



# L2- SALIVARY GLANDS



**GIT**

# Objectives

- Mastication and Chewing reflex
- The functions of secretory glands
- Anatomical types of glands
- Salivary glands
- Secretion of saliva and its characteristics
- Composition of saliva
- Lubricating and protective properties of mucus
- Secretory unit (salivon)
- Saliva and its flow rate
- Functions of saliva
- Control of secretion by sympathetic and parasympathetic nervous systems



# MASTICATION (CHEWING)

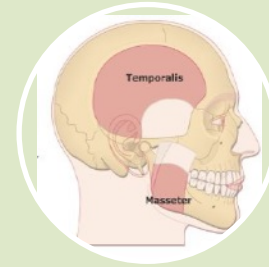
## Functions:

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



### Teeth organization:

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



### Chewing muscles are innervated by cranial nerve V:

- Masseter
- Temporalis
- Lateral Pterygoid
- Medial Pterygoid



### Taste center: (Hypothalamus) → Rhythmical chewing movements:

- Chewing reflex
- Stretch reflex

## CHEWING REFLEX & STRETCH REFLEX

The presence of a bolus of food in the mouth



initiates **reflex inhibition** of the muscles of mastication  
→ which allows the lower jaw to drop



The drop in turn initiates a **stretch reflex** of the jaw muscles  
→ leads to **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*



which inhibits the jaw muscles once again → allowing the jaw to drop and rebound another time  
*; this is repeated again and again.*

# SALIVARY GLANDS

## The principal glands of salivation are:

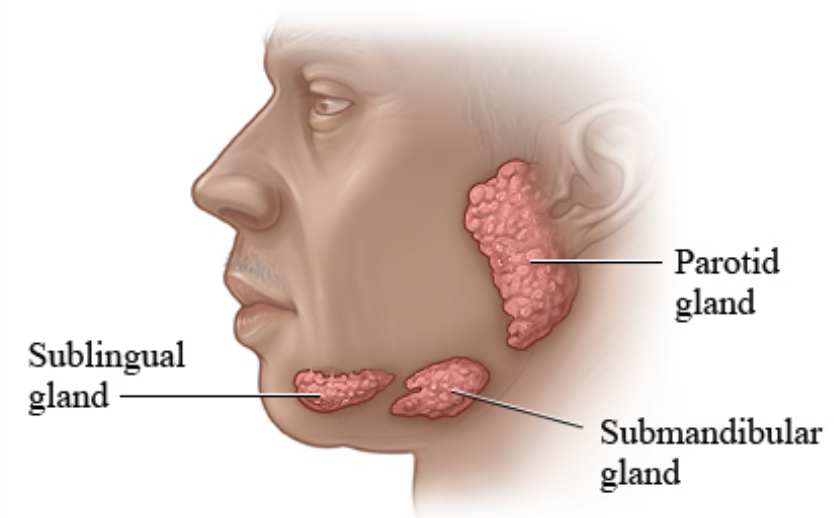
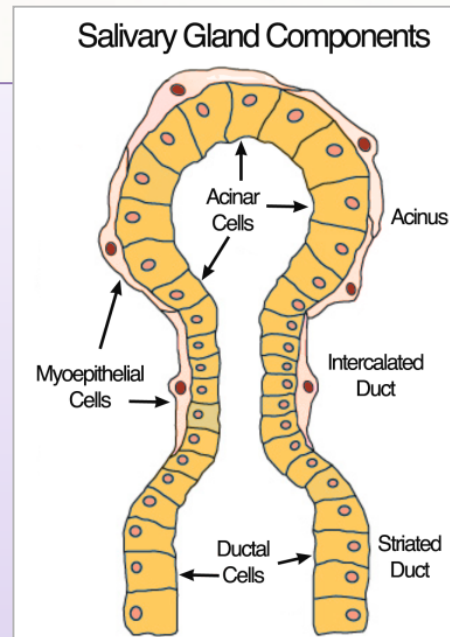
1. Parotid glands
2. Submandibular (Submaxillary) glands
3. Sublingual glands
4. Smaller glands in mucosa of tongue, palate, etc.

Salivary glands are typical exocrine glands.

## Secretory Unit (Salivon)

The basic unit "salivon" consists of:

1. **Acinus:** initial secretory process, *has 2 types of cells:*
  - serous cells
  - larger mucous cells
2. **Intercalated duct:** initial portion of duct
3. **Striated duct:** modification of secretory product
4. **Myoepithelial cells:**
  - surround acinus and intercalated duct
  - contraction moves saliva, prevents development of back pressure



## Types of saliva secretions:

### Aqueous fluids (a serous secretion)

#### Consist of:

1. Water
2. Ions
3. Enzymes; such as *ptyalin* (an  $\alpha$ -amylase)

#### Secreted from:

1. Parotid glands
2. Submandibular glands
3. Sublingual glands

### Mucus secretion (mucin)

#### Secreted from:

1. Submandibular glands
2. Sublingual glands



# Characteristics of saliva

Daily secretion of saliva:

