PASSION ACADEMIC TEAM

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Sheet# 4

YU - MEDICINE

GASTROINTESTINAL SYSTEM

Lec. Title : Propulsion & Mixing of Food in the Alimentary Tract (Gastric & Intestinal Motility) .

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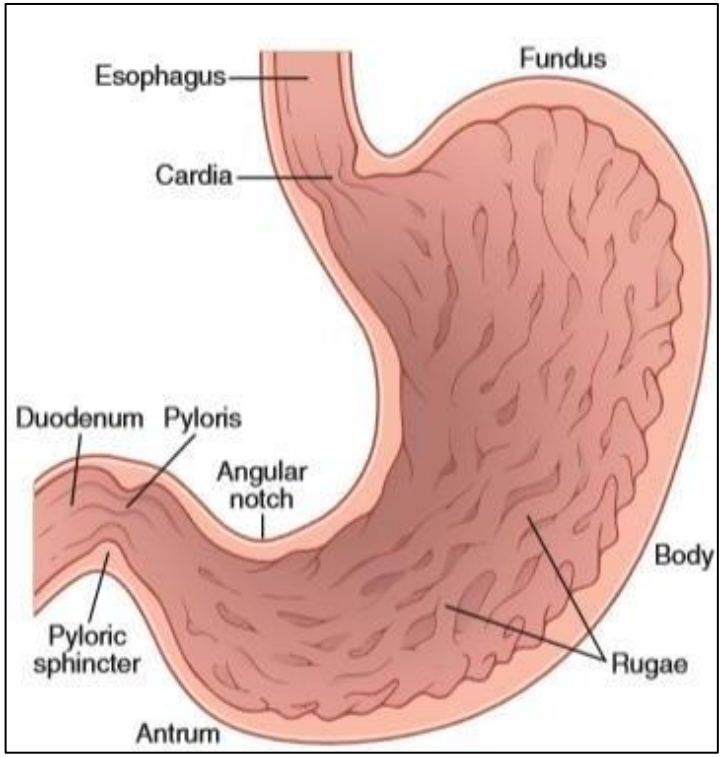
Gastric Motility

Motor Functions of the Stomach

Motor Functions of the Stomach

- Anatomical regions of the stomach are: 4 Regions
  - fundus
  - Body
  - antrum,
  - pylorus.

- Two functional (Physiologically) divisions of the stomach:
  - Orad region (thin wall → A few smooth muscles) of the stomach includes the fundus and proximal 1/3rd of the body
    - This region is responsible for receiving the ingested food (Store food) .
  - Caudad region(thick wall with more musculature → More smooth muscles) of the stomach includes the antrum and the distal 2/3rd of the body.
    - This region is responsible for the contractions that mix food and propel (emptying) it into the duodenum.



Sheet# 1

Smooth muscle contraction + relaxation helps with mixing , storing , peristalsis .
Storage takes place in fundus + 1/3 upper of the body due to thinner walls , less muscles → stretchable walls that can increase in size to store without having the intragastric pressure increase . It is a highly distensible area . The distal part has more muscles → thicker walls → good for mixing + emptying .

Receiving and storage the ingested food (Receptive Relaxation)

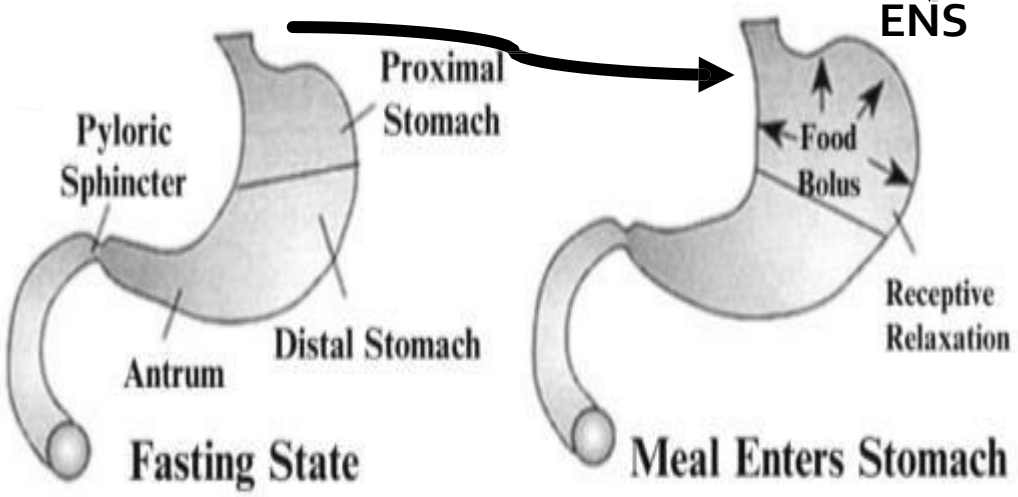
Mechano-receptor in the mouth, pharynx and esophagus + Gastric distention

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.

