

**Anesthesia Techniques Department**  
**First year**



**General chemistry**  
**Biochemistry**

LEC : 5,6

**Carbohydrates**

## Carbohydrates, classification, main carbohydrates in human body

### Carbohydrates:

Carbohydrates are molecules consisting of carbon, hydrogen, and oxygen their formula is  $C_n(H_2O)_n$ . or They are polyhydroxy aldehydes or ketons.

### Functions of carbohydrates:

1. They are the most abundant dietary source of energy for all organisms.. أكبر موفر (مصدر) للطاقة للكائنات الحية
2. They also serve as the storage form of energy (glycogen) to meet the immediate energy demands of the body. تخزن الطاقة في الجسم (كلايوجين) لتلبية احتياجات الجسم من الطاقة بشكل مباشر
3. They provide energy through oxidation. توفر الطاقة بعملية الأكسدة
4. They are precursors for many organic compounds (fats, amino acids). مصدر للعديد من المركبات العضوية كالدون والاحماض الأمينية.
5. Carbohydrates such as glycoproteins and glycolipids participate in the structure of cell membrane and cellular functions such as cell growth, and fertilization. تدخل البروتينات السكرية و الدهون السكرية في تركيب بنية الخلية والوظائف الخلوية مثل نمو الخلية والإخصاب
6. They are structural components of many organisms. These include the fiber (cellulose) of plants, exoskeleton of some insects. تدخل في تركيب العديد من الكائنات الحية مثل الالياف والسيلولوز والهيكلي الخارجي لبعض الحشرات
7. In plants, glucose is synthesized from carbon dioxide and water by photosynthesis and stored as starch or used to synthesize cellulose of the plant framework reaction. يتم تصنيع الكلوكوز في النبات من ثنائي أوكسيد الكربون والماء وتخزينه على شكل نشاء أو استخدامه في تصنيع السيلولوز
8. Animals can synthesize carbohydrate from lipid glycerol and amino acids, (but most animal carbohydrate is derived from plants)

يمكن للحيوانات تصنيع الكربوهيدرات من الجلسرين الدهني والأحماض الأمينية (ولكن معظم الكربوهيدرات الحيوانية مشتقة من النباتات).

❖ **Classification of carbohydrates:** according to the hydrolysis (التحلل المائي) products

Monosaccharide	Contain 1 sugar unit
Oligosaccharides	Contain 2 -10 sugar units
Polysaccharides	Contain more than 10 sugar units

### Monosaccharide

❖ **Definition:** They are the simplest units of carbohydrate containing **one sugar unit**.

**Naming of monosaccharides:**

**A. According to the Functional group:**

1. **Aldoses:** monosaccharides containing aldehyde group (-CHO).
2. **Ketoses:** monosaccharides containing ketone group (-C=O).

Sugar	No. of Carbons	Includes
Trioses	3	Glyceraldehyde - Dihydroxyacetone
Tetroses	4	Erythrose - Erythrulose
Pentoses	5	Ribose, arabinose - Ribulose ,xylulose.
Hexoses	6	glucose, mannose, galactose - fructose

**Importance (functions) of pentoses:**

**Ribose:**

- Enter in the structure of nucleic acids (**RNA** and **DNA**.)
- Enters in the structure of **ATP**, **GTP** .
- Enters in the structure of coenzymes **NAD**, **NADP** and **FAD**.

**Importance (functions) of Hexoses:**

**Glucose:**

“**grape sugar**” is the most important sugar of carbohydrate:

- Glucose is the main sugar in blood

- Glucose is one of major sources of energy in the body.
- In the liver and other tissues, glucose is converted to all carbohydrates in the body e.g. glycogen, galactose,

**Galactose:**

It can be converted into glucose in the liver.

It is synthesized in mammary gland to make the lactose of milk (**milk sugar**)

**Fructose:** “**fruit sugar**”:

It can be converted into glucose in the liver.

It is the main sugar of semen.

