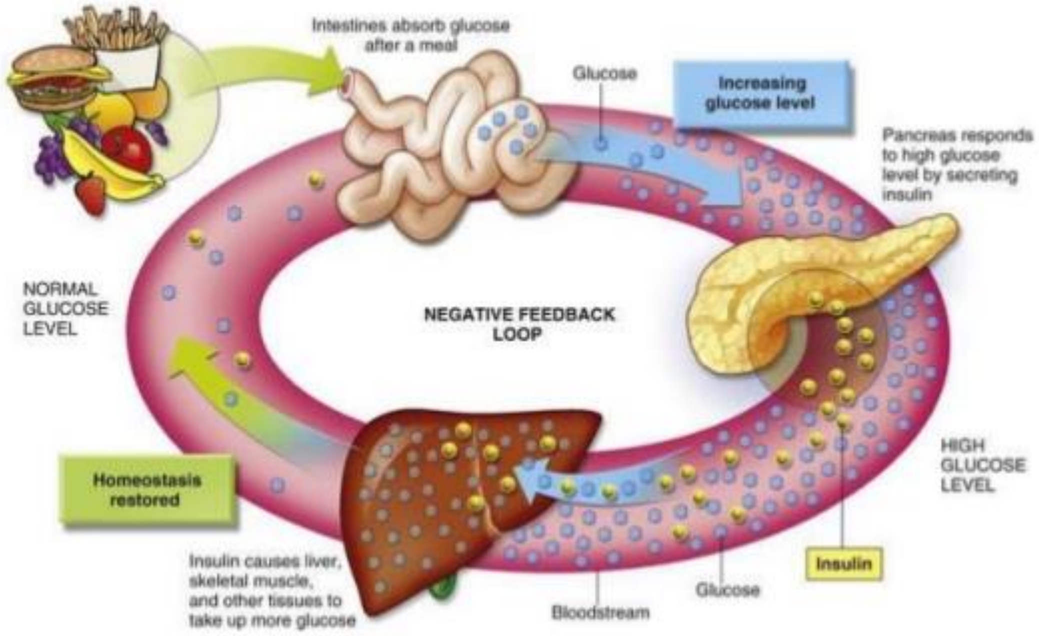


Carbohydrates Metabolism

Dr. Diala Abu-Hassan

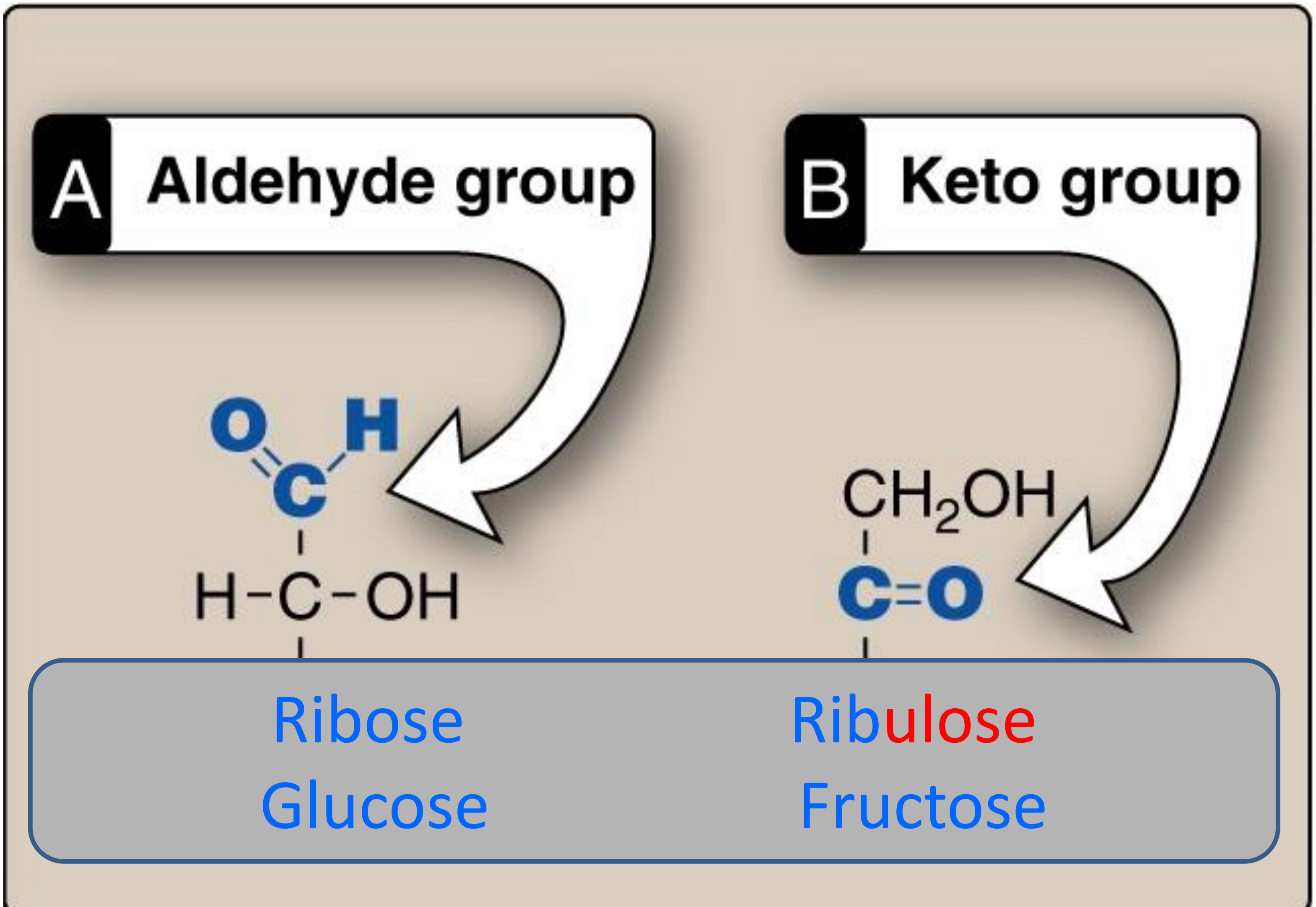
Review of Carbohydrates
Digestion and absorption of carbohydrates

Suggested Readings:

1: Lippincott's Illustrated reviews: Biochemistry

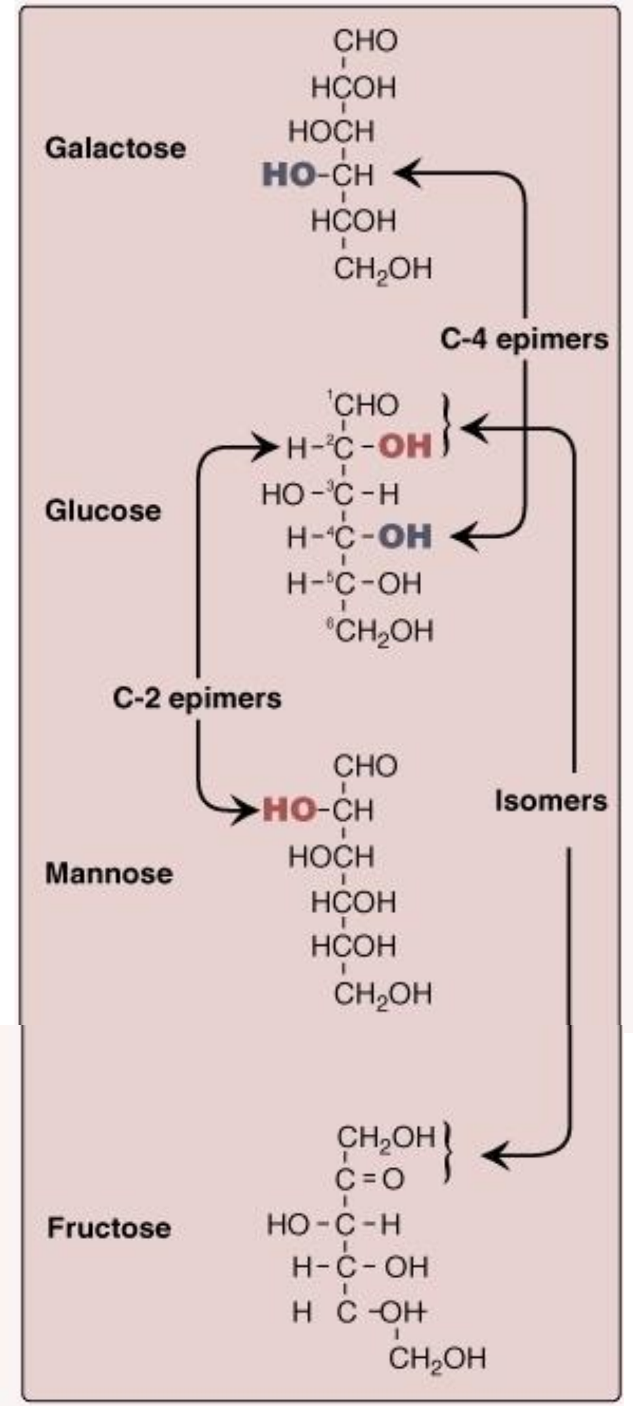
2: Marks' Basic Medical Biochemistry

Sugars are either
aldoses or ketoses



Examples of monosaccharides found in human

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



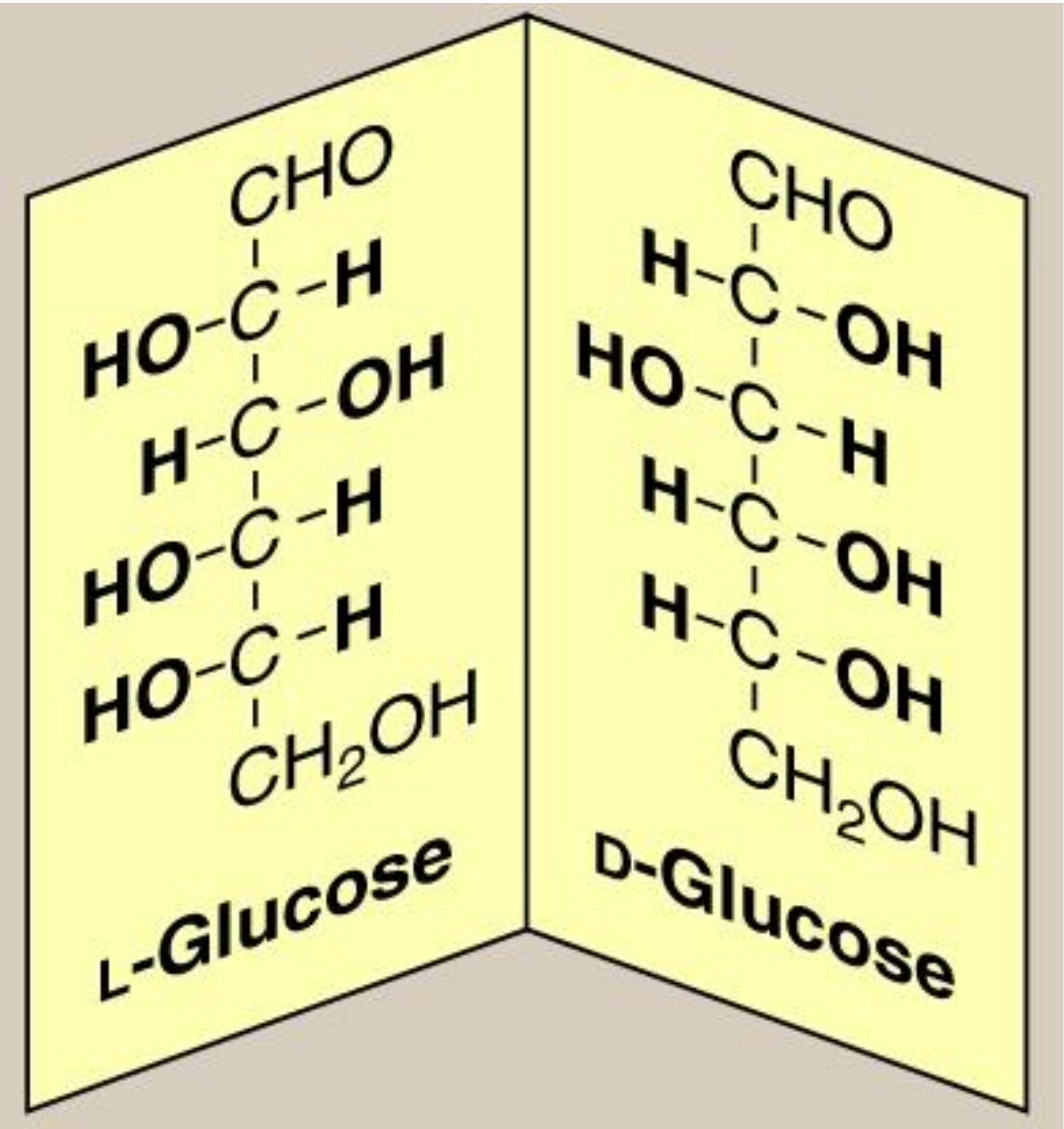
Sugars have Isomers

Epimers are isomers:

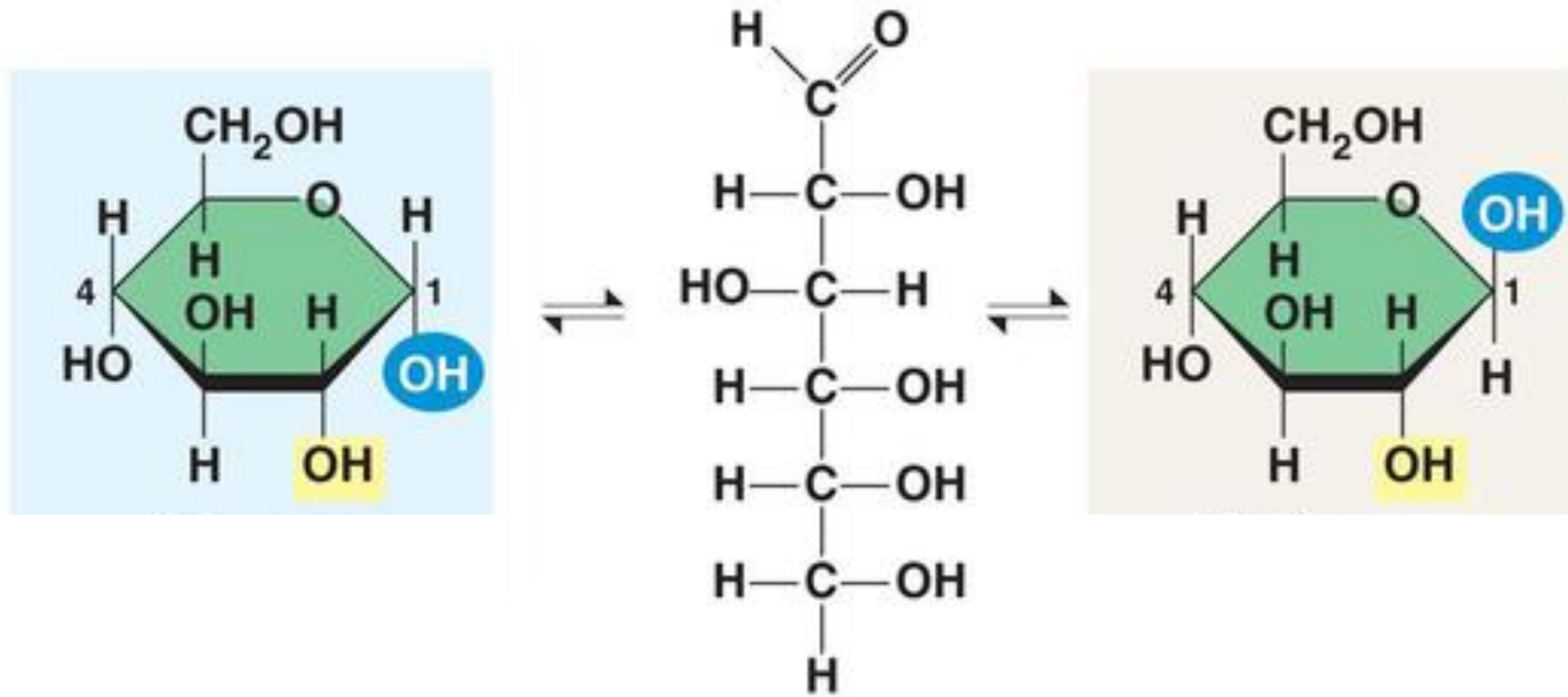
Changing the orientation of one hydroxyl group will produce a different sugar

Glucose and Fructose are isomers

Enantiomers



Alpha and Beta Sugars (Anomers)

