

Introduction to Carbohydrate and Structure

Part I: Carbohydrate Structures (General Information)[©]

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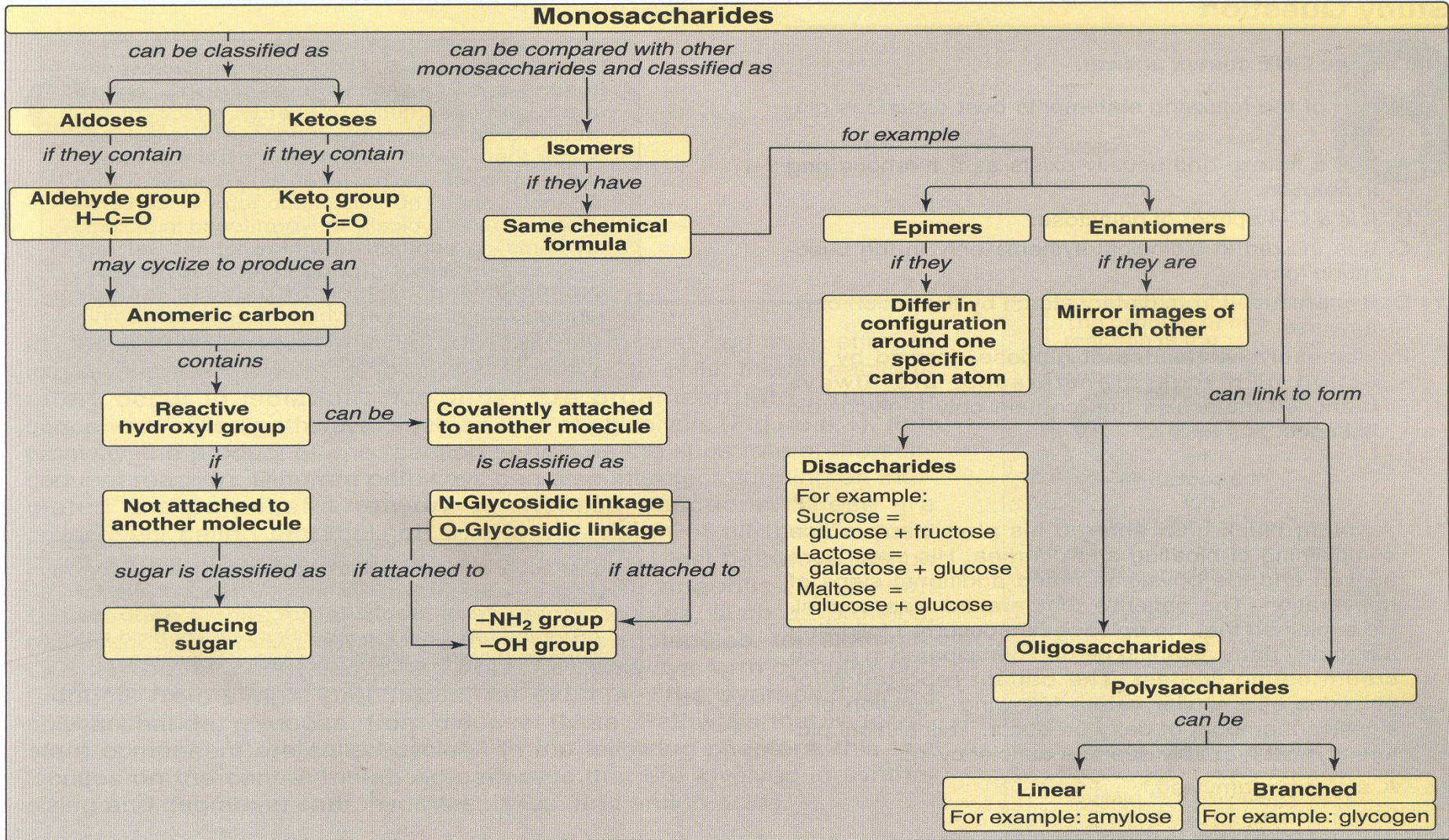
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Carbohydrate Nomenclature©

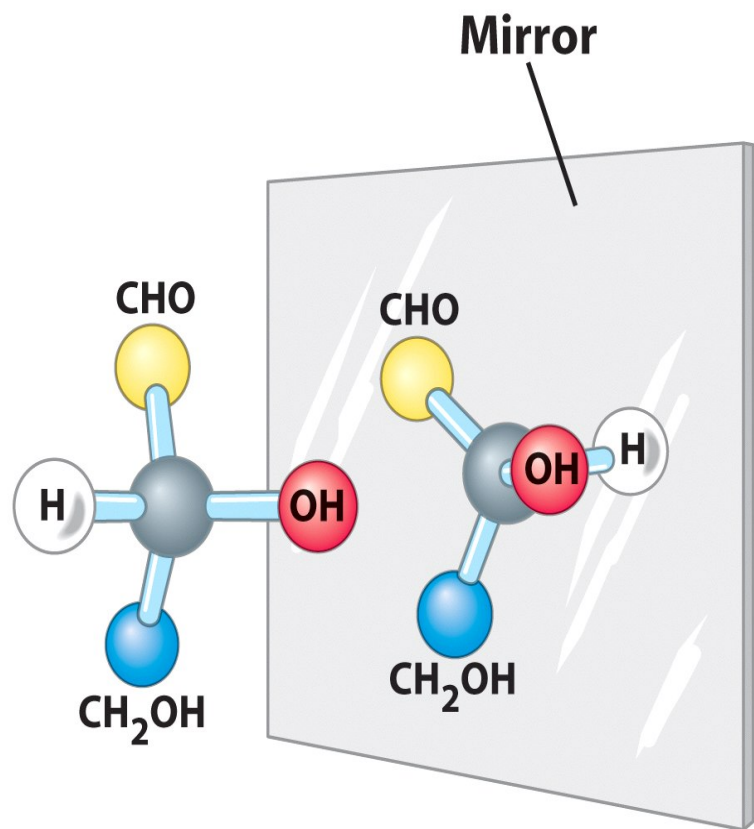
- **Monosaccharides** (*classification/configuration/conformation*)
- **Disaccharides/Oligosaccharides**
- **Polysaccharides: Homopolysaccharides & Heteropolysaccharides** [structural (*cellulose & chitin*), storage (*starch & glycogen*), functional (*glycoproteins, glycosaminoglycans & glycolipids*)]
- **Glycoconjugates** (*glycolipids, proteoglycans, peptidoglycan, and glycoproteins*)

