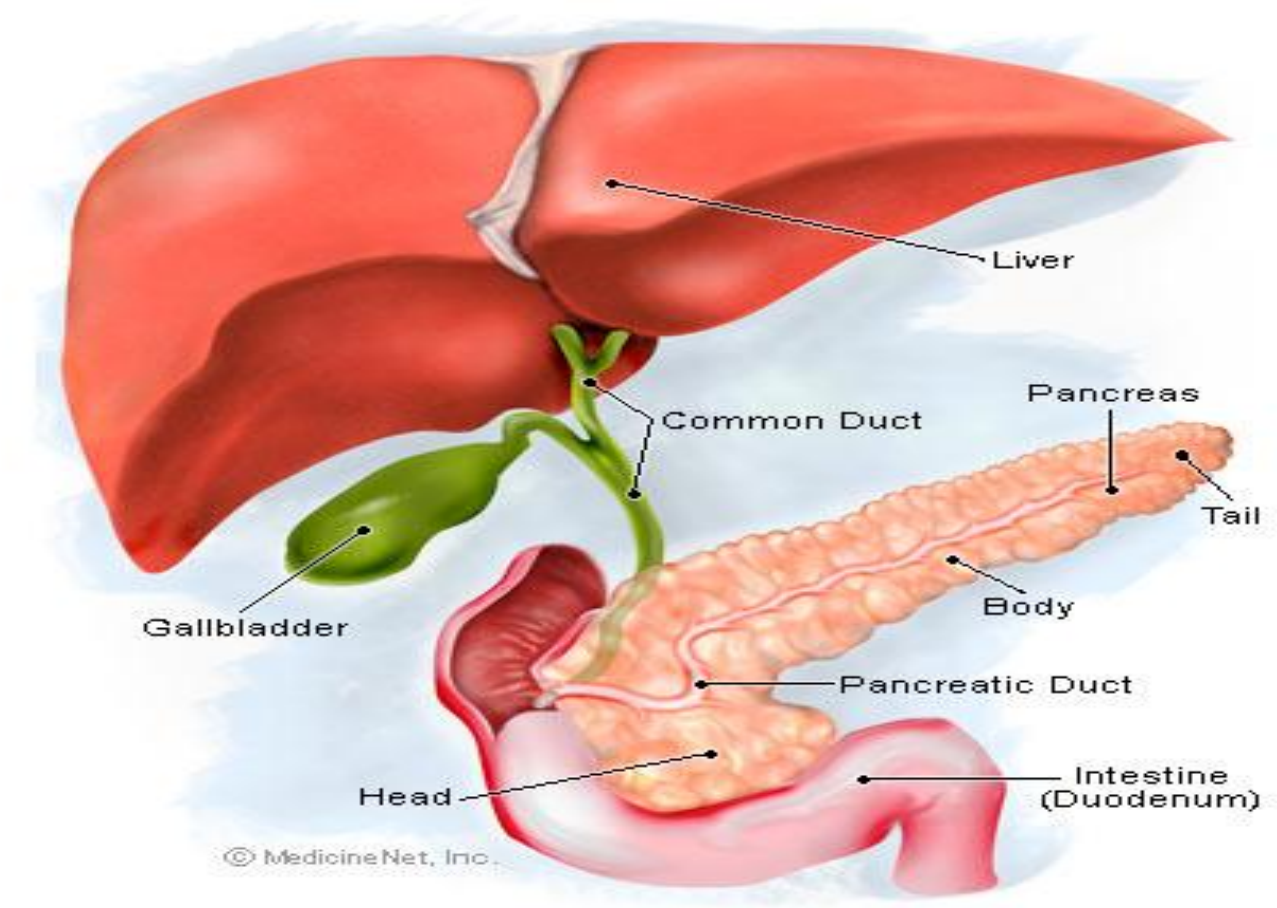
GIT Block

2nd Lecture

Anatomy and Physiology of salivary glands



PHYSIOLOGY TEAM – 430

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Secretory Functions of the Alimentary Tract (Secretion of Saliva)

