Lecture series
Gastrointestinal tract

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Carbohydrates

Learning Objectives:

- Understand the different classes of carbohydrates
- Understand the enzymes responsible for digestion of carbohydrates
- What are sites for absorption
- Molecular basis of glucose transpotation
- Learn about the function of carbohydrates

Carbohydrates : provide a substantial energy substrate for metabolism (4 kcals/g).

Approximately 45% to 60% of dietary carbohydrate is in the form of starch, which is a polysaccharide

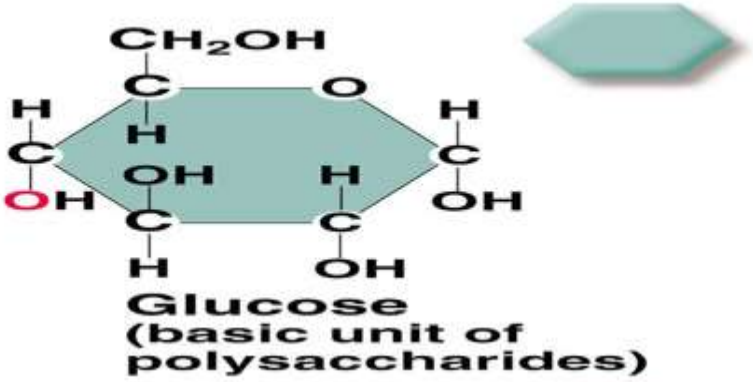
- ***BALANCED DIET***-Diet consisting of the proper quantities & proportions of foods needed to maintain health or growth

- **Simple sugars**

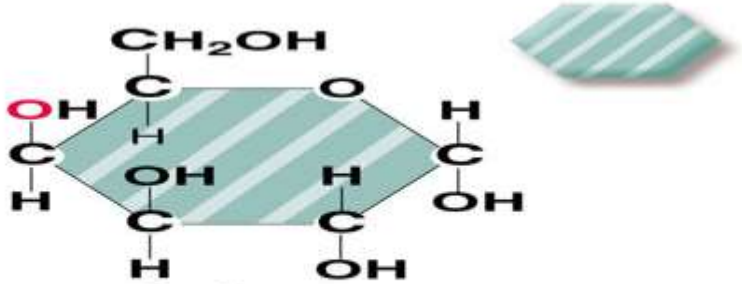
- **Complex** (starch and fiber)
  - -Monosaccharide – One unit
  - -Disaccharides – Two units
  - -Oligosaccharides – 10 or fewer units
  - -Polysaccharides – Up to 1000 units

Monosaccharides

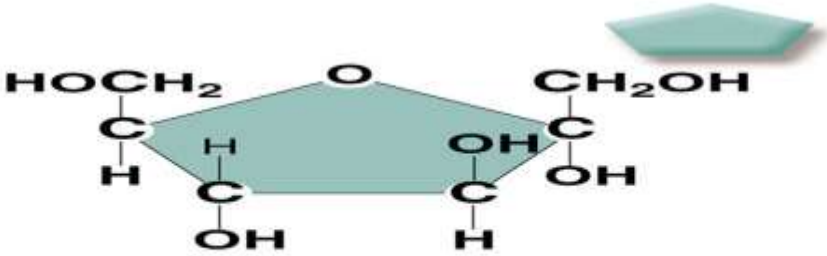
- Glucose
- Galactose
- Fructose



Glucose
(basic unit of
polysaccharides)



