Carbohydrates Digestion And Absorbance

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NARJES NASIRI-ANSARI

B.SC,M.SC,PH.D/NNASIRI@MED.UOA.GR

LABORATORY OF BIOLOGICAL CHEMISTRY

MEDICAL SCHOOL OF ATHENS UNIVERSITY

Aim:

- At the end of this lesson student should be able to define:

Dietary sources of carbohydrates

- To classify the carbohydrates present in human nutrition
- The different sites of carbohydrates digestion in the human body
- Classification of enzymes involved in the carbohydrates digestion
- The clinical significance of carbohydrates digestion and absorbance.

Dietary Carbohydrates

- **Polysaccharides**

Starch from plant origin, Glycogen from animal origin, Cellulose from plant origin (such as amylopectin and amylose).

- **Oligosaccharides**

Contain between 3 and 10 single sugar residues and are not relatively abundant in the diet(raffinose, stachyose, and verbascose. These oligosaccharides can be found in relatively abundant levels in legumes, whole grains, some cruciferous vegetables, and some fruits.).

- **Disaccharides**

sucrose, Lactose, Maltose

- **Monosaccharides**

(Fructose, galactose, and xylose. The most nutritionally important and abundant monosaccharide is glucose)

Carbohydrates digestion:

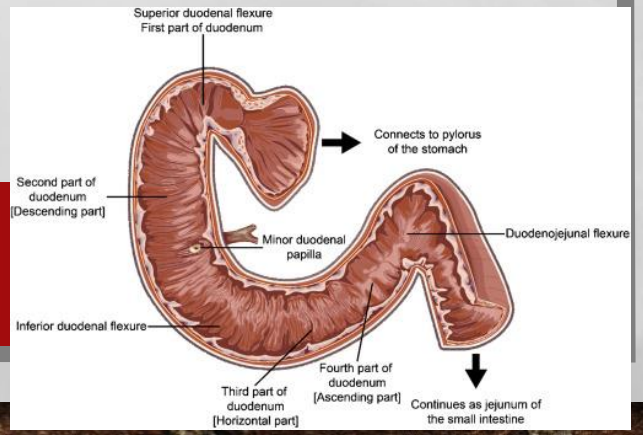
- Carbohydrates digestion is rapid:
- Generally completed by the time the gastric contents reach the junction of the duodenum & jejunum.
- Sites for digestion of dietary carbohydrates:

1.Mouth

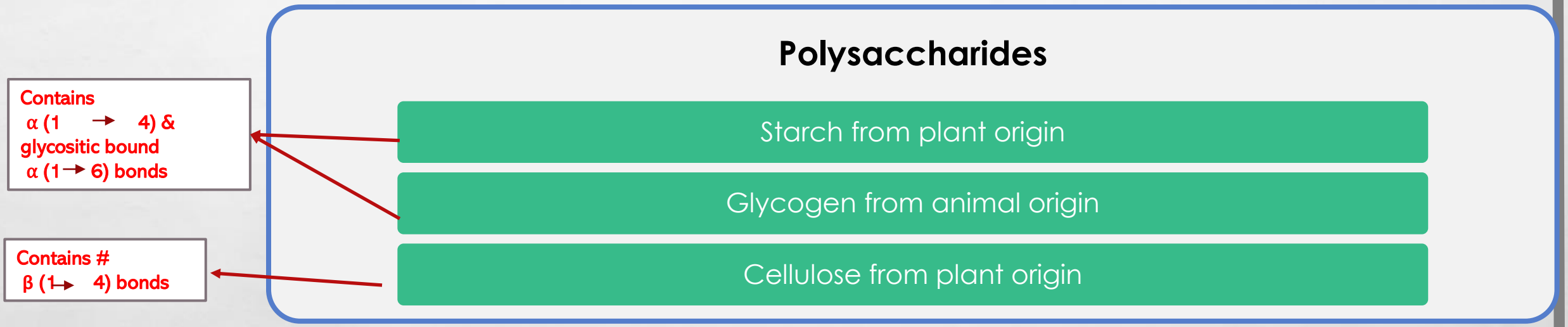
Rapid digestion because it starts in the mouth (physical chewing and alpha amylase enzyme)

No carbs digestion in the stomach (due to high acidity).