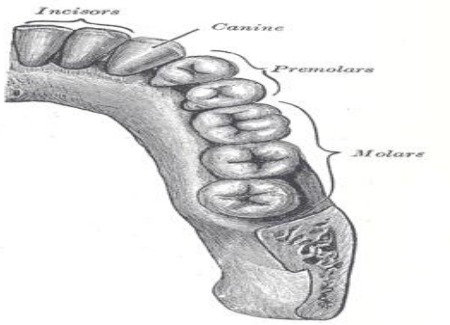
• Mastication (Chewing):

– **Functions:**

1. To lubricate the bolus with salivary secretion
2. To breakdown the bolus to small particles
3. To begin digestion of carbohydrate (amylase)

Amylase is an enzyme that catalyses the breakdown of starch into sugars

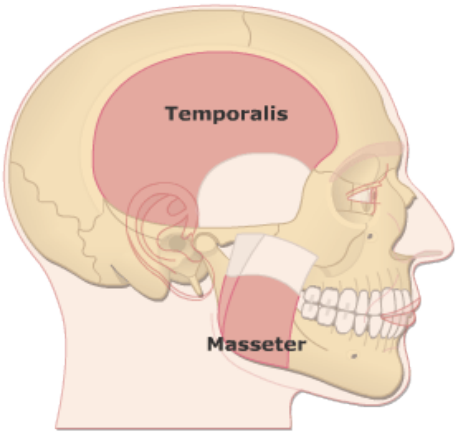
– **Teeth organization:**



- Anterior teeth (incisors) for cutting
- Posterior teeth (molars) for grinding

❖ **Chewing muscles are innervated by CN V:**

- Masseter
- Temporalis
- Lateral Pterygoid
- Medial Pterygoid



❖ **Taste center (Hypothalamus) → rhythmical chewing movements**

- Chewing reflex & stretch reflex.

  Stimulation of specific reticular areas in the brain stem taste centers will cause rhythmical chewing movements. Also, stimulation of areas in the hypothalamus, amygdala, and even the cerebral cortex can often cause chewing.

Chewing reflex & stretch reflex *Very Important*

- The presence of a bolus of food in the mouth → initiates reflex inhibition of the muscles of mastication → the lower jaw to drop.

- The drop in turn initiates a stretch reflex of the jaw muscles → *rebound contraction.*

- *This automatically raises the jaw to cause closure of the* teeth, but it also compresses the bolus again against the linings of the mouth → inhibits the jaw muscles once again → the jaw drops and rebounds another time; this is repeated again and again.

- *The functions of secretory glands:*

1. *Secretion of digestive enzymes*
2. *Provide mucus for lubrication and protection*

- **Anatomical Types of Glands**

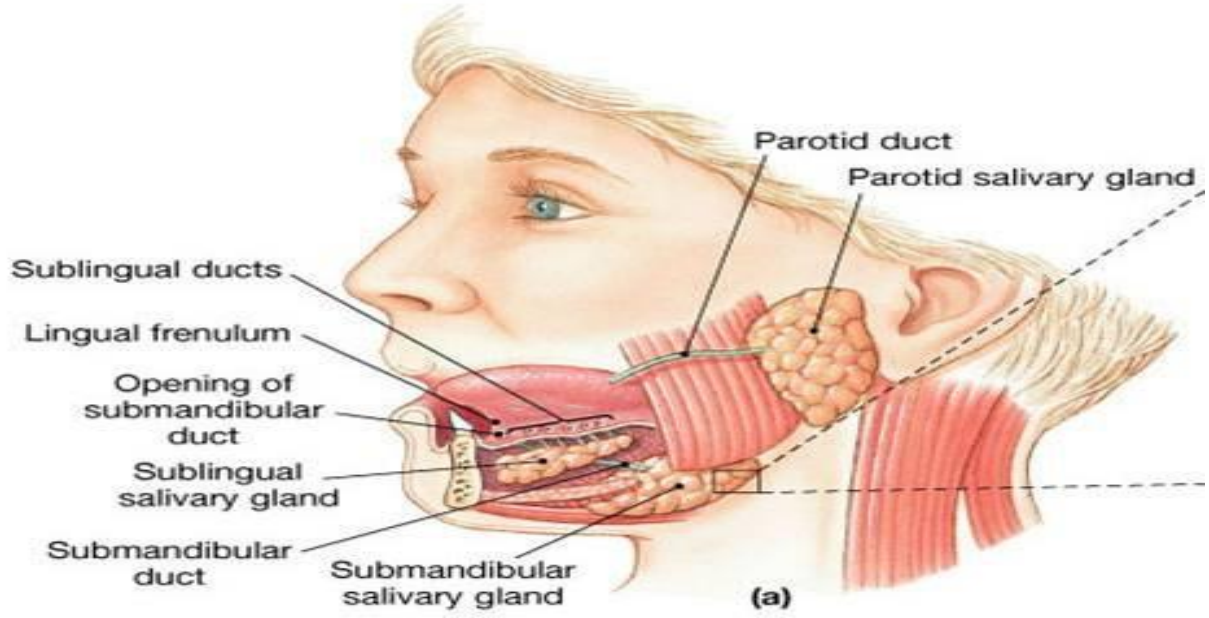
1. Single-cell mucous glands (goblet cells), they produce mucus.
2. Crypts of Lieberkühn at the mucosal pits.
3. Tubular glands (in the stomach and duodenum)
4. Salivary glands, pancreas, and liver

