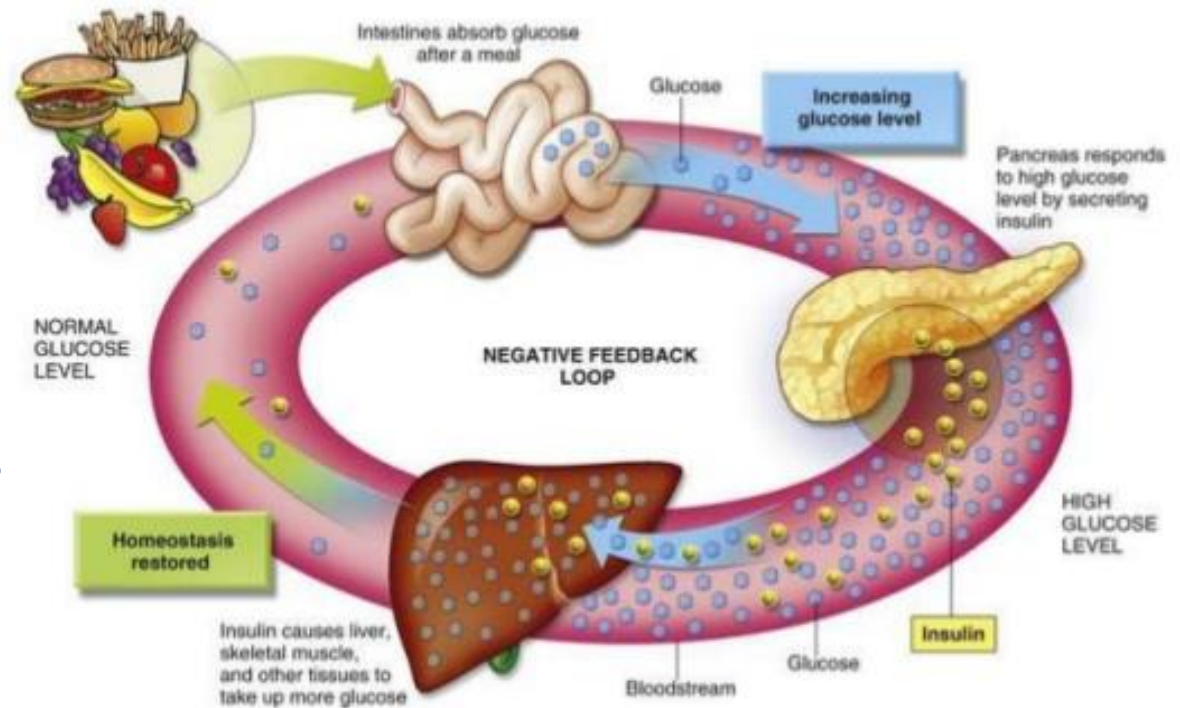
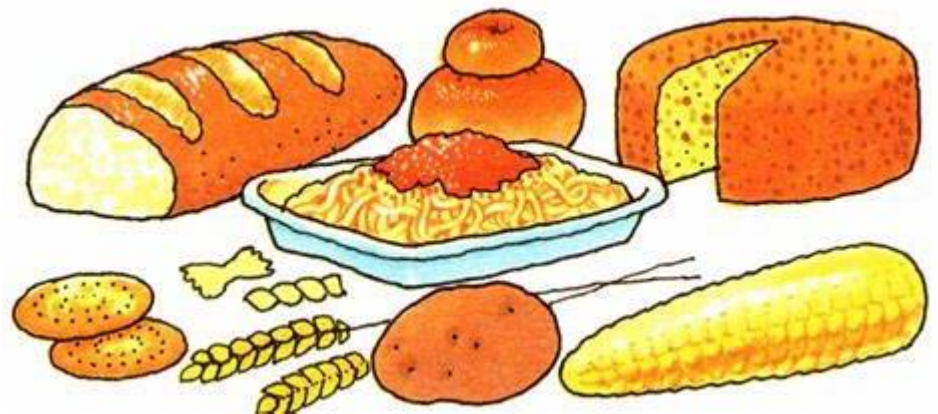


Carbohydrates Metabolism



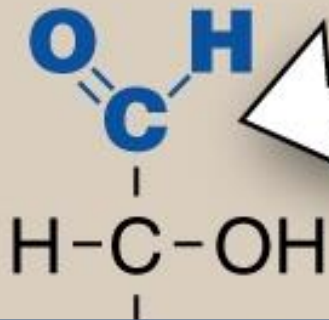
Review of Carbohydrates
Digestion and absorption of carbohydrates