**Oligosaccharides**

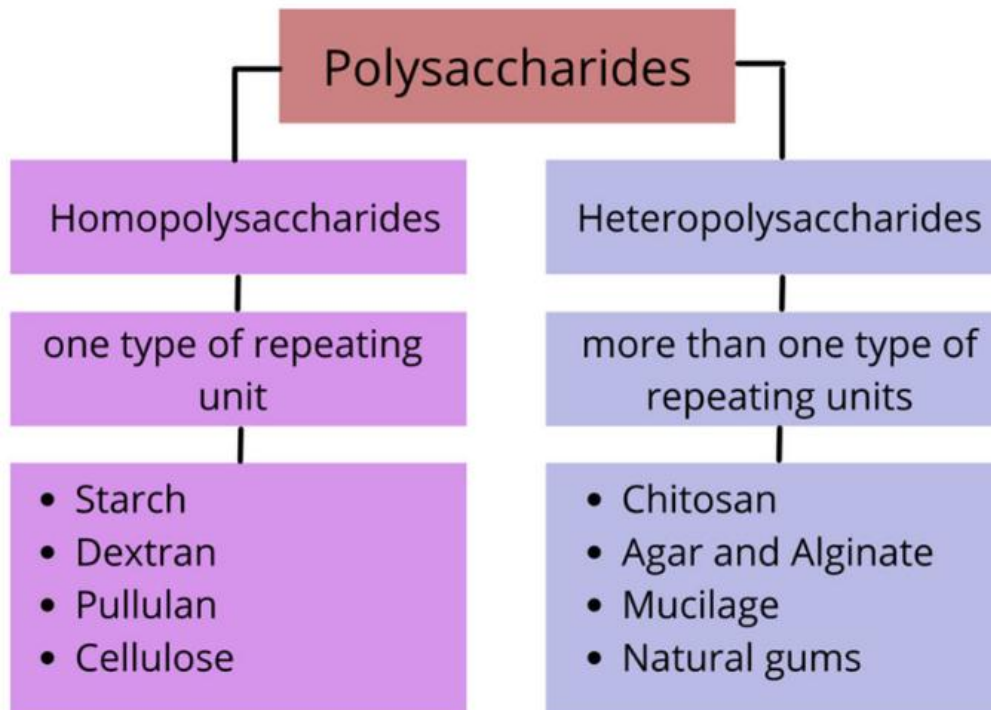
Oligosaccharides is a saccharide polymer containing a small number (2-10) of monosaccharides (simple sugar).

Disaccharides	made up of	Source
Maltose <b>Disaccharides</b>	glucose+glucose	- Malt sugar . - Product of digestion of starch by amylase enzyme. سكر الشعير- ينتج من تحلل النشاء بواسطة أنزيم الأميلاز
Lactose <b>Disaccharides</b>	glucose+galactose	- Milk sugar. - Found in milk and dairy products سكر الحليب- يوجد في الحليب ومشتقات الالبان
Sucrose <b>Disaccharides</b>	glucose+fructose	-Table sugar - sugar cane and sugar beets سكر المائدة – يوجد في قصب السكر و الشمندر السكري
Raffinose <b>Trisaccharides</b>	galactose + glucose + fructose.	-beans, cabbage, broccoli and whole grains. الفاول والملفوف والبروكلي والحبوب الكاملة.

## Polysaccharides

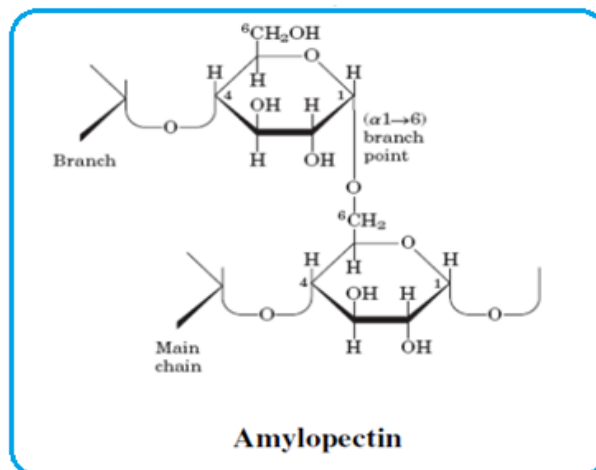
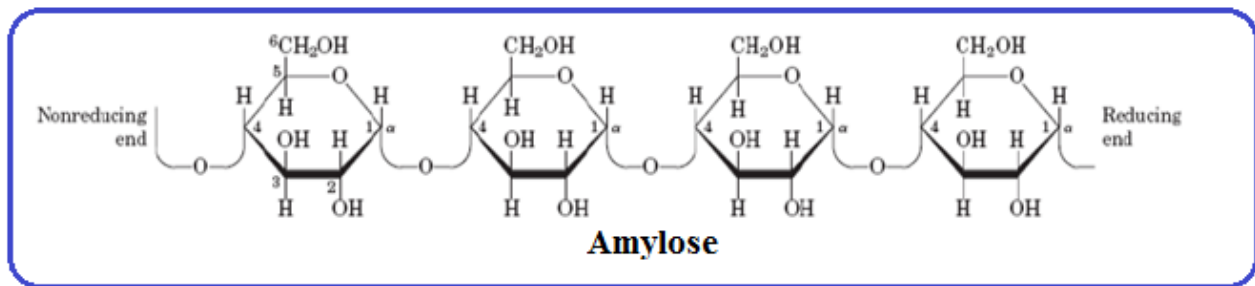
They are polymer of more than 10 unit of monosaccharides or their derivatives, which may be linear or branched polymers.

