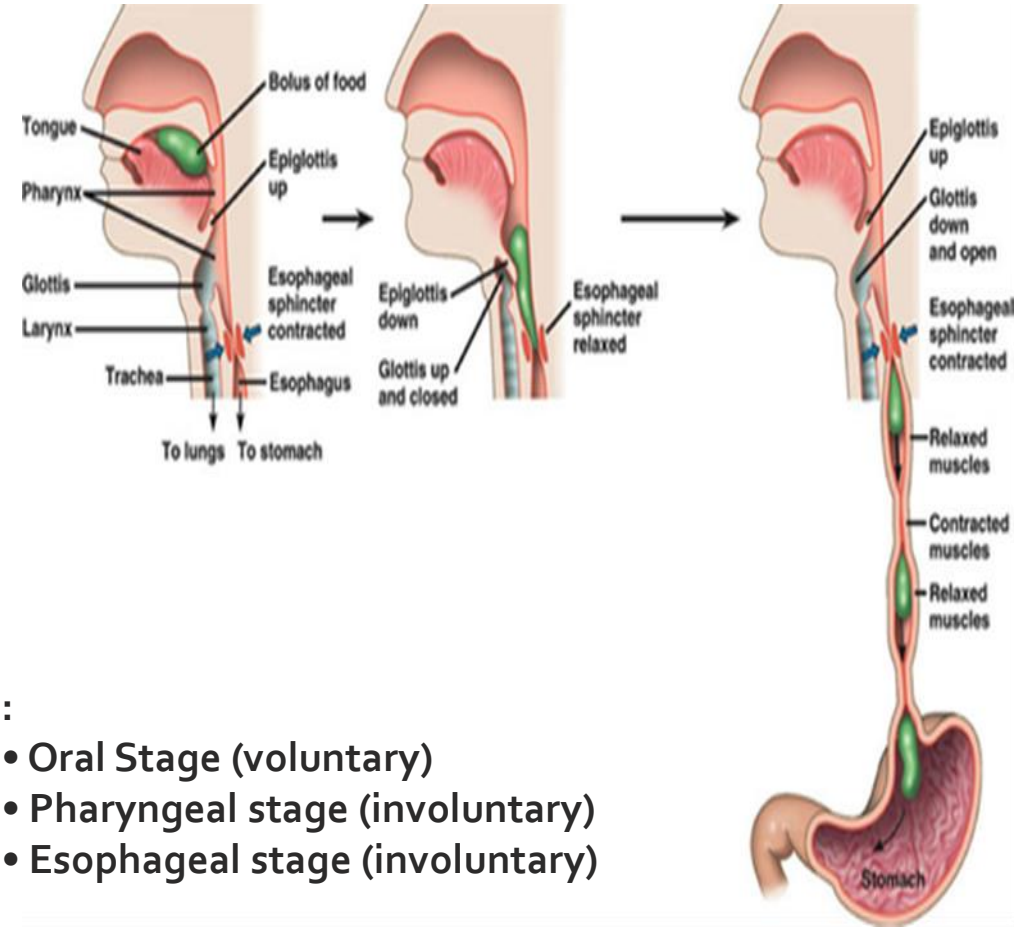
Propulsion and Mixing of Food in the Alimentary Tract

Swallowing and Gastric Motility

By Dr. HAKAM ALKHATEEB

SWALLOWING (DEGLUTITION)

- Swallowing (Deglutition)
  - Swallowing is the ordered sequence of events that propel food 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.



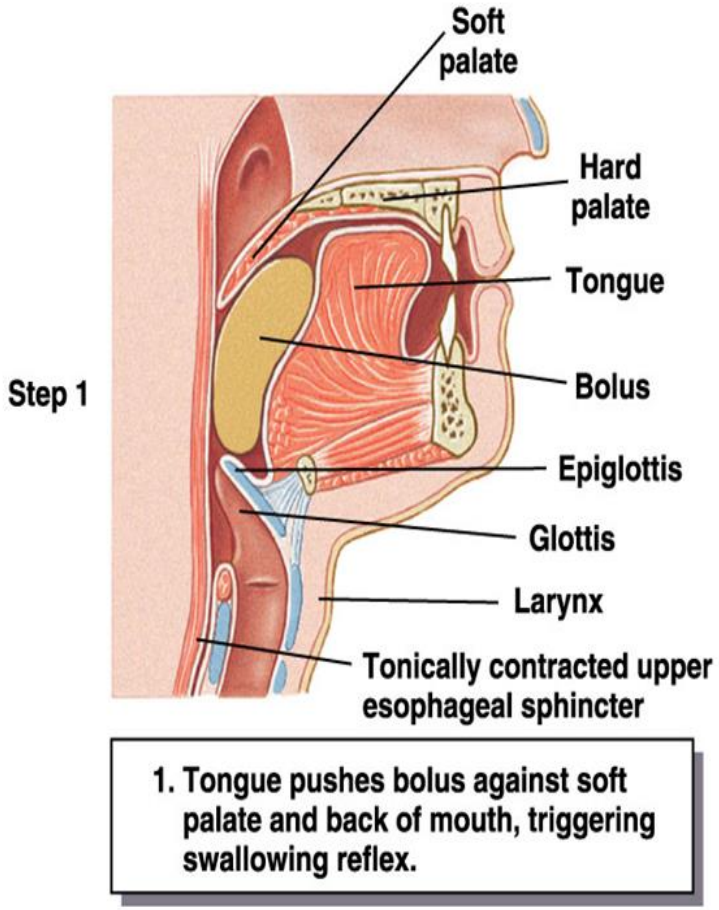
:

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

Stages of Swallowing

Oral stage

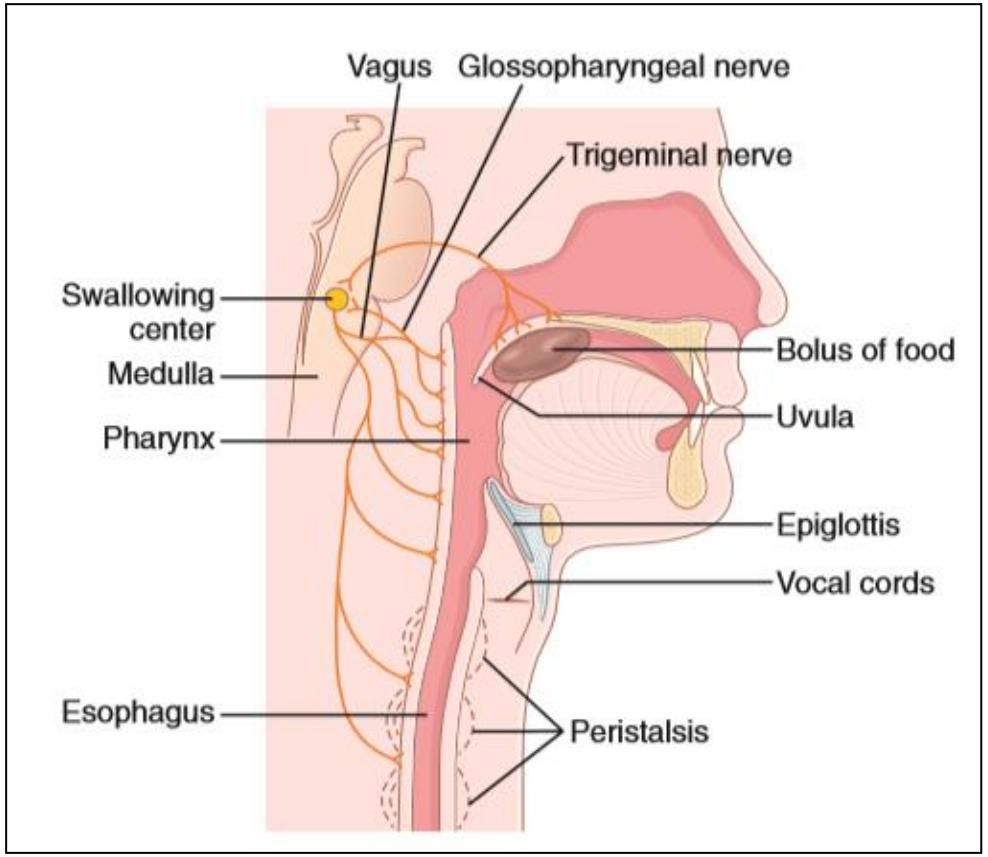
- The first stage of swallowing involves the voluntary rolling of bolus into the pharynx by the upward and backward pressure applied by the tongue against the palate.
- The pharynx contains high density of somatosensory receptors. The activation of these receptors initiates the involuntary swallowing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



