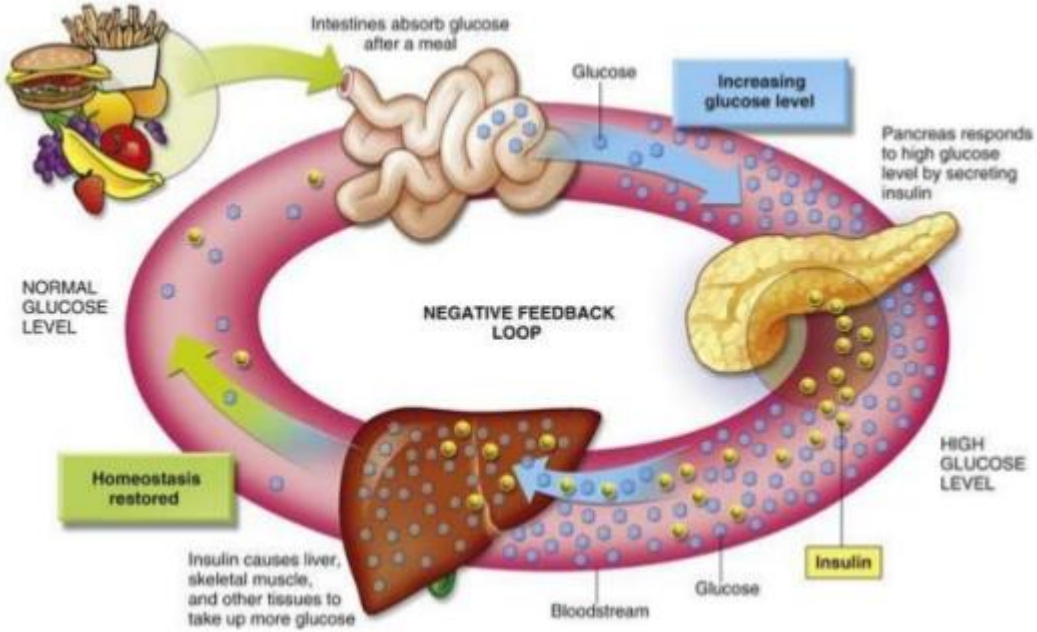


Carbohydrates Metabolism

Dr. Diala Abu-Hassan

Review of Carbohydrates

Digestion and absorption of carbohydrates

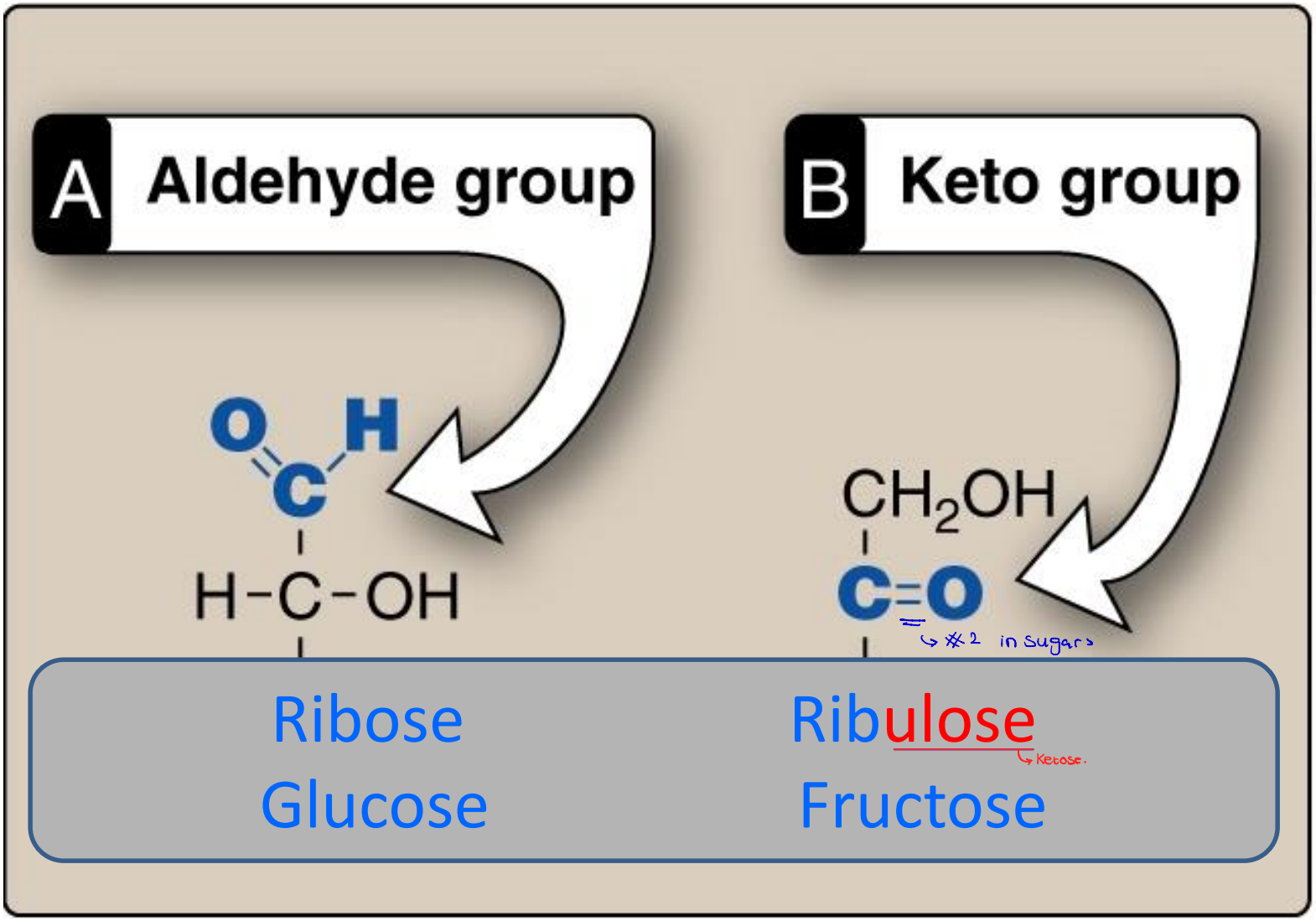
Suggested Readings:

1: Lippincott's Illustrated reviews: Biochemistry

2: Marks' Basic Medical Biochemistry

↳ Polyhydroxy Aldehydes or Ketones.