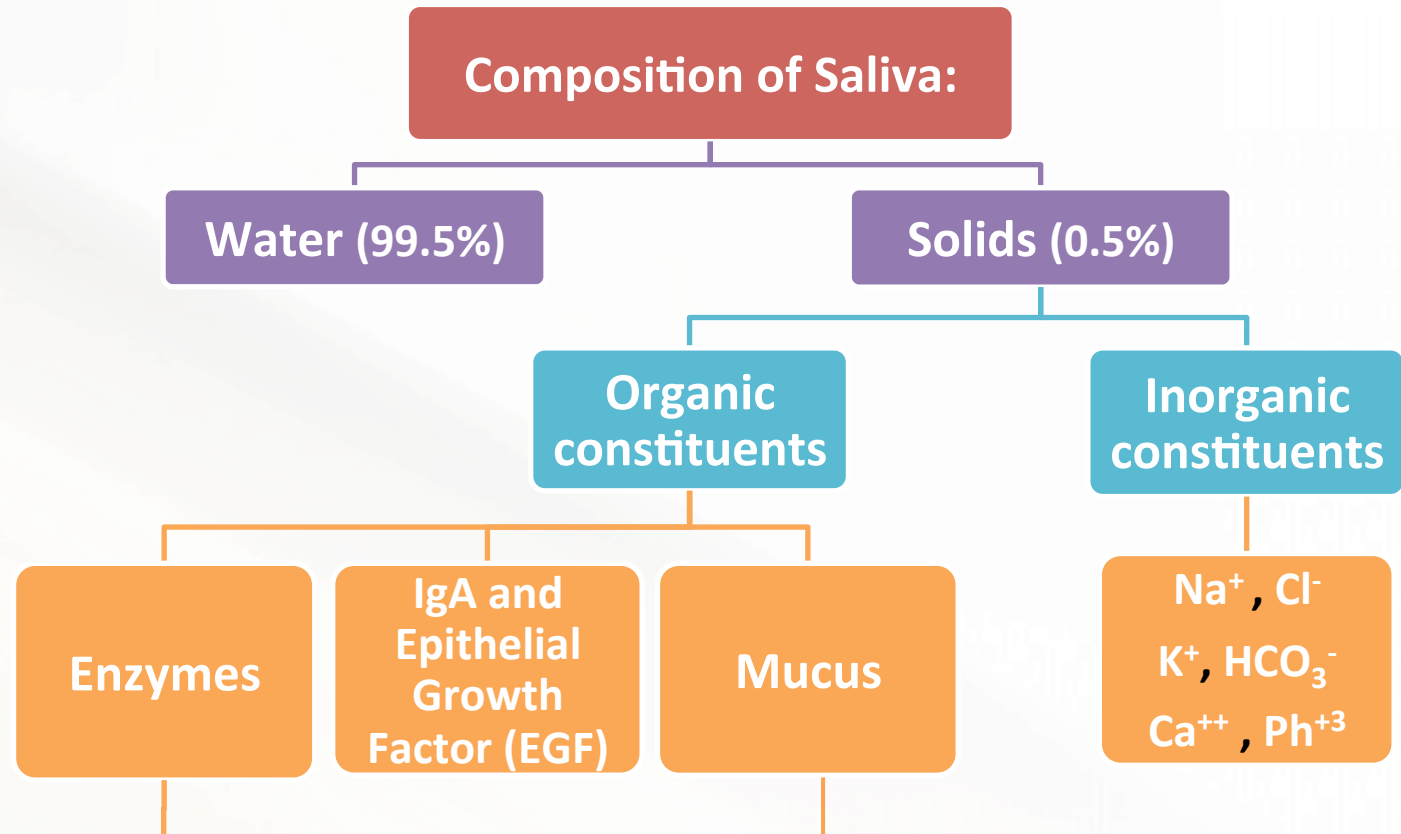
800-1500 mL

Specific gravity:

1002-1010

It is hypotonic.