- ✚ Polysaccharides containing only one kind of monosaccharide molecule it is a **(homopolysaccharide)** such as glycogen, starch, and cellulose. السكريات المتعددة التي تحتوي نوع واحد من السكر الأحادي (سكريات متجانسة).
- ✚ Polysaccharides containing more than one kind of monosaccharide are **(Heteropolysaccharides)** such as gum, agar السكريات المتعددة التي تحوي أكثر من نوع من السكريات الأحادية (الغير متجانسة)



## Starch:

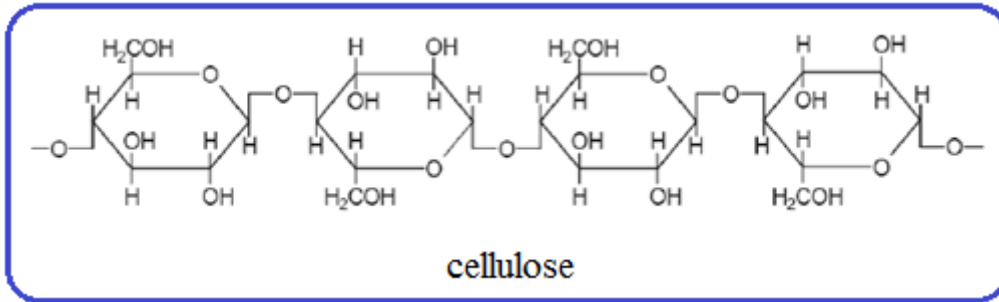
Starch	
amylose	amylopectin
Inner layer طبقة داخلية	Outer layer طبقة خارجية
15-20% of the granule and formed of <b>straight chains</b> سلاسل مستقيمة	80-85% of the granule and formed of <b>branched chain.</b> سلاسل متفرعة
structure of glucose units linked together by $\alpha 1 - 4$ glycosidic bond	glucose units linked together by $\alpha 1 - 4$ glycosidic bond and a $1 - 6$ glycosidic bond



## Cellulose:

- It is composed of linear chains (unbranched) of glucose molecules.
- It is the major constituents of plant cell walls.

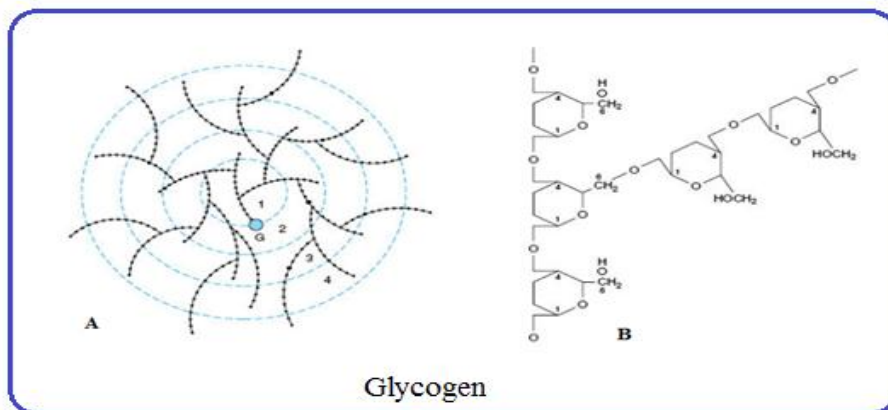
يتألف من سلاسل خطية (غير متفرعة) من جزيئات الجلوكوز - وهو المكون الرئيسي لجدران الخلايا النباتية.



## Glycogen:

- Highly branched chains of glucose molecules.
- Body's storage form of carbohydrate.
- Good food source such as (bread, dried peas and beans) and some vegetables (corn and potatoes).

سلاسل متفرعة بشكل كبير من جزيئات الجلوكوز - الشكل الخزين. للكربوهيدرات في الجسم مصدر غذائي جيد مثل (الخبز والبازلاء المجففة والفاصوليا وبعض الخضار (الذرة والبطاطس).



## Isomers

Isomers are compounds that contain exactly the same number of atoms, i.e., they have exactly the same empirical formula, but differ from each other by the way in which the atoms are arranged.

الأيزومرات هي مركبات تحتوي على نفس عدد الذرات بالضبط، أي أن لها نفس الصيغة الجزيئية تمامًا، ولكنها تختلف عن بعضها البعض من خلال طريقة ترتيب الذرات.

