بسم الله الرحمن الرحيم

MONOSACCHARIDES

3rd lecture

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MONOSACCHARIDES OF BIOLOGICAL IMPORTANCE

(a) **Trioses:** Both D-glyceraldehyde and dihydroxyacetone occur in the form of phosphate *esters,* as intermediates in glycolysis. ***They are also the precursors of glycerol,*** which the organism synthesises and incorporates into various types of lipids.

(b) Tetroses: Erythrose-4-P occurs as an intermediate in hexosemonophosphate shunt which is an alternative pathway for glucose oxidation.

(c) Pentoses:

- D-ribose is a constituent of nucleic acid *RNA;* also as a constituent of certain coenzymes, e.g. FAD, NAD, coenzyme A.
- D-2-deoxyribose is a constituent of *DNA.*
- Phosphate esters of ketopentoses—D-ribulose and D-xylulose occur as intermediates in HMP shunt.
- L-xylulose is a metabolite of D-glucuronic acid and is excreted in urine of humans afflicted with a hereditary abnormality in metabolism called ***pentosuria*.**
- L-fucose (methyl pentose): occurs in glycoproteins.
- ***D-Lyxose: It forms a constituent of lyxoflavin*** isolated from human heart muscle whose function is not clear.

(d) Hexoses

1. D-Glucose: (Synonyms: Dextrose, Grape Sugar)

- It is the **chief physiological sugar** present in normal blood continually and at fairly constant level, i.e. about 0.1 per cent.
- All tissues utilise glucose for energy. ***Erythrocytes and Brain cells utilise glucose solely for energy purposes***.
- Occurs as a constituent of disaccharide and polysaccharides.
- Stored as glycogen in liver and muscles mainly.
- Shows mutarotation.

2. D-galactose: Seldom found free in nature. In combination it occurs both in plants and animals.

- ***Occurs as a constituent of milk sugar lactose*** and also in tissues as a constituent of galactolipid and glycoproteins.
- It is an **epimer of glucose** and differs in orientation of H and OH on carbon-4.
- It is less sweet than glucose and less soluble in water.
- It is dextrorotatory and shows mutarotation.

3. **D-fructose:** It is a ketohexose and commonly called as **fruit sugar**, as it occurs free in fruits.

• It is very sweet sugar, much sweeter than sucrose and more reactive than glucose. It occurs as a constituent of sucrose and also of the ***polysaccharide inulin.***

Biomedical Importance:

Seminal fluid is rich in fructose and sperms utilise fructose for energy. Fructose is formed in the seminiferous tubular epithelial cells from glucose.

4. D-mannose: It does not occur free in nature but is widely distributed in combination as the polysaccharide mannan, e.g. in ivory nut. In the body, it is found as a constituent of glycoproteins.

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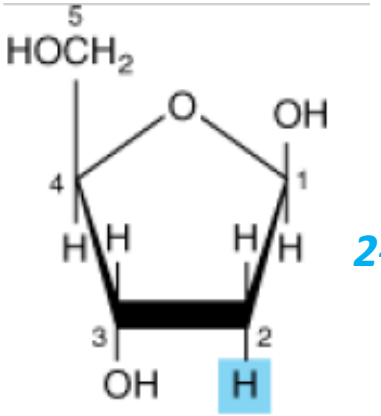
5. Sedoheptulose: It is a ketoheptose found in plants of the sedum family. Its phosphate is important as an intermediate in the HMP-shunt and has been identified as a product of photosynthesis.

OTHER SUGAR DERIVATIVES OF BIOMEDICAL IMPORTANCE

1. **Deoxy sugars:** Deoxy sugars represent sugars in which the ***oxygen of a –OH gr. has been removed,*** leaving the hydrogen.

Deoxy sugars of biological importance are:

- **2-deoxy-D-Ribose** is found in nucleic acid *(DNA).*
- **6-deoxy-L-Galactose** is found as a constituent of glycoproteins, blood group substances and bacterial polysaccharides.