pH: 6-7



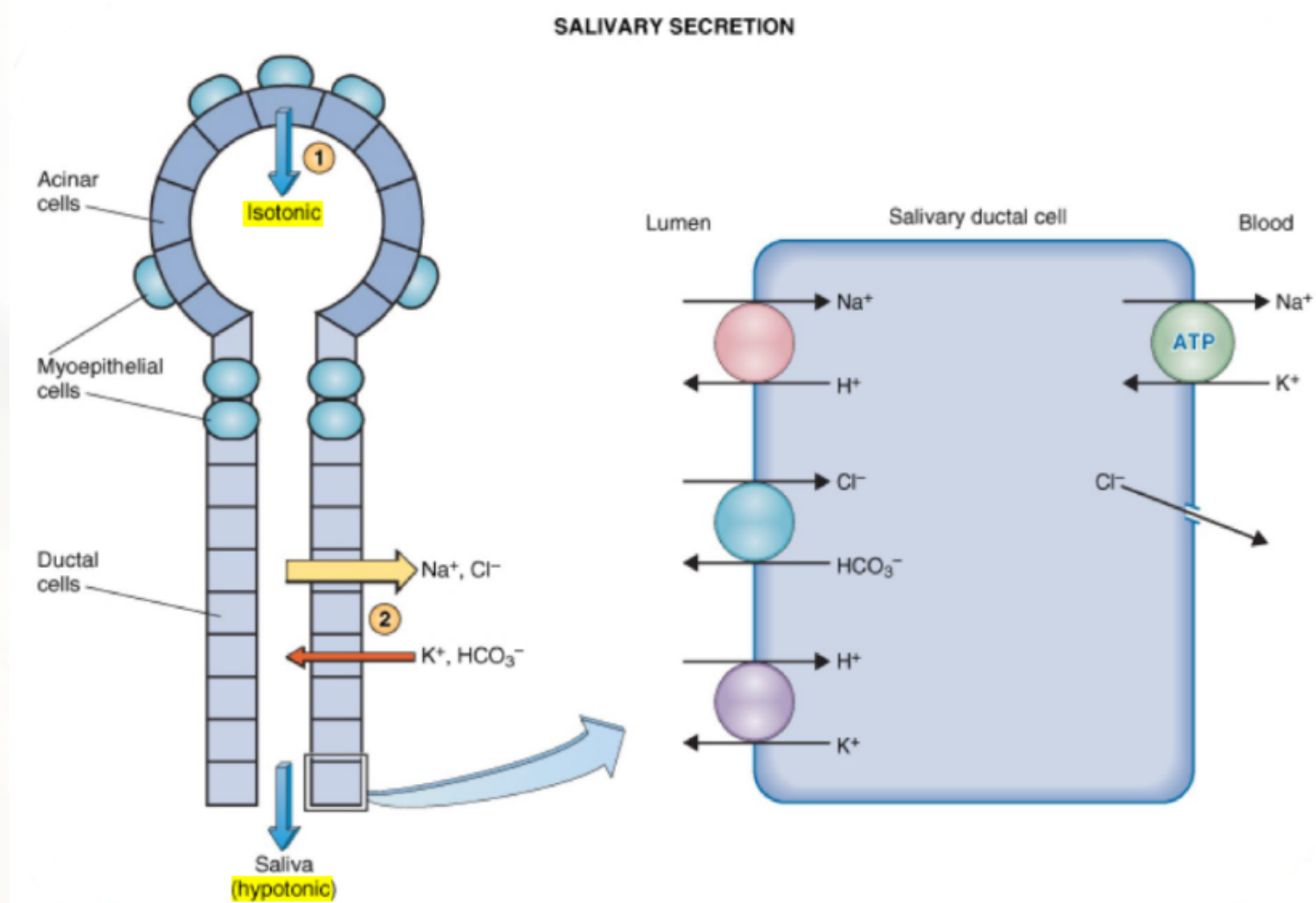
- **α-amylase** (from parotid glands)
- **Lingual lipase**
- **Kallikrin** (protease, from acinar cells):
  1. Catalyzes production of bradykinin (vasodilator) from α-globulin
  2. Increases local blood flow
- **Muramidase** (lyses muramic acid of Staphylococcus)
- **Lactoferrin, lysozymes**

**Mucus is a thick secretion composed mainly of water, electrolytes, and glycoproteins**

**It is an excellent lubricant and a protectant for the wall of the gut because of the following:**

1. It has adherent qualities that make it adhere tightly to the food.
2. It causes food particles to adhere to one another.
3. It coats the wall of the gut and prevents actual contact of most food particles with the mucosa.
4. It has a low resistance for slippage.
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 alkalis).

# Secretion of water and electrolytes by salivary glands



## 1- The primary acinar secretion (in the acini)

- It is isotonic to plasma.
- The amylase concentration and the rate of its secretion vary with the level and type of stimulation.
- The electrolyte composition is similar to that of plasma.

## 2- The striated ducts

- Modify the primary secretion by extracting  $\text{Na}^+$  &  $\text{Cl}^-$  from, and adding  $\text{K}^+$  &  $\text{HCO}_3^-$  to the saliva.
- $\text{Na}^+$  is actively reabsorbed unaccompanied by  $\text{H}_2\text{O}$ , and  $\text{K}^+$  is secreted while  $\text{HCO}_3^-$  is actively secreted. This process is influenced by **aldosterone**.
- Because the ducts remove more  $\text{Na}^+$  &  $\text{Cl}^-$  ions from saliva than they add  $\text{K}^+$  and  $\text{HCO}_3^-$ , saliva becomes progressively more hypotonic as it flows through the ducts.

### Concentrations of electrolytes:

- **Na<sup>+</sup> and Cl<sup>-</sup>:**

Their concentration is less than those of plasma.

- **K<sup>+</sup> and HCO<sub>3</sub><sup>-</sup>:**

Their concentration is higher than those of plasma.

### The concentration of these ions depends

**on:** the **rate** of salivary flow.

- At low flow rate, salivary secretions have:

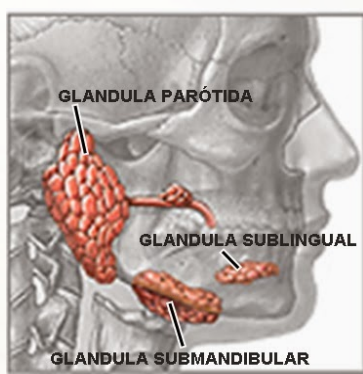
- High **K<sup>+</sup>** and **HCO<sub>3</sub><sup>-</sup>**
- Low **Na<sup>+</sup>** and **Cl<sup>-</sup>**

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

Electrolytes	Under resting conditions	Under maximum secretion	In presence of excess aldosterone secretion
Na <sup>+</sup> and Cl <sup>-</sup>	concentration of Na <sup>+</sup> and Cl <sup>-</sup> in saliva are <b>1/7</b> their concentration in plasma	concentration of Na <sup>+</sup> and Cl <sup>-</sup> in saliva <u>rises</u> to <b>1/2-2/3</b> their concentration in plasma.	NaCl reabsorption <u>increase</u> so that NaCl concentration in saliva <u>decreases</u> to <b>almost zero</b>
K <sup>+</sup>	concentration of K <sup>+</sup> is <b>7 times</b> greater than in plasma	concentration of K <sup>+</sup> <u>falls</u> to only <b>4 times</b> that of plasma	K <sup>+</sup> secretion <u>increase</u> , so K <sup>+</sup> concentration <u>increases</u>
HCO <sub>3</sub> <sup>-</sup>	concentration of HCO <sub>3</sub> <sup>-</sup> is <b>2-3 times</b> that of plasma		

