Carbohydrates

MB CC3

12 Credits

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Lecture objectives

- What are the carbohydrates?
- Classification of the carbohydrates
- Monosaccharide
- Family of carbohydrates
- Properties of Monosaccharide
- Oligosaccharides
- polysaccharides

CARBOHYDRATES

- Carbohydrates are the most abundant biomolecules on Earth.
- oxidation of carbohydrates is the central energy-yielding pathway in most non photosynthetic cells.
- Insoluble carbohydrate polymers serve as structural and protective elements.

- Carbohydrates are polyhydroxy aldehydes or ketones or substances that yield aldehydes and ketones compounds on hydrolysis.
- Carbohydrates have the empirical formula $(CH_2O)_n$, some also contain nitrogen, phosphorus or sulfur.

Classes of carbohydrates

- There are three major size classes of carbohydrates.
- Monosaccharides, oligosaccharides, and polysaccharides.
- The word "saccharide" is derived from the Greek *sakcharon*, meaning "sugar".

Monosaccharides

- simple sugars, consist of a single polyhydroxy aldehyde or ketone unit.

Oligosaccharides

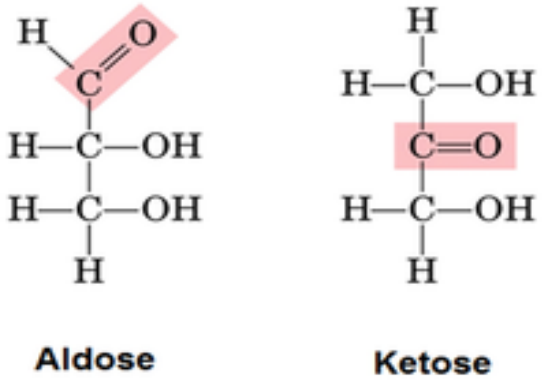
- consist of short chains of monosaccharide units, or residues.

Polysaccharides

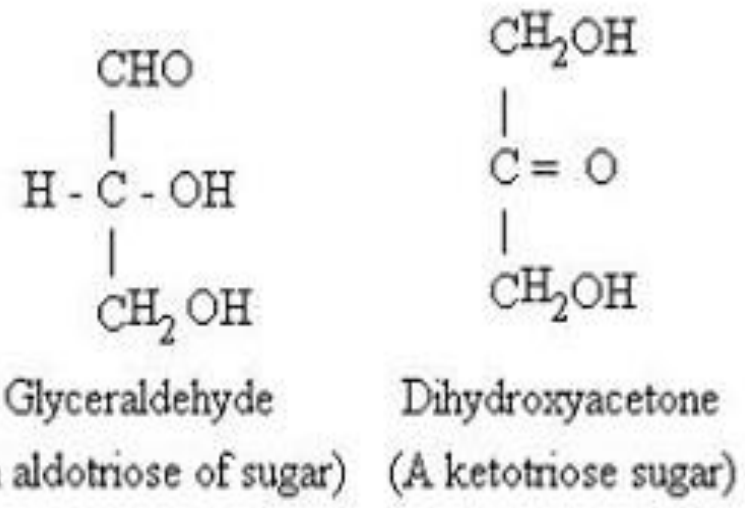
- They are sugar polymers containing more than 20 or so monosaccharide units.

Monosaccharides

- Monosaccharides are colorless, crystalline solids that are freely soluble in water but insoluble in nonpolar solvents.
- Monosaccharides has Two Families Aldoses and Ketoses.



- The simplest monosaccharides are the three-carbon trioses.

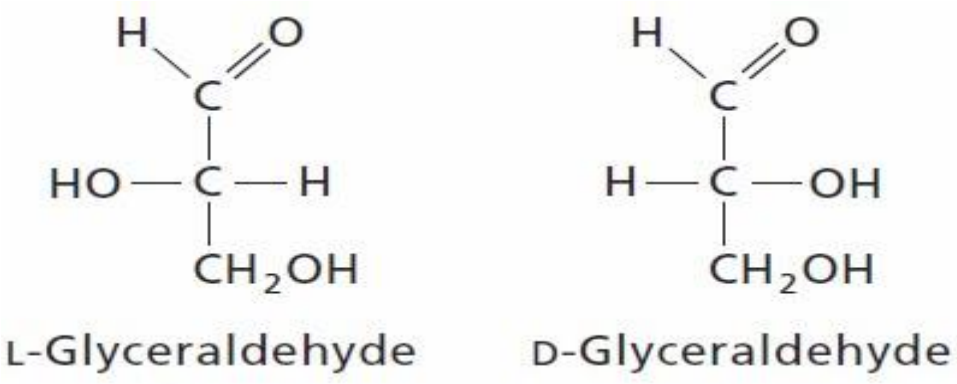


Glyceraldehyde (An aldotriose of sugar)

Dihydroxyacetone (A ketotriose sugar)

