College of Environmental Science
Department of Environmental Health
2nd Undergraduate Stage
Fourth Lecture

Biochemistry

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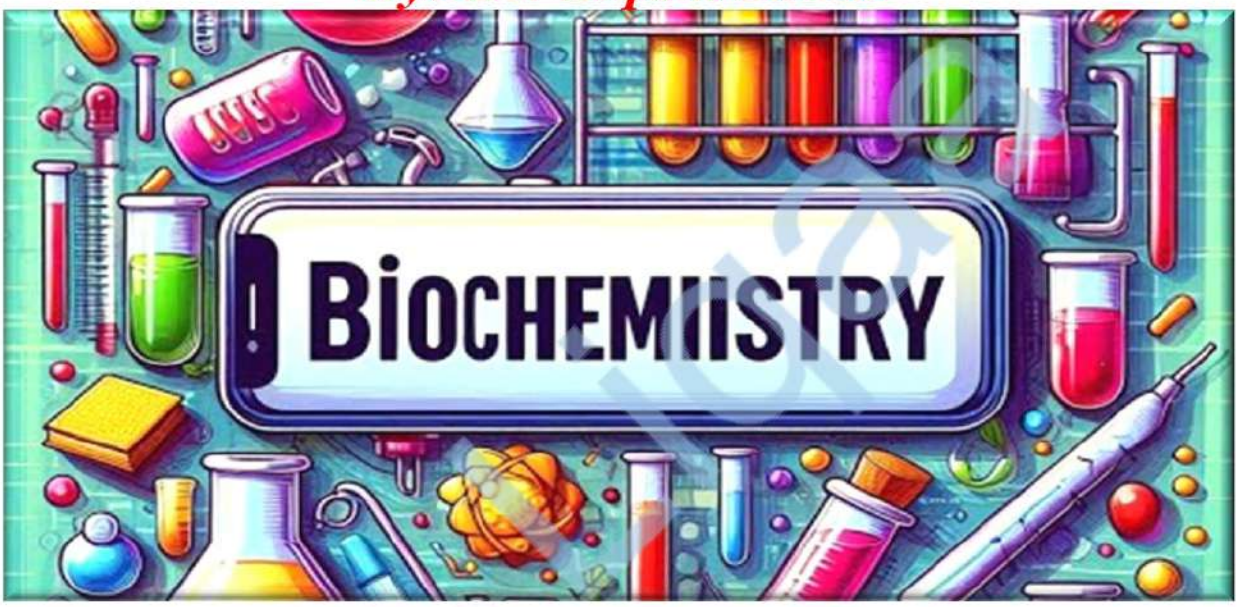
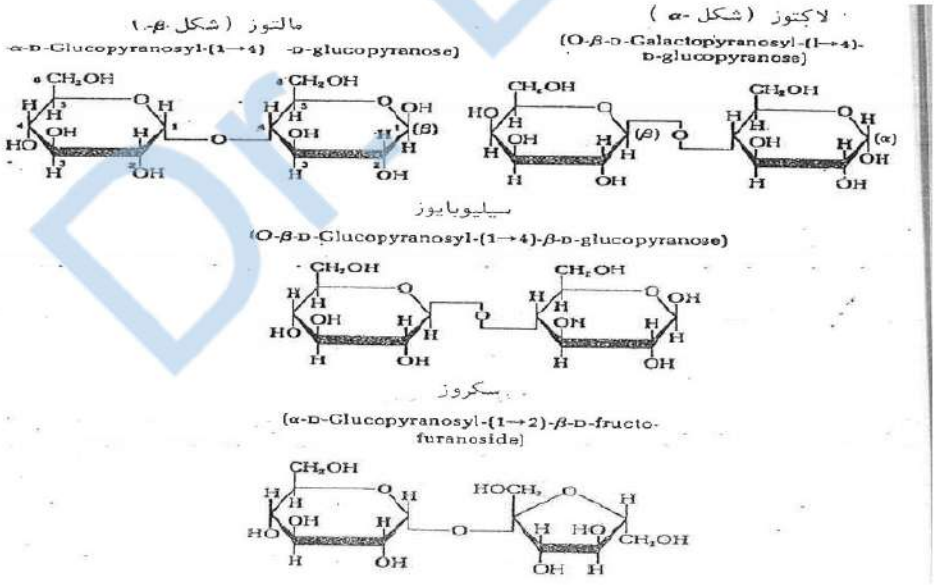


