



PASSION ACADEMIC TEAM



Sheet# 3

YU - MEDICINE

GASTROINTESTINAL SYSTEM

Lec. Title : Swallowing &
Gastric Motility .

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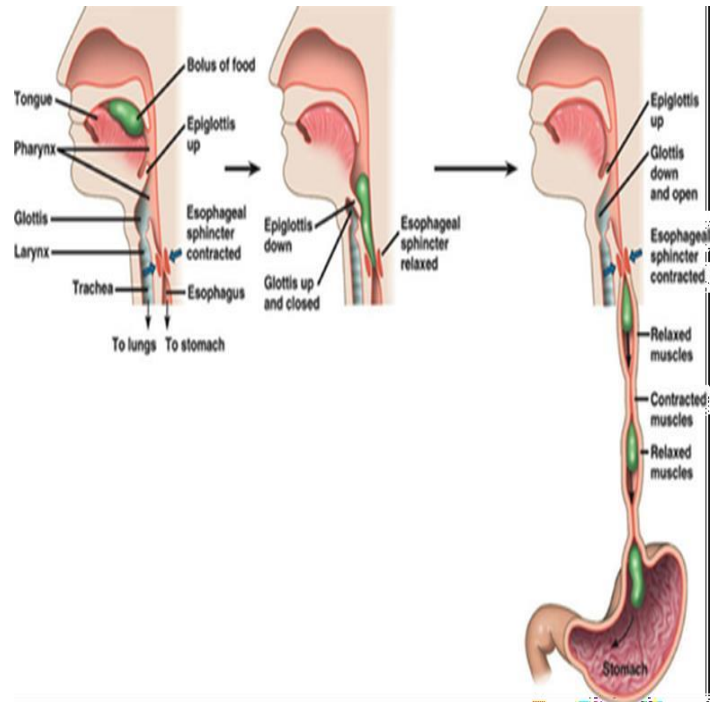
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Note : the explanation that was mentioned by doctor is in the boxes

Propulsion and Mixing of Food in the Alimentary Tract (Swallowing and Gastric Motility)

○ Swallowing (Deglutition):

- Swallowing is the ordered sequence of events that propel food (bolus → chewed food after mixed with saliva) from the oral cavity, through the pharynx and esophagus, and into the stomach whilst avoiding the possibility of aspiration
- Swallowing can be initiated voluntary in the mouth, but thereafter is under involuntary or reflex control.
- The reflex portion is controlled by the swallowing center in the medulla.



- Oral Stage (voluntary)
- Pharyngeal stage (involuntary)
- Esophageal stage (involuntary)

Swallowing is divided into 3 stages :

- 1- Oral stage (voluntary)
- 2- Pharyngeal stage (involuntary)
- 3- Esophageal stage (involuntary)

When we say that the process is under involuntary control we mean it's under reflex control which composed of:

- 1- afferent neurons(sensory neurons)
- 2- interneurons (swallowing center in medulla oblongata in brainstem and lower portion of the pons)
- 3- efferent neurons.

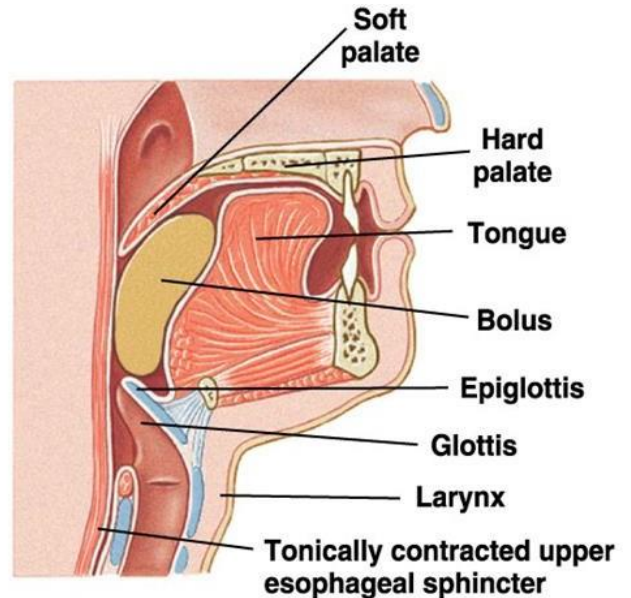
As we said , the swallowing center is located in medulla oblongata which means it's very close to respiratory center so while swallowing there will be a spillovering of certain impulses from swallowing center to respiratory center which will lead to **deglutition apnea** (inhibition of breathing)

○ Stages of swallowing :

1- Oral stage

- The first stage of swallowing involves the voluntary rolling of bolus into the pharynx by the upward and backward pressure applied by the tongue against the palate.
- The pharynx contains high density of somatosensory receptors. The activation of these receptors initiates the involuntary swallowing reflex in the medulla.