2.Intestinal lumen



Carbohydrates digestion:



(1, 4) can not be digested in human because we don't have enzymes for it

- **Dissacharides:**

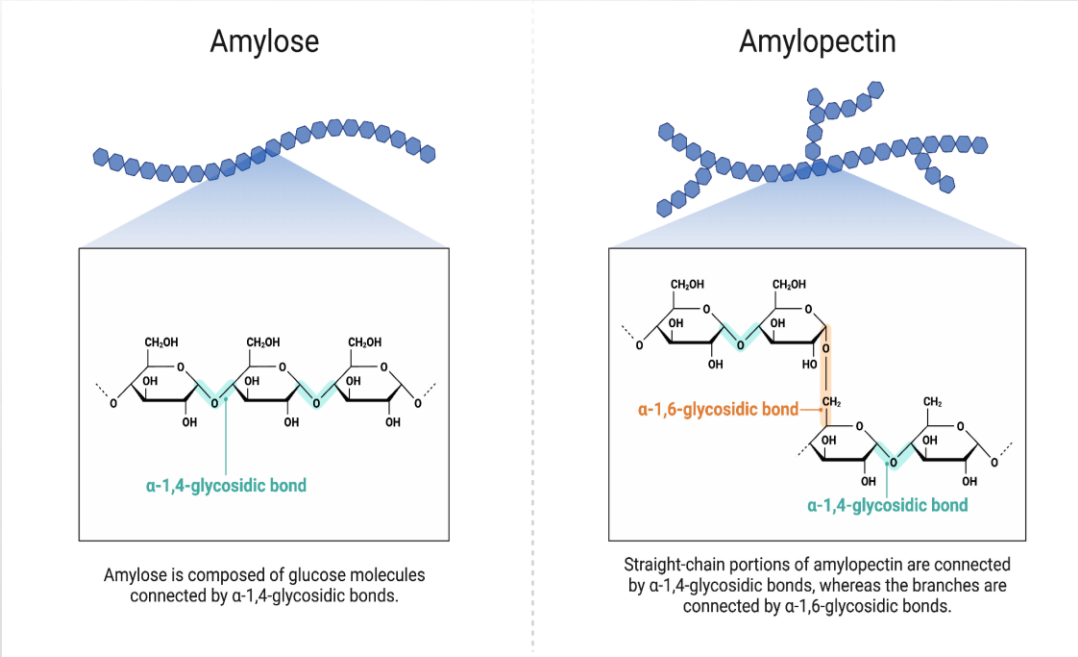
Sucrose = Glucose & fructose
Lactose = Glucose & galactose
Maltose = two glucose units

Enzymes for digestion of dietary carbohydrates

- **α-AMYLASE**

It is a **salivary and pancreatic enzyme** (Most of the digestion is due to pancreatic α-amylase)

Substrate: Polysaccharides.



- **DISACCHARIDASE**

It is an intestinal enzyme.

Substrate: Disaccharides.

- **ISOMALTASE**

It is an intestinal enzyme.

Substrate: Branch points of oligo- and di-saccharides.

- **α (1,6) GLUCOSIDASE**

It is an intestinal enzyme.

Substrate: Branch points of oligo- and di-saccharides

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Carbohydrates digestion:

- No dietary carbohydrate digestion occurs in the stomach (the high acidity of the stomach inactivates the salivary α-amylase).

- Pancreatic α-amylase continues the process of starch & glycogen digestion in the small intestine(secreted by pancreas and works in small intestine).

α-amylase:

- Normal level in serum: 25 -125 U/L (unit per liter)
- The clinical significance of rising circulating levels of α- amylase activity leads to diagnosis of acute pancreatitis however; amylase is not specific for pancreatitis so there is another enzyme (pancreatic lipase) which should be also elevated.