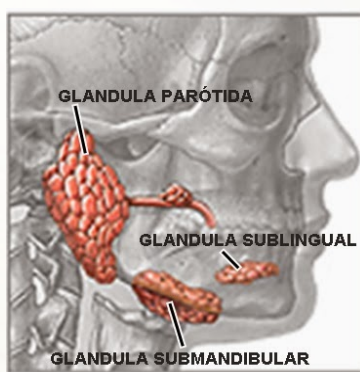


\* Will explained in next slides



# Functions of saliva

1. Saliva moistens and lubricates food and thus **facilitates swallowing**.
2. Saliva keeps the oral mucosa moist and so **helps movement of tongue and lips in speech**.
3. Saliva has a **digestive function**:- (digestive of carbohydrate especially starch and lipids "Minor") \*
  - $\alpha$ -amylase
  - Lingual lipase
4. By **acting as a solvent**, saliva is important for the **sense of taste**. Any substance must first dissolve in saliva before it can be sensed by the taste buds.
5. Saliva prevents the deteriorative process of oral mucosa in several ways (**Protective Function**) \*
6. **Buffering (تعادل) action**, saliva neutralizes any acids that may result from bacterial action, also swallowed saliva may help to **neutralize gastric HCl** in empty stomach.
7. The **epidermal growth factor** in salivary secretion is responsible for **healing of ulcers** in the mucous membrane of oral cavity.



# Functions of saliva

- \* **Starch:** contain units of glucose
- \* **Maltose:** two units of glucose . Maltose, dextrans and maltotriose are **less complicated than starch.**
- \* Works in the stomach for **half an hour** → mixing of food with gastric juice “HCL” → ↓ pH → inactivation
- \* Digestive of lipids by lingual lipase (**Minor function**)

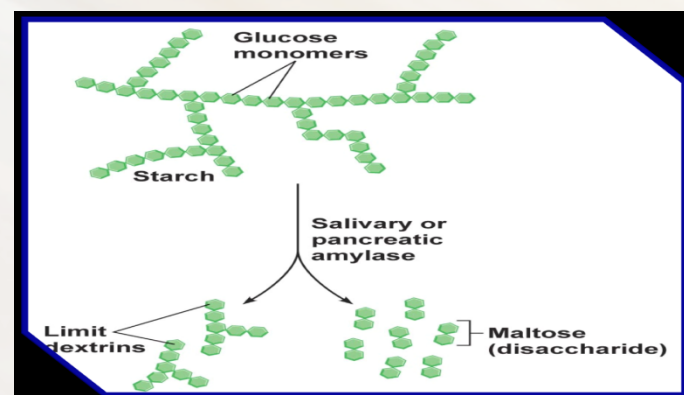
## 3.Saliva has a **digestive function** :-

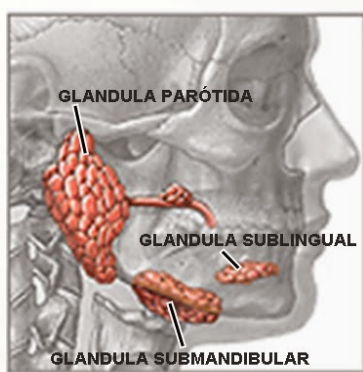
### Ptyalin ( Salivary $\alpha$ -amylase )

- ✓ It is secreted mainly from **parotid gland.**
- ✓ It cleaves  **$\alpha$ -1 ,4-glycosidic** bonds and **breaks down starch** \* to **maltose, dextrans and maltotriose.** \*
- ✓ Its optimum **pH = 6.8.** (pH of saliva = 6-7)
- ✓ Inactivated at pH 4 but continues to work for sometime in unmixed food in **Orad portion** of stomach for about **half an hour** and is arrested only when gastric acid penetrates the food mass.\*

### Lingual lipase \*

- ✓ It is secreted from **serous salivary glands on the tongue;** it **breaks down triglycerides into monoglycerides and fatty acids.** Its action may continue in the stomach after food is swallowed.





# Functions of saliva

- \***thiocyanate ions**: has toxic affect on bacteria “destroy the bacteria”
- \***lysozyme**: destroy the cell wall of bacteria “lysis of cell membrane”
- \***proteolytic enzymes**: digest the protein of the bacteria

## 5. Saliva prevents the deteriorative process of oral mucosa in several ways (Protective Function) :

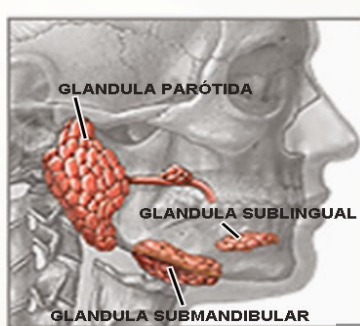
**A.** The flow of saliva helps **wash away** the pathogenic **bacteria** as well as the food particle that provide their metabolic support.

**B.** Saliva contains several factors that **destroy bacteria** as **thiocyanate ions\***, **lysozyme\*** and **proteolytic enzymes\*** (by entering the bacteria wall where they become bactericidal). **Lactoferrin** can deprive bacteria of iron.