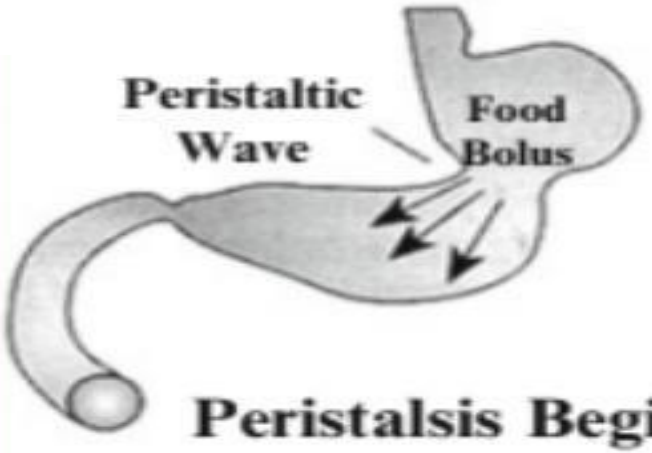
Sheet# 2

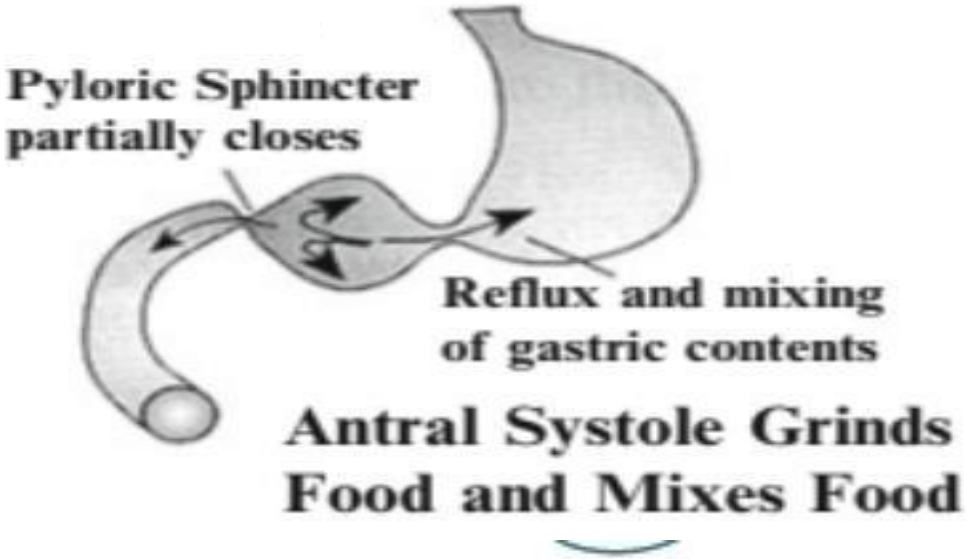
How does stomach receive food without increasing in gastric pressure ?

Stomach distention / filling (or) as food is in the mouth , this stimulate for :

1. " Receptive Relaxation " : vagovagal reflex by sensory efferent fiber + motor efferent fiber .
2. Proximal stomach wall bulging → Secretin , GIP , CCK → Inhibit emptying of stomach .

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.

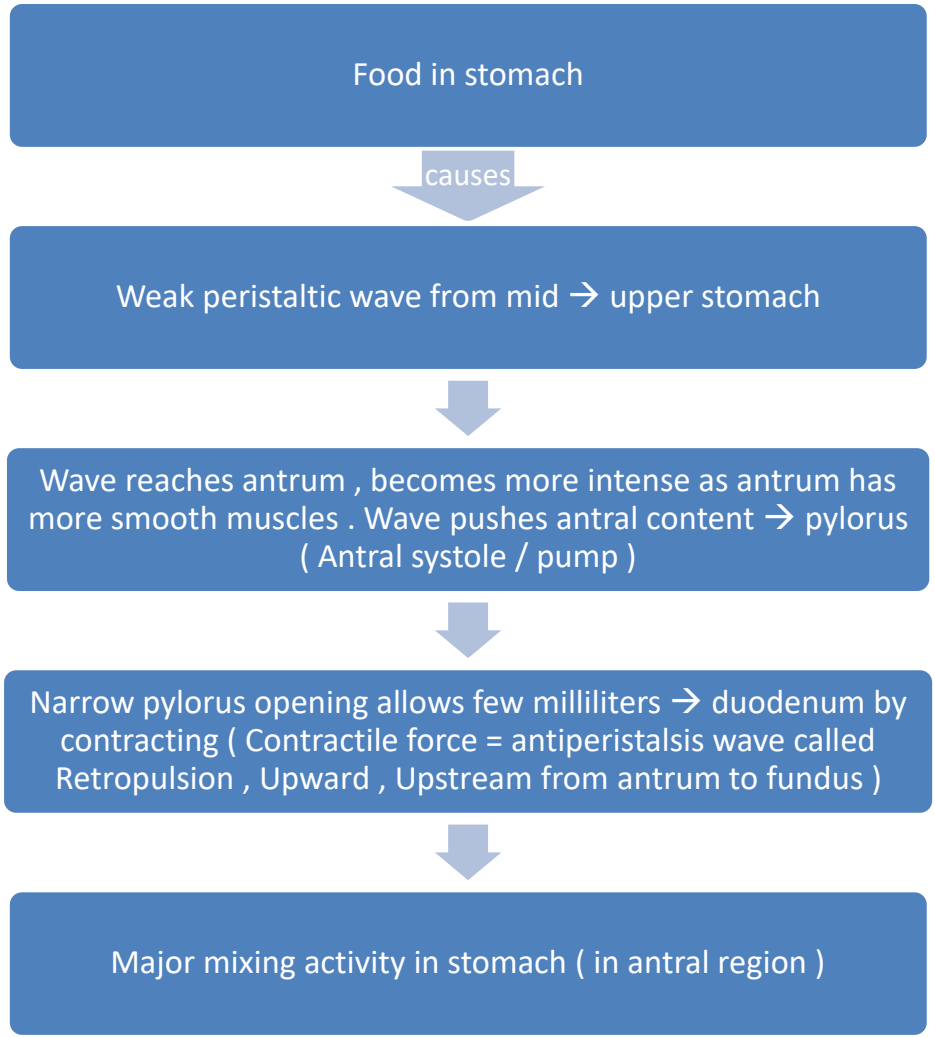
Sheet# 3

Mixing / Propulsion food :

Caudad (antrum , distal 2/3rd.)