Step 1



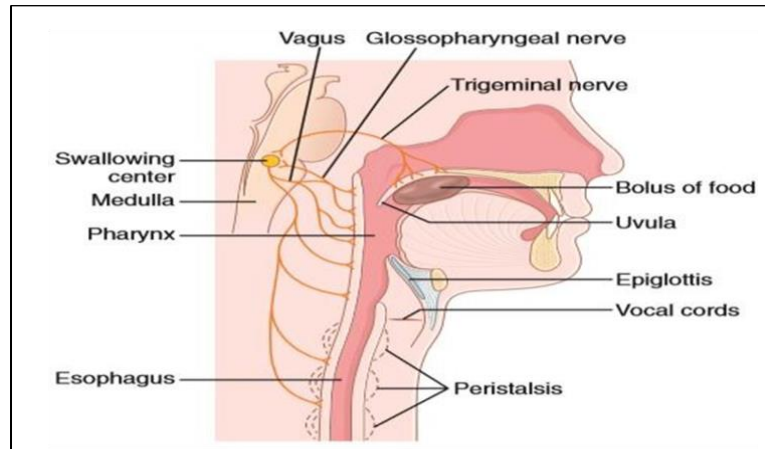
1. Tongue pushes bolus against soft palate and back of mouth, triggering swallowing reflex.

2- Pharyngeal stage

- At the pharynx, the bolus of food stimulates epithelial swallowing receptor areas all around the pharynx opening and impulses from this area pass to the swallowing center in brain stem and accordingly initiate a series of autonomic pharyngeal muscle contractions that end up with the following events:
 - The trachea is closed, the esophagus is opened, and a fast peristaltic wave initiated by the nervous system of the pharynx forces the bolus of food into the upper esophagus (time of process is < 2 seconds).

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Nervous initiation of the pharyngeal stage of swallowing



Reflex process starts when the bolus leaves oral cavity and reaches the pharynx. A high density of receptors is located in this area (mechanoreceptors or somatosensory receptors) when the bolus enters, these receptors are stimulated and **reflex start**:

- 1- Electrical signals moves through sensory neurons (the first part of reflex process) :
 - Trigeminal nerve (5th nerve)
 - Glossopharyngeal nerve (9th nerve)
- 2- These signals will reach swallowing center in medulla (2nd part of reflex) where they are processed and appropriate signals are given to efferent nerve (3rd part of reflex) which is the vagus nerve.
- 3- A lot of events occur when the pharynx picks up these signals , these events are summarized as contractions and changes of structures in this region :
 - Soft palate moves upward to close the posterior nostrils to prevent regurgitation of food to nasal cavity.
 - Vocal cords are adducted (closed)
 - Epiglottis folds backward to close airway passage (trachea).
 - Palatopharyngeal folds pulled medially to close, but they leave a narrow slit (sagittal slit) through which small bolus can pass and not large ones.
 - The first peristaltic wave is generated in pharynx (primary peristalsis). Secondary peristalsis occurs if the primary one fails
 - UES relaxes and opens

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How many swallowing occur per day?

600 swallowing occur , most of them occur without food and 20-50 occur while you are sleeping ...

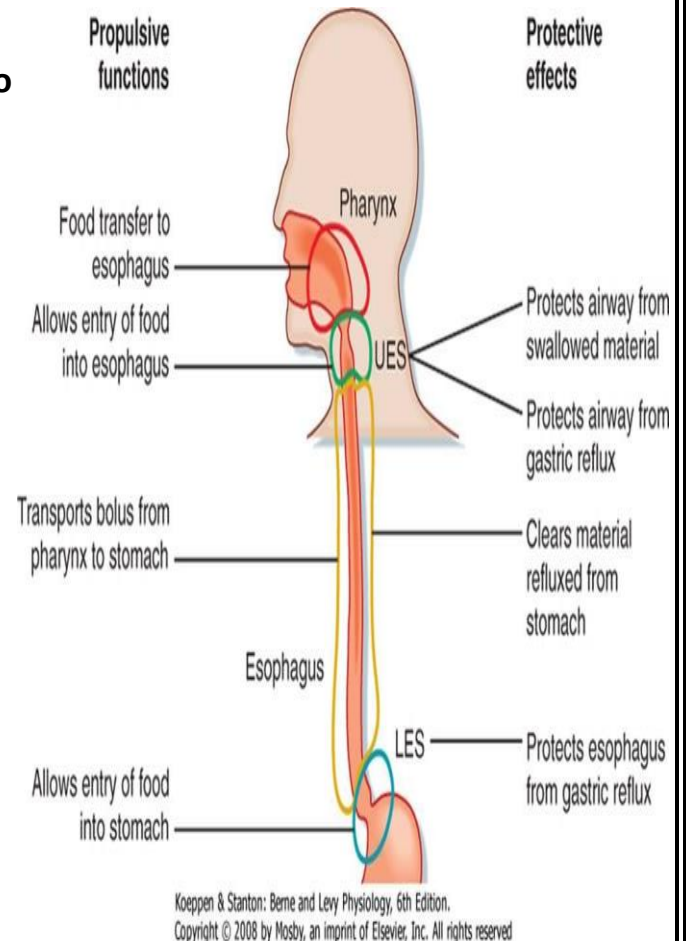
3- Esophageal stage:

- Physiologically , esophagus is divided into three functionally distinct regions:

1- Upper esophageal sphincter (UES)

2- Esophageal body

3- lower esophageal sphincter(LES)



- In normal conditions the UES and LES are closed, what is the importance of these sphincters and why they are closed?
 - UES: to prevent air passage to the stomach
 - LES: to prevent gastric content to move to esophagus.

(The gastric content moves to esophagus because of negative pressure in the thorax)

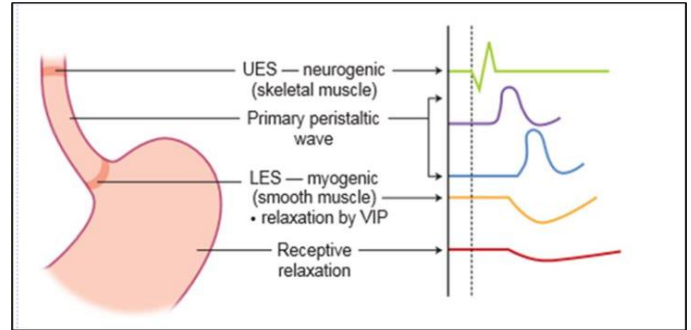
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- **Types of Esophageal Peristalsis:**

Two waves of peristalsis, in this stage,

Move the bolus down:

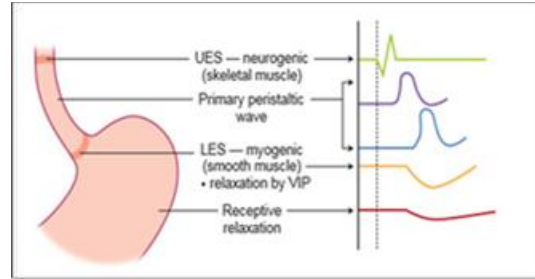
- **Primary peristalsis**
- **Secondary peristalsis**



- **Primary peristaltic movement: a sequential contraction in caudal direction and it's a continuation of peristaltic wave that begin in pharynx as a sequence of swallowing reflex. (This movement is specialized for esophagus but the origin of it is the pharynx).**
- **This movement needs 8-10 seconds to spread out the esophagus reaching the stomach , this time is changeable depending on the structure of the bolus (liquid , semi-liquid, solid or semi-solid).**
- **What are the regulators for this movement?**
- **In the first third of esophagus (contains skeletal muscles) it's completely regulated by vagus nerve.**
- **In the lower two third (contains smooth muscles) it's regulated by vagus through connection with myenteric plexus. We didn't say by submucosal because it is involved in controlling of mucus secretions more than motility and movement of contents.**

Almost done...