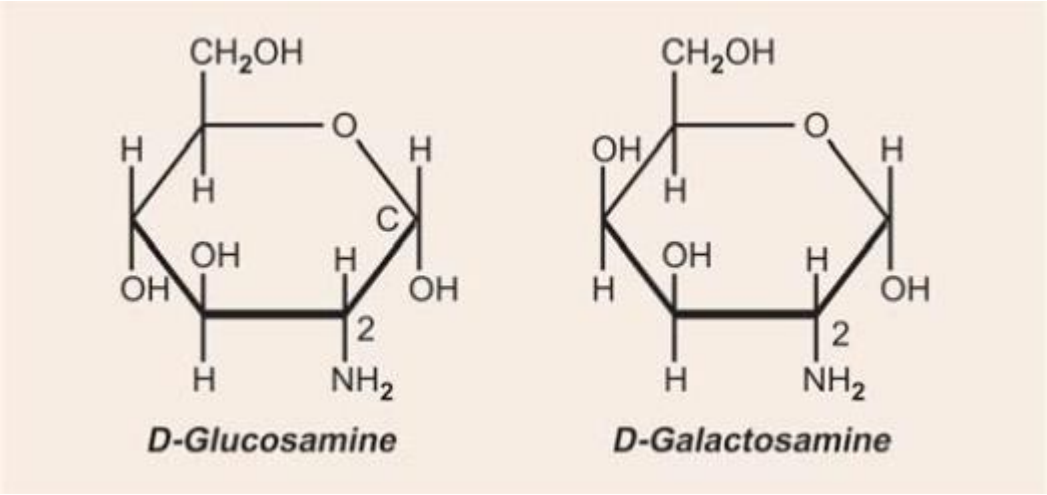


2-Dexoy-D-ribofuranose

2. Amino sugars (hexosamines): Sugars containing an –NH2 group in their structure are called ***amino sugars***.

Types: Two types of amino sugars of physiological importance are:

- ***Glycosylamine:*** The ***anomeric –OH group*** is replaced by an –NH2 group. **Example:** A compound belonging to this group is ***Ribosylamine,*** a derivative of which is involved in the synthesis of purines.
- ***Glycosamine (Glycamine):*** In this type, the alcoholic – OH group of the sugar molecule is replaced by – NH2 group. Two naturally occurring members of this type are derived from glucose and galactose, in which – OH group on carbon 2 is replaced by – NH2 group, and forms respectively ***Glucosamine*** and ***Galactosamine.***



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Biomedical Importance:

- **Antibiotics:** Certain antibiotics, such as **Erythromycin, carbomycin,** contain **amino sugars**. Erythromycin contains dimethyl amino sugar and carbomycin 3-amino-D-Ribose. It is believed that amino sugars are related to the antibiotic activity of these drugs.
- Galactosamine occurs as N-acetyl-Galactosamine in **chondroitin sulphates** which are present in cartilages, bones, tendons and heart valves. **Hence Galactosamine is also known as Chondrosamine.**
- N-acetyl derivative of D-Glucosamine occur as a constituent of certain mucopolysaccharides (MPS).

3. Glycosides

1. Formation of glycosides

a. Glycosidic bonds form when the hydroxyl group on the anomeric carbon of a monosaccharide reacts with an OH (O-glycosidic bond) or NH2 group of another compound(N-glycosidic bond).

b. α-Glycosides or b-glycosides are produced depending on the position of the atom attached to the anomeric carbon of the sugar.

CLINICAL CORRELATES: The glycoside digitalis and its derivatives are of clinical significance because they inhibit the Na+-K+ ATPase on cell membranes. Such drugs are used in the treatment of congestive heart failure.

