Physiology (code)-year 2

Gastrointestinal tract (GIT)

Lecture 2(secretory activity of moth and stomach)

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- **Objectives:**

1.Describe the motor functions of the stomach and the control of that functions.

2.Describe the secretary functions of the mouth and stomach, and their control.

Saliva and the Salivary Glands

- **Saliva: a thick, colorless, opalescent fluid that is constantly present in the mouth of humans and other vertebrates.**

- It is a solution of 97.0% to 99.5% water, a pH of 6.8 to 7.0, and the following solutes:
- Mucus, which binds and lubricates the food bolus;
- Electrolytes, salts of Na^+, K^+, Cl^- , phosphate, and bicarbonate;
- Lysozyme, an enzyme that kills bacteria;
- Immunoglobulin A (IgA), an antibacterial antibody;
- Salivary amylase, an enzyme that begins starch digestion in the mouth; and
- Lingual lipase, an enzyme that begins fat digestion in the mouth (but mainly after the food is swallowed).

Function:

1. Saliva moistens and cleanses the mouth
2. Inhibits bacterial growth, dissolves molecules so they can stimulate the taste buds
3. Digests a little starch and fat
4. Makes swallowing easier by binding the food particles into a soft mass (bolus) and lubricating it with mucus.

Salivary Glands

In humans, the saliva is secreted by three pairs of major (larger) salivary glands and some minor (small) salivary glands in the oral and pharyngeal mucous membrane. **The major glands** are:

1. Parotid glands
2. Submaxillary or submandibular glands
3. Sublingual glands.

1.Parotid glands

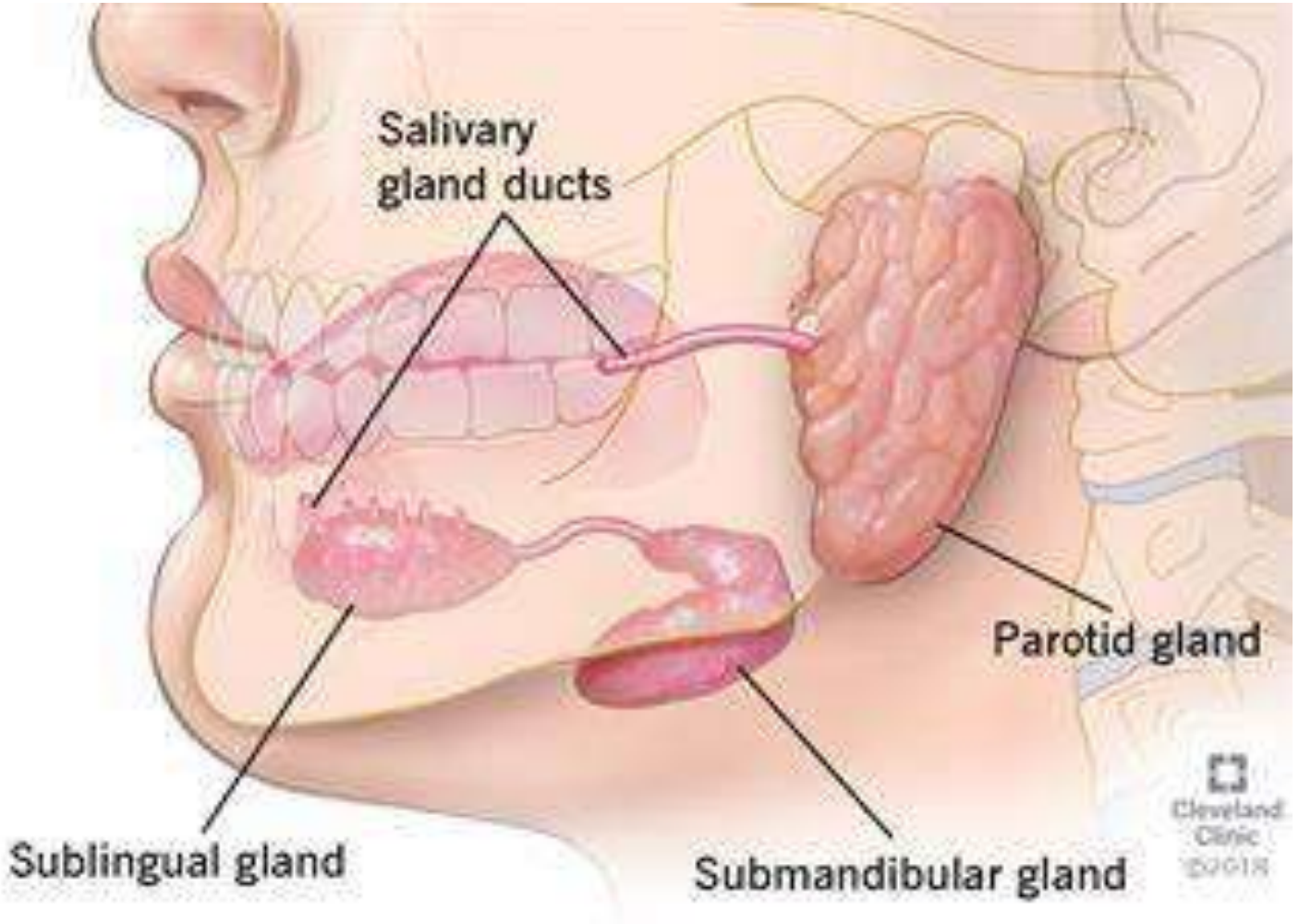
Parotid glands are the largest of all salivary glands situated at the side of the face just below and in front of the ear.