MONOSACCHARIDES®

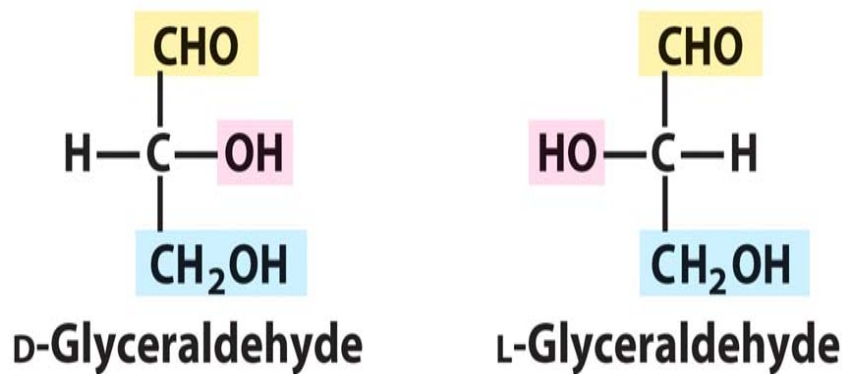
Key Concept Map for Structure of Monosaccharides©



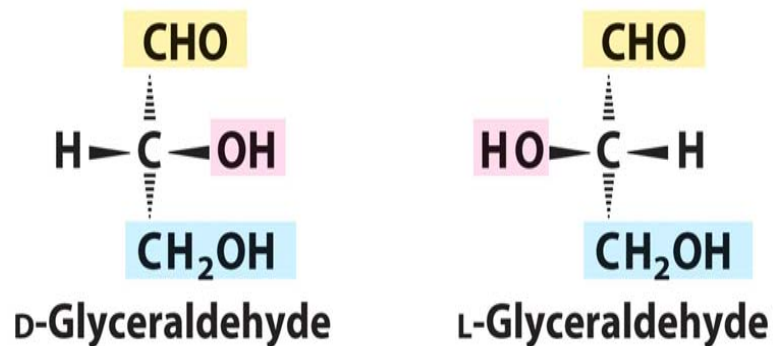
Chirality: Ball and Stick Model[©]



Ball-and-stick models



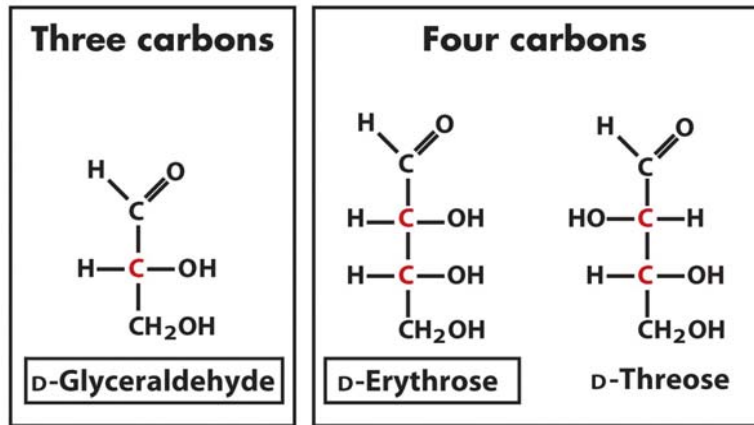
Fischer projection formulas



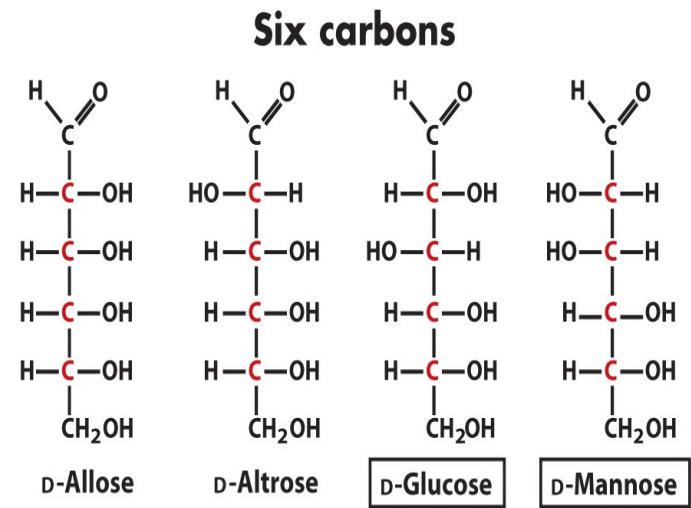
Perspective formulas

D/L-Aldoses (three - six carbons)©

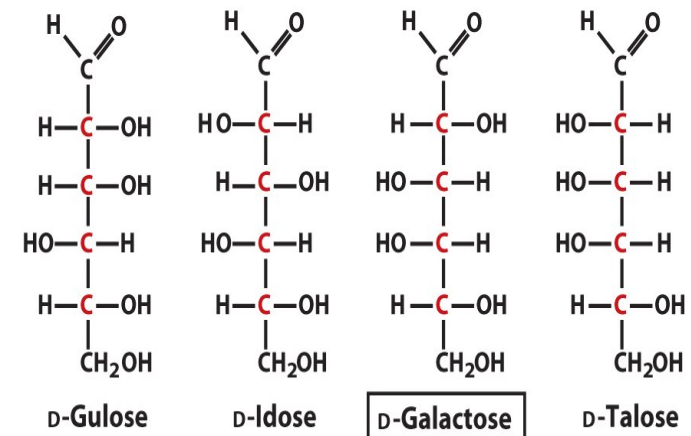
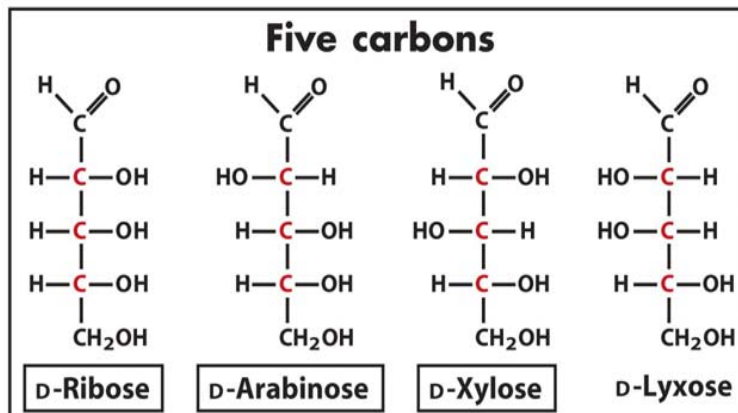
D-Aldoses