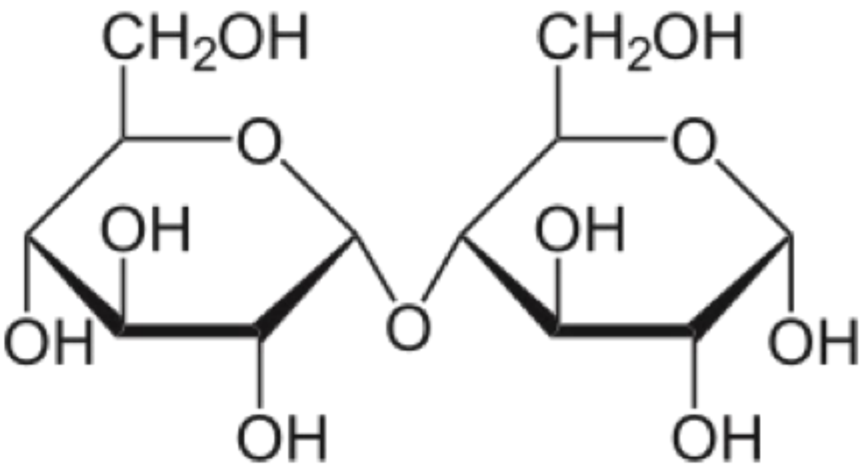


α-D-Gluco-pyranose　　D-Glucose　　β-D-Gluco-pyranose

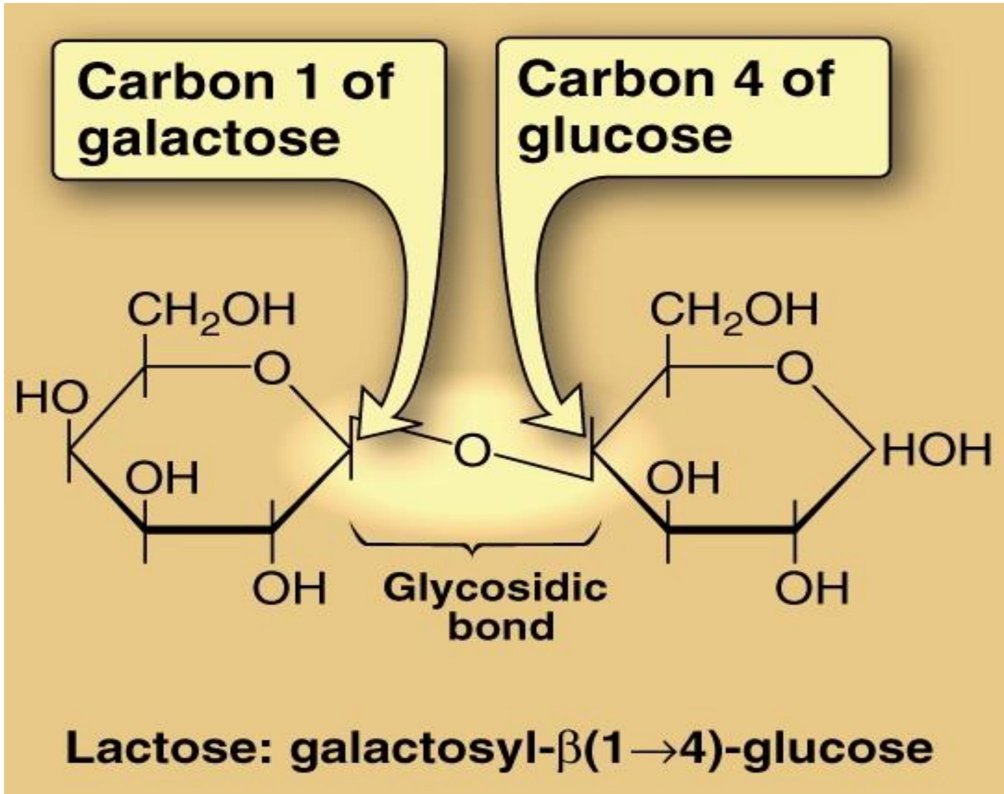
https://mysciencesquad.weebly.com/ib-hl-23a1--s1-cellulose--starch-v-glycogen.html

Disaccharides

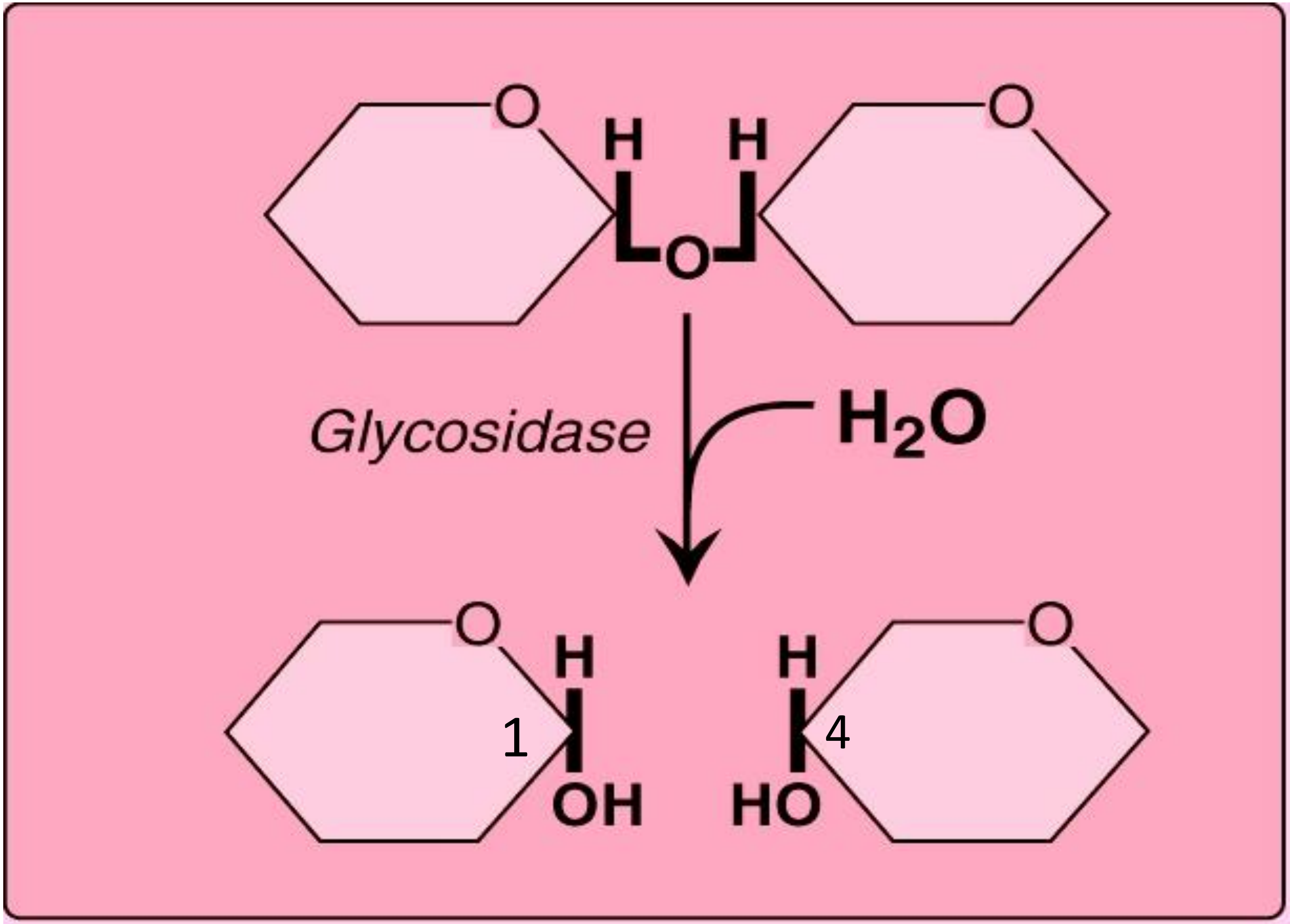
Sugars made of two monosaccharide units joined by a glycosidic bond

