2.1 Carbohydrates

Functions

- Some carbohydrates (Sugar and Starch) are dietary supplements
- Oxidation of carbohydrates in the central energy-yielding pathway in most non- photosynthetic cells
- Insoluble carbohydrates polymers serve as a structural and protective elements in the cell walls of bacteria and plants and in the connective tissues of animals
- Carbohydrate polymers lubricate skeletal joints and participate in the recognition and adhesion between cells
- More complex carbohydrates polymers covalently attach to proteins or lipids act as signals that determine the intracellular location or metabolic fate called glycoconjuagtes

Types of Carbohydrates: carbohydrates include sugars and polymers of sugars

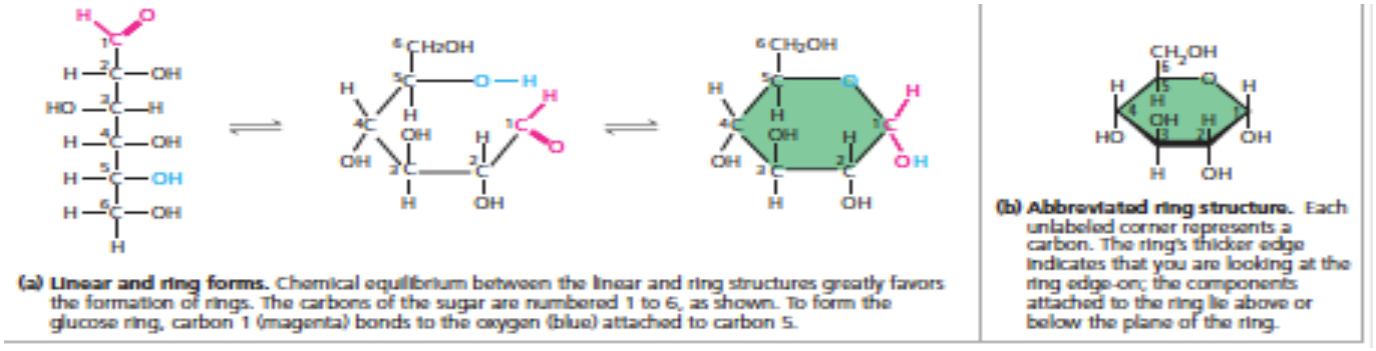
1. Monosaccharaides

- **Monosaccharaides:** have the molecular formulas that are multiples of the unit CH_2O
- **Monosaccharaides** or simple sugars consist of a single polyhyrdroxl unit a ketone or aldehyde unit → depending on where the carbonyl group is you categories carbohydrates into Aldehyde (glucose) or Ketone (Fructose) Sugar.
- Glucose – $C_6H_{12}O_6$ the molecule has a carboxyl group (CO) and multiple hydroxyl groups (OH)
- Another aspect of diversity in simple sugars is in the spatial arrangement of their parts around asymmetric carbon – this shape is significant in binding activities and show different behaviors
- Function of Glucose: Cellular respiration cells extract energy from glucose molecules by breaking them down in a series of biochemical reactions
- The 6-carbon monosaccharaides glucose and fructose have five hydroxyl groups → many of the carbon atoms to which hydroxyl groups are attached are chiral centers which give rise to the many sugar stereoisomers which are found in nature
- CHEMICAL COMPOSITION: They are **colourless, crystalline solids that are freely soluble in water but insoluble nonpolar solvents**
- STRUCTURAL COMPOSITION: unbranched carbon chain in which all the carbons are linked by single bonds – however in the open chain form one of the carbon atoms is double bonded to an oxygen atom to form a carbonyl group
- **Most monosaccharaides have asymmetric carbon atoms and thus occur in optically active isomeric forms → glyceraldehyde contains one chiral center and therefore has two different optical isomers or enantiomers of each carbon chain length can be decided into two groups that differ in the configuration about the chiral center most distant from the carbonyl carbon**
- The carbons of a sugar are numbered beginning at the end of the chain nearest the carbonyl group
- Two sugars that differ only in the configuration around one carbon atom are called **epimers** → some sugars occur naturally in only one form
- In aqueous solutions aldotetroses and all monosaccharaides with five or more carbon atoms in the backbone occur predominantly as cyclic structure in which the carbonyl group has formed a covalent bond with the oxygen of the hydroxyl group along the chains – the formation of these ring structures is the result of a general reaction between alcohols and aldehydes or ketones
- ***Isomeric forms of monosaccharaides that differ only in their configuration about the hemiacetal or hemiketals carbon atom are called anomers.***
- The carbonyl carbon atom is called the **anomeric carbon** – the **α** and **β** glucose invert in aqueous solution by a process called mutarotation → Ketohexoses also occur in the **α** and **β** glucose anomeric forms – in these compounds the hydroxyl group reacts with the keto group – two configurations can be interconverted only by the breaking of a covalent bond – THE SPECIFIC 3D DIMENSIONAL CONFORMATIONS OF THE MONOSACCHARIDE UNIT ARE IMPORTANT IN DETERMINING THE BIOLOGICAL PROPERTIES AND FUNCTIONS OF SOME POLYSACCHARIDES

OTHER FORMS OF MONOSACCHARAIDES

- In monosaccharaides such as glucosamine, galactosamine and mannosamine the hydroxyl group is replaces with another group such as an amino acid – Amino acids is nearly always condensed with acetic acid, as in N-acetylglucosamine → made using structural polymers including bacterial cell wall

1. Phosphorylated PO_4
2. Amino Sugars NH_2
3. Acid Sugars COO(H)



(a) Linear and ring forms. Chemical equilibrium between the linear and ring structures greatly favors the formation of rings. The carbons of the sugar are numbered 1 to 6, as shown. To form the glucose ring, carbon 1 (magenta) bonds to the oxygen (blue) attached to carbon 5.

(b) Abbreviated ring structure. Each unlabeled corner represents a carbon. The ring's thicker edge indicates that you are looking at the ring edge-on; the components attached to the ring lie above or below the plane of the ring.

2. Disaccharides

- Disaccharides consist of short chains of monosaccharaides joined by Glycosidic bonds/linkage, a covalent bond formed between two monosaccharaides by a dehydration reaction
- **Glycosidic Bonds:** formed when a hydroxyl group of one sugar reacts with the anomeric carbon of the other
- E.g. Maltose is a disaccharide formed by the linking between two monosaccharaides by a dehydration reaction **OR** sucrose which are two monomers of glucose and fructose → plants transport carbohydrates from leaves to roots and other non- photosynthetic organs in the form of sucrose
- **Sucrose contains no free anomeric carbon atom the anomeric carbons of both monosaccharide units are involved in the Glycosidic bonds – therefore its considered a non reducing sugar**
- Anomers are relevant
  a. **α Glycosidic bonds → adjacent monomers are the same side up such as starch**
  b. **β Glycosidic Bonds →** adjacent **monomers are upside down such as cellulose**