- **Salivary glands :**

The principal glands of salivation are:

1- **Parotid glands**
2- **Submandibular (Submaxillary) glands**
3- **Sublingual glands**
4- **Smaller glands in mucosa of tongue, palate, etc.**

Daily secretion of saliva = 800-1500 mL with pH = 6-7



- **Saliva contains two major types of secretion:**

1. **Aqueous fluids (a *serous secretion*):**

   (Water, ions and enzymes such as *ptyalin (an* α-amylase))

- **Parotid, Submandibular and Sublingual glands**

2. **Mucus secretion (mucin):**

- **Submandibular and Sublingual glands**

- **Composition of Saliva**

Aqueous Fluids	Enzymes	Water	Mucus
H_2O, K, HCO_3, Na, Cl, α-amylase, lingual lipase, IgA, kallikrein, muramidase (lyses muramic acid of Staphylococcus), lactoferrin and epithelial growth factor (EGF)	**α-amylase (from parotid glands)** - cleaves α -1 ,4-glycosidic bonds - In pH = 7 to work properly - Inactivated at pH 4 but continues to work for sometime in unmixed food in Orad portion	(0.5 L saliva/day)	**thick secretion composed mainly of water, electrolytes, and glycoproteins**
Hypotonic Solution	**Lingual lipase** - hydrolyzes lipids - continues working in the duodenum	----------	An excellent lubricant and a protectant for the wall of the gut
At low flow rate, the salivary secretions have: **i. High K and HCO_3** **ii. Low Na and Cl–**	**Kallikrein (protease, from acinar cells)** - Catalyzes production of bradykinin (good vasodilator) from α-globulin - Increases local blood flow	----------	----------

- **Mucus:**

1. **Adheres tightly to the food.**
2. **Coats the wall of the gut and prevents actual contact of food particles with the mucosa.**
3. **It has a low resistance for slippage.**
4. **It causes fecal particles to adhere to one another.**
5. **It is strongly resistant to digestion by the GI enzymes.**
6. **The glycoproteins of mucus have amphoteric properties, (buffering small amounts of either acids or alkalies).**

• Secretory Unit (salivon) :

The basic secretory units "salivon" consists of:

1- Acinus (initial secretory process) :

Two types of cells:

- Serous cells
- Mucous cells

2- Salivary ducts :

- Intercalated duct (initial portion)
- Striated duct OR intralobular ducts – (modification of secretory product)

The intercalated ducts join to form → the striated ducts or intralobular ducts → interlobular ducts that drain into the main duct opening into the mouth.

3- Myoepithelial cells :

- surround acinus and intralobular duct
- Stimulation of both sympathetic and parasympathetic nerves cause contraction of myoepithelial cells and increase salivary flow prevents development of back pressure.

• Salivary secretion

Two stages:

➢ **The first stage involves the acini (primary secretion):**

- It's isotonic to the plasma.
- It contains ptyalin and/or mucin in a solution of ions in concentrations similar to that of plasma.

➢ **Second stage involves the salivary ducts** :

- The cells lining the intralobular (striated) ducts are metabolically very active and responsible for two major active transports of electrolytes which modify the composition of the primary acinar secretion.