SWALLOWING (DEGLUTITION)

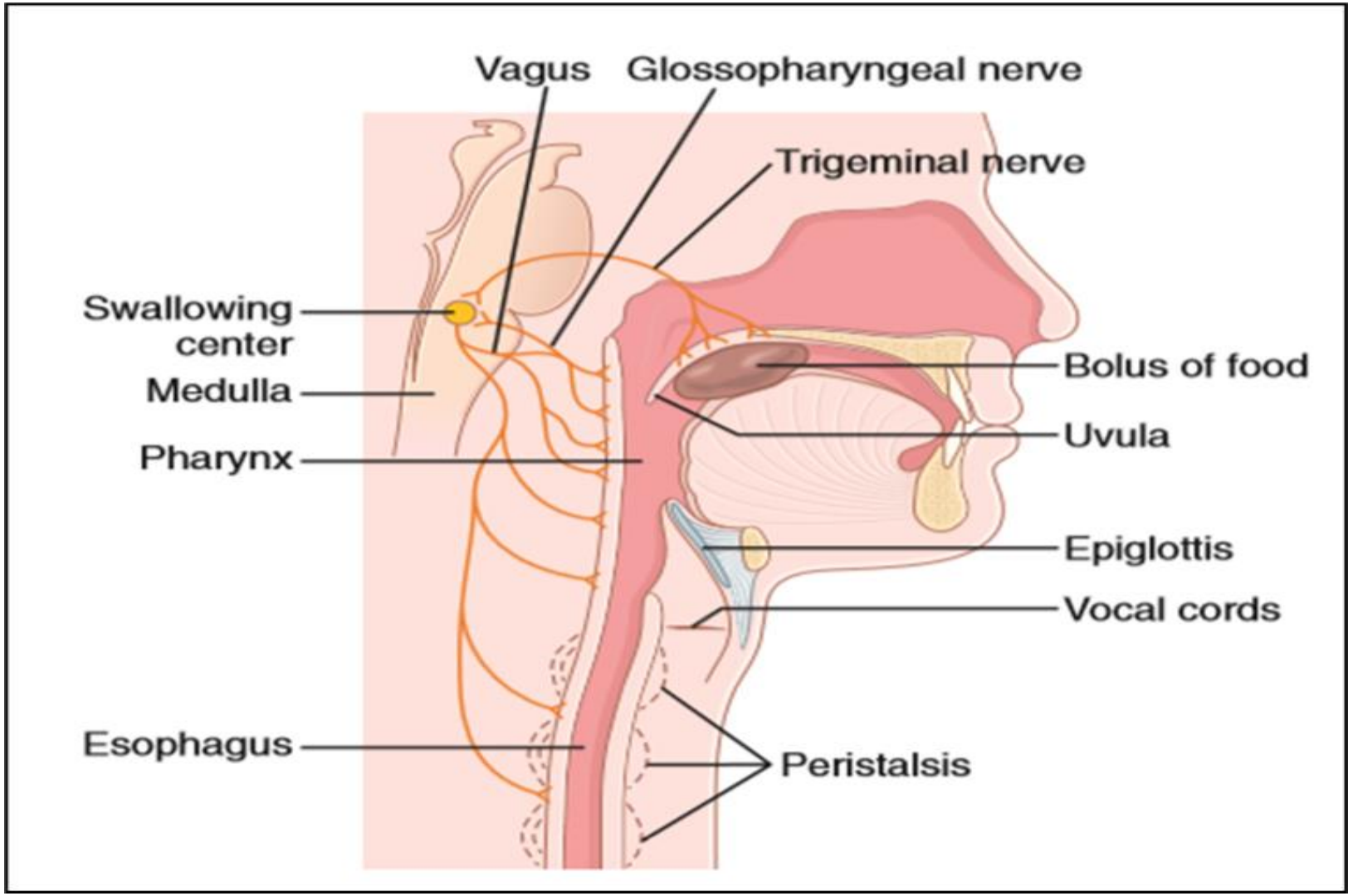
Pharyngeal stage

- 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).



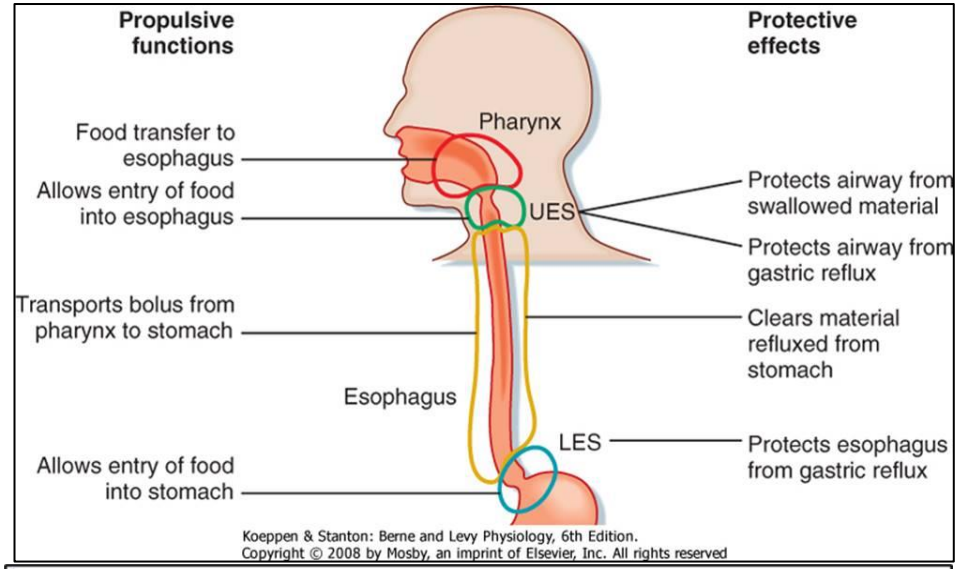
Deglutition apnea

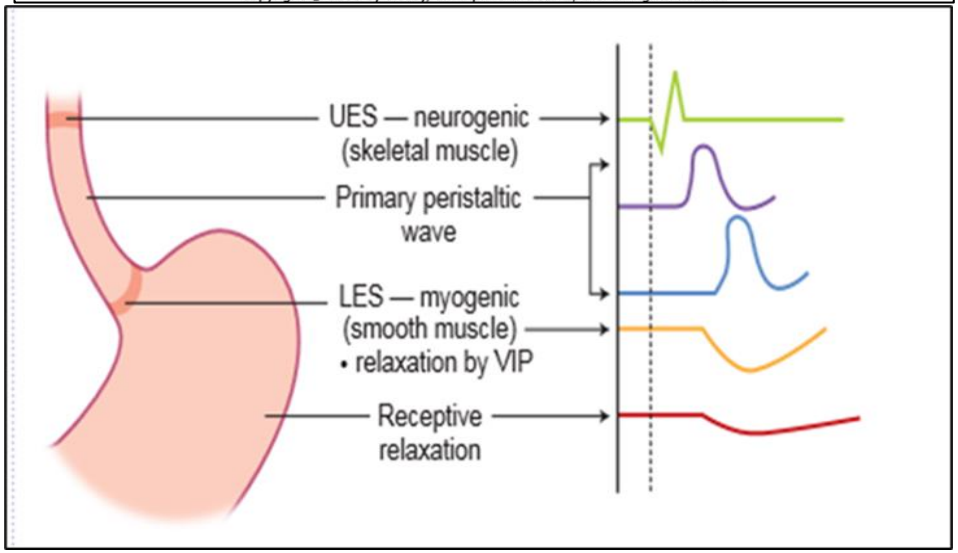
Nervous initiation of the pharyngeal stage of swallowing