No.of Carbon atoms	Aldoses	Ketoses
3 (Triose)	Glycerose (or) Glyceraldehyde	Dihydroxy acetone
4 (Tetrose)	Erythrose	Erythrulose
5 (Pentose)	Ribose, Xylose Arabinose	Ribulose Xylulose
6 (Hexose)	Glucose, Galactose Mannose	Fructose
7 Heptose	Glucoheptose Galactoheptose	Pseudo heptulose

Monosaccharides Have Asymmetric Centers

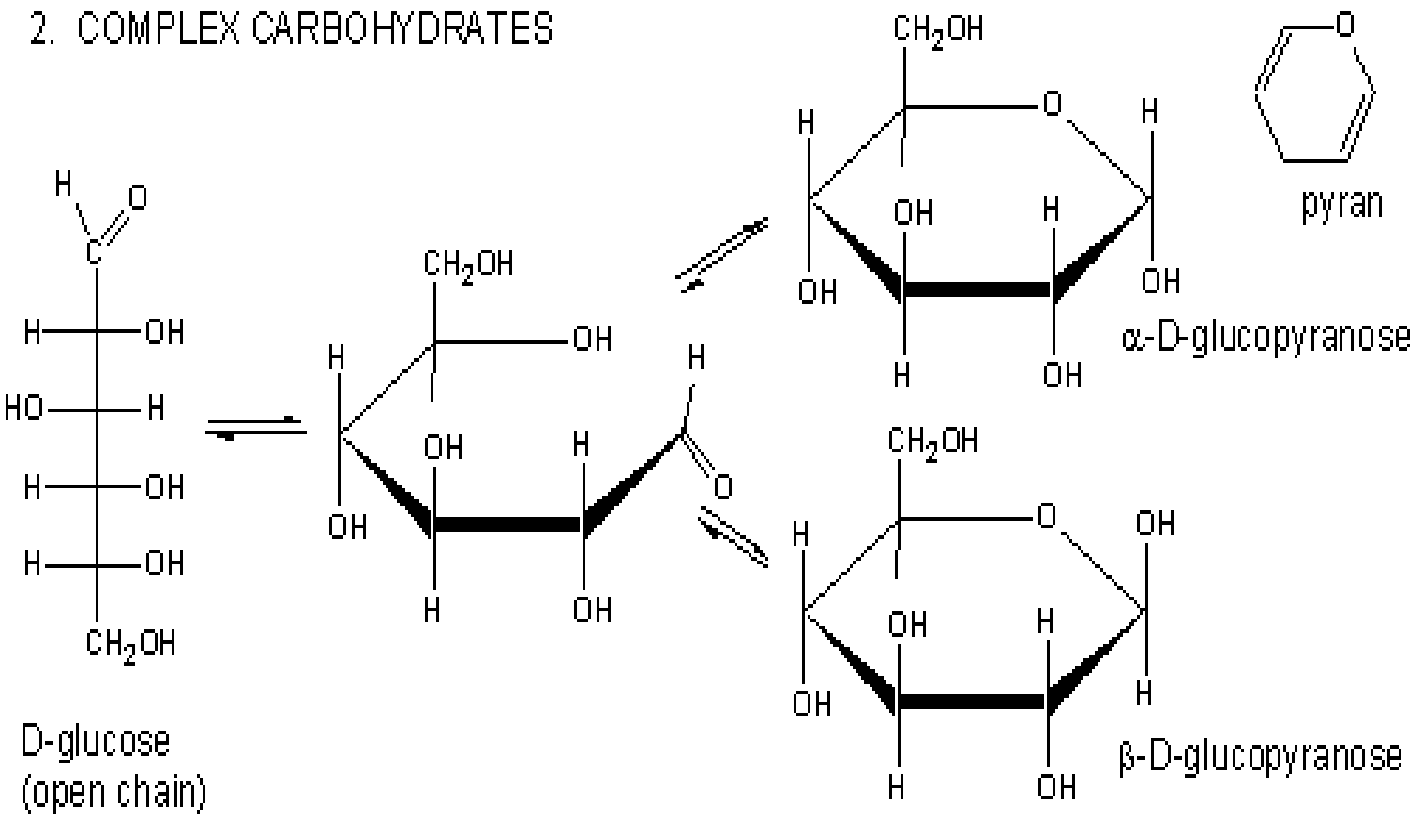


In general, a molecule with n chiral centers can have $\mathbf{2^n}$ stereoisomers.

