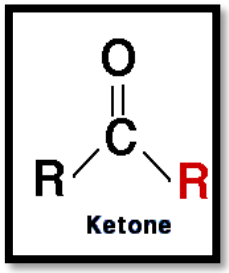
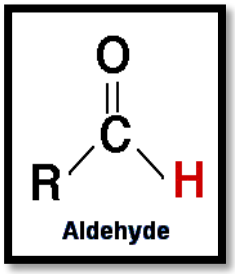
Pharmacognosy II
First semester
Lecture 3/ 2022-2023
Carbohydrates (CHO)

Carbohydrates are a large group of organic compounds occurring in foods and living tissues and including sugars, starch, and cellulose. They contain hydrogen and oxygen in the same ratio as water (2:1) and typically can be broken down to release energy in the animal body.

The name "carbohydrate" means a "hydrate of carbon." The chemistry of carbohydrates most closely resembles that of **alcohol, aldehyde, and ketone functional groups**. As a result, the modern definition of a **Carbohydrates** is that the compounds are **polyhydroxy aldehydes or ketones.**





Why we study carbohydrates2

• Carbohydrates are among the first products that are form as a result of photosynthesis.

• They constitute a large proportion of the plant biomass and are

responsible as cellulose, for the rigid cellular framework and, as starch, for providing an important food reserve.

• Have pharmacognostic importance, in fact that sugars unite with a wide variety of other compounds to form glycosides and secondary metabolites.

• Mucilage act as water-retaining vehicles, whereas gums and mucilage, which are similar in composition and properties, are formed in the plant by injury or stress and usually appear as solidified exudates; both are typically composed of uranic acid and sugar units.

• Low molecular weight carbohydrates are crystalline, soluble in water and sweet in taste, for example, glucose, fructose, sucrose, etc.

•The high molecular weight carbohydrates (polymers) are amorphous, tasteless and relatively less soluble in water, for example, starch, cellulose, inulin, etc

• Glucose is the fuel of the tissues of the body & it can be converted to other carbohydrate having special specific function such as:

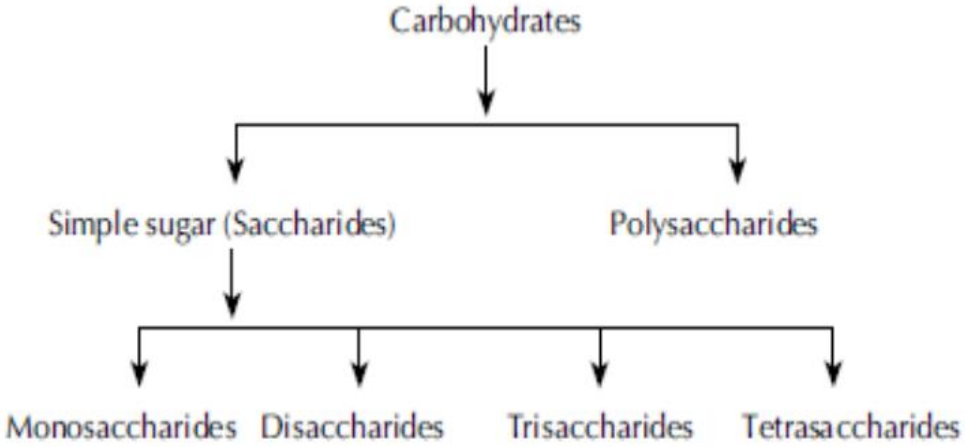
Ribose → **Nucleic acid**

Galactose → **Lactose (in milk)**

Combination with protein to form complex molecules called (glycoprotein).

Sources of carbohydrates

- **Bread, pasta, cereal and rice.**
- **Fruit and vegetables.**
- **Meat, egg, fish, poultry, milk, yogurt & cheese.**
- **Fats, oils & sweet.**



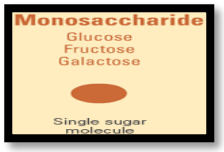
CLASSIFICATION OF CARBOHYDRATES

We have 2 broad groups:

1) Saccharides (simple sugar)
2) Polysaccharides.

