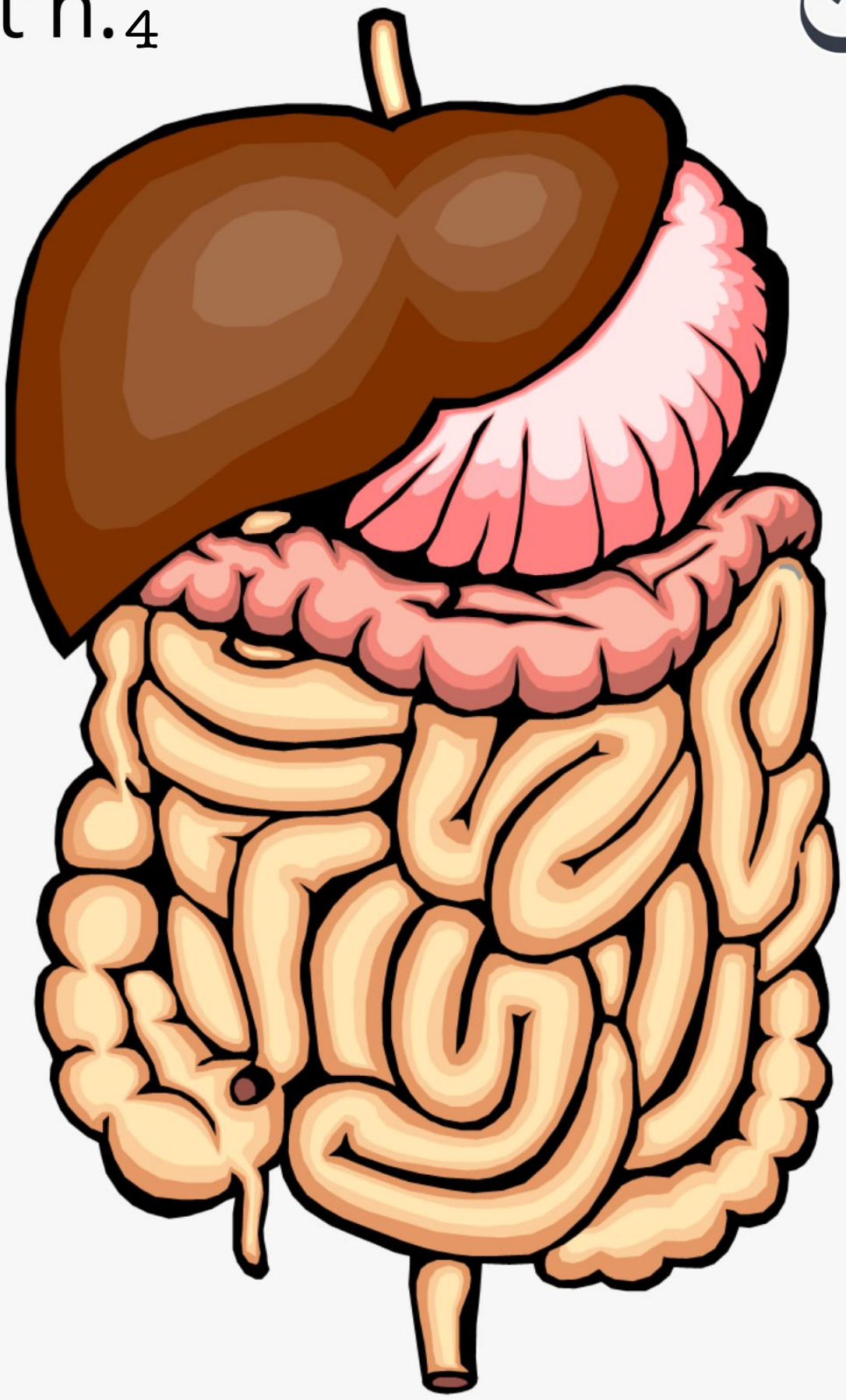
Physiology

Sheet n.4



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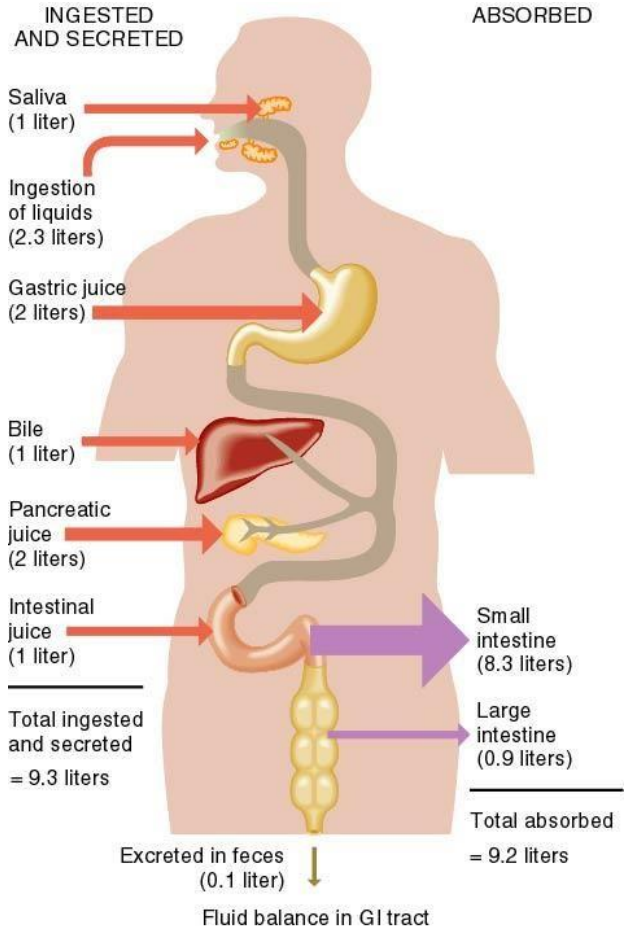
GASTROINTESTINAL SECRETION

The amount of secretions by these structures are 9.3 liters per day
Do all these fluids get excreted in faces?
From the 9.3 liters secreted and ingested, only about 0.1liter is excreted, while 9.2 is absorbed about 85%(lower part of small intestine absorbs 8.3 liters and colon 0.9 liters).



Secretions along digestive system appear as a response to the presence of food in GI tract. The composition of secretions (enzymes and other constituents) varies according to the type of food, **and serves to:**
- Digest food. (chemical digestion of food). (serous secretion)
- Lubricate and protect the mucosa. (mucus secretion)

The composition of secretion includes:
- Organic materials that secretory cells synthesize are stored in vesicles, and then secreted upon stimulation.
- Water and electrolytes are taken from blood vessels, and then secreted by secretory cells.

What types of secretion do we have along these organs?
We have two types:
1- serous secretion: rich in <u>water</u> and electrolytes which contains proteins such as amylase (ptyalin),

which is a digestive enzyme.
2-mucus secretion: rich with mucin (a glycoprotein) for lubrication and for surface protection purposes.

Many types of secretory glands are found along the GI tract, these include:
- Single-cell secretory glands (goblet cells).
- Pits that represent invaginations of the epithelium in the submucosa in small intestine are known as “Crypts of Lieberkühn” and in the stomach “Tubular glands”.
- Complex glands: like mucus glands at lower part of esophagus.
- Organs: like Salivary glands, Pancreas and Liver.
Located outside the tubular structure of the GI.

Regulation of glandular secretion:

The role of ENS:
The presence of food in certain segments usually stimulates glandular secretions. This appears as a response to mechanical or chemical stimulation, which induces activation of secretory reflexes that are responsible for the increased secretions by gland.

