Salivary secretion, Swallowing & esophageal motility

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2025-2026

Mastication (chewing)

❑ Definition:

- It is the process of mechanical breakdown of large food particles into smaller ones in the mouth.

❑ Importance:

1. Stimulation of taste and smell receptors.
2. Help **swallowing** by lubrication of food by saliva.
3. Help **digestion** by:

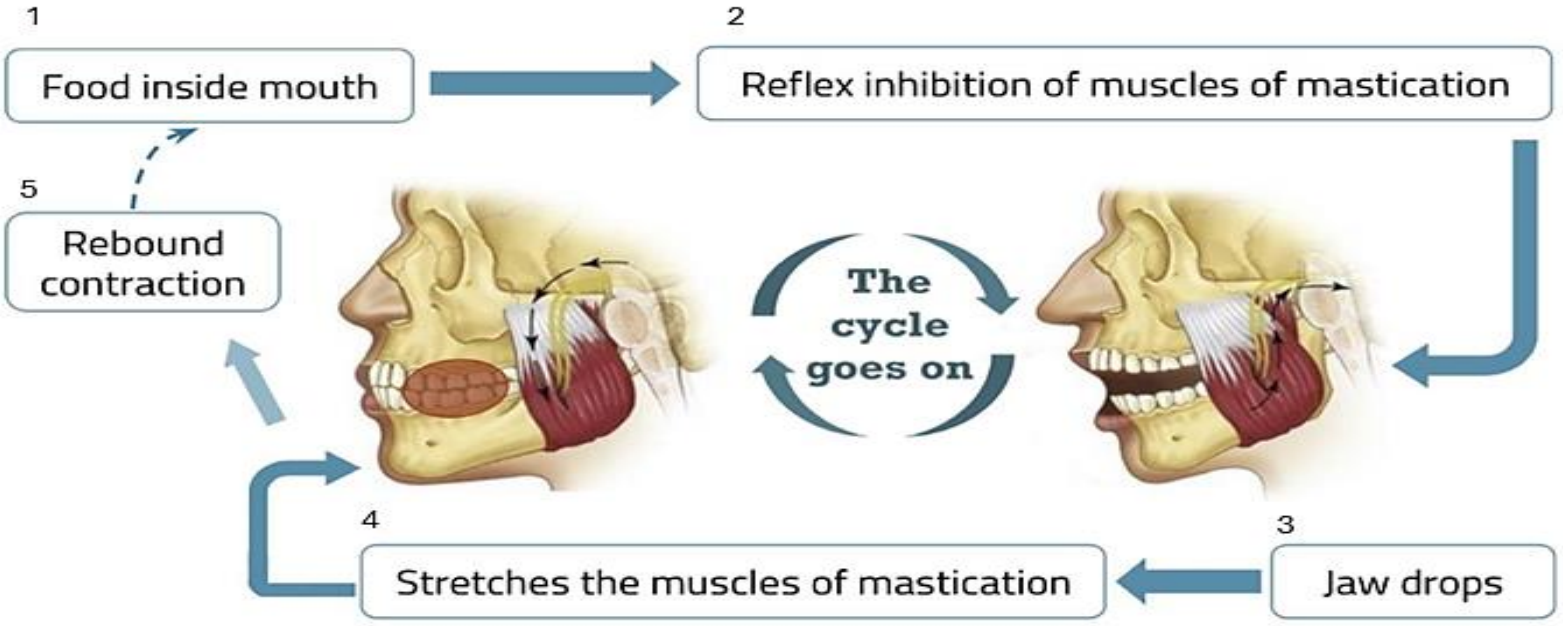
- break down of indigestive cellulose membrane around the digestive portion of fruits and vegetables
- ↑ exposed surface area to enzymatic effect.

❑ Mechanism:

It is **partly voluntary** and **partly reflexly** by **chewing reflex.**

Chewing reflex:

Presence of food in mouth → Reflex relaxation of chewing muscles → Drop of mandible and open the mouth → Initiates a stretch reflex of the jaw muscles that leads to muscles contraction, and closure of the mouth and so on.