Propulsion (Mid → downstream)

Retropulsion (downstream → upper region)



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

Emptying :

1. Signals from stomach → Promote emptying .
2. Signals from duodenum → Inhibit emptying .

Sheet# 4

Signals from stomach & duodenum are regulated so chyme emptying is regulated to allow it to be absorbed in small intestine.

If (Chyme emptying speed > Chyme absorption rate) → Dumping Syndrome .

This means that the food's full nutritional value is not being absorbed . Dumping of large volume of hypertonic content into duodenum . Hypertonic food has consequences if in the duodenum .

Consequences : Rapid stomach emptying .

Abdominal cramps .

Diarrhea .

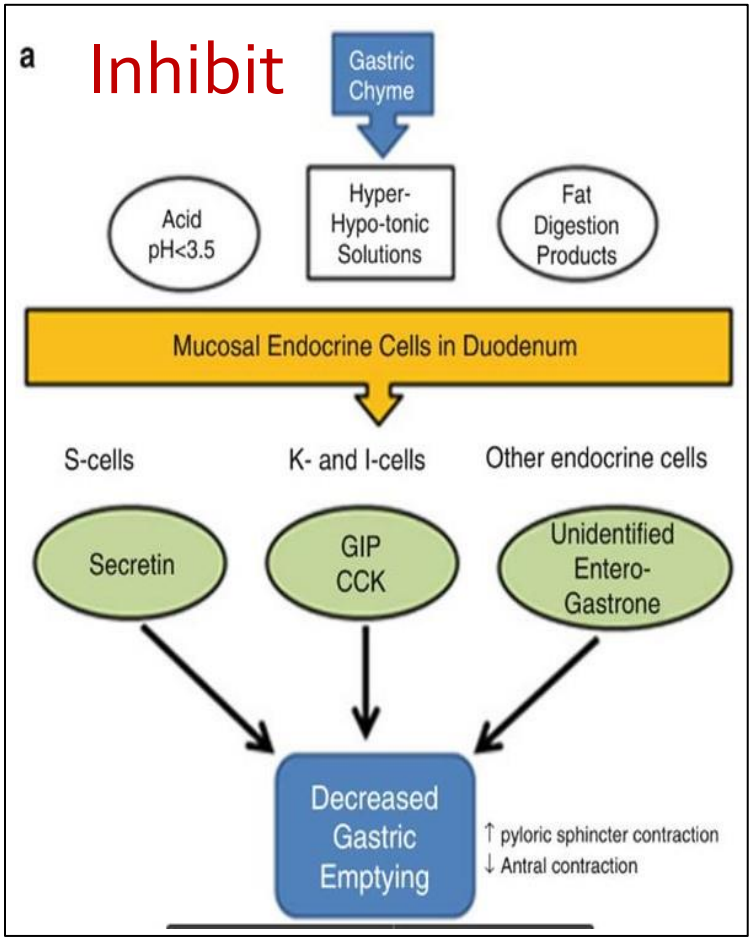
Rapid heart rate .

