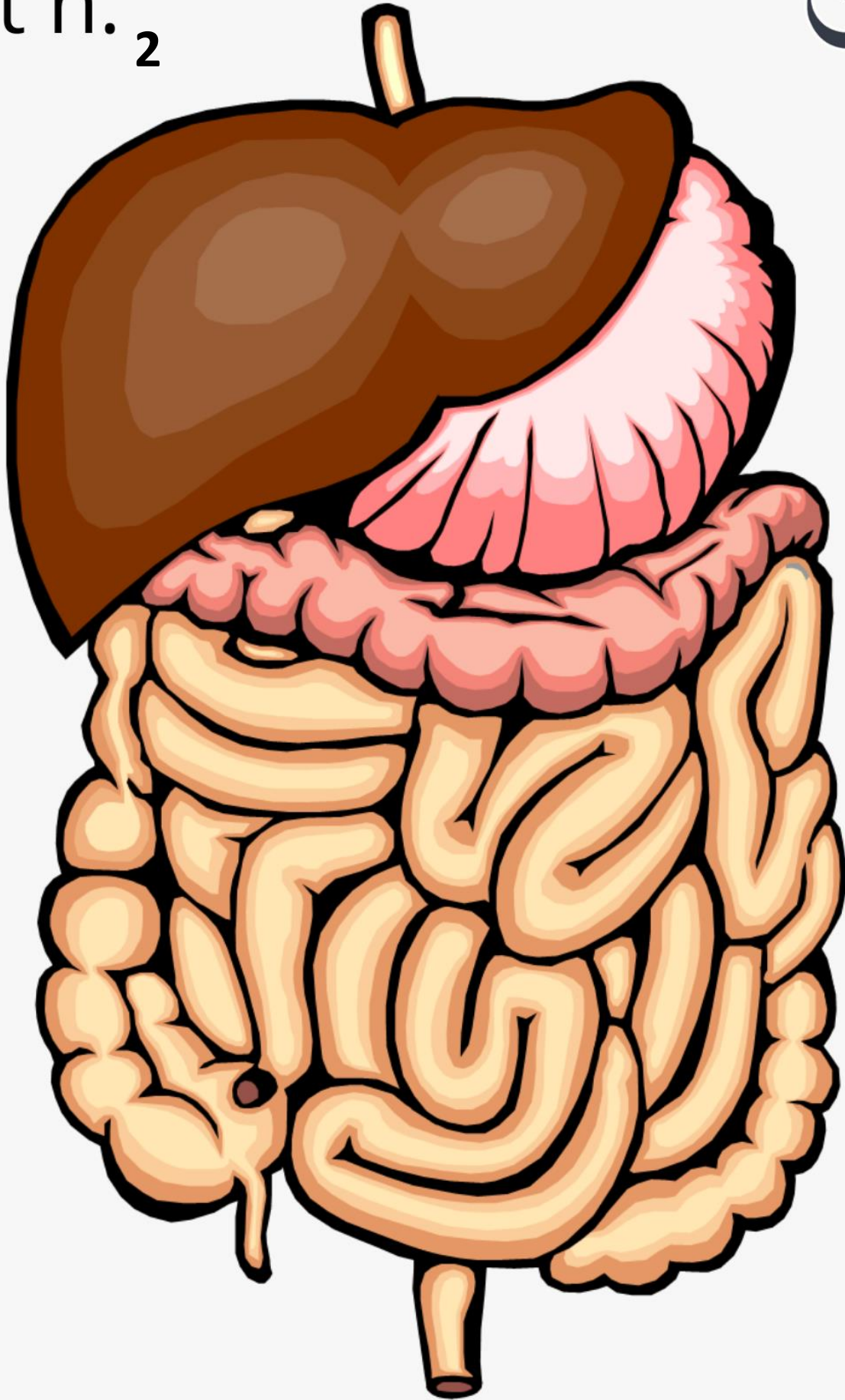


# Physiology

Sheet n. 2



Writer:

Sara Omar  
Subhi Nassar

Corrector:

Tareq Abdallah

# Gastrointestinal Motilities

- Doctor
- Additional
- Slides + handout

Mixing and movements of food along the GI tract:



## 1. MASTICATION (CHEWING):

- Voluntary, but has more of reflex behavior?