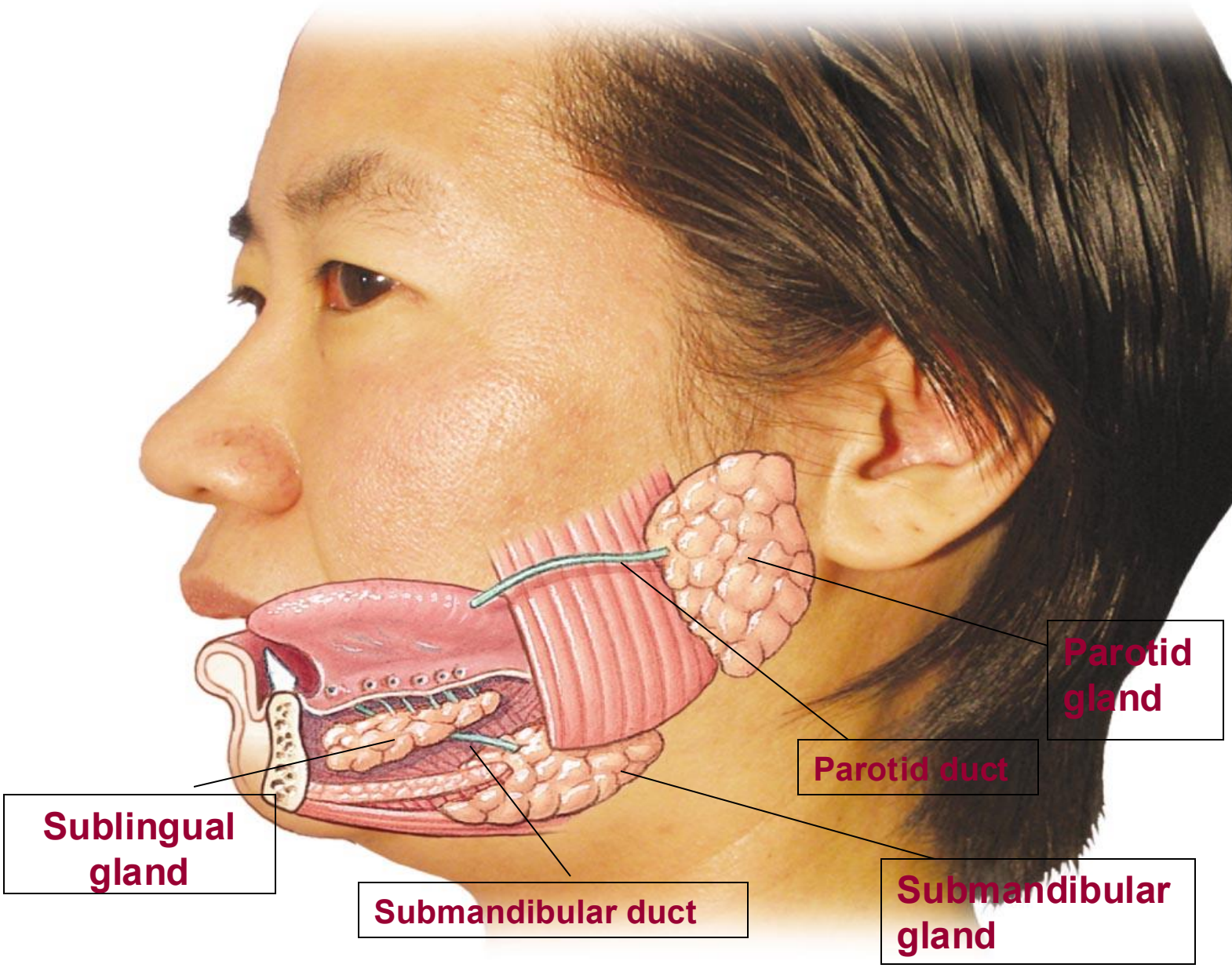
- The chewing center is present in the pons.
- Mastication muscles are supplied by motor branch of the trigeminal nerve.

Salivary Secretion

- **Saliva : Average** 1.5 L/day, hypotonic, **pH** is 6.8 : 7
- **Salivary glands :** Three pairs of salivary glands.

	Parotid gland	Submandibular gland	Sublingual gland
• Secretion %	20 %.	70%.	5 %.
• Type of secretion	Serous secretion (watery & rich in enzymes).	Mixed	Mucus (thick, rich in mucin).
• supplied by	Glossopharyngeal N	Facial N	Facial N

N.B : Ebner's glands and buccal glands secrete ~ 5% of saliva.


Parotid gland
Parotid duct
Sublingual gland
Submandibular duct
Submandibular gland

- **Composition of saliva**

a- 99.5 % water. **b- 0.5 % solids.**

- **0.3 % organic :** as enzymes (amylase, Lipase, Lysozymes) and mucus.
- **0.2 % inorganic**
- **Buffers** as **phosphate** & **bicarbonate** buffering systems
- **Soluble calcium salts**: which saturate saliva to prevent decalcification of teeth.
- **Some electrolytes** as Na+ , Cl-, Hco3-, and K+ ,they act as **coenzymes** for salivary enzyme amylase.

Functions of saliva

1. ***Facilitation of speech*** and **deglutition.**
2. ***Cleaning (hygiene)*** of the mouth by washing and antibacterial effect of **lysozymes** & **immunoglobulin A**
3. ***Buffering function*** : by **bicarbonate** and **phosphate** systems to keep the PH at about 7.0 → the teeth do not lose their calcium.

Also, saliva neutralizes gastric secretion in case of gastroesophageal reflux.