SUGARS: Are crystalline, soluble in water with sweet taste, they are classified to:

• **Monosaccharides:** compounds that cannot be hydrolyzed to simpler sugars.

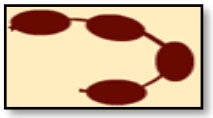


Oligosaccharid

- **Disaccharides:** compounds that yield 2 monosaccharide molecules on hydrolysis

- **Trisaccharides:** compounds that yield 3 monosaccharide molecules on hydrolysis

- **Tetrasaccharide:** compound that yield4 monosaccharide molecules on hydrolysis & so forth.



All these types represent Oligosaccharide

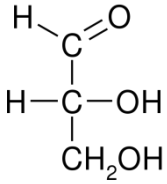
(Often applied to saccharides containing 2-10 units of sugar)

Monosaccharides

Monosaccharides they are the simplest carbohydrates, classified by the number of carbon atoms in the molecules.

Bioses: They contain 2 carbon atoms. They do not occur free in nature.

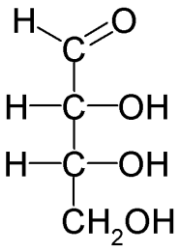
Trios: They contain 3 carbon atoms ,for example: Glyceraldehyde

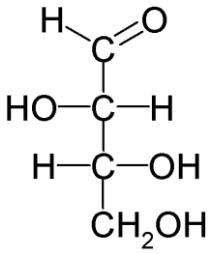


(aldotriose)

Tetrose: They contain 4 carbon atoms, for example: Erythrose & Threose

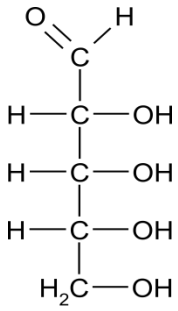
Erythrose (aldotetrose)



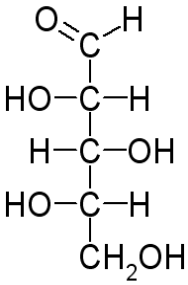


Threose (aldotetrose)

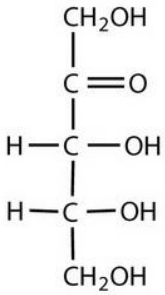
Pentose: They contain 5 carbon atoms , very common in plants and are the products of hydrolysis of polysaccharides like hamicelluloses, mucilages and gums, for example, ribose, ribulose and xylose. They are further divided into two types: aldoses and ketoses.



Ribose (aldopentose)



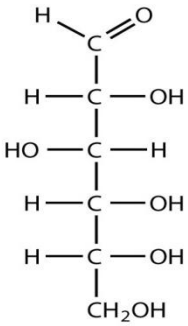
Xylose (aldopentose)



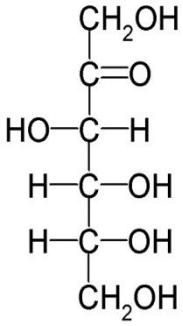
Ribulose (ketopentose)

Other: arabinose & xylulose.

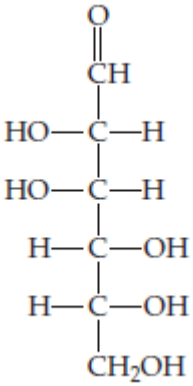
Hexose: They are monosaccharides containing 6 carbon atoms and are abundantly available carbohydrates of plant kingdom. They are further divided into two types: aldoses and ketoses. They may be obtained by hydrolysis of polysaccharides .