SWALLOWING (DEGLUTITION)

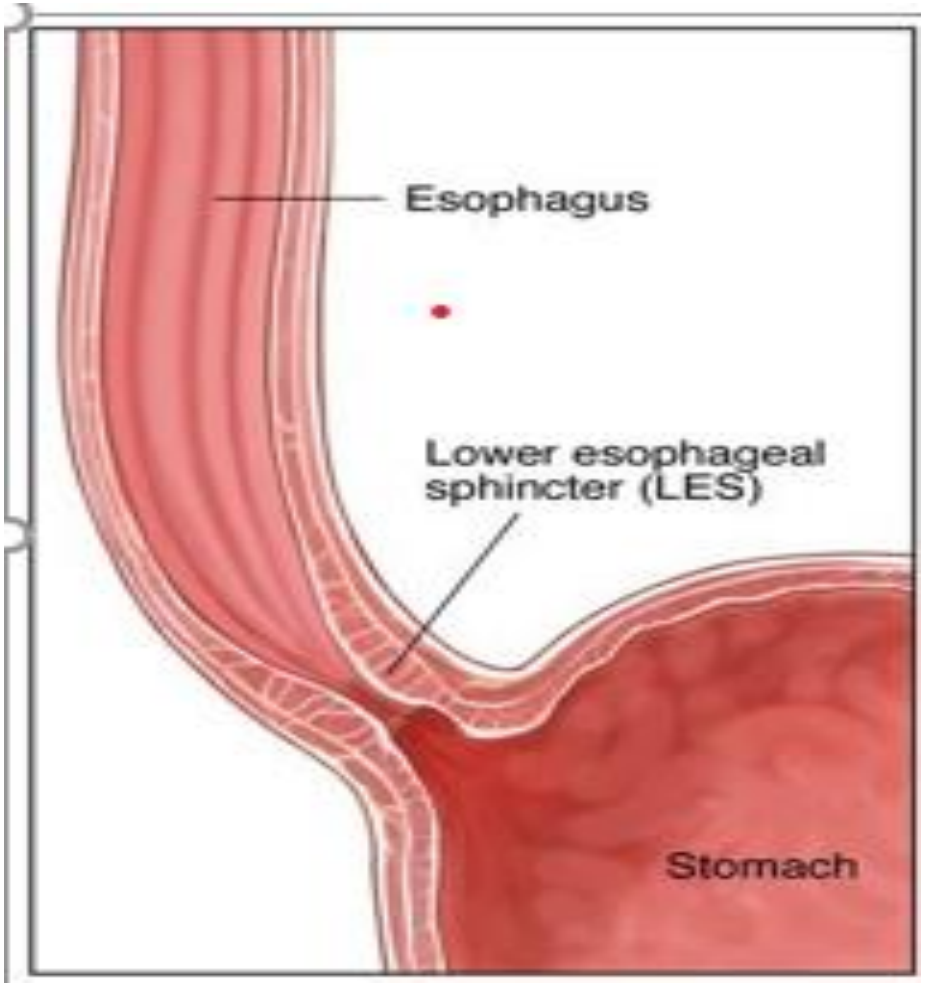
- Physiologically , esophagus is divided into three functionally distinct regions:
  - 1- Upper esophageal sphincter (UES)
  - 2- Esophageal body
  - 3- lower esophageal sphincter(LES)
- Types of Esophageal Peristalsis:
  - Two waves of peristalsis, in this stage, move the bolus down:
    - Primary peristalsis
    - Secondary peristalsis





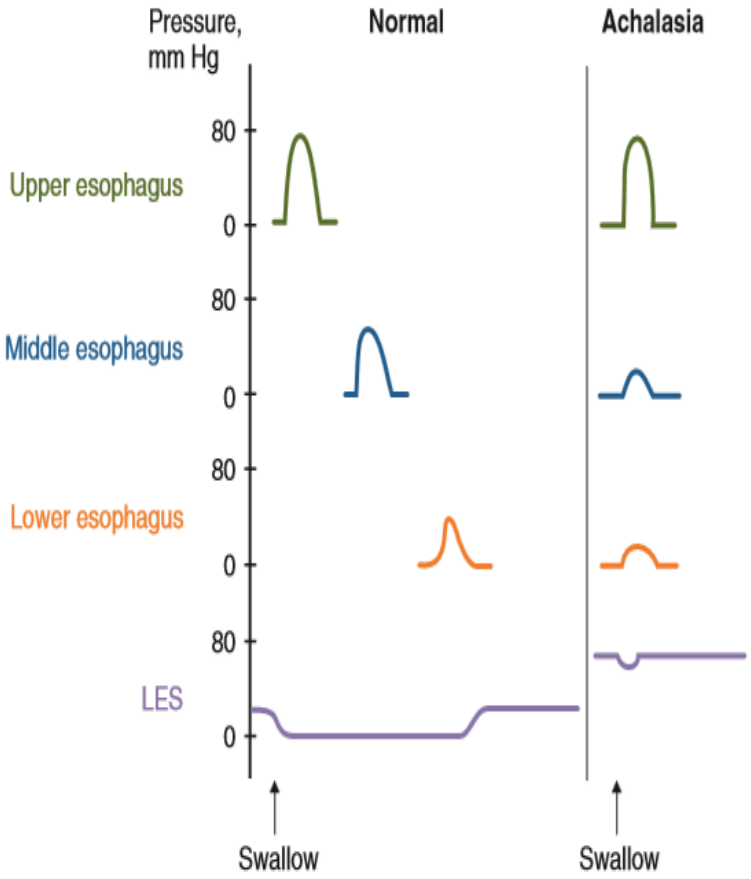
The lower esophageal sphincter (LES)

- 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



Incompetence of the LES:
esophagitis, heart burn, esophageal ulcer and dysplastic changes that may become cancerous.