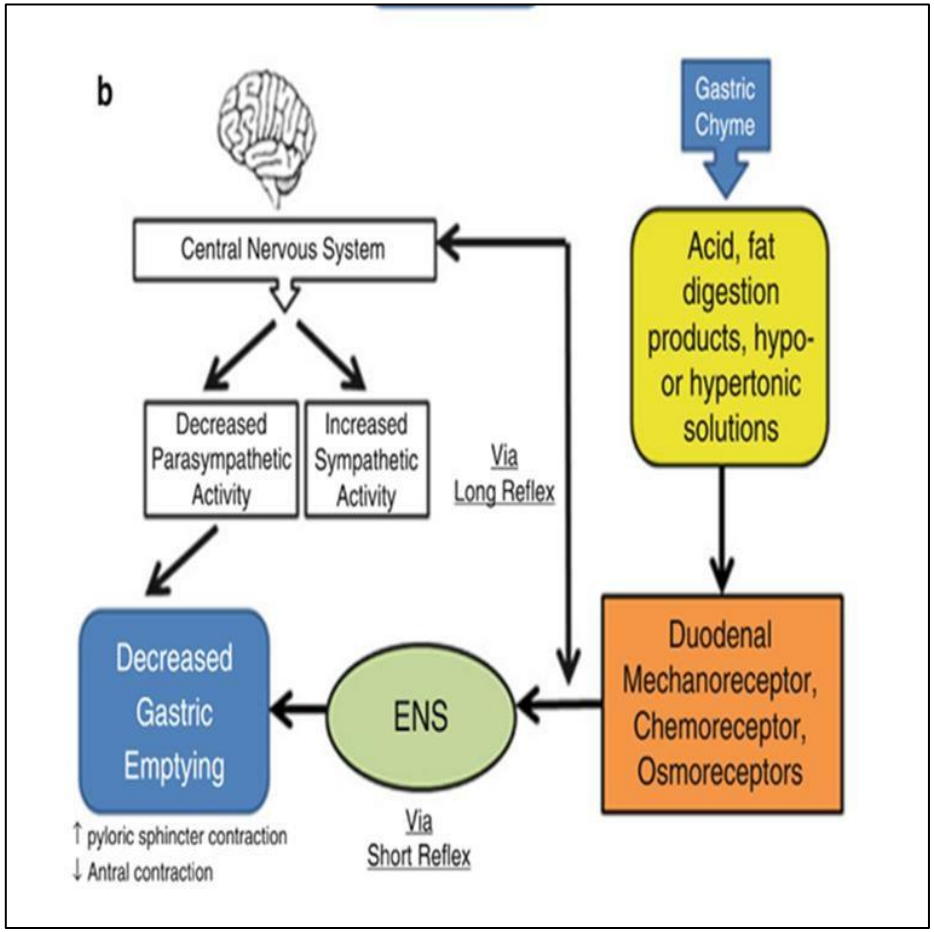
Sheet# 5

Increasing in stomach volume → activation of intrinsic myenteric reflex → pyloric / antral pump → inhibition of pyloric sphincter ==========> More Emptying .

Regulation of Gastric Emptying

Gastric is processed by G cells in the antral mucosa → increasing in peristaltic + contractility → stomach emptying + pyloric sphincter constriction .
This makes it a week factor .





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

Sheet# 6

Motilin is produced by the upper portion of intestinal . It helps empty food remaining in stomach . (MMC peristaltic wave)

Fatty food take the longest time to empty from stomach .

CK has another way to inhibit gastric emptying . It inhibits gastric → Inhibit stomach motility .

Fat & Carbohydrates (the last one is in duodenum) stimulus : GIP (Gastric Inhibitory Peptide) , CCK & Secretin .

Fat is a very good stimulus to inhibit gastric emptying due to it taking the longest time for digesting .

GIP also stimulates insulin secretion

Sheet# 7

Duodenum distention → receptor stimulation.
Food content → osmoreceptors and ph receptors stimulation.
This stimulation of these receptors → intrinsic/extrinsic neuro reflexes.
Intrinsic reflex mediated by myenteric nervous system → Inhibition of gastric emptying .
Long reflex → stimulates sympathetic activity →
X contraction in stomach .
√ Contraction of pyloric sphincters .

Sheet# 8 (Extra Questions)

Pregnancy's Effect on emptying : Normal solid gastric emptying in all stages of pregnancy . Irritation of duodenal mucosa causes less gastric emptying . To prevent toxin (in food) to be absorbed from stomach to duodenum to the blood stream .

Propulsion and Mixing of Food in the Alimentary Tract

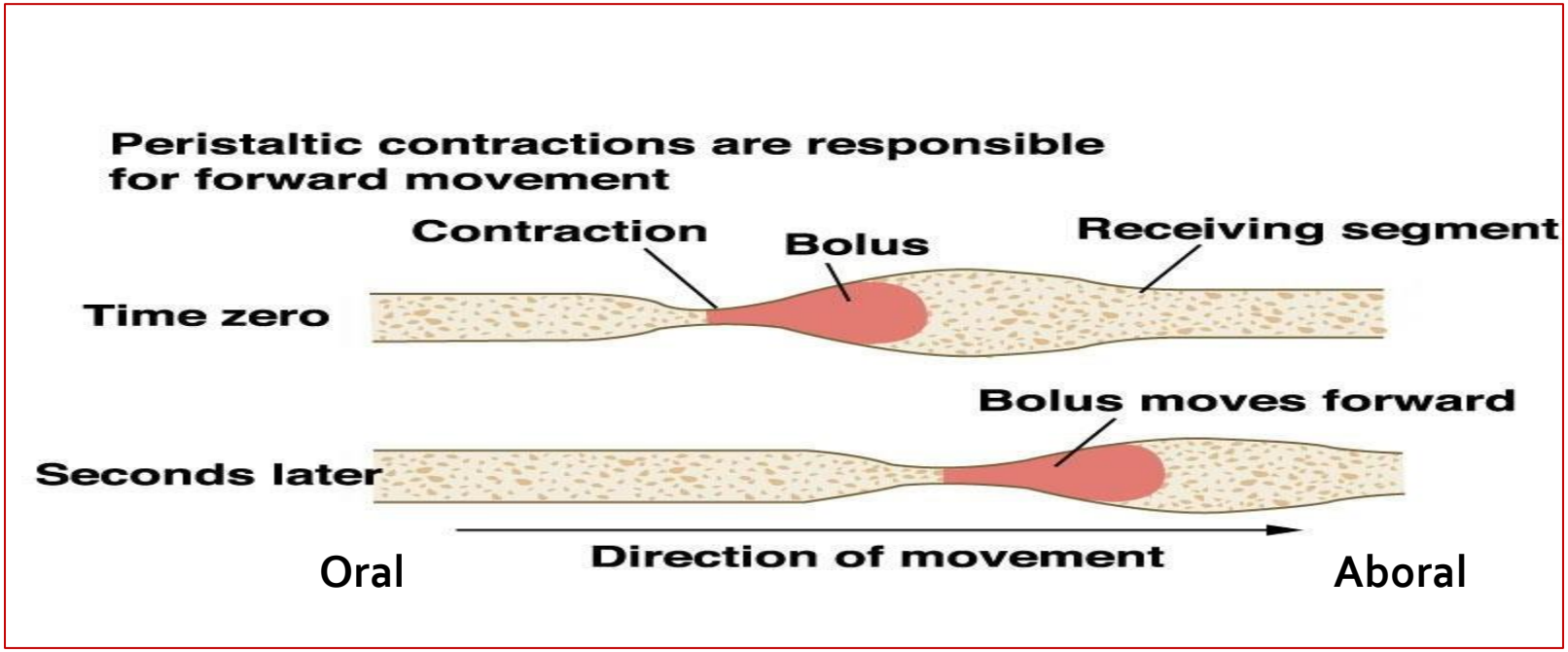
Intestinal Motility

Motility of the small intestine

A- Motor activity in the fed state:

i- Peristalsis:

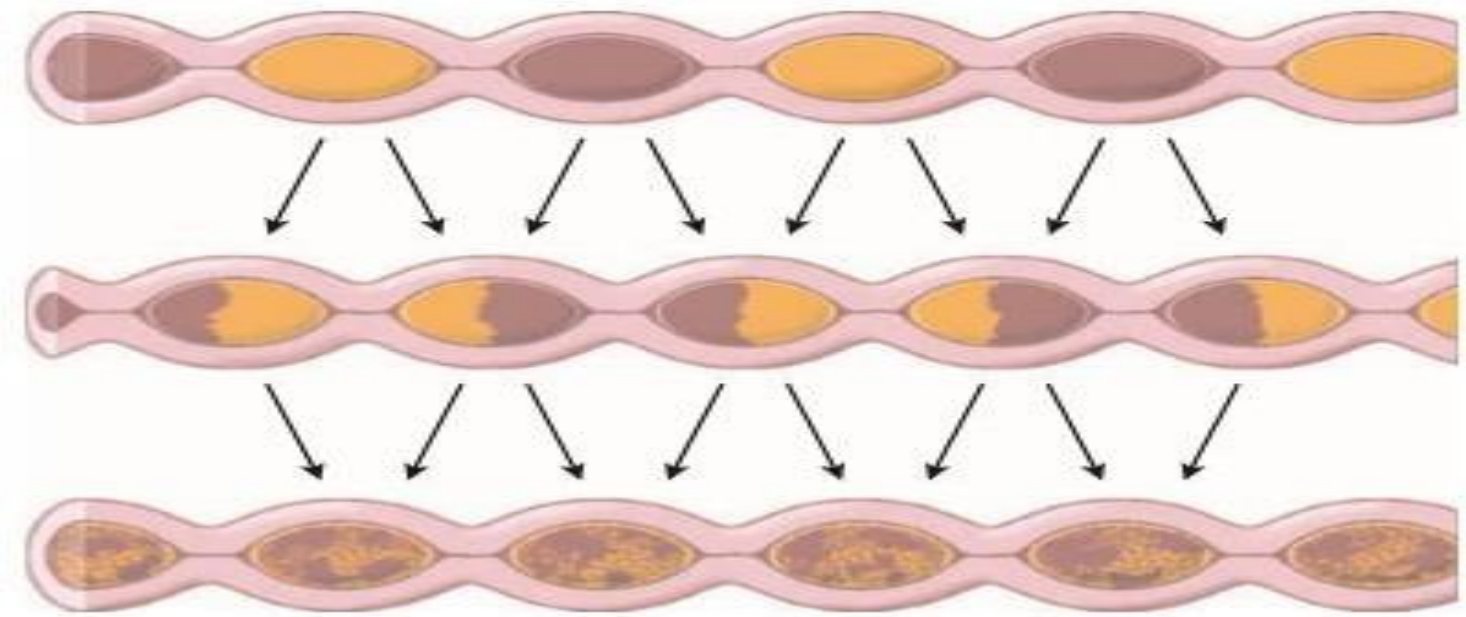
- co-ordinated entirely by the ENS
- net movement along the small intestine normally averages only 1 cm/min
- 3 to 5 hours are required for passage of chyme from the pylorus to the ileocecal valve



Motility of the small intestine

ii- Segmentation or mixing movements:

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



Segmentation : Mixing movement not propulsive movement .

Sheet# 9

Motility in small intestine :

A. Segmentation FED state .

B. Peristaltic move FED state (Enteric nervous system) .

C. MMS later digestive period .

Initiated when any segment undergoes distention . The segment behind distention period .

Intrinsic nervous system → Releasing of excitatory neurotransmitters (acetylcholine among them) which causes the contraction of the segment behind the distention period .

Sheet# 10

The peristaltic wave in small intestine is weak and lasts for 3 – 4 cm . The wave's rate is very small . For the chyme to move from pylorus → end at small intestine (ileocecal valve) . Takes 3 – 4 hours (This gives time for absorption) .

Once chyme reaches ileocecal valve , it gets blocked for hours until the person eats another meal , Why ?

Due to reflex initiated by myenteric plexus + extrinsic autonomic nerve (Sympathetic) .