Sugars are either aldoses or ketoses

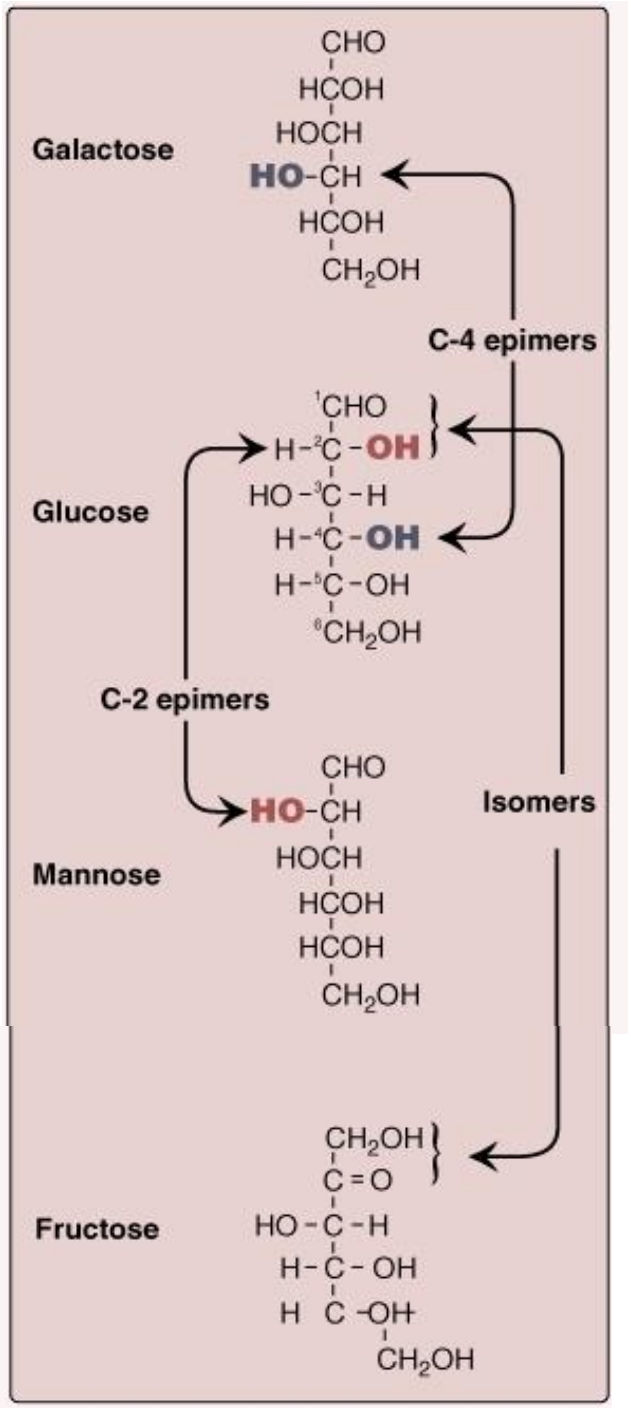


Examples of monosaccharides found in human

* The simplest Ketone sugar →→ dihydroxy acetone. → NO chiral center.
* The simplest Aldose sugar →→ GlycerAldehyde → has a chiral center.

Generic names	Examples
3 carbons: trioses	Glyceraldehyde → The simplest Aldose sugar.
4 carbons: tetroses	Erythrose
5 carbons: pentoses	Ribose
6 carbons: hexoses	Glucose
7 carbons: heptoses	Sedoheptulose
9 carbons: nonoses	Neuraminic acid

* Remember: Anomeric carbon → 1 in Aldoses.
→ 2 in Ketoses.



Sugars have Isomers
same

Epimers are isomers:

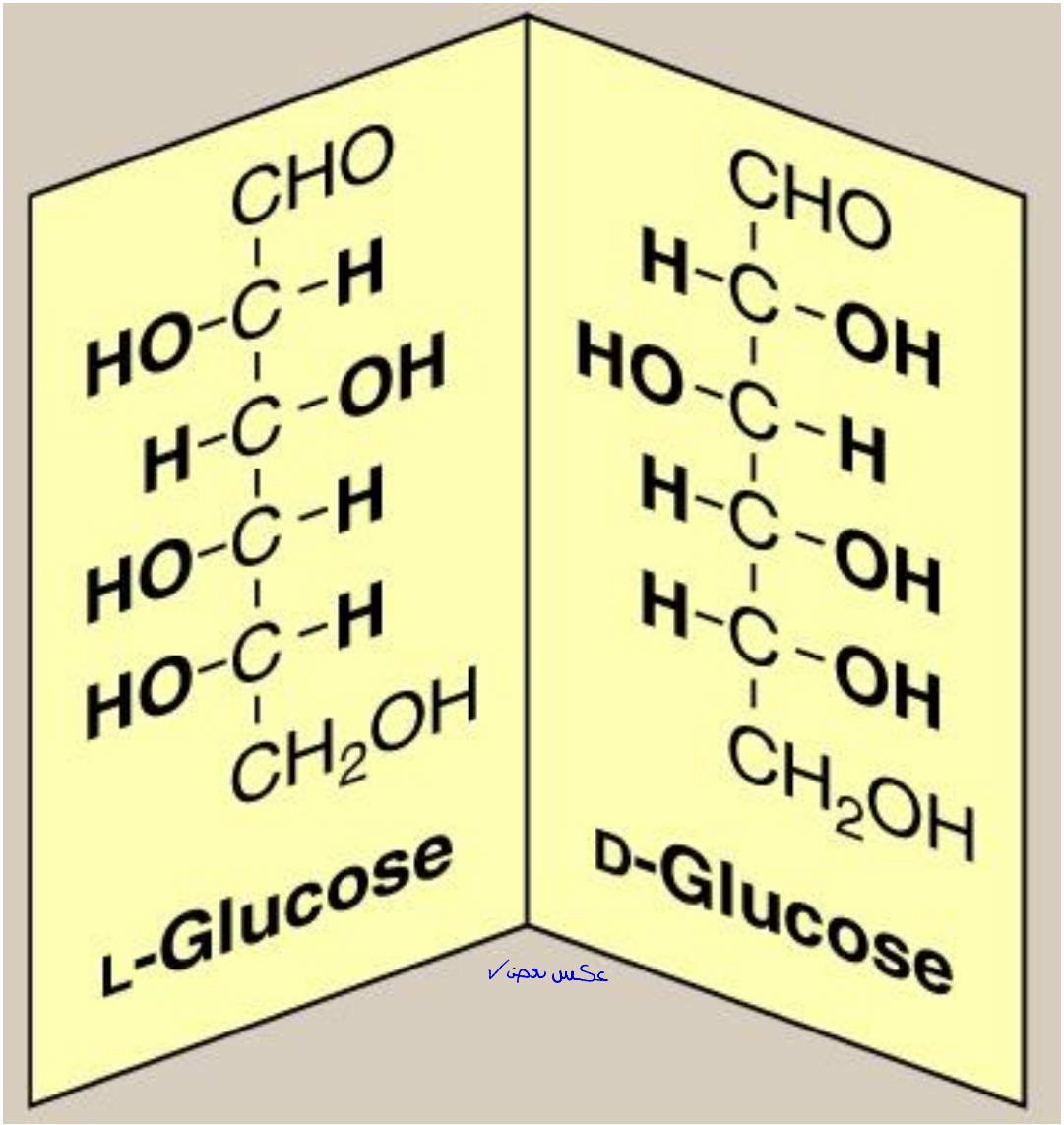
↳ 1 Chiral center change. **ONLY 1**.