4. ***Digestive function***

-**Ptyalin** (**salivary α- amylase**) : digest starch to maltose in PH 6.9 so it is inhibited in the stomach.

-**Lingual Lipase**: digest **30 % of lipids** and secreted from Ebner's gland of tongue.

5. ***Excretory function*** : of lead, mercury, fluoride and some drugs as morphine and alcohol.
6. **Facilitate taste sensation**
7. **Regulation of water balance** (↓ in dehydration and give thirst sensation).

The Stages of salivary secretion

- **I) Salivary acini (Primary):**

→ saliva similar in composition to plasma

isotonic (**Na^+**= 150mmol/L, **K+** = 10 mmol/L, **CL^-** = 113 mmol/L, **HCO_3^-** = 23-30mmol/L).

- **II) Salivary duct (secondary):**

-Modification by the duct cells under effect *of* **aldosterone hormone** → active reabsorption of Na^+, & CL^- and active secretion of K^+ & HCO_3^-.

-Because ductal cells are relatively water impermeable, water is not absorbed along with the solute, making the **final saliva hypotonic** to plasma.

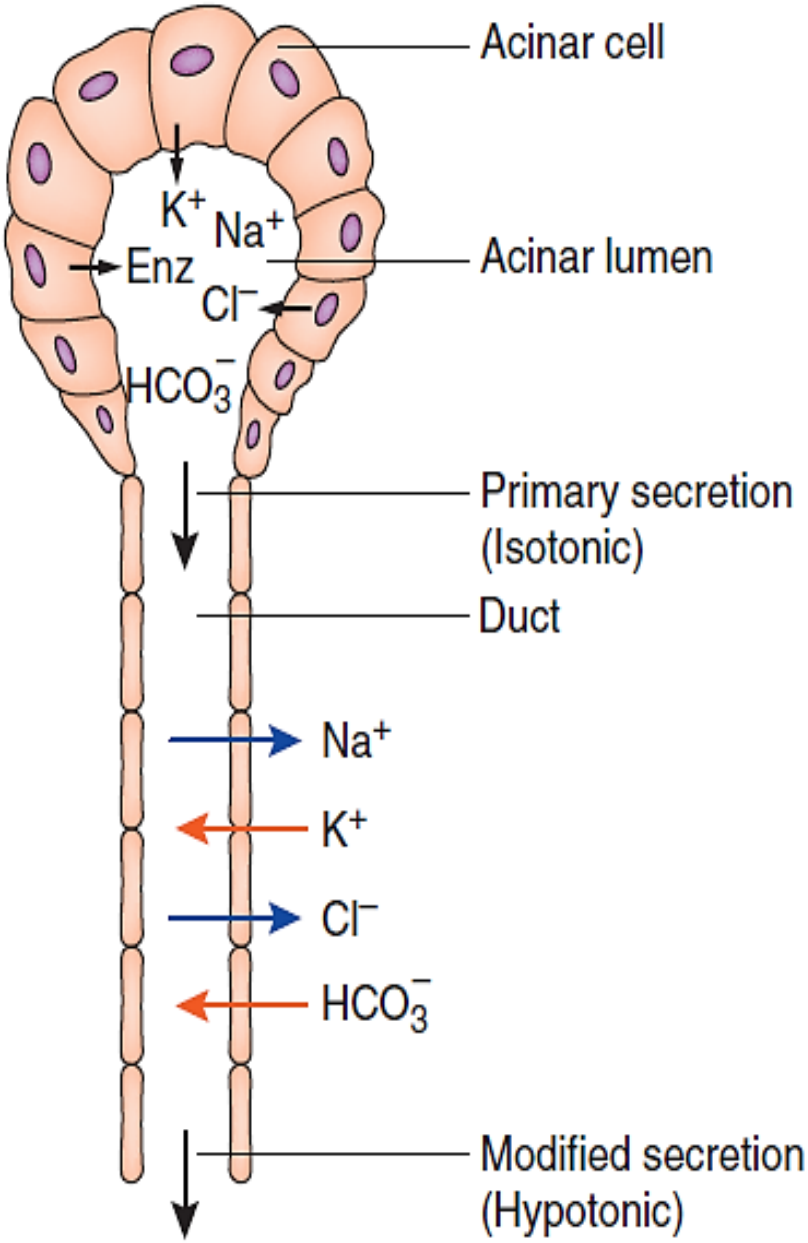
- So, the final concentration:

  Na^+ = 50 mmol/L,

  CL^- = 15 mmol/L,

  HCO_3^- =50-70 mmol/L, K^+ = 15 mmol/L.