Note : the explanation that was mentioned by doctor is in the boxes



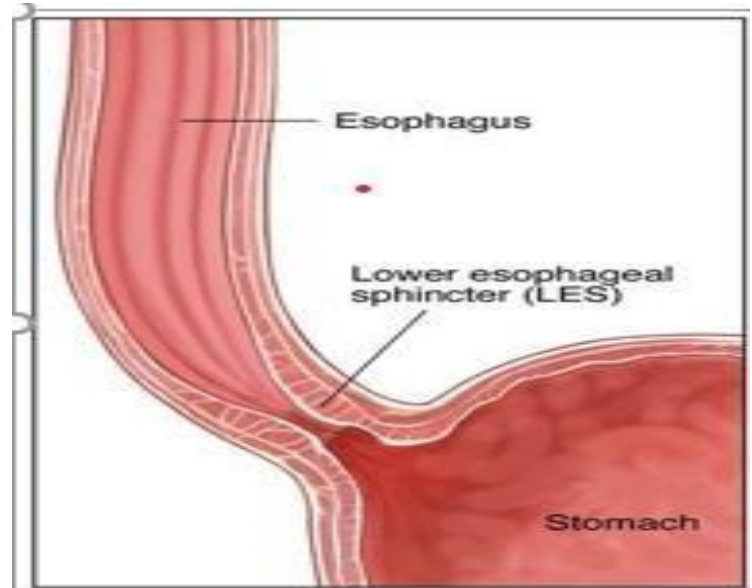
- **Before the wave initiation, in normal conditions the pressure in all areas of esophagus body is in the resting pressure which is zero, except for LES which has a high pressure due to tonic contraction (positive pressure).**
- **once the peristaltic wave initiates :**
 - 1- **in the first region (purple) the pressure starts to increase until it reaches a certain point that the contraction occur in , it contract pushing the bolus into the next region.**
 - 2- **The second segment (blue) was relaxed while the first one was contracted, when the bolus reached to this area the smooth muscles was stimulated by stimulatory vagus and contracted, while the previous segment (purple) relaxed, when it contract it pushes the bolus to the next region, and so on along the body of esophagus.**
 - 3- **The yellow line indicates the pressure in LES, it was positive pressure before the entry of bolus into the esophagus. when it entered ,the sphincter relaxed and the pressure decreased until it reached zero, this relaxation occurred by inhibitory vagus that stimulates inhibitory myenteric plexus to increase secretion of VIP and NO, the zero pressure starts from the entry of bolus to esophagus and it will stay until the peristaltic movement proceeds throughout the entire esophagus.**

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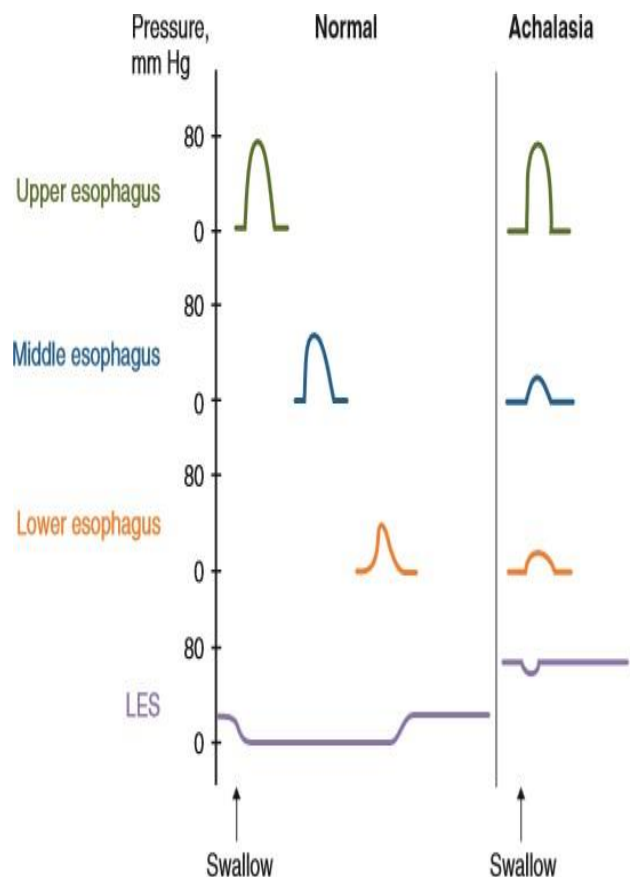
contraction

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- **LES formed by the esophageal circular muscle located in an area of ~ 3 cm upward of the junction with the stomach.**
- **The principle function of the LES is to prevent reflux of stomach contents into the esophagus.**
- **Control of LES function:**
 - **Between swallows: tonic vagal cholinergic impulses.**
 - **During swallows: inhibitory vagus (NO or VIP).**



- **Achalasia :**
 - **It is a condition due to high resting pressure of the LES so; it fails to relax during swallowing.**
 - **As a result, food transmission from the esophagus into the stomach is impeded or prevented.**
 - **Physiological basis of this condition is either pathology of or absence of the myenteric plexus containing VIP & NO**



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- **Normal condition: indicates sequential peristaltic movement:**
 - **Upper esophagus contracted, middle and lower relaxed.**
 - **Middle contracted, upper and lower relaxed.**
 - **Lower contracted, upper and middle relaxed.**
 - **LES contracted, upper, middle and lower relaxed (no bolus in esophagus).**

- **Achalasia: failure of LES to relax (pathological condition in myenteric plexus due to damage or deficiency of inhibitory myenteric plexus).**

- **Two changes occur in pressure:**
 - 1- **There is no sequential peristaltic movement → each segment of esophagus contract at the same time' so there is no movement of bolus.**

 - 2- **Lack of inhibitory innervation of LES, it's pressure is elevated at rest and remains elevated through swallowing, so the bolus will be accumulated.**

Done...