Biology

Topic: Carbohydrates

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Carbohydrates

❖ Molecular structure

الصيغة الكيميائية
Carbohydrates have the stoichiometric formula $(CH_2O)_n$
➔ n is the number of carbons in the molecule represents **carbohydrates**.

➔ the ratio of carbon to hydrogen to oxygen is 1:2:1 in carbohydrate molecules.

❖ Carbohydrates classification:

- Scientists classify carbohydrates into three subtypes:

1. Monosaccharides سكريات أحادية
2. Disaccharides سكريات ثنائية
3. Polysaccharides.سكريات متعددة

❖ Monosaccharides

- Monosaccharides are simple sugars

- the most common monosaccharide is **glucose**.

- In monosaccharides, the number of carbons usually ranges from **three to seven**.

- Most monosaccharide names end with the suffix -**ose**.

- Monosaccharide (Sugars) classified according to:

1. the number of carbons in the sugar:

   1) trioses (three carbons): glyceraldehyde, dihydroxyacetone
   2) pentoses (five carbons): ribose, ribulose
   3) hexoses (six carbons): glucose, galactose, fructose

2. their structure position of double bonds:

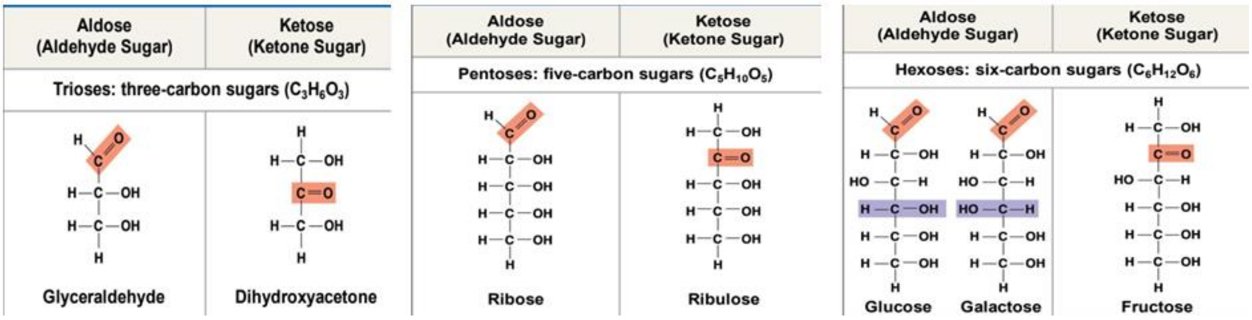
1) Aldoses: Glyceraldehyde, Ribose, Glucose and Galactose.

2) Ketoses: Dihydroxyacetone, Ribulose and Fructose

- If the sugar has an aldehyde group (the functional group with the structure (**R-CHO),** it is an **aldose**

✓ where R can be a variety of carbon-containing substituents

- If sugar has a ketone group (the functional group with the structure (**$R_2C=O$)**it is a **ketose**.



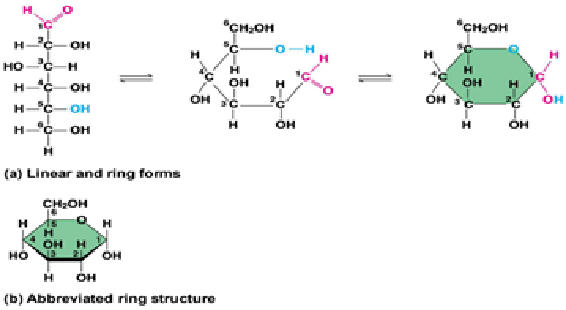
- The chemical formula for glucose is $C_6H_{12}O_6$.
- In humans, **glucose is an important source of energy**.

- During cellular respiration, energy releases from glucose, and that energy helps make adenosine triphosphate (ATP).

- Humans and other animals that feed on plants often store excess glucose as catabolized (cell breakdown of larger molecules) **starch.**

- Galactose and Fructose (in fruit) are other common monosaccharides.