- If the flow of salivary secretion increased → little time for modification →↑ Na^+, CL^- &, ↓ K^+ & HCO_3^- concentration as in **parasympathetic stimulation (Active secretion)**



Mechanism of formation of saliva

Innervation of salivary glands

A-Parasympathetic

It arises from ***superior salivatory nucleus in the pons*** *→ chorda tympani as a branch of* ***the facial nerve→ submandibular ganglion*** *→ submandibular and sublingual glands.*

Also, **inferior salivatory nucleus in medulla oblongata** →lesser superficial petrosal nerve as a branch of **glossopharyngeal nerve** → otic ganglion→ parotid gland

→ **True secretion** : large in volume ,watery, rich in ptyalin , rich in (Na+, CL-) with low protein content

Parasympathetic causes V.D of blood vessels of salivary glands

B- Sympathetic

- It arises from lateral horn cells of the **upper two** thoracic segments and relay in **the superior cervical sympathetic ganglia**→ **Salivary glands**

- ***Trophic secretion***: little in volume, viscus, and rich in mucin.
- **VC** of blood vessels of salivary glands.
- **Contraction** of myo-epithelial cells → squeeze saliva → evacuation.

N.B **Augmented secretion** occurs by stimulation of parasympathetic then sympathetic→ salivary secretion **large volume rich in mucus and ptyalin**.

Control of salivary secretion

- **Nervous only via conditioned and unconditioned reflexes.**
  - **[I] Unconditioned reflex**
- Inborn reflex that needs no pervious learning.
- **Stimuli** : Direct contact of food , Chewing
- **Receptor** : Taste receptors & Receptors in GIT wall.

- **Afferent**

  - Chorda tympani : Taste sensation from ant. 2/3 of tongue.
  - Glossopharyngeal : Taste sensation from post. 1/3 of tongue.
  - Lingual nerve : General sensation from ant. 2/3 of tongue.
  - Vagus nerve : Taste & General sensation from epiglottis.

- **Center** : Superior & inferior salivatory nuclei in brain stem

- **Efferent**: Chordae tympani & glossopharyngeal.

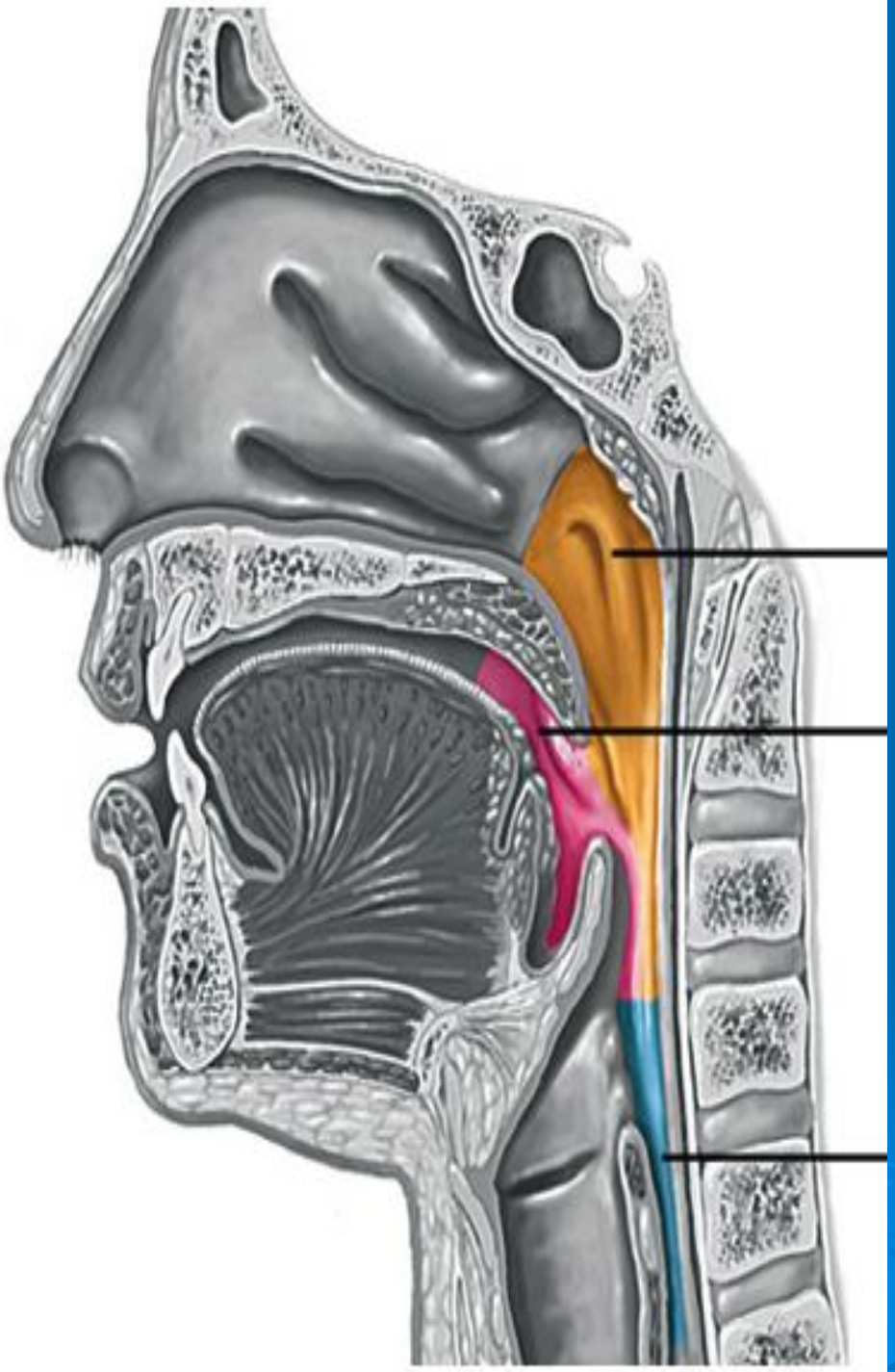
- **Response**: ↑ salivary glands secretion.