The role of Autonomic nervous system:
- Parasympathetic stimuli increase the rate of glandular secretions.
- Sympathetic stimuli can cause moderate increase in glandular secretion by increasing vesicular transport and the mucin synthesis increases (increases secretion of organic materials).
On the other hand it can reduce secretion of water and electrolytes by its effect on vessels (reduces blood flow).
But the bulk of sympathetic stimulation over water and electrolytes is inhibition

Hormonal regulation:
- Some hormones are secreted by the presence of food in digestive organs which affect the glands where they stimulate secretions.

Salivary Glands secretion

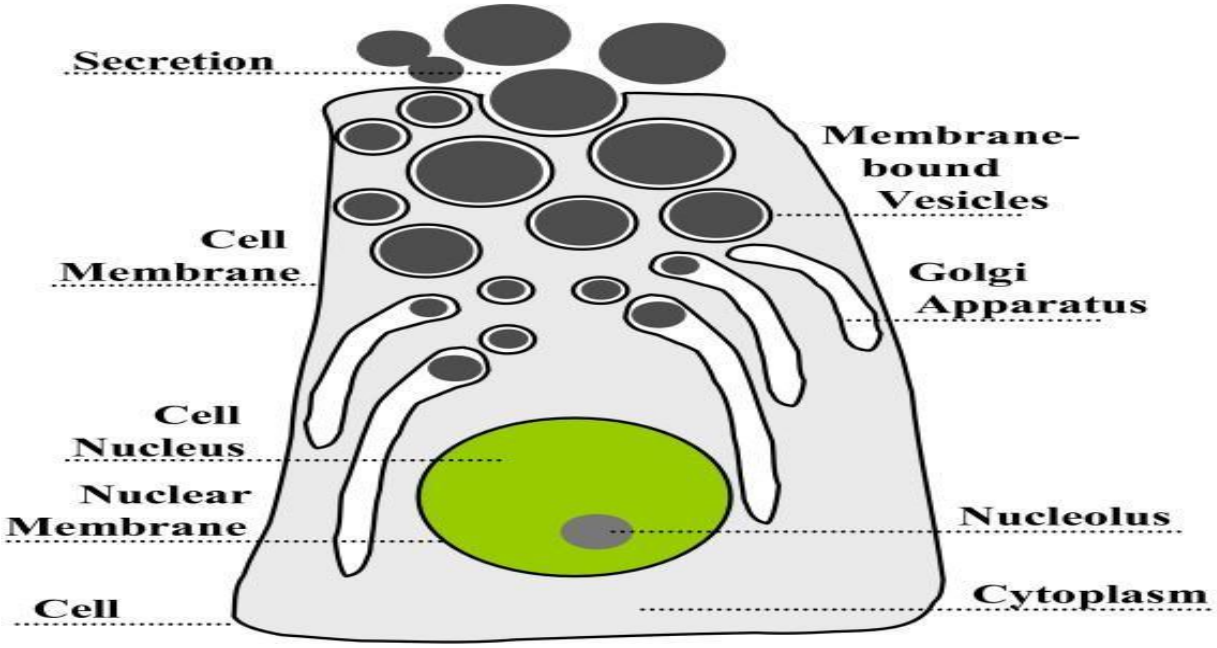
General consideration:
Secretion: is a net movement of water, electrolytes and proteins (starch splitting enzyme (amylase) and glycolproteins) into the lumen of salivary duct.

Salivary Glands

Name of Gland	Type of Saliva	% of Total Saliva Secreted
Submandibular	Mucous-serous	70
Parotid	Serous	25
Sublingual	Mucous	5

What does this cell represent?

We can notice that it is filled with vesicles and endoplasmic reticulum , because cells that secrete proteins use vesicular transport and exocytosis to secrete proteins.



Water and electrolytes secretion

There are two types of cells:

Cells that form the parenchyma of the gland and secreting saliva (ACINAR CELLS)

Once the saliva gets secreted it goes through the ducts system that lined by another type of cells called duct cells, the acinar cells secrete primary secretion (primary saliva).