**C.** Saliva contains significant amount of protein **antibodies** (IgA) that can destroy the oral bacteria.

- \* **Saliva is important to oral hygiene .**
- \* **If the salivary secretion decrease → ulceration, damage of oral mucosa due to loss of these protective function of saliva (Ex: Xerostomia(dry mouth) will explain last slides)**

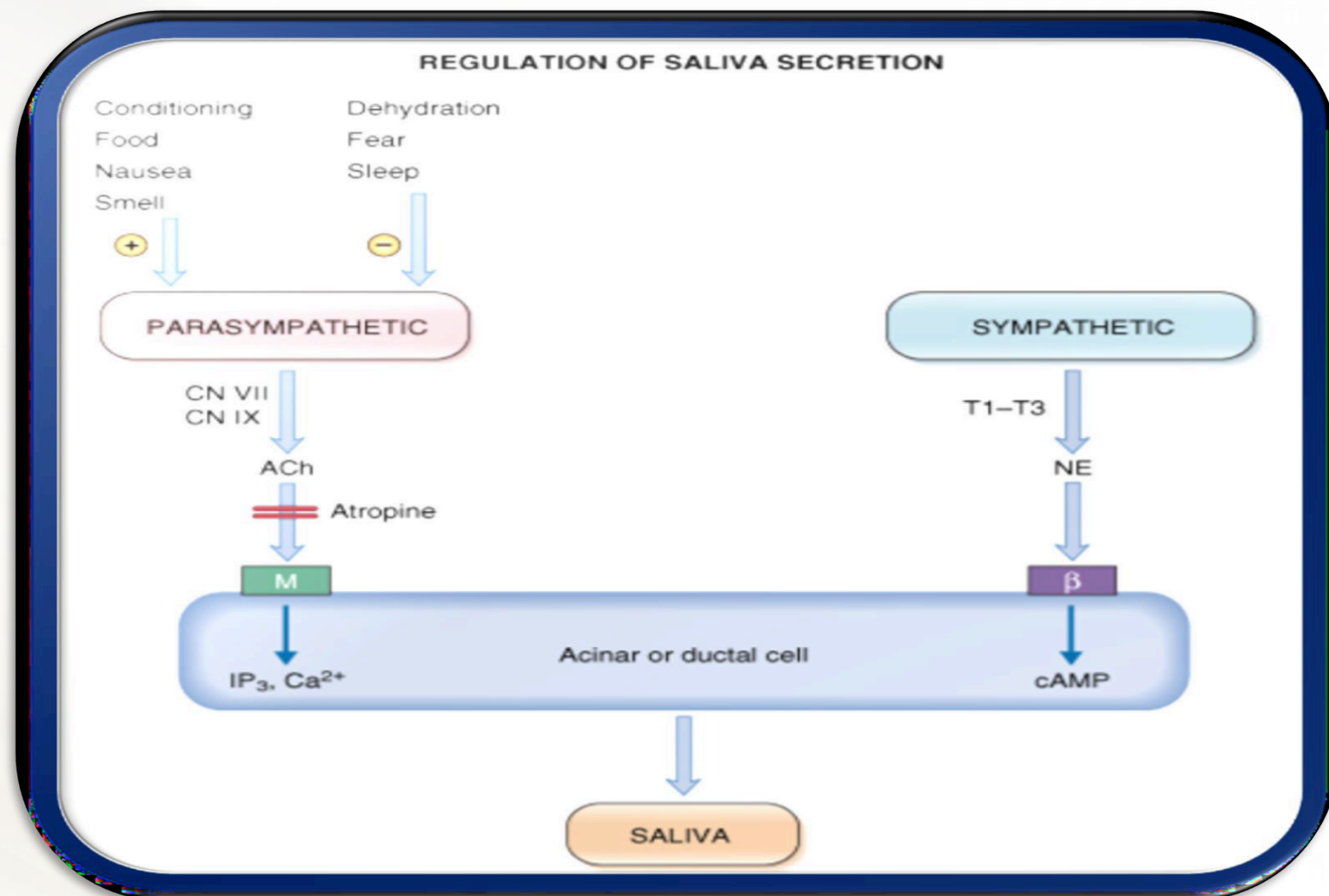




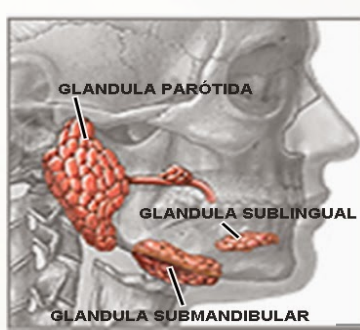
# Control of Salivary Secretion

## • Unique aspect of control of salivary secretion :

- ✓ Secretion rate **depends entirely on neural control** – autonomic nervous system (ANS)
- ✓ **Both** Parasympathetic and Sympathetic lead to **increase** secretion
- ✓ Composition is **modified** by Aldosterone:
  - i. Increases  $\text{Na}^+$  ,  $\text{Cl}^-$  reabsorption
  - ii. Increases  $\text{K}^+$  secretion

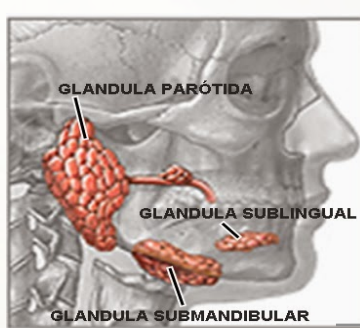


- Salivary secretion : hypotonic, slightly acidic, neural control.
- Secretion depends on **neural control ONLY** because the food stays in the mouth for limited time so we need something quick, hormonal control takes time.
- Parasympathetic and Sympathetic don't have contradiction (opposite (معاكسة) action).
- Parasympathetic and Sympathetic are complementary to each other.
- Parasympathetic = watery secretion, Sympathetic = viscous (concentrated) secretion.
- Aldosterone **only modifies** without affecting the secretion rate.



