

# Carbohydrates



# General characteristics

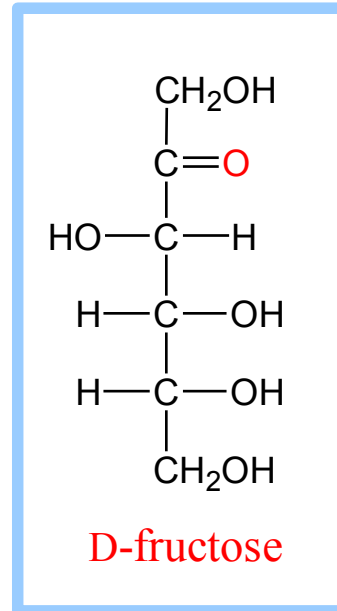
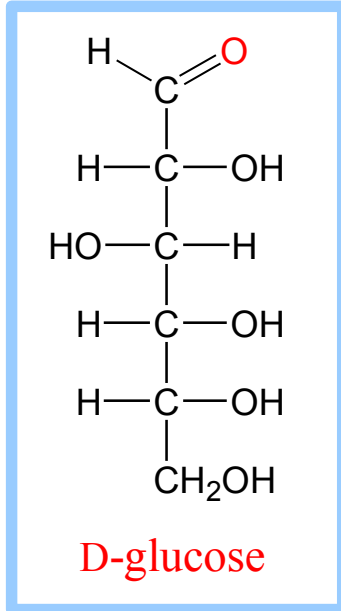
- The term came from the hydrate ( $H_2O$ ) of carbon ( $C$ )
- It has the general formula  $(CH_2O)_n$  } → ابطة و انا هو ال  
glyceraldehyde  
(trioses) → 3 سكرات  
و اباني OH
- The most abundant compounds found in nature  
cellulose ← في النباتات في قسم
- Used as source of energy and energy storage  
in Plant → starch  
in human → glycogen
- Can be converted into fats and proteins → for non essential  
عامة  
جدر
- Important in the formation of genes, vitamins and drugs → Acyclovir  
↳ (ribose) sugar  
↳ glucose
- Participate in biological transport  
Proteins ← في سكرات  
glycoproteins ← في سكرات  
النيوكليو سايد و ال بي بعد ذلك  
A.A مش من ال  $(CH_2O)_n$

# Classification of carbohydrates

- **Monosaccharides:** *ribose sugar*
  - Trioses, tetroses, **pentoses** and hexoses
  - Examples: glucose, galactose, mannose, fructose
- **Disaccharides:** 2 monosaccharides covalently linked (e.g. Sucrose, maltose, lactose)
- **Oligosaccharides:** *من 10 واقل*
  - Tri, tetra, penta up to 9 or 10 units covalently linked
- **Polysaccharides or glycans** *السكر من عشرة*
  - Simple polysaccharides (starch, glycogen, amylopectin)
  - **Complex carbohydrates** (nucleic acid, glycoproteins, glycolipids, ...etc)
    - MONOSAC. وسكر* → like starch → *هو عبارة عن وسكر*
    - Disaccharides وسكر*

# Monosaccharides

- Either aldose or ketose } →  
isomerization (isomerase enzyme)  
میں سے یا ہو سکتا ہے  
یکوہ سے دوسرے میں  
کے الے الآخر؟؟ (علیہ تلمیح الے  
isomerization  
isomerase enzyme)