The role of acinar cells:

- Secretion of water and electrolytes:

Origin of water and electrolytes is extracellular fluid. The acinar cells are surrounded by capillary plexus which plays an important role in glandular secretion

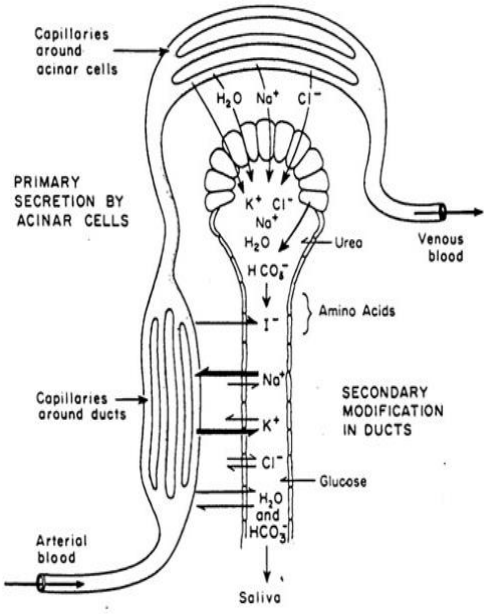
The basolateral membrane of these acinar cells is facing interstitial fluid in this part there is active transport of chloride

Chloride from interstitial to inside the cells (more negative)so this will attract positive charge particles from interstitial to inside (sodium) the osmolarity increases and this will attract water so the large enlarge but this cells are not rapture

Proposed steps of secretion:

1. Active transport of Cl- at the basal portion of the membrane causes more negative membrane potential.
2. Increased negativity of membrane potential attracts the positive ion (Na+).
3. Increase osmotic pressure inside the cell causes water to move inside, which in turn increase hydrostatic pressure inside acinar cells.

4. This increase results in minute ruptures at the apical membrane of secretory cells which cause flushing of water, electrolytes and organic materials out of the cell into the lumen.



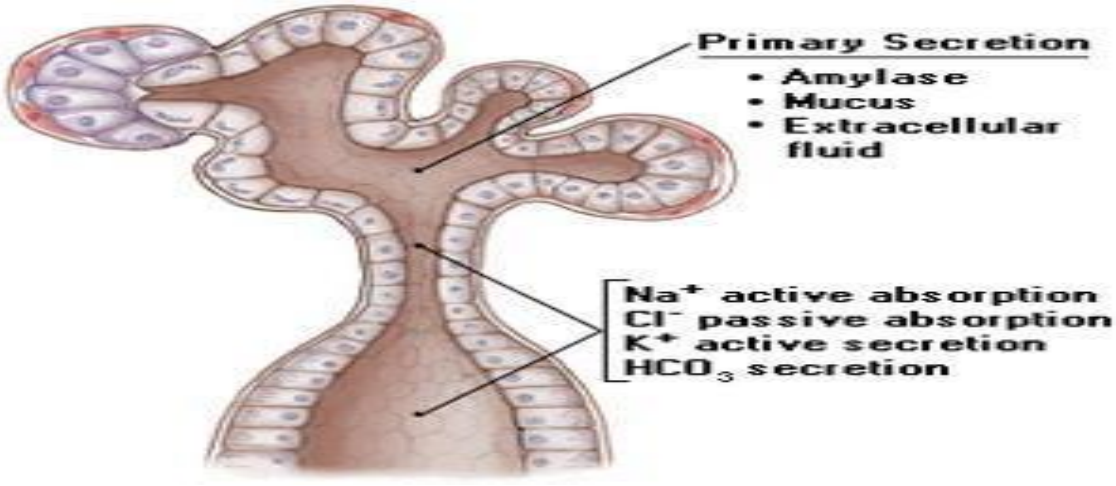
The primary saliva has almost the same composition as interstitial fluid

2ND STAGE: Modification of primary saliva through ducts to get final saliva.