[II] Conditioned reflex

- Acquired reflexes and need previous learning

- **Stimuli :** - Sight of food.
  - Smelling of food.
  - Hearing about food.
  - -Thinking of food.
- **Receptors** : Special sense receptors.
- **Afferent** : Optic, olfactory & auditory nerves.
- **Center** : To cerebral cortex → salivatory nuclei.
- **Efferent & response** → as unconditioned reflex.

Pharynx and esophagus



Pharynx

Pharynx

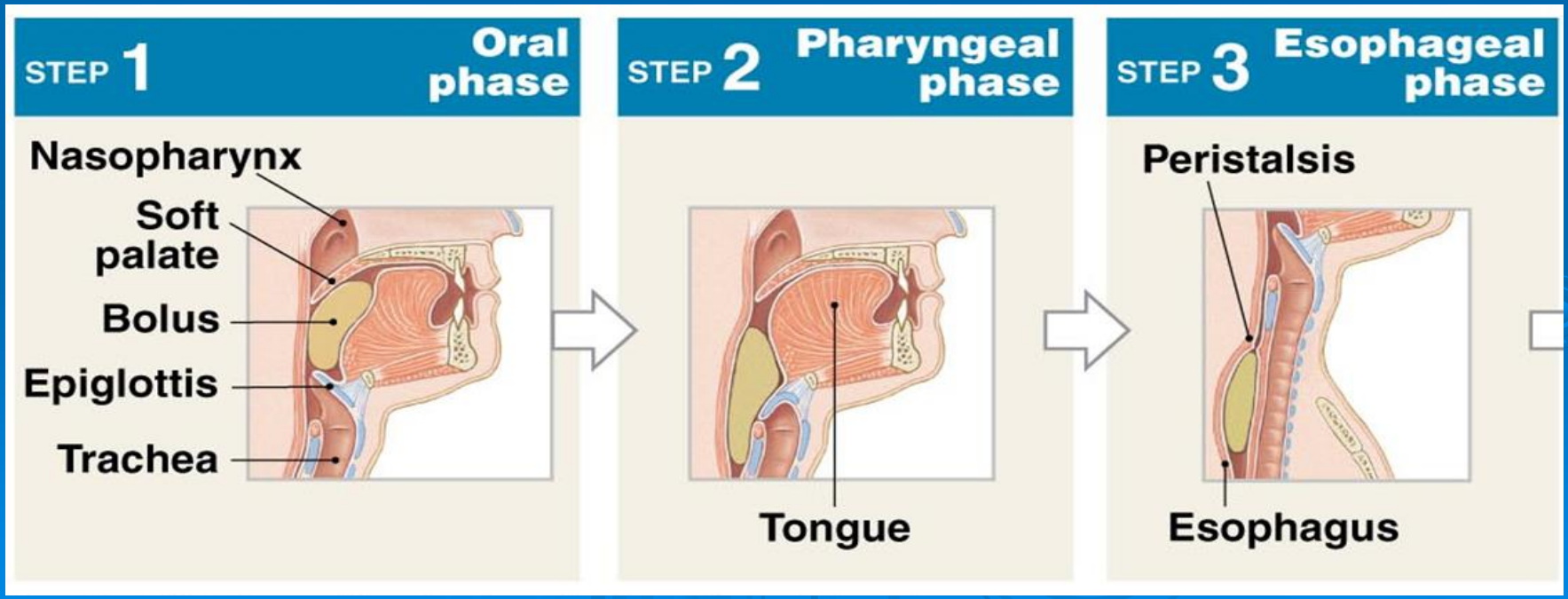
- It is a common pathway for respiratory and digestive system and has **swallowing receptor area** and **the primary peristalsis waves** start from it. It is separated from esophagus by the upper esophageal sphincter which is normally closed.

Esophagus

- It is a muscular tube has outer longitudinal and inner circular muscle layers which are striated in the upper portion and smooth in the lower portion .So, the peristalsis in the upper portion depends on the vago-vagal reflex, however in the lower portion it depends on the local enteric reflex.