2.Submaxillary glands

Submaxillary glands or submandibular glands are located in submaxillary triangle medial to mandible.

3.Sublingual glands

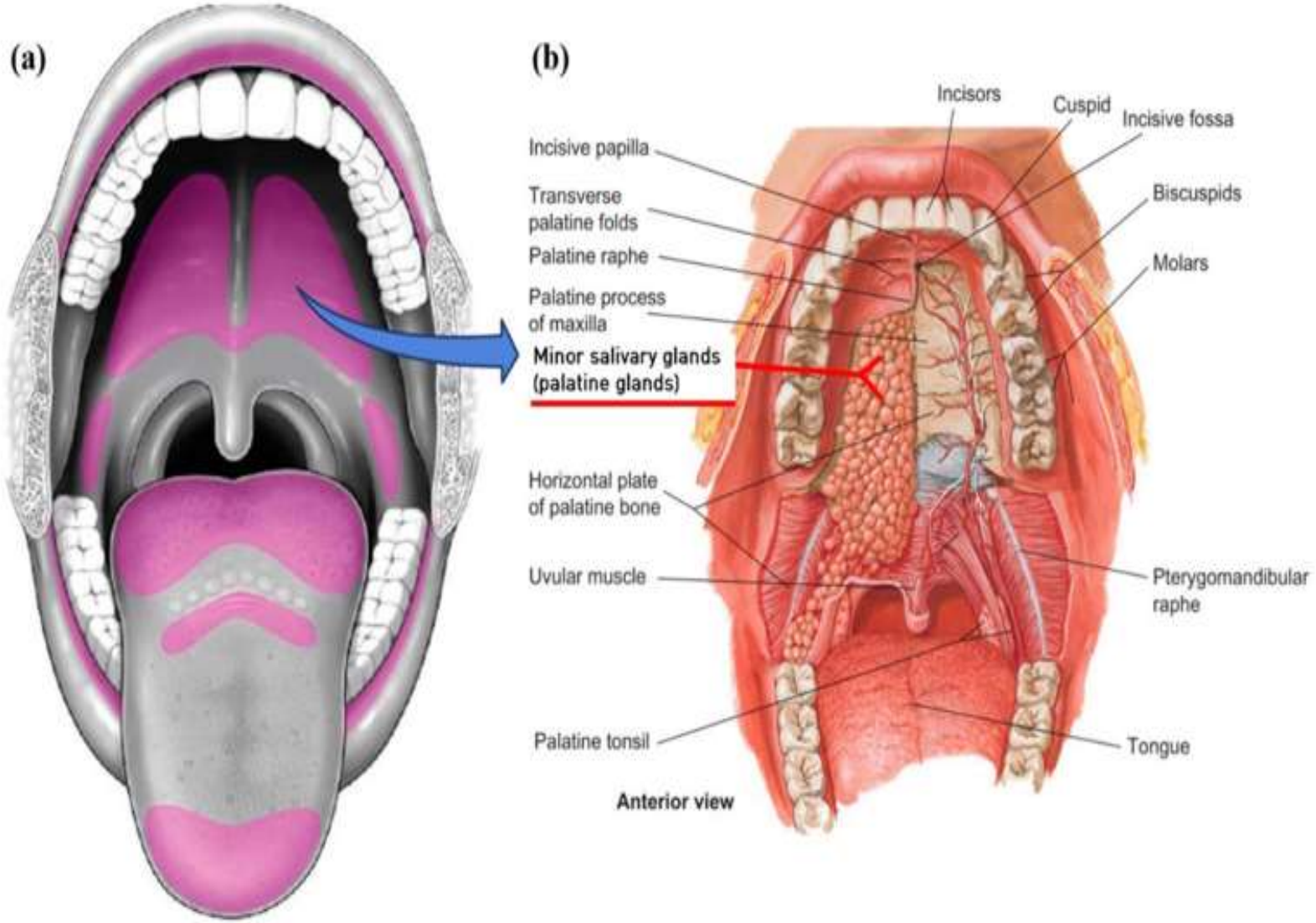
Sublingual glands are the smallest salivary glands situated in the mucosa at floor of mouth.



Major salivary glands

Minor salivary glands

1. Lingual mucus glands situated in posterior 1/3 of the tongue
2. Lingual serous glands
3. Buccal glands
4. Labial glands
5. Palatal glands.



Classification of salivary glands

Salivary glands are classified into three types based on the type of secretion.

1. Serous Glands

This type of gland is predominantly made up of serous cells. These glands secrete thin and watery saliva. Parotid glands and lingual serous glands are serous glands.

2. Mucus Glands

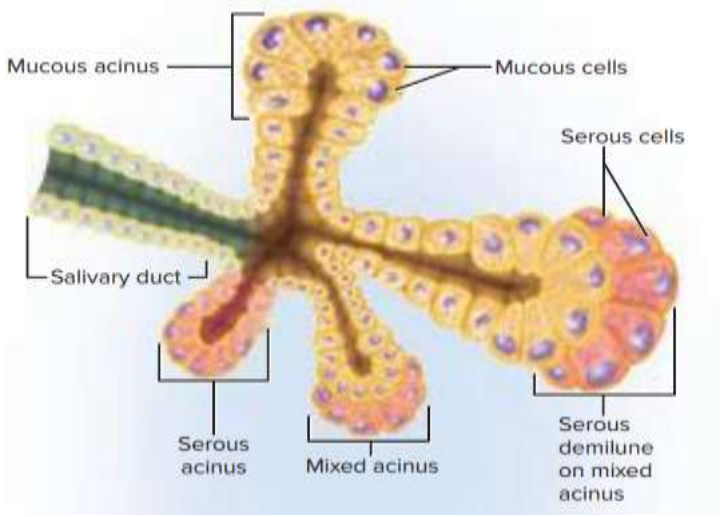
This type of glands is made up of mainly the mucus cells. These glands secrete thick, viscus saliva with high mucin content. Lingual mucus glands, buccal glands and palatal glands belong to this type.