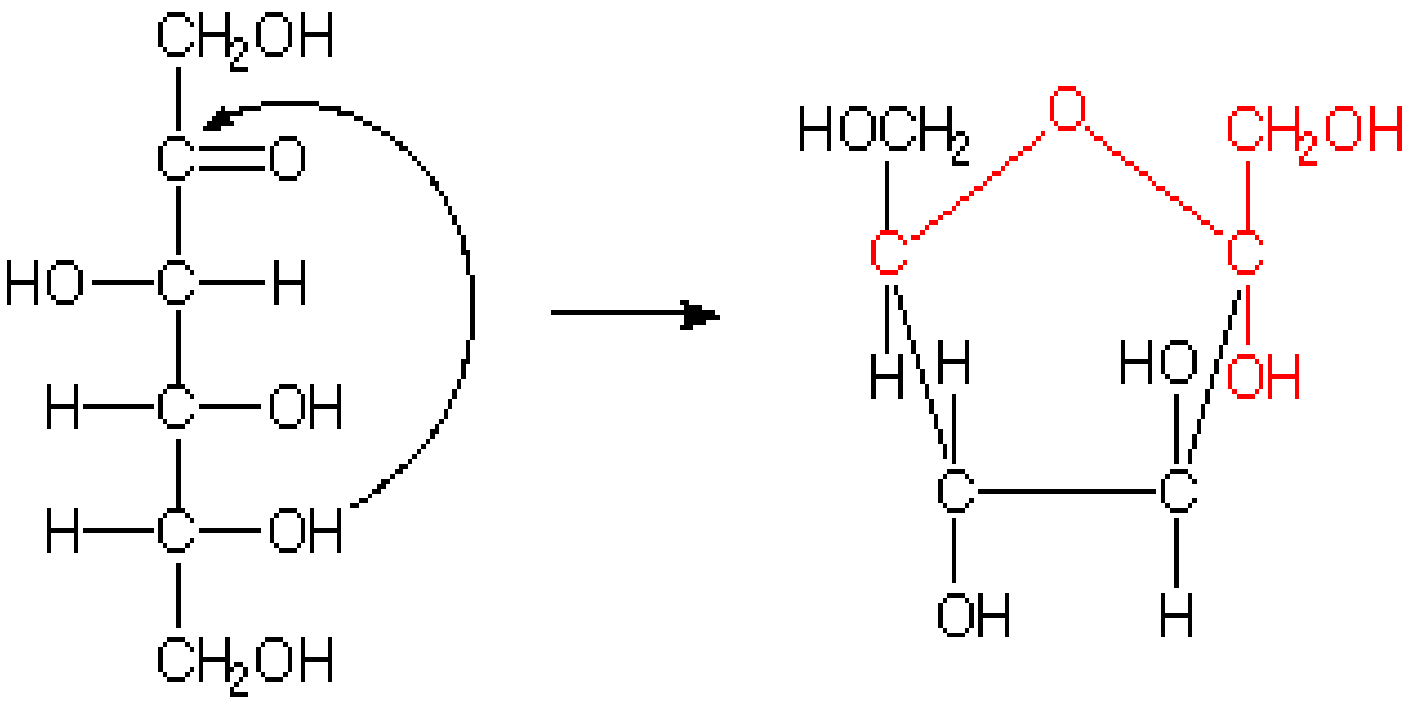
Cyclic structure and mutarotation

- In aqueous solution all monosaccharides with five or more carbon atoms in the backbone occur predominantly as cyclic(ring) structures.
- 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.**

Mutarotation

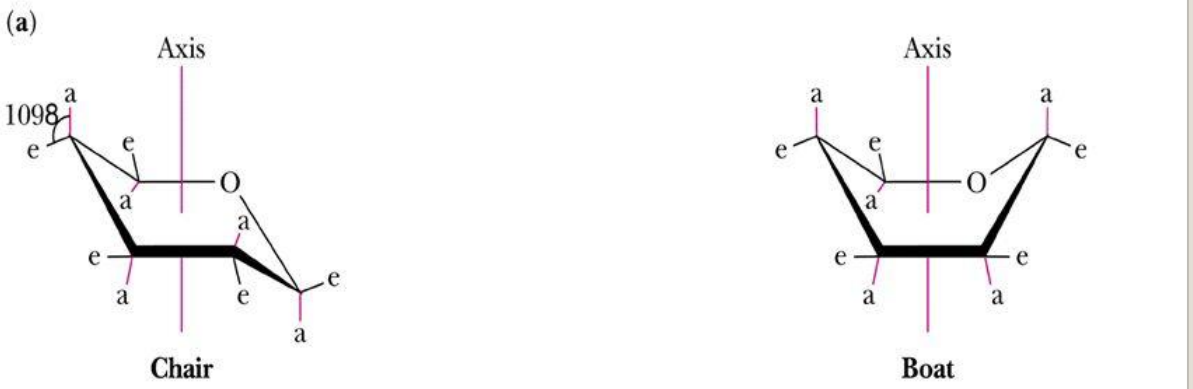


Fucose form of ketose



- Isomeric forms of monosaccharides that differ only in their configuration about the hemiacetal or hemiketalcarbon 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.