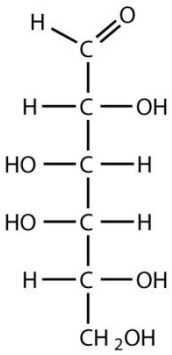
Glucose (aldohexose)



Fructose (ketohexose)



Mannose (aldohexose)

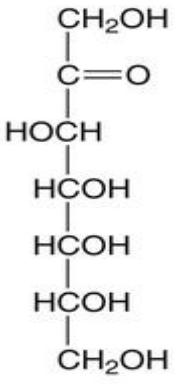


Galactose (aldohexose)

Other: rhamnose

Heptose: They contain 7 carbon atoms, vitally important in the photosynthesis of plant and glucose metabolism of animals and are rarely found accumulated in plants, for example, Sedoheptulose

Sedoheptulose



(ketoheptose)

Hexoses

Hexoses are the most important monosaccharide found in the plants, they are first detectable sugars synthesized by plants & form the units from which most of the polysaccharides are constructed.

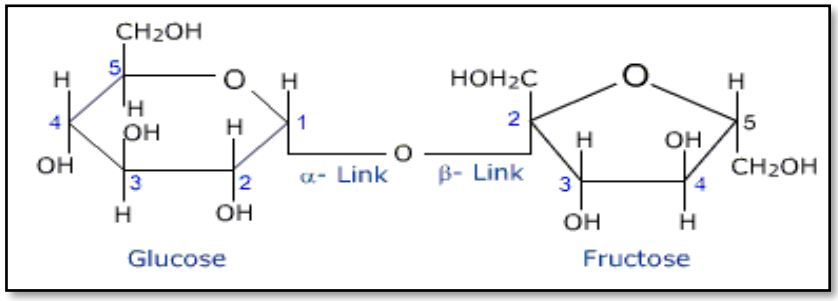
- **There are 16 possible aldohexoses & 8 ketohexoses & if we consider both α & β form we will get 48 isomers. Of these isomers only 2 occur in the free state in plants, they are:**
- **D-fructose (levulose) & D-glucose (dextrose), both are found in sweet fruits, honey & invert sugar. When starch is hydrolyzed it yields glucose whereas inulin yields fructose.**

Inuline is polysaccharides produced by many types of plants, industrially most often extracted from Chicory.

Cichorium intybus **(Chicory)**

Disaccharides

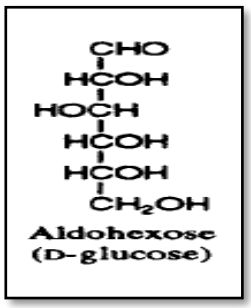
Sucrose (α-D-glucopyranosyl-β-D -fructofuranoside) is the only disaccharides that occur abundantly in the free state in plants, although maltose has occasionally been reported in the cell sap.

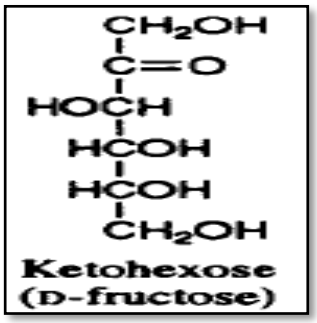


Polysaccharides:

They are derived from monosaccharides. They are complex, high molecular weight such as starch, inulin, glycogen & cellulose. They usually are hydrolyzed to their component.

Reducing and Non Reducing Sugars





The presence of these groups (C=O of aldehyde & ketone) explains the reducing properties of monosaccharides & accounts for the commonly applied term "reducing sugars"

Reducing sugars are sugars that can act chemically as a reducing agent, which measn that they are easily oxidized. All monosaccharide sugars, like glucose, fructose, xylose are reducing, and a few disaccharide sugars are also reducing sugars, such as maltose. The common table sugar, sucrose is a non-reducing disaccharide.

Reducing sugars are chemically different from non-reducers by the presence of either a free aldehyde or a ketone group. The presence of reducing sugars is determined chemically by several common test methods like using Benedict's reagent. Upon hydrolysis sucrose yields invert sugar which consists of equimolecular quantities of glucose & fructose. Sucrose is a non-reducing sugar.