3. Mixed Glands

Mixed glands are made up of both serous and mucus cells. Submandibular, sublingual and labial glands are the mixed glands.

Structure and duct system of salivary glands

Salivary glands are made up of acini or alveoli. Each acinus is formed by a small group of cells which surround a central globular cavity. The central cavity of each acinus is continuous with the lumen of the duct. The fine duct draining each acinus is called intercalated duct. Many intercalated ducts join together to form intralobular duct. Few intralobular ducts join to form interlobular ducts, which unite to form the main duct of the gland.



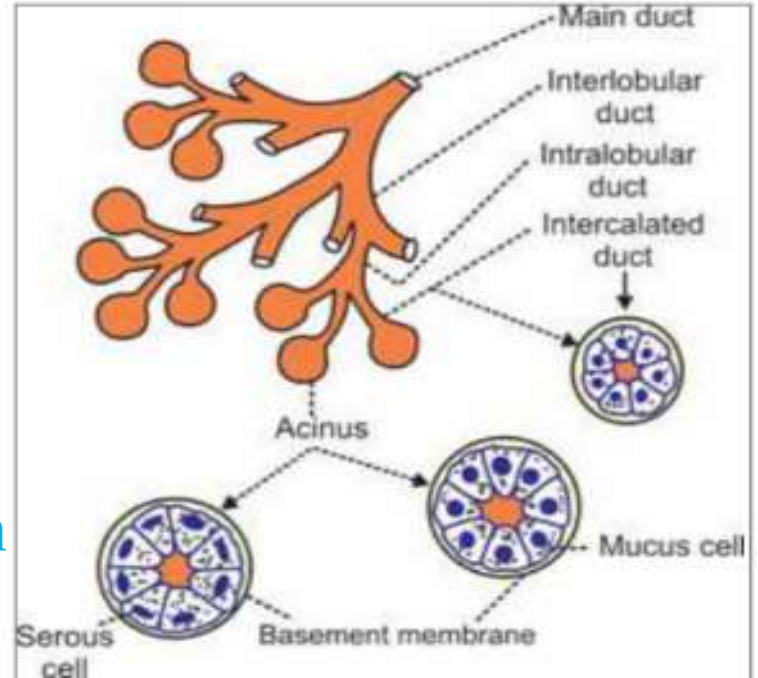


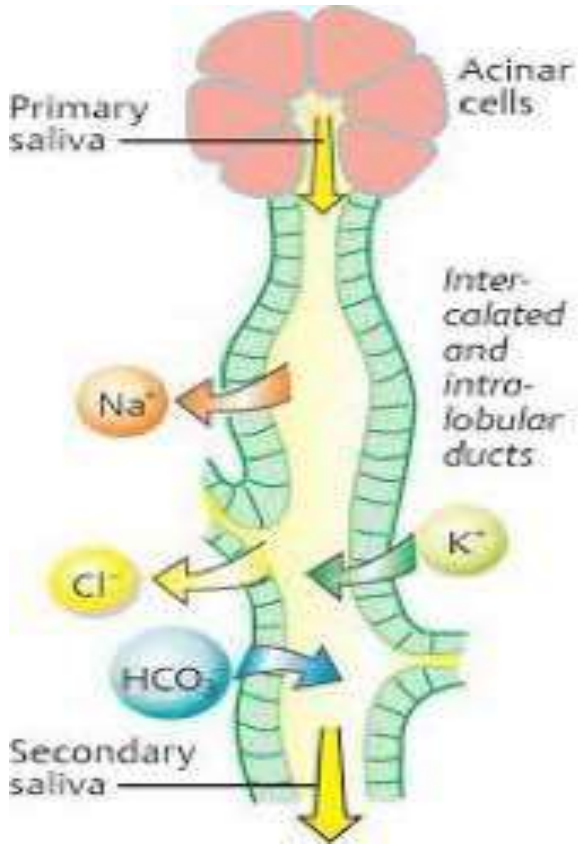
Diagram showing acini and duct system in salivary glands

Control of salivary gland:

•It is completely under the control of autonomic nervous system:

a. Parasympathetic nervous signals from the salivatory nuclei that located at the juncture of the medulla and pons → increase salivary secretion by stimulating the muscarinic receptors due to the release of acetylcholine and the parasympathetic stimulation is initiated by the presence of food in the mouth. Drugs that block muscarinic receptors like atropine inhibit salivary secretion and leads to dryness of the mouth.