# Control of Salivary Secretion

	Parasympathetic	Sympathetic
Origin	Salivary nucleus in medulla	Intermediolateral gray T1-T3
Outflow	CN VII & IX (facial, glossopharyngeal nerves)	
Transmitter	Ach	Norepinephrine
Stimulates	<ul style="list-style-type: none"> <li>✓ The secretion (protein poor, high k<sup>+</sup> and HCO<sub>3</sub><sup>-</sup>)</li> <li>✓ The contraction of myoepithelial cell</li> <li>✓ The metabolic rate</li> <li>✓ The blood flow due to marked vasodilatation. This occurs due to the release of kallikrin enzyme from active gland tissues which cause conversion of α<sub>2</sub> globulin into bradykinine, a potent vasodilator.</li> <li>✓ The growth and development of different cells</li> </ul>	<ul style="list-style-type: none"> <li>✓ Secretion (mostly enzymes)</li> <li>✓ Contraction of myoepithelial cell</li> <li>✓ Metabolic rate</li> <li>✓ Growth and development of different cells</li> </ul>
Effect	Sectioning ( <b>blocking</b> ) of parasympathetic <b>markedly decreases flow</b> & leads to <b>atrophy</b>	Sectioning of sympathetic nerves has <b>minimal</b> impact on secretion
	<ul style="list-style-type: none"> <li>✓ <b>Increases stimulation in response to</b> Conditioned reflexes (taste, smell)</li> <li>✓ <b>Decreases stimulation due to</b> Sleep, fear, dehydration</li> </ul>	



# Unconditioned and conditioned reflexes

Salivary secretion is controlled exclusively by nervous mechanism through:

- ✓ Unconditioned reflex
- ✓ Conditioned reflex

Any reflex contain : 1-stimulus. 2-receptor. 3-afferent. 4-center. 5-efferent. 6-effector. 7-response.

## 1- Unconditioned reflex : (( غير مشروط ))

- ✓ The **presence of food** in the mouth (**stimulus**) stimulates general receptors and especially **taste receptors**. (**receptor**)
- ✓ Impulses travel along **afferent nerves** (**afferent**) to the **salivary nuclei** in brain stem- medulla. (**center**)
- ✓ Efferent impulses travel along **autonomic nerves** (sympathetic and parasympathetic) (**efferent**) to **salivary glands** (**effector**) to stimulate **salivary secretion**. (**response**)
- ✓ This reflex is innate and is **not acquired\*** by learning.

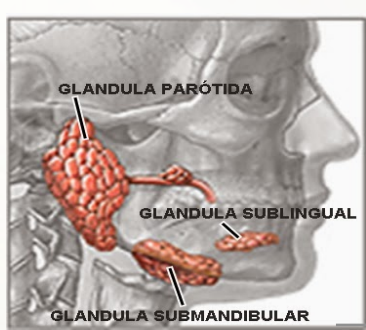
لو حظيت سكر أو شيء في فم طفل لسه مولود بيفرز لعاب (\*)