Which means that it happens automatically without thinking

Voluntary control allows us to initiate and regulate the chewing process consciously, while involuntary reflexes, help in the coordination and regulation of the muscles involved in chewing, such as the masseter and temporalis muscles, when we're not consciously focusing on it.

- Chewing results in grinding action on food to get smaller particles.
- This occurs by activation of chewing reflex (centers in hypothalamus and cerebral cortex are stimulated by smell and taste to cause chewing of food in the mouth).
- The initiation of chewing reflex appears by muscle stretching caused by drop of the lower jaw (due to the presence of food bolus in the mouth). This will result in a rebound of the lower jaw by activation of stretch reflex.

- **What is the purpose of mastication?**

Mixing of food with saliva and grinding

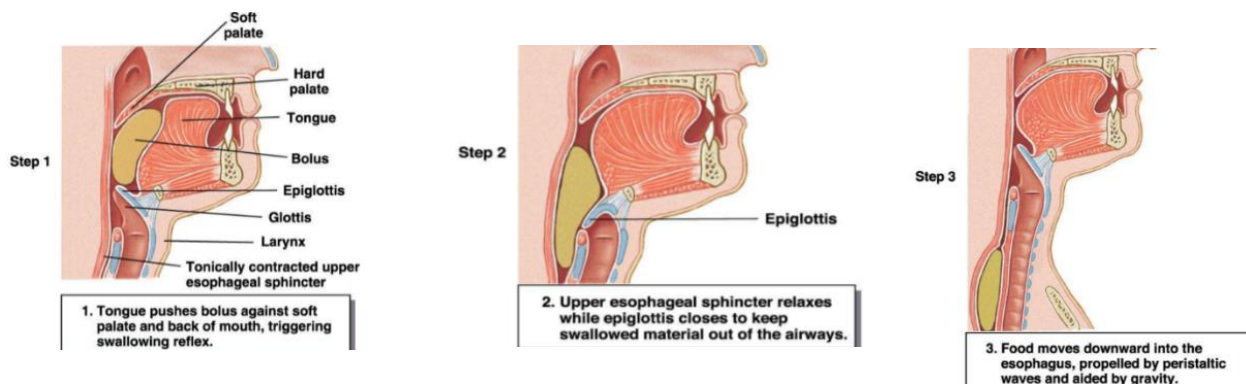
- In mouth, in addition to grinding by chewing, mixing is also promoted by the movements of the tongue.

## 2. DEGLUTITION (SWALLOWING):

IS it voluntary or involuntary?

Initiated voluntarily, Continuing as involuntary reflex.

Check the figure step 1 is voluntary, while 2 and 3 are involuntary



● **Two stages of deglutition:**

**1- Voluntary stage:**

In which tongue is pressing food by upward and backward movement against soft palate, which results in squeezing food bolus into pharynx.

**2- Involuntary stages:**

<sup>1</sup>reflexes initiated by introducing food into pharynx will result in contraction of pharynx and <sup>2</sup>then esophageal peristalsis that induce movement of bolus along esophagus. In these reflexes, swallowing receptors at the pharyngeal mucosa and swallowing centers in the brain are involved.

✓ **The involuntary stage is subdivided into:**

**1. Pharyngeal stage:**

▪ **Why do you think it is an involuntary stage?? Think....**

Once you push the bolus, it will face a lot of openings one towards the tracheae, one toward nasal cavity and one toward esophagus which is guarded by sphincter\*, the control of these openings is **involuntary**.