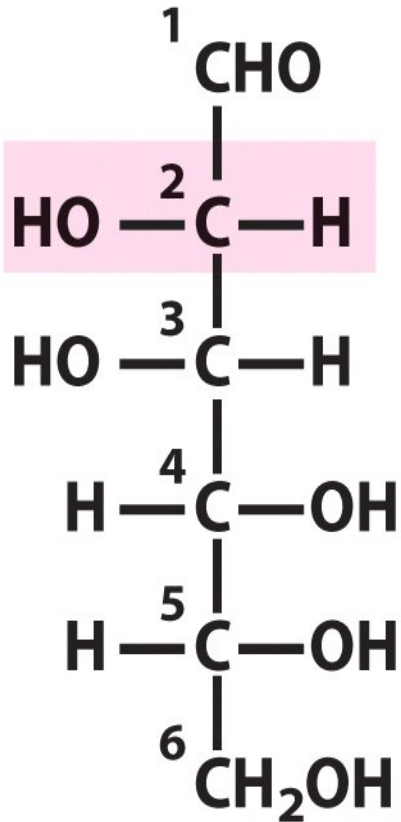
D-Aldoses



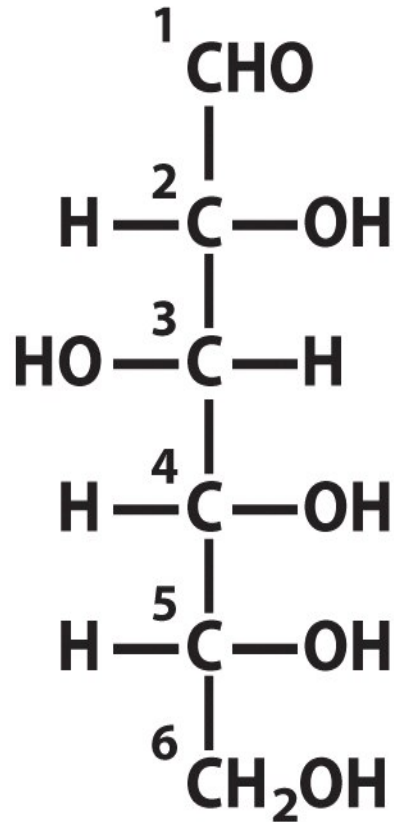
D-Aldoses



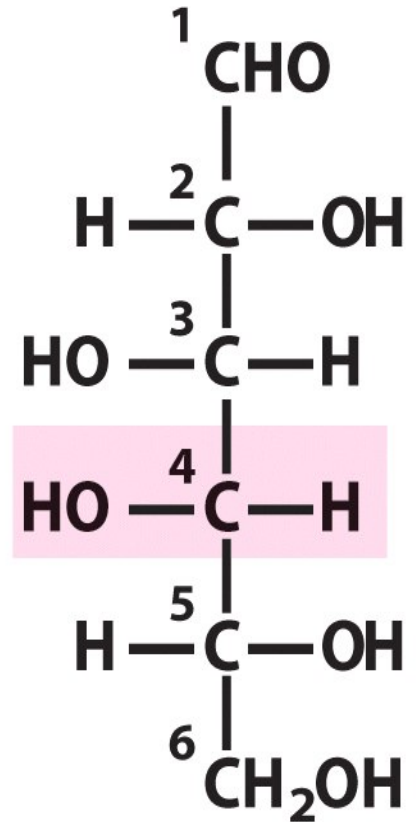
Epimers[©]



D-Mannose
(epimer at C-2)



D-Glucose

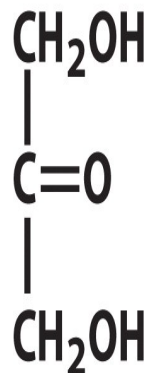


D-Galactose
(epimer at C-4)