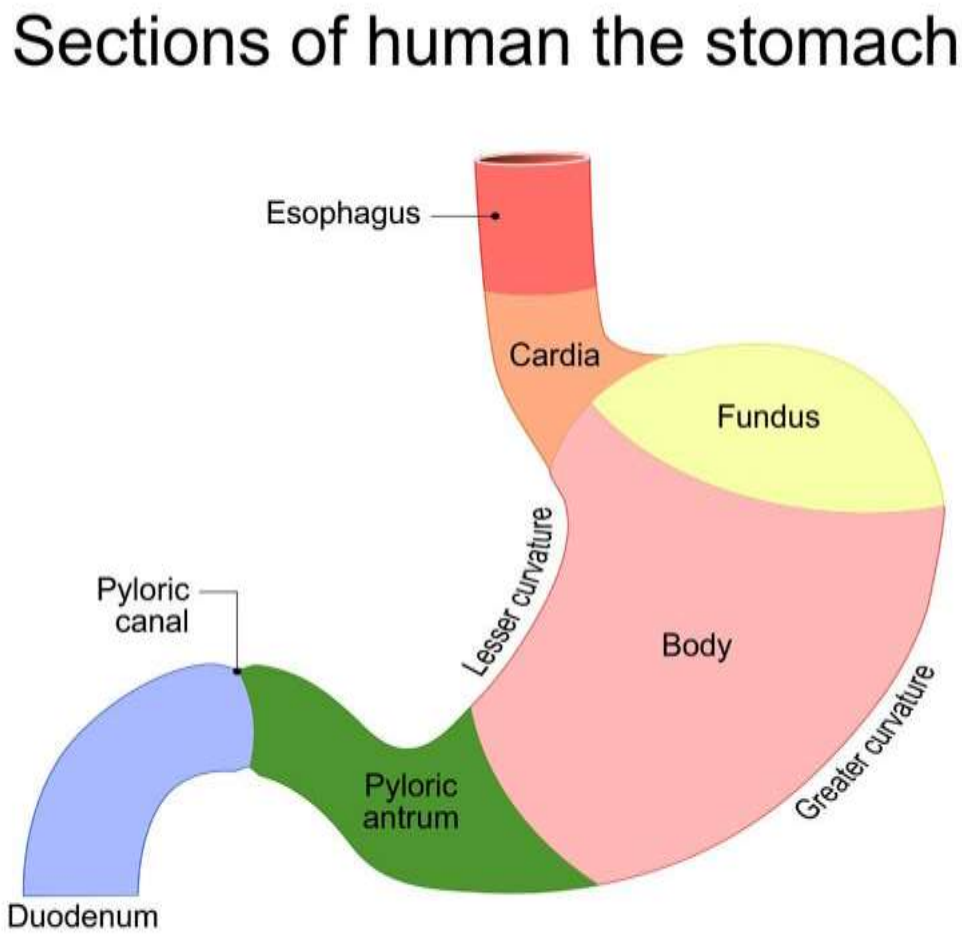
b. Sympathetic stimulation → will decrease salivary secretion as in fear so person can not speak normally.



STOMACH

ANATOMY OF STOMACH

• Stomach is the most dilated part of the gastrointestinal tract • It lies upper left quadrant of abdominal cavity, Capacity- 1.5 to 2 Ltr. It has 4 parts- • Cardia • Fundus • Body • Antrum pylorus



Main function of the stomach are:

1. Storage of food until digested. When food enters the stomach a vagel reflex greatly reduces the tone in the muscular wall of the body of the stomach, so that the wall can bulge progressively outward accommodating greater and greater quantities of food up to a limit of about (1 liter), this process is called receptive relaxation.

2. Mixing of food with gastric secretion until it forms a semi fluid mixture called chyme. When the stomach is filled, weak peristaltic constrictor waves called mixing waves, move toward the antrum along the stomach wall approximately once every 20 seconds. As the constrictor waves progress from the body of the stomach into the antrum, they become more intense, providing powerful peristaltic constrictor rings that force the antral contents under high pressure toward the pylorus.

3. Slow emptying of chyme to the duodenum at a rate suitable for proper digestion and absorption by the small intestine.

- Normal diet takes 3 hours to be emptied to the duodenum. Fasting for 12 hours → increases antral peristalsis → hunger contraction accompanied with pain.

Gastric secretions:

Are aid in the breakdown of food into small particles and continue the process of digestion had begun by the salivary enzymes. The stomach mucosa contains two types of gastric glands:

1. **Oxyntic glands** which are located in the fundus and the body of the stomach, they contain three types of cells:

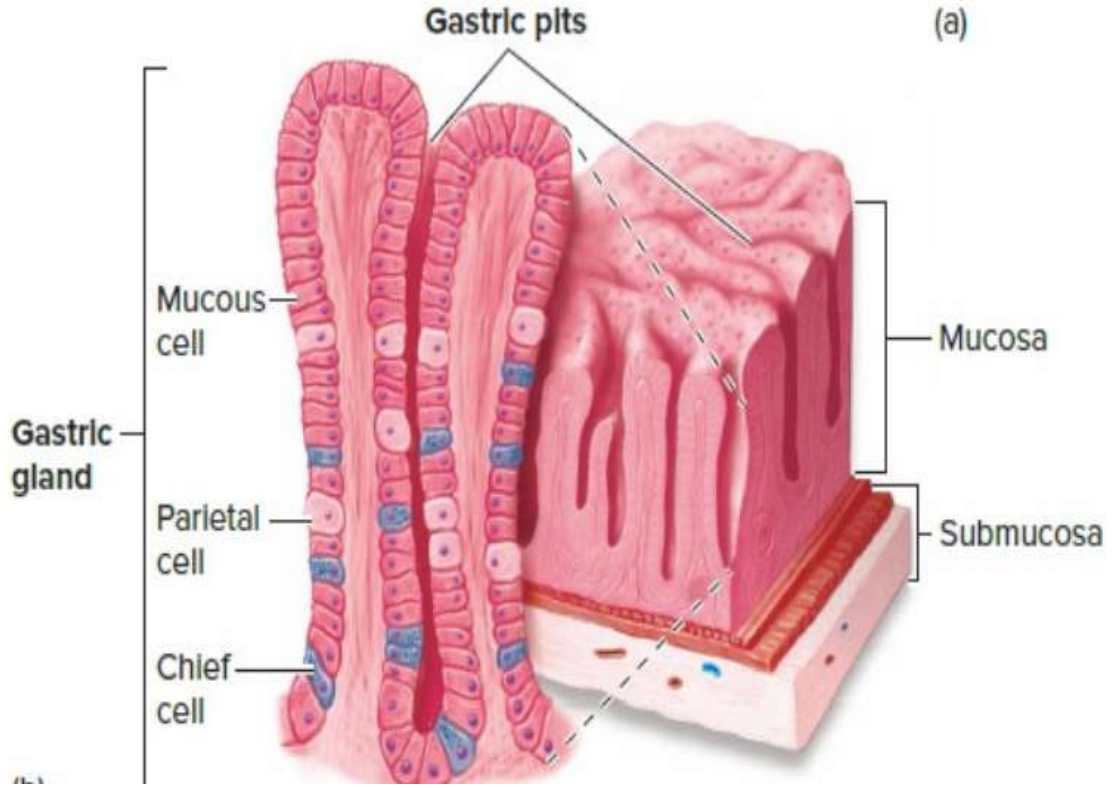
a. *Mucus secreting cells* that line the surface of the stomach.

b. *Oxyntic (parietal) cells* which secrete intrinsic factor and HCL.

c. *Peptic (chief) cells* which secrete pepsinogen.

2. **Pyloric glands** which are located in the antral and pyloric regions of the stomach, contain G cells (responsible for the release of the gastrin hormone) and some mucous cells.

Pepsin and gelatinase enzyme: They are released by exocytosis (need Ca++ and energy) by chief cells in mucosa of stomach. The cells release their secretion directly to the lumen of stomach.



Mucous secretion of stomach:

•The surface of the stomach mucosa between glands has a continuous layer of mucus cells that secrete large quantities of a viscid and alkaline mucus that coats the mucosa with a mucus gel layer often more than 1mm thick. Thus providing a major shell of protection for the stomach wall from auto digestion by acid as well as contributing to lubrication of food transport. The irritation of the mucosa directly stimulate the mucus cells to secrete this thick, viscid mucus.

- Patient with peptic ulcer will have a defect in mucous secretion, when damage to the mucosa as it occurs due to highly concentrated HCL, 10% ethanol, drugs (e.g. aspirin) and smoking , allows pepsin and HCL to penetrate the mucosal barrier and destroy mucosal cells, this liberates histamine, which increases acid secretion and produces increased capillary permeability and vasodilatation and lead to edema. Direct exposure of mucosal capillaries to the digestive process and lead to bleeding.
- The mucous layer covering is only found in stomach
- Patient with lower esophageal sphincter incompetence → regurgitation of gastric juice → reflex esophagitis (heart burn).

HCL secretion by stomach:

Functions of HCL:

1. Important for activation of pepsinogen to pepsin.

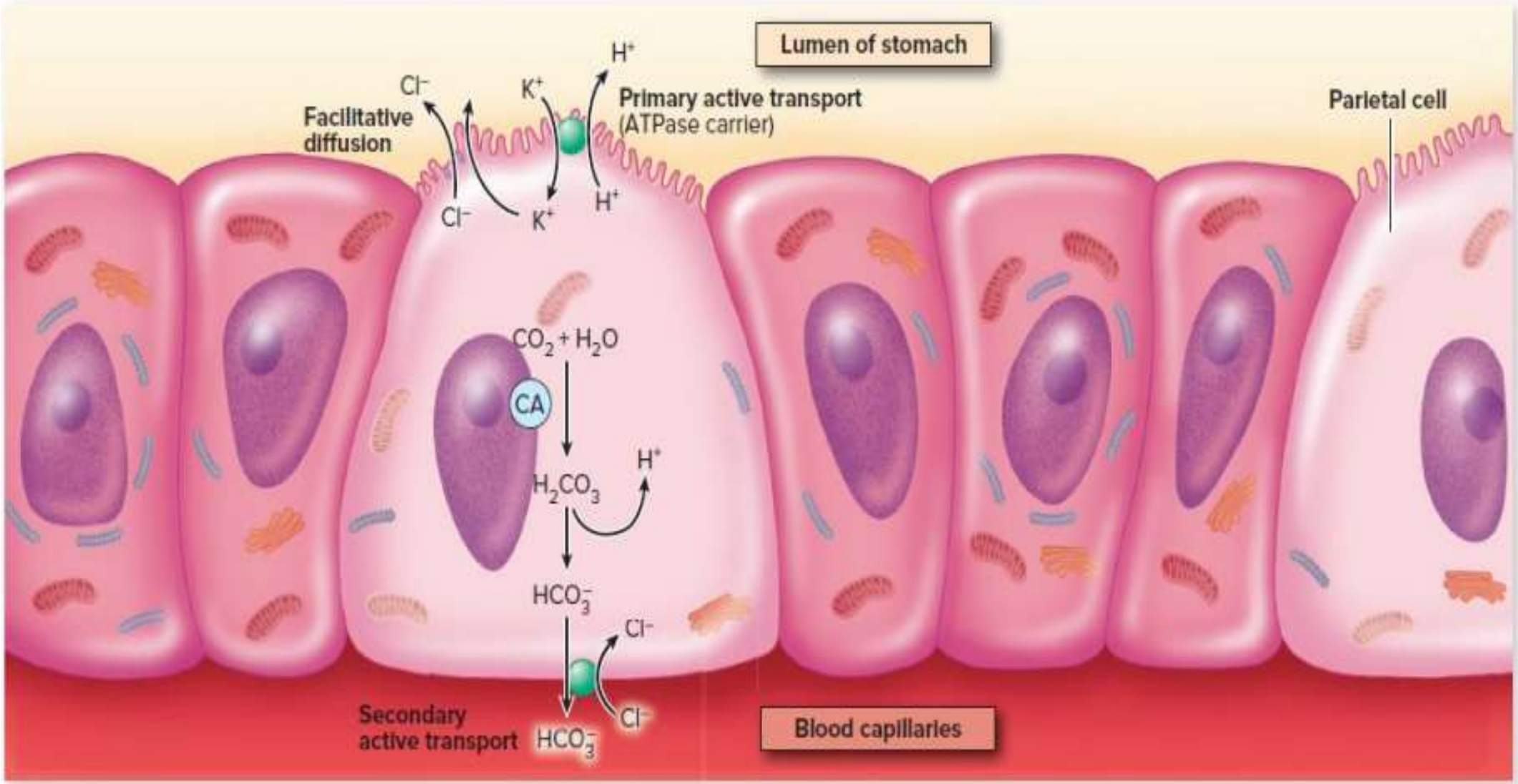
2. Aid in protein digestion (due to formation of pepsin).