Gastric Motility

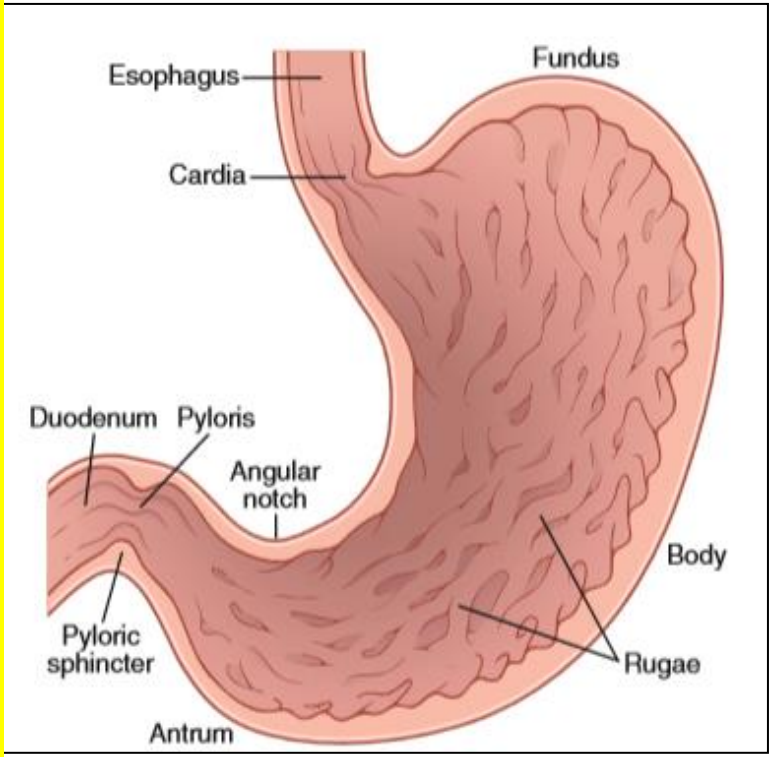
Motor Functions of the Stomach

Motor Functions of the Stomach

- Anatomical regions of the stomach are:
  - fundus
  - Body
  - antrum,
  - pylorus.

- Two functional divisions of the stomach:
  - Orad region (thin wall) of the stomach includes the fundus and proximal 1/3rd of the body
    - This region is responsible for <u>receiving the ingested food.</u>

  - Caudad region(thick wall with more musculature) of the stomach includes the antrum and the distal 2/3rd of the body.
    - This region is responsible for the contractions that <u>mix food</u> and <u>propel</u> (emptying) it into the duodenum.



Receiving and storage the ingested food (Receptive Relaxation)

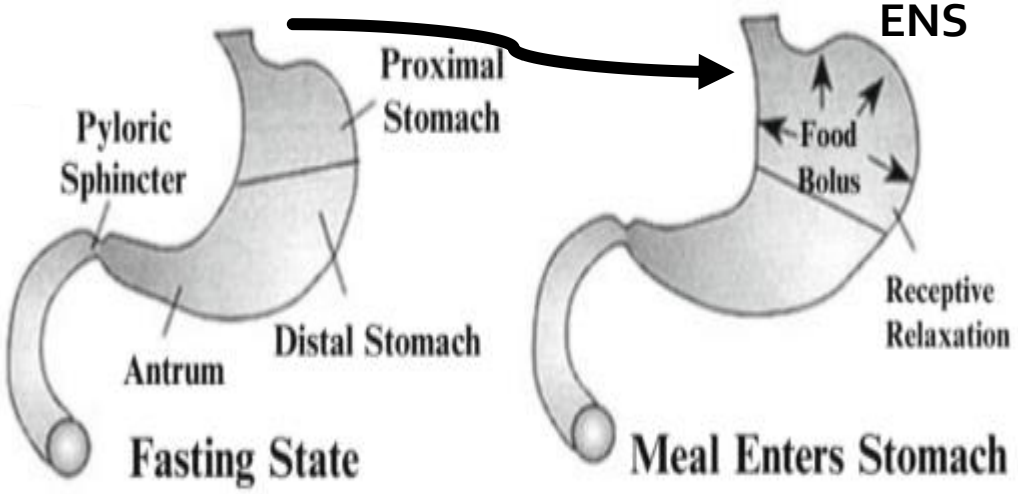
Mechano-receptor in the mouth, pharynx and esophagus + Gastric distention

Sensory afferent fibers

Vagus centre

Inhibitory vagal fiber

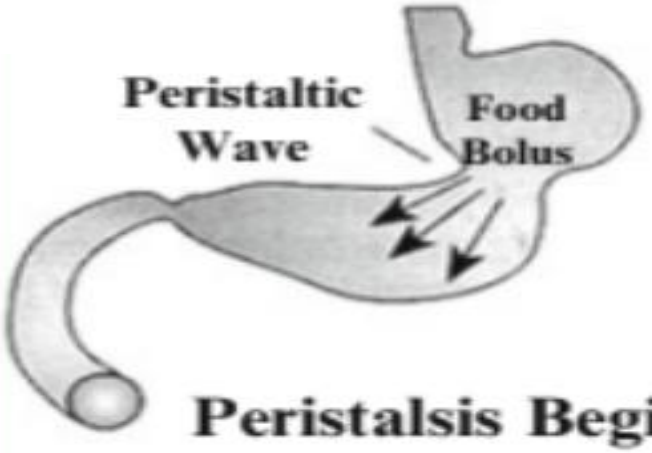
ENS

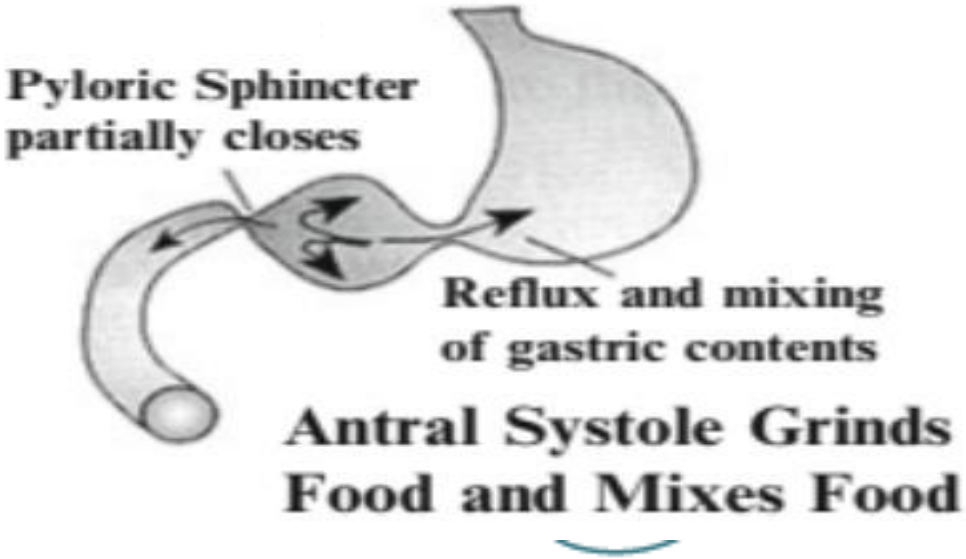


Mechanism: stretching-vagovagal reflex

Distensibility of the proximal stomach is increased by release of secretin, GIP, and CCK.

Mixing and propulsion of food in the stomach





(1) **Propulsion:** Peristaltic waves move from the fundus toward the pylorus. → (2) **Grinding:** The most vigorous peristalsis and mixing action occur close to the pylorus. The pyloric end of the stomach acts as a pump that delivers small amounts of chyme into the duodenum. → (3) **Retropulsion:** The peristaltic wave closes the pyloric valve, forcing most of the contents of the pylorus backward into the stomach.

Regulation of Gastric Emptying

- The rate at which the stomach empties is regulated by signals from both the stomach (Weak gastric factors that promote gastric emptying) and the duodenum (Strong duodenal factors that inhibit gastric emptying).