Changing the orientation of one hydroxyl group will produce a different sugar

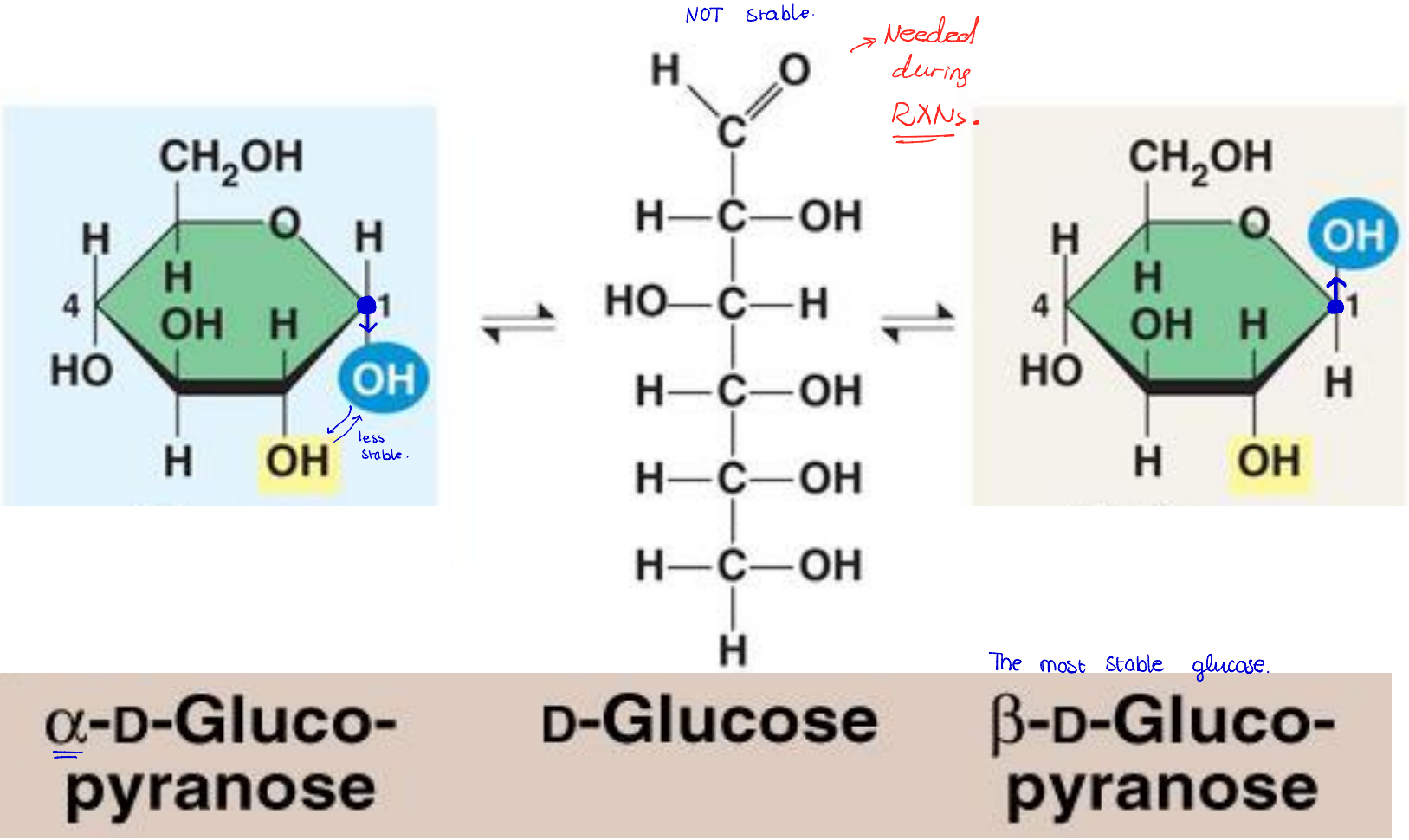
Glucose and Fructose are isomers

* enatumers? → mirror images.] same molecule → L / D → in our body.
* Diastereomers → NOT mirror images] some groups ar reversed and some are **NOT**.] different compounds

Enantiomers



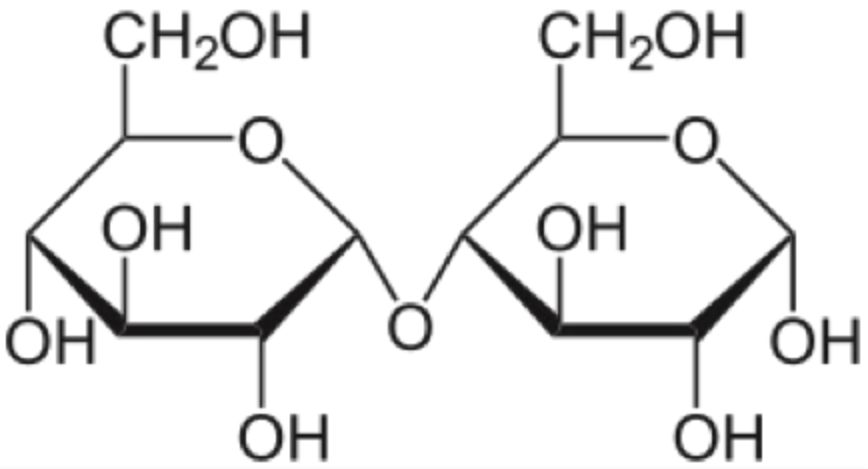
Alpha and Beta Sugars (Anomers)



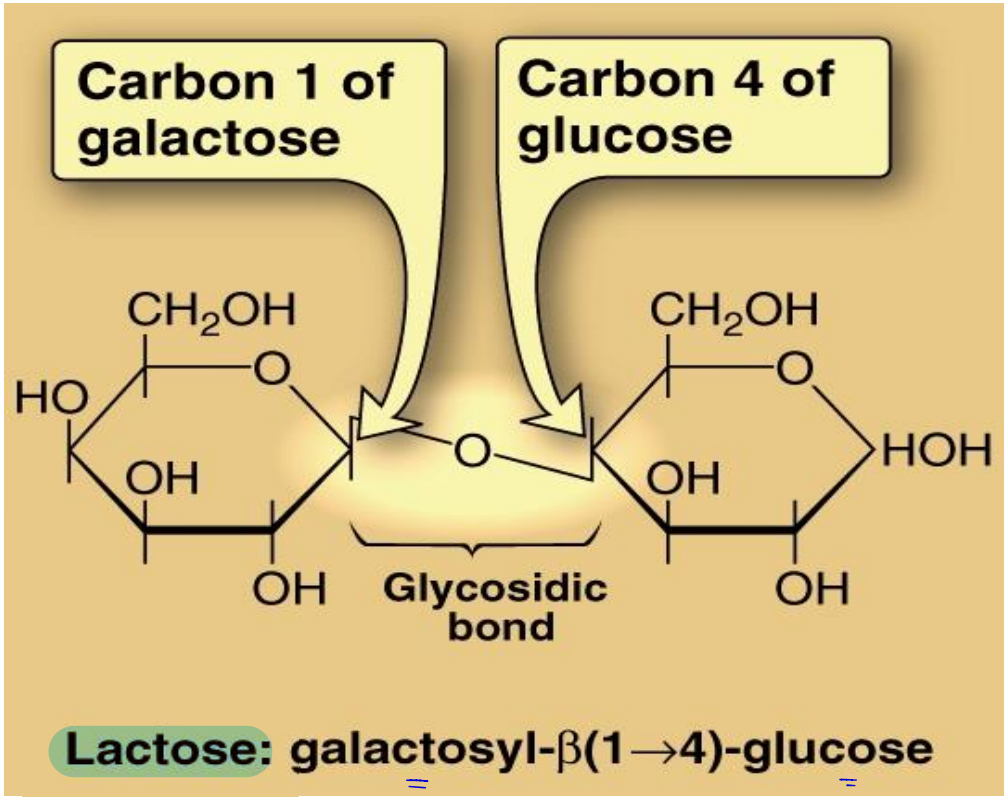
https://mysciencesquad.weebly.com/ib-hl-23a1--s1-cellulose--starch-v-glycogen.html