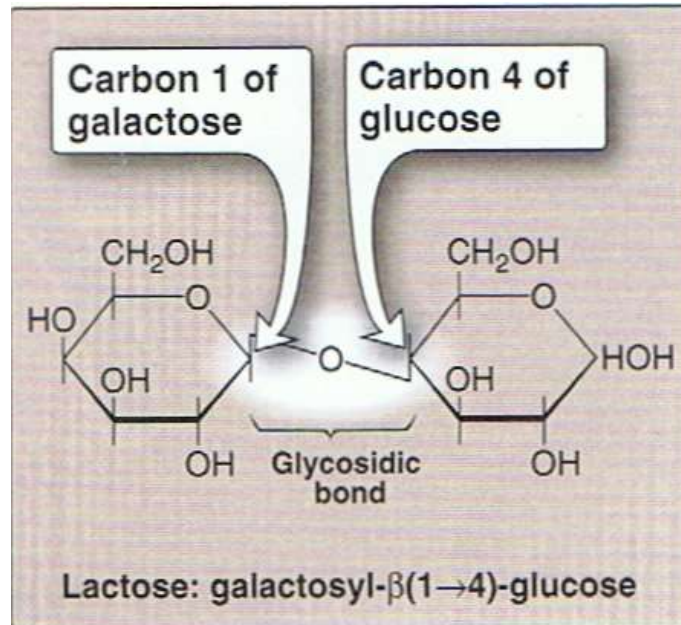


# Glycosidic bond

ہی یلی بتعد ایڈا  
کنری  $\alpha$  or  $\beta$  کی تحریک  
رقم 4

- For di- and polysaccharides
- Can form O- or N-glycosidic bond

ہی یلی رابطہ الیٹین



# Disaccharides

- **Maltose**: is a disaccharide with an  $\alpha(1 \rightarrow 4)$  glycosidic link between C1 - C4 OH of 2 glucoses.
- **Cellobiose**: is the otherwise equivalent  $\beta$  anomer (O on C1 points up) linked by  $\beta(1 \rightarrow 4)$  glycosidic linkage
- **Sucrose**, common table sugar, has a glycosidic bond linking the anomeric hydroxyls of **glucose** & **fructose**. the linkage is  $\alpha(1 \rightarrow 2)$   
*هنا ما له reducing activity*  
*شئ الباقي في الاسم*
- **Lactose**, milk sugar, is composed of **galactose** & **glucose**, with  $\beta(1 \rightarrow 4)$  linkage from the anomeric OH of galactose.

سكر الحاندة

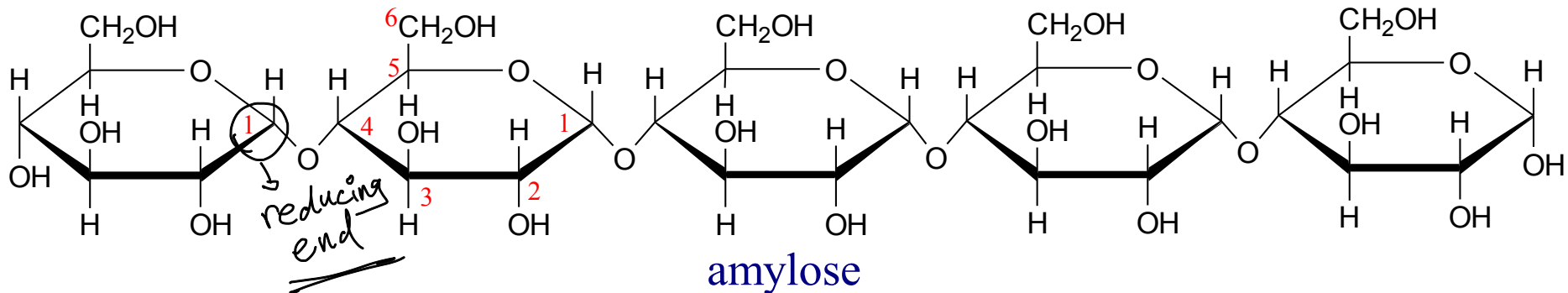
reducing activity

شئ الباقي في الاسم

# Polysaccharides

إلى عينة على صفة نبات

- **Plants** store glucose as **amylose** or **amylopectin**, glucose polymers collectively called **starch**. *linear polymer of glucose units*
- **Glucose** storage in **polymeric** form minimizes osmotic effects.
- **Amylose** is a glucose polymer with  $\alpha(1 \rightarrow 4)$  linkages.
- The end of the polysaccharide with an anomeric C1 not involved in a glycosidic bond is called the reducing end.



