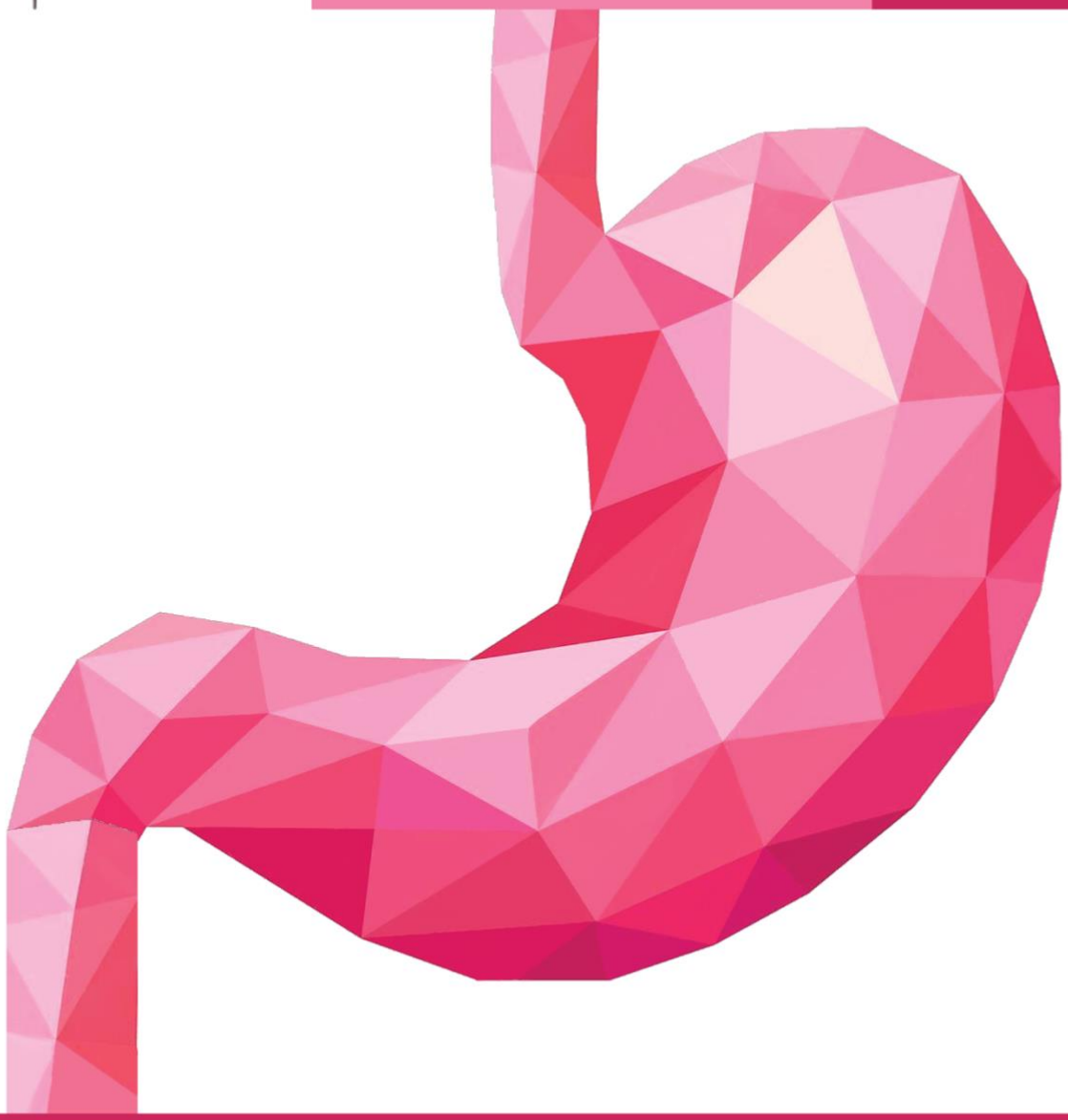
GIS 6

PHYSIOLOGY



Done by: Bashar Alamour

Scientific Correction: Bashar Alamour

Gramatical Correction: Name

Doctor: Mohammad Al Khatatbah

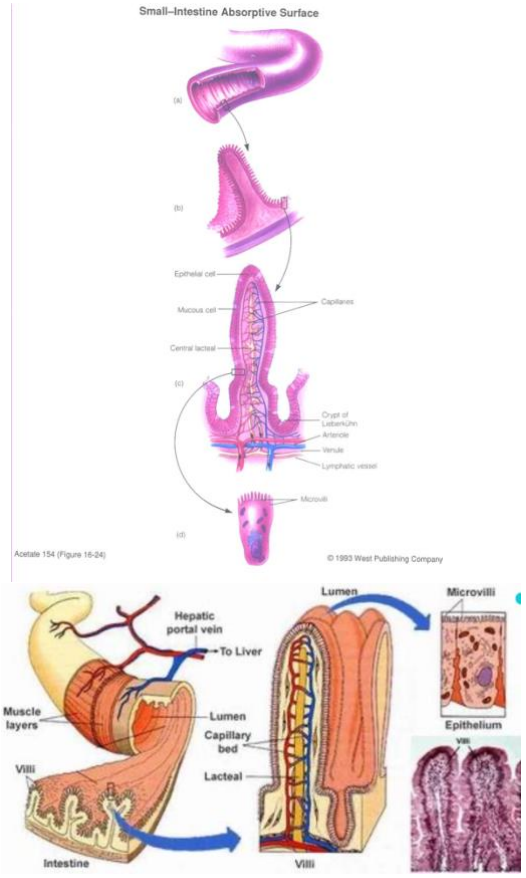
❖ General considerations

There is **NO** absorption in the esophagus, **little** in the stomach and **vast majority** of absorption occurs in small intestine.

But why?

- The small intestine has **specialized characteristics** to increase the absorptive capacity by increasing the absorptive surface area of the mucosa.
- Most nutrients are absorbed **before reaching the ileum**.
- Colon is responsible for final removal of electrolytes and water.

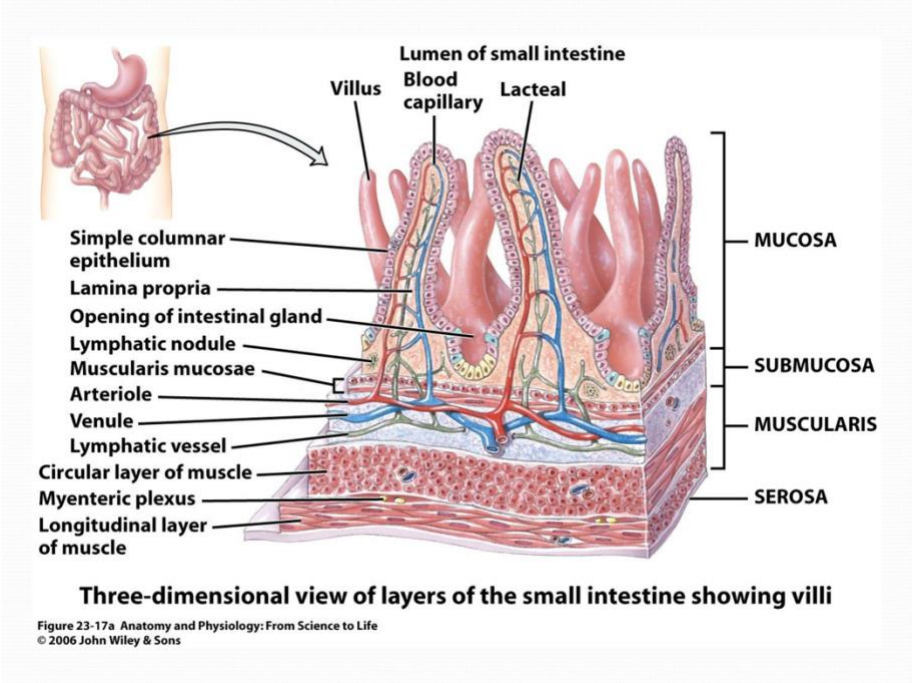
Intestinal special characteristics



- Folds in mucosa and submucosa like folds of **kerckring**(circular folds) increase the surface area.
- **Villi** (villus: singular) which increases surface area 10 fold. **(The structure of villi is highly vascularized …which is important for the removal of absorbed nutrients. Lymphatic vessels are also found in villi, there carry lipid absorption.)**
- **Microvilli (specialized structures on the apex of epithelial cells on the surface of the villi)** which increase surface area 20 fold.
- The net increase in the surface area is **600 fold**.
- Smooth muscle cells of the **muscularis mucosa** allow folds to move (**shortening and elongation)** and villi to wave in lumen.
  (Villi are constantly waving for better absorption)

Villus structure (look at the figure)

1. **Capillary network** which removes the absorbed nutrients very quickly.
2. **Central lacteals** which are the lymphatic vessels (removes lipids)
3. **Innervation** provides mechanism to regulate secretion by epithelial cells.