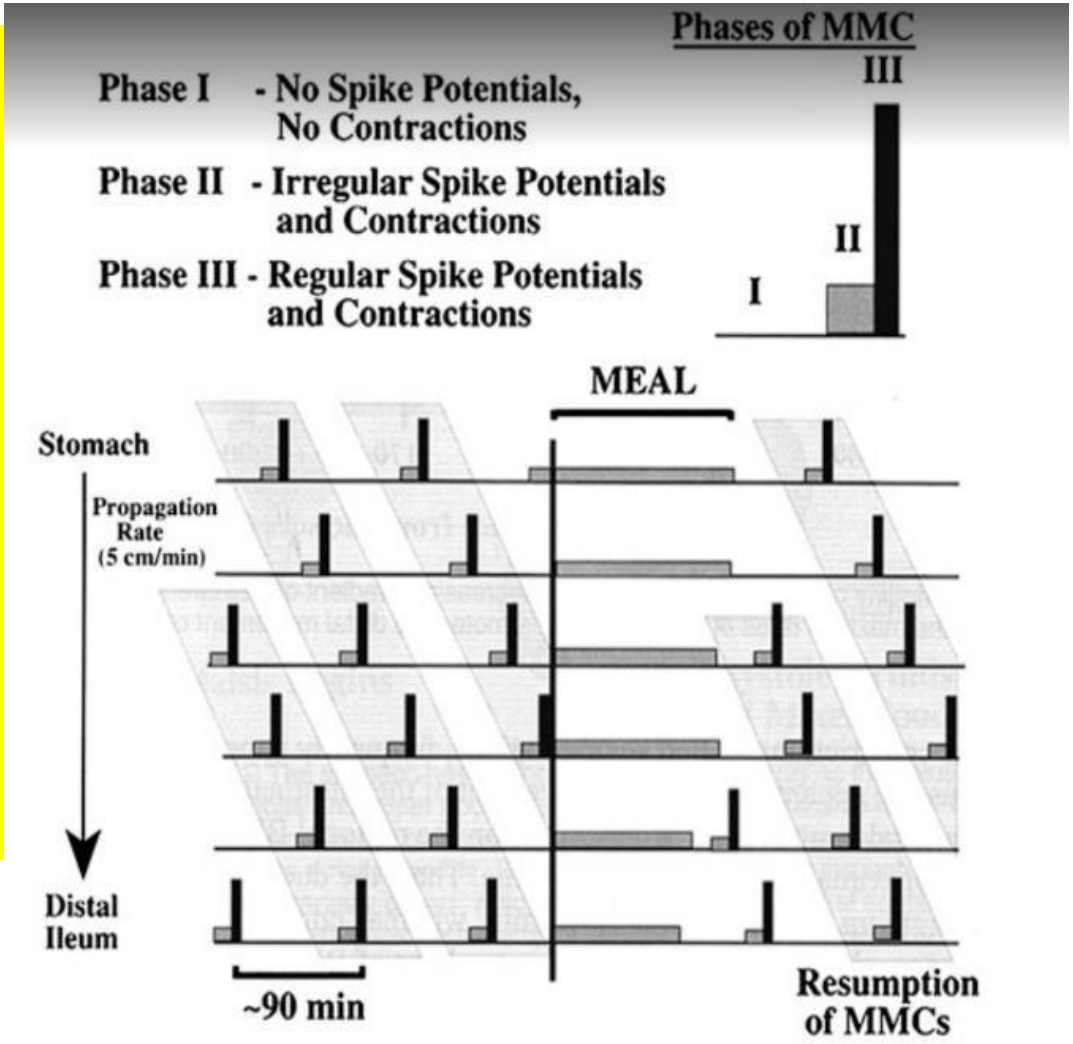
This leads to increase in valve contractility and inhibition of peristaltic wave in ileum .

When the person eats again , a gastroileal reflex starts in the stomach and intensifies the peristaltic wave in ileum + valve relaxation → Emptying of chyme from ileocecal valve to large intestine .

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)