Disaccharides

Sugars made of two monosaccharide units joined by a glycosidic bond

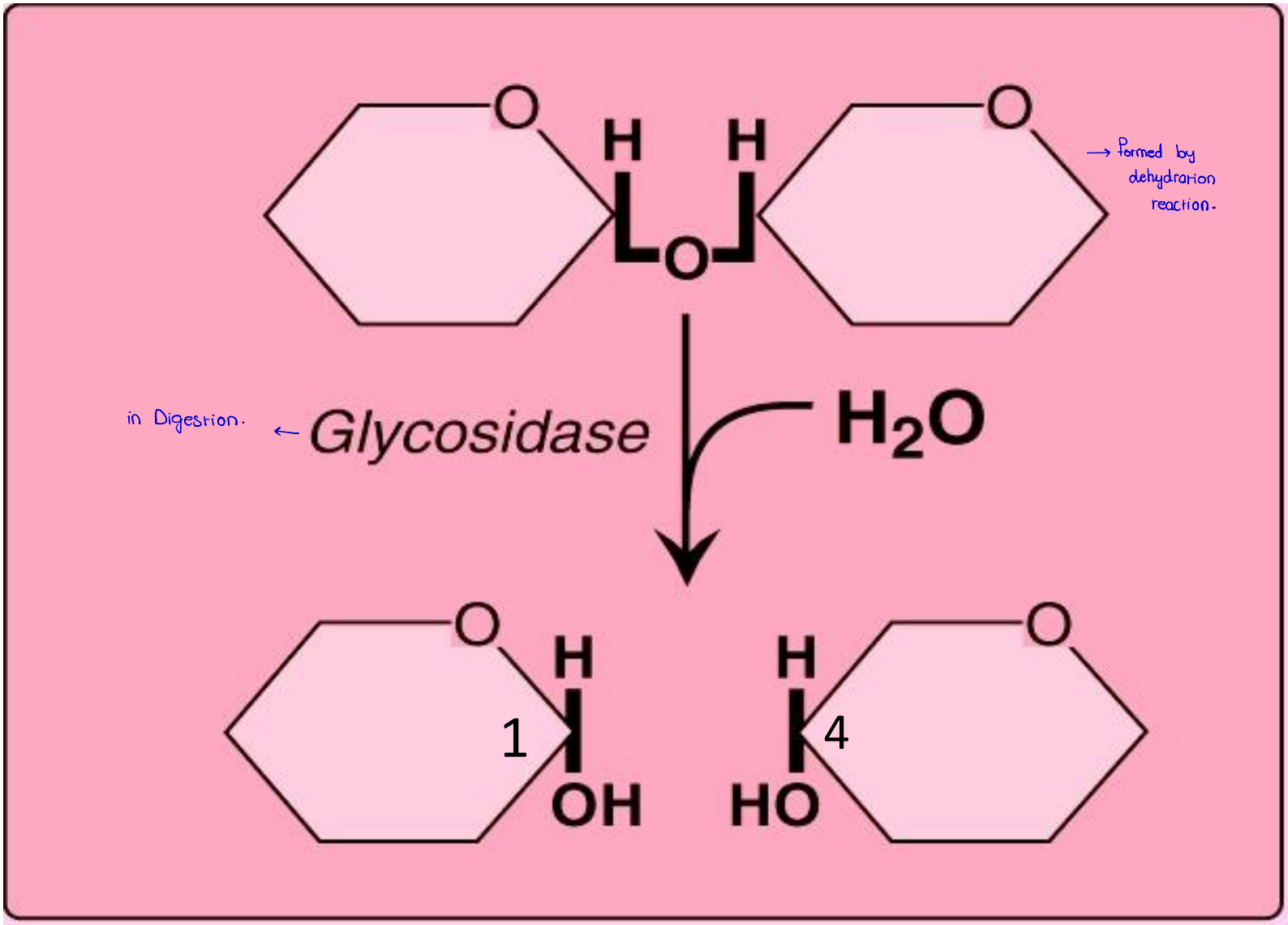


Maltose: a disaccharide made from two glucose units



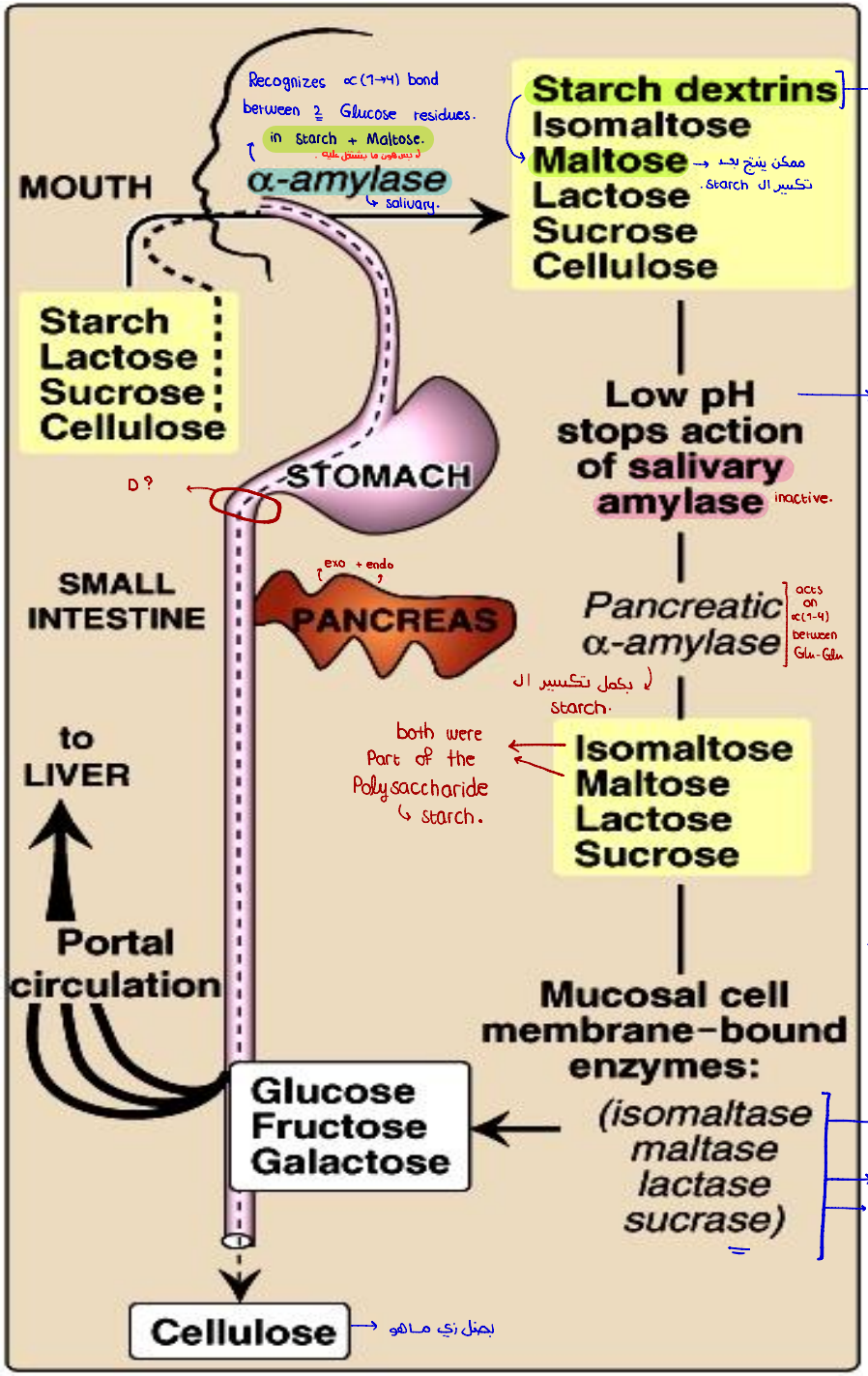
* Sucrose → ∝ Glucose (1→2) β fructose.