3. Kills bacteria, viruses, and many toxins.

4. Converts the dietary ferric Fe^{+3} to ferrous Fe^{+2} , which is better absorbed. Without HCL the person→ decrease iron absorption suffer → iron deficiency anemia.

Mechanism of HCL secretion:

- **Secretion of gastric acid by parietal cells :**The apical membrane (facing the lumen) secretes H + in exchange for K + using a primary active transport carrier that is powered by the hydrolysis of ATP.
- The basolateral membrane (facing the blood) secretes bicarbonate (HCO_3^-) in exchange for Cl^-. The Cl^- moves into the cell against its electrochemical gradient, powered by the downhill movement of HCO_3^- out of the cell.
- This HCO_3^- is produced by the dissociation of carbonic acid (H_2CO_3), which is formed from CO_2 and H_2O by the action of the enzyme carbonic anhydrase (abbreviated CA).
- The Cl^- then leaves the apical portion of the membrane by diffusion through a membrane channel. The parietal cells thus secrete HCl into the 1. 2. 3. stomach lumen as they secrete
- HCO_3^- into the blood.


Lumen of stomach
Cl⁻
K⁺
H⁺
Facilitative diffusion
Primary active transport (ATPase carrier)
Parietal cell
Cl⁻
K⁺
H⁺
$CO_2 + H_2O$
CA
H_2CO_3
H⁺
HCO_3^-
Cl⁻
Secondary active transport
HCO_3^-
Cl⁻
Blood capillaries

Transmitters involved in HCL secretion:

1.Histamine

2.Acetyl choline

3. Gastrin

Control of gastric secretion:

a. ***Cephalic phase*** this is responsible for about 1/3 of gastric juice secreted /day, this phase is initiated by:

1. Food in the mouth.

2. Smell, sight and thought of food.

3. Anger and hostility.

•Neurogenic signals originate in cerebral cortex or appetite centre →vagus n →stomach → HCL secretion.