D/L-Ketoses (three - six carbons)©

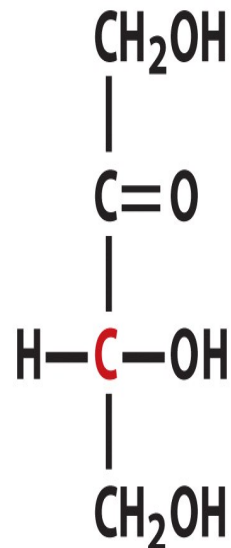
D-Ketoses

Three carbons



Dihydroxyacetone

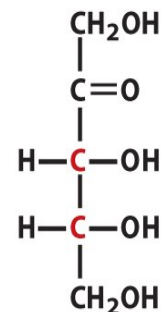
Four carbons



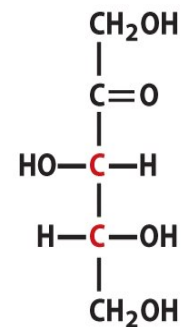
D-Erythrulose

D-Ketoses

Five carbons

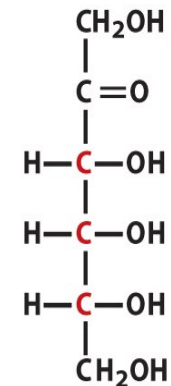


D-Ribulose

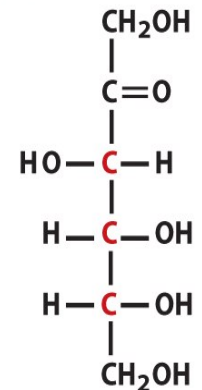


D-Xylulose

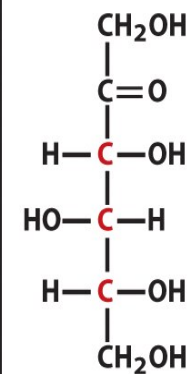
Six carbons



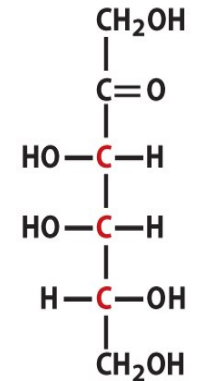
D-Psicose



D-Fructose

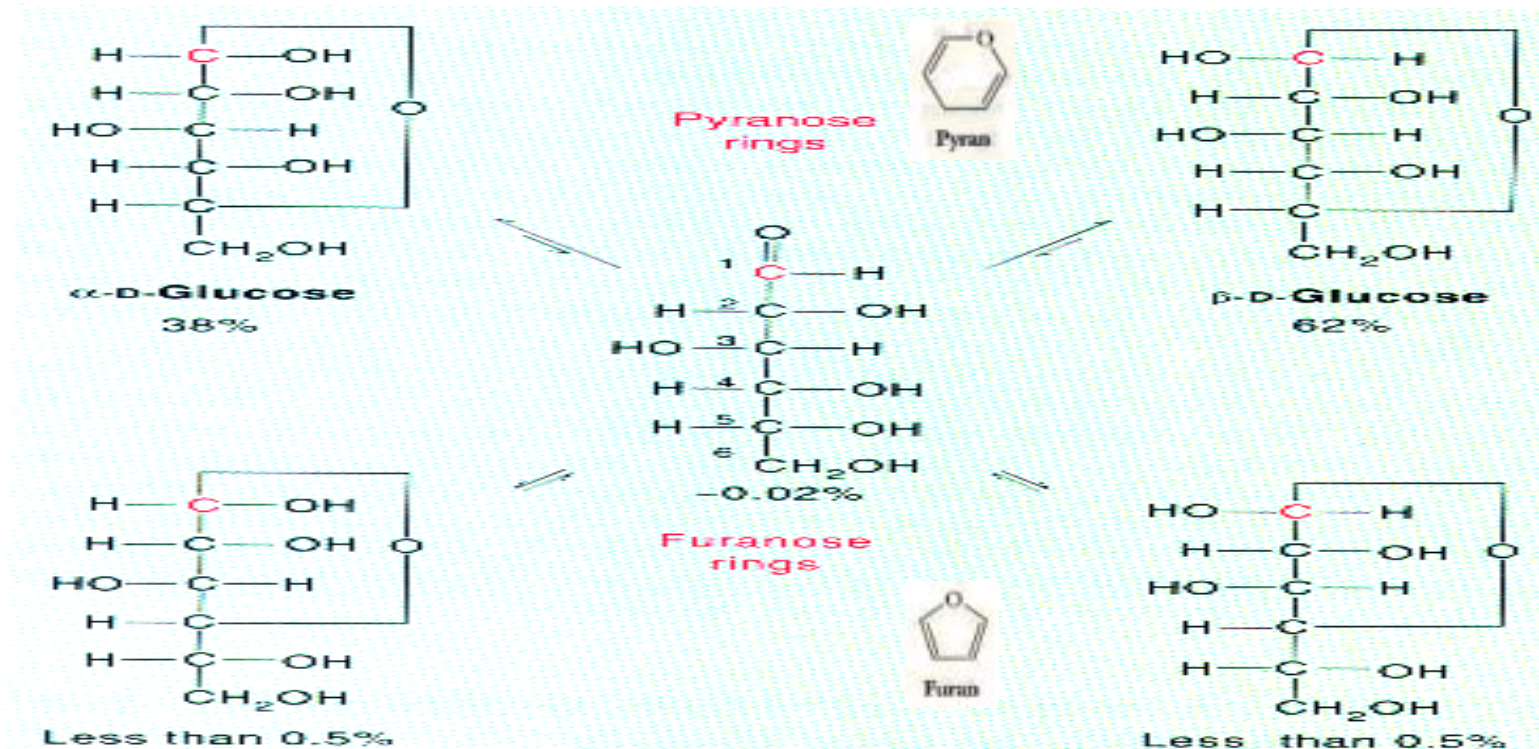
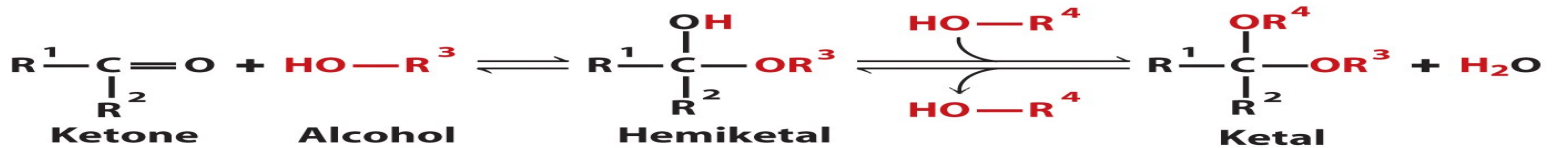
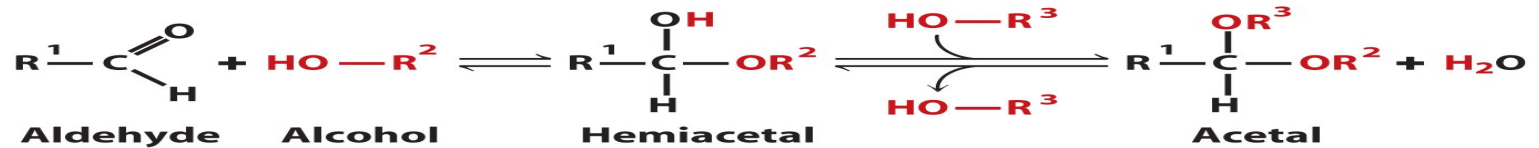