Dr. Diala Abu-Hassan



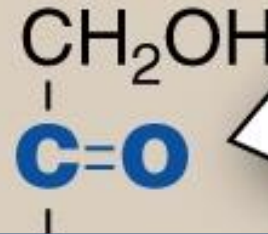
Sugars are either
aldoses or ketoses

A Aldehyde group



Ribose
Glucose

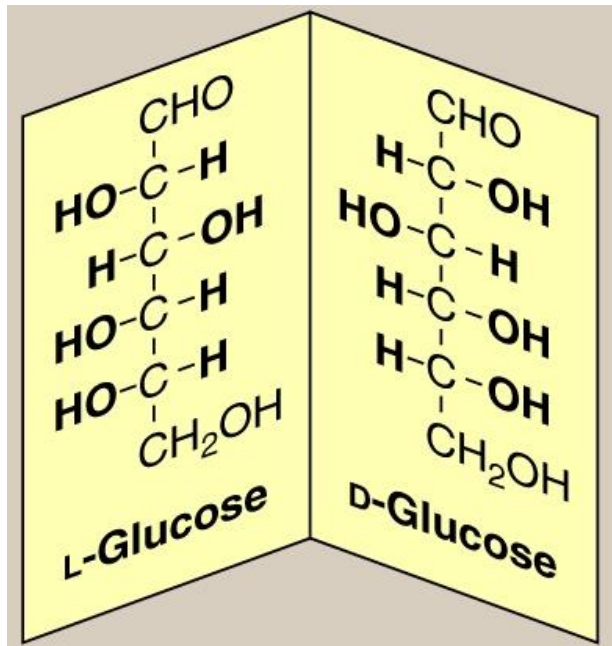
B Keto group



Ribulose
Fructose

Examples of monosaccharides found in humans

Enantiomers



Generic names

3 carbons: trioses

4 carbons: tetroses

5 carbons: pentoses

6 carbons: hexoses

7 carbons: heptoses

9 carbons: nonoses

Examples

Glyceraldehyde

Erythrose

Ribose

Glucose

Sedoheptulose

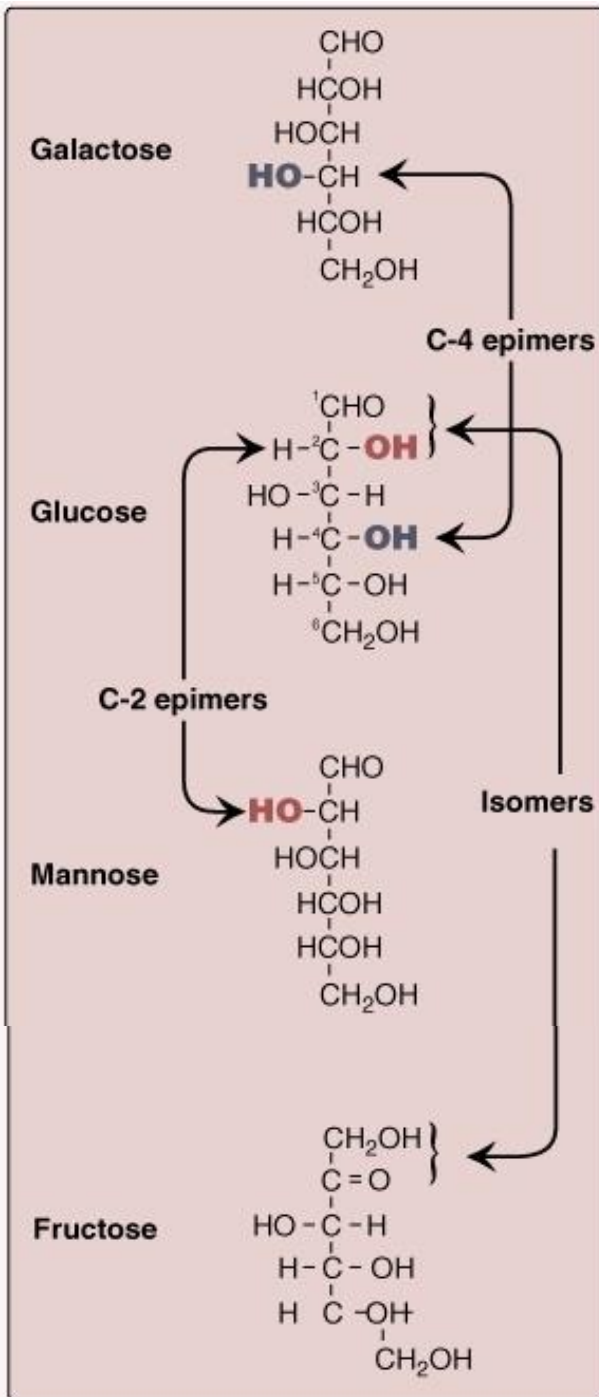
Neuraminic acid

Sugars have Isomers

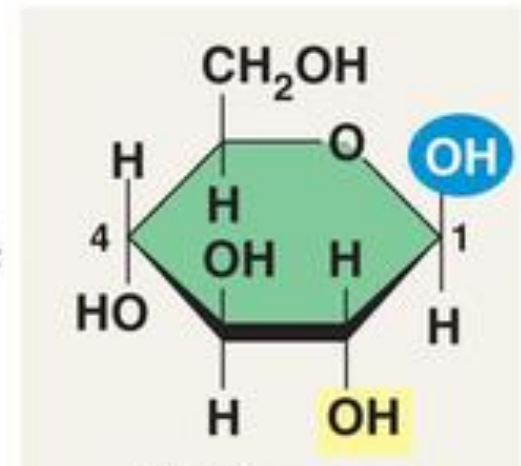
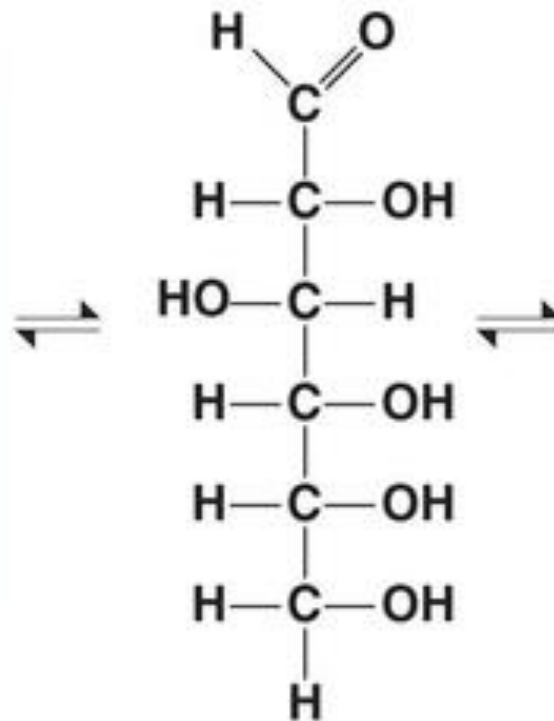
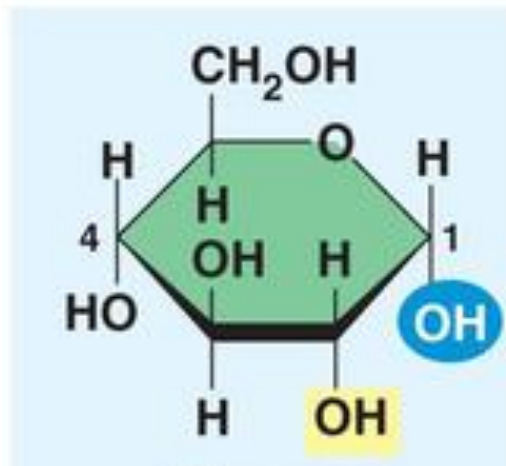
Epimers are isomers:

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

Glucose and Fructose are isomers



Alpha and Beta Sugars (Anomers)



