

Lecture 2

Carbohydrates

Are the most abundant biomolecules belonging to class of organic compounds found in living organisms on earth.

-Important of carbohydrates

1-Source and storage of energy e.g. glucose and glycogen.

2- Structural components e.g. skin, bone, cell mm.

3- Involved in cell-cell interaction.

4- Their derivatives are drugs e.g. erythromycin.

5-Survival of Antarctic fish in icy environment is due to presence of anti-freeze glycoproteins in their blood.

6 -Ascorbic acid, a derivative of carbohydrate is a water- soluble vitamin...

-Classification of carbohydrates

1) **Monosaccharides**: which contain in their structure one building unit its classify to:

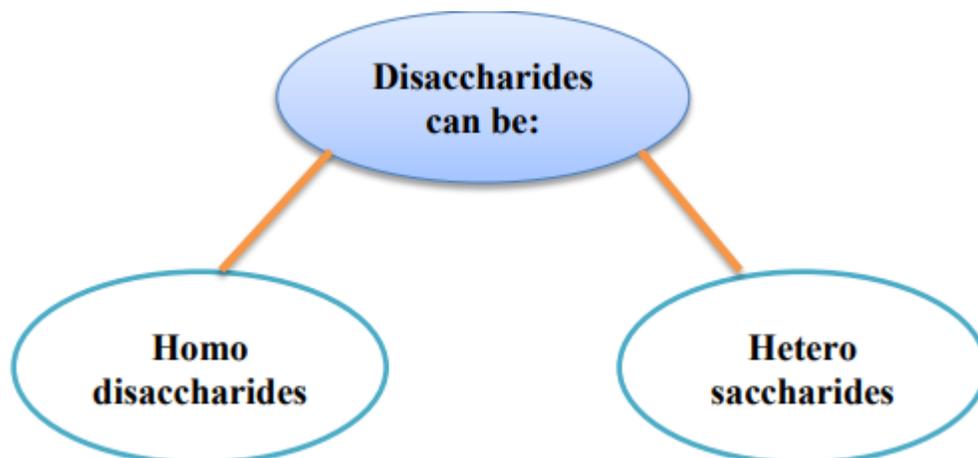
***Trioses**: which contains in its composition three carbon atoms, such as glycerol.

***Tetroses**: which contain in its composition four carbon atoms, such as erythrose.

***Pentoses**: which contains five carbon atoms, such as ribose.

***Hexoses**: which contain in their composition six carbon atoms and are the most important and most common types of sugars, including glucose, fructose and galactose.

2- A **disaccharide**: consists of two monosaccharides joined by an (O-glycosidic bond).



Three most abundant disaccharides are:

*sucrose (the anomeric carbon atoms of a glucose unit and a fructose unit are joined).

*lactose (the disaccharide of milk, consists of galactose joined to glucose).

*maltose (linkage joins two glucose units).

-glycosidic linkage for sucrose and lactose is β (1 \rightarrow 4).

-glycosidic linkage for maltose is α (1 \rightarrow 4).

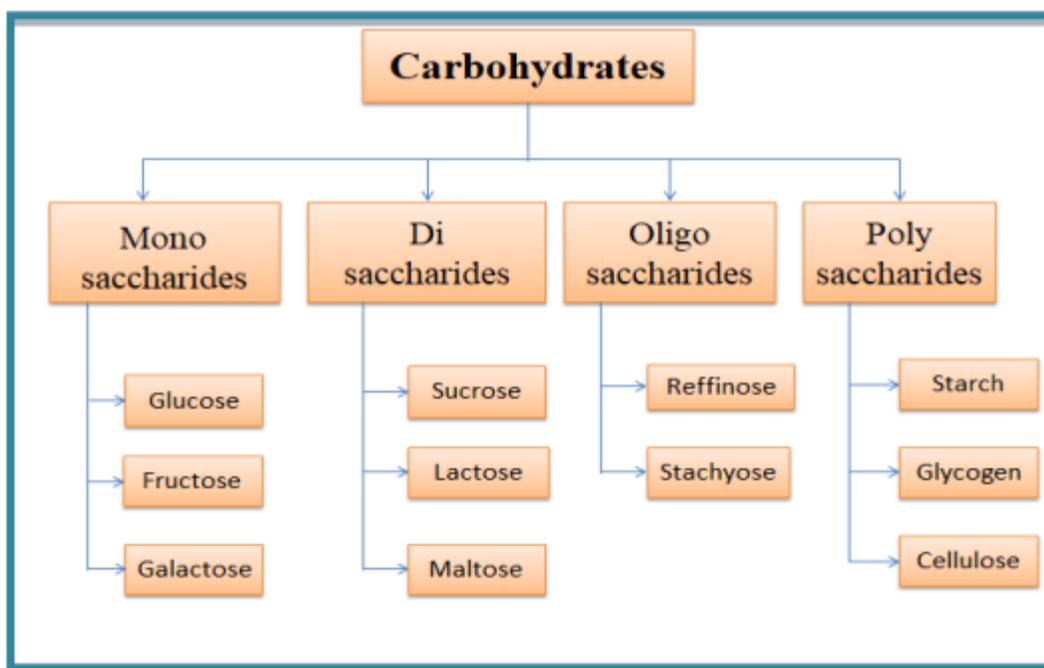
*Sucrose and lactose are heterosaccharides.

