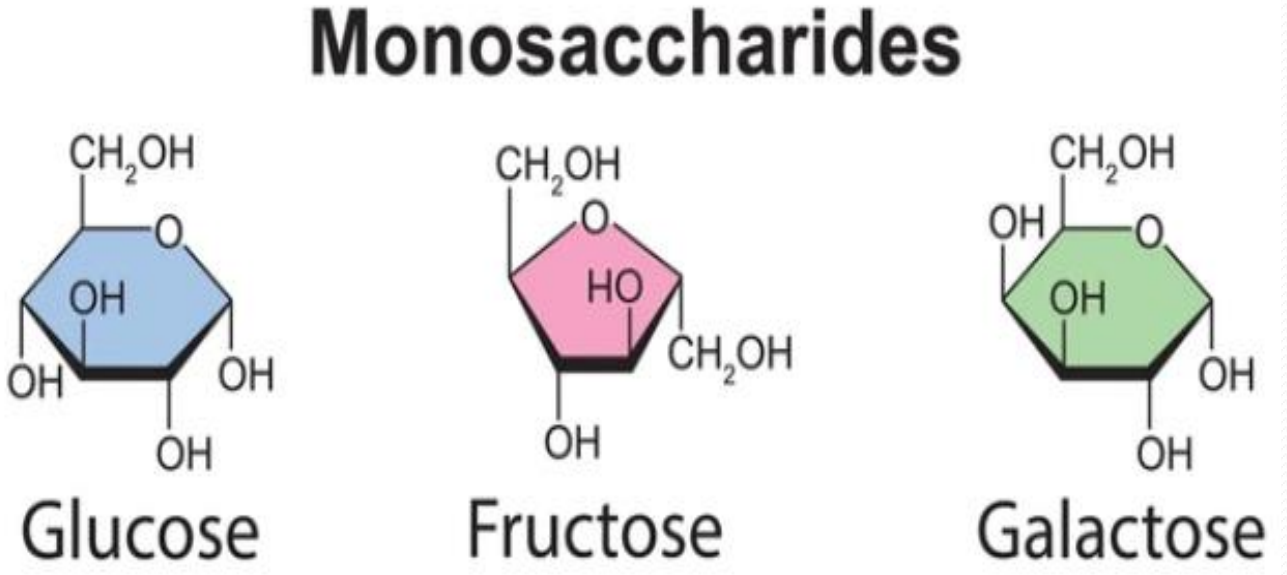
Polysaccharides (More than 10 Saccharide Units)

Monosaccharides (1 Saccharide Unit)

- The most nutritionally important monosaccharides are the pentoses (5-carbon atom skeleton), e.g., ribose, and the hexoses (6-carbon atom skeleton), e.g., glucose.