\*Sphincter: it is more presentation of circular layer with higher tone keeping the opening closed

▪ **duration is about 2 sec**

▪ **In this stage respiration is interrupted, 1soft palate is pulled upward to close posterior nares and 2larynx is pulled upward and anteriorly which results in closure of epiglottis. In addition to these complex events, 3the upper esophageal sphincter (pharyngo-esophageal sphincter) is relaxed and esophageal opening is enlarged. This will end in enforcing bolus to 4move into esophagus.**

**2. Esophageal stage:**

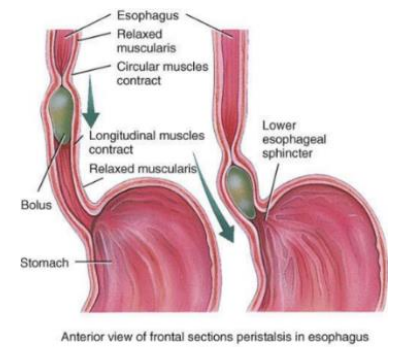
▪ **Conduct the bolus along esophagus to the stomach.**

▪ **What are the esophagus contractions called?**

The contractions of the esophagus are called peristaltic contractions and they are two types.

▪ **What is the difference between the 2 peristaltic contractions?**

The difference is the origin, if the peristaltic contraction is a continuation of esophageal waves, it is called primary, however If the primary failed moving the bolus along the esophagus, esophagus will initiate the same pattern of contractions to get the contraction up and relaxation down the bolus, reaching the lower part which is controlled by enteric nervous system, makes the sphincter relaxes



▪ **Two types of contraction are taking place by esophageal muscle:**

<u>Primary peristaltic contractions:</u>	<u>Secondary peristalsis:</u>
Continuation of the contractions initiated in the pharynx which conduct bolus through the esophagus. The wave of contractions passes along esophagus in about 8-10 second.	Represented by intrinsic (within myenteric plexus) and extrinsic (through afferent and efferent vagus fibers) reflexes promoted by the distension of the esophagus by the retained food in esophagus or when the primary reflex fails to move bolus of food along esophagus.

- **Note: Pharynx and Upper third of the esophagus is striated muscle and controlled by glossopharyngeal nerve. The lower third is smooth muscle and controlled by the vagus nerve as extrinsic control.**

▪ **How the swallowing stage ends?**

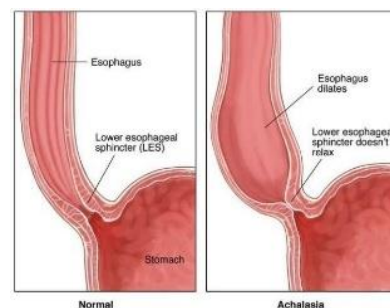
Peristaltic wave of the esophagus ends with relaxation of gastroesophageal sphincter (lower esophageal sphincter) and receptive relaxation of the stomach.

The relaxation is caused by the activation of the inhibitory neurons from the lower part of the esophagus. These neurons induce inhibition of the tonic contraction of the sphincter and the relaxation of the stomach.

▪ **Some problems associated with swallowing, mention them (3 points):**

1. Failure of the sphincter to relax may result in a pathological condition known as ***achalasia***. In which the ability of myenteric plexus to cause relaxation of the sphincter has failed.

Mainly it is resulting from the absence of the myenteric neurons or degeneration of inhibitory neurons of the myenteric plexus which are responsible of relaxation, no inhibitory neurons → no sphincter relaxation → dilation of the lower part of esophagus. **Recall pathology lecture!!**



2. Gastro-esophageal sphincter is equipped also by valve like closure at the distal opening of the esophagus to prevent reflux of food from the stomach. The failure of this system may result in ***esophageal reflux*** (Return of gastric content toward esophagus).