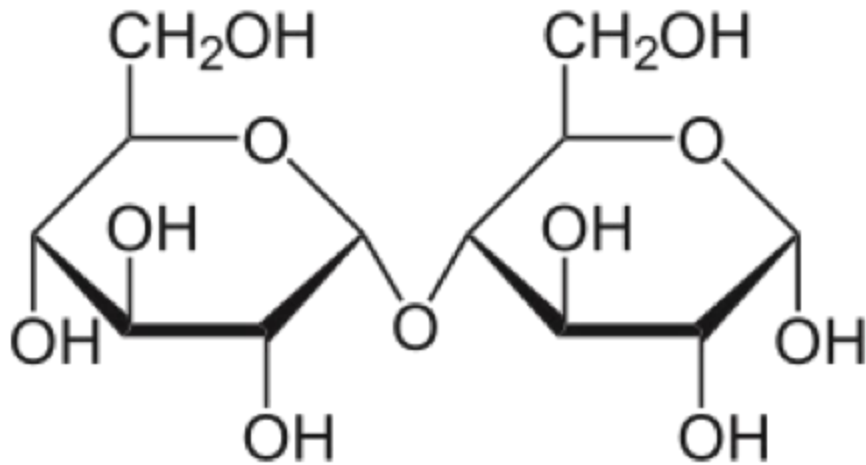
α -D-Glucopyranose

D-Glucose

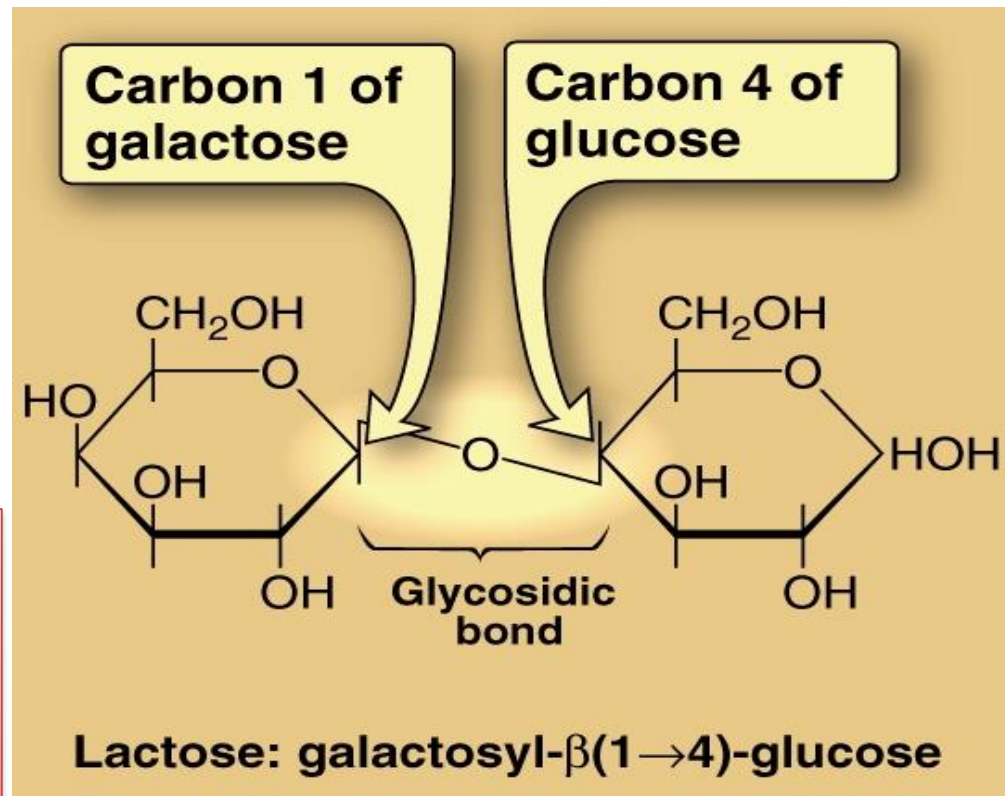
β -D-Glucopyranose

Disaccharides

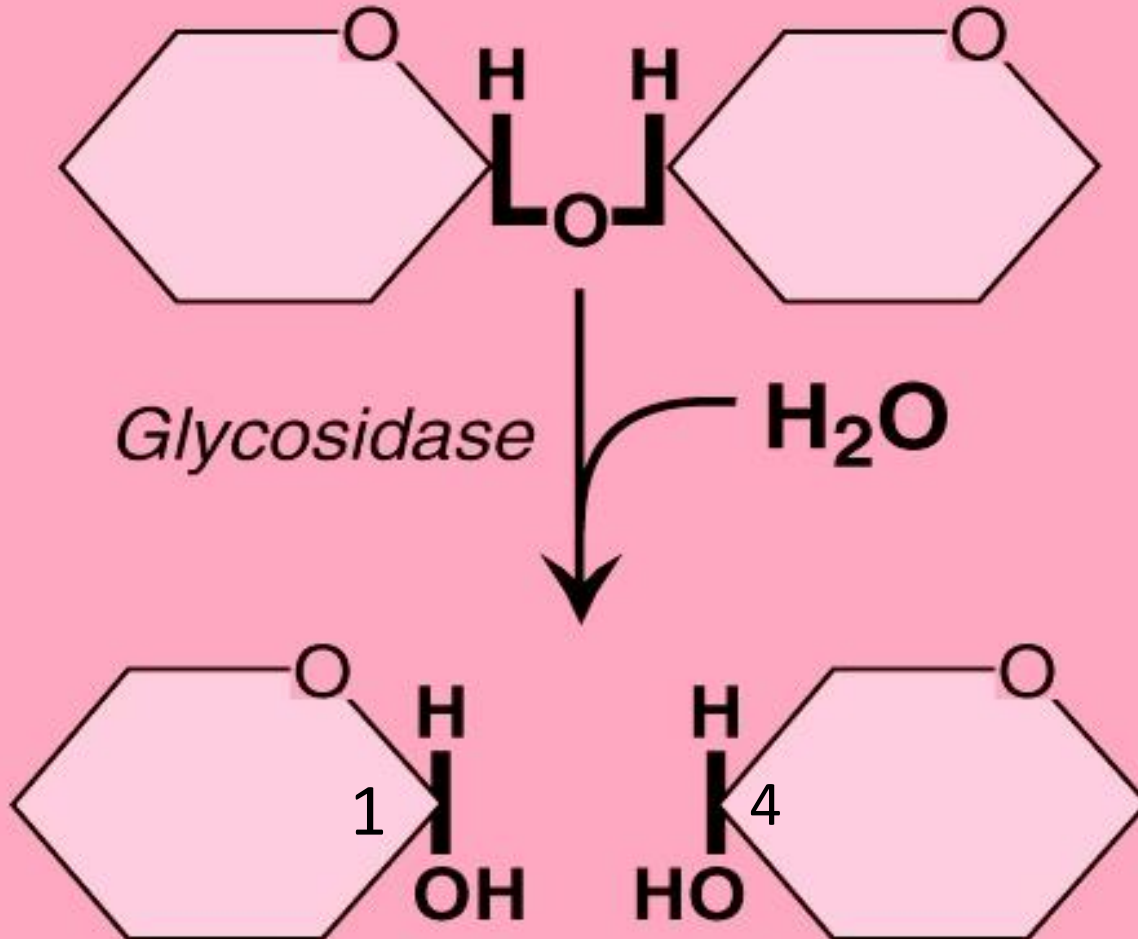
Sugars made of two monosaccharide units joined by a glycosidic bond