Swallowing (Deglutition)

- It is the propelling of food bolus from mouth to stomach.
- It is under control of the **swallowing center in the medulla.**
- *It can be divided into **3 phases**:*



Swallowing (Deglutition)

- *It can be divided into 3 phases:*
  - **Buccal (Oral) phase: (voluntary)**

    (voluntary) elevation and retraction of tongue against the hard palate propels the bolus to the pharynx.
  - **Pharyngeal phase (involuntary)**

It is very rapid (1 second), occur reflexely via :

Swallowing reflex

Swallowing reflex

- **Receptor:** in oropharynx (tonsillar pillars).
- **Afferent**: glossopharyngeal & Vagus nerves.
- **Center:** medulla oblongata (swallowing center).
- **Efferent**: motor fibers of 5^{th}, 9^{th} , 10^{th} and 12^{th} cranial nerves.

- Response: Series of reflexes **(Protective reflexes)**
- to prevent entry of food into air passages

  - Elevation of soft palate → closure of nasal cavity.

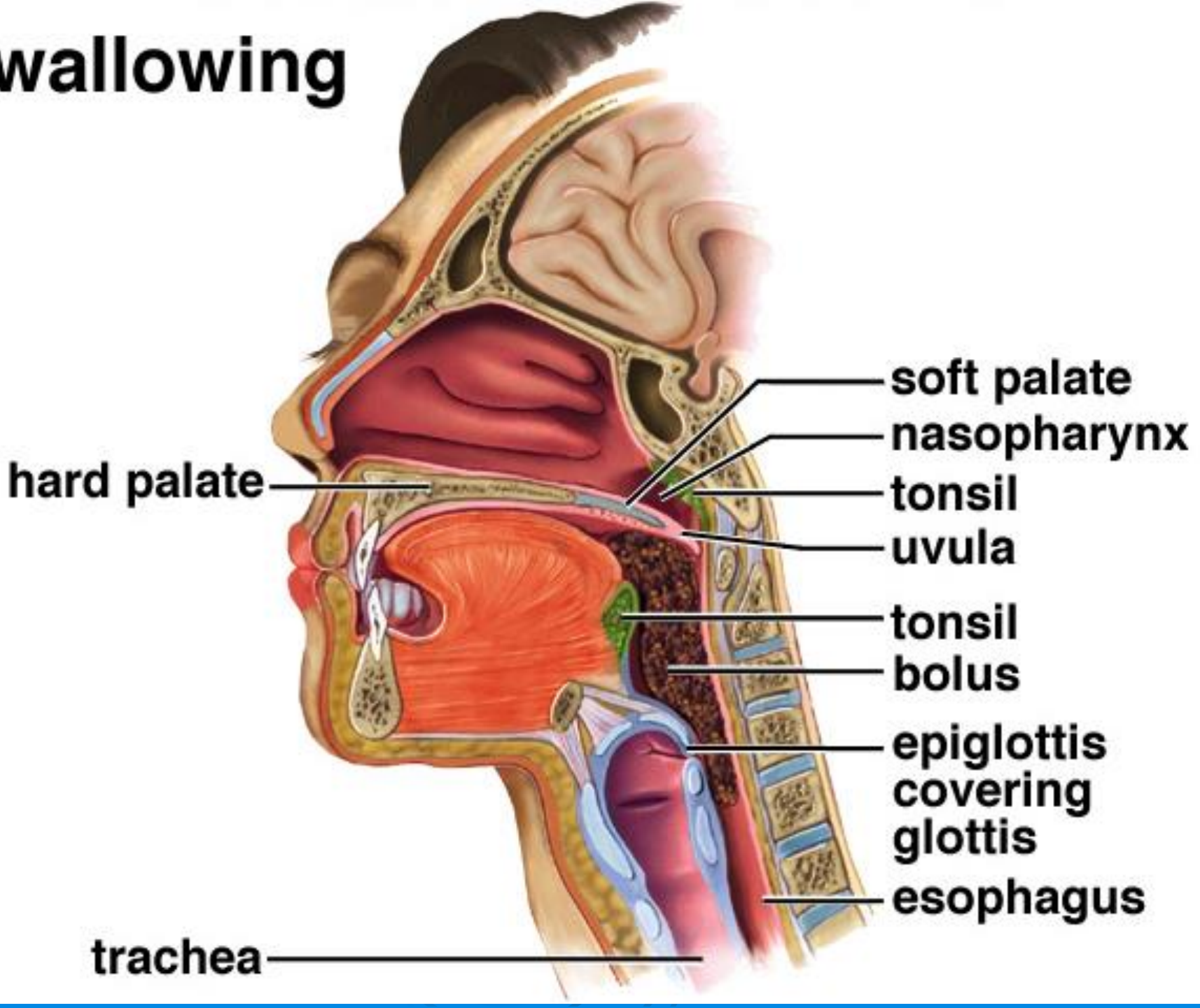
  - Approximation of palato-pharyngeal folds → sagittal slit through which small food particles pass and prevent passage of large particles.