# Sugar isomers

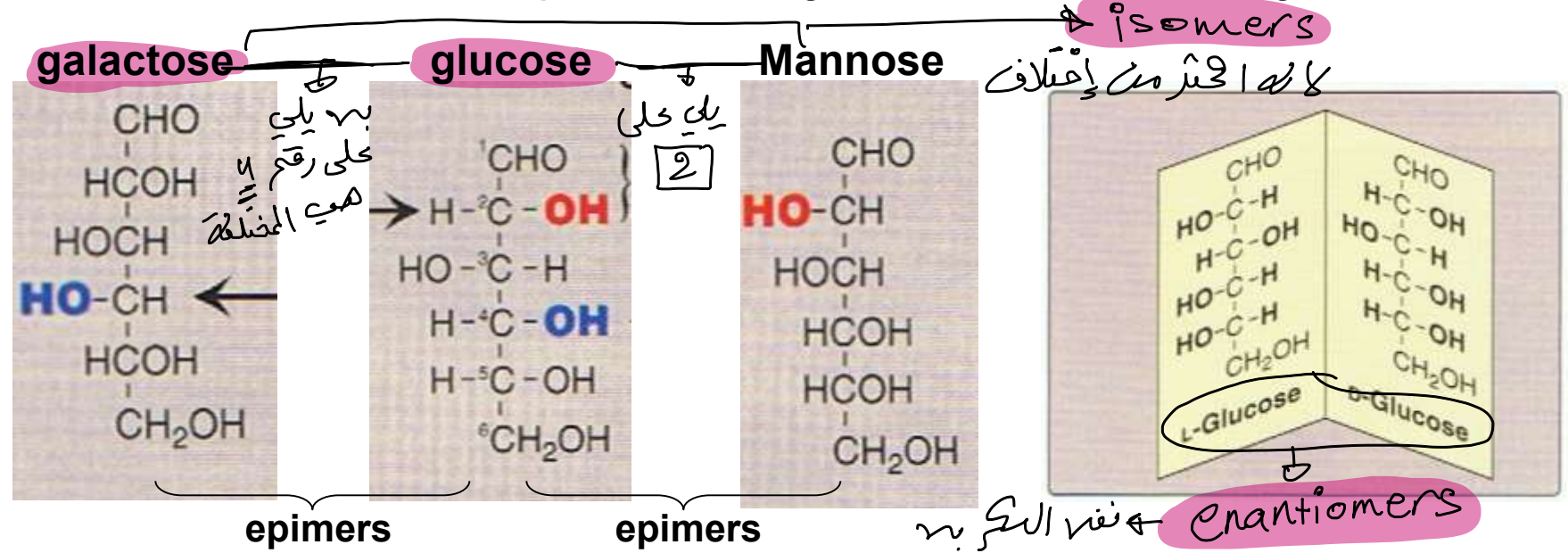
لما يكون عندي  
السكر من وحدة OH  
مختلفة بالإنجاء

➤ Compounds with the same chemical formula are called isomers.

لما يكون بوحدة OH مختلفة  
بالإنجاء

**Epimers** If two monosaccharide isomers differ in configuration around **one** specific carbon atom (with the exception of the carbonyl carbon), they are defined as epimers of each other.

➤ If a pair of sugars are mirror images of each other (enantiomers), the two members of the pair are designated as D- and L-sugars.



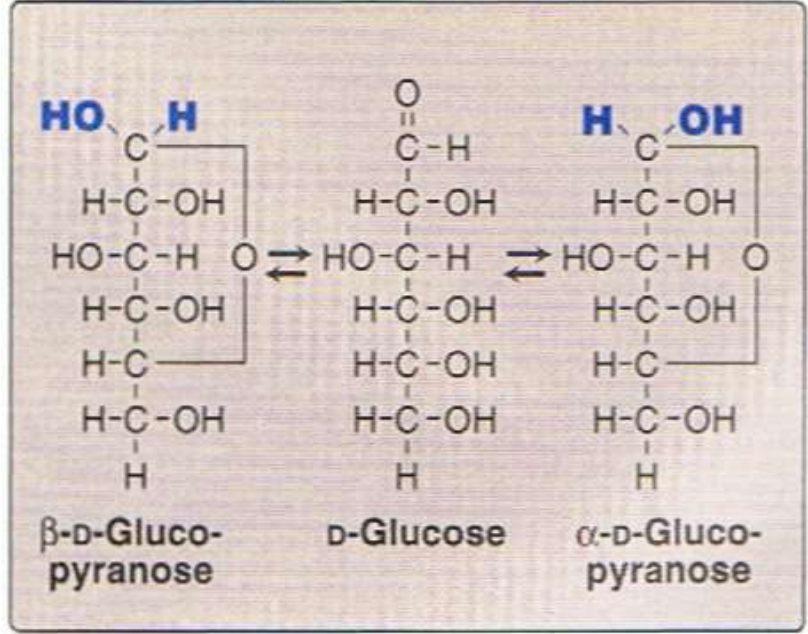
glucose بالسكر، L-amino acid، مختلف L, D، قلة انزيماتها، الى تحاليلها  
 D  
 L  
 toxic