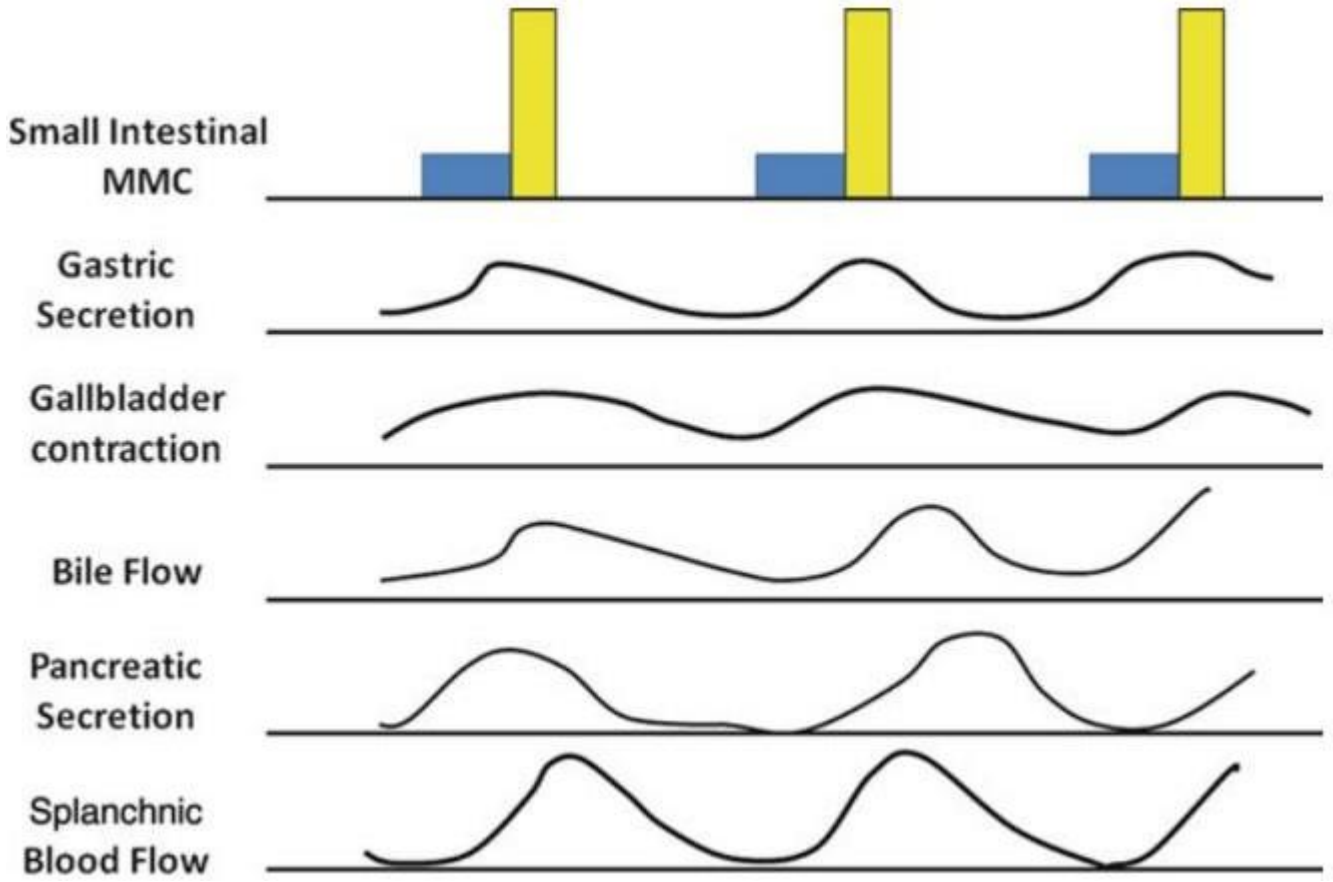
Sheet# 11

MMC : Stomach → Distal ileum .

But sometimes , it is inhibited in duodenum instead of stomach . But mostly , it is the stomach .

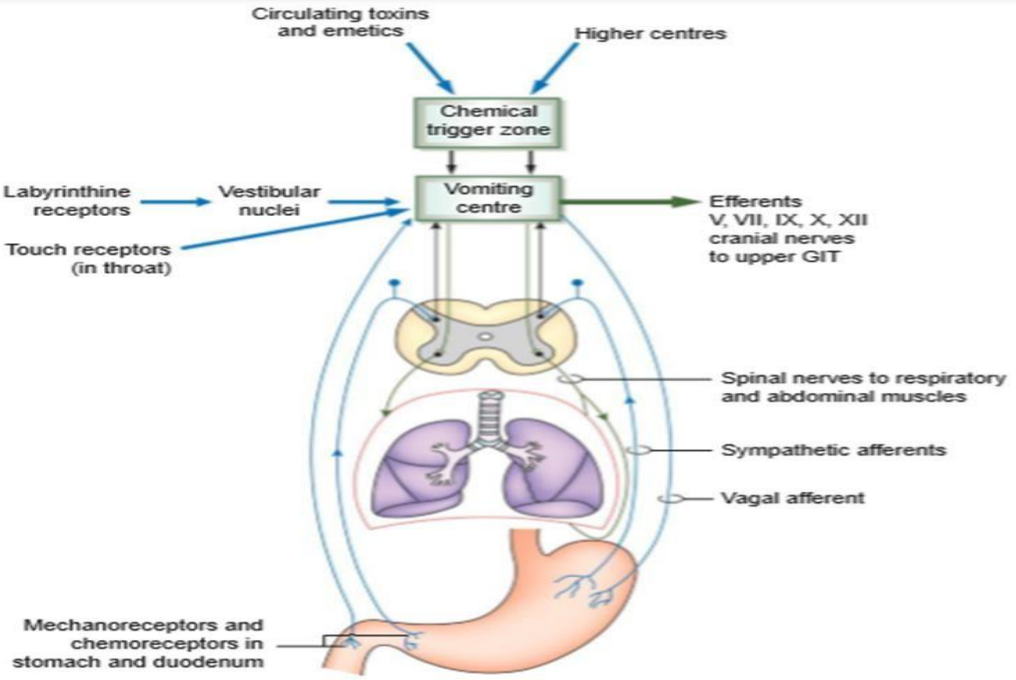
Its function is to clear the stomach and small intestine from food content that remains without being digested to a size of 2 mm .

Myoelectric or migrating motor complex (MMC)



Vomiting (Emesis)