Now let's talk about digestion

❖ Digestion of carbohydrates

The most ingested carbohydrate form is starch **(a polymer of alpha 1-4 and alpha 1-6 linkages)**
In addition to starch we ingest:

Lesser amounts as sugar dimmers:

- ✓ **Sucrose (known as sugar)** which is made of fructose and glucose.
- ✓ **Lactose (found in milk)** which is made of glucose and galactose.
- ✓ **Cellulose (a glucose polymer of 1,4 beta linkage.)**

Digestive enzymes are specialized enzymes that catalyze **hydrolysis** (digestion)

The process of carbohydrate digestion begins in the **oral cavity by salivary amylase named Ptyalin (an alpha amylase).**

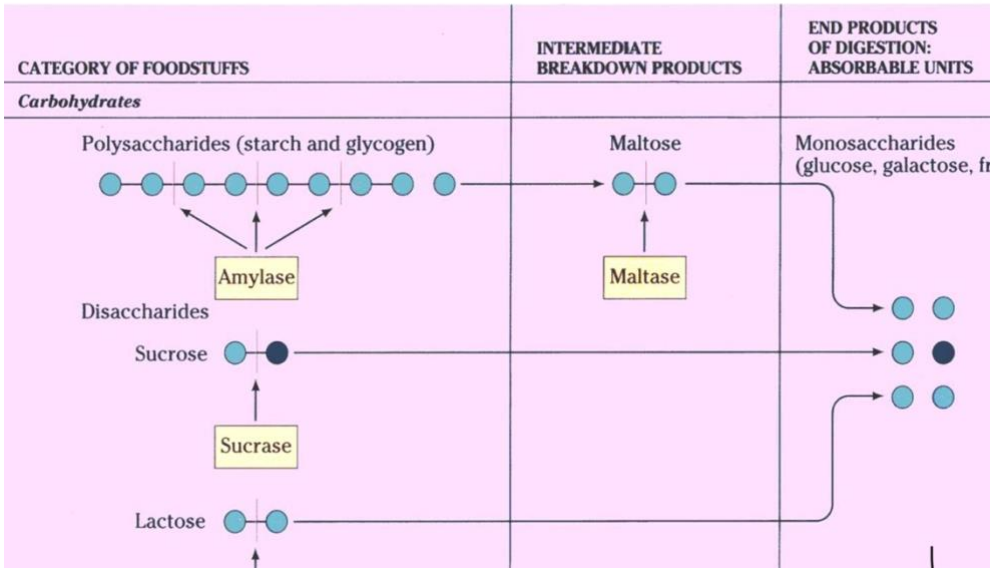
Ptyalin is specialized for **starches** and results in **small starch polymers of glucose and alpha limit dextrins.**

Ptyalin + starches → Smaller polymers of glucose + alpha limit dextrins

In the **gastric phase (after swallowing)** the gastric low pH will **reduce** the activity of Ptyalin.
(The optimal activity of Ptyalin is at neutral toward alkaline pH)

Recall: Alpha limit dextrins are a group of low-molecular-weight carbohydrates produced by the hydrolysis of starch or glycogen.

Process of Digestion



After gastric emptying we will need **more** amylase **(Because Ptyalin activity is reduced by gastric pH)** thus the pancreas releases **Pancreatic amylase**.**(also an alpha amylase).**

Pancreatic amylase digests **50-80% of starch.**

Alpha amylase attacks at **alpha 1,4 linkages resulting in maltose, maltotriose and alpha limit dextrins**

Pancreatic amylase + smaller polymers of glucose → Maltose + Maltotriose + alpha limit dextrins

In addition to that we have **Brush border enzymes in the intestine**

Brush border enzymes are the enzymes that are responsible for the **final hydrolysis of glucose polymers and disaccharides producing monosaccharides.**