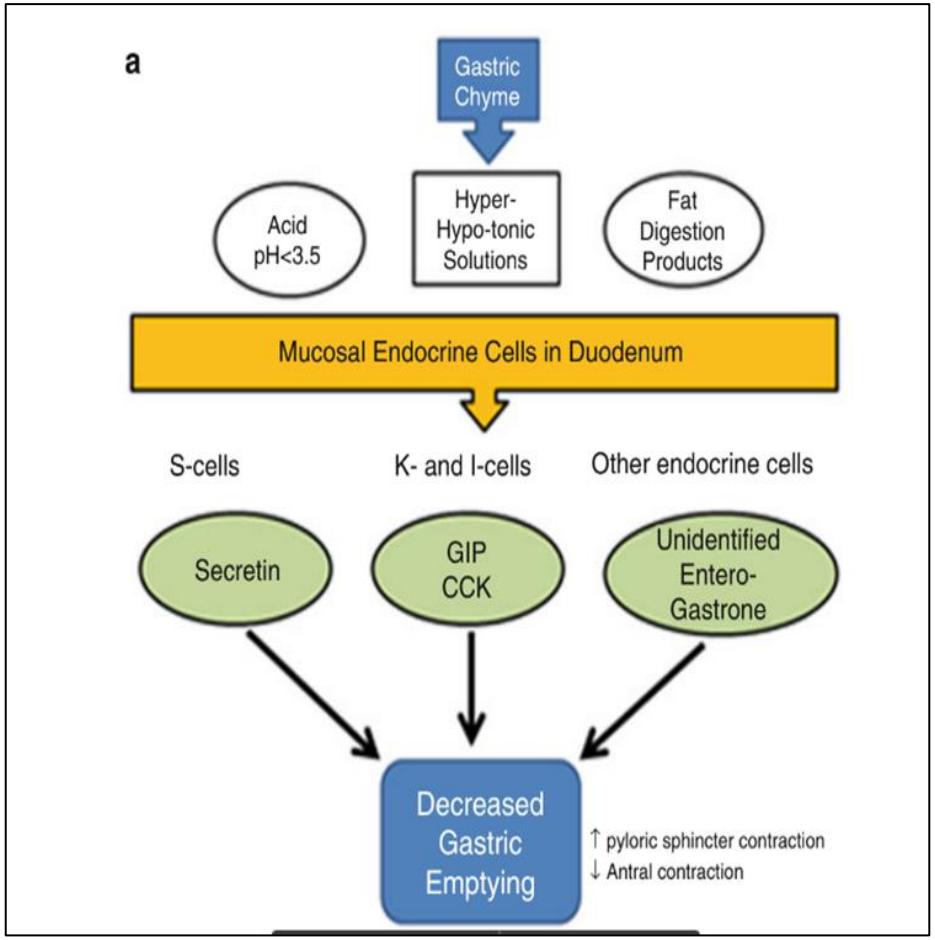
Promote:

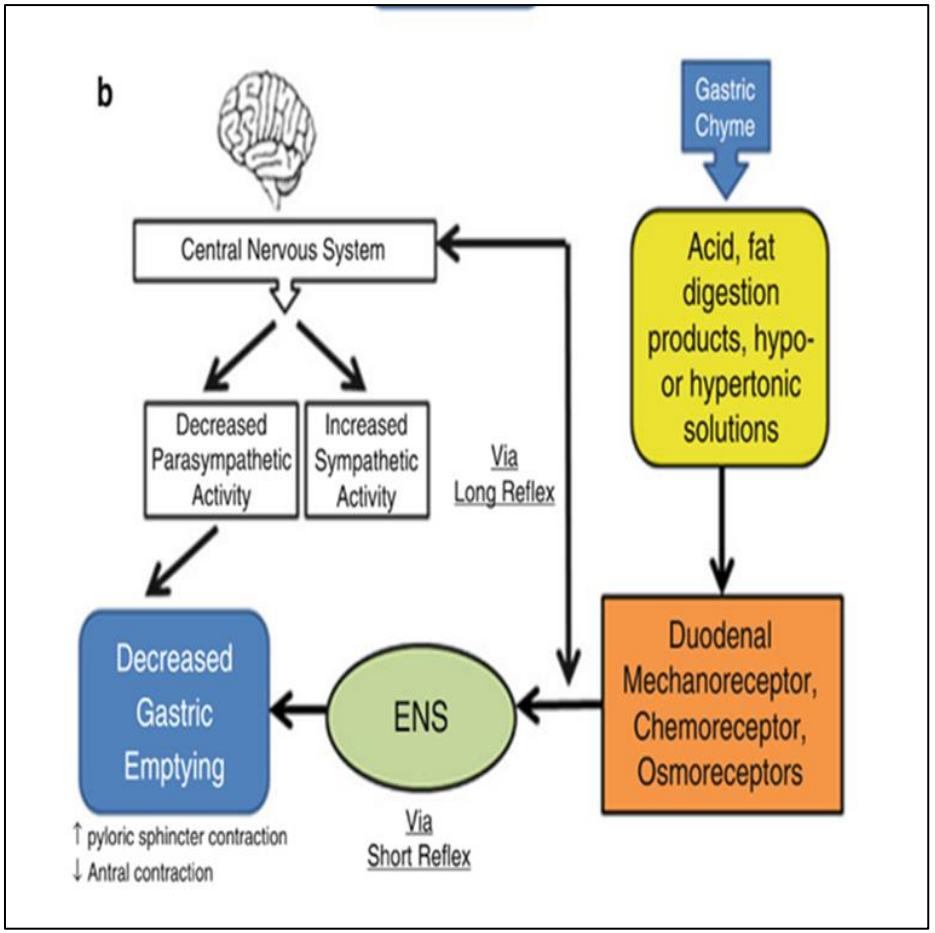
- Gastric volume: Increased food volume in the stomach promotes increased emptying from the stomach.
- Liquid vs solid food: Clear fluids are empty rapidly. Solids stay in stomach longer .
- Types of food: Protein empties fastest, followed by carbohydrates. Fats take longest to empty

- Neural:
  - Parasympathetic innervation (via vagus) stimulates motility
  - Local myenteric reflex
- Hormonal factors:
  - Gastrin
  - Motilin

Regulation of Gastric Emptying

Inhibit





Abnormalities of gastric emptying lead to several clinical problems (e.g dumping syndrome)