Glycosidic bond is cleaved by glycosidase enzyme



Digestion of Carbohydrates

"NOT metabolism".



smaller fragments — could give:
- Maltose
- isomaltose "α(1→6)"

ممكن ينتج بعد تكسير ال starch.

Pepsin enzyme is present too, BUT it is a protease.
ما الهدف بال sugars

acts on α(1-4) between Glu-Glu

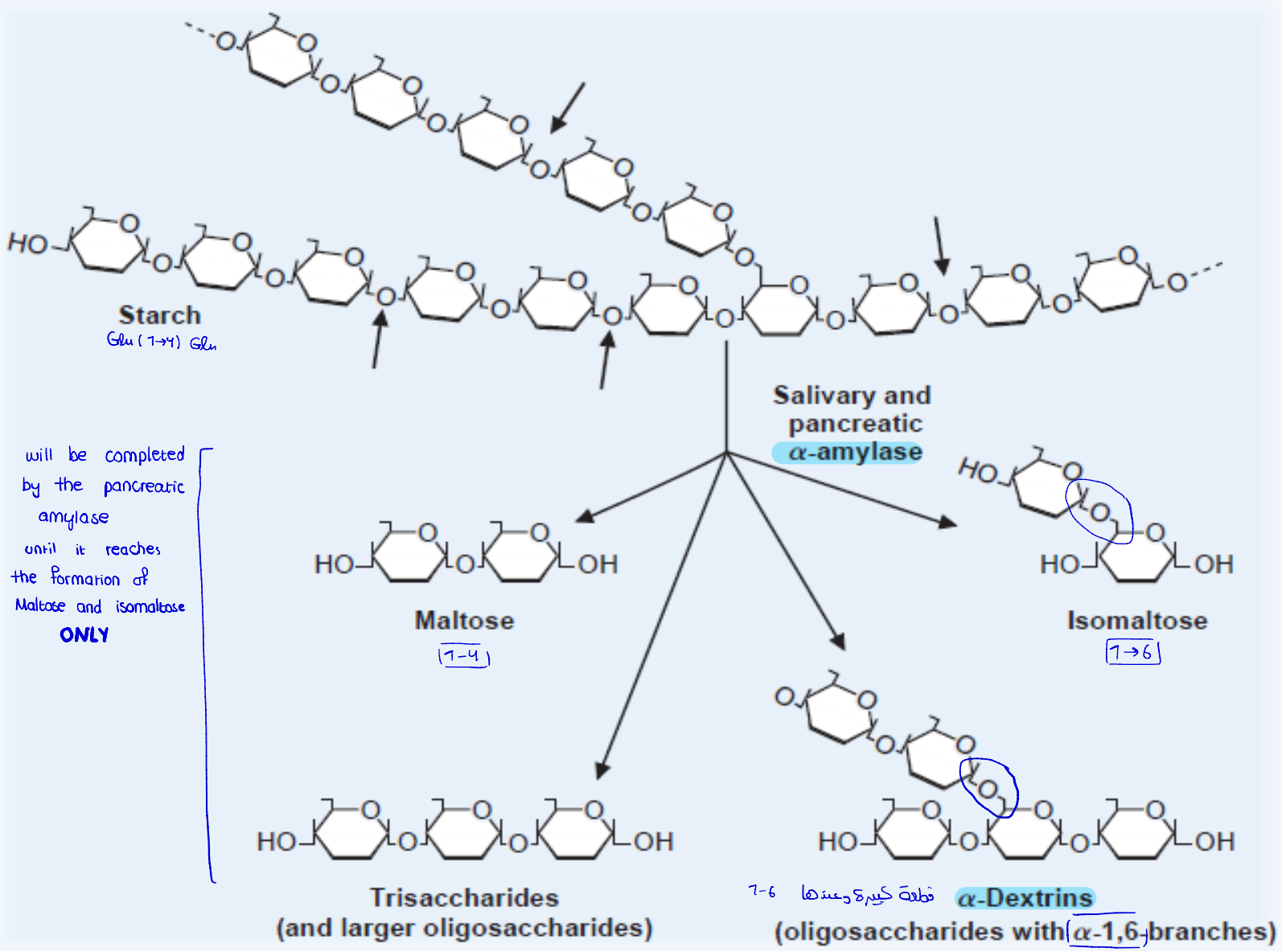
بكمل تكسير ال starch.

of the small intestine.