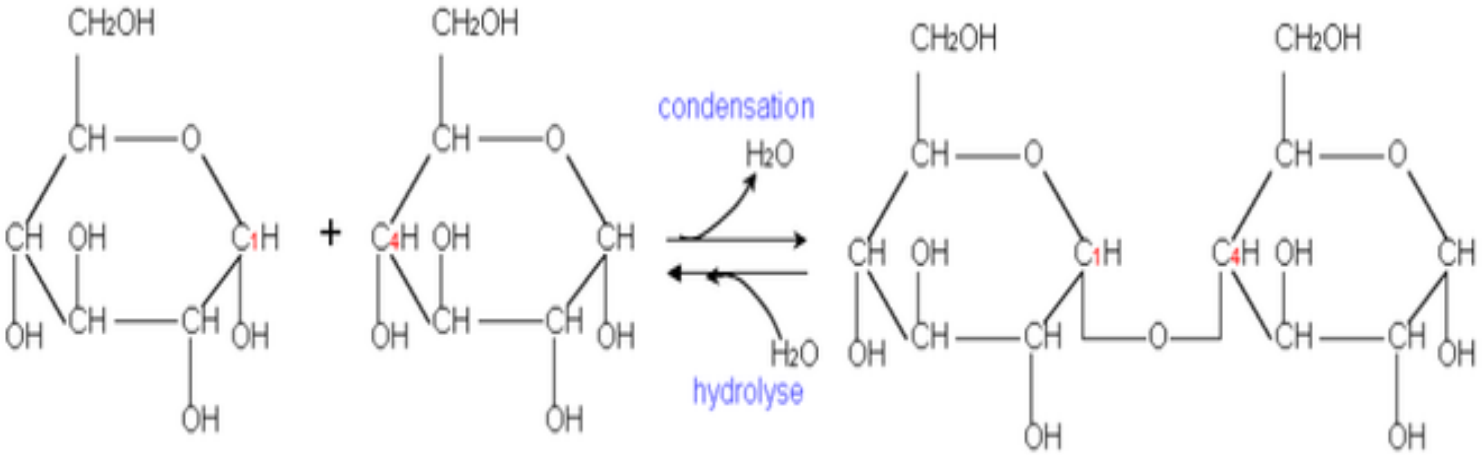
Confarmation of glucose



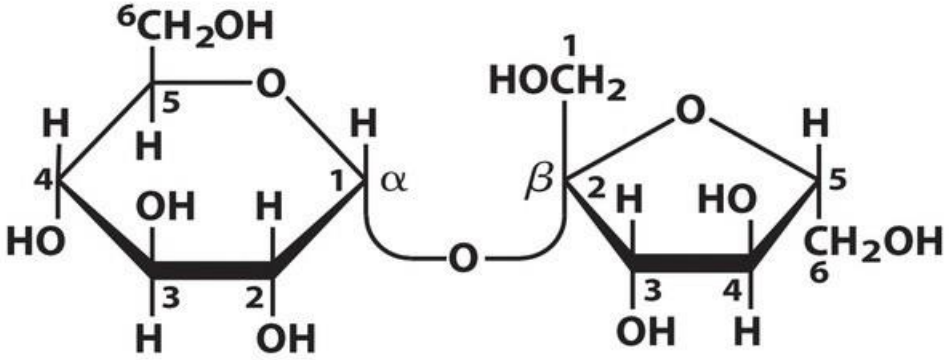
- Monosaccharides can be oxidized by relatively mild oxidizing agents such as ferric (Fe3) or cupric (Cu2) ion.
- Glucose and other sugars capable of reducing ferric or cupric ion are called reducing sugars.

Glycosidic Bond

- Disaccharides (such as maltose, lactose, and sucrose) consist of two monosaccharides joined covalently by an***O-glycosidic bond.***
- Glycosidic bond is formed when a hydroxyl group of one sugar reacts with the anomeric carbon of the other.
- When the anomeric carbon is involved in a glycosidic bond, that sugar residue cannot take the linear form and therefore becomes a non reducing sugar.



α-D-glucose α-D-glucose Maltose



Sucrose

α-D-glucopyranosyl β-D-fructofuranoside

Glc(α1↔2β)Fru

Types of Oligosaccharides

2. Trisaccharides :

- Contains 3 monosaccharide units .

Raffinose Fructose+Galactose+Glucose

3. Tetrasaccharides :

- Contains 4 monosaccharide units.

Stachyose 2(Galactose)+Glucose+Fructose

4. Pentasaccharides :

- Contains 5 monosaccharide units.