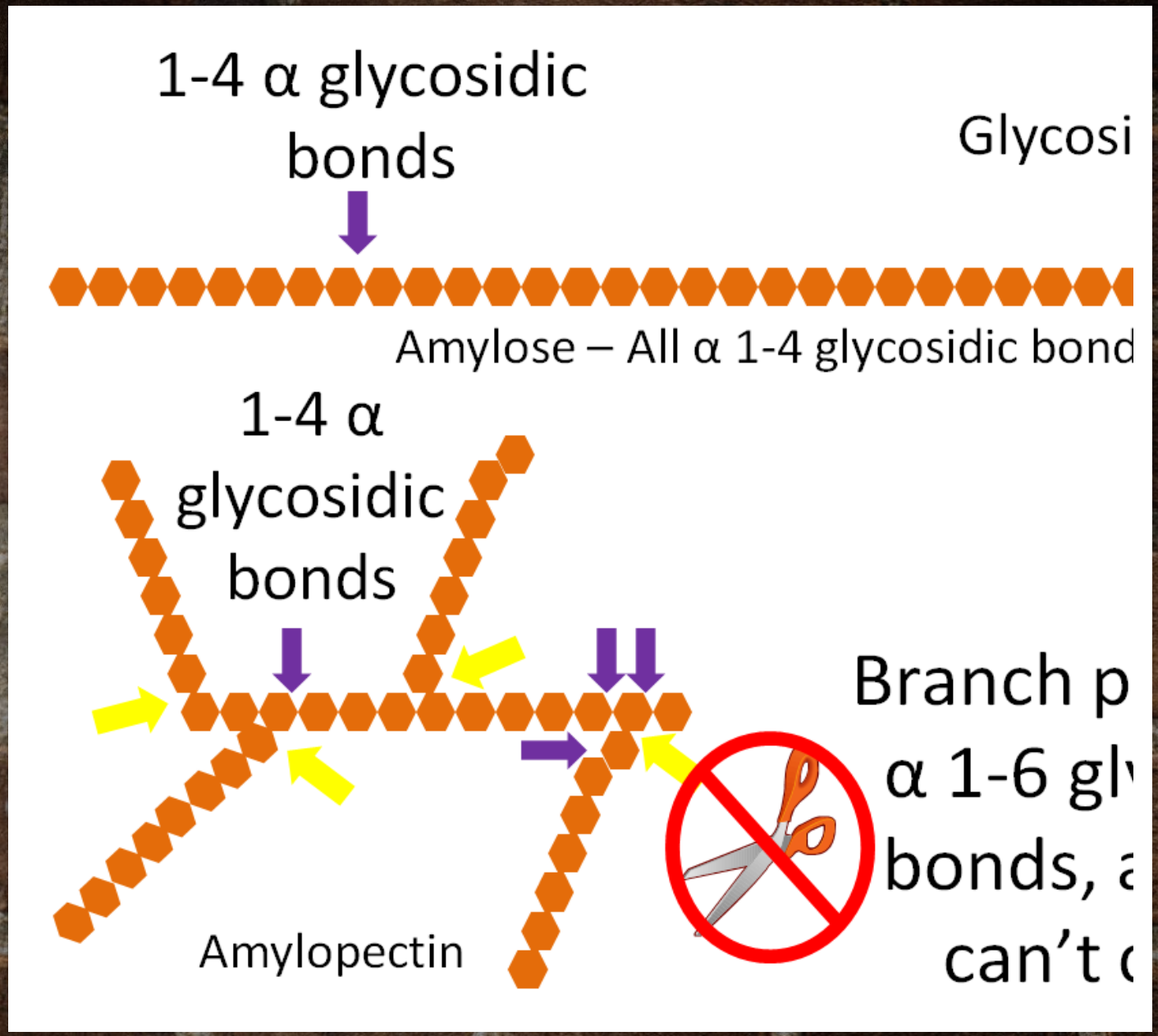
Acute pancreatitis:

- Damage of pancreatic cells : release & activation of the intracellular enzymes into the blood
- Its level starts to rise within few hours.
- Reaches a peak within 12- 72 hours.
- Then returns to normal within few days, usually 5 days but lipase is much more specific when it is elevated it will be maintained for 8 days, then returns gradually to its normal levels within 14 days.
- High levels can also be caused by an infection, cancer, or even alcohol or certain medicines.