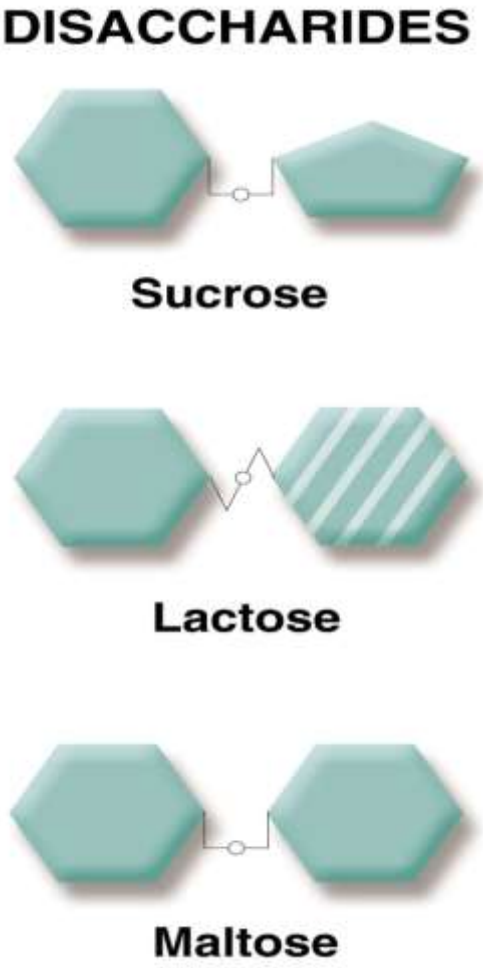
Galactose
(found as part
of lactose in milk)



Fructose
(found in fruits, vegetables
and honey)

Disaccharides

- **Sucrose**
  - Glucose + Fructose
- **Lactose**
  - Glucose + Galactose
- **Maltose**
  - Glucose + Glucose



Polysaccharides

- Starch
  - Amylose
  - Amylopectin
- Dextrins
  - Produced when starch molecules are partially broken down by enzymes, acid, or heat.

    -Less thickening power than starch
- Glycogen
- Plant Fiber Components

Digestion of Carbohydrates Begins in the Mouth and Stomach.

- When food is chewed, it is mixed with saliva, which contains the digestive enzyme ptyalin (an α-amylase) secreted mainly by the parotid glands.

- This enzyme hydrolyzes starch into the disaccharide maltose and other small polymers of glucose that contain three to nine glucose molecules.

- However, the food remains in the mouth only a short time, so probably not more than 5 percent of all the starches will have become hydrolyzed by the time the food is swallowed.

.Activity of the salivary amylase is then blocked by acid of the gastric secretions because the amylase is essentially inactive as an enzyme once the pH of as an enzyme falls below about 4.0