3. **Hypomotility** of esophagus Or difficulty of swallowing is called ***dysphagia***, it could be resulted from taking some **toxins** or odynophagia which is associated with pain after ingestion of acid, alkaline for example which causes **pain** and **muscle obstruction**

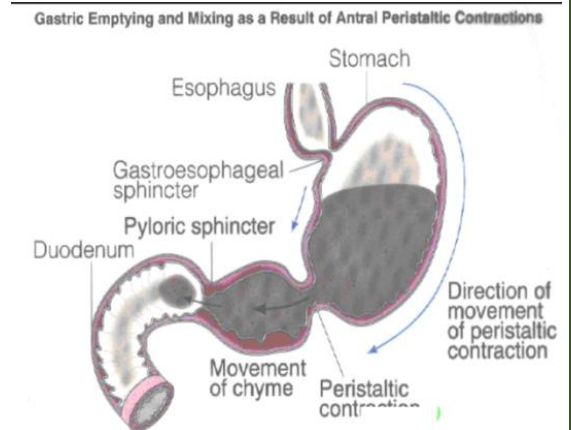
### 3. THE MOTOR ACTIVITIES OF THE STOMACH:

- The most important function of the stomach is storage of food.
- Stomach secretes large amount of secretions (2000ml/day)
- This organ can dilate from the capacity of 50ml up to 1000ml
- When we review the stomach when it's empty, it has small capacity (about 50ml), but when you eat it could be filled up to 1 Liter (and even 2 Liters or more in some people), is that contraction or dilation (relaxation)? It is dilation **by the intervention of vago-vagal reflex**, changing the tonic contraction to lower tone, and that is called **receptive relaxation**.
- After that receptive relaxation, we will have **phasic contractions (basic electrical rhythm (BER) or rhythmic contractions) and peristaltic contractions (or mixing contractions)** at the level of the body of the stomach, These activities (peristaltic contractions) appear in the mid portion of the stomach at frequency of 3/min and move toward the antrum. The frequency is determined by the frequency of basic electrical rhythm (BER) of gastric smooth muscle. These contractions are very intense as they approach the antrum and they are forming constrictive rings. Phasic contractions happen about 3 times in a minute (3/min), but you should imagine that the peristaltic contraction also occurs beside them.

External: The mixing contractions are initiated by the gut wall basic electrical rhythm 'Guyton book'

→ **So how peristaltic movements look like?**

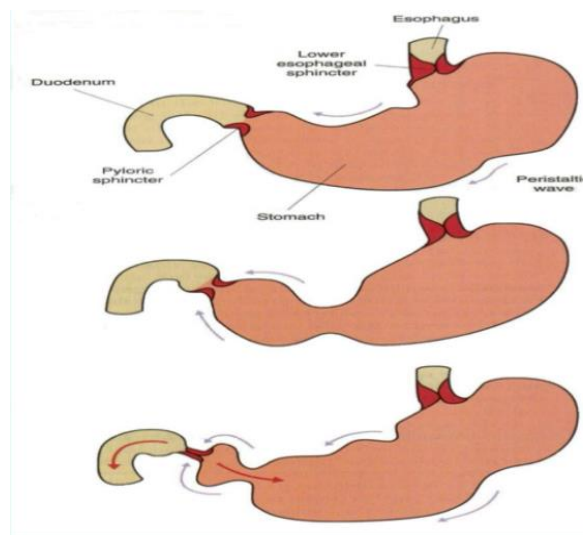
It is like a constrictive ring, starting from mid to upper portions of the stomach wall and move toward the antrum about once every 15 to 20 seconds. And toward a sphincter called pyloric sphincter (This movements is controlled by the ENS),



**Pylorus is a small opening between stomach and duodenum guarded by smooth muscle cells that form the pyloric sphincter.**

- Okay, then what happens to the pyloric sphincter when this constriction wave is in near proximity to it?

**It will close more (constrict more) and will not relax**, and most of the content will twist back toward the body, which impedes emptying of chyme into the duodenum. The result of these contractions not only mixes food, they also grind food and toss the content of the antrum back toward the body and forth.