Product of glycogen digestion by α-amylase:

1.Mixture of short oligosaccharides (both branched & unbranched)

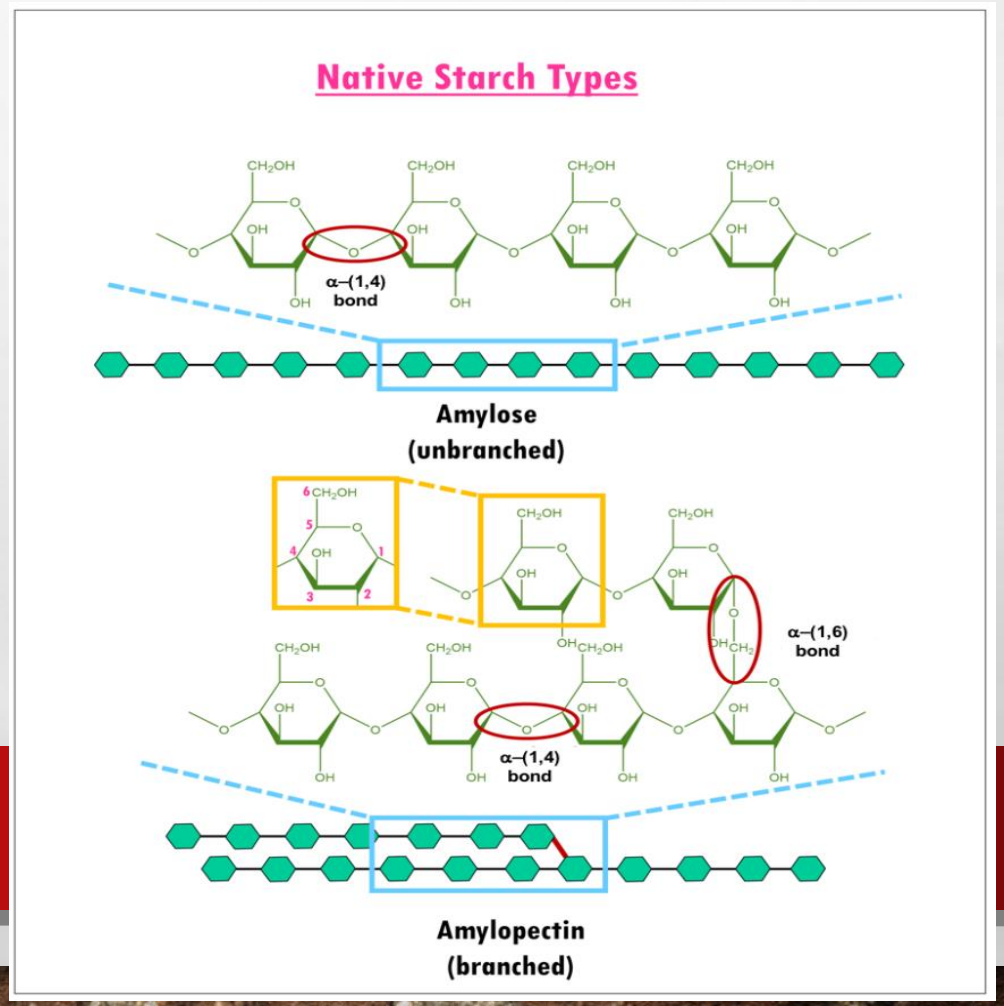
2.Disaccharides: Maltose and isomaltose



Digestion of carbohydrates by intestinal enzymes

Disaccharidases and α (1,6) glucosidase (for branched oligosaccharides)

- Both of the secreted by enterocytes of the small intestine & remain associated with the luminal side of the brush border membranes of the intestinal mucosal cells.