## 2- Conditioned reflex : (( مشروط ))

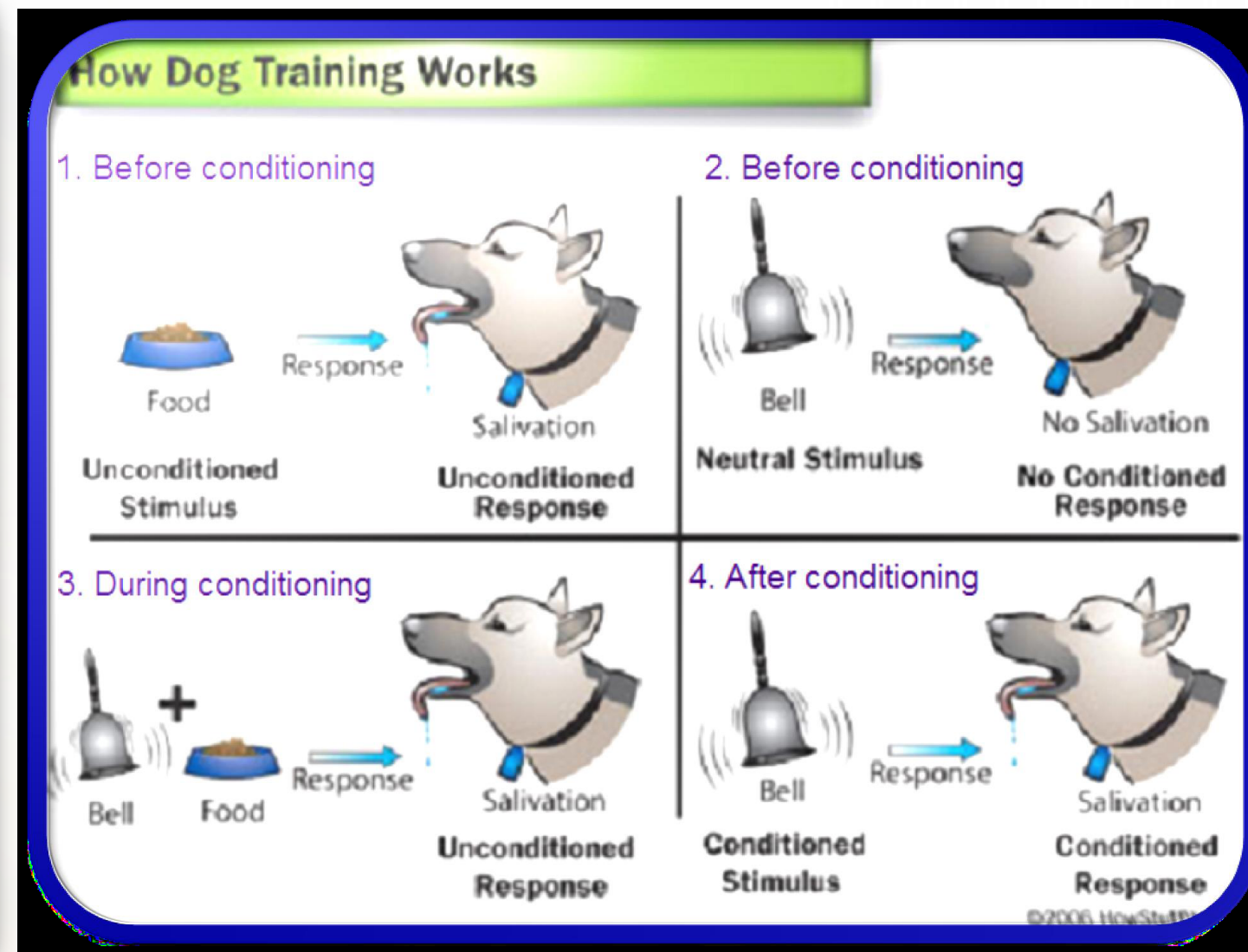
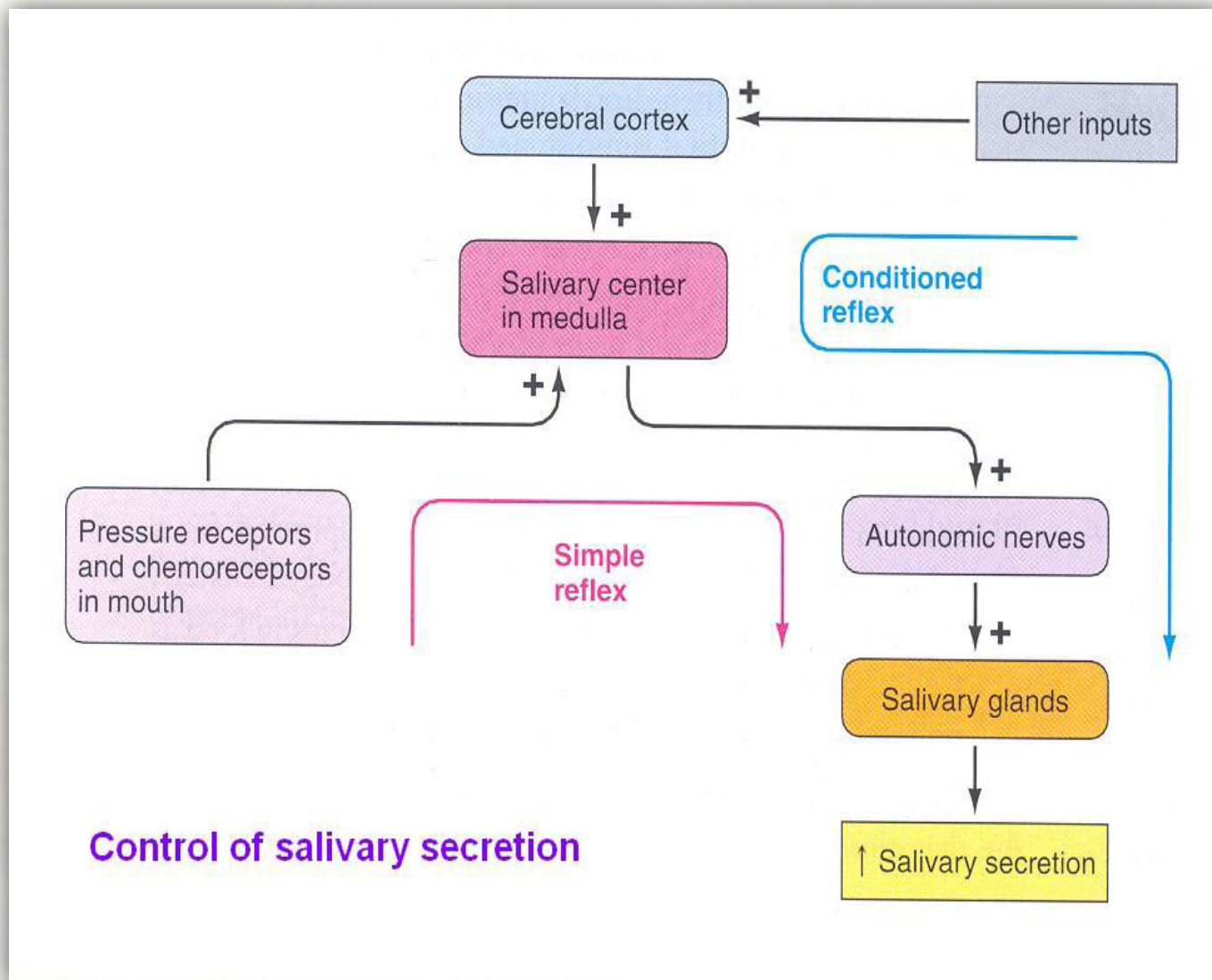
- ✓ **Seeing, smelling, hearing or even thinking** about appetizing food (**stimulus**) can result in secretion of saliva. (**Psychic stimulation**)
- ✓ Initial impulses arise in the parts of the brain concerned with these **special sensations** (**receptor**) and stimulates the **salivary centers**. (**center**)
- ✓ In human, **mouth watering** (**response**) on seeing or thinking of food provides evidence of this psychic reflex. (**acquired\***)