Act on All sugars — except for cellulose.
Poly → Di
Di → mono

بضل زي ما هو

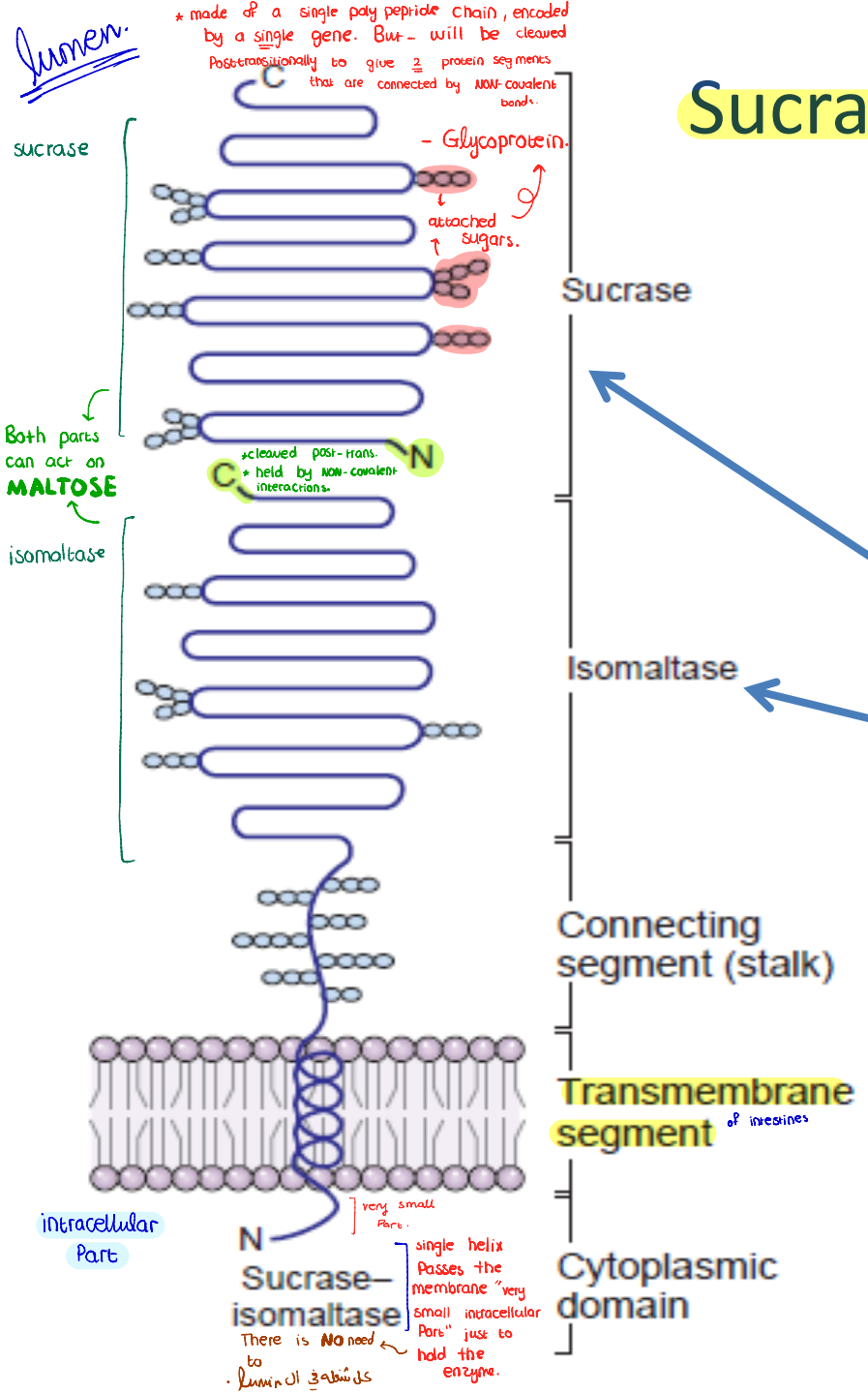
Starch Digestion



Mucosal cell membrane-bound enzymes

ENZYME	Bond Cleaved	Substrates
Isomaltase	α 1→ 6	Isomaltose
Maltase	α 1→ 4	Maltose
Sucrase	α 1→ 2	Sucrose to Fructose and glucose.
Lactase	β 1→ 4	Lactose to galactose and glucose.
Trehalase	α 1→ 1	Trehalose Glu 1→1 Glu. → NON Reducing. ∴ Sol. because both anomeric are Forming Bonds.
Exoglycosidase (Glucoamylase) they cleave the terminal bonds.	α 1→ 4 and α 1→ 6	Starch

Sucrase-isomaltase complex and Glucoamylase



* Sucrase + isomaltase
  Single protein → complex of two associated subunits
  -Sucrase-maltase
  - Isomaltase-maltase
  Together 80% of the maltase activity

* Maltase + exoglycosidase (glucoamylase): no split

The same as sucrase iso-maltase ... But NO posttranslational cleavage. 1 segment.

Sucrase-isomaltase complex

FIG. 27.5. The major portion of the sucrase–isomaltase complex, containing the catalytic sites, protrudes from the absorptive cells into the lumen of the intestine. Other domains of the protein form a connecting segment (stalk) and an anchoring segment that extends through the membrane into the cell. The complex is synthesized as a single polypeptide chain that is split into its two enzyme subunits extracellularly. Each subunit is a domain with a catalytic site (distinct sucrase–maltase and isomaltase–maltase sites). In spite of their maltase activity, these catalytic sites are often called just *sucrase* and *isomaltase*.

Clinical Hint: Abnormal Degradation of disaccharides

1. Sucrase-isomaltase deficiency:

- Causes:
  - Genetics → mutation → different levels. → depends on → the location of the mutation.
  - Variety of intestinal diseases → like in chron's disease. Death of the organ. → هاد هو السبب : because cells are lost less enzymes and transporters.
  - Malnutrition → NO substrate for the enzymes.
  - Injury of mucosa i.e by drugs → may be caused by chemotherapy causing: severe irritation that may cause cell death, with poor regeneration capacity...
  - Severe diarrhea → العجل؟ chrons? sugars, food will NOT stay in the intestin for along time → NO complete digestion.

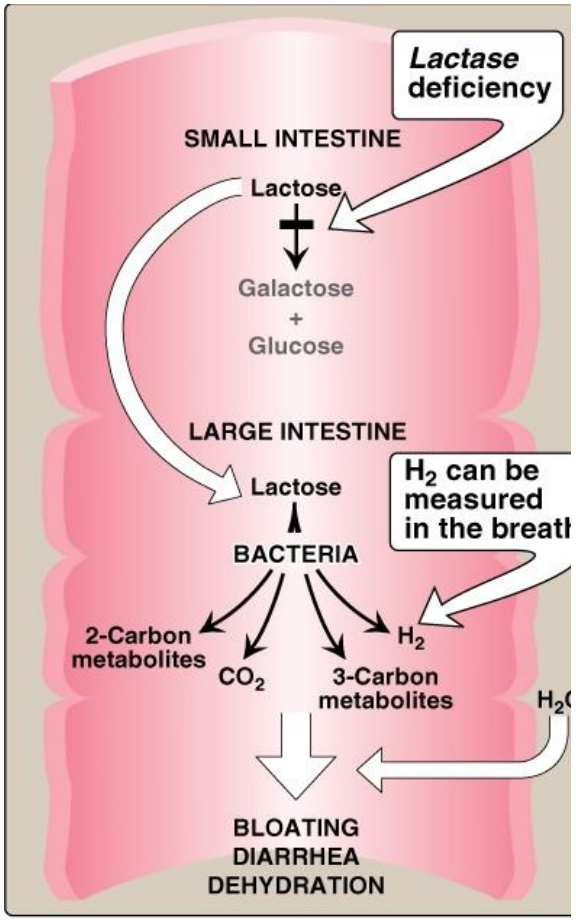
The same Result → food + sugars won't be exposed to the enzyme. → NO cleavage.