D-Sorbose

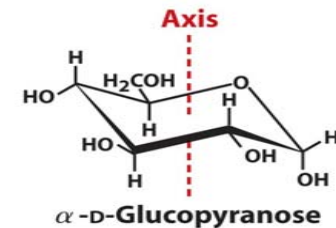
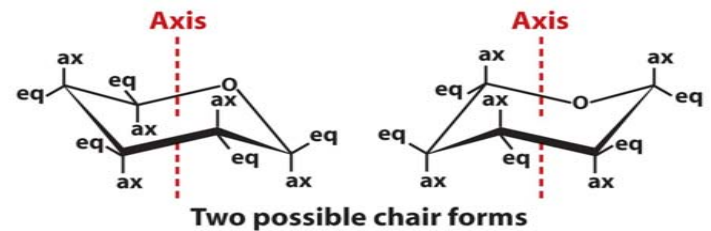
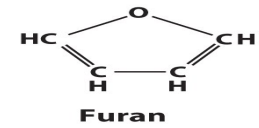
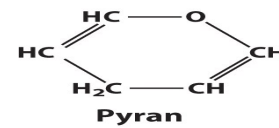
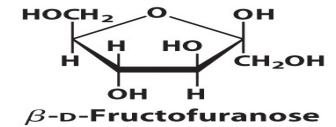
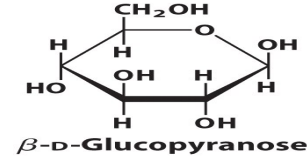
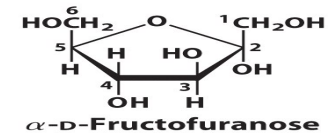
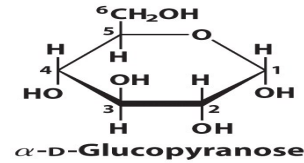
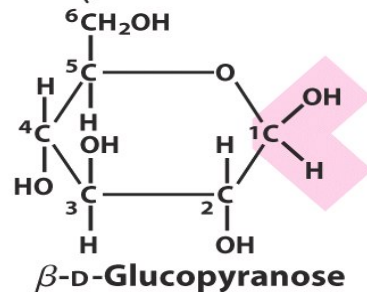
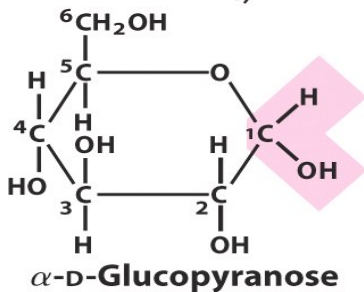
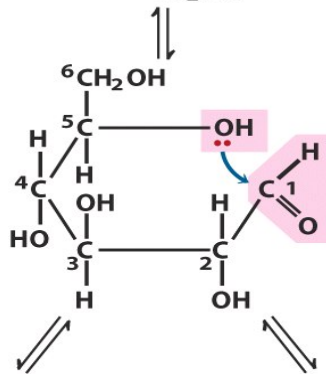
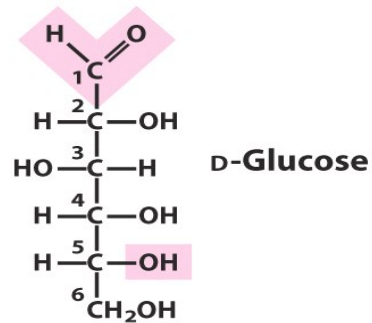


D-Tagatose

Configuration of D-glucose[©]

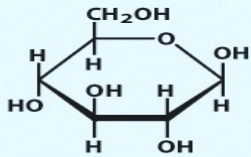


Configuration and Conformation of D-glucose[©]

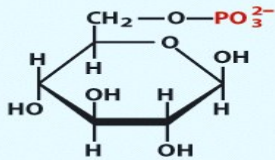


Hexose Derivatives Important in Biology[©]

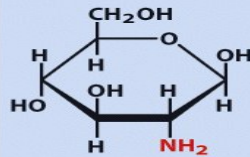
Glucose family



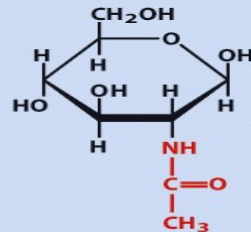
β-D-Glucose



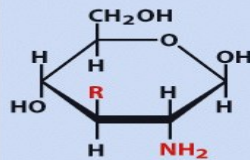
β-D-Glucose 6-phosphate



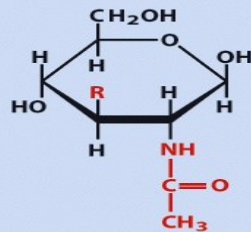
β-D-Glucosamine



N-Acetyl-*β*-D-glucosamine



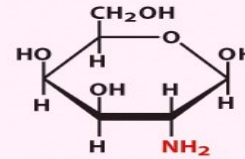
Muramic acid



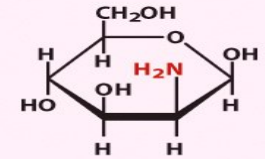
N-Acetylmuramic acid



Amino sugars

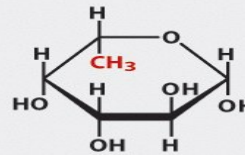


β-D-Galactosamine

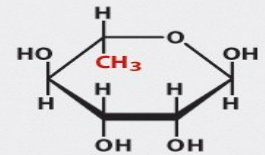


β-D-Mannosamine

Deoxy sugars

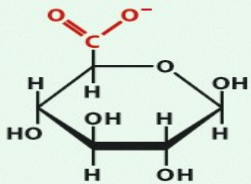


β-L-Fucose

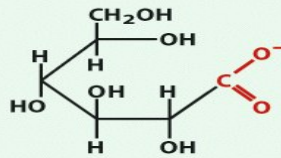


α-L-Rhamnose

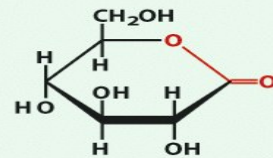
Acidic sugars



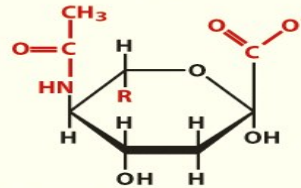
β-D-Glucuronate



D-Gluconate



D-Glucono- δ -lactone



N-Acetylneuraminic acid (a sialic acid)