Intestinal disaccharides (brush-border enzymes)

- **Isomaltase**

Substrate : Isomaltose

Product: Two glucose

- **Maltase (Glucoamzlase)**

Substrate : Maltose

Product: Two glucose

- **Sucrase**

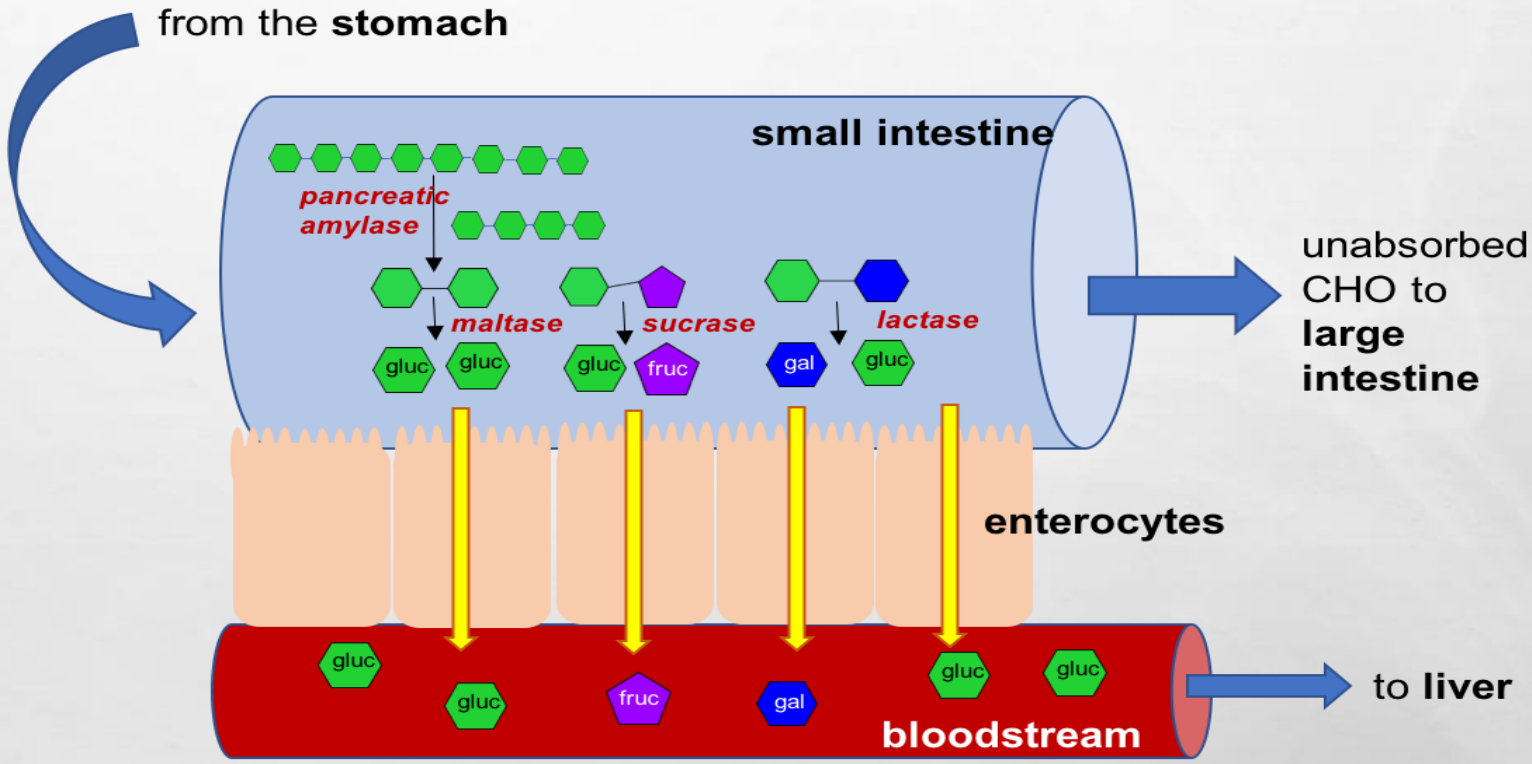
Substrate : Sucrose

Product: Glucose + fructose

- **Lactase (α-galactosidase)**

Substrate : Lactose

Product: glucose + galactose



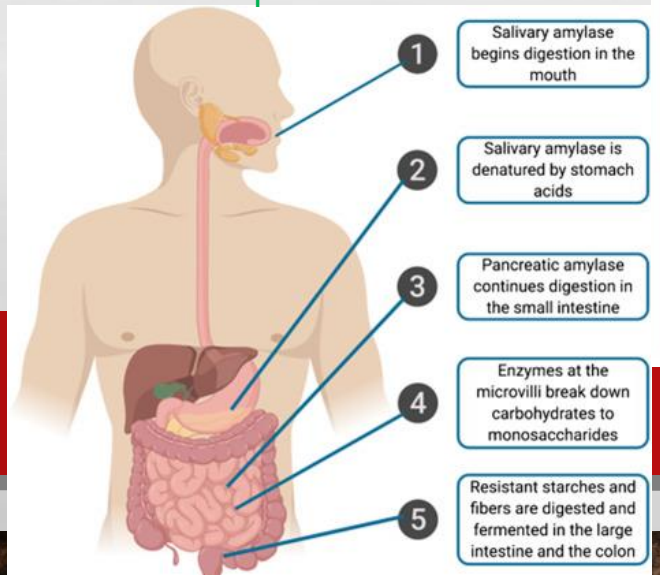
https://openoregon.pressbooks.pub/nutritionscience/chapter/4c-digestion-absorption-carbohydrates/

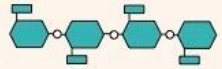
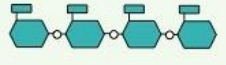
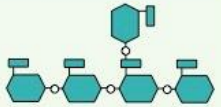
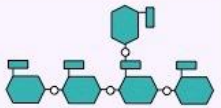
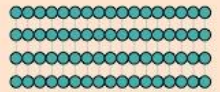
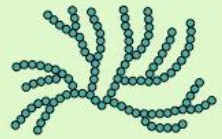
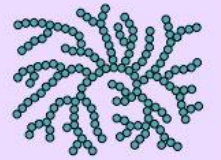
Cellulose, as the major component of plant biomass, is the most abundant polysaccharide in the world

- Dietary cellulose *cannot be digested* due to the absence of enzyme that can cleave $\mathcal{B}$ (1-4) bonds. It passes through the GIT largely intact.

- Despite that, it has several beneficial effects.

- It Increases motility and treat constipation



	Cellulose	Starch		Glycogen
		Amylose	Amylopectin	
Source	Plant	Plant	Plant	Animal
Subunit	β-glucose	α-glucose	α-glucose	α-glucose
Bonds	1-4	1-4	1-4 *and* 1-6	1-4 *and* 1-6
Branches	No	No	Yes (~per 20 subunits)	Yes (~per 10 subunits)
Diagram				
Shape				

https://doi.org/10.1016/B978-0-323-66162-1.00003-2
https://ib.bioninja.com.au/standard-level/topic-2-molecular-biology/23-carbohydrates-and-lipids/sugar-polymers.html