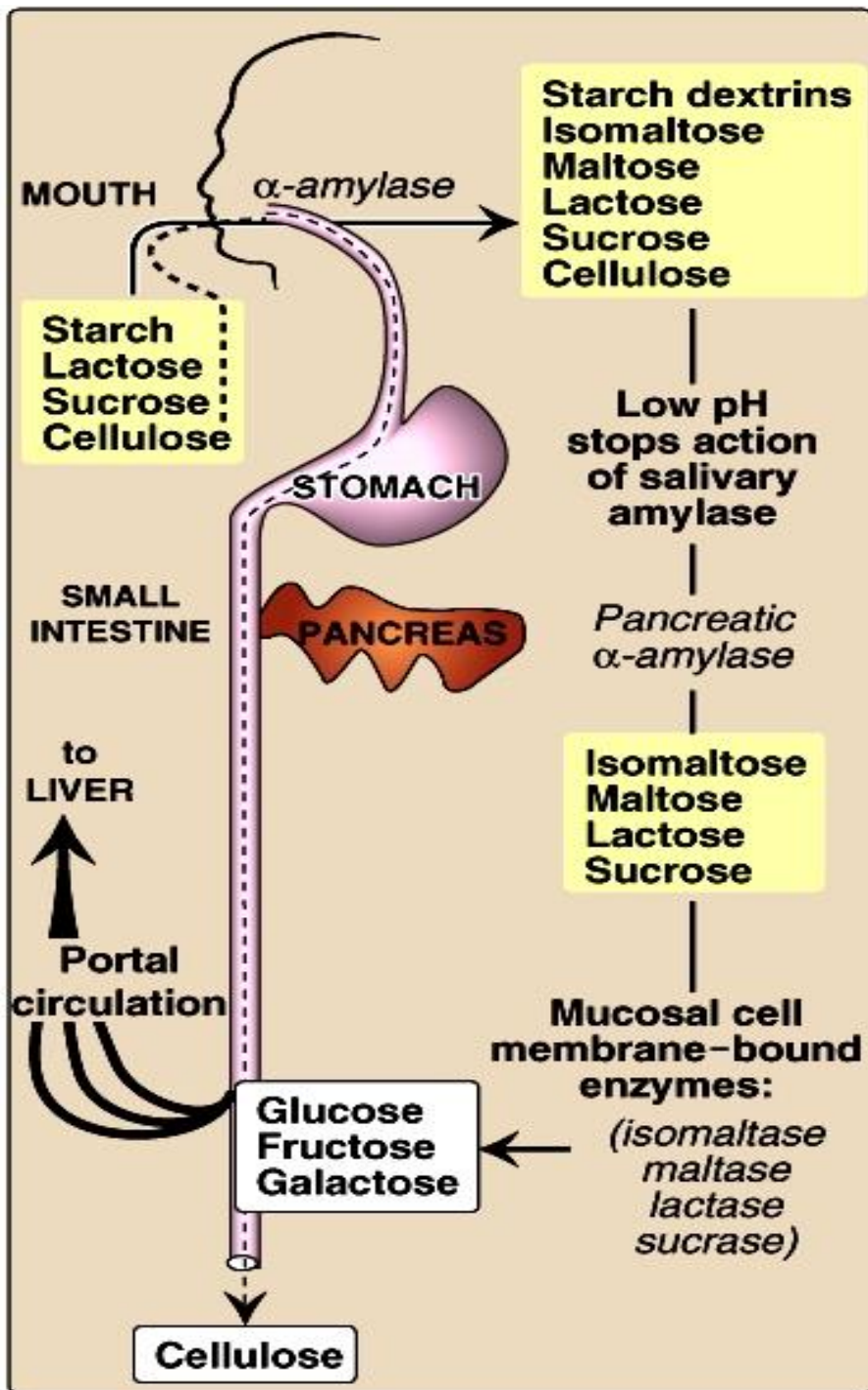
Maltose: a disaccharide made from two glucose units