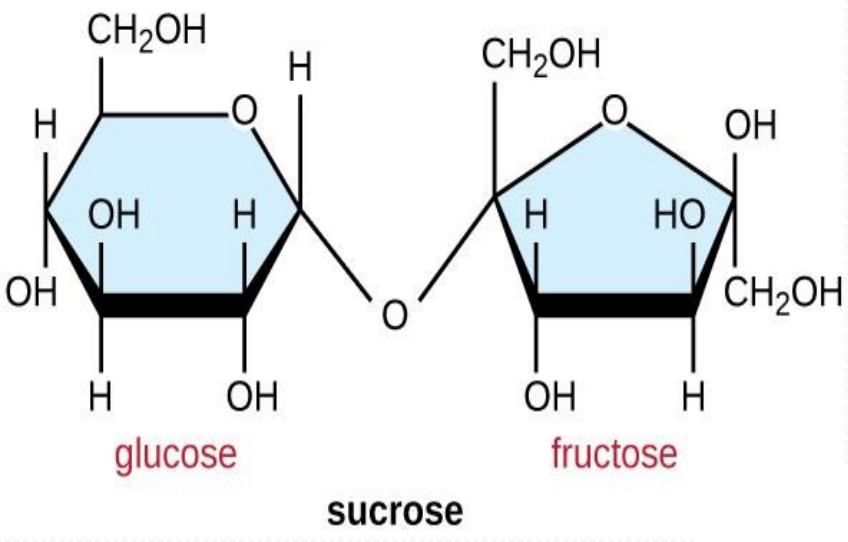


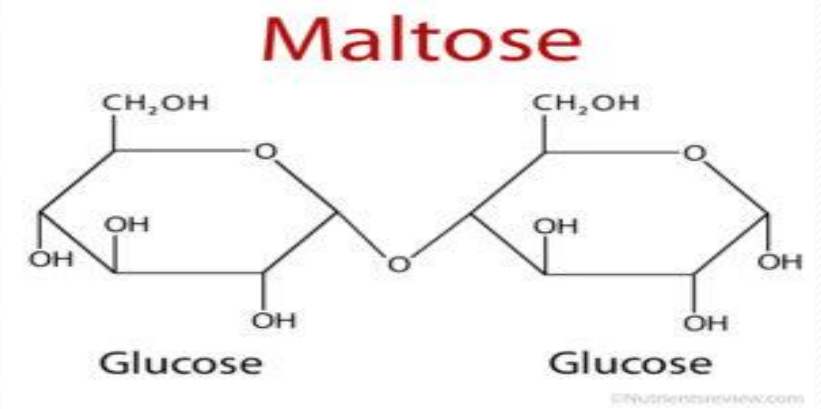
Glucose

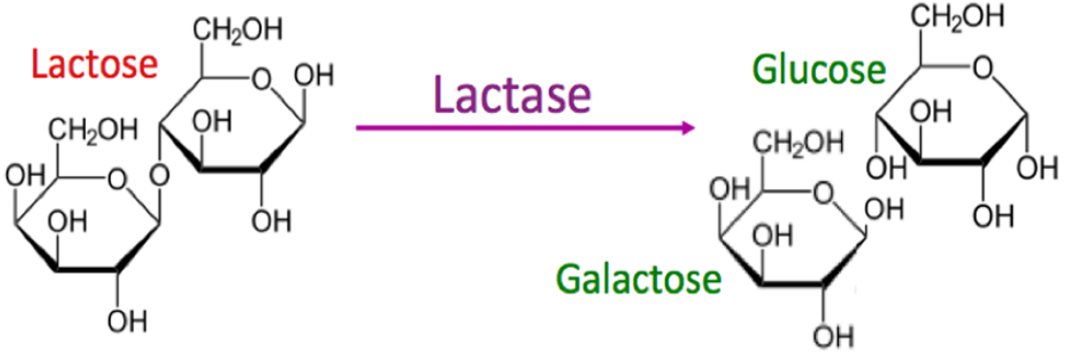


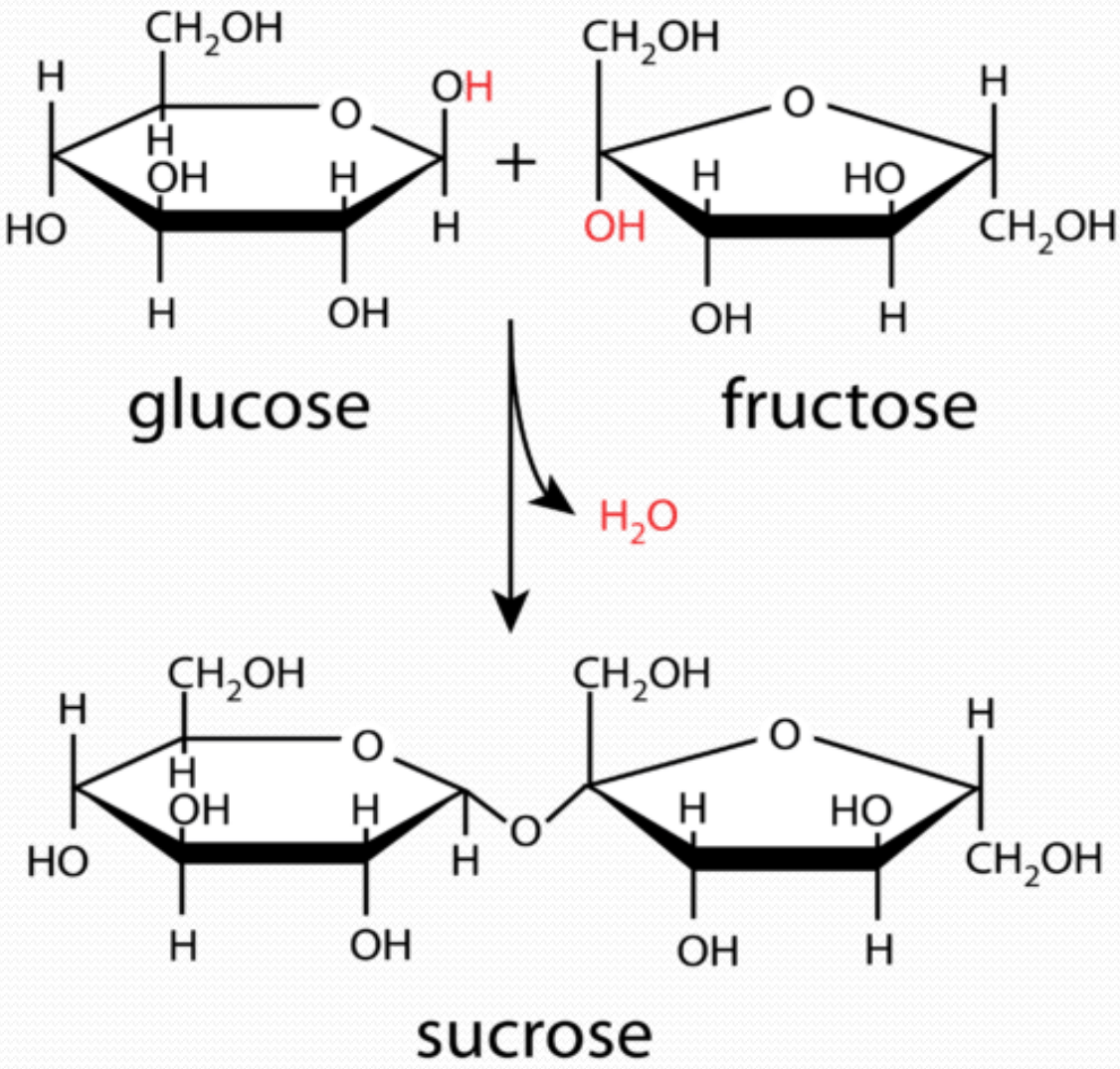
Disaccharides (2 Saccharide Units)

- A disaccharide is a sugar formed when two monosaccharides are joined by glycosidic linkage. Like monosaccharides, disaccharides are simple sugars soluble in water.
- The three major disaccharides are sucrose, lactose, and maltose.