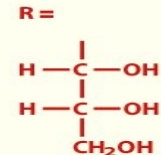
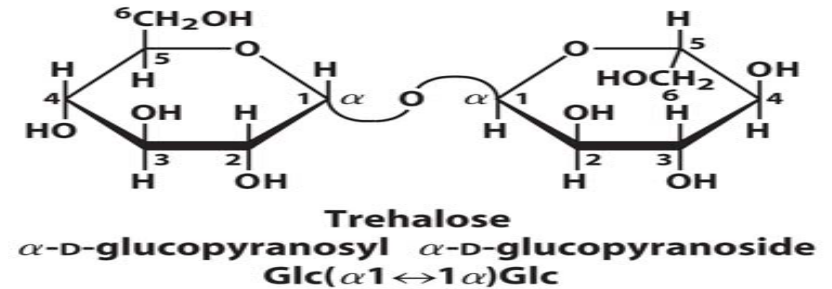
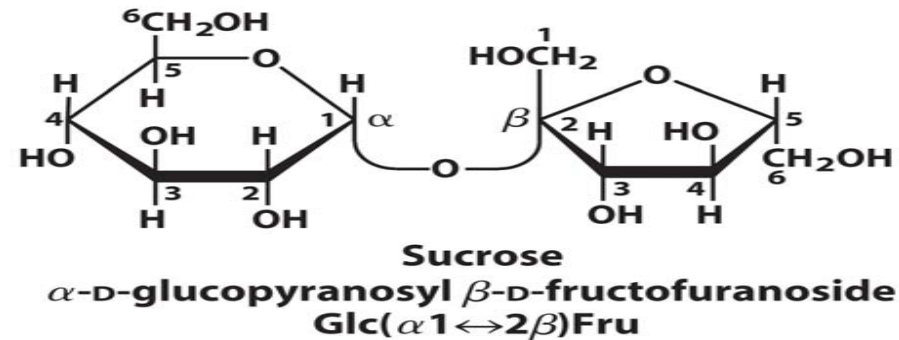
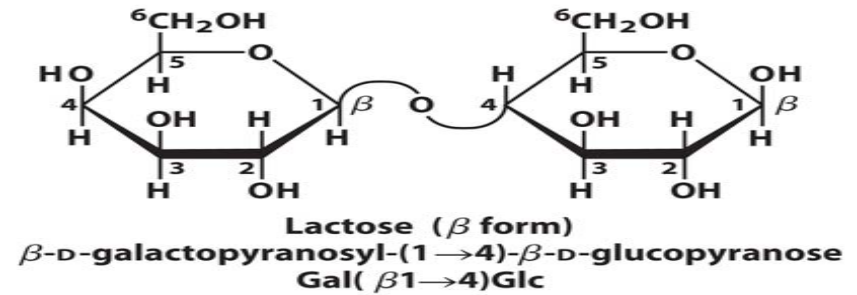
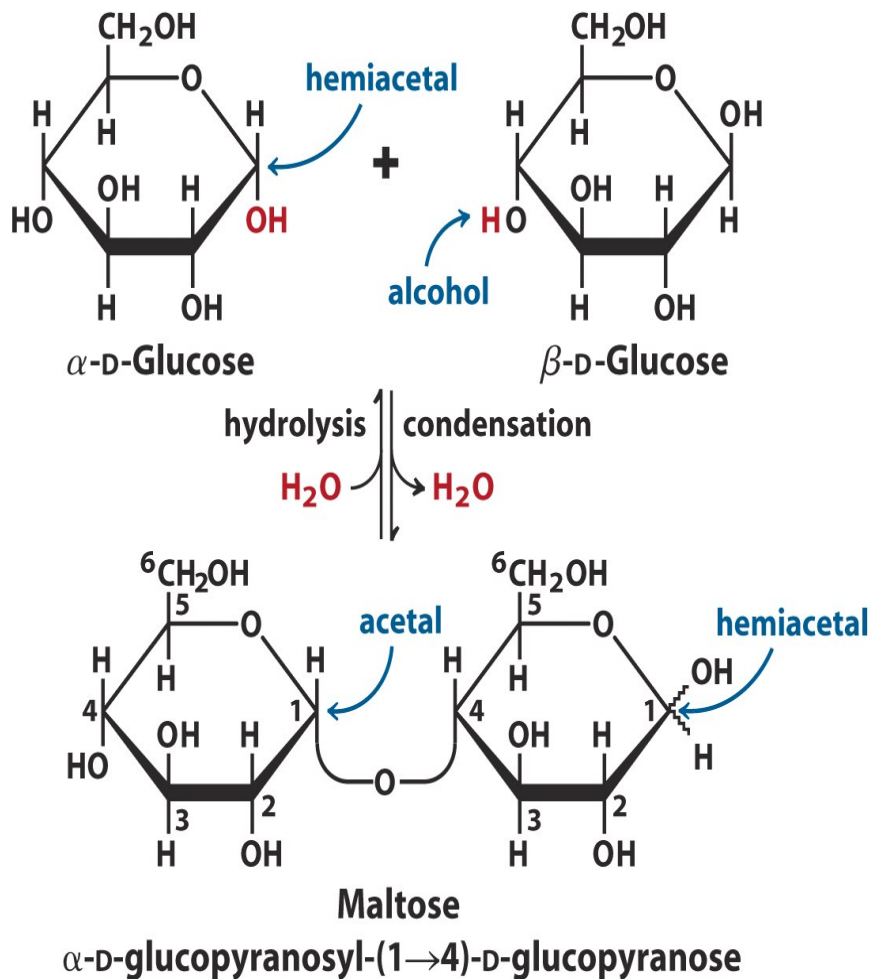


TABLE 7-1 Abbreviations for Common Monosaccharides and Some of Their Derivatives

Abequose	Abe	Glucuronic acid	GlcA
Arabinose	Ara	Galactosamine	GalN
Fructose	Fru	Glucosamine	GlcN
Fucose	Fuc	<i>N</i> -Acetylgalactosamine	GalNAc
Galactose	Gal	<i>N</i> -Acetylglucosamine	GlcNAc
Glucose	Glc	Iduronic acid	IdoA
Mannose	Man	Muramic acid	Mur
Rhamnose	Rha	<i>N</i> -Acetylmuramic acid	Mur2Ac
Ribose	Rib	<i>N</i> -Acetylneuraminic acid	Neu5Ac
Xylose	Xyl	(a sialic acid)	

DISACCHARIDES©

Formation of Maltose and Some Common Disaccharides[©]



Summary©

- Sugars are compounds containing an aldehyde or ketone group and two or more hydroxyl groups.
- Monosaccharides contain several chiral carbons and therefore exist in a variety of stereochemical forms. Epimers are sugars that differ in configuration at only one carbon atom.
- Monosaccharides form hemiacetals or hemiketals, creating a cyclic structure, and is represented as a Haworth perspective formula. The carbon atom in the aldehyde or ketone (the anomeric carbon) can assume either α or β configuration, which are interconvertible by mutarotation. In the linear form, which is in equilibrium with the cyclized forms, the anomeric carbon is easily oxidized.
- A hydroxyl group of one monosaccharide can add to the anomeric carbon of a second monosaccharide to form an acetal, this glycosidic bond protects the anomeric carbon from oxidation.

Summary[©]

- Oligosaccharides are short polymers of several monosaccharides joined by glycosidic bonds.
- The common nomenclature for di- or oligosaccharides specifies the order of monosaccharide units, the configuration at each anomeric carbon, and the carbon atoms involved in the glycosidic linkage(s).