- This process is influenced by Aldosterone.
- (Na^+) ions → actively reabsorbed → (low concentration)
- (K^+) ions → actively secreted → (high concentration)
- (Cl^-) ions → reabsorbed passively → (low concentration)
- (HCO_3^-) ions → secreted actively.
- Because the ducts remove more Na^+ & Cl^- ions from saliva than they add K^+ and HCO_3^-, saliva becomes progressively more hypotonic.

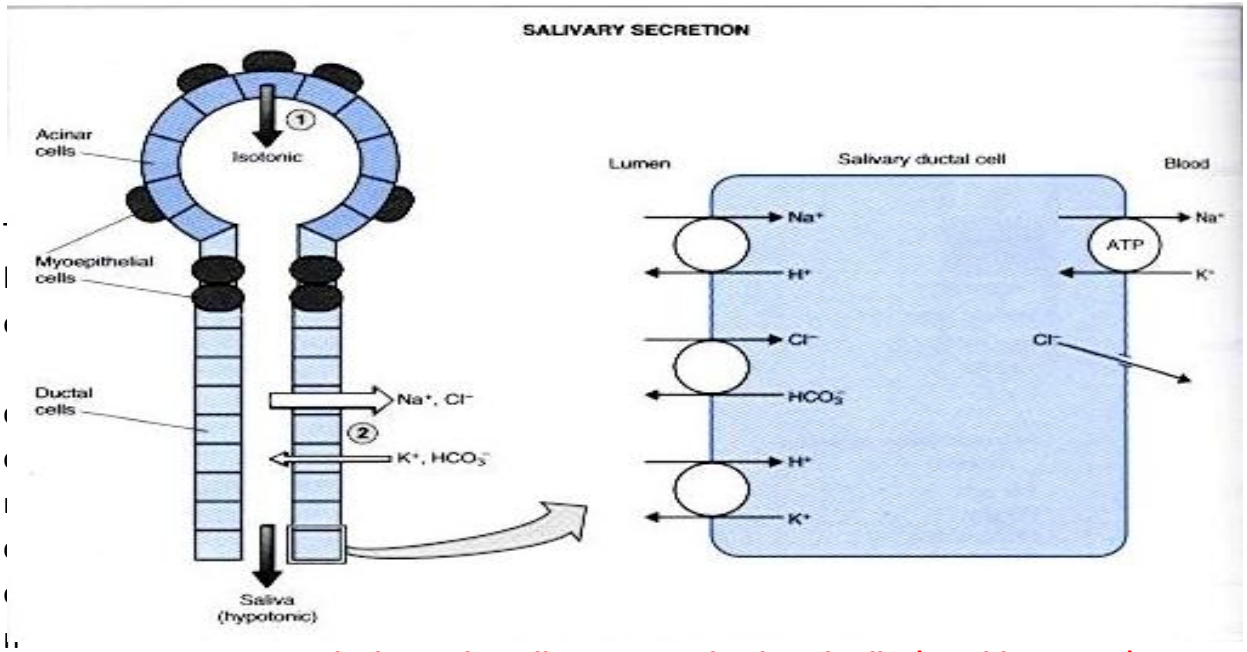


Figure 1Notice the big and small arrows on the ductal cells. (By Aldosterone)

- The concentration of electrolytes depends on the flow rate as follows:

- **Under resting conditions:**
  - The concentration of **Na+ and Cl- in saliva are 1/7** their concentration in plasma.
  - The concentration of **K+ is 7 times greater** than in plasma.
  - The concentration of **HCO3- is 2-3 times** that of plasma.

- **Under maximum secretion:**
  - The concentration of **K^+ falls to only 4 times** that of plasma.
  - The concentration of **Na+ and Cl- in saliva rises to 1/2-2/3** their concentration in plasma.
- **In presence of excess aldosterone secretion:**
  - ($NaCl$ reabsorption and K^+ secretion) ↑ → **NaCl concentration** in saliva ↓to almost zero and **K+ concentration** ↑.