Monosaccharides absorption by intestinal mucosal cells

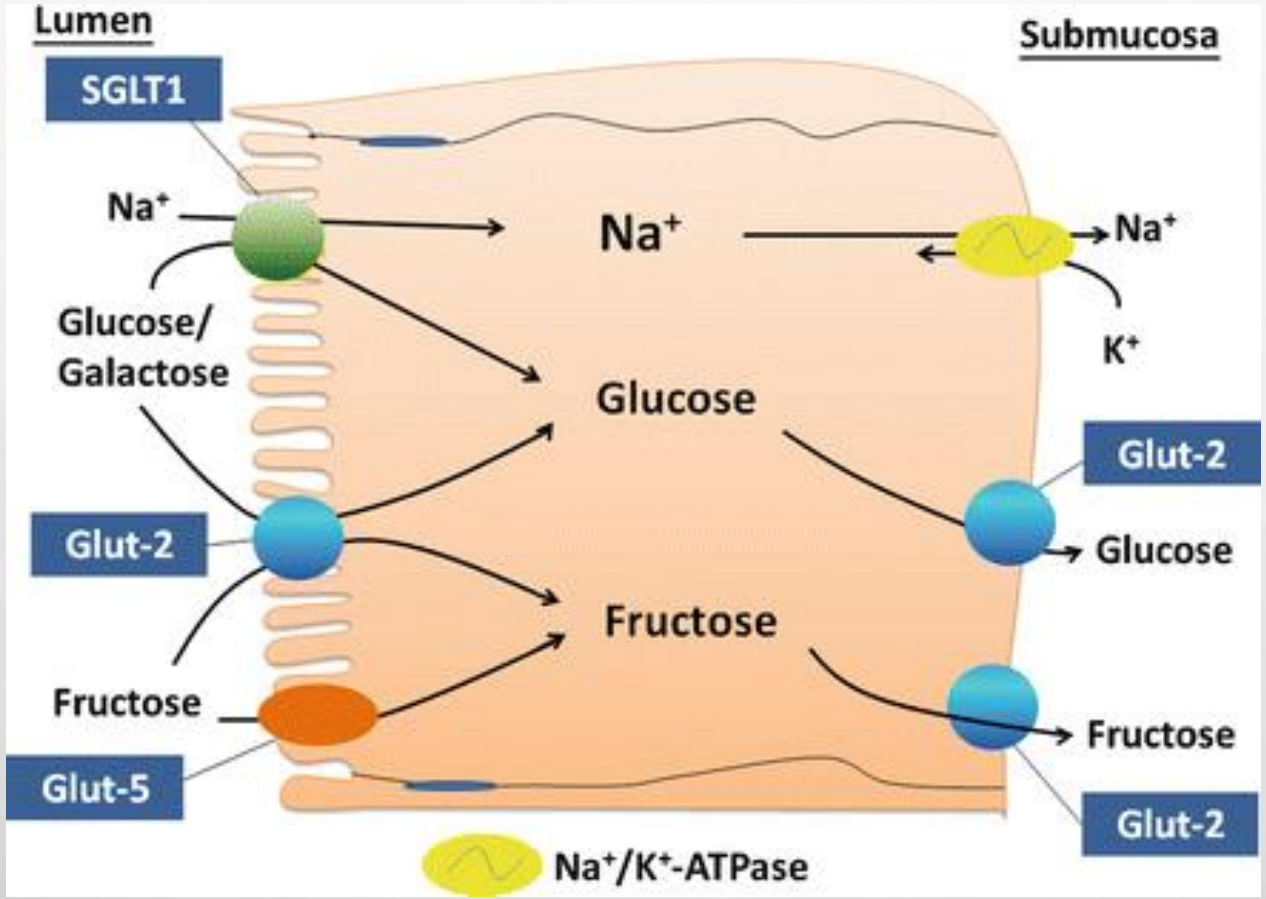
- It take place in the duodenum & upper jejunum.

- **Different monosaccharides have different mechanisms of absorption:**

1. Facilitated diffusion (glut-mediated) sodium independent

2. Active transport (energy-dependent): Sodium co-transport with Na^+

Absorption of digested carbohydrates



GLUTs are responsible for Transportation of all monosaccharaides into the blood stream