  - Closure of glottis (opening of larynx) by approximation of vocal cords & elevation of larynx and folding of epiglottis

  - Inhibition of breathing **(swallowing apnea)**

- Relaxation of pharyngo-esophageal sphincter and contraction of superior pharyngeal muscle → rapid pharyngeal peristalsis → forces the food into relaxed upper esophagus.

Swallowing


soft palate
nasopharynx
hard palate
tonsil
uvula
tonsil
bolus
epiglottis
covering
glottis
esophagus
trachea

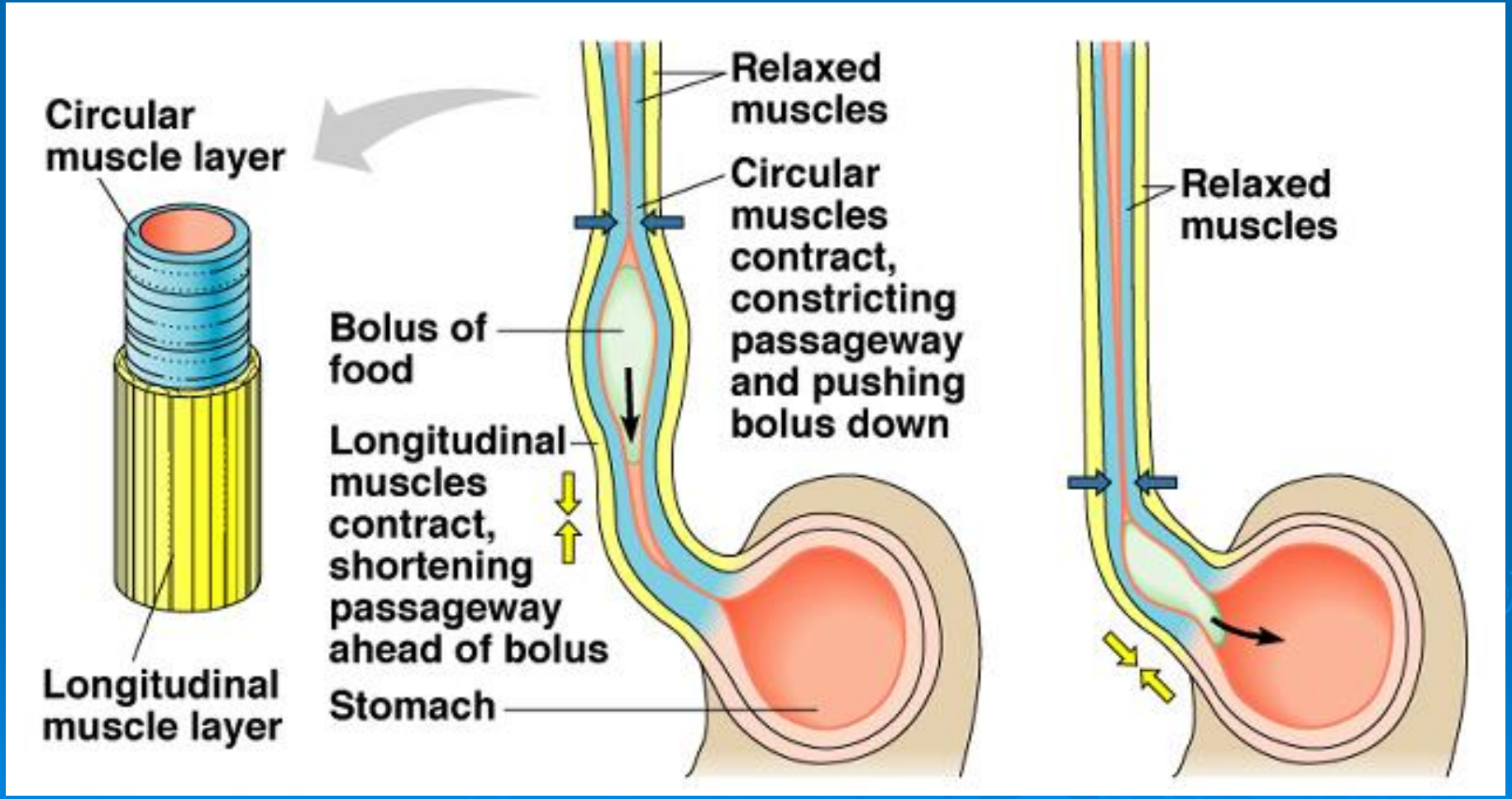
Esophageal phase (involuntary)

- ***Upper esophageal sphincter : (UES)***

- The pharyngeo – esophageal junction is normally closed by striated muscle tone to prevent entry of inspired air into stomach. During swallowing the sphincter relaxes reflexely and then reclosed after swallowing.