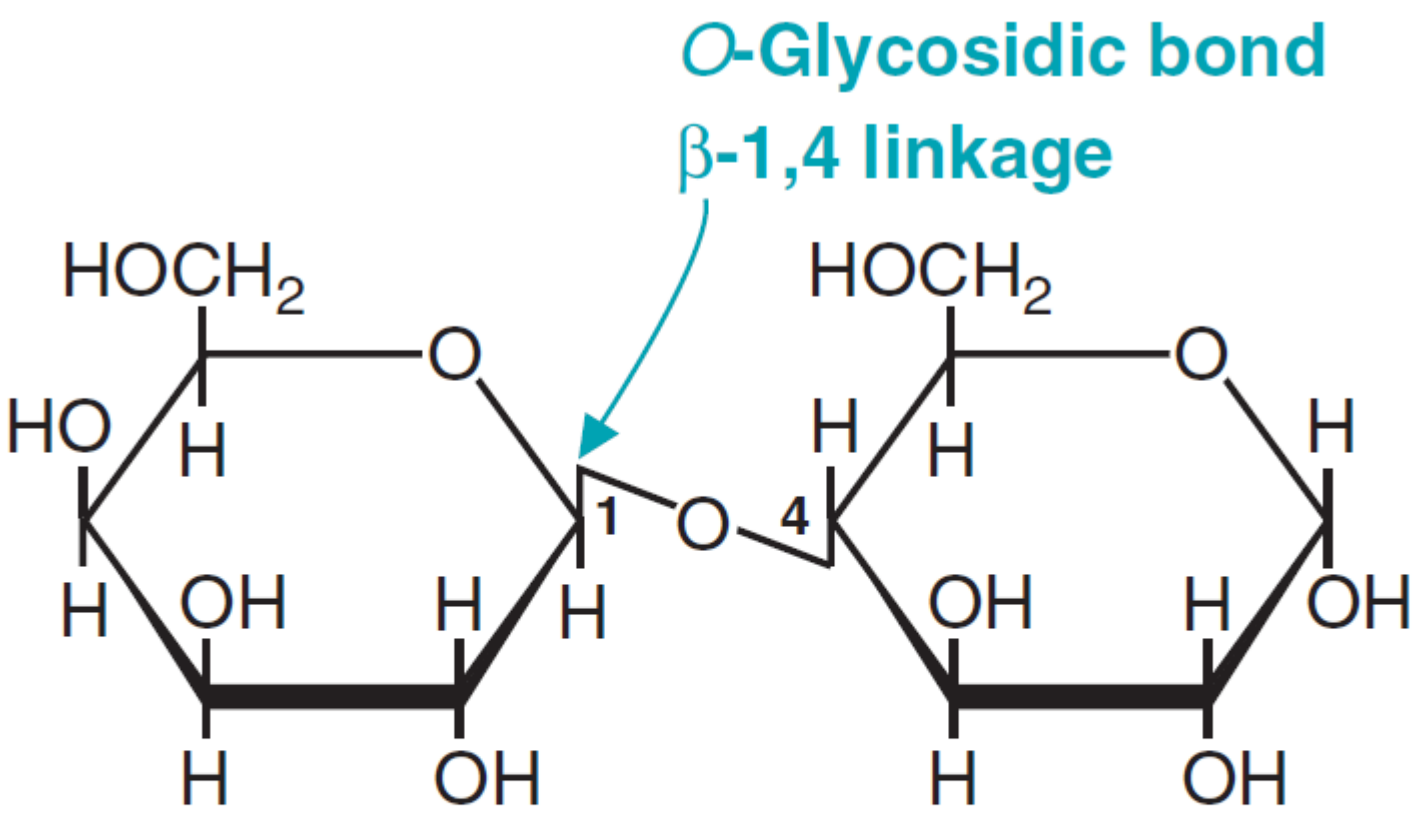
2. O-Glycosides

a. Monosaccharides can be linked via O-glycosidic bonds to another monosaccharide, forming O-glycosides.

b. Disaccharides contain two monosaccharides. Sucrose, lactose, and maltose are common disaccharides.

c. Oligosaccharides contain up to about 12 monosaccharides.

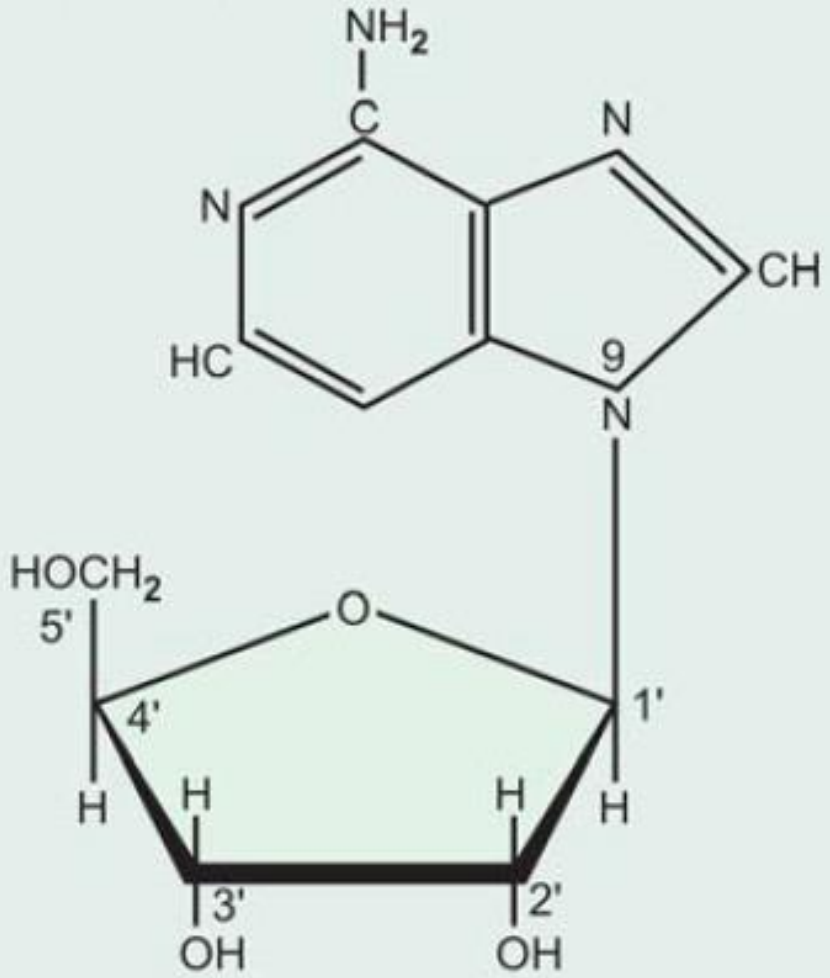
d. Polysaccharides contain more than 12 monosaccharides, for example, glycogen, starch, and glycosaminoglycans.



Lactose
(Galactose-β(1→4)-glucose)

The most common disaccharides.

Adenosine (Adenine-9-riboside)
(Adenine purine base + ribose sugar)



β – ***N – glycosidic linkage with position 9 of Purine base-adenine and 1' carbon of ribose sugar***

THANK YOU!