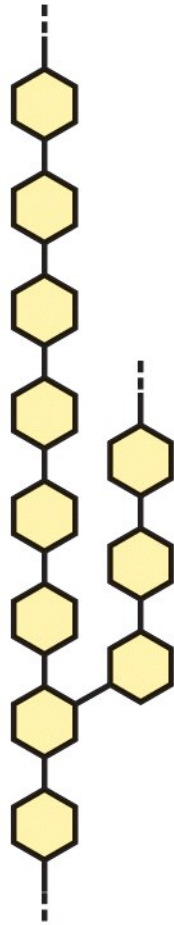
POLYSACCHARIDES®

- 1. Homopolysaccharides**
- 2. Heteropolysaccharides**

Homopolysaccharides

Unbranched

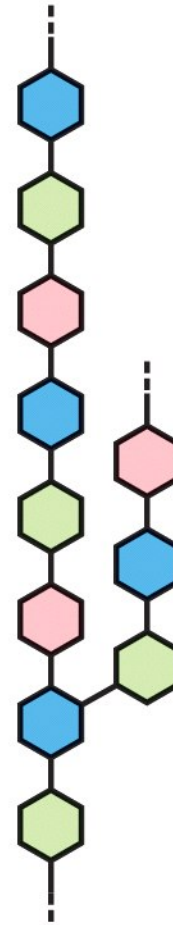
Branched



Heteropolysaccharides

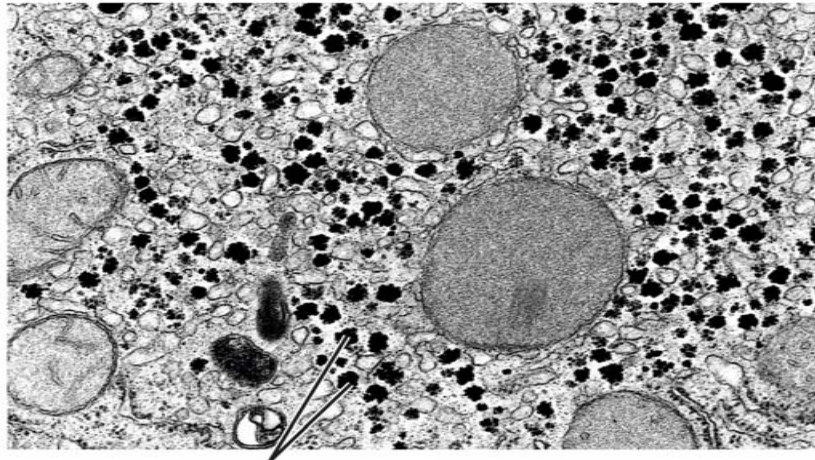
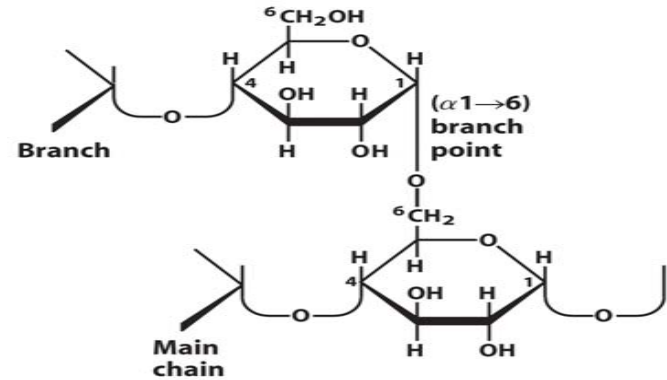
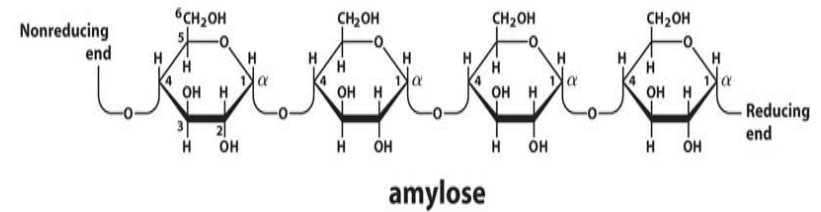
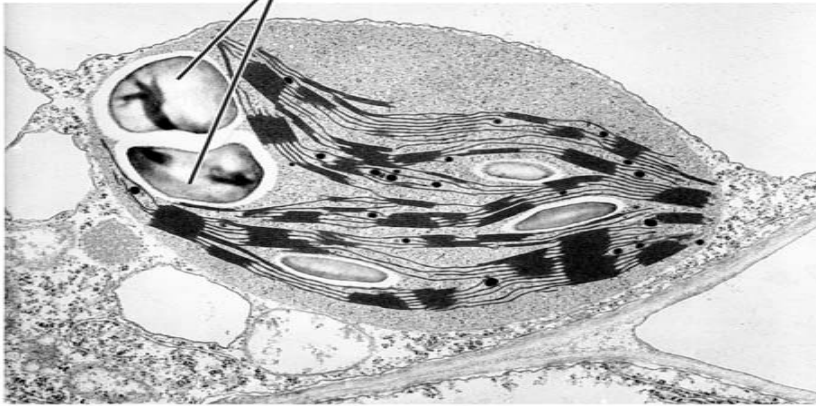
Two monomer types, unbranched