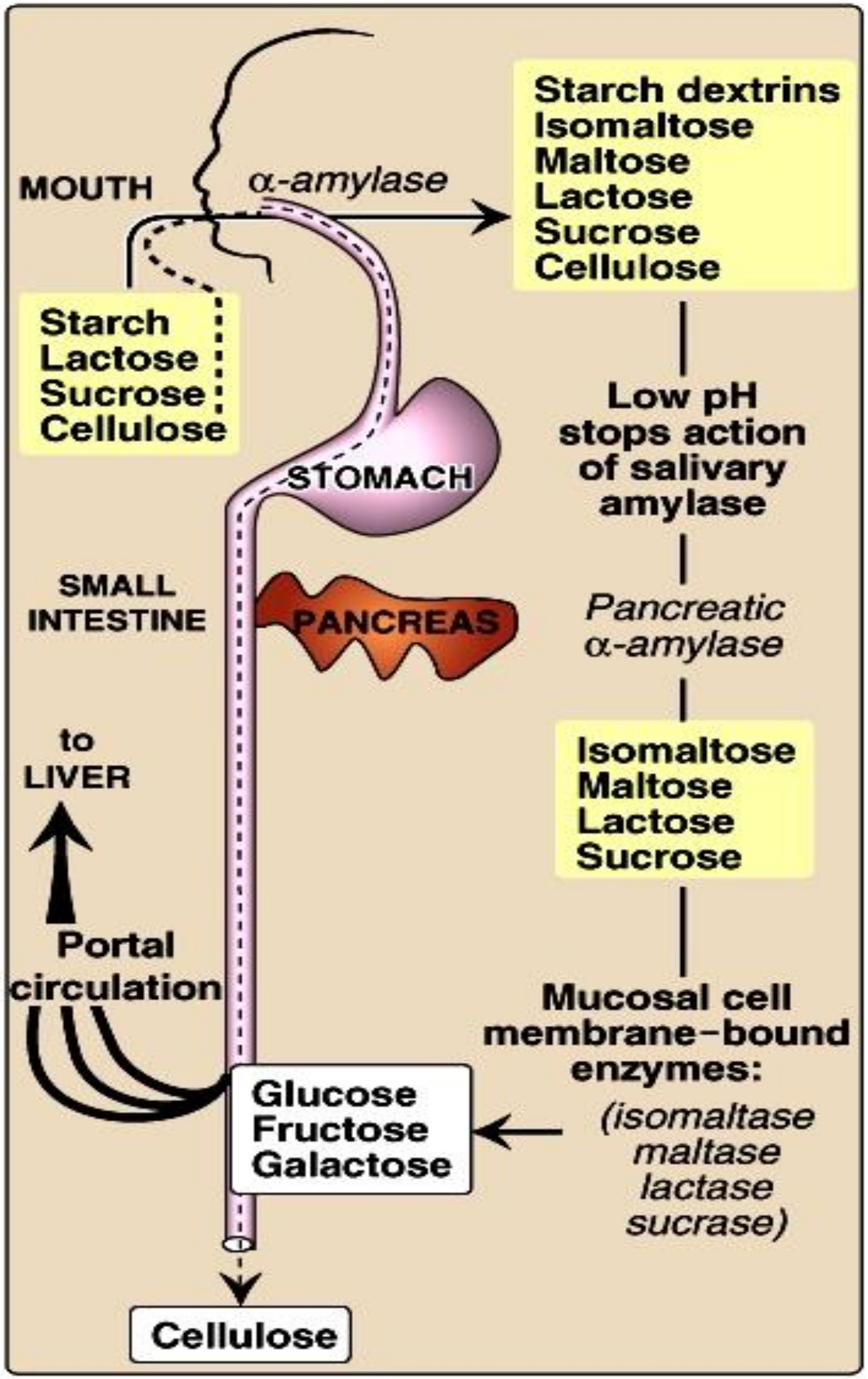


Maltose: a disaccharide made from two glucose units



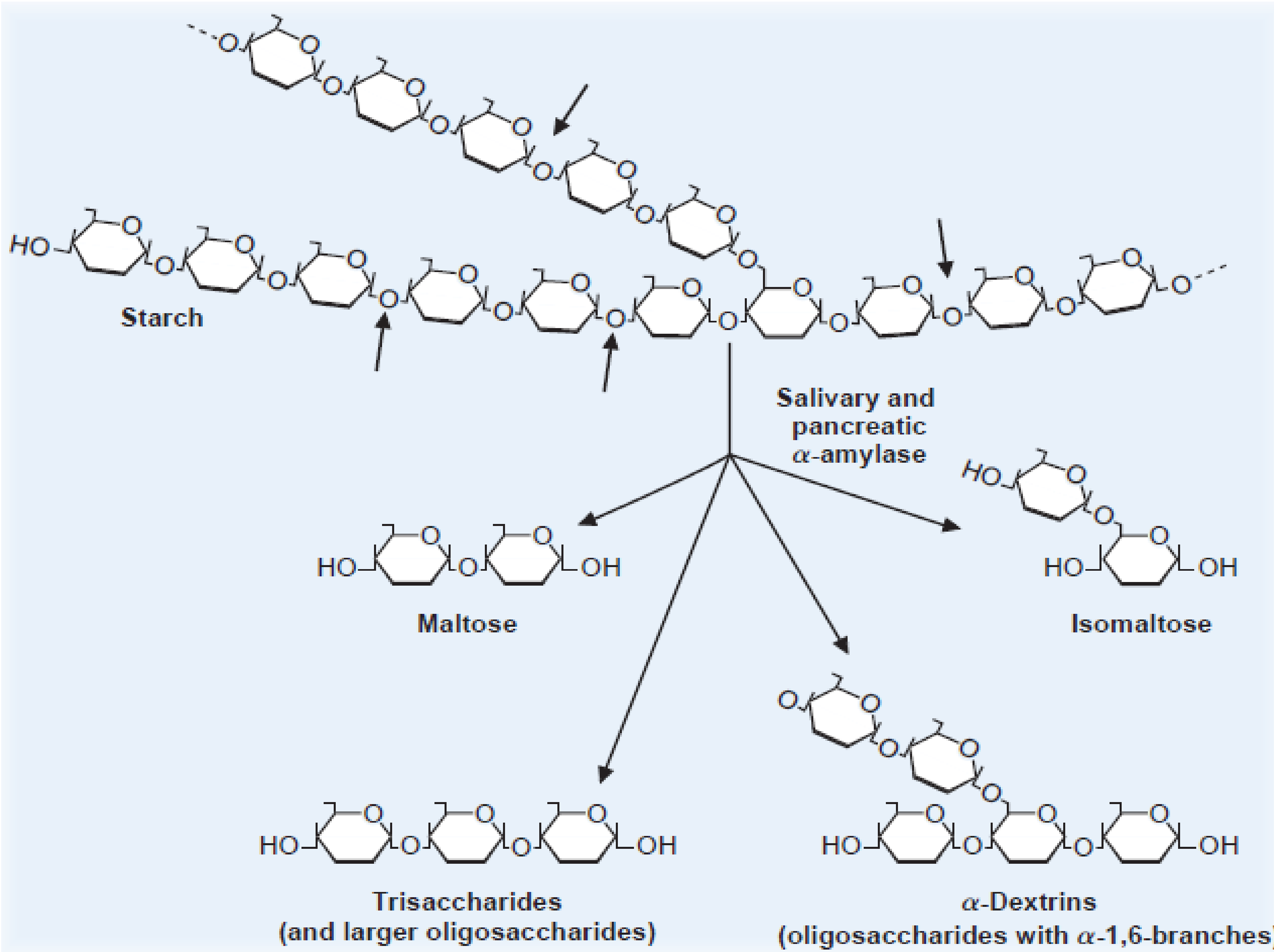
Glycosidic bond is cleaved by glycosidase enzyme