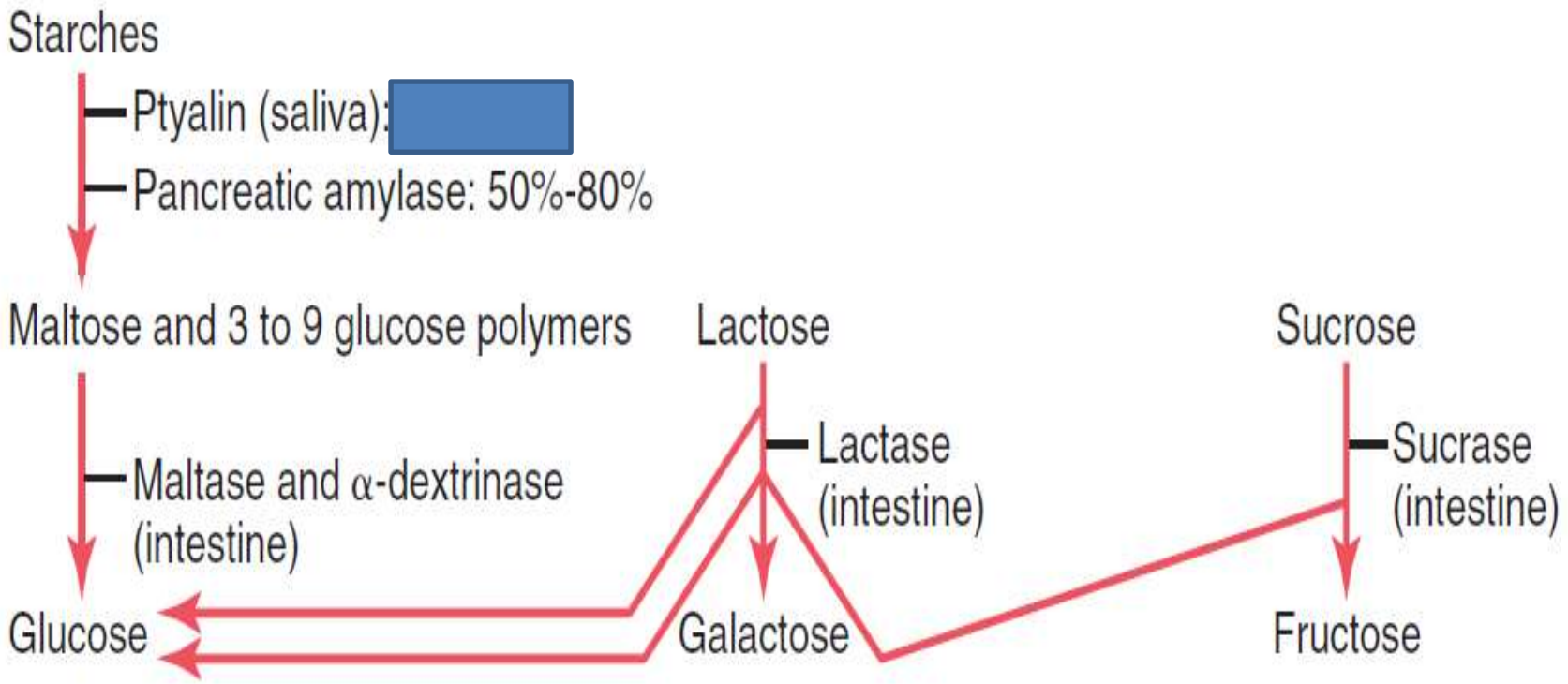