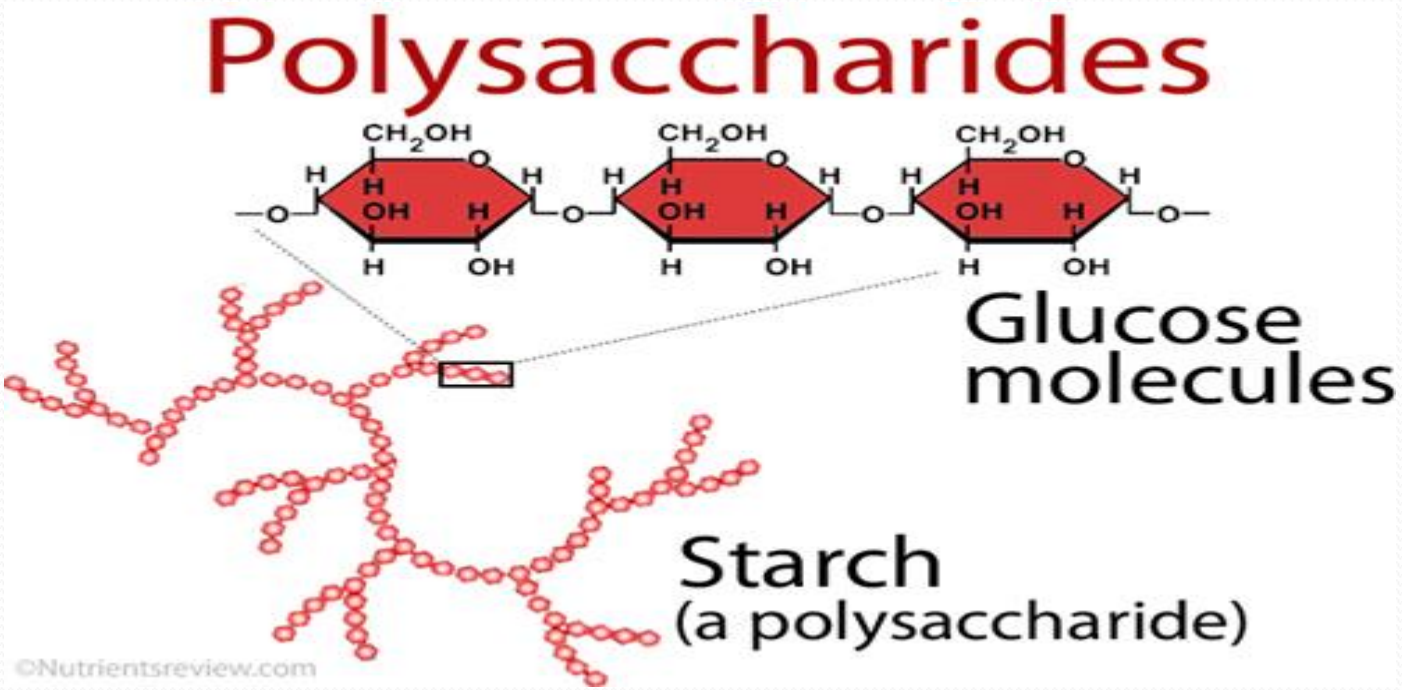





CH2OH
H
O
OH
H
OH
H
HO
H
H
OH
+
CH2OH
O
H
H
HO
OH
CH2OH
OH
H
glucose
fructose
H2O
CH2OH
CH2OH
O
O
HO
CH2OH
sucrose

Polysaccharides

- The most abundant, long-chain polymeric carbohydrates composed of monosaccharide units bound together by glycosidic linkages. This carbohydrate can react with water using amylase enzymes as catalysts, which produce constituent sugars.



Reducing Sugar

- Sugar structure **possessing free or potential(reactive)** aldehyde or ketone group is termed as **reducing sugar.**
- Reducing sugars **show reducing property** efficiently in alkaline medium and **reduces certain metallic ions** as- Cu^{++} **and** Fe^{+++}
- **Reducing Sugars** answer following **tests positive**
- Benedict's Test
- Fehling's test