*maltose is homosaccharide.

3-An **oligo saccharide**: is a saccharide polymer containing a small number (typically three to ten) of component sugars, and is also known as simple sugars.

*They are generally found either(O- or N-)linked to compatible amino acid side chains in proteins or to lipid moieties. They(homo-and heterooligosaccharides).

4- A **Poly saccharides**: are relatively complex carbohydrates. They are polymers made up of many monosaccharides. joined together by glycosidic bonds. They are, therefore, very large, often branched, macromolecules.



-Main carbohydrates in human body

1-Glucose: is the main type of sugar in the blood and is the major source of energy for the body's cells.

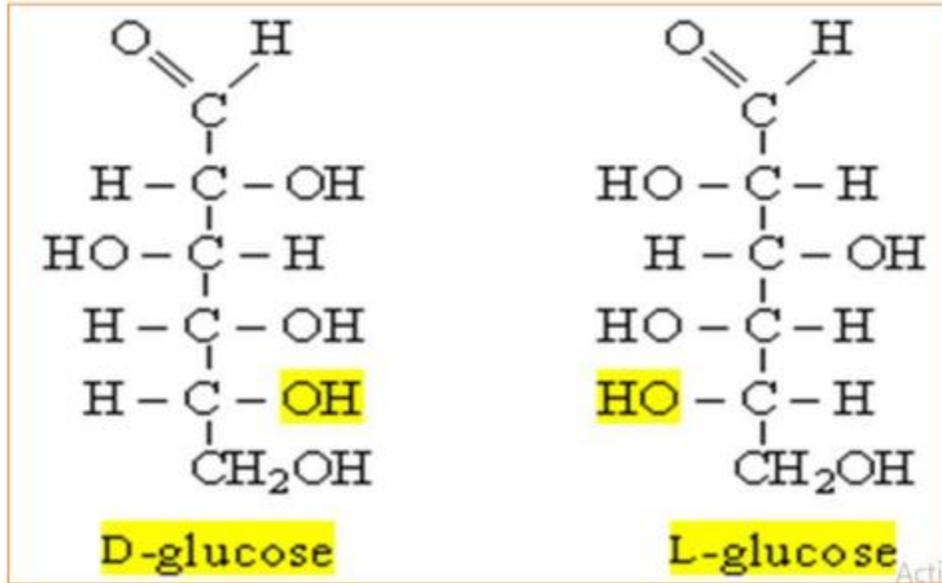
-Glucose comes from the foods we eat or the body can make it from other substances. Glucose is carried to the cells through the bloodstream.

-D-glucose ,L-glucose and chiral center

D-glucose :It is the presence of a hydroxyl group in the chiral center farthest to the right of the carbon atom.

L-glucose: It is the presence of a hydroxyl group in the chiral center farthest to the left of the carbon atom.

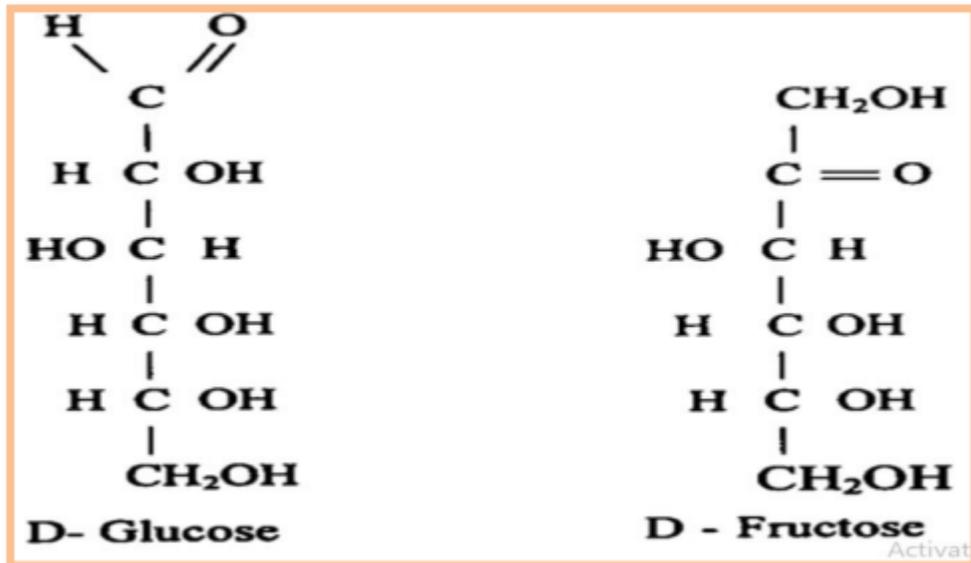
Chiral center: are tetrahedral atoms (usually carbons) that have four different substituents.



2- Fructose: a crystalline sugar, sweeter and more soluble than glucose. very sweet levorotatory d-form of fructose that occurs especially in fruit juices and honey.