- But we can have very small amount passing through the pyloric sphincter (toward the duodenum) but it should be of fluid consistency. **So this structure gives access only to fluids to pass into duodenum and prevents the passage of food particles until they are grind and mixed well with secretions by forming chyme with fluid consistency.**

- Now the effect over the gastric content (which is called chyme, because the food is not alone anymore but with GI secretions) as we said can be twisted back (most of it, and this phenomenon is called **retropulsion**) and small amount can cross the pyloric sphincter (small amount, this is called **gastric emptying**), **For about 20% of time these peristaltic contractions become very intense and cause an increase in the pressure in the antrum. This action forces several ml of chyme to pass into the duodenum. The process that results in passage of chyme into duodenum is known as gastric emptying. The whole activity that results in gastric emptying is known as pyloric pump.**
- The pyloric sphincter activity can be described as pump (and some literatures describe it as pump activity).
- Stomach has many functions, stomach secrete enzymes but the actual function is simply continuing the process we started in the mouth, grinding and mixing.
- **What happens if someone ingest solid (like coin)?**  
After 4-6 hours the peristaltic contractions become more powerful, and even solid structures can pass through the pyloric sphincter and released with feces. In general, anything can pass through the mouth or the **upper esophageal sphincter** (pharyngeal-esophageal sphincter) can mostly pass through the pyloric sphincter.
- In addition, we have **hunger contractions**, this type of intense contractions (**rhythmical peristaltic contractions with duration of 2-3 minutes for each**) in the stomach appears when the stomach is empty and lasts for several hours. Nobody know exactly why they happen but we have strong relation with the decreased concentration of glucose in the blood, and these contractions happen when you are hungry.

## Neural and hormonal control of gastric emptying:

Stimulation of gastric emptying:

- Filling of the stomach: initiates myenteric reflexes that causes an increase in the activity of pyloric pump and inhibits the tone of pyloric sphincter.
- Gastrin: secreted by the antral mucosa. This hormone has mild stimulatory effect on the peristaltic activities of the stomach, which result in enhanced pyloric pump.

Inhibition of gastric emptying:

- Entero-gastric reflex: The passage of chyme to the duodenum causes decrease pH (in duodenum). This initiates intrinsic and extrinsic reflexes to decrease gastric emptying.

3 levels of inhibition induced by entero-gastric reflexes:

- Through ENS.
- Through prevertebral ganglia.
- Through signals via the vagus nerve to inhibit the excitatory signals of vagus nerve to the stomach (vago-vagal reflexes).

The effects of these reflexes decrease the antral propulsive contractions and increase the tone of the pyloric sphincter.

- Hormonal feedback from the duodenum:
  - CCK cholecystokinin: (secreted by jejunum) the release is stimulated by fat in chyme.
  - GIP: Gastric Inhibitory Peptide: released from upper small intestinal specialized cells and stimulated by fat and carbohydrates in chyme.
  - Secretin: stimulated by acid in duodenum.

Past papers :

The remaining food particles in the esophagus initiate:

- A. Primary peristalsis
- B. Secondary peristalsis
- C. MMC

Answer: B

about swallowing, all true except:

a-composed of voluntary and involuntary phases.

b-primary peristalsis is initiated at the pharynx

c-secondary peristalsis is initiated in the esophagus by remnant of food in the esophagus.

d- preceded by relaxation wave to open the lower esophageal sphincter.

e- closure of epiglottis is voluntary

Answer: E



All of the following are true about deglutition EXCEPT:

- A. It is initiated voluntarily
- B. It involves reflex centers in the brain
- C. Respiration is impeded during the esophageal phase
- D. It is less effective when lying down
- E. All of the above are true statements

Answer:C

(Respiration is impeded during the pharyngeal phase)

تم بحمد الله تعالى

V2 — Added additional things+ sentences from handout in page 5+6 (underlined)

V3 — page 5

**basic** contraction —> **Phasic** contraction

(Sorry for the typo..)

**Edits highlighted with Yellow in page 5+7**

**V 4 — page 8 ' neural and hormonal control of gastric emptying**