Examples Of Reducing Sugars

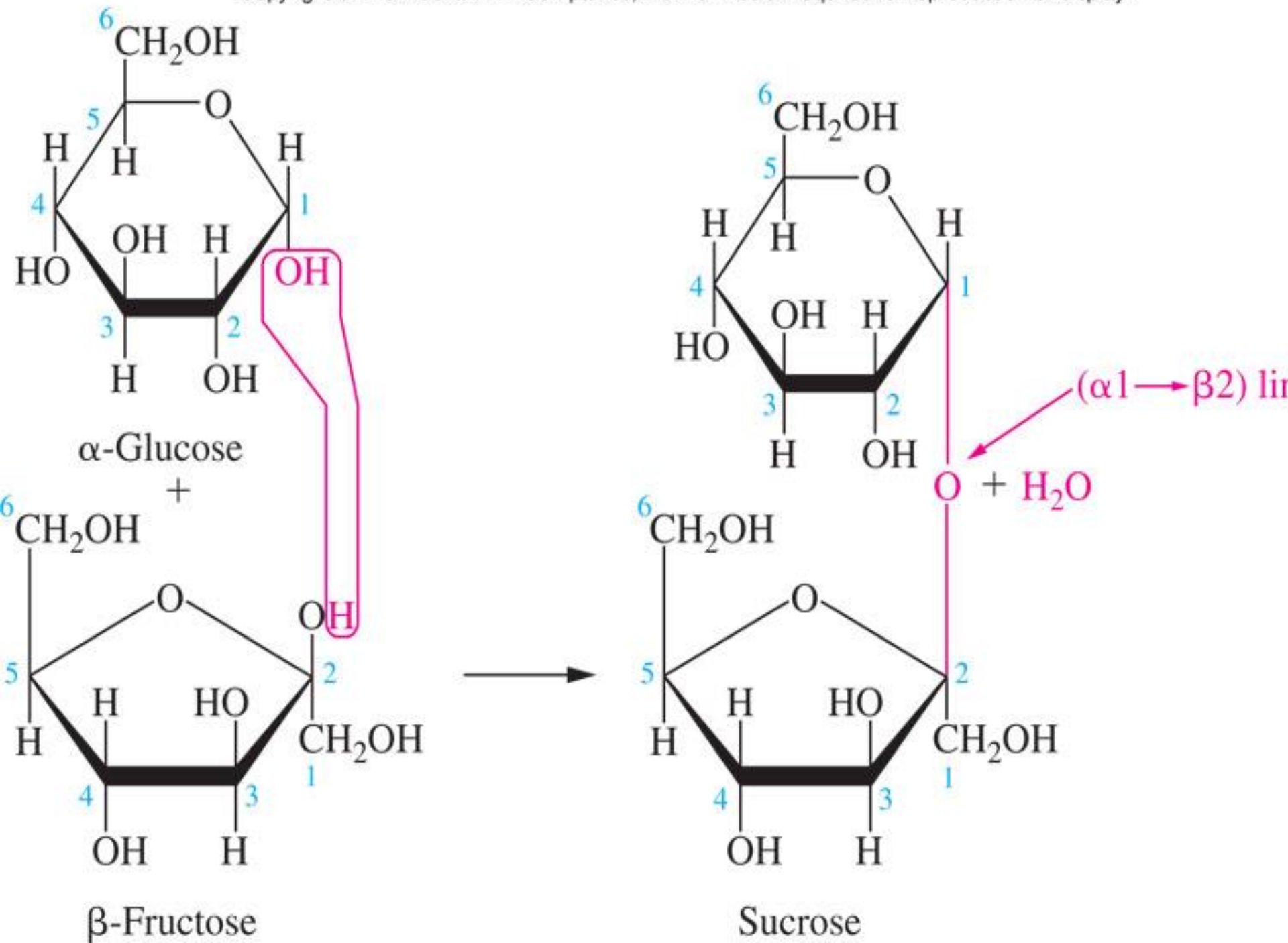
- All Monosaccharides are reducing sugars.
- Monosaccharides are strong reducing agents.
- Disaccharides are weak reducing agents.
- Reducing Disaccharides-
  - Lactose, Maltose.

Non Reducing Sugars

- Sugar structure **not possessing free or potential aldehyde or ketone** group in its structure is termed as non reducing sugar.
- Non reducing sugar **does not show reducing property** and do not reduce metallic ions.
- **Non reducing sugars** give following **reducing tests negative.**