# α and β sugars

Carbon 1 ← Glucose, Galactose  
 Carbon 2 ← Fructose

المكان مفتوح وبها  
 يسكن جدير α و β ففا بقدر احد  
 ممكن احد بهما يربط

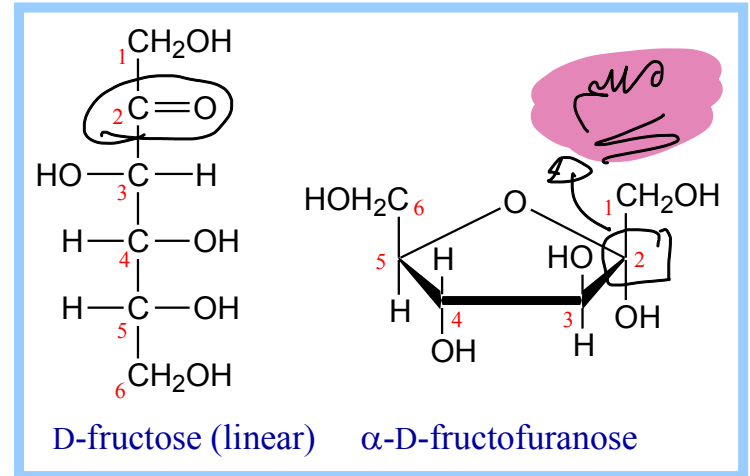
When a sugar cyclizes, an anomeric carbon is created from the aldehyde group of an aldose or keto group of a ketose.



➤ Glucose forms an intra-molecular hemiacetal, as the C1 aldehyde & C5 OH react, to form a 6-member pyranose ring, named after pyran

➤ This carbon can have two configuration, α or β. If the oxygen on the anomeric carbon is not attached to any other structure, that sugar is a reducing sugar

- α (OH below the ring)
- β (OH above the ring).



D-fructose (linear)      α-D-fructofuranose

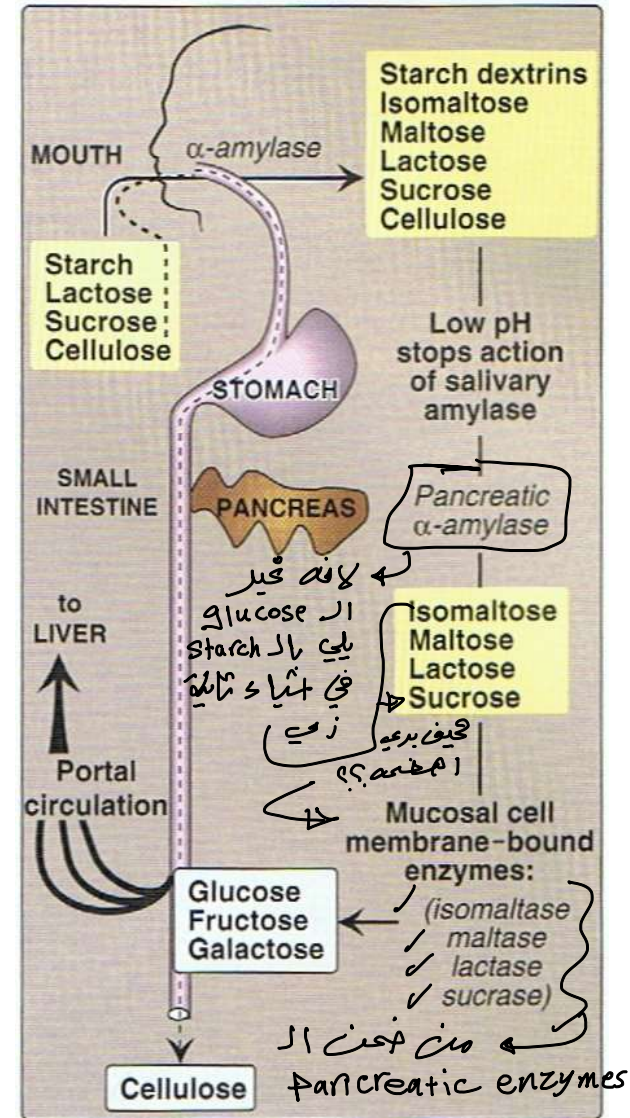
# Digestion of carbohydrates

- Digestion of carbohydrates begins in the mouth by salivary  $\alpha$ -amylase enzyme which breaks  $\alpha$ -1,4 glycosidic bond
- The digestion stops in the stomach because the amylase is inactivated by the high acidity
- further digestion of carbohydrates by pancreatic enzymes occurs in the small intestine by pancreatic amylase

نكسر الـ starch  
و بجوله glucose

amylase

mono and di...  
بشكل عليه التفسير



# Absorption of monosaccharides

هون الخاب عملية الامتصاص

➤ The **duodenum and upper jejunum** absorb the **bulk of the sugars**.