Propulsion and Mixing of Food in the Alimentary Tract

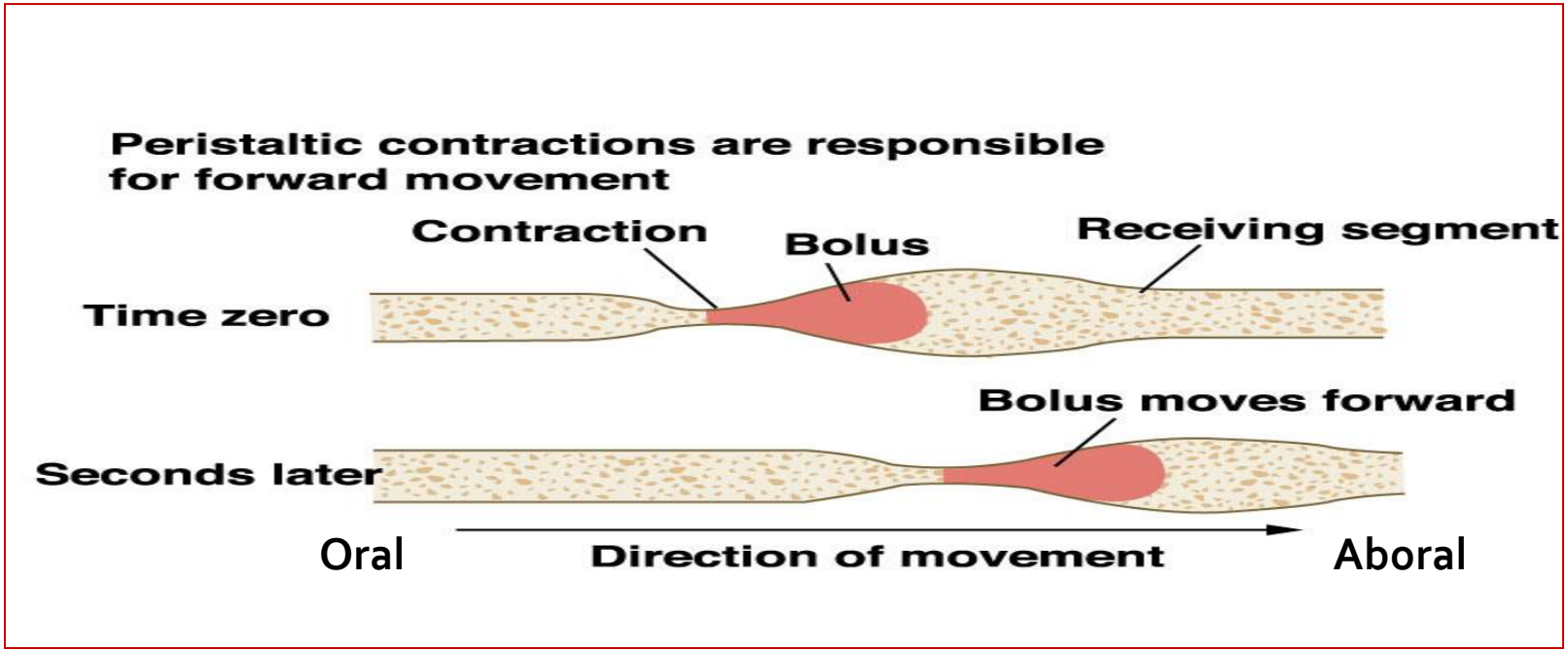
Intestinal Motility

Motility of the small intestine

A- Motor activity in the fed state:

i- Peristalsis:

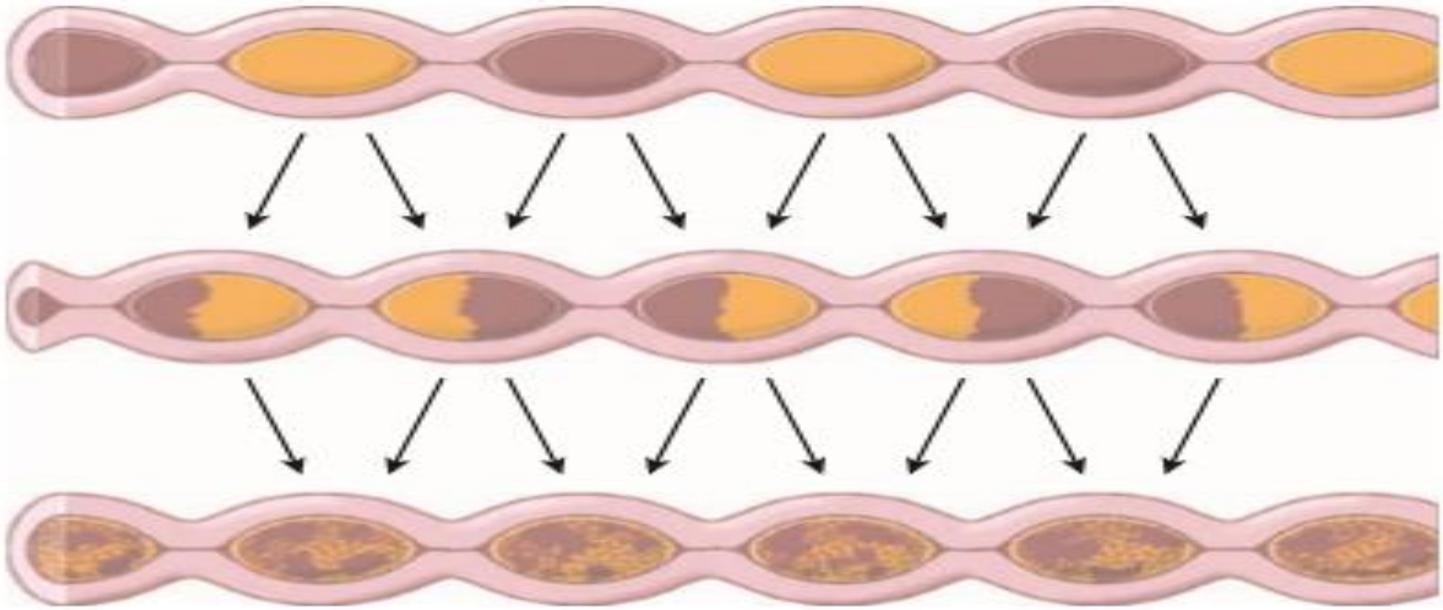
- **co-ordinated entirely by the ENS**
- **net movement along the small intestine normally averages only 1 cm/min**
- **3 to 5 hours are required for passage of chyme from the pylorus to the ileocecal valve**



Motility of the small intestine

ii- Segmentation or mixing movements:

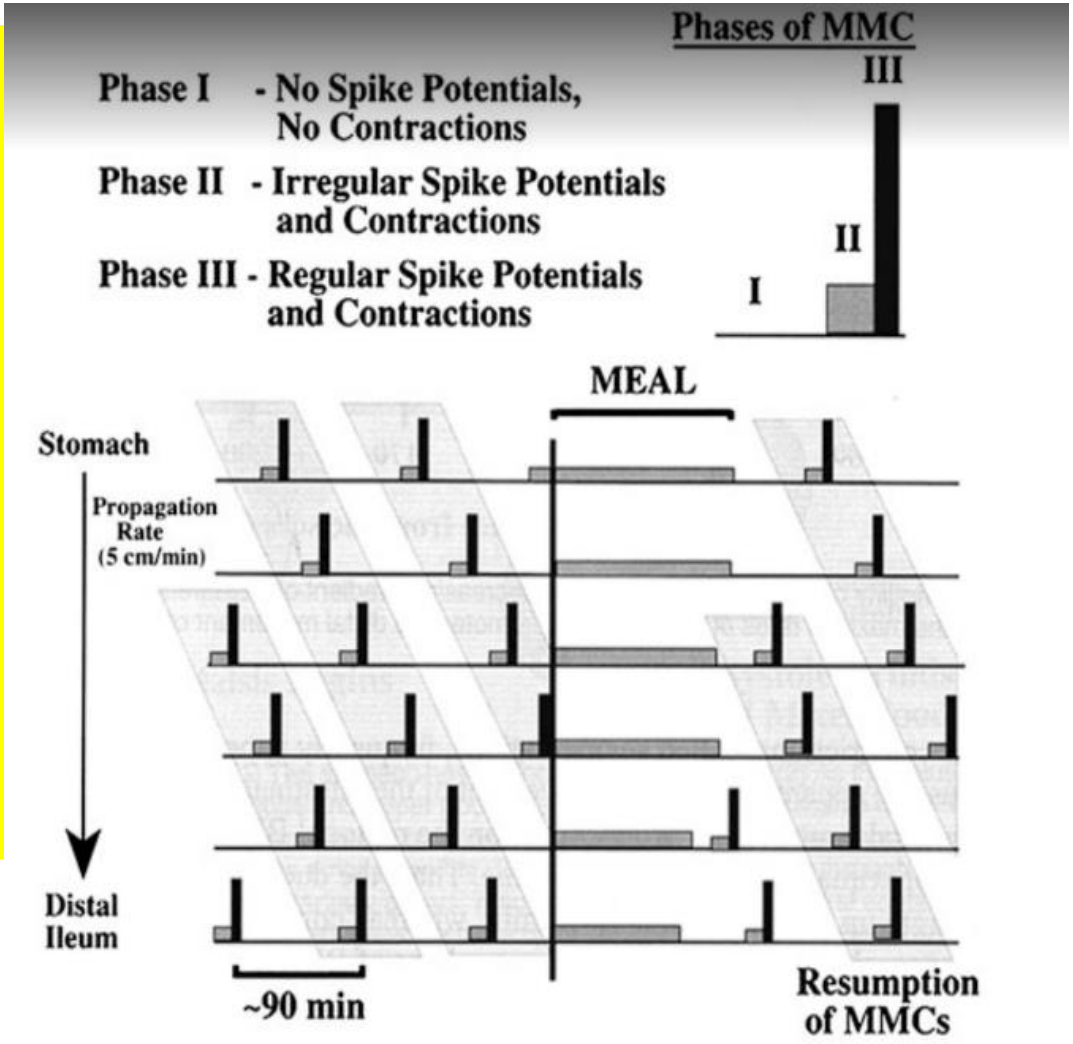
- **They cause mixing of intestinal contents without any net forward movement of chyme.**