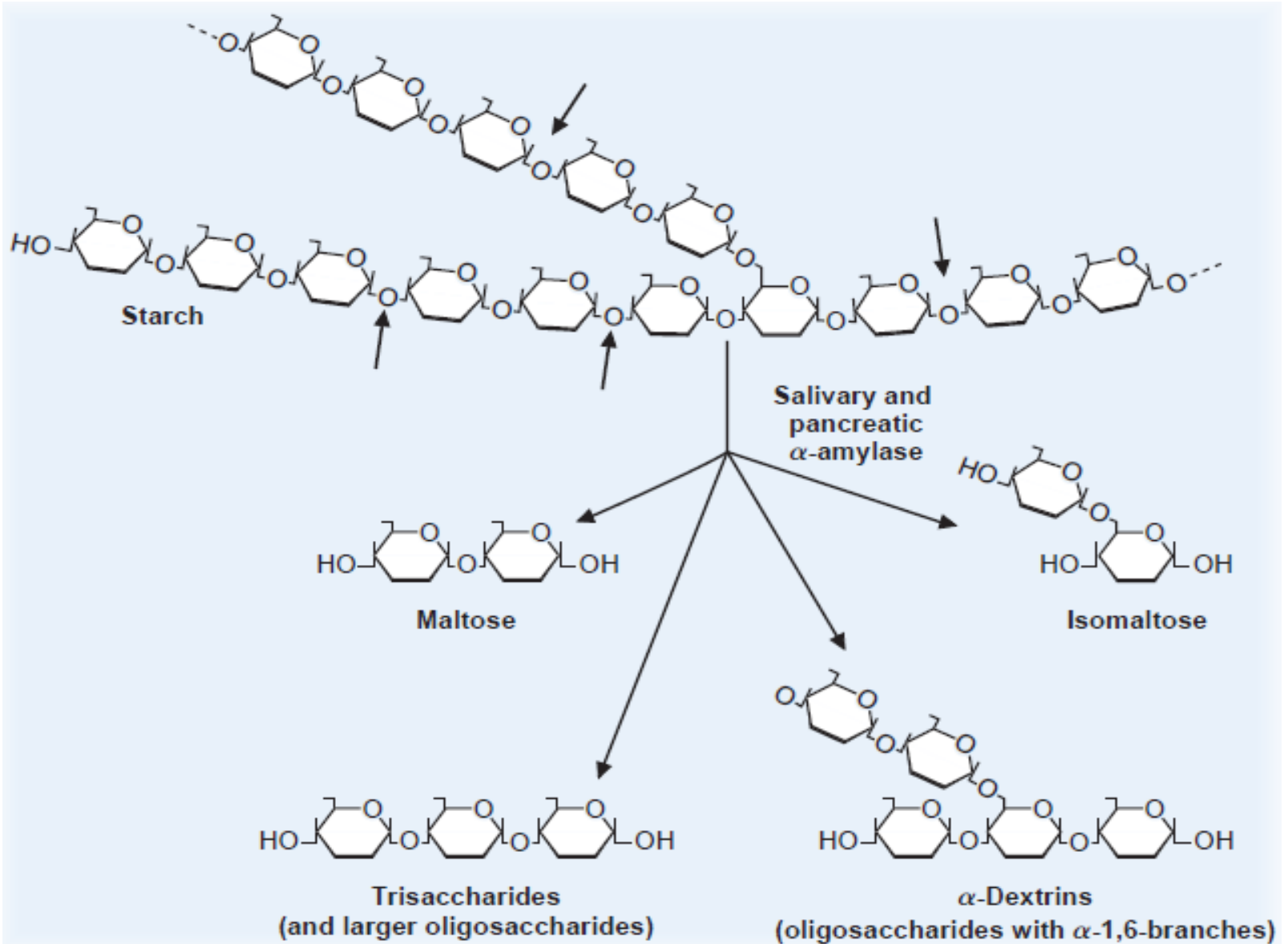
Glycosidic bond is cleaved by glycosidase enzyme



Digestion of Carbohydrates



Starch Digestion



Mucosal cell membrane-bound enzymes

ENZYME	Bond Cleaved	Substrates
Isomaltase	α 1 \rightarrow 6	Isomaltose
Maltase	α 1 \rightarrow 4	Maltose
Sucrase	α 1 \rightarrow 2	Sucrose
Lactase	β 1 \rightarrow 4	Lactose
Trehalase	α 1 \rightarrow 1	Trehalose
Exoglycosidase (Glucoamylase)	α 1 \rightarrow 4 and α 1 \rightarrow 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