*Called also fruit sugar, levulose.

*Molecular formula for glucose and fructose $\text{C}_6\text{H}_{12}\text{O}_6$

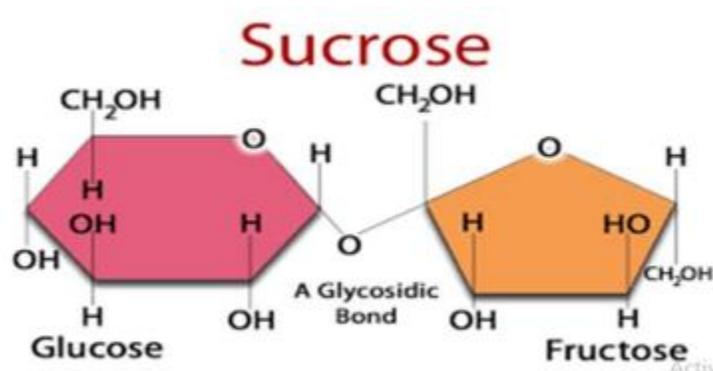


*We notice from the previous figures that there are two functional groups, aldehyde for glucose and ketone for fructose, hence the two names for the sugars aldose and ketose,

| | |
|--------------|--|
| C=O Function | Aldose: sugars having an aldehyde function or an acetal equivalent. |
| C=O Function | Ketose: sugars having a ketone function or an acetal equivalent. |

3- Sucrose : is a disaccharide made of glucose and fructose.

-Molecular formula for Sucrose $C_{12}H_{22}O_{11}$



4-Starch: is polysaccharide carbohydrate $(C_6H_{10}O_5)_n$ consisting of a large number of glucose molecules joined together by glycosidic bonds, and found especially in seeds, bulbs, and tubers.

-There are two types of starch (amylose and amylopectin).

The main difference between **amylose and **amylopectin** is that amylose is a straight chain polymer whereas amylopectin is a branched chain polymer.

Glucose level in blood

In a healthy person, the blood glucose level does not drop below 70 mg / 100 ml blood. Even in the case of continuous fasting for several days, and it cannot rise from 170 mg / 100 ml blood after eating a meal containing more than 500 g of Carbohydrates. This balance is maintained in normal conditions through an organized dynamic that occurs inside the body as follows:

-What are the sources of glucose entering the blood?

1-Eating foods containing dietary carbohydrates.

2-Glycogenolysis decomposes animal starch stored in cells of the liver, kidneys, and muscles.

3-Gluconeogenesis forms glucose from non-carbohydrate sources.

-How is excess glucose removed from the blood?

1-Oxidation of glucose into energy, carbon dioxide and water (oxidation of glucose).

2-Which is stored in the form of animal starch (Conversion to glycogen).

3-Conversion to fatty acids that are stored in fatty tissue(fatty acids in adipose tissues).

4-Excreted through the urinary system(renal excretion).

-Factors controlling of level glucose in blood

1- Insulin hormone: is secreted from beta cells in the pancreas. It works to lower the level of glucose in the blood.

2- Glucagon hormone: is secreted from alpha cells in the pancreas, and its action is anti-insulin hormone, meaning it works to increase the level of glucose in the blood by aiding the process of dissolution of animal starch glycogen into glucose.

3-Growth hormone: is secreted by the anterior lobe of the pituitary gland, and its effect is felt by the pancreas on the secretion of the hormone glucagon, meaning that its action works to increase the level of glucose in the blood.

4-Adrenocorticotrophic hormone: which is also secreted from the anterior lobe of the pituitary gland, and has the same action as growth hormone.

5-Hydrocortisone hormone: which is secreted from the adrenal cortex and helps in the formation of glucose from noncarbohydrate sources, that is, it works to raise the level of glucose in the blood.

6- Epinephrine hormone: is secreted from the medulla of the adrenal gland and helps break down animal starch into glucose, leading to an increase proportion in the blood.

7- Thyroxin hormone: which is secreted from the thyroid gland, and its effect is to help inhibit the dissolution of animal starch Glycogen into glucose, meaning that it works to reduce the level of sugar in the blood.

Glucose Abnormalities

1-Hypoglycemia

An decrease in blood glucose below the minimum normal level and occurs in the following cases:

- 1-Hyperinsulism.
- 2-Hyperthyroidism.
- 3-Fasting state.
- 4-Hepatic diseases.
- 5- Adrenal or pituitary insufficiency.
- 6-Non pancreatic tumors.
- 7-Sensitivity to glucose.
- 8-Hereditary fructose intolerance.
- 9- Alcohol consumption.
- 10-Starvation cases.

2-Hyperglycemia

An increase in the level of glucose in the blood from the upper limit of the normal level and occurs in the following cases:

- 1-Diabetes mellitus.
- 2-Intravenous glucose injection.
- 3-Pregnancy.
- 4-Hypothyroidism
- 5-Hyperpituitarism.
- 6-Nephritis.

7-Chronic Severe stress.

8- Cerebrovascular accidents.

9- Coronary thrombosis.

10- High level of blood urea (uremia).