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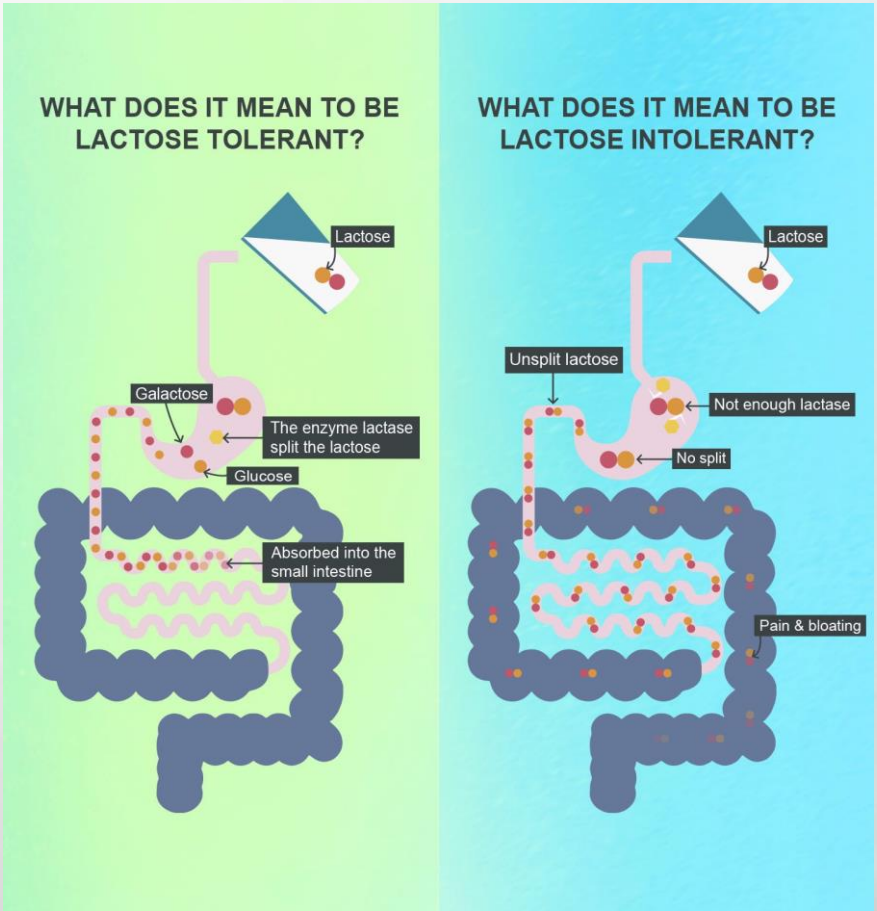
Abnormal digestion of disaccharides (e.g: lactose)

- Lactose intolerance (lactase deficiency)
- Lactase ($\mathcal{B}$-galactosidase) deficiency undigested carbohydrate in large intestine osmotic diarrhea.
- Bacterial fermentation of the undigested compounds in the large intestine co2 , h2 gas abdominal cramps, diarrhea & distension (flatulence)
- Lactose intolerance is common in adults

There are bacteria present in the large intestine, and the water reabsorbed to make the feces solid, people who have indigested carbohydrates in large intestine it is osmotically active and will not reabsorb the water so these people develop diarrhea.



Take home massage :

- ✓ Dietary cellulose cannot be digested due to the absence of enzyme that can cleave β (1-4) bonds, so it passes through the GIT largely intact. Despite that, it has several beneficial effects.
- ✓ Absorption of the monosaccharides requires specific transporters (GLUTs and SGLT1).
- ✓ Lactose intolerance is due to deficiency of lactase enzyme and causes abdominal cramps, diarrhea & flatulence
- ✓ Salivary α-amylase acts on dietary glycogen & starch in the mouth.
- ✓ Pancreatic α-amylase continues the process of polysaccharide digestion in small intestine.
- ✓ The final digestive processes of carbohydrates into monosaccharides occur at small intestine by disaccharidases & α(1,6) glucosidase.

Learning objectives:

-Which kind of carbohydrates present in human nutrition

-To know the different sites of carbohydrates digestion in the human body

-to be able to Classify enzymes involved in the carbohydrates digestion

- to describe the role of each enzyme during carbohydrate digestion

-The clinical significance of carbohydrates digestion and absorbance.

1.Carbohydrate can not be digested in ?
A- Mouth
B- Stomach
C- Duodenum
D- Small and large intestine

2.Which ONE of the following causes rising in a-Amylase levels ?
A- Hyperlipedimia
B- Acute Pancreatitis
C- Lactose intolerance
D- None of the above

3. Where the digested monosaccharides will be absorbed ?
A.Mucosal lining of Large and small Intestine
B- Partially in the Mucosal lining of stomach and then in the duodenum
C- Duodenum & upper jejunum.
D- all the above

4.he final digestion of carbohydrates occurs in ?
A- Mucosal lining of Large Intestine
B- Mucosal lining of Stomach
C- Mucosal lining of Small Intestine
D- C and B