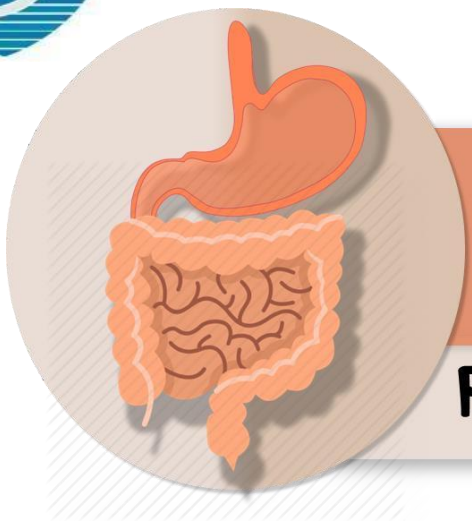

GI system

Physiology

◉ Sheet ○ Slide

Number: - 4

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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.

In this sheet we'll take about salivary glands secretions.

Let's begin!!

- So, what is Secretion?

Secretion: is a net movement of water, electrolytes and proteins into the lumen of salivary ducts.

- As we know, Salivary glands are classified into **3 types**; each one has a special type of secretion:

1. **Submandibular (submaxillary) glands:** they secrete about 70% of the saliva and the type of secretion is **mixed** (both mucous and serous secretions).
   Note: Here we don't have cells that secrete both mucous and serous secretions together (in the submandibular gland we have cells for mucous and cells for serous secretions).
2. **Parotid glands:** secrete about 25% of saliva and the type of secretion is **serous**.
3. **Sublingual glands**: secrete about 5% of saliva and the type of secretion is **mucous**.

- The cells of these glands have many characteristics that help in the synthesis and secretion of protein components:

1. They are filled with vesicles which contain high mucin content in case of mucous-secreting cells.
2. They have high representation of endoplasmic reticulum which plays an important role in the synthesis of proteins.

- According to **function**, salivary glands have 2 types of cells:

1. **Acinar cells**: Forming the parenchyma of the gland, and they secrete the **primary saliva** into the duct of the gland.

2. **Duct cells**: line the duct of the glands, and are responsible for some modifications of the primary saliva.

- **The role of Acinar cells:**
  1. At the basolateral membrane (which faces the interstitial fluid), there are active Cl-transporters, so, Cl ions will move from the interstitial fluid to the inside of the cell.
  2. The polarity inside the cell will become more negative
  3. This will result in the attraction of sodium ions from the interstitial fluid toward inside of the cell.
  4. This will make osmolarity inside the cell much higher; thus, water will enter the cell from the interstitial fluid causing its swelling which in turn increase hydrostatic pressure inside acinar cells.
  5. At the apical membrane (which faces the luminal duct of the gland) small ruptures will take place making the primary saliva flushing into the lumen.

Now we have the primary saliva released, which is almost similar to the interstitial fluid, also, some mucin and other secretions are being released with it.

- **The role of duct cells:**

  The duct is responsible for the modification process of the primary saliva.

  What happens is:
  1. 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 (the +ve Na ions that are reabsorbed will attract the –ve Cl ions)
  2. HCO3- secretion into the duct: partly by the exchange of HCO3- for Cl- and may result also by an active transport of HCO3-.

The net result will be that: the final saliva will have much less Na+ concentration than the primary saliva; also, it will have much less Cl- concentration, much higher concentration of K+ and much higher HCO3- concentration

- **By these modifications:**
  1. Na+ and Cl- concentrations will decrease to 1/10 of their initial concentration in the primary saliva.
  2. K+ concentration will increase to 7 times and HCO3- to 2-3 times of their initial concentration in the primary saliva.
- The final saliva is a hypotonic solution because there is a higher absorption rate of Na+ and Cl- than secretion of K+ and HCO3-
- **Do you expect that the composition of the final saliva will be similar if we have a higher or lower rate of secretion?**

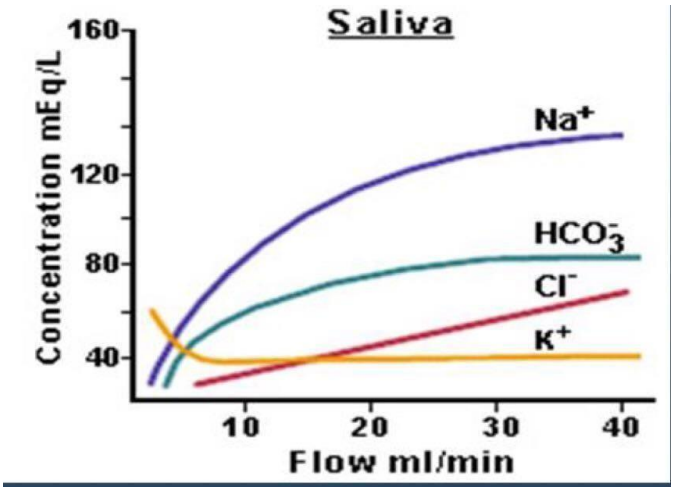
Synthesis and secretion of protein components:

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.