Digestion of Carbohydrates

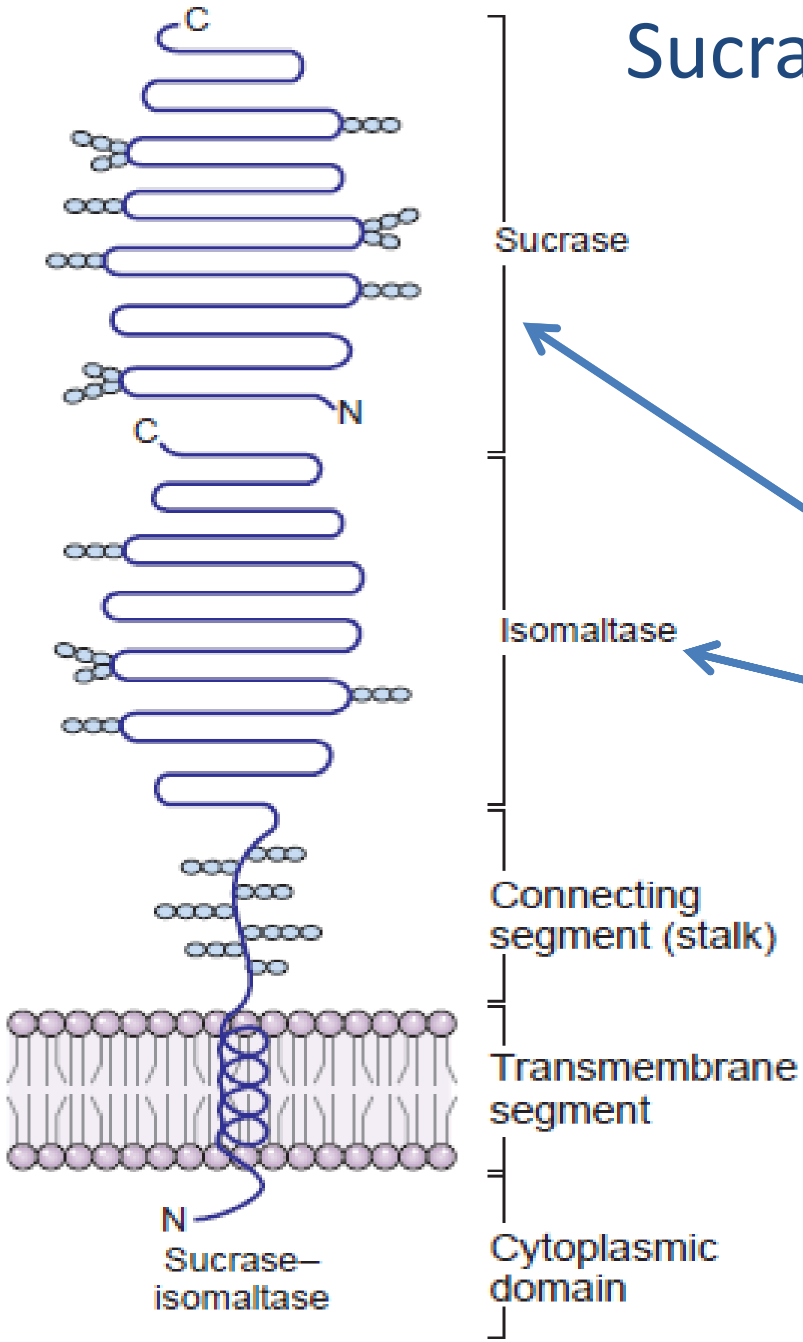
Starch Digestion



Mucosal cell membrane-bound enzymes

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

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

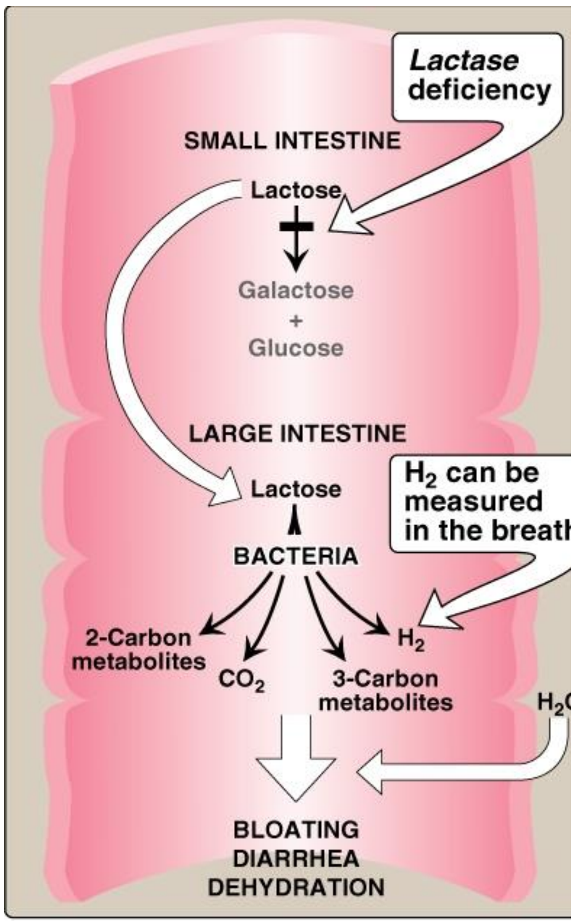
1. Sucrase-isomaltase deficiency:

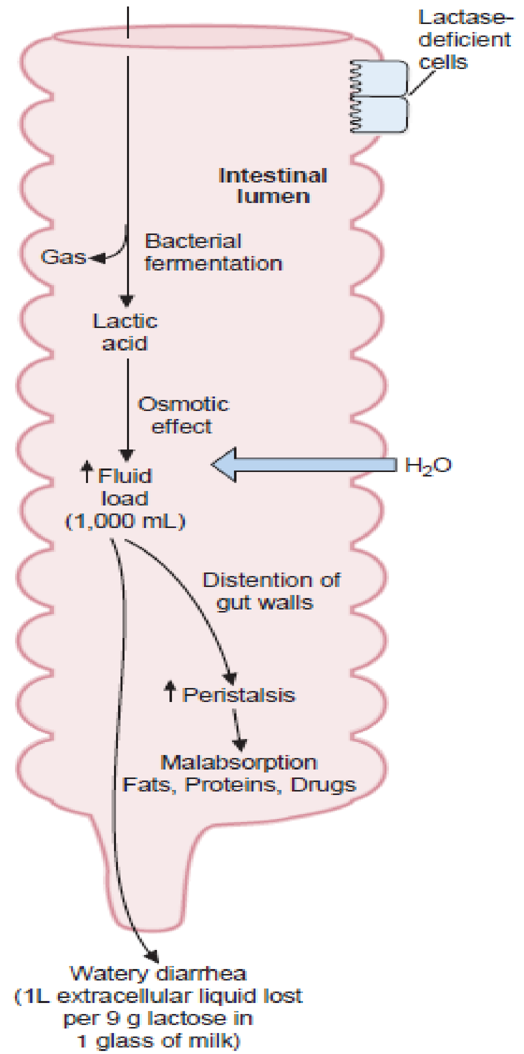
- Causes:
  - Genetics
  - Variety of intestinal diseases
  - Malnutrition
  - Injury of mucosa i.e by drugs
  - Severe diarrhea