- glucose, galactose, and fructose all have the same chemical formula C6H12O6 they differ structurally and chemically ➔ they are isomers.



- Linear and ring forms of glucose

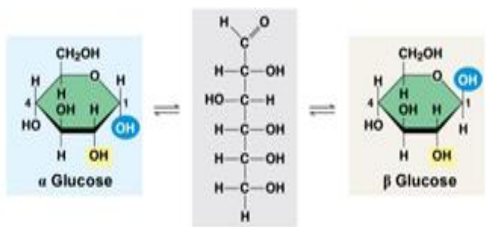
- Monosaccharides can exist as a **linear** chain or as **ring-shaped** molecules.

- In **aqueous solutions** they are usually in ring forms.

- To form the glucose ring, carbon 1 bonds to the oxygen attached to carbon 5.

- Alpha and beta glucose:

- If the hydroxyl group is below in the sugar, it is in the alpha (α) position, and if it is above the plane, it is in the beta (β) position



❖ Disaccharides

- Disaccharides: form when two monosaccharides **undergo a dehydration** reaction (condensation reaction).

- During this process, one monosaccharide's hydroxyl group combines with another monosaccharide’s hydrogen, **releasing a water molecule** and forming a covalent bond.

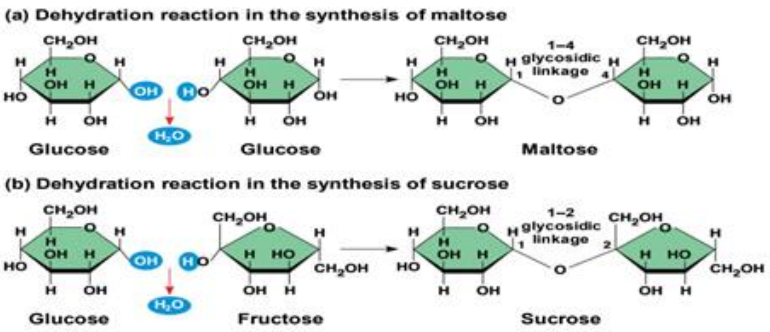
- A covalent bond forms between two monosaccharides called **glycosidic bond** .

- Common disaccharides include:

1) **Lactose**: glucose + galactose.
   - It is naturally in milk.

2) **Maltose**: glucose + glucose
   - malt sugar

3) **Sucrose:** glucose + fructose
   - The most common disaccharide
   - table sugar



❖ Polysaccharides

- A long chain of monosaccharides linked by glycosidic bonds is a **polysaccharide**.

- The chain may be branched or unbranched, and it may contain different types of monosaccharides.

- primary examples of polysaccharides:

1. **Starch**

- storage form polysaccharide in plants

- comprised of monomers of alpha glucose.

- two types: 1. Amylose (unbranched)
  2. amylopectin (somewhat branched)

- Act as a food source for humans and animals.

- Enzymes break down the starch that humans consume.

➔ Ex: an **amylase** present in saliva catalyzes break down of starch into smaller molecules, such as maltose and glucose