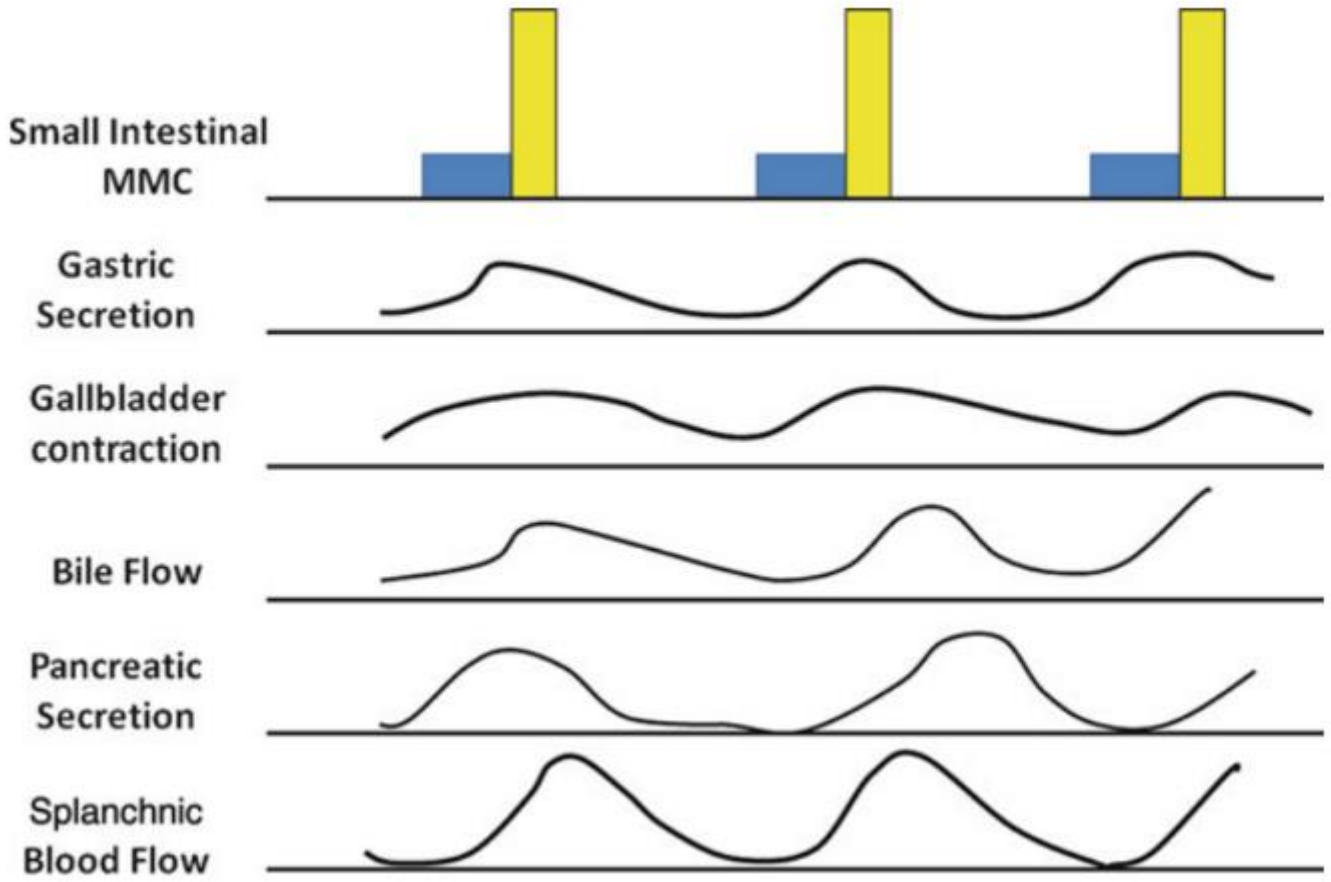
Motility of the small intestine

B- Motor activity in the interdigestive period:

- The myoelectric or migrating motor complex (MMC)– "The housekeeper":
  - Each cycle of MMCs has 3 phases:
    - phase 1 – *quiescent phase* (about 70 minutes).
    - phase 2 – (about 10-15 minutes).
    - phase 3 – (last 5-10 minutes)

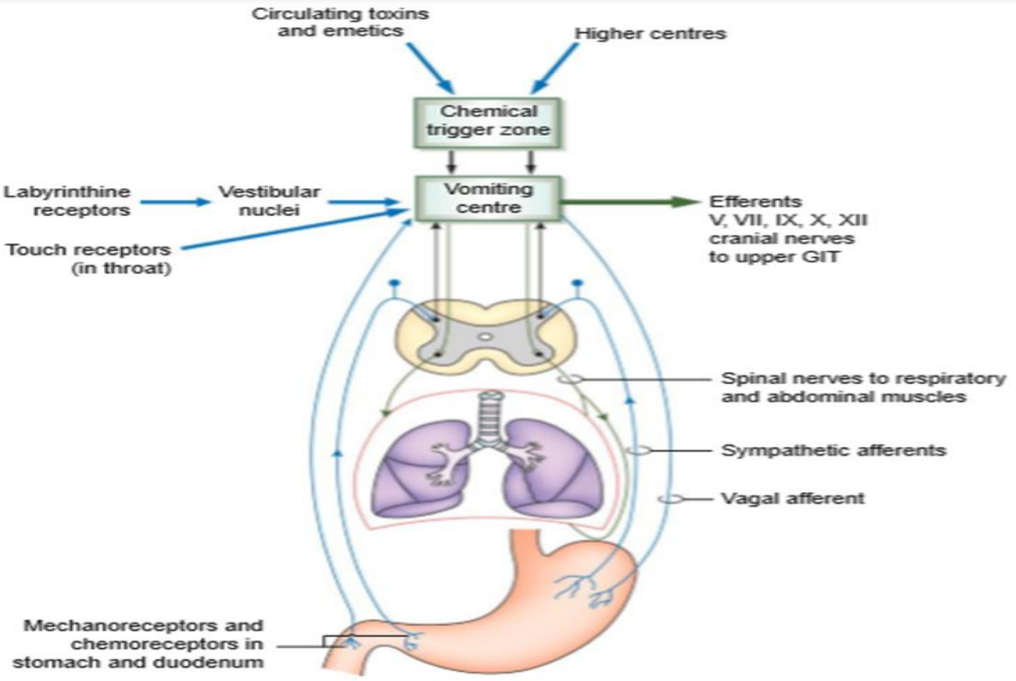


Myoelectric or migrating motor complex (MMC)



Vomiting (Emesis)