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

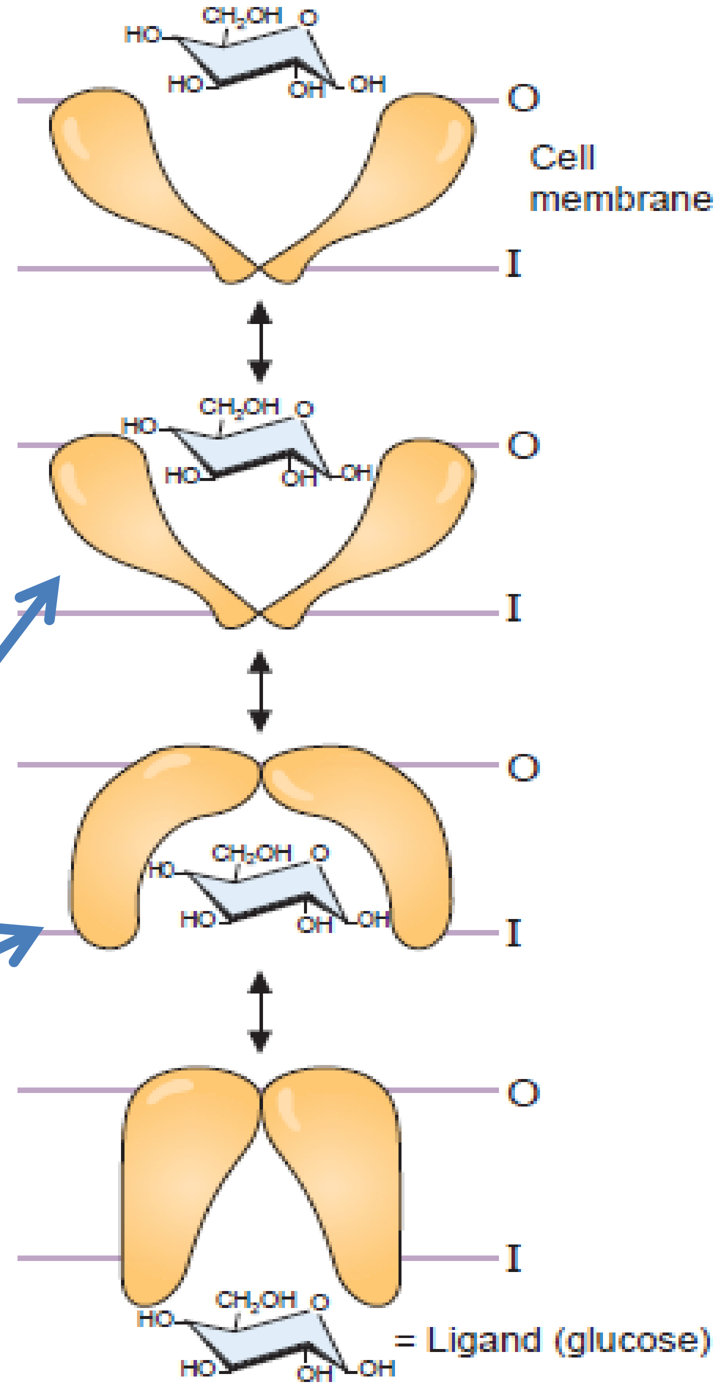
Polar molecules can not diffuse

A: Na^+-independent facilitated diffusion transport

GLUT 1-----GLUT 14

Glc. Movement follows concentration gradient

Two conformational states

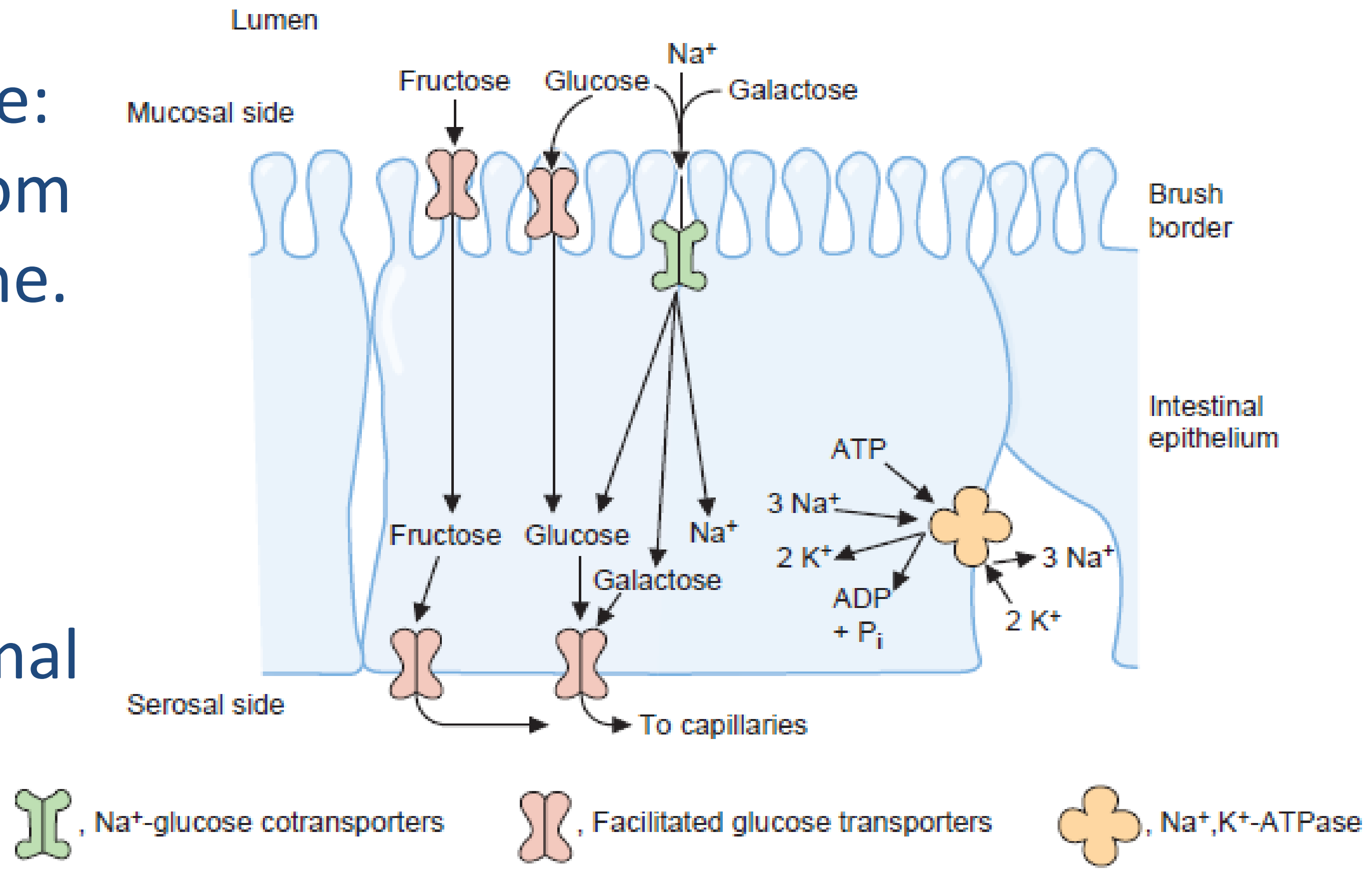


Na⁺ monosaccharide cotranspoerter system (SGLT)

- Against concentration gradient (requires energy).

* Small intestine: Active uptake from lumen of intestine.

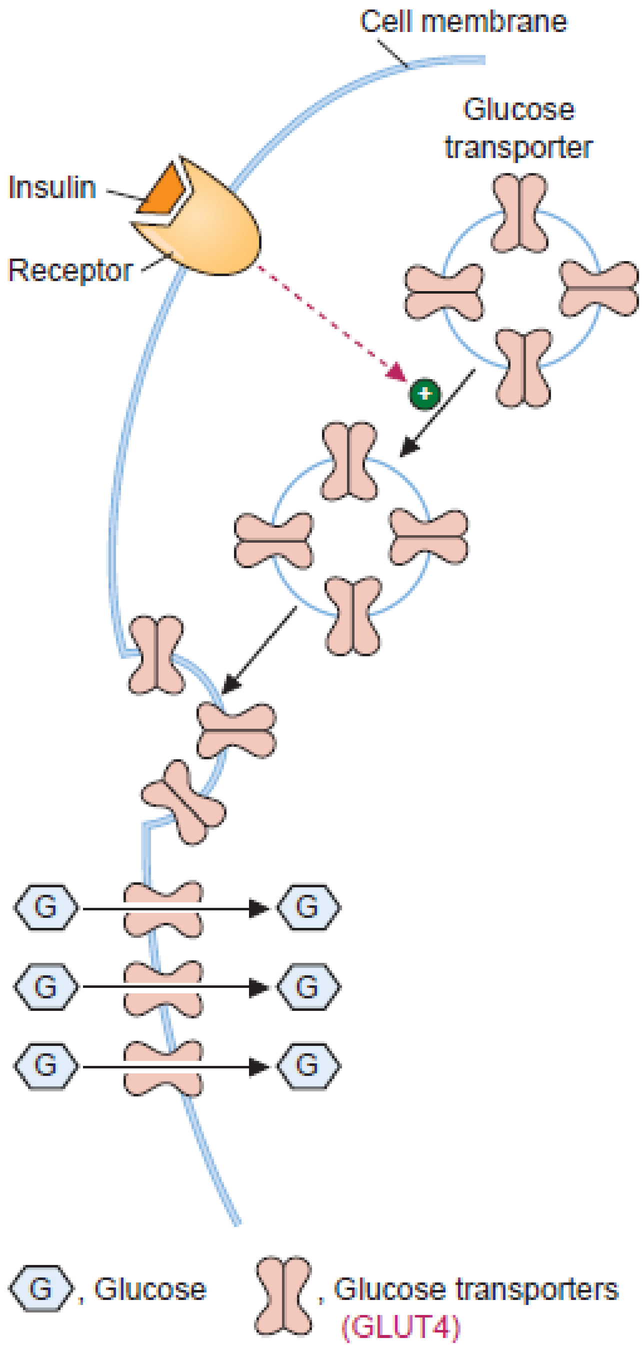
* Kidney: reabsorption of glucose in proximal tubule.



- For glucose and galactose absorption

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

Transporter	*Tissue Distribution*	*Comments*
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	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	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