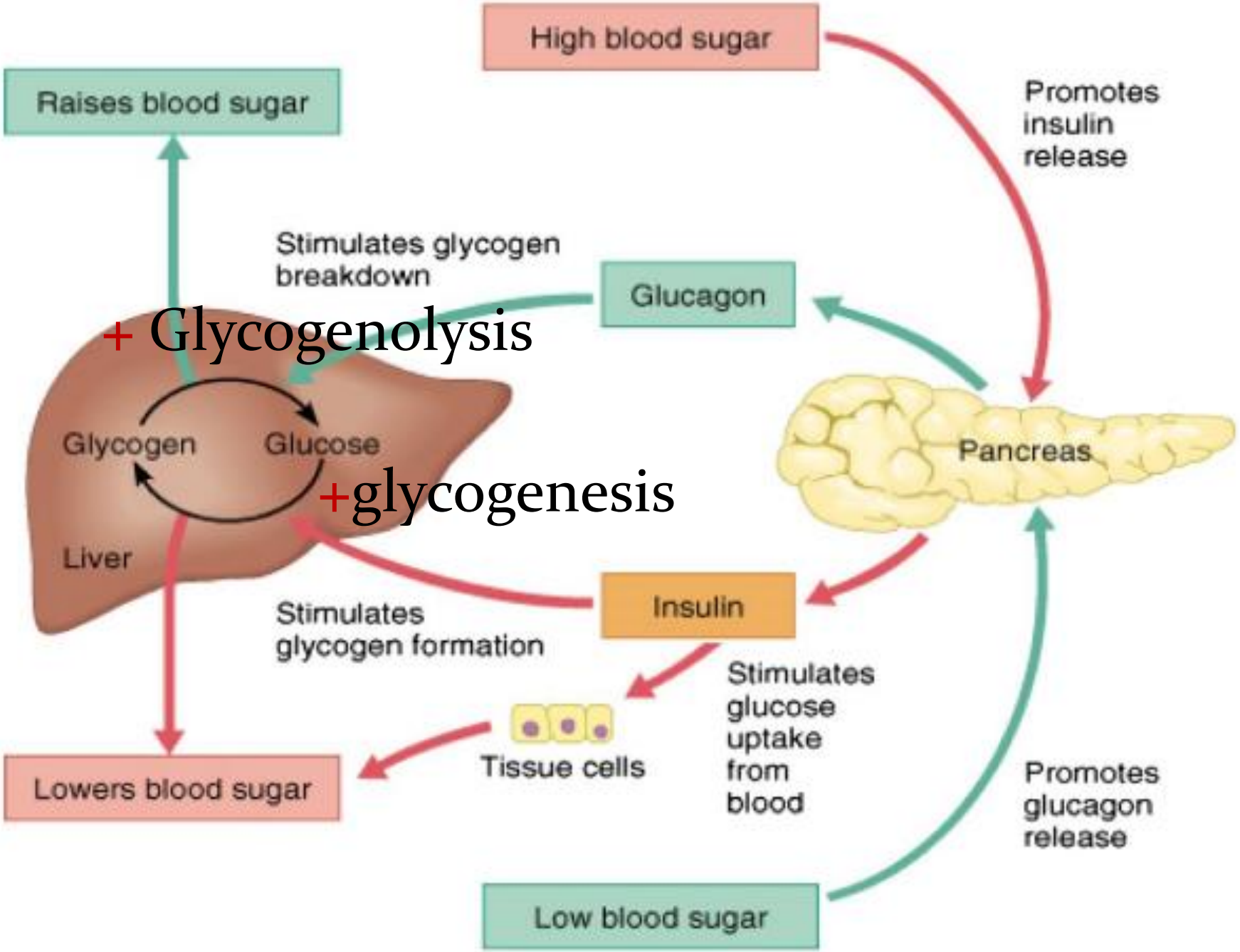
Benedict's Test

Fehling's test



Examples of Non reducing Sugars

- Non reducing Disaccharides.
  - **Sucrose** (Biomedically Important)
  - **Trehalose** (Glu-Glu linked with α(1-1) glycosidic bond)
- Polysaccharides/Complex Carbohydrates are Non reducing.


High blood sugar
Raises blood sugar
Promotes insulin release
Stimulates glycogen breakdown
Glucagon
+ Glycogenolysis
Glycogen
Glucose
+glycogenesis
Liver
Pancreas
Insulin
Stimulates glycogen formation
Stimulates glucose uptake from blood
Tissue cells
Lowers blood sugar
Promotes glucagon release
Low blood sugar