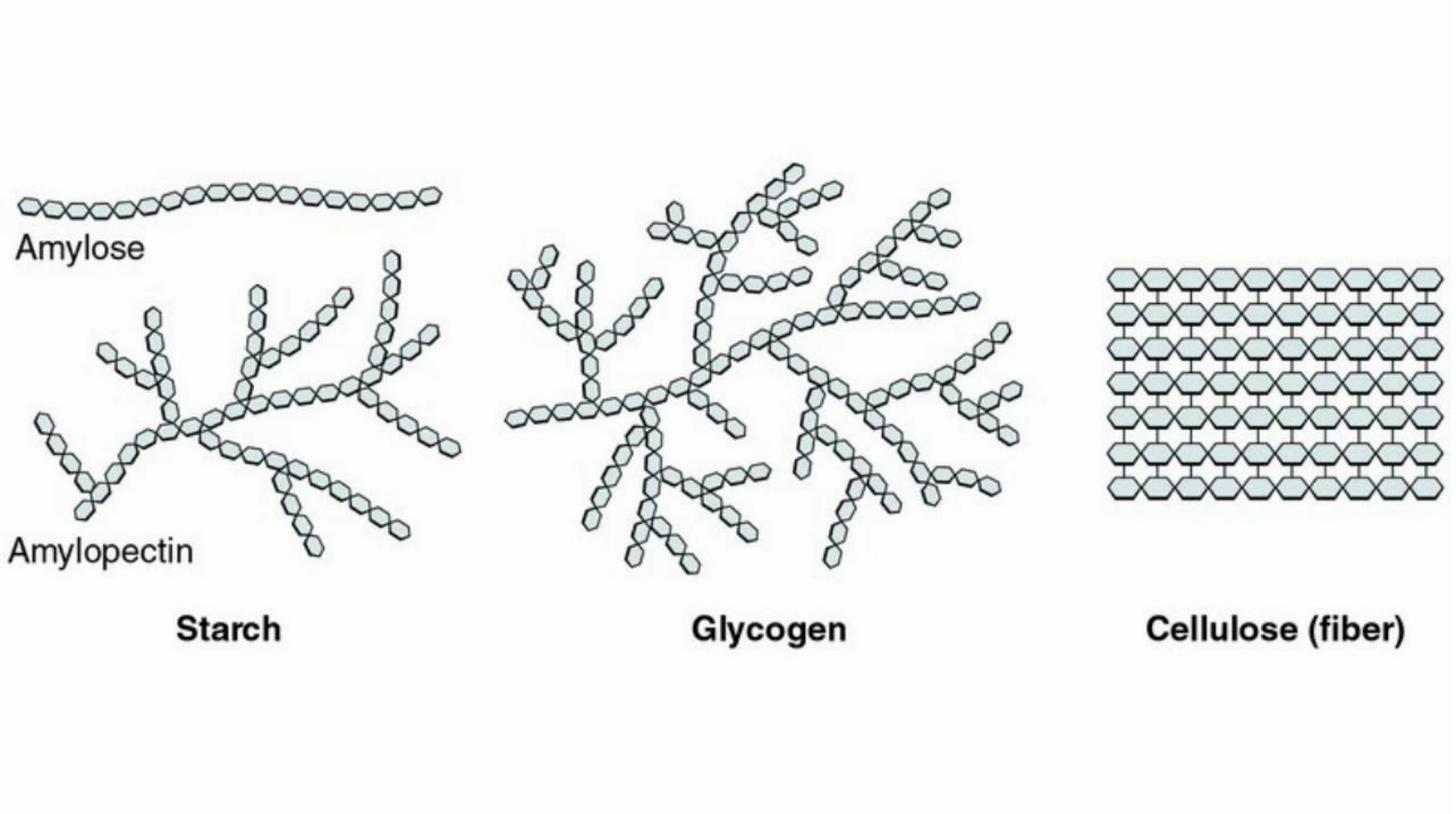
Verbascose 3(Galactose)+Glucoce+Fructose

Polysaccharides

- **Homopolysaccharides** contain only a single type of monomer.
- **heteropolysaccharides** contain two or more different kinds of monomers.
- Some homopolysaccharides serve as storage forms of monosaccharides that are used as fuels; starch and glycogen are homopolysaccharides of this type.

- 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.

Homopolysaccharide (Glucans)