Disaccharides

Disaccharides belong to oligosaccharides, which consist of 2-10 units of monosaccharides. Disaccharides are formed by the association of two monosaccharides by the elimination of a water molecule. The bond between the two units varies from sugar to sugar. For example, **if the bond that connects the two groups of dehyde or ketone, the sugar produced has non-reducing properties, as in sucrose. If the binding involves one group of aldehyde or ketone so that the other group is free and unbonded, then sugar is reduced, as in lactose, maltose and cellobiose**. The four most common disaccharides are **maltose, lactose, sucrose and cellobiose**, whose chemical compositions are shown as in the following figure. When we look at the chemical structures of maltose, lactose and cellobiose, we notice that **the glycosidic bond is formed between carbon atoms No. 1 and 4, symbolized by the symbol 1—4, all of which are reducing sugars, because their non-cyclic composition contains a free carbon atom that has the ability to reduce. As for sucrose, the glycosidic bond takes place between carbon 1 of glucose sugar and 2 of fructose 1—2. That is, between the aldehyde group and the ketone group respectively, and therefore sucrose is non-reducing because its noncyclic structure does not contain a free carbonyl group.** The following **table** shows the sources and properties of these four sugars.



5.3 Differences between sucrose, lactose and maltose

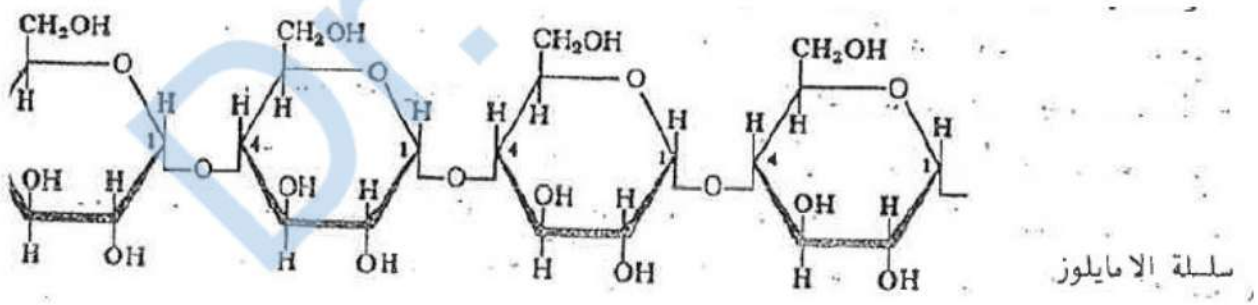
S. No	Character	Sucrose	Lactose	Maltose
1.	Commercial Name	Cane sugar	Milk sugar	Maltsugar
2.	Composition	(Glucose + Fructose)	(Galactose + Glucose)	(Glucose + Glucose)
3.	Glycosidic linkage	α(1-2)	α(1-4)	α(1-4)
4.	Reducing Nature	Non reducing Sugar	Reducing Sugar	Reducing Sugar
5.	Hydrolysing Enzyme	Invertase	Lactase	Maltase
6.	Osazone formation	Does not	Yellow colour osazone shaped crystals are formed	Yellow colour tennis ball shaped crystals are formed after 40 minutes
7	**Sources**	**Sugar cane**	**Milk**	**From the digestion of starch by the enzyme amylase, or acid hydrolysis of starch, and from barley**

Polysaccharides

Polysaccharides are polymers resulting from the bonding of one or more types of monosaccharides by glycosidic bonds With deletion of water molecule. When polysaccharides are completely hydrolyzed by certain acids or enzymes, monosaccharides or their derivatives are generated. **If multiple sugar contains one type of recurring sugar. Called homo polysaccharides, it includes starch, glycogen, cellulose, inulin, and chitin. If multiple sugar contains two or more polysaccharides, it is called hetero polysaccharides, and includes hyaluronic acid and heparin.**