- ***Traveling along the esophagus***

Smooth Muscle Peristalsis Moves Food Along Alimentary Canal



- Entry of food bolus into the esophagus initiate peristaltic waves of 2 types :

Primary peristaltic waves :

- They start at the upper end of esophagus.
- They are continuation of the pharyngeal peristalsis.
- It travels at the rate of **2-4 cm/sec**. But gravity may increase velocity of food bolus .

Secondary peristaltic waves

- Presence of bolus in the esophagus initiate peristaltic waves at site of bolus.
- These waves repeated until food bolus is driven down the stomach.
- Peristaltic movements in the **upper part** of esophagus is coordinated by **vago – vagal reflex** (striated muscles), while in **lower part** is coordinated by **local enteric reflex**.

Table summarizes the main differences between the upper & lower parts of esophagus

	Upper part	Lower part
Musculature	Striated	Smooth
Nerve Supply	Vagus nerve only	Vagus nerve + E.N.S
Movement	Rapid	Slow
Effect of bilateral Vagotomy	Complete Paralysis	Secondary Peristalsis Persists

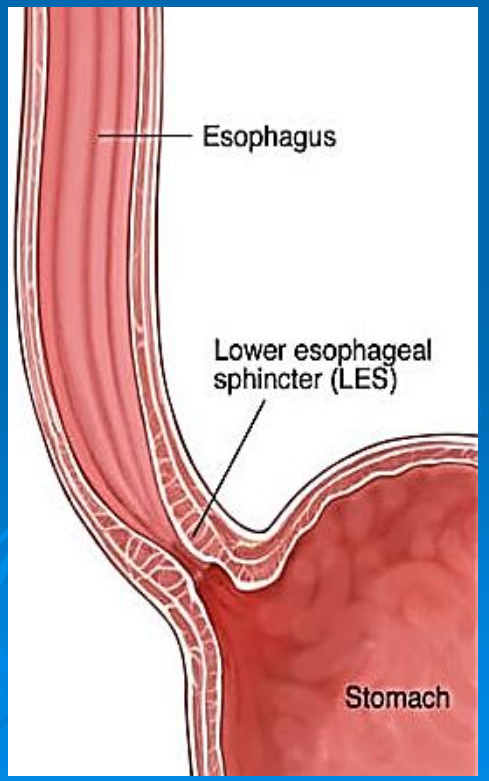
Lower esophageal sphincter (LES)

- It is called the cardiac sphincter.
- It is the lower 3-5 cm of the esophagus.
- It has high resting tone (**High – pressure zone**) and exert a pressure **15-30 cm H_2O** above intra – abdominal pressure to prevent reflux of gastric content into esophagus.
- It is relaxed when food bolus reaches it **with some delay**, so this area is liable to damage or ulceration by cold, hot and spicey food.

Lower esophageal sphincter (LES)

- **Its tone is increased by : (contracted)**
  - Sympathetic alpha adrenergic receptors activation.
  - Gastrin hormone (so, drugs which neutralize gastric acidity →↑ gastrin hormone release → contraction of the LES.

- **Its tone is decreased by : (Relaxed)**
  - Inhibitory vagal effect via VIP secretion.
  - Some food as fats, chocolate, alcohol & coffee.



Achalasia

- It is failure of relaxation of lower esophageal sphincter during swallowing.
- **Causes** : **a.** Decrease the myenteric nerve plexus. **b.** High sensitivity to gastrin hormone. **c.** Lesions of the vagus.
- **Complications**: **a.** Mega-esophagus due to accumulation of food in the esophagus causing its dilatation. **b.** Increase incidence of esophageal ulcer & carcinoma. **c.** Recurrent pneumonia due to aspiration of esophageal contents.
- **Treatment**: Dilatation or surgical cardio-myotomy (removal of LES).

How gastric reflux into esophagus is prevented ?

- High pressure zone sphincter.
- The intra abdominal small part of the esophagus is squeezed by the increased intra abdominal pressure.
- The oesophagus enters the stomach in acute angle and act as a flap.
- Gastrin hormone increases the tone in the lower oesophagus.

Gastro esophageal reflux

- It is the return of gastric contents to esophagus **due to** failure of anti- reflux mechanisms as weak sphincter pressure.

- **-Increases in:** pregnancy, smoking, ↑ coffee , alcohol & obesity.

- **-Leads to:**
  - Ulcer of lower esophagus.
  - **Heart burn** : It is pain across the chest to neck (similar to anginal pain) due to gastric acid reflux. This pain increased at night when the patient lies flat and increased by **hot drinks** and **alcohol**.
  - Stricture of cardiac sphincter.
  - **Barrett's esophagus** due to prolonged effect on mucosa which are premalignant.

Thank you