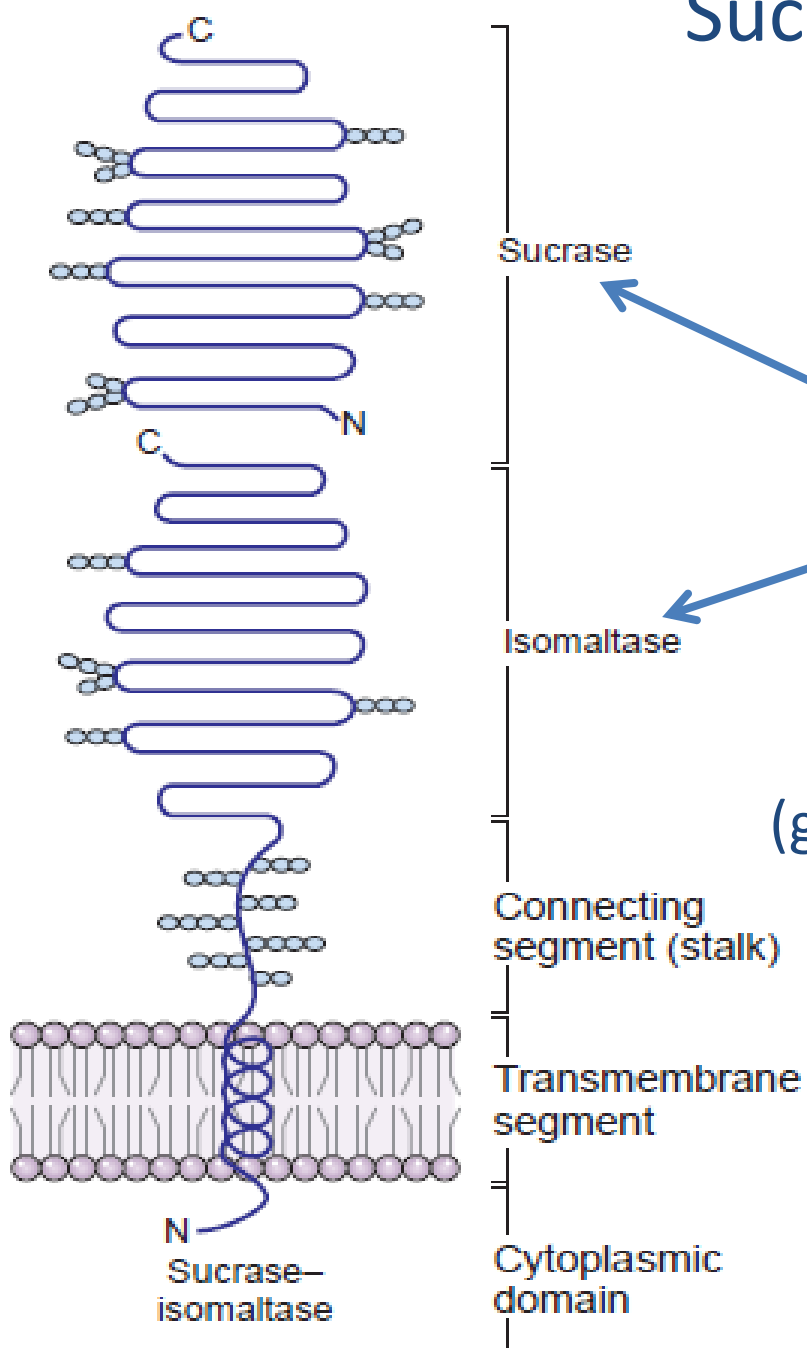


FIG. 27.5. The major portion of the sucrase–isomaltase complex, containing the catalytic sites, protrudes from the absorptive cells into the lumen of the intestine. Other domains of the protein form a connecting segment (stalk) and an anchoring segment that extends through the membrane into the cell. 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*.

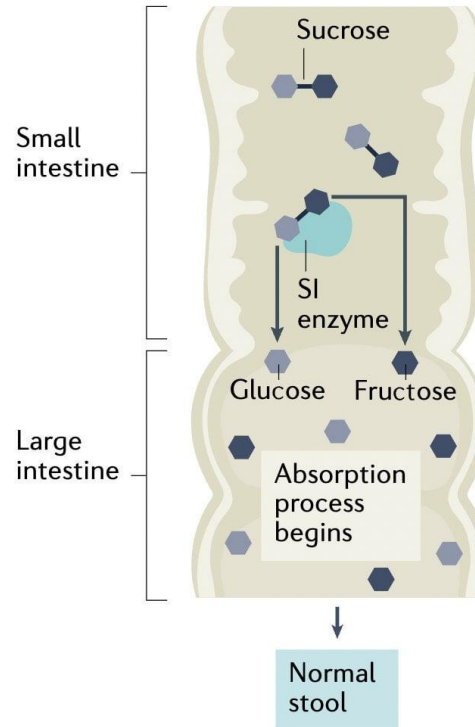
Clinical Hint: Abnormal Degradation of disaccharides

1. Sucrase-isomaltase deficiency:

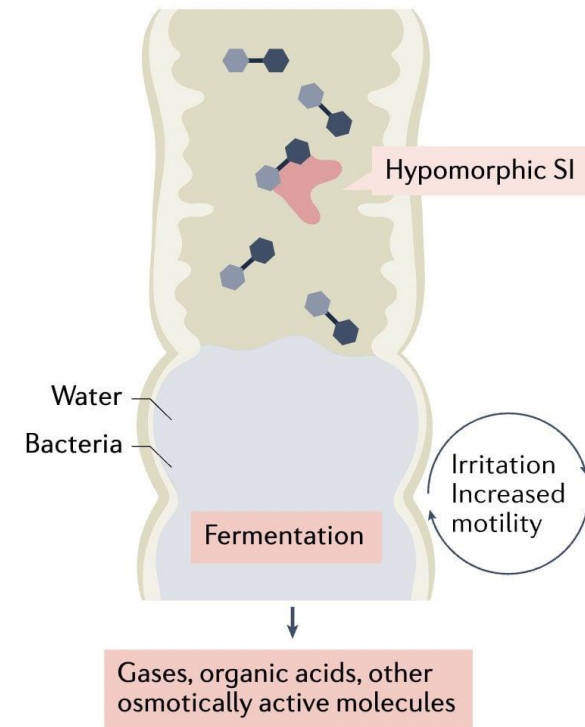
Causes:

- Genetics
- Variety of intestinal diseases
- Malnutrition
- Injury of mucosa i.e by drugs
- Severe diarrhea