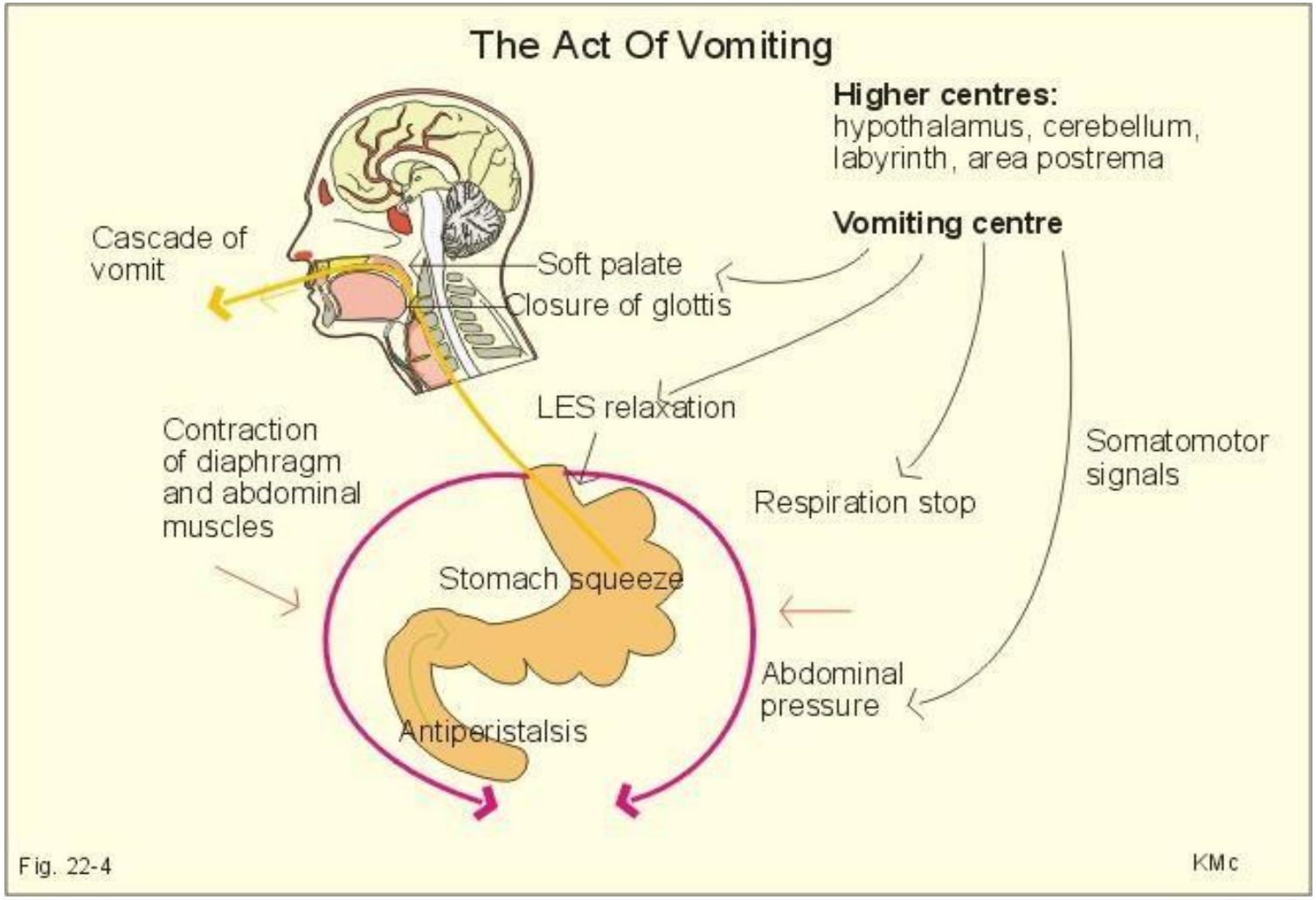
- Vomiting can also be referred to as emesis, and consists of the following stages:
  - Nausea
  - Retching
  - Vomiting
- Vomiting serves as:
  - a protective reflex (acidosis and hypoxia)
  - an important clinical symptom (intracranial tumors.



The mechanisms of emesis can be divided into three components:

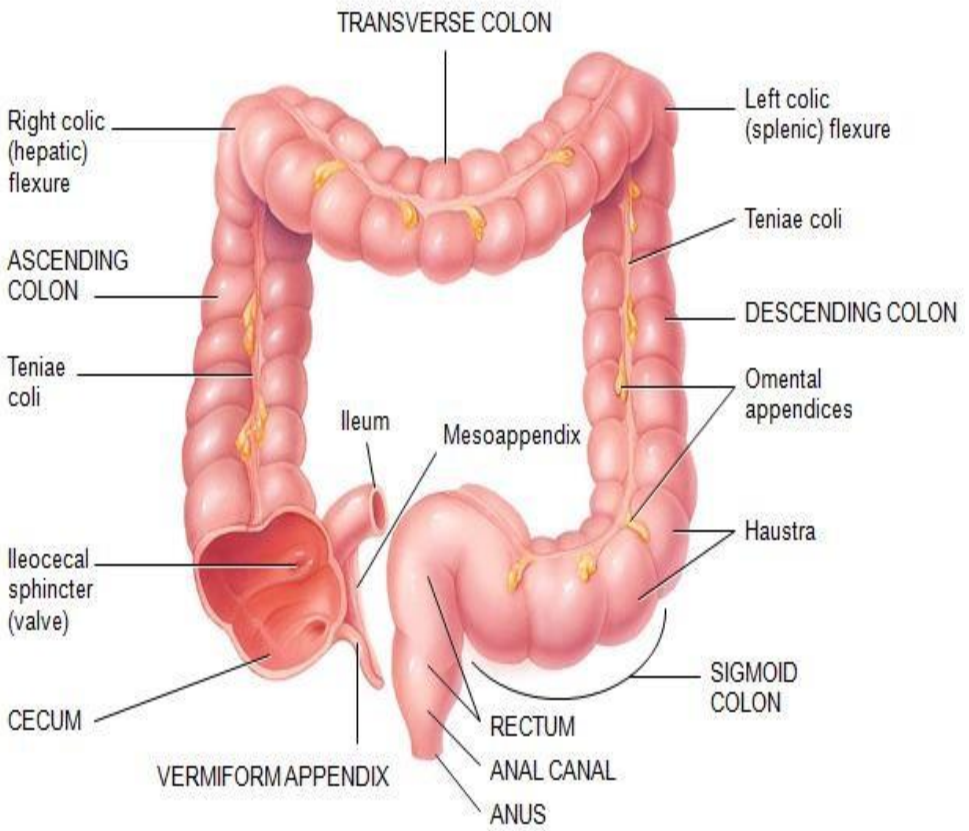
- Afferent inputs
- Central nervous system:
  - chemoreceptor trigger zone (CTZ)
  - integrative vomiting center
- Emetic efferent signals

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