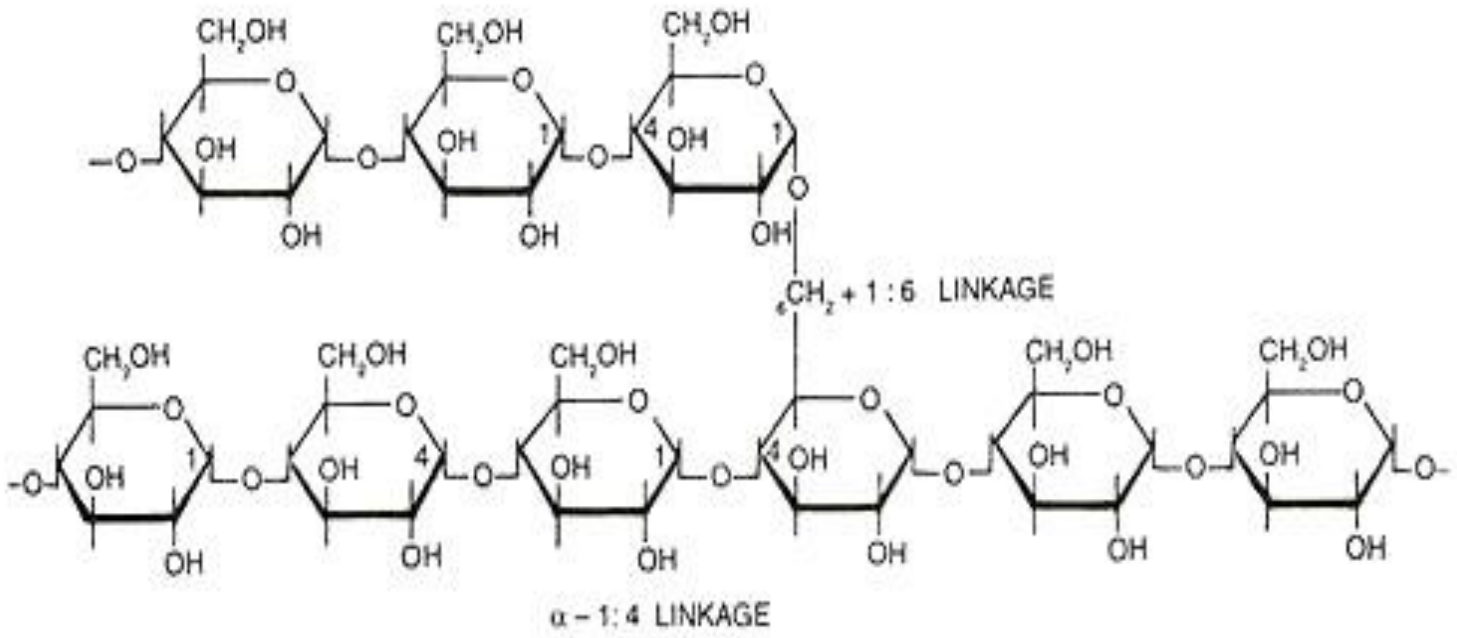
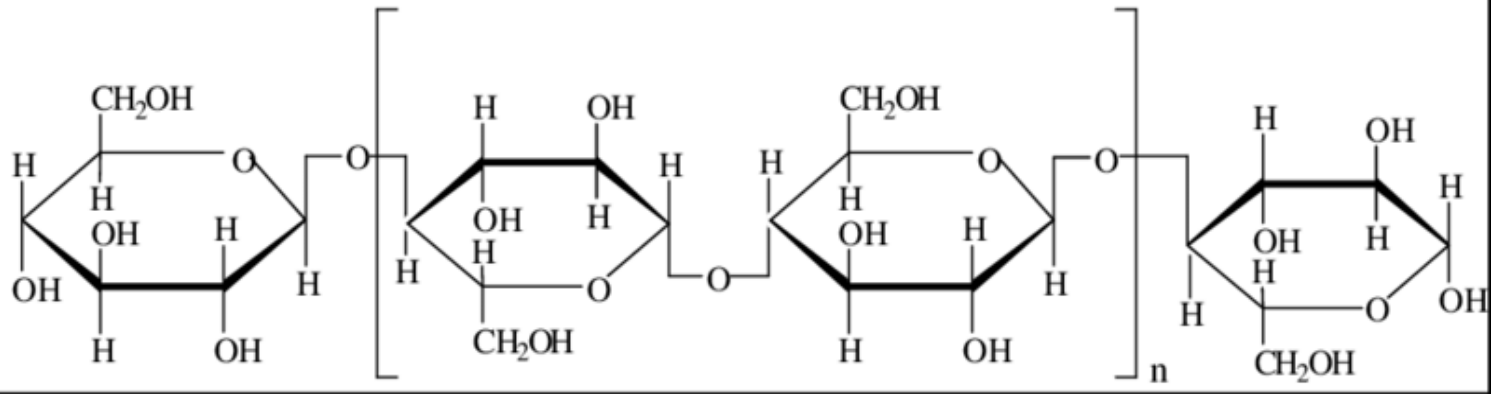


Fig. 9.8. Structure of starch.

The structure of cellulose :