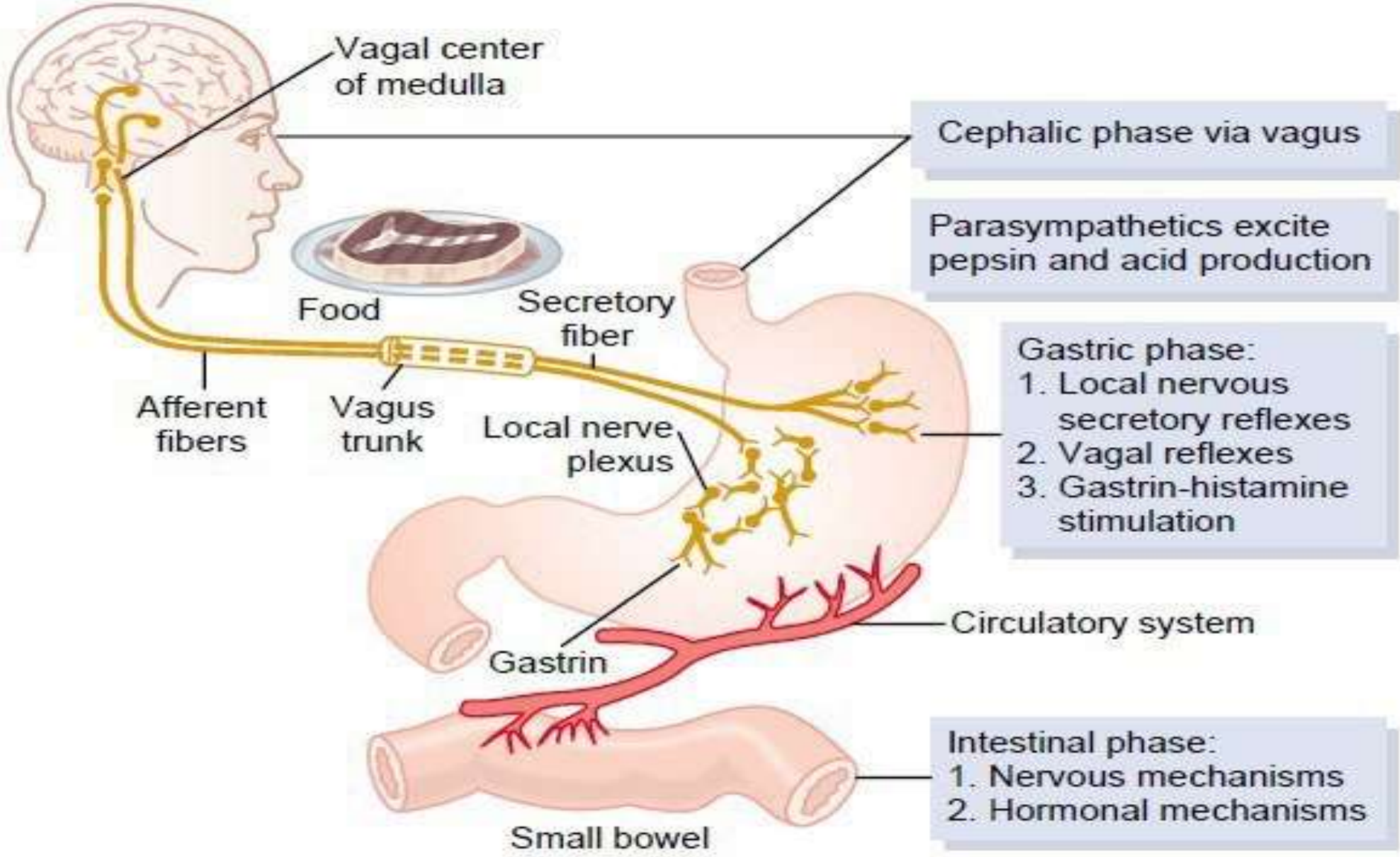
b. Gastric phase this is responsible for 2/3 of gastric juice /day occurs when there is food in stomach this cause :

a. Nerve effect:

•*ENS:* mechanoreceptors and chemoreceptors stimulation → stimulation of enteric nervous system (ENS) → release of acetylcholine which will act on parietal cells to release HCL and on G cells causing release of gastrin.

•*Vagus:* nervous effect stimulate vagus nerve to lead the secretion of acetylcholine .

•*Acetylcholine* act on parietal cell and G cells directly.



Phases of gastric secretion and their regulation.

b. Humeral effect:

•Gastrin: from G cells act on parietal cells causing secretion of HCL.

•Histamine: acts on parietal cells causing increase release of HCL.

b. Intestinal phase:

Can be present but not always. It depends on nature of chyme entering the small intestine. Some types of chyme can stimulate duodenal mucosa to release enteric gastrin which act on parietal cells to increase HCL especially when diet needs more digestion so the intestine will share in this part.

The effect of intestine on gastric secretion is mostly inhibitory this is when the chyme contains acid or fat or both in the duodenum.

1.Small Intestine

Layers of Small intestine (4) 1)Mucosa Absorb nutrients from chyme.

2)Submucosa Provides blood vessels ,lymphatic vessels and nerves to support mucosa on the surface.

3)Muscularis layer Contracts and moves the small intestine.

4)Serosa Continuous throughout and surrounds the intestine.

major regions of Small intestine: 1:Duodenum: (10 inches) Shortest region of small intestine Chyme and bile mix completing digestion.

2:Jejunum: (3 feet) Middle section Serves as primary site of nutrient absorption.

3:Ileum: (6 feet) Final section of small intestine Empties into large intestine Completes nutrient absorption.

The interior walls of the small intestine are tightly wrinkled into projections called *circular folds* that greatly increase their surface area

 Microscopic examination of the mucosa reveals that the mucosal cells are organized into finger-like projections known as villi, which further increase the surface area. Many villi are present on the surface of intestine.

 The cells on the surface of the mucosa also contain finger-like projections of their cell membranes known as microvilli, which further increase the surface area of the small intestine.

 Epithelial cells have a ‘brush like’ border

 Purpose: All of these wrinkles and projections help to greatly increase the amount of contact between the cells of the mucosa and chyme to maximize the absorption of vital nutrients.

Each square inch of mucosa contains around 20,000 villi.

Digestion in GIT:

•***Digestion of carbohydrates*****:** Because the food remains only for a short time in the mouth, only 3-5% of all starches that have been eaten will have become digested, enzyme ά-amylase hydrolyzes starches into disaccharide, maltose and other small polymers of glucose. The action of the enzyme can continue for up to an hour after the food has entered the stomach, then the action is blocked by the acid of the gastric secretions, about 30-40% of the starches will hydrolyzed mainly to maltose.

Pancreatic secretion in the small intestine contains a large quantities of amylase that continue splitting starches into maltose and other small polymers of glucose. The brush border epithelial cells lining the small intestine contain enzymes lactase, sucrose and maltase, which are capable of splitting the disaccharides lactose, sucrose and maltose into their constituent monosaccharides.