During the flow of saliva through the ducts, two major transport processes (by duct cells) are taking place to finalize the ionic composition of saliva: First, sodium ions are actively reabsorbed from all the salivary ducts and potassium ionsare actively secreted into the ducts in exchange for the sodium. Therefore, the sodium ion concentration of the saliva becomes greatly reduced, whereas the potassium ion concentration increases.

However, there is more sodium reabsorption compared with potassium secretion, which creates electrical negativity of about −70 millivolts in the salivary ducts; this negativity in turn causes chloride ions to be reabsorbed passively. Therefore, the chloride ion concentration in the salivary fluid falls to a very low level.

Second, bicarbonate ions are secreted by the ductal epithelium into the lumen of the duct. This secretion is at least partly caused by the passive exchange of bicarbonate for chloride ions, but it may also result partly from an active secretory process.



The role of duct cells:
During the flow of saliva through the ducts, two major transport processes are taking place to finalize the ionic composition of saliva:
Na+ reabsorption and K+ secretion: by the activity of Na+ / K+ pump.
This will result in a negative trans-cellular potential which induces reabsorption of Cl- ions.
HCO3- secretion into the duct, partly by exchange of HCO3- for Cl- and may result also by an active transport of HCO3-.

The NET result is a change in the ionic composition of saliva by decreasing Na+ and Cl- concentration to the 1/10 of their plasma concentration and increasing K+ concentration by 7 folds and HCO3- concentration by 2-3 folds.
The final saliva is a hypotonic solution because there is a higher absorption rate of Na+ and Cl- than secretion of K+ and HCO3- by tubular cells.

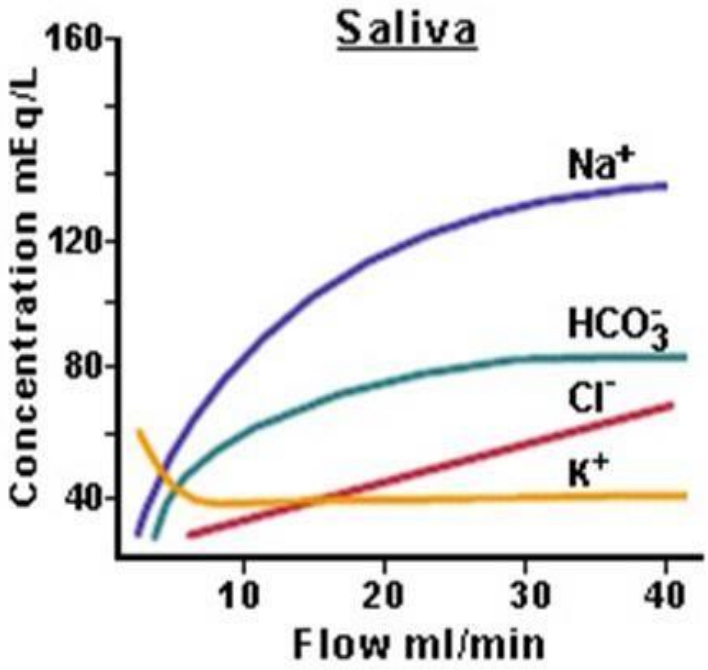
Can we have the same composition of saliva if the salviary gland has been stimulated and when it's not stimulated??
We have a lot of differences

Are we having the same amount of saliva secreted all the time?
No, it can be increased by stimulation, when we are having food.
The amount of secretion by saliva is about 1500ml/day.
1-The rate of secretion is less than 0.025 (during sleep) to about 0.5ml/min (during the basal conditions). The spontaneous secretion of saliva is maintained by a constant low level of parasympathetic stimulation. The pH of saliva during resting secretion is around (7.0).

2- During maximal stimulation, the formation of primary saliva increased as much as 20 folds by increasing the secretory activity of acinar cells. As a result the flow rate of saliva through the ducts is increased, which may result in relative reduction of the reabsorptive and secretory activity of the duct cells. This will change the composition of secondary (final) saliva (more Na+ and Cl-, and less K+ are found in secondary saliva during high stimulation than their concentration at low rate of flow). pH during active secretion (stimulated secretion) approaches 8.0 due to the formation and release of more bicarbonate HCO3-.