(\*) لو حظيت تورته قدام طفل لسه مولود و خليته يشوفها  
ما راح يآثر فيه و لا بيشتيهها و ما راح يفرز لعاب)





# Unconditioned and conditioned reflexes



\* Simple reflex= Unconditioned reflex

\*Pavlov experiment : <http://www.youtube.com/watch?v=hhqumfpxuzl>



# Xerostomia(dry mouth)

Definition	Common causes of xerostomia	Signs and symptoms of xerostomia
<ul style="list-style-type: none"> <li>•Xerostomia is defined as dry mouth resulting from reduced or absent saliva flow.</li> <li>•It may or may not be associated with decreased salivary gland function.</li> </ul>	<ul style="list-style-type: none"> <li>•Medications as antihistamines, antidepressants.</li> <li>•Diseases as HIV, rheumatoid arthritis, systemic lupus erythematosus, diabetes mellitus, hypertension, endocrine disorders, nutritional deficiencies, nephritis and thyroid dysfunction.</li> <li>•Radiation to the head and neck in cancer therapy.</li> </ul>	<ul style="list-style-type: none"> <li>•Difficulty of eating, speaking, swallowing.</li> <li>•Burning sensation</li> <li>•Taste disorders (dysgeusia)</li> <li>•A painful tongue (glossodynia)</li> <li>•Thirst, especially at night.</li> <li>•Increased dental caries</li> <li>•Inflammation and fissuring of the lips (cheilitis)</li> </ul>
Diagnosis of xerostomia	Management of xerostomia	Complications
<ul style="list-style-type: none"> <li>•The patient's history</li> <li>•Examination of the oral cavity: dry, erythematous or sticky oral mucosa due to an overgrowth of Candida albicans. Little or no pooled saliva in the floor of the mouth, and the tongue may appear dry with decreased numbers of papillae. The saliva may appear stringy,ropy or foamy.</li> <li>•Sialometry, that measures the flow rate of saliva. The normal resting flow rate is 0.3 to 0.5 mL/min; for stimulated saliva, 1 to 2 mL/min. Values less than 0.1 mL/min are considered xerostomic.</li> <li>•Sialography involves the injection of radio-opaque media into the salivary glands.</li> <li>•Biopsy of major salivary glands when malignancy is suspected.</li> </ul>	<ul style="list-style-type: none"> <li>•Identification of the underlying cause.</li> <li>•Self-care: Patients should be encouraged to conduct a daily mouth examination, checking for red, white or dark patches, ulcers or tooth decay, plaque removal.</li> <li>•Increasing existing saliva flow using saliva stimulants or sialogogues, such as chewing gum.</li> <li>•Replacement therapy using Saliva substitutes</li> <li>•Treatment of dental caries</li> <li>•Specific measures such as treatment of infections.</li> </ul>	<ul style="list-style-type: none"> <li>•Decreases the oral pH and significantly increases the development of plaque and dental caries and tooth loss</li> <li>•Gum disease as oral candidiasis.</li> <li>•Inflammation or ulcers of the tongue and buccal mucosa, oral candidiasis, salivary gland infection (sialadenitis).</li> </ul>



# ***SUMMARY***

## **Mastication (Chewing)**

**the bolus Functions is to lubricate ,breakdown  
And to begin digestion of carbohydrate .**

**The principal glands of salivation are:**

**1.Parotid 2.Submandibular 3.Sublingual 4.Smaller  
glands in mucosa**

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

**Mucus secretion (mucin)**

**Aqueous fluids (a *serous secretion*)**

**EGF and Mucus The organic constituents include Enzymes , IgA ,**

***The inorganic constituents include* Na<sup>+</sup>, Cl<sup>-</sup> K<sup>+</sup>, HCO<sub>3</sub><sup>-</sup> ,Ca<sup>++</sup> and Ph<sup>+3</sup>**

**The concentration of these ions depends on the rate of salivary flow**

**The secretion of H<sub>2</sub>O & electrolytes occurs in two stages**

**1- The primary acinar secretion**

**2- The striated ducts modify the primary secretion**



# **SUMMARY**

## **Functions of saliva**

- 1-moistens and lubricates food**
- 2-keeps the oral mucosa moist and so helps movement of tongue and lips in speech**
- 3-digestive function:- alfa amylase , Lingual lipase**
- 4-By acting as a solvent, saliva is important for the sense of taste.**
- 5-prevents the deteriorative process of oral mucosa**
- 6-Buffering action**
- 7-responsible for healing of ulcers in the mucous membrane of oral cavity.**

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

**Salivary secretion is controlled exclusively by nervous mechanism through:**

**Unconditioned reflex**

**Conditioned reflex**



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