•***Digestion of fat:*** The first step in fat digestion is to break the fat globules into small size so that the water soluble digestive enzymes can act on the globule surfaces, this process is called emulsification of the fat and it is achieved under the influence of bile salts. Digestion of fats by pancreatic enzymes (lipases, cholesterol esterase and phospholipase A2), however, the epithelial cells of the small intestine also contain a minute quantity of lipase known as enteric lipase

•***Digestion of proteins:*** Pepsin is capable of digesting essentially all different types of proteins in the diet, pepsin digestion represents 10-30% of total protein digestion. Most protein digestion occurs principally in the small intestine under the influence of the proteolytic enzymes of the pancreatic secretions. Trypsin and chymotrypsin can split protein molecules into small polypeptides. The brush border of the small intestine contains several different enzymes aids in the digestion of proteins.

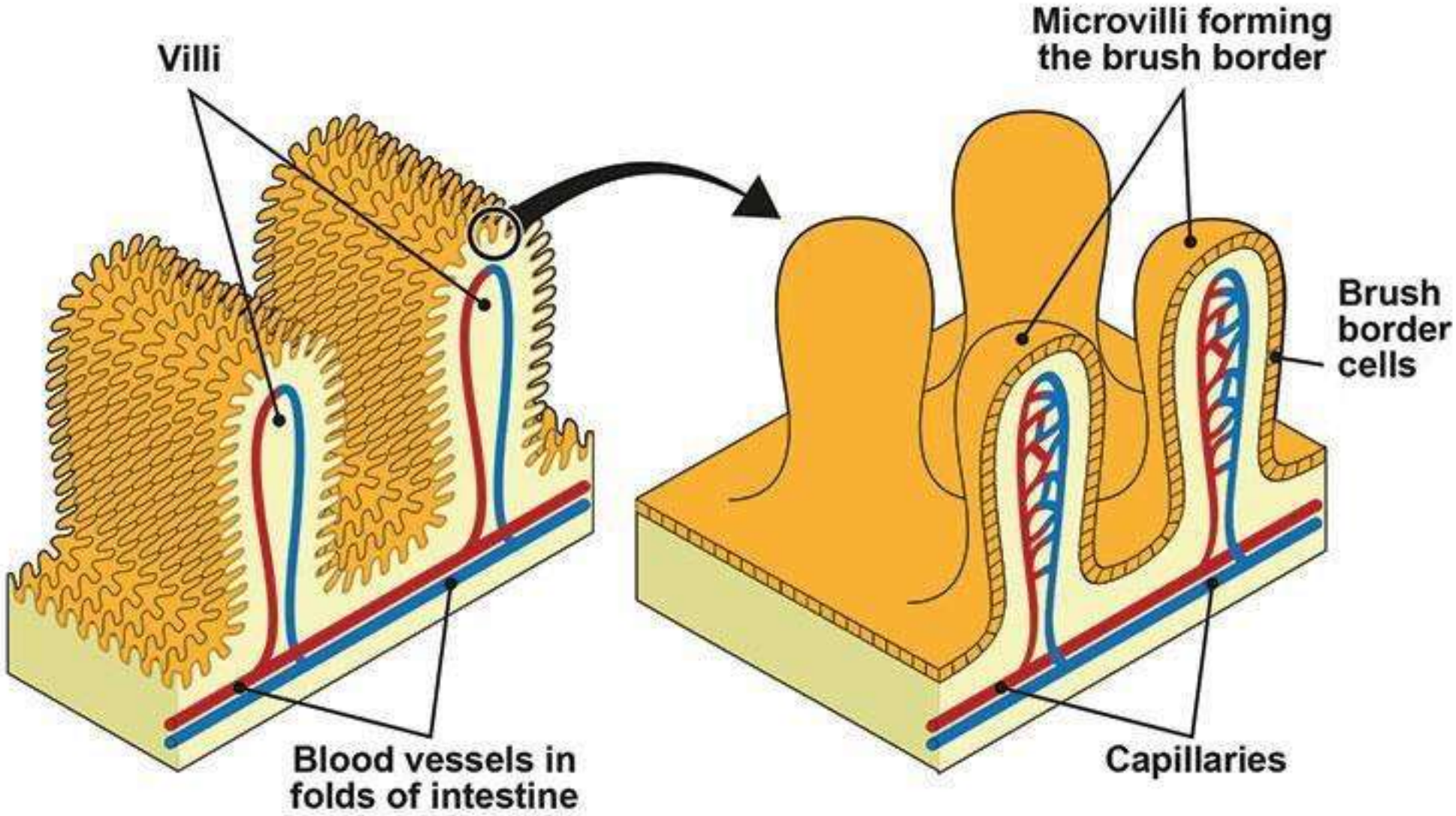
Absorption in GIT:

Absorption in stomach:

•Although gastric enzymes begin breaking down proteins, the stomach wall is not well adapted to absorb digestive products. However, the stomach absorb small quantities of water, glucose, certain salts, alcohol, and some lipid soluble drugs.

•Most nutrients are absorbed in the small intestine. Alcohol, which is not a nutrient, is absorbed in the stomach. This is why?? The intoxication effects of alcohol are felt soon after consuming alcoholic beverages.

Absorption in the small intestine: The villi and microvilli greatly increase the surface area of the intestinal mucosa.


Villi
Microvilli forming the brush border
Brush border cells
Blood vessels in folds of intestine
Capillaries


Thank You!