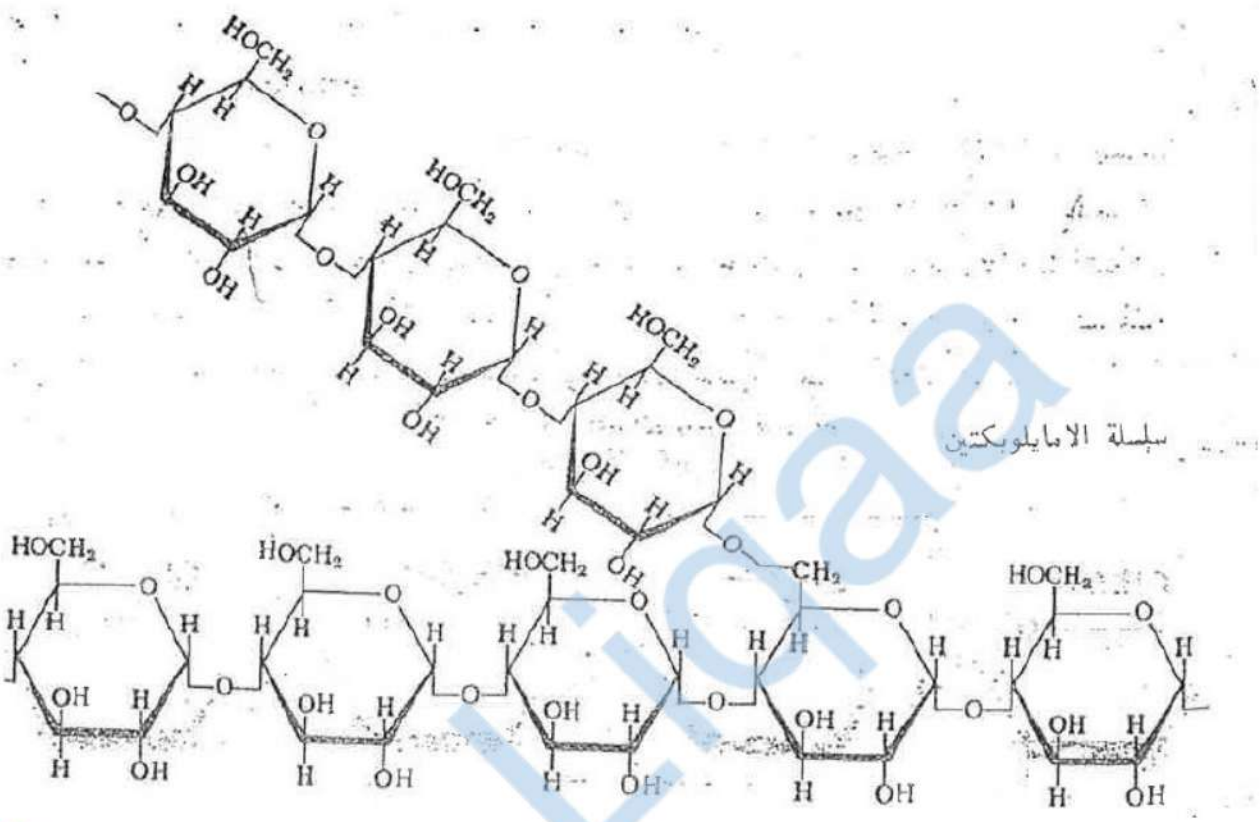
Starch: Starch contains two main types of polysaccharides, amylose and amylopectin.

Amylose: It is a long unbranched chain of glucose units linked together by alpha-1-4 glycosidic bonds. As in the following figure, the percentage of amylose ranges between 15-20%, and contains approximately 250-300 units of glucose sugar units that are usually found in the form of a helix chain, **and amylose is hydrolyzed by the alpha-amylase enzyme found in saliva and pancreatic juice, where it works to break down the alpha 1-4 bond, producing a mixture of glucose and maltose**, the amylose reacts with iodine solution and gives a blue solution.



Amylopectin: **It consists of branched chains** and the number of glucose sugar units per branching ranges between 12 units. Branching also occurs between 25–30 glucose units. **There are two types of glycoside bonds that bind glucose sugar units, alpha1-4 and alpha 1-6**. Amelopectin is present in a ratio ranging between 80-85%, and **amylopectin is hydrolyzed by two enzymes, the first is alpha-amylase and breaks the α 1-4 bond, and the second enzyme is α 1-6 glucosides, breaking the α**

1-6 bond at the branching point. The result is the formation of a mixture of glucose and maltose, which reacts with iodine solution and gives a red color.