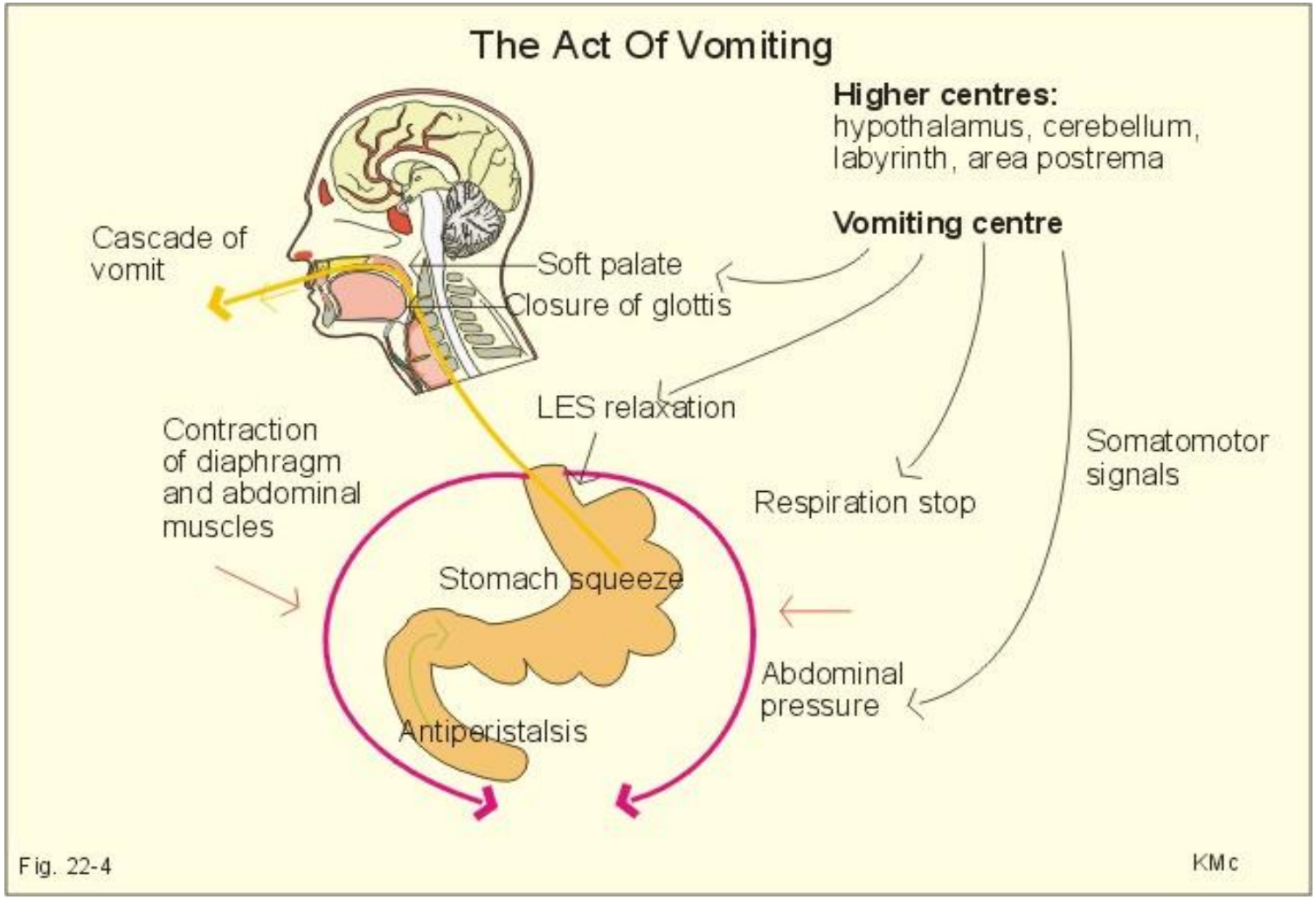
- Vomiting can also be referred to as emesis, and consists of the following stages:
  - Nausea
  - Retching
  - Vomiting
- Vomiting serves as:
  - a protective reflex (acidosis and hypoxia)
  - an important clinical symptom (intracranial tumors.



The mechanisms of emesis can be divided into three components:

- Afferent inputs
- Central nervous system:
  - chemoreceptor trigger zone (CTZ)
  - integrative vomiting center
- Emetic efferent signals

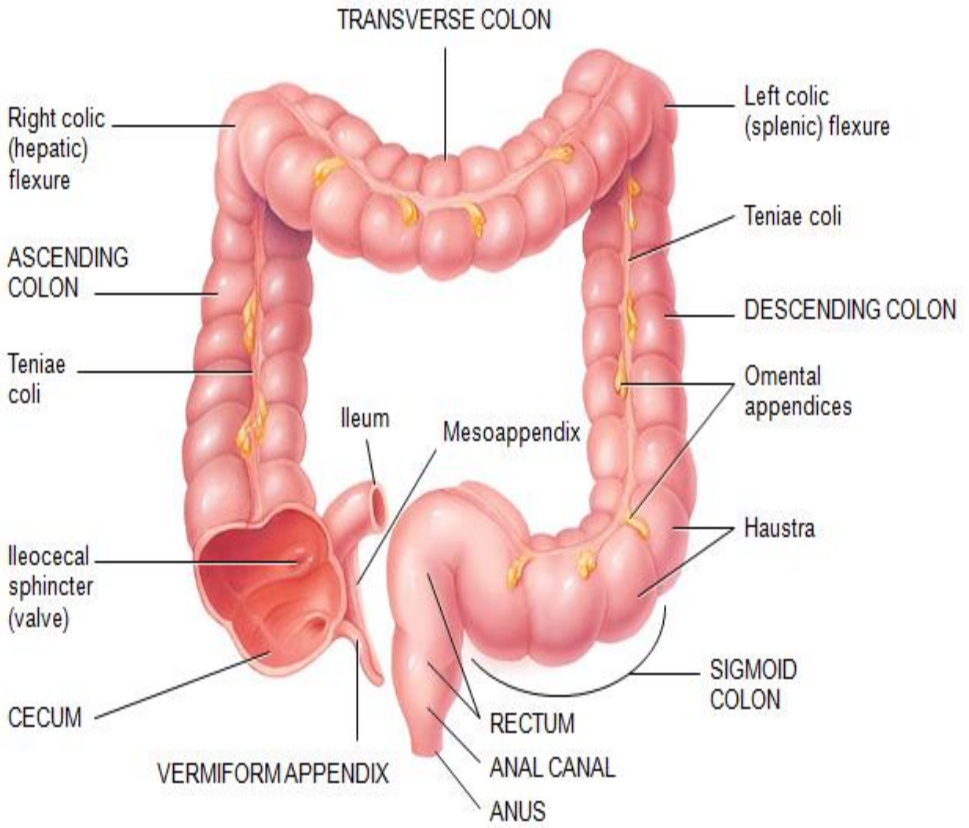
Mechanical events of vomiting



Motility of the large intestine

- The colon of an adult human receives 0.5–2.5 L of chyme per day. This consists of undigested and unabsorbed residues of food, in addition to water and electrolytes.
- The colon must reduce the volume of this intestinal chyme to about 100–200 g.
- The principal functions of the colon is absorption of water and electrolytes from the chyme to form solid feces .

- The movements can be divided into:
  - Mixing Movements—"Haustrations."
  - Propulsive Movements—"Mass Movements."
    - 1 to 3 times per day for 3 min.
    - Gastrocolic reflex



Rectal Function and Defecation

- ❑ Gastrocolic reflex → Mass movement → Intrarectal pressure (18mmHg):
  - ✓stimulates the stretch receptors
  - ✓sets up defecation reflexes
  - ✓produces an urge to defecate
  - ✓external anal sphincter further contracts (new borns??)

- ❑ Defecation reflexes:
  - ✓ Intrinsic reflex
  - ✓ Parasympathetic defecation reflex
  - ✓ The rectal pressure reaches to about 55 mm Hg.
  - ✓ the voluntary control mechanism depending upon the convenience may or may not allow the act of defecation to occur.
  - ✓Pudendal nerve.
  - ✓Valsalva manoeuvre