2. **Glycogen**

- storage form of glucose in humans and other vertebrates

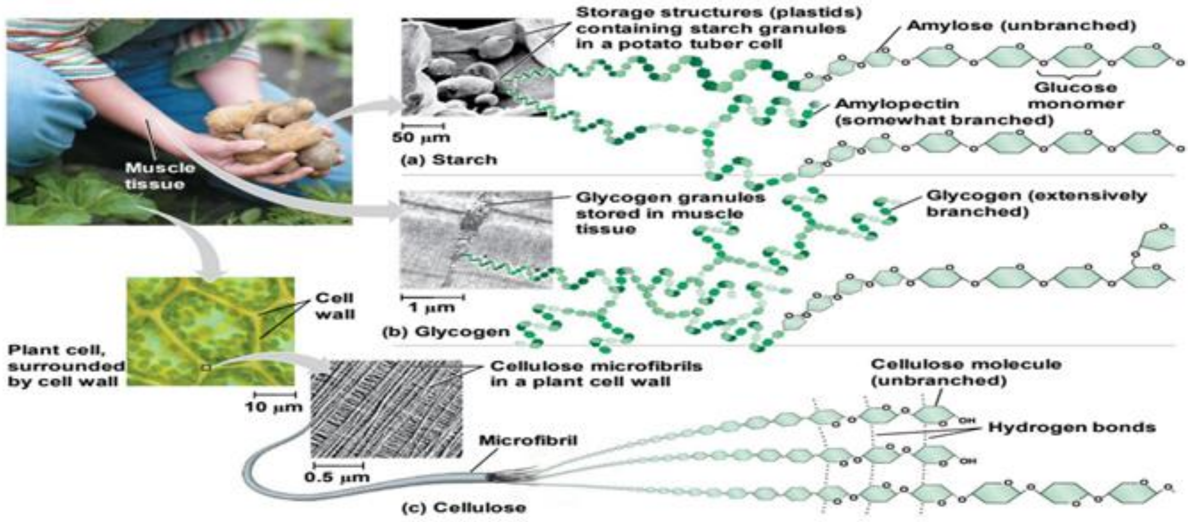
- comprised of monomers of alpha glucose.

- Glycogen is the animal equivalent of starch

- Highly branched molecule

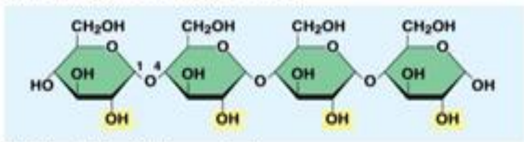
- Stored in liver and muscle cells.

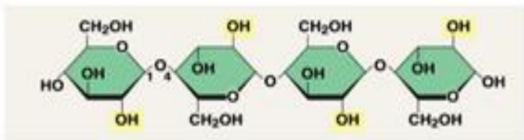
- When Blood glucose levels decrease, glycogen breaks down to release glucose in a process scientists call glycogenolysis.



3. **Cellulose**

- Cellulose is the most abundant natural biopolymer.
- Polymer of beta glucose
- Cellulose mostly comprises a plant's cell wall.
- This provides the cell structural support.
- Wood and paper are mostly cellulosic in nature.

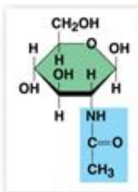

(b) Starch: 1–4 linkage of α glucose monomers


(c) Cellulose: 1–4 linkage of β glucose monomers

4. **Chitin**

- structural polysaccharide
- polymer of beta glucose that contains nitrogen
- Found in:

1. exoskeleton of Arthropods (insects, crustaceans, and others) ➔ outer skeleton which protects their internal body parts.
2. cell wall of fungi
3. surgical thread.



The structure of the chitin monomer

Chitin, embedded in proteins, forms the exoskeleton of arthropods.

monosaccharide

	aldehyde	ketone
triose	glyceraldehyde	dihyroxyacetone
pentose	ribose	ribulose
hexose	Glucose, galactose	fructose

Disaccharides

	maltose	sucrose	lactose
monomers	Glucose + glucose	Glucose + fructose	Glucose + galactose
bond	1-4 glycosidic link	1-2 glycosidic link	1-4 glycosidic link
location	Malt sugar	Table sugar	Milk sugar

	storage		structure	
	starch	glycogen	cellulose	chitin
location	In plants (in chloroplast)	In animals (in liver and muscle)	1. Plant cell wall 2. Wood, paper, cotton	1. Exoskeleton of arthropods 2. fungi cell wall 3. surgical thread
monomer	α glucose	α glucose	β glucose	β glucose with nitrogen
branching	Amylose: unbranched Amylopectin: somewhat branched	Extensively branched	unbranched (arranged to microfibrils)	unbranched