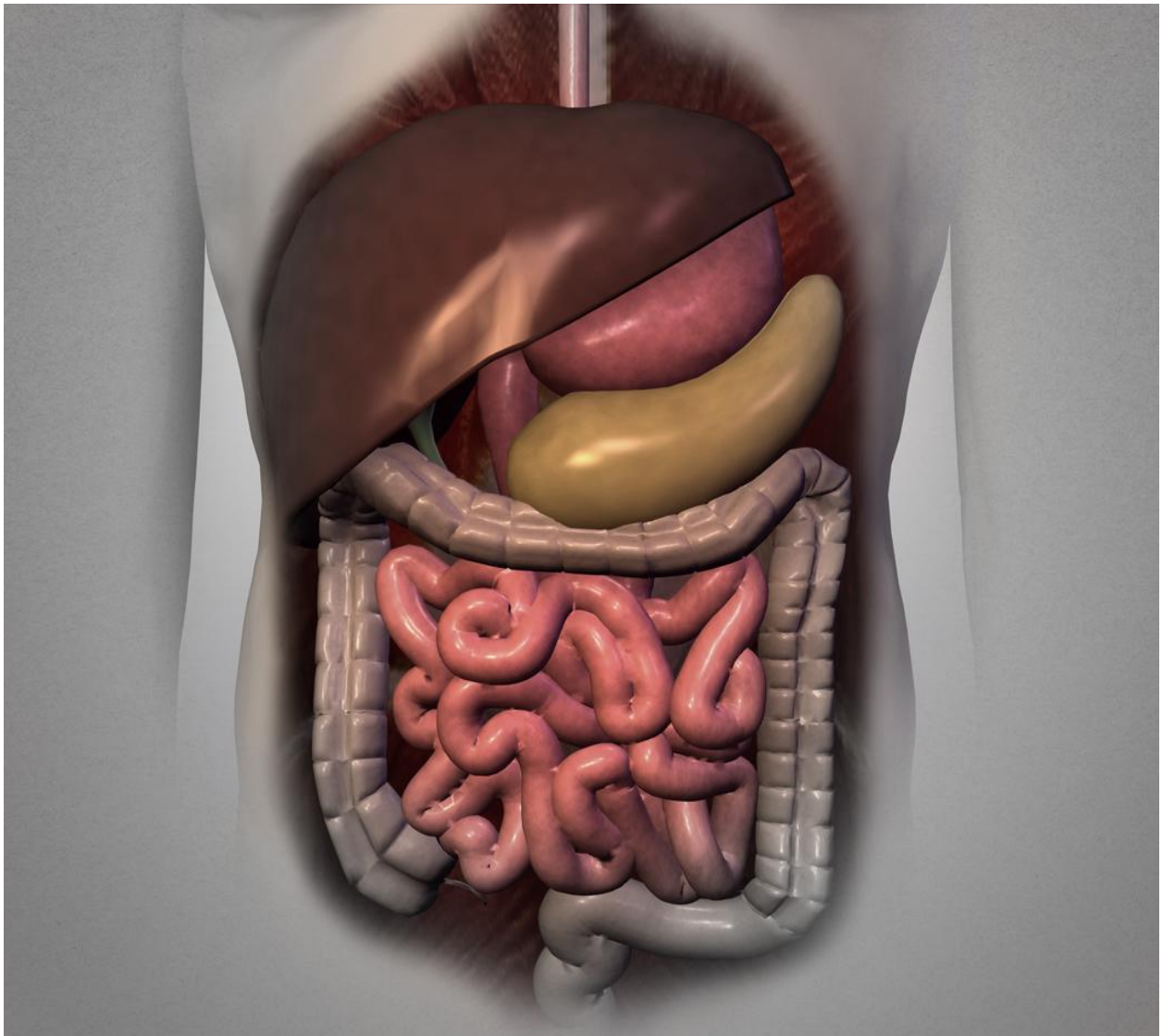

GIT Block

Physiology Team 431

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Physiology of the Stomach & Regulation of Gastric Secretion

Part 2

GREEN: mentioned by doctor
BLUE: team's notes
RED: very important
GREY: not important
Other than that is just a format

➢ Motor functions of stomach:

I. Motor behavior of the upper part of the stomach "Reservoir part":

The main functions of the upper part of the stomach:

1. To maintain a continuous compression (tonic contraction)
2. To accommodate the received food without significant gastric wall distention or pressure (Storage of food).