Upon stimulation of salivation bicarbonate secretion increases which makes the ph more alkaline .

From this picture we can see the difference in concentration of ions in final saliva between basal secretion and stimulated secretion.
Na+, Cl- and HCO3- are low while K+ is high during basal secretion. During active Secretion Na+ and Cl- both are high due to reduced reabsorption while HCO3- is high because of increased formation and release.
We can see that sodium and chloride at low rate there is a little amount
But at high rate vice versa.
Unlike the potassium at low rate has more amount than high rate .



Comparing the final saliva at low and high rate, not the final and primary saliva

Synthesis and secretion of protein components:
Protein secretion: Proteins (ptyalin, lingual lipase and mucin) are synthesized at ER (endoplasmic reticulum) of acinar cells, then transported by a mean of vesicular transport toward the apical (luminal part) membrane where they are secreted by exocytosis.
The secretory cells are rich in ER and mitochondria. Mitochondria provide sufficient energy supply for transport of nutrients that enter in the constitution of synthesized materials and for the process of synthesis.
The acinar cells secrete primary secretion that contains ptyalin and mucin in a solution of electrolytes. The water and electrolyte concentration in primary secretion is not far from that in extracellular fluid.

Control of salivary secretion.

-The control is achieved by ANS

Stimulation of salivation can be induced by:

- **Nervous regulation**: Both sympathetic and parasympathetic increase salivation, but by different mechanisms.

> **parasympathetic** increase water and electrolyte secretion.
> **Sympathetic** increase mucin synthesis. But more increase in the sympathetic activity can reduce salivation by its effects on blood vessel supply (decreased blood flow, so it has indirect effect on reducing saliva secretion).

- Unconditioned salivary reflex:
Occurs by stimulation of chemo-receptors and pressure-receptors in oral cavity to the presence of food.
For ex. dental procedures induce activation of pressure receptors.
These transmit signals through afferent fibers to salivary centers in the medulla, which transmit stimulatory signals through efferent fibers via extrinsic autonomic nerve fibers to increase salivation.

- Conditioned salivary reflex (learned response):
Stimulation of salivation by thinking about, seeing, smelling, or hearing about pleasant food. This is known as (Mouth watering) in anticipation of something delicious to eat.
The conditioned response is learned and based on previous experience.

Function of saliva

1. Saliva begins digestion of carbohydrates in the mouth:
Amylase that breaks polysaccharide into maltose
(Disaccharide consists of 2 glucose).
Amylase enzymes work best in alkaline so, the food bolus in the stomach is in acidic places so the amylase enzymes cannot functioning well so this enzyme starts the digestion of starch

2. Facilitate swallowing by:
- Moistening the food particles.
- Lubrication by mucus which protects the mucosa during swallowing and allowing easy slippage of solid food, which prevents physical damage to the mucosa.

3. Antibacterial actions:

- Lysozyme: an enzyme that lyses or destroys certain bacteria.
- The constant flow of saliva rinsing away materials (food residues, shed epithelial cells, and foreign particles) that may play an important role in oral hygiene and keeping mouth and teeth clean.
- IgA helping in the destruction of bacteria