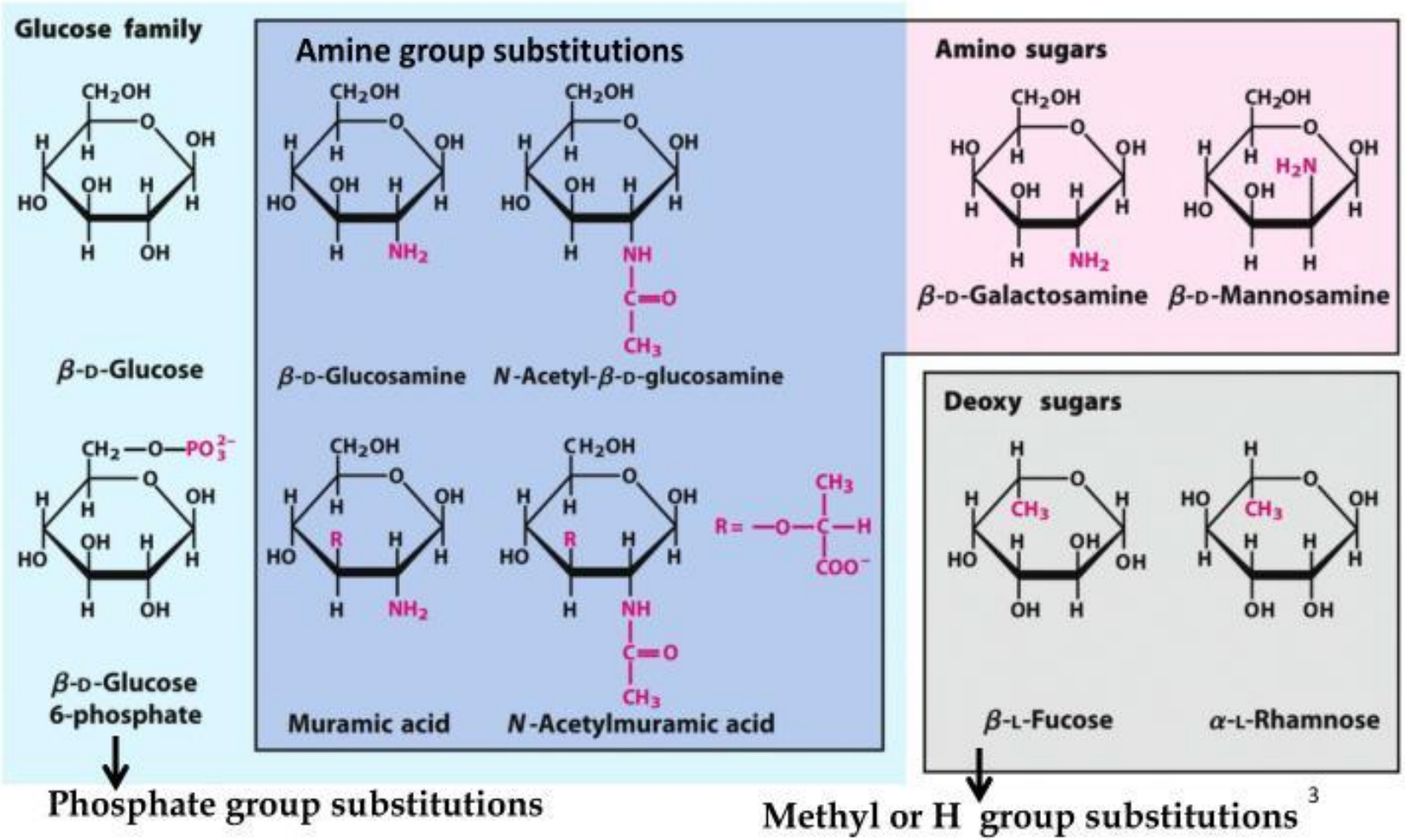


Derivatives of monosaccharides

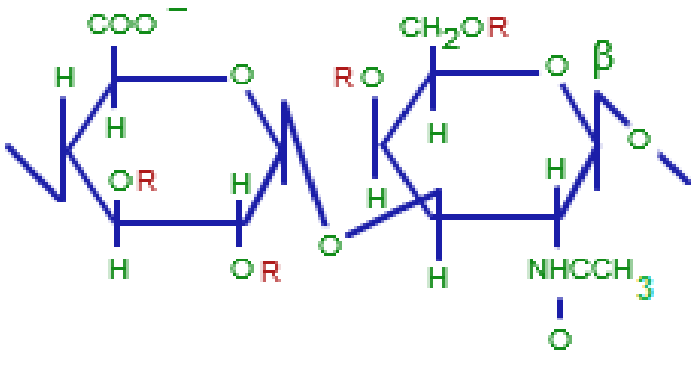
- Many derivatives of the monosaccharides are found in the systems, which include sugar phosphate, deoxy and amino sugars, sugar alcohol, and sugar phosphate, deoxy and amino sugar, sugar alcohols, and sugar acids.

1. Monosaccharide Derivatives-
A. Hydroxyl Group Substitutions

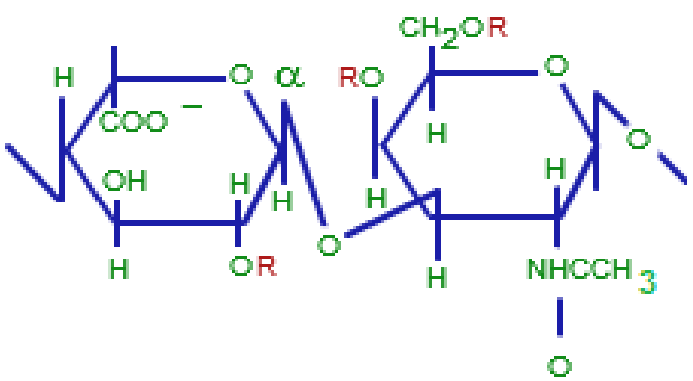
Glucose: An aldose.