- ## Functions of Saliva

1. It moistens and lubricates food.
2. Saliva keeps the oral mucosa moist and so helps movement of tongue and lips in speech
3. It begins digestion **:**

i. **Ptyalin (salivary amylase):**
- From parotid gland.
- **Function**: It breaks down starch to maltose, dextrins and maltotriose. Its optimum pH = 6.8.
- Continues in the stomach for about half an hour and is arrested only when gastric acid penetrates the food mass.

ii. **Lingual lipase**
- From serous salivary glands on the tongue.
- **Function**: it breaks down triglycerides into monoglycerides and fatty acids.
- Its action may continue in the stomach after food is swallowed.

4. It adjusts salt appetite.
5. Saliva is important for the sense of taste.
   (Any substance must first dissolve in saliva before it can be sensed by the taste buds.)
6. Helps wash away pathogenic bacteria.
7. Saliva contains several factors that destroy bacteria such as thiocyanate ions, antibodies, lactoferrin which chelates iron necessary for bacterial growth and proteolytic enzymes (lysozyme):

   a) *Active against bacterial walls.*
   b) *Helps thiocyanate in entering bacterial wall where they become bactericidal.*

8. Buffering action, saliva neutralizes any acids that may result from bacterial action, also swallowed saliva may help to neutralize gastric HCl in empty stomach.

(Shifting of pH of saliva to the acidic side increases the solubility of Ca^{++} in saliva. Ca^{++} ions are lost from the teeth enamel leading to dental caries.)

Excess alkalis leads to precipitation of Ca^{++} salts around the teeth which forms tarter. Bacteria flourish underneath the tarter leading to chronic inflammation of the gum. If Ca^{++} salts precipitate in the salivary duct system, salivary calculi result.

9. The epidermal growth factor is responsible for healing of ulcers in the mucous membrane of oral cavity.

- **Unique aspect of control of salivary secretion**

- Secretion rate depends entirely on neural control –autonomic nervous system (ANS).
- Both Parasympathetic and Sympathetic → ***increase secretion***.

	Sympathetic nerves	Parasympathetic nerves
Origin:	In the upper thoracic → synapse in the superior cervical ganglion. (intermediolateral gray T1-T3)	In the superior & inferior salivary nuclei in in medulla brain stem.
Outflow	----------	CN VII & IX (details in the box below)
Transmitter	norepinephrine	Acetycholine
Functions	**Stimulates :** - Secretions (mostly enzymes) .They act on mucous cells and produce small amount of viscous secretion. - metabolic rate - the contraction of myoepithelial cell - growth and development of different cells **It causes vasoconstriction**	**Stimulates :** - the secretion (protein poor, high k and HCO_3) - the contraction of myoepithelial cell - the metabolic rate - the blood flow - the direct innervation of blood vessels - the growth and development of different cells **Decreases stimulation due to** → sleep, fear, dehydration **Increases stimulation in response to** → conditioned reflexes (taste, smell)
	Sectioning of sympathetic nerves has **minimal impact on secretion**	Sectioning of parasympathetic **markedly decreases flow & leads to atrophy**

Outflow of parasympathetic nerves in details:

- Fibers from the superior salivary nucleus leave in VII cranial nerve, enter the chorda tympani nerve and synapse in submandibular ganglion. Postganglionic fibers supply both submandibular and sublingual glands.
- Fibers from the inferior salivary nucleus leave the medulla in IX cranial nerve and synapse in otic ganglion. Postganglionic fibers supply the parotid gland.

Xerostomia

If salivary glands are congenitally absent or destroyed by diseases or irradiation, xerostomia (dry mouth) results. Swallowing and speech are difficult. Loss of cleaning and protective functions of saliva leads to degeneration of the oral epithelium.

- **Salivary secretion is controlled exclusively by nervous mechanism through unconditioned and conditioned reflexes.** **FOR READING**

- **Unconditioned reflex:-**
  The presence of food in the mouth stimulates general receptors and especially taste receptors. Impulses travel along afferent nerves to the salivatory nuclei in brain stem. Efferent impulses travel along autonomic nerves to salivary glands to stimulate salivary secretion. This reflex is innate and is not acquired by learning

- **Conditioned reflex**
  Seeing, smelling, hearing or even thinking about appetizing food can result in secretion of saliva. Iinitial impulses concerned with these special sensations and stimulate the salivatory centers. In humans, mouth watering on seeing or thinking of food provides evidence of this psychic reflex.