4. Solvent for molecules that stimulate taste buds.

5. Facilitate movements of lips and tongue → aids in speech.

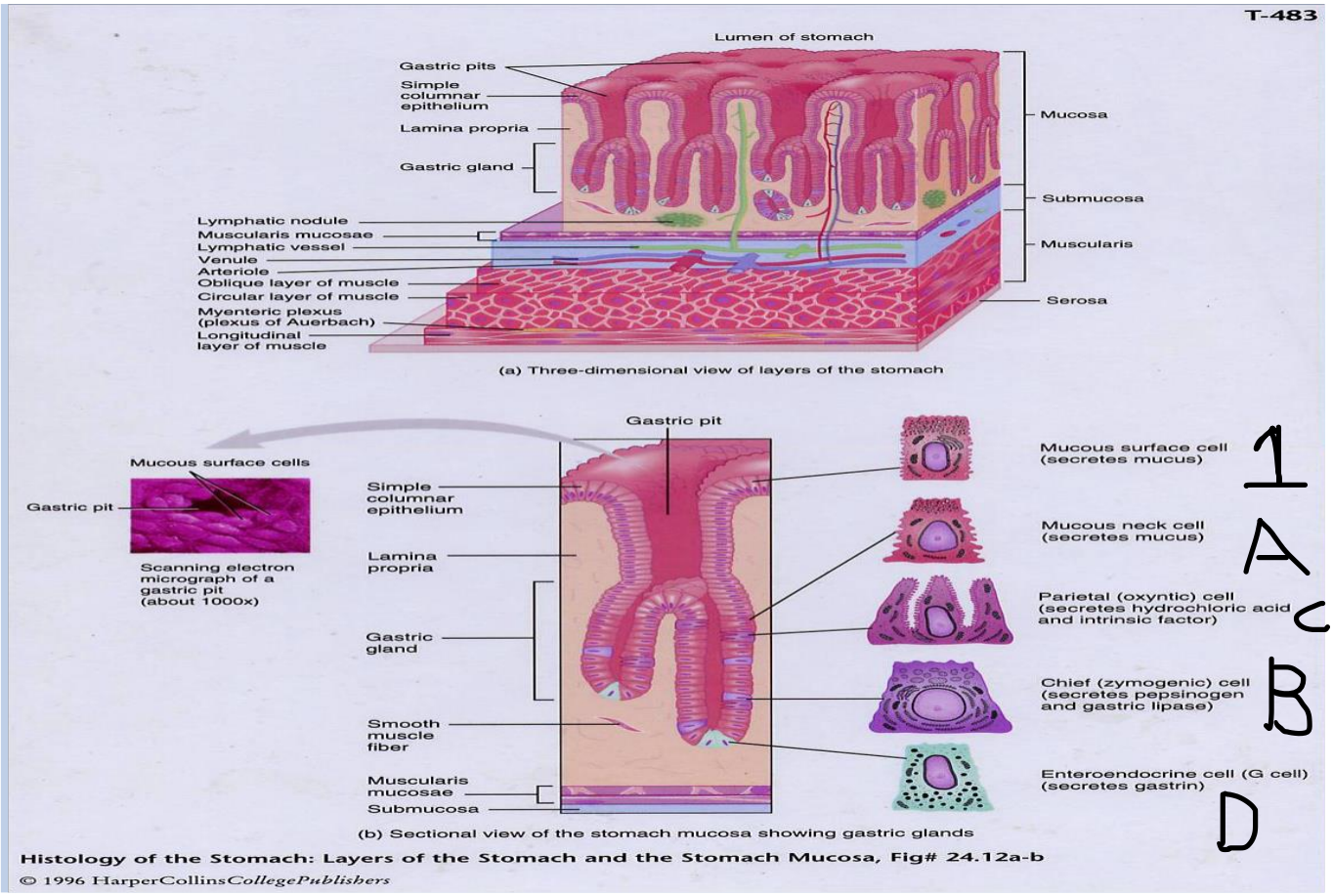
6. Bicarbonate **neutralizes acids** in food and that produced by bacteria → preventing caries(تسوس الأسنان)

ESOPHAGEAL SECRETION:

- Mainly **simple mucus glands** and that have secretion with mucoid character, which help in lubrication and protection of esophageal mucosa from excoriation during swallowing process.

- **Compound mucus glands** near the esophago-gastric junction with alkaline secretion that protect esophageal wall from the gastric reflux into the esophagus.