The stomach can store 0.8-1.5 L of food. Gastric contents may remain unmixed for 1hour in the corpus.

- **Relaxation reflexes in gastric reservoir part:**

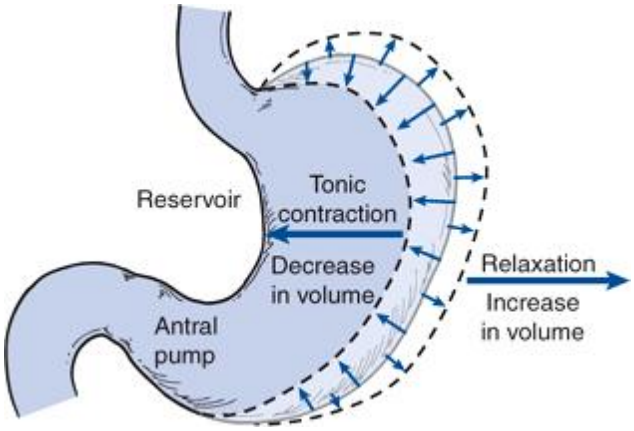
Three Kinds of Relaxation Occur in the Gastric Reservoir: all are vagovagal reflexes

A- Receptive Relaxation Reflex:

•Triggered by swallowing reflex.

•When the esophageal peristaltic waves reach the stomach, a vagovagal reflex is initiated from the stomach to the brain stem and back to the muscular wall of the stomach resulting in reduction in muscular wall tone and the stomach relaxes through inhibition of myenteric neurons which prepares the stomach to receive the food.

•The pressure in the stomach remains low until the volume reaches ~1.5 L of food.

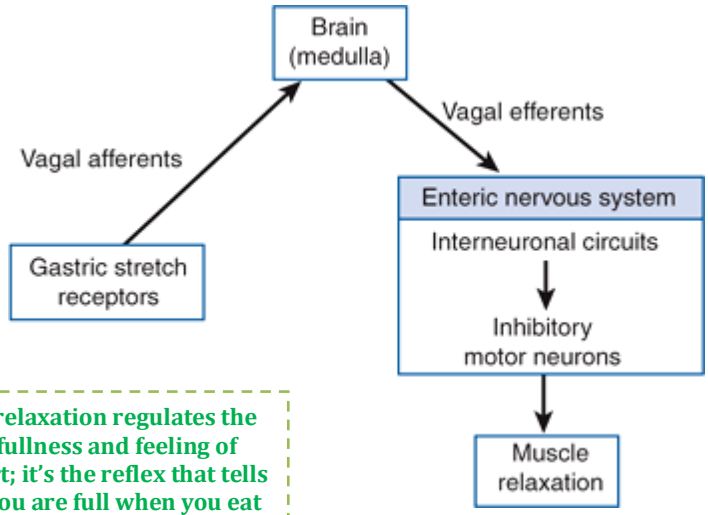


B- Adaptive relaxation:

•Triggered by stretch receptors (vago-vagal reflex).

•Normally, when food stretches the stomach, a "vagovagal reflex" from the stomach to the brain stem and then back to the stomach reduces the tone in the muscular wall of the body of the stomach so that the wall bulges progressively outward, accommodating greater and greater quantities of food up to a limit (0.8 to 1.5 L).

•This reflex is lost in vagotomy.



Adaptive relaxation regulates the feeling of fullness and feeling of discomfort; it's the reflex that tells you that you are full when you eat a lot of food.

C- Feedback Relaxation:

•The presence of nutrients in the small intestine triggers feedback relaxation.

•It can involve both local reflex connections between receptors in the small intestine and the gastric ENS "enteric nervous system" or hormones that are released from endocrine cells in the small intestinal mucosa and transported by the blood to signal the gastric ENS and stimulate firing in vagal afferent terminals in the stomach

II. Motor behavior of the Antral Pump region, "Phasic contraction":

Major mixing activities take place in the antrum:

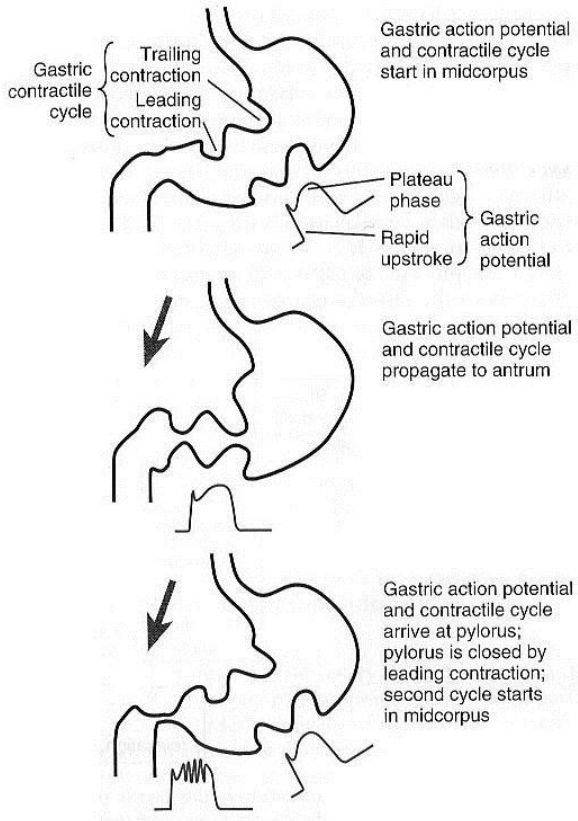
- Contact of gastric chyme with the mucosal surface of the stomach, causes weak peristaltic constrictor waves called mixing waves once every 15-20 sec.
- These waves are initiated by the gut wall basic electrical rhythm of the slow spontaneous electrical waves.

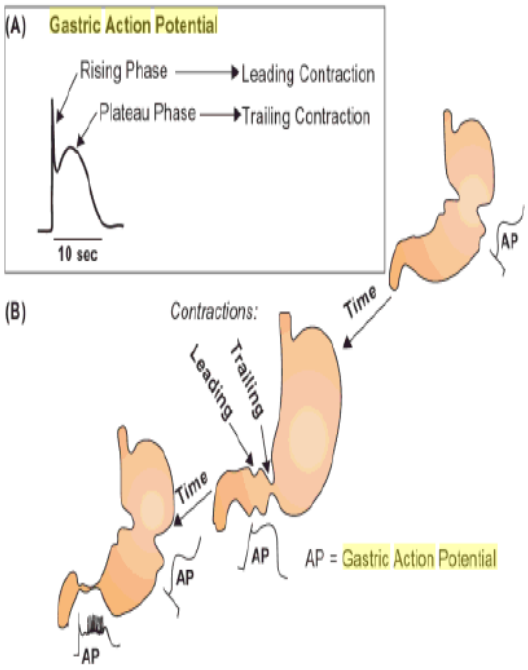
- These waves progress from the body to the antrum and become intense forcing the chyme to mix and move under high pressure from the antrum toward the pylorus.
- Each time a peristaltic wave passes from to the antrum to the pylorus, few millimeters of antral content move into the duodenum through the pyloric sphincter.

➢ Gastric Action potentials:

- Gastric action potentials are initiated at a frequency of 3/min and lasts about 5 seconds . They propagate rapidly around the gastric circumference and trigger a ring-like contraction.
- The action potentials and associated ring-like contraction then travel more slowly toward the gastroduodenal junction.
- Electrical syncytial properties of the gastric musculature account for propagation of the action potentials to the gastroduodenal junction.

Gastric Action Potentials are characterized by an initial rapidly rising upstroke, followed by a plateau phase, and then a falling phase back to the baseline membrane potential





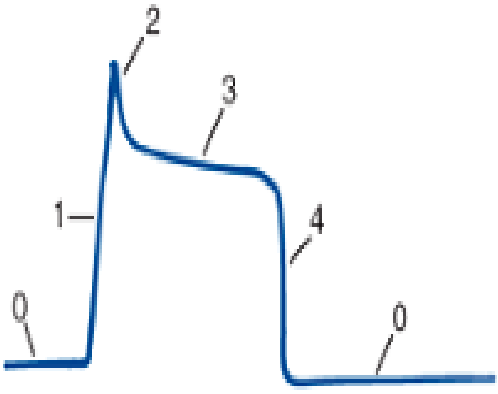
▪ **The gastric action potential triggers two kinds of contractions:**

The gastric action potential is responsible for two components of the propulsive contractile behavior in the antral pump.

(1) A leading contraction, which has relatively constant amplitude, is associated with the rising phase of the action potential