- The composition (HCO3- content) will be different according to the flow rate of salivation, so during basal rate, we get these changes in saliva without any stimulation.
- The spontaneous secretion of saliva is maintained by a constant low level of parasympathetic stimulation
- Once the process of salivation is stimulated, there will be high flow of saliva with no time to exchange ions, thus, the pH will become **more alkaline,** and the composition of the final saliva will have higher content of (Na+, Cl- & HCO3-).
- However, when saliva is secreted with low rate (basal/rest rate of secretion), cells will have time to exchange ions and the final saliva pH will be acidic, not alkaline, and the composition of the final saliva will have higher content of K+, lower content of Na+, Cl- & HCO3-.
- Note: The pH mostly will depend on the concentration of HCO3-, so, when salivation is stimulated, duct cells will synthesize and secrete HCO3- that's why the pH will be alkaline during stimulation (the opposite thing happens during basal rate).



- **Important note:**

Here we are comparing the concentrations of the final saliva at two situations (when secreted at lower & higher rates), **BUT ALWAYS primary saliva** will have more Na+ and Cl- concentrations, Less K+ and HCO3- than the **final saliva**.

- ## The control of salivation:

This can only be performed by the action of ANS.
(Aldosterone , that's usually involved in the reabsorption of Na+, doesn't have any effect over the process of salivation)

1. **Parasympathetic**: increases the salivation process by its direct effect over the secretory cells, thus, their activity increases leading to more salivation.

- This could happen by two ways:

A. **Unconditioned reflex:**

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

Conditioned reflex:

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

2. **Sympathetic:**

- It activates secretory cells by activating the synthesis of mucin. But here it has an indirect effect over salivary glands which is reducing blood flow toward them thus reducing salivation.

Note: the parasympathetic stimulations activates salivation both directly by its effect over secretory cells and indirectly by increasing blood flow toward salivary glands .

The functions of saliva:

1. It contains the amylase enzyme, which will partially digest carbohydrates. Amylase that breaks polysaccharide into maltose (disaccharide consists of 2 glucose).

- Note that this enzyme needs an **alkaline pH** for its optimal activity, but the time that food spends in the oral cavity is too short, so, in the stomach this enzyme won't be active anymore as the acidity increases.

2. Facilitates 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:

- There are some lysozymes which secrete some enzymes that can destroy the bacteria.

4. Oral hygiene:

- This happens by rinsing the mouth with saliva, which will keep the mouth clean.
- Also, an immunoglobulin "A" (IgA), that acts as neutralizer for some pathogens, is released.

5. Solvent:

- In our tongue we have taste buds that need dissolved food to feel the taste of it.

6. Helps in speech as the dryness of the mouth will make talking difficult.
7. Bicarbonate neutralizes acids in food and that produced by bacteria → preventing caries.

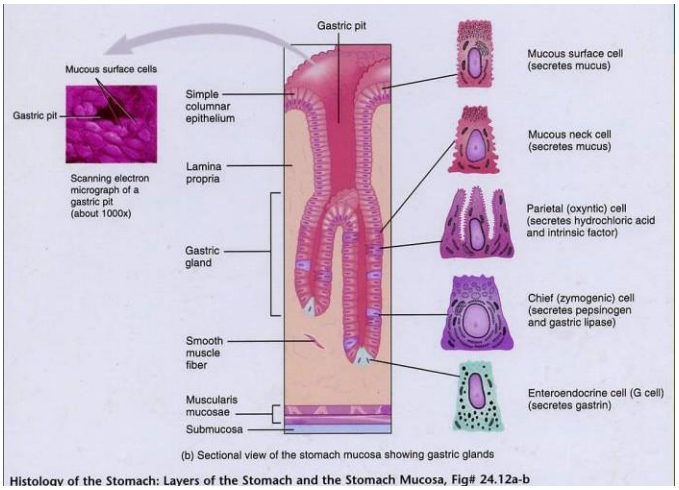
Esophageal secretion:

- Mainly it's a **mucus** secretion, which helps in the protection of esophageal mucosa from solid food particles while swallowing.
- The upper part of the esophagus is composed of ***simple mucus glands*** (within the **mucosa)**, while the lower part secretes more mucus with alkaline secretion and it's composed of ***compound glands*** **(**within the **submucosa).**

The reason why compound glands at the lower part secrete more mucus is that when the sphincter muscle is weakened, the **gastric content** will go back **(reflux)** to the esophagus causing **heartburns**

Gastric secretions:

- The gastric wall of the stomach is composed of: Mucosa (big layer),Submucosa,Muscularis.
- Within the **<u>mucosa</u>** there are some gastric glands or gastric pits.
- Gastric glands contain many types of cells:
  1. Mucous surface cells → from their names (function: release mucus, Location: at the surface of the mucosa).
  2. Mucous neck cells → (function: release mucus and pepsinogen , Location: at the neck of the gland).
  3. Parietal cells or Oxyntic cells:



Histology of the Stomach: Layers of the Stomach and the Stomach Mucosa, Fig# 24.12a-b

- They're specialized in the release of **Hydrochloric acid** and **<u>intrinsic factors and .</u>**
- For absorption of vitamin B12, intrinsic factors are needed in the stomach, so, vitamin B12 deficiency results due to a deficiency in the release of these intrinsic factors.
- A gastric atrophy in the Oxyntic cells will affect the secretion of intrinsic factors, so some complications may occur including Anemia.
  4. Chief/Peptic/zymogenic cells:
- They're specialized in the synthesis and release of **Pepsinogen** which is important in the digestion of proteins.
- At the level of the stomach there is no bulk of digestion, the rest of digestion will take place starting from the duodenum.
  5. Endocrine cells: composed of 2 types:

A. **G cells:** they release Gastrin hormone.

B. **S cells:** they release somatostatin hormone.