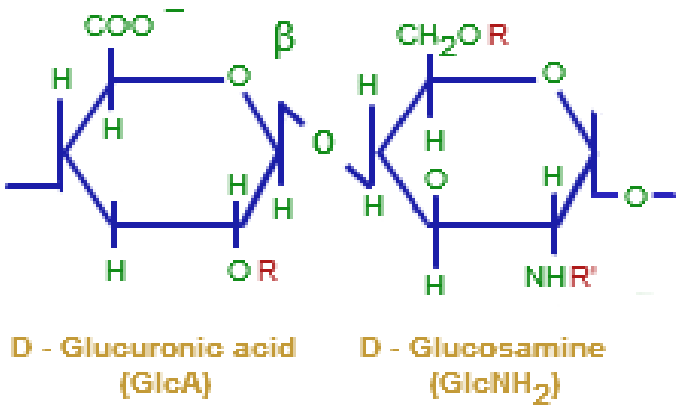
2. Heteroploysaccharides



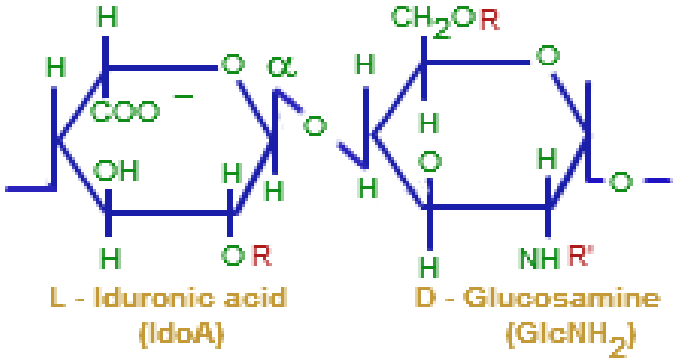
Chonodroitin Sulfate



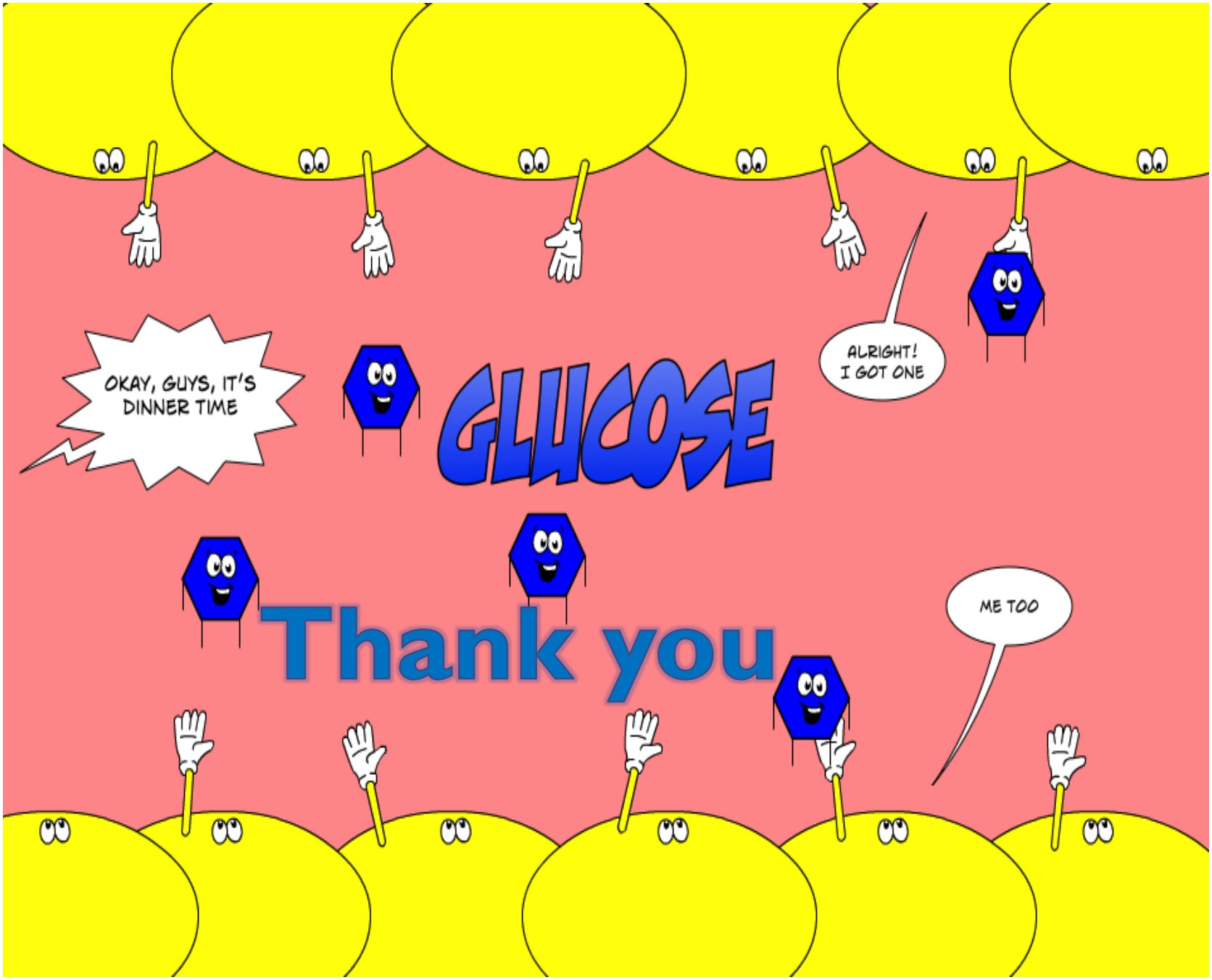
Dermatan Sulfate



Heparan Sulfate



Heparin


OKAY, GUYS, IT'S DINNER TIME
GLUCOSE
ALRIGHT! I GOT ONE
Thank you
ME TOO