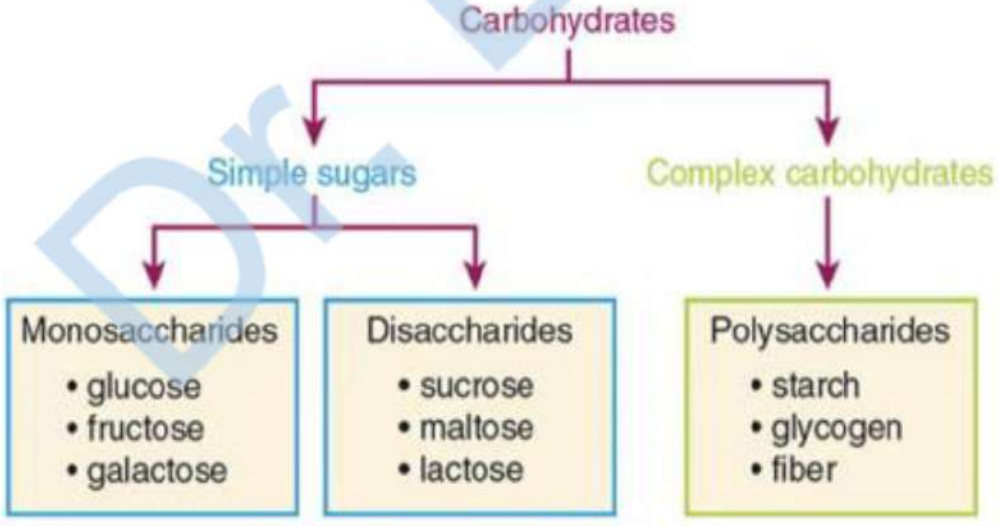
Glycogen: **Glycogen is sometimes called animal starch. It is found in animal tissues, especially in the liver and muscles**, and it is similar to amylopectin in terms of structure, but it is more branched, and branching occurs between 8-12 glucose units. **The building unit of glycogen is alpha-D-glucose related to two types of glycosidic bonds, α 1-4 and α 1-6. Glycogen is hydrolyzed by the enzyme α-amylase and α 1-6 glucosidase into glucose. Liver glycogen is the direct source of blood glucose. As for muscle glycogen, it is a store of energy used when muscular effort and exercises.**

Cellulose: Cellulose is one of the most prevalent organic compounds on Earth. Cotton is the richest source of cellulose. It ranges between 98-99% cellulose. The chemical composition of cellulose is repeated units of glucose bonded to the glycoside β1-4 bond, **and the cellulose is the main compound of the thick cell wall and the wood is 50% cellulose.** The complete breakdown of cellulose by strong acids produces only glucose sugar units. When partilly degraded, the reducing sugar produces cellobise. **A person cannot benefit from cellulose nutritionally because**

his digestive system does not contain the cellulase enzyme that converts cellulose into maltose and glucose. While ruminants, various insects, snails, fungi, algae and bacteria contain the enzyme cellulase. Therefore, we see cows and cattle in pastures eating various herbs, moths eating cotton clothes, and we notice damaged wood in a damp place infected with mold.

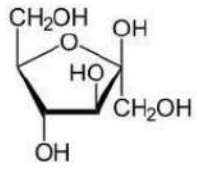
Inulin: It is a polysaccharide composed of repeating units of fructose sugar joined together by beta-1-2 glycosidic bonds. Inulin abounds in the roots of some plants such as artichokes and dahlias.

Chitin: It is a polysaccharide of repeated units of N-acetyl-D-glucoseamine associated with β1-4-glycosidic bond. It is found in the scales of crustacean animals such as crabs and shrimp. The of insects are made of chitin with a solid texture to protect insects from external influences.

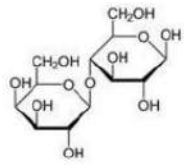


Examples of sugar

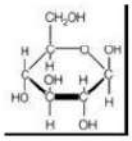
1. Fructose:
   fruit sugar



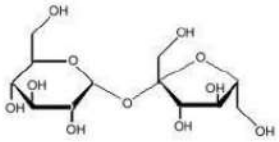
- Lactose:
  milk sugar



- Glucose:
  blood sugar



- Sucrose
  table sugar



Types of Sugar

SUGAR	OTHER NAME	FOOD SOURCE
GLUCOSE (dextrose)	"Blood Sugar"	Fruits, Veggies, Grains, Honey, corn syrup
SUCROSE	"Table Sugar"	Table Sugar, Sugar Cane
FRUCTOSE	"Fruit Sugar"	Fruit
MALTOSE	"Malt Sugar"	Grains
LACTOSE	"Milk Sugar"	Milk