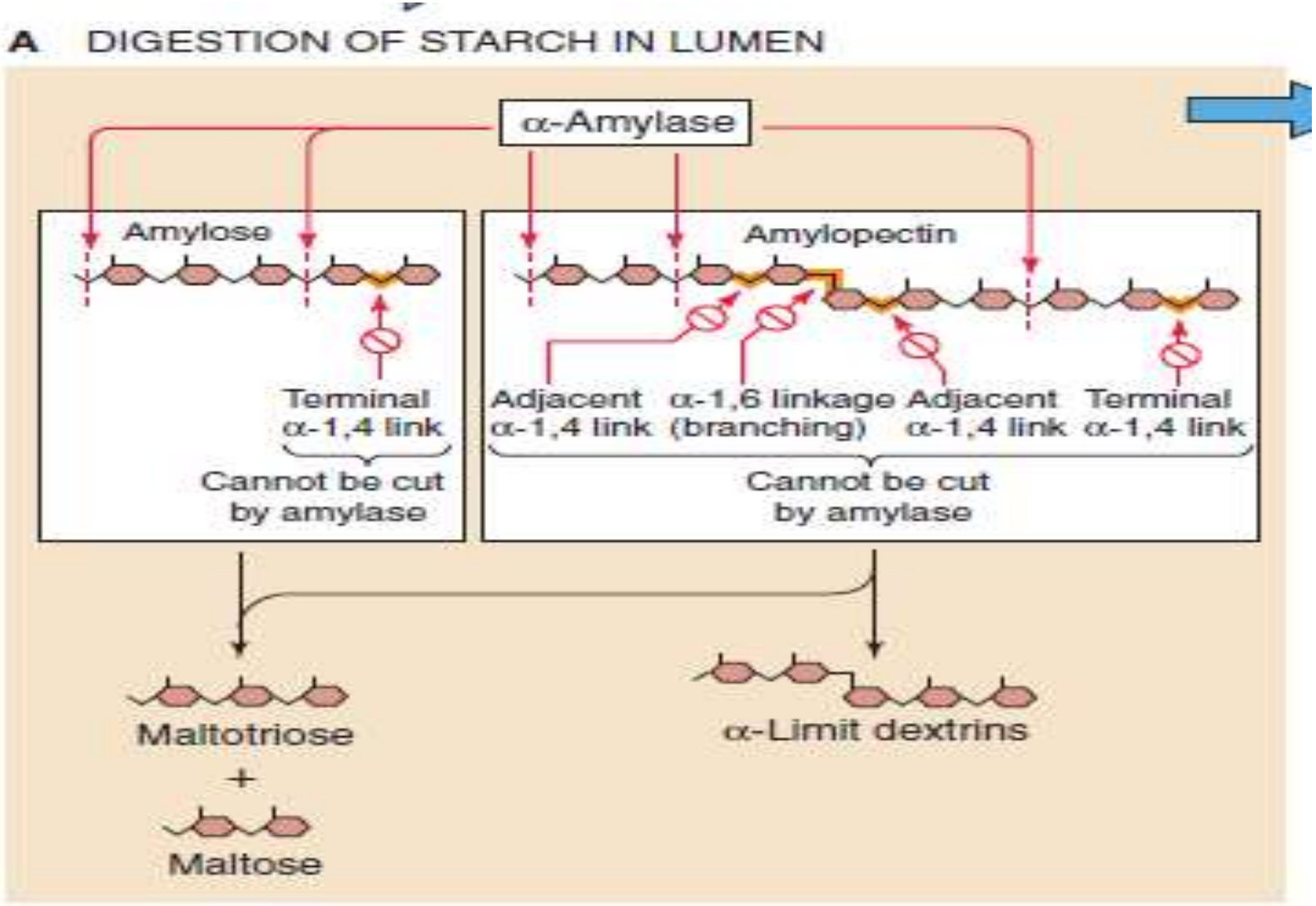