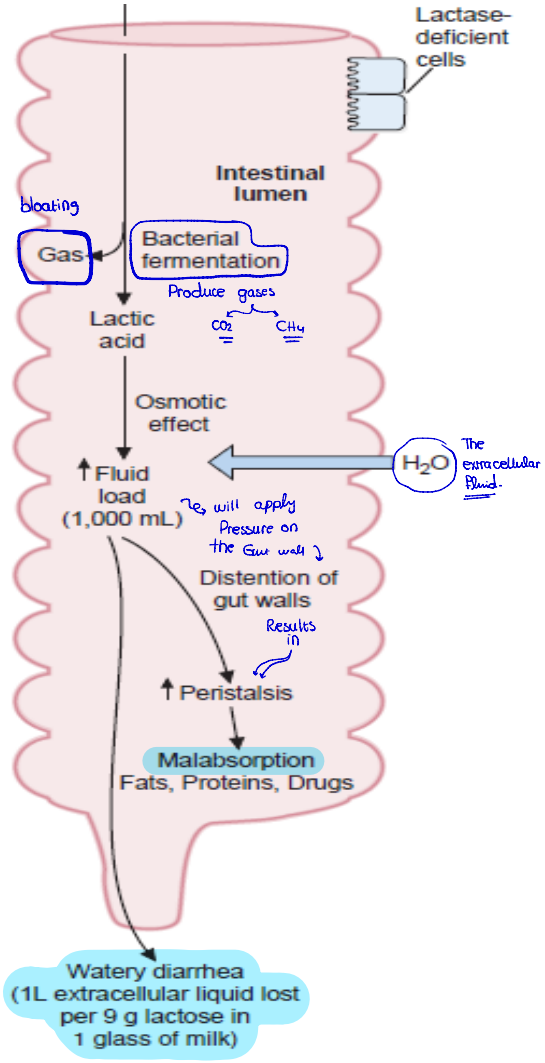
Absorption will be allected.

Clinical Hint: Abnormal Degradation of disaccharides

2. Lactase deficiency: ½ world's population

- ✓ Lactase reached maximal activity @ 1 month of age
  - The only food in their diet is Milk
  - The digestion is affected → ↓ Activity, ↓ enzymes.
- ✓ Declines ----- >> adult level at 5 to 7 year of age
  - Kids at 7 years have the same enzymatic activity as adults.
- ✓ 10 % of infant level ?
  - maybe that the activity is only 10 % the activity of an infant.
- ✓ 1 cup of milk (9 grams of lactose) → loss of 1 liter of extracellular fluid
  - 9 grams → need 1L of water to be absorbed from the extra cellular fluid to balance the osmotic pressure.