c SI carbohydrate breakdown



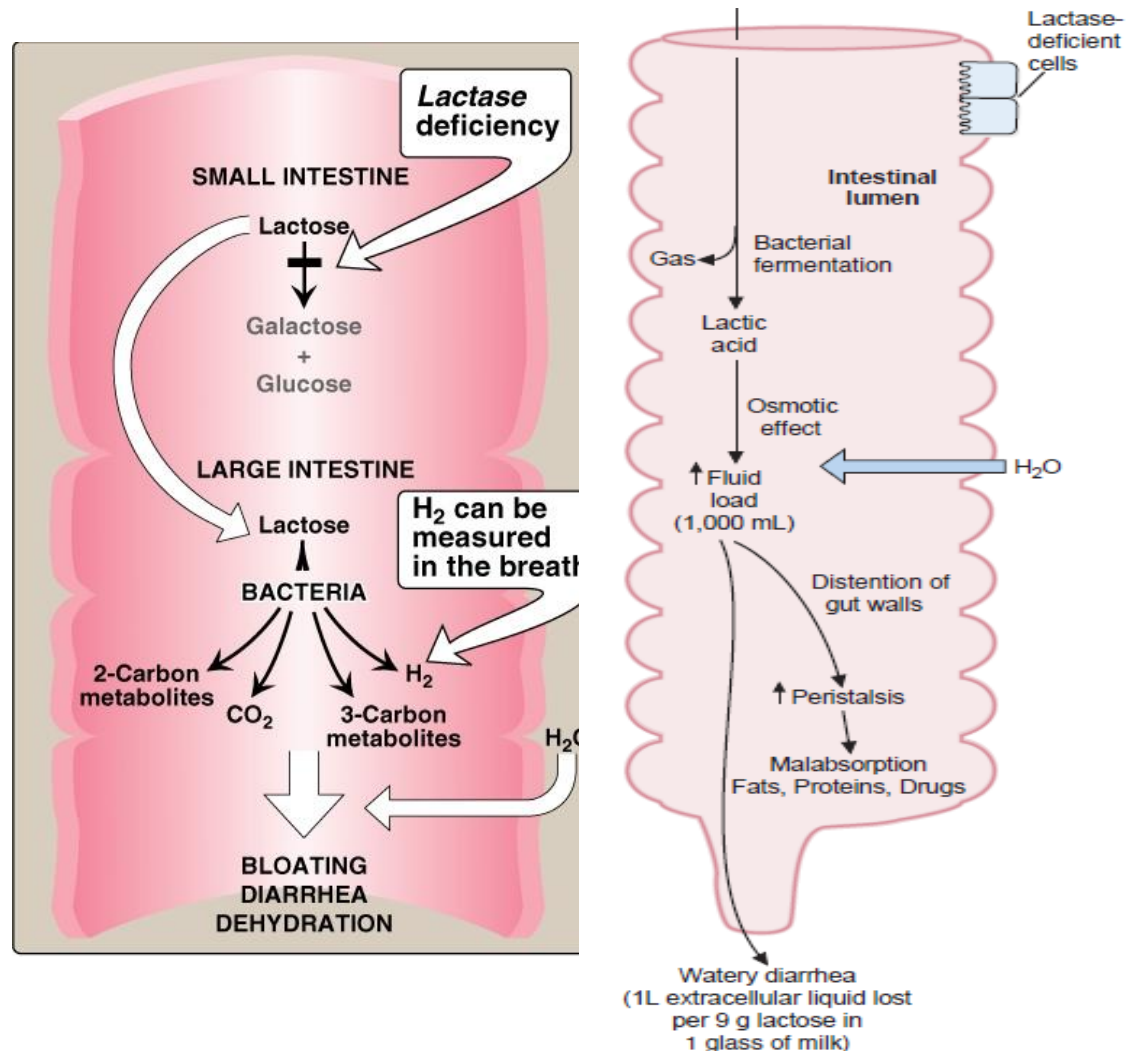
CSID and IBS risk variants



Clinical Hint: Abnormal Degradation of disaccharides

2. Lactase deficiency: ½ world's population

- ✓ Lactase reached maximal activity @ 1 month of age
- ✓ Declines ----- >> adult level at 5 to 7 year of age
- ✓ 10 % of infant level
- ✓ 1 cup of milk (9 grams of lactose) → loss of 1 liter of extracellular fluid



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

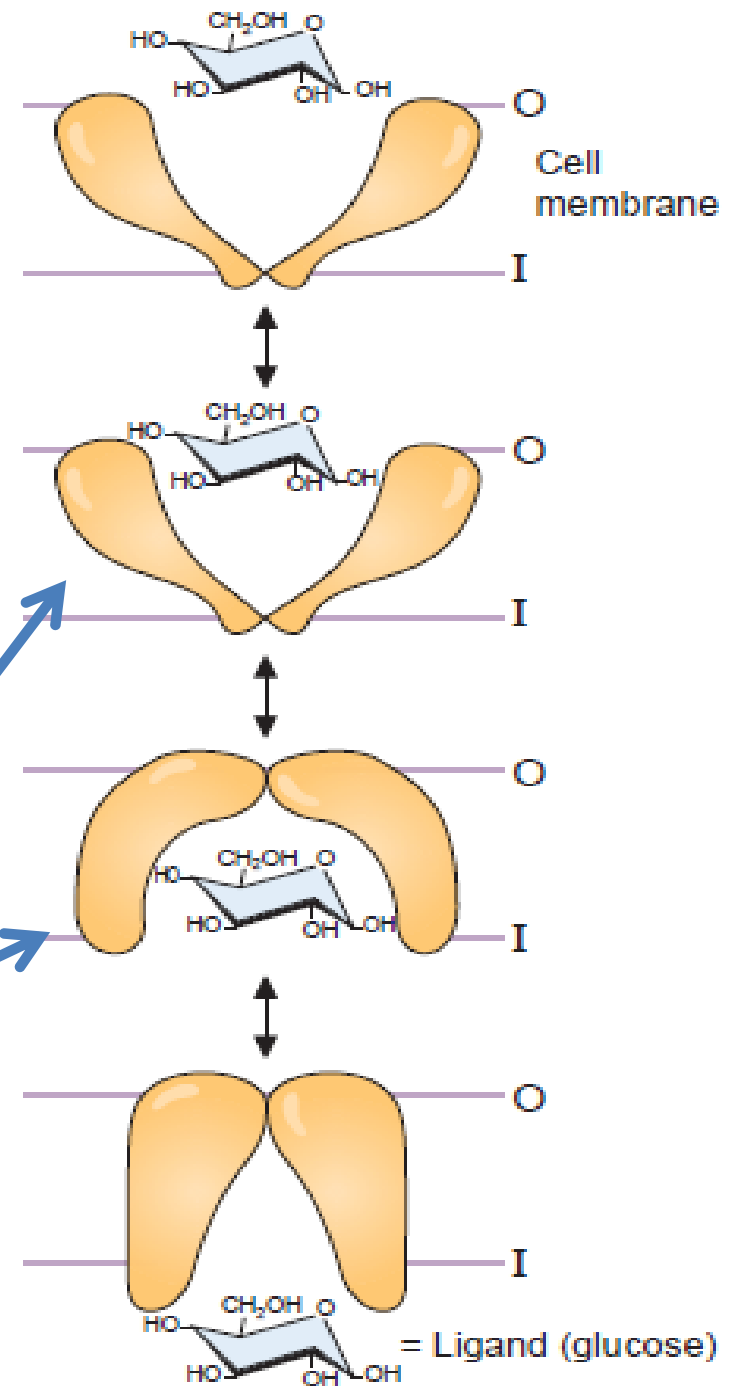
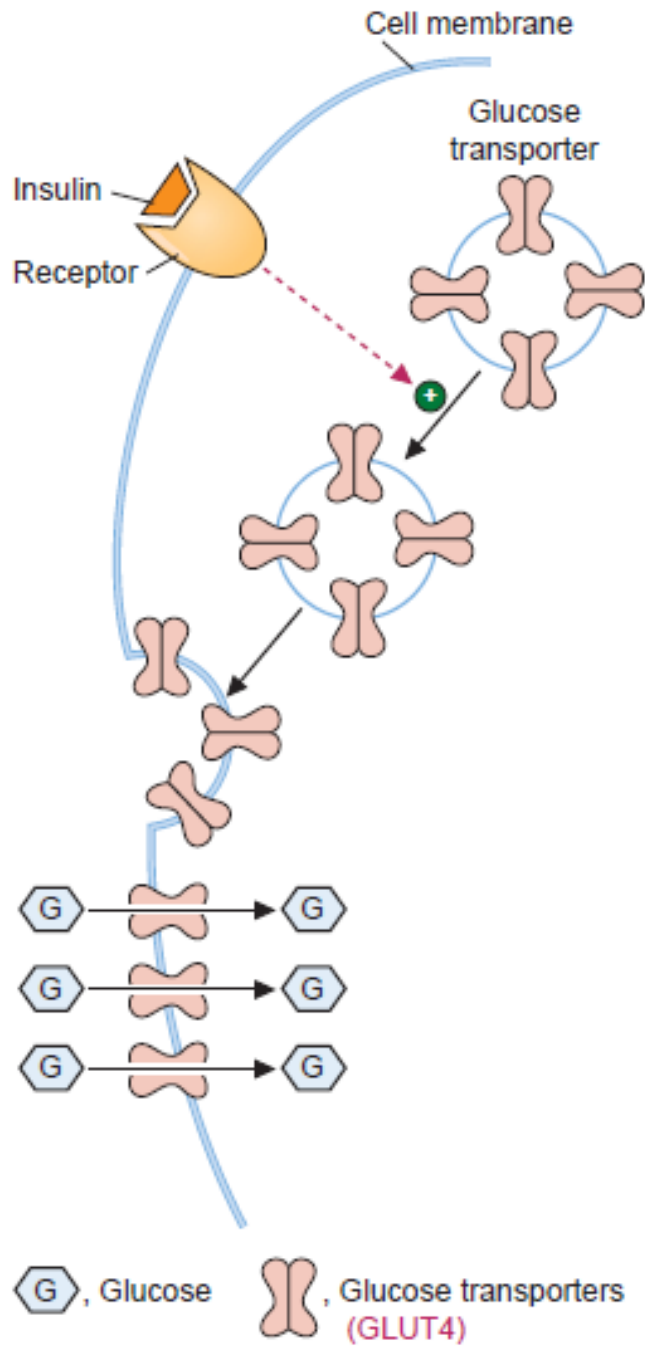