Gastric Secretions



1- **Mucus secreting (surface) cells**: line all the stomach surface. These cells secret viscid mucus which may have the following functions:6
- Lubricating functions that protect against mechanical injury.
- The secreted mucus lines the mucosa prevents proteolytic enzymes to act on the mucosa (protective).
- The secreted mucus has an alkaline pH which neutralize HCl and protect the mucosa from the chemical injury caused by HCl

2- **Tubular glands:**
-. Oxyntic (gastric glands): HCl forming glands. Secrete HCl, Intrinsic factor and Mucus.

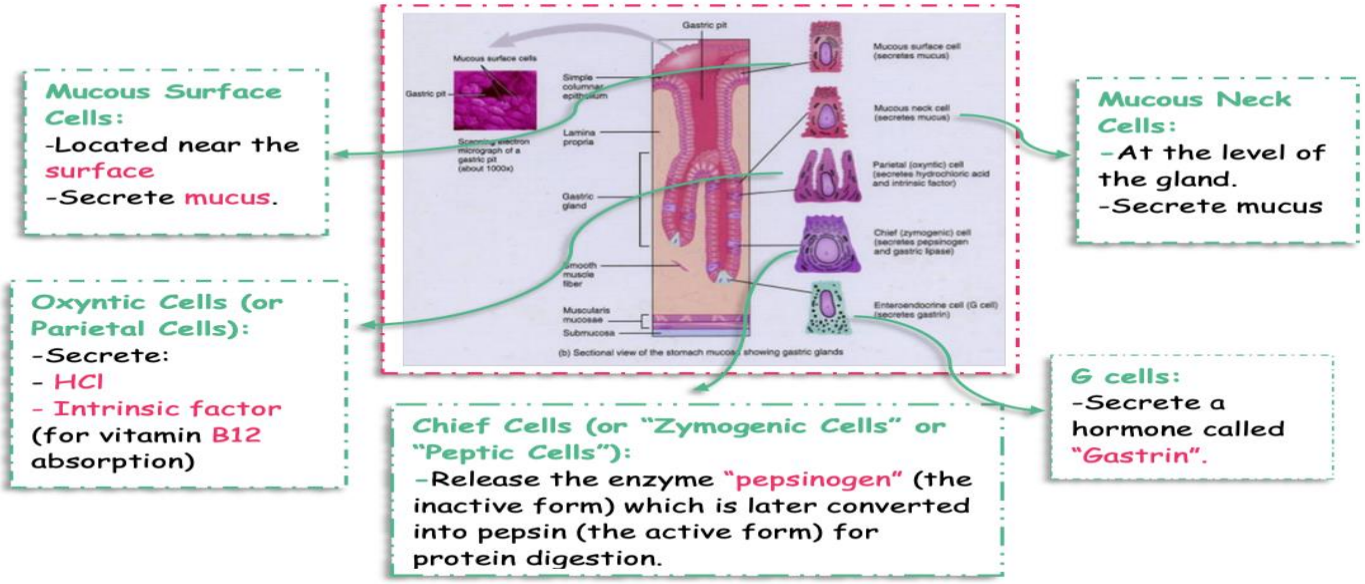
These glands are composed of 3 types of cells:
A- *Mucus neck cells*: secrete mucus and some pepsinogen.

B- *Peptic* or *chief cells*: secrete large amount of pepsinogen.

C- *Parietal* or *oxyntic cells* secrete HCl and intrinsic factor (for absorption of B12).

D- G cells: release a hormone that starts with G, which is Gastrin. They are found at the bottom of the gland and release hormones for regulation.

Summary by (Obada and Nabil):



✓ The professor also mentioned another type of cells: D cells, which secrete somatostatin.

ولدتكَ أُمُّكَ يابنَ آدمَ باكياً
والنَّاس حَولكَ يَضحَكونَ سُرورِاً
فاعمَل لِنَفسِك أن تكون إذَا بكَوا
فِي حينِ مَوتِكَ ضاحِكاً مسروراً