Figure 66-1. Digestion of carbohydrates.

Starch digestion in the lumen of intestine

- Pancreatic α-Amylase is an hydrolyzes *internal* α-1,4 linkages
- α-Amylase does not cleave terminal α-1,4 linkages, α-1,6 linkages (i.e., branch points), or α-1,4 linkages that are immediately adjacent to α-1,6 linkages.
- As a result, starch hydrolysis products are maltose, maltotriose, and α-limit dextrins.

Digestion in the lumen of intestine



Digestion at the brush border in the lumen of intestine

- The intestine cannot absorb these products of amylase digestion of starch, and thus further digestion is required to produce monosaccharides

- The human small intestine has enzymes on brush border oligosaccharidases: lactase, glucoamylase (most often called maltase), and sucrase-isomaltase.

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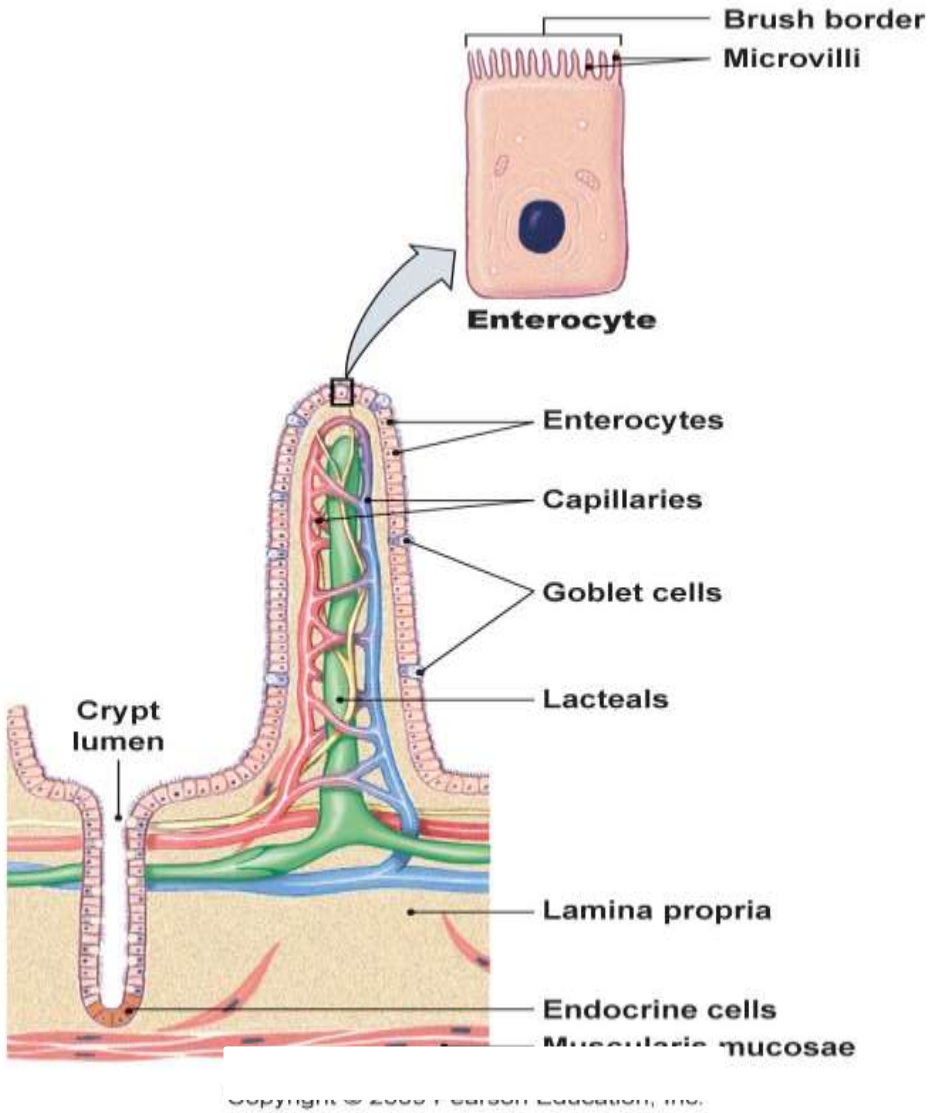
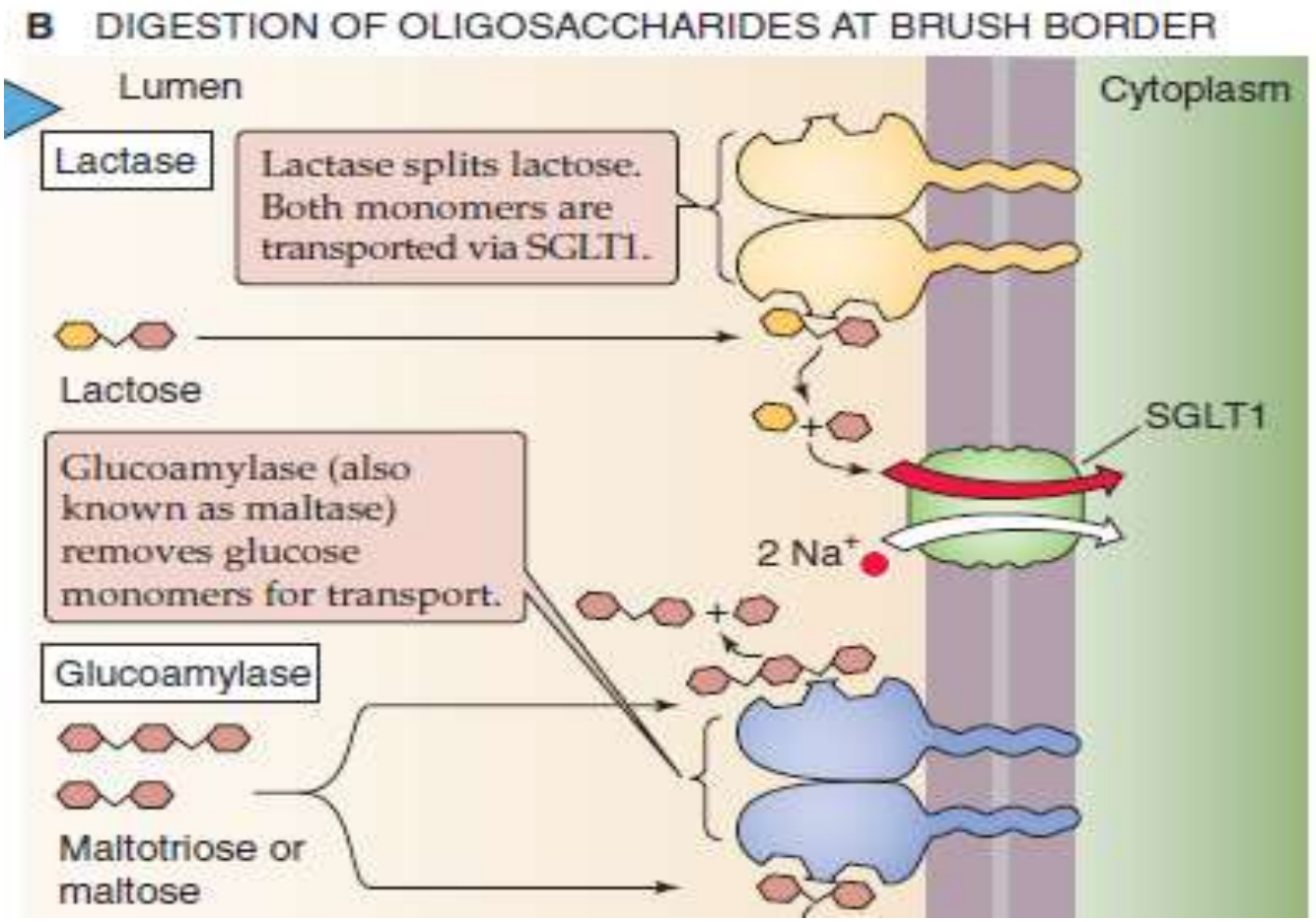