Table 27.5 Properties of the GLUT 1 to GLUT 5 Isoforms of the Glucose Transport Proteins

<i>Transporter</i>	<i>Tissue Distribution</i>	<i>Comments</i>
GLUT 1	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 Glucose, galactose and fructose	Liver Kidney Pancreatic β -cell Serosal surface of intestinal mucosa cells (Basolateral surface)	A high-capacity, low-affinity transporter May be used as the glucose sensor in the pancreas
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	This is actually a fructose transporter Na independent
GLUT 7	Glucogenic tissues	at endoplasmic reticulum membrane



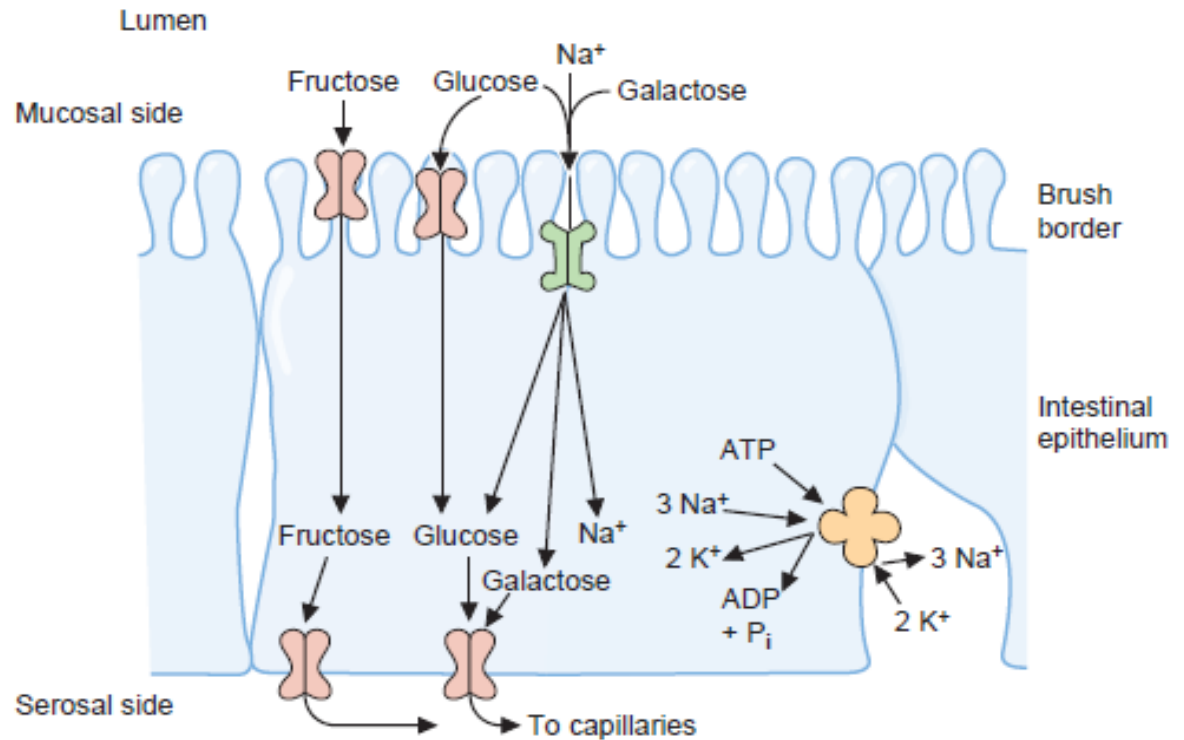
Insulin stimulates transport of glucose into muscle and adipose tissues

Na⁺ monosaccharide cotransporter system (SGLT)

- Against concentration gradient (requires energy).

* Small intestine:
Active uptake from lumen of intestine.

* Kidney:
reabsorption of glucose in proximal tubule.



, Na⁺-glucose cotransporters



, Facilitated glucose transporters



, Na⁺,K⁺-ATPase

- For glucose and galactose absorption