### What are the 3 types of isomers?

Structural isomers come in three varieties: **functional group isomers**, **chain isomers**, and **positional isomers**.

### D- and L-isomers:

✚ The D and L isomers are mirror images of each other (**Fischer projections**). انعكاس لبعضهما في المرآة.

✚ The main difference between D and L isomers is in the position of -OH group in the penultimate carbon atom. الاختلاف في موضع زمرة الهيدروكسيل عند ذرة الكربون قبل الأخيرة.

If the -OH group is on **the right side**, the sugar is of **D** isomer.

Whereas -OH group is on **the left side**, the sugar is of **L** isomer.

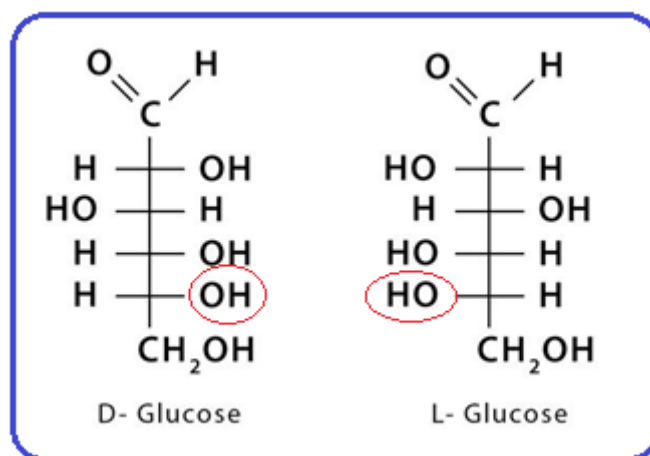


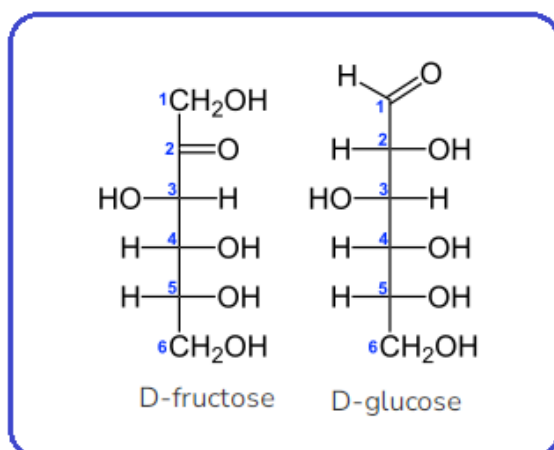
Figure D and L Glucose isomers



## Glucose and fructose

Aldose-Ketose isomerism (**functional group isomerism**): Have the same molecular formula but differs in functional group. اختلاف في المجموعة الوظيفية

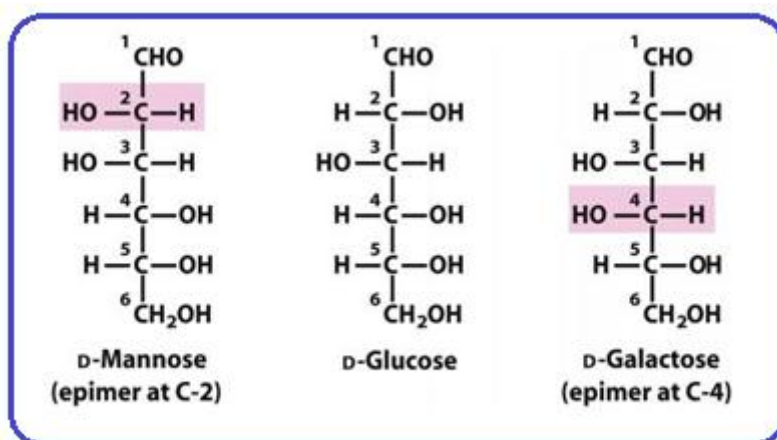
**Example** : **Fructose & glucose** One contains **Ketone group (C=O)** and the other contains **aldehyde group (-CHO)**. Both are isomers.



## Epimers

**Epimers** are isomers having **more than asymmetric carbon**, all are same except only one is different.

- Glucose & Mannose** are epimers at **carbons 2**.
- Glucose & Galactose** are epimers at **carbons 4**.



**Anomeric carbons & anomers: ring structure (Hawarth form)**

a. **Anomeric carbon**: is the asymmetric carbon atom obtained from active carbonsugar group: C1 in aldoses and C2 in ketoses.

b. **Anomers**: These are isomers obtained from the change of position of hydroxyl group attached to the anomeric carbon e.g.  **$\alpha$**  and  **$\beta$**  glucose are 2 anomers. Also  **$\alpha$**  and  **$\beta$**  fructose are 2 anomers.