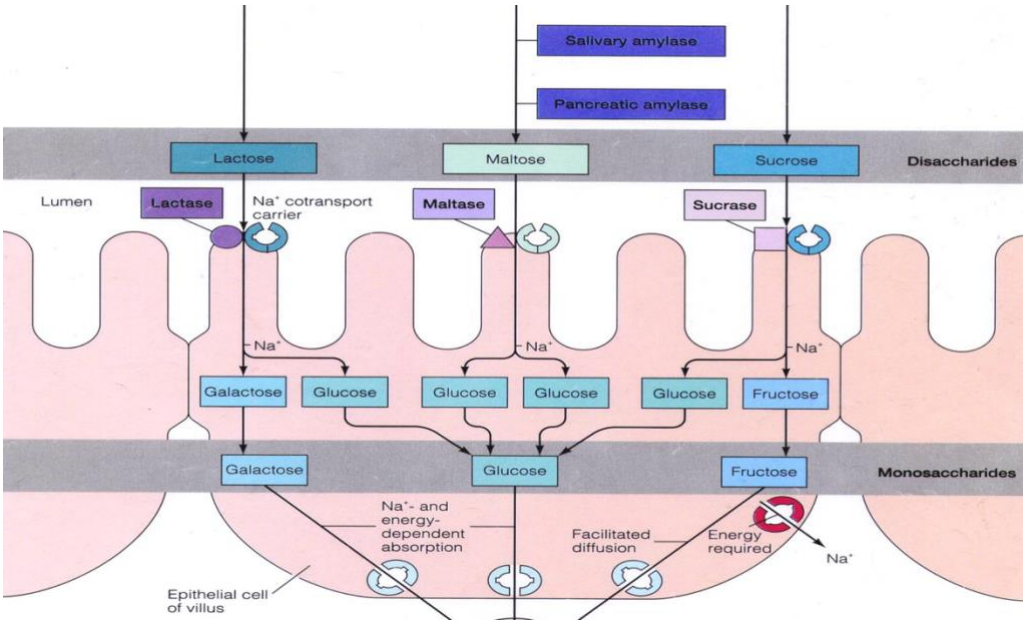
Brush border enzymes + glucose polymers/ disaccharides → monosaccharides

Brush border enzymes are 4 enzymes:

1. **Lactase (split lactose) → glucose + galactose**
2. **Sucrase (split sucrose) → fructose + glucose.**
3. **Maltase (split maltose/ glucose polymers) → glucose.**
4. **The fourth brush border enzyme is Alpha Dextrinase.**
   It can digest alpha 1-6 bond at ramification resulting in Maltose and glucose.

After the final digestion of carbohydrates in the intestinal lumen and by brush border enzymes the resulting products are **monosaccharides (glucose, fructose, galactose).**

To sum up look at the figure below:



❖ Absorption of carbohydrates (11:00)

Absorption of glucose

- Absorption of glucose is done by two ways:

1. **Na+ Dependent carrier (Secondary active co-transport).**

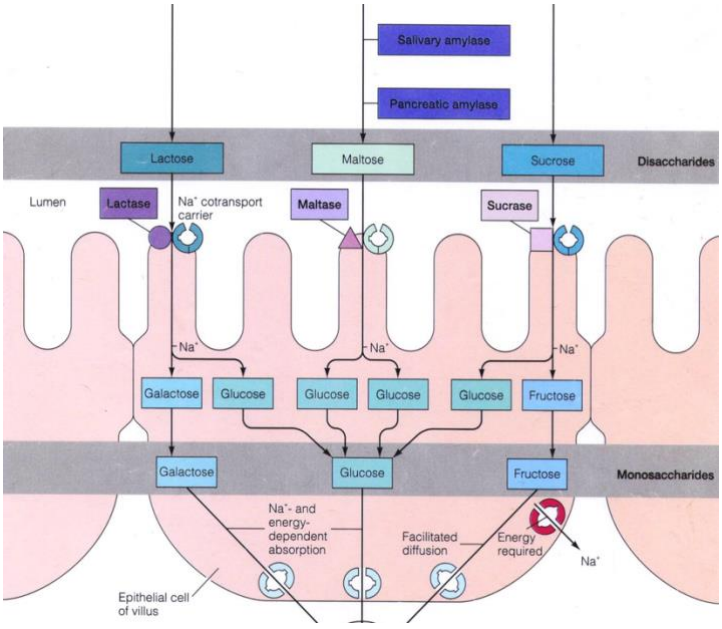
2. Absorption with **solvent drag** through the **tight junction of intestinal epithelial cells**
   (Increased glucose concentration in chyme → increased absorption →increased osmotic pressure in the paracellular space → increased fluid flow through the tight junction which carries anything dissolved.)

Absorption of galactose

- By **Na+ Dependent carriers (secondary active transport)**

Absorption of fructose

- By **facilitated diffusion (Na+ independent)**



- Once the absorptive cell absorbs the monosaccharides , it carries the monosaccharide to the interstitial fluid by carriers at the basolateral membrane.
- These carriers transport from the high conc. Of molecules inside the cell to the low conc. in the interstitial space.
- Once the monosaccharides are in the interstitial fluid (they are hydrophilic, thus can be absorbed to the blood stream

Note. At the basolateral membrane there are Na/k pumps which are important to ensure that Na conc is lower in the cell (this process is impotant for Na dependent carriers.

We cannot absorb carbohydrates as dimers or polymers
We only absorb monosaccharides
People with lactase deficiency cannot absorb lactose .