Multiple monomer types, branched

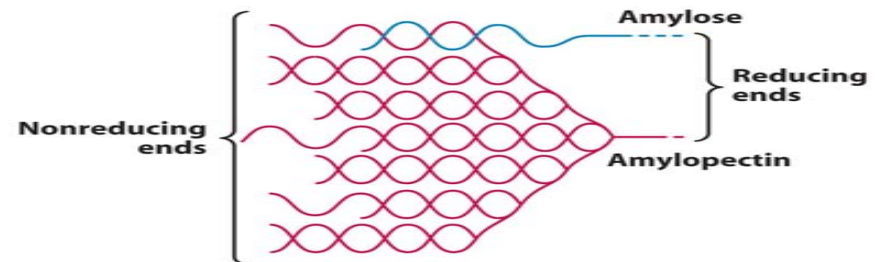


Homopolysaccharides As Stored Forms of Fuel©

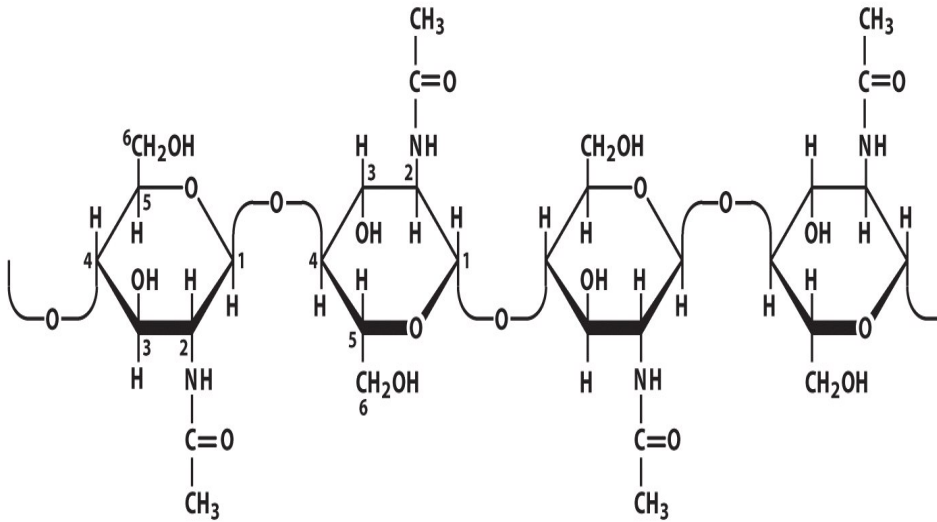
Starch granules



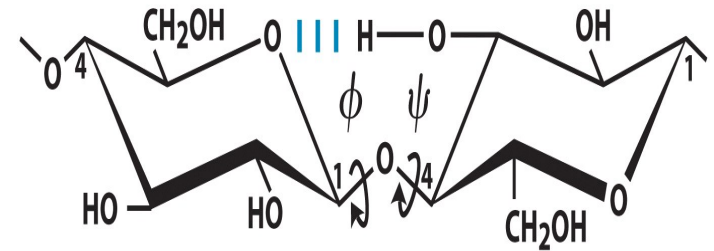
Glycogen granules



Structural Roles of Homopolysaccharides©



Chitin

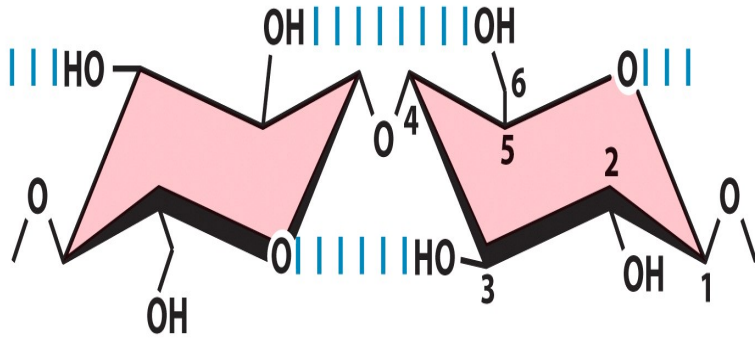


Cellulose
($\beta(1\rightarrow4)$ Glc repeats)

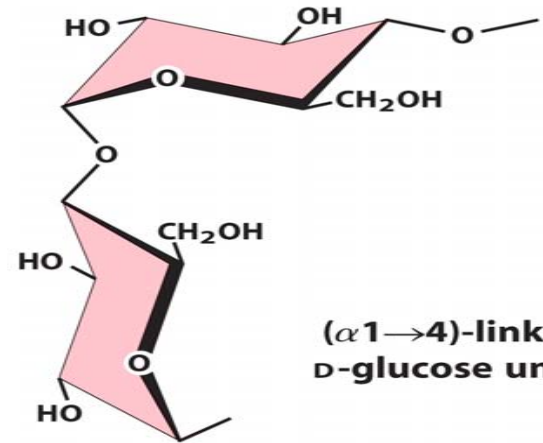


The Structures of Cellulose and Starch

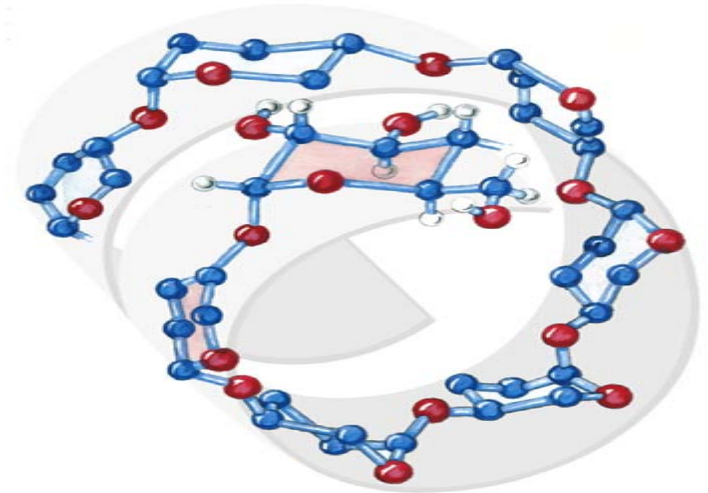
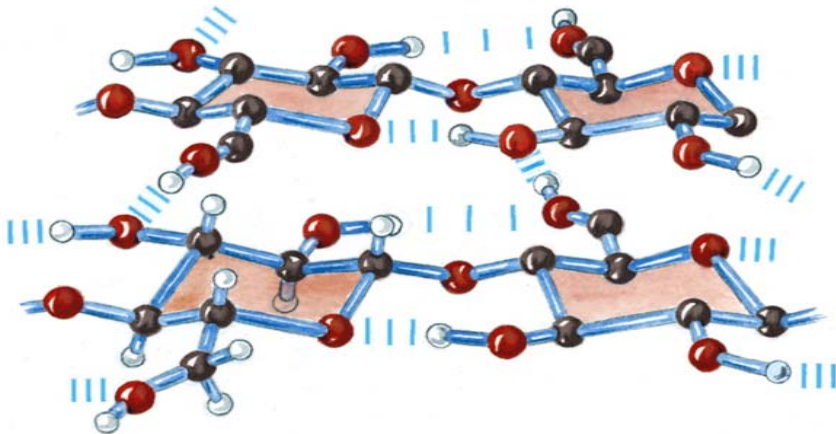
(α -amylose)[©]



$(\beta$ 1 \rightarrow 4)-linked D-glucose units



$(\alpha$ 1 \rightarrow 4)-linked D-glucose units



Glycogen®