Absorption of Sugars

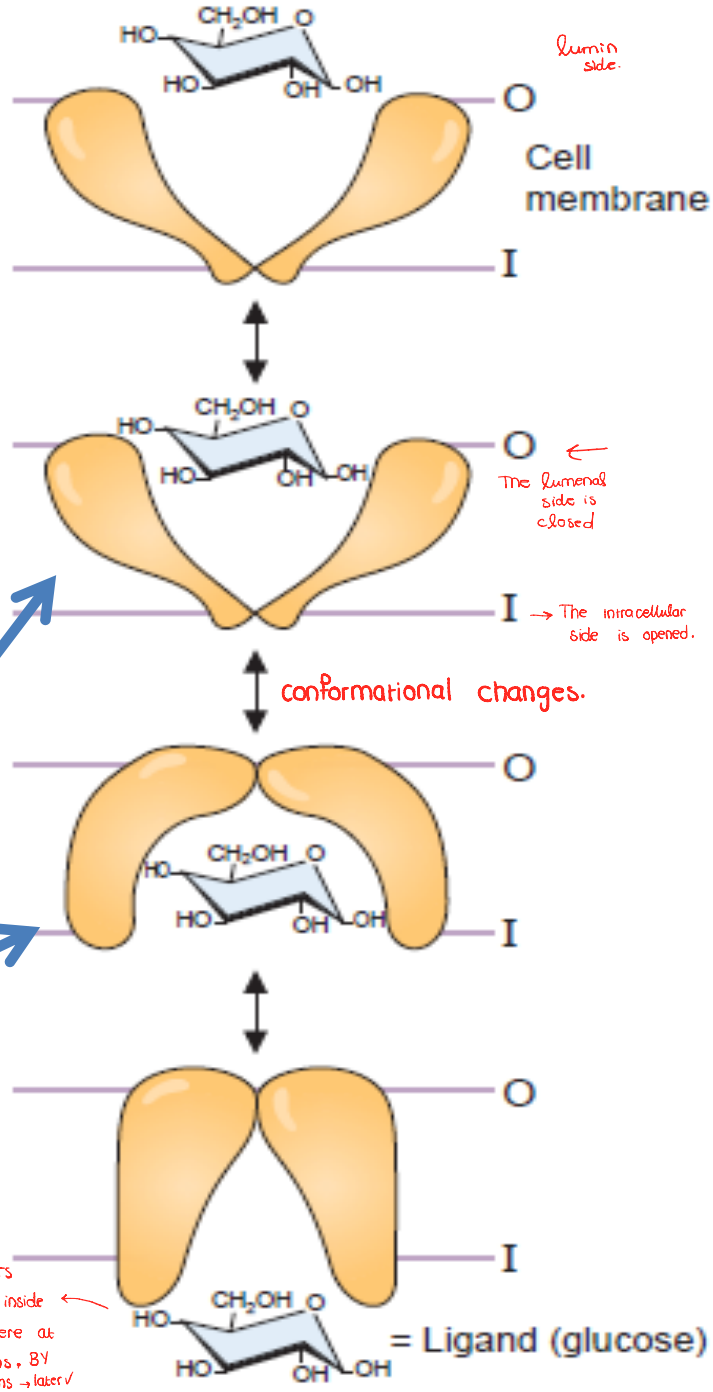
Polar molecules can not diffuse

A: Na^+-independent facilitated diffusion transport

GLUT 1-----GLUT 14

Glc. Movement follows concentration gradient

Two conformational states

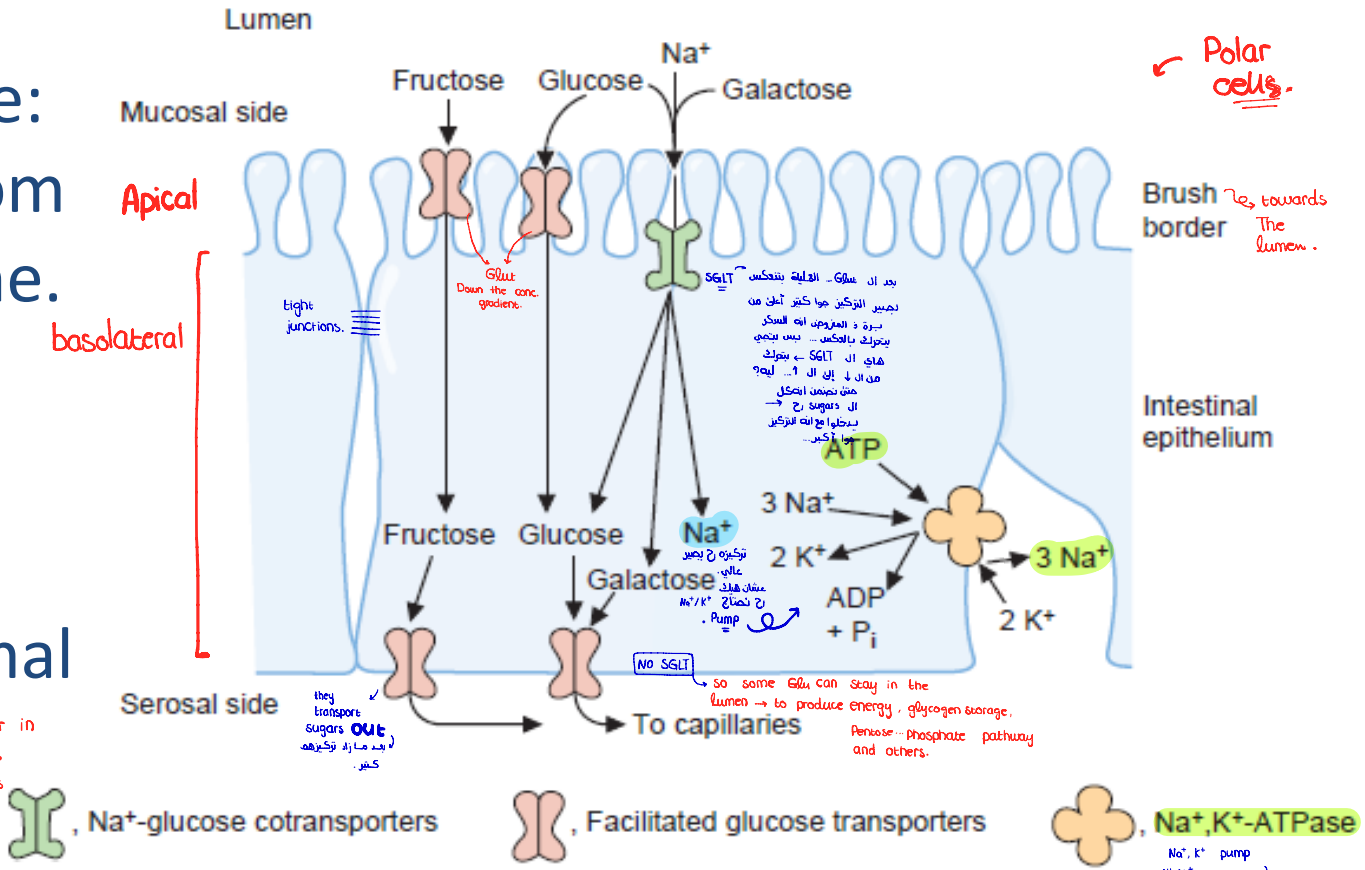


Na^+ monosaccharide cotranspoerter system (SGLT)

- Against concentration gradient (requires energy).

* Small intestine: Active uptake from lumen of intestine.

* Kidney: reabsorption of glucose in proximal tubule.



- For glucose and galactose absorption

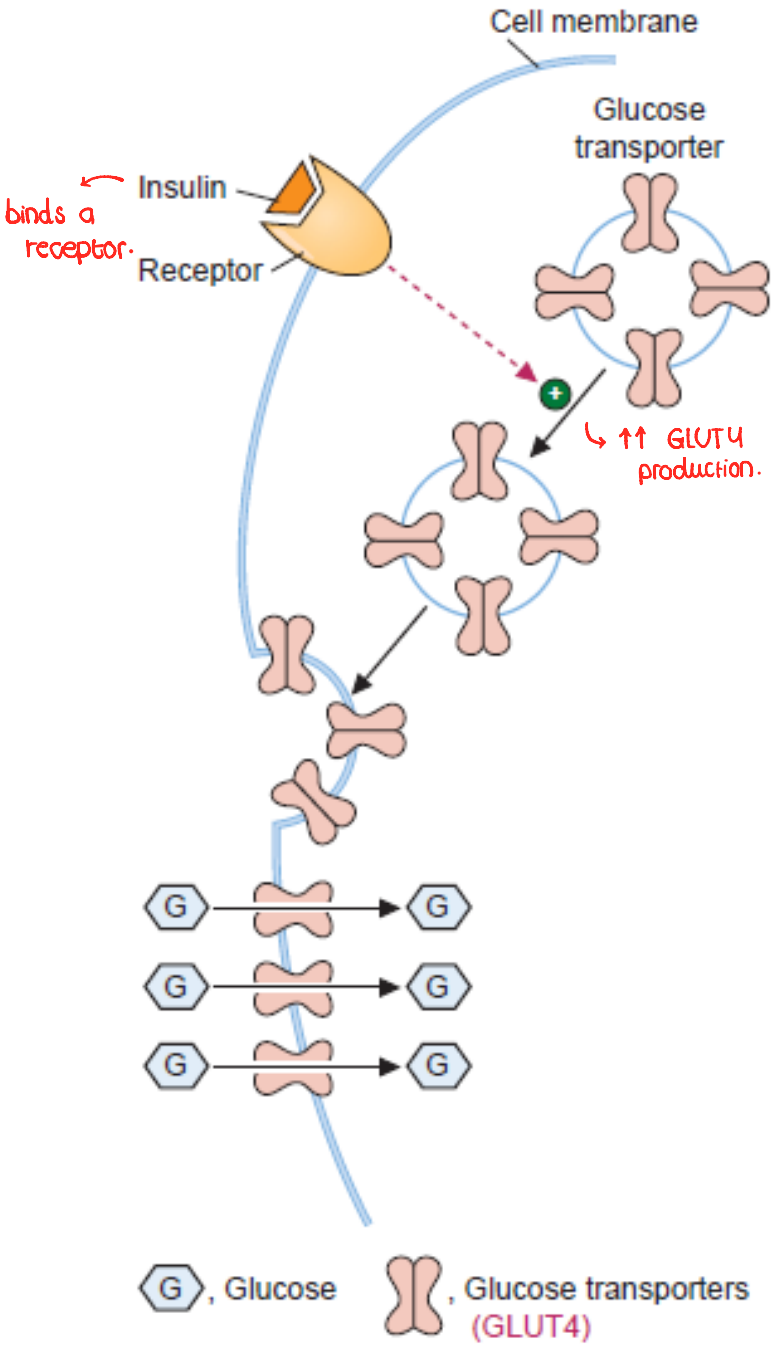
some examples of Glut's .]

All are membrane proteins except for Glut 7.

Table 27.5 Properties of the GLUT 1 to GLUT 5 Isoforms of the Glucose Transport Proteins

Transporter	Tissue Distribution	Comments
GLUT 1 * in barriers *	Human erythrocyte Blood–brain barrier Blood–retinal barrier Blood–placental barrier Blood–testis barrier	Expressed in cell types with barrier functions; a high-affinity glucose transport system
GLUT 2 → NON-specific → All sugars can enter. → high capacity "Fast". → low affinity of Glu. لأن كانت عالية كان هو ما بياخد غير ال Glucose. Glucose, galactose and fructose	Liver Kidney Pancreatic β-cell Serosal surface of intestinal mucosa cells	A high-capacity, low-affinity transporter May be used as the glucose sensor in the pancreas (Basolateral surface)
GLUT 3	Brain (neurons)	Major transporter in the central nervous system, a high-affinity system
GLUT 4	Adipose tissue Skeletal muscle Heart muscle	Insulin-sensitive transporter. In the presence of insulin, the number of GLUT 4 transporters increases on the cell surface; a high-affinity system
GLUT 5 Fructose	Intestinal epithelium Spermatozoa → use Fructose ONLY	This is actually a fructose transporter Na independent
GLUT 7] Found on ER membrane.	Glucogenic tissues	at endoplasmic reticulum membrane

insulin binds to a receptor on target cells: "RTK" → Activates its signaling pathway that involves the activation of many proteins → Activate the gene expression of many genes → one of them is Glut 4. → بتصير بكميات كبيرة هتتزيد ال Glu اللي زايد.



Insulin stimulates transport of glucose into muscle and adipose tissues