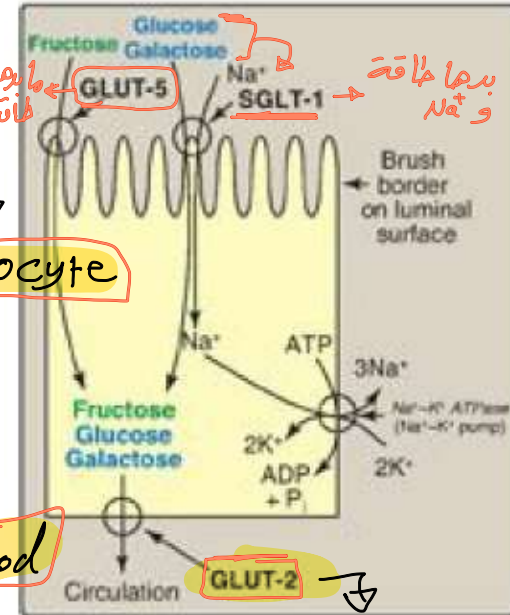
ما يزيد او يقل  
الامتصاص  
للسكر

➤ **Insulin is not required for the uptake of glucose by intestinal cells.**

مسوية  
حتى لو حذره سكري حاد يمتص السكر...

➤ **galactose and glucose** are transported to the mucosal cells by an **active, energy-requiring process** that involves a **specific transport protein** and **requires a concurrent uptake of sodium ions**.

مسوية



Enterocyte

بتتصلق بين (في حالة الأيونات) بدما اياه والباقي على الدم

➤ **Fructose** uptake requires a **sodium-independent monosaccharide transporter (GLUT-5)** for its absorption

blood

في حالة الليمف من الدم إلى enterocyte

مسوية

معقول اقوت ووجله lipid على ال H (Polar)

Sugar transporter in the intestine } membrane transporter في حجاب الغشاء و اجسنا (GLUT-2) نواقل تنقل باجاصين  
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# Abnormal degradation of disaccharides

← إذا بقي ثقلها بأي واحد من الإنزيمات يكذب ذبحها باليد 20 بالرسعة، من ربح  
 في تغيير في هضم و ربح يدخل ماضي بالأمعاء حلسا وما إلى امتصاص، لازم السكر يكون على شغل  
 Because predominantly monosaccharides are absorbed, any defect in a specific disaccharidase activity of the intestinal mucosa causes the passage of undigested carbohydrates into the large intestine.  
 ← يدخل ماضي و يوجد عند ال Ileum إلى حليه  
 normal flora، و يتشوفه حنجر، يبدش التخمر و بغير منفوخ النفس و يشبه صبي و يشبه شمال  
 له بتوله  $CO_2, H_2$

mono  
 كتان  
 امته

- As a consequence of the presence of this osmotically active material, water is drawn from the mucosa into the large intestine, causing osmotic diarrhea.
- This is reinforced by the bacterial fermentation of the remaining carbohydrate to two- and three-carbon compounds (which are also osmotically active) producing large volumes of  $CO_2$  and  $H_2$  gas, causing abdominal cramps, diarrhea, and flatulence,

# Abnormal degradation of disaccharides

- Digestive enzyme deficiency *ممکن وراثتہ*  
*و ممکن تغیر بسبب تقرحات بالامعاء*
- **Lactose intolerance: lactase deficiency**
- **Isomaltase-sucrase deficiency: defect in sucrose degradation (10% of eskimos)**
- **Measurement of hydrogen gas in the breath** is a reliable test for determining the amount of ingested carbohydrate not absorbed by the body *کنندہ نفی*  $H_2$

*طریقہ اخرف اذا عنده نفی بانزیمات معیبه  
پہلے بتبشٹی*