Lactose and maltotriose at brush border



Absorption of carbohydrate

Absorption of carbohydrate

- There are three monosaccharide products of carbohydrate digestion—glucose, galactose, and fructose
- They are absorbed by the small intestine in a two-step process:
- Their uptake across the apical membrane into the epithelial cell
- Their coordinated exit across the basolateral membrane
- The Na/glucose transporter 1 (SGLT1) is the membrane protein responsible for glucose and galactose uptake at the *apical membrane*
- the apical step of fructose absorption occurs by the facilitated diffusion of fructose through GLUT5
- a single transporter (GLUT2) is responsible for the movement of both monosaccharides across the basolateral membrane.

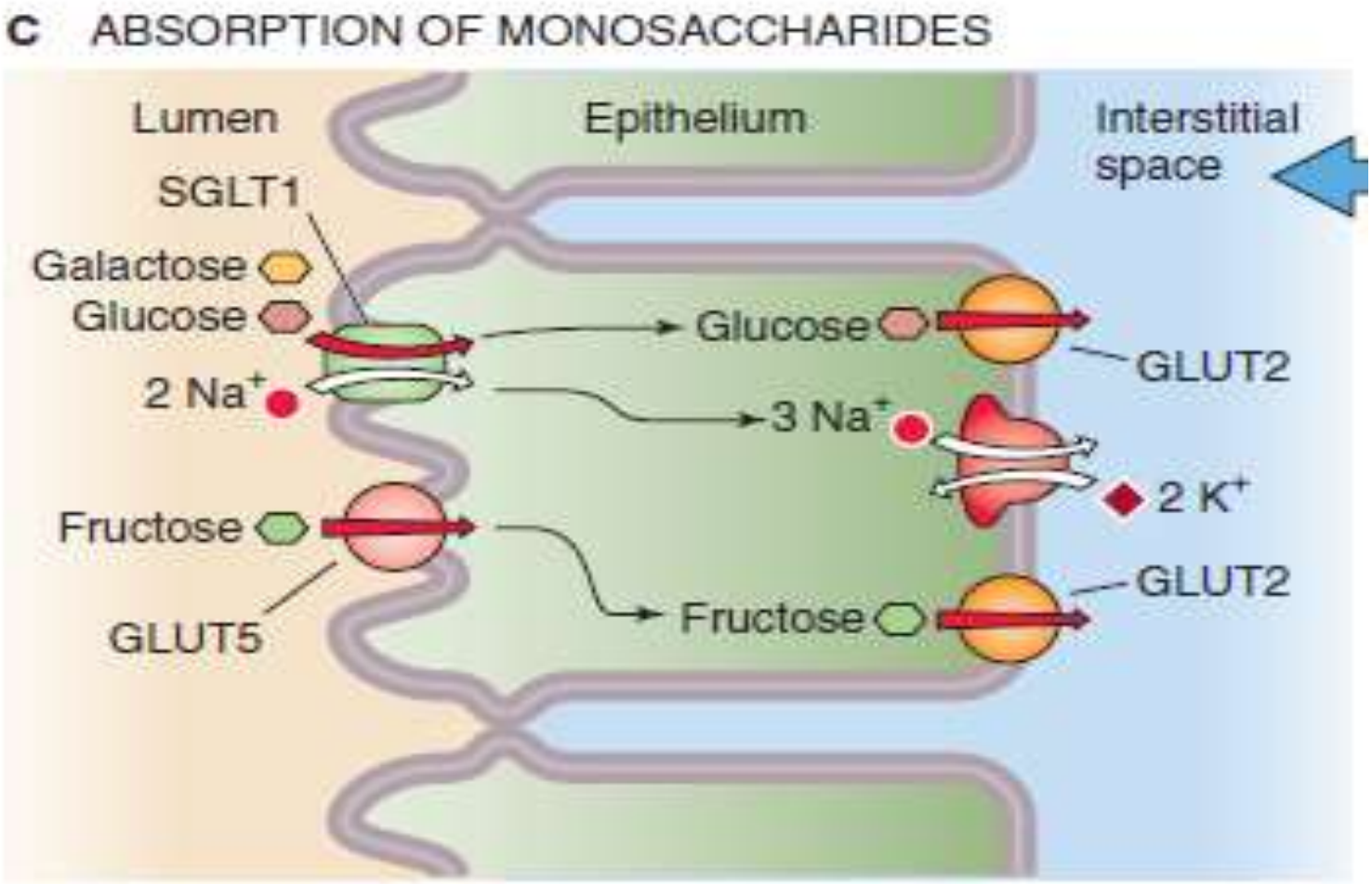
Absorption of glucose , galactose and sucrose

- The uptake of glucose across the apical membrane through SGLT1 (secondary active transport,) because the glucose influx occurs against the glucose concentration gradien

- Glucose uptake across the apical membrane is energized by the electrochemical Na+ gradient, which, in turn, is maintained by the extrusion of Na+ across the basolateral membrane by the Na-K pump

- The apical step of fructose absorption occurs by the facilitated diffusion of fructose through GLUT5

Absorption of glucose, galactose and sucrose



Lactose Intolerance

- In most mammals and in many races of humans, intestinal lactase activity is high at birth, then declines to low levels during childhood and adulthood.
- The low lactase levels are associated with intolerance to milk **(lactose intolerance).**
- When such individuals ingest dairy products, they are unable to digest lactose sufficiently, and so symptoms--such as bloating, pain, gas, and diarrhea are produced
- The simplest treatment for lactose intolerance is to avoid dairy products in the diet,
- Commercial lactase preparations, Yogurt is better to administration

APPLIED

DIABETES MELLITUS

- It is a syndrome of impaired carbohydrates,fat and protein metabolism due to either insulin lack or decreased sensitivity of tissue to insulin

TYPES- Type 1/IDDM

-Type 2/NIDDM

CAUSE

- Hereditary
- Autoimmune
- Viral infection
- Obesity

SYMPTOMS &SIGNS

- Glucosuria
- Dehydration
- Osmotic diuresis
- Polyurea,polydipsia
- Hypertension,heart strokes,artherosclerosis

- End stage kidney disease
- Retinopathy
- Peripheral neuropathy.
- ANS dysfunctions
- Ketoacidosis,diabetes coma,death
- Asthemia(lack of energy)
- Weight loss

References

- Lippincott’s Illustrated Reviews: Physiology (2013)
- Medical Physiology, Updated second edition (walter F. Boron, MD, phd)
- Berne & levy, physiology, sixth edition, updated edition
- Ganong’s Review of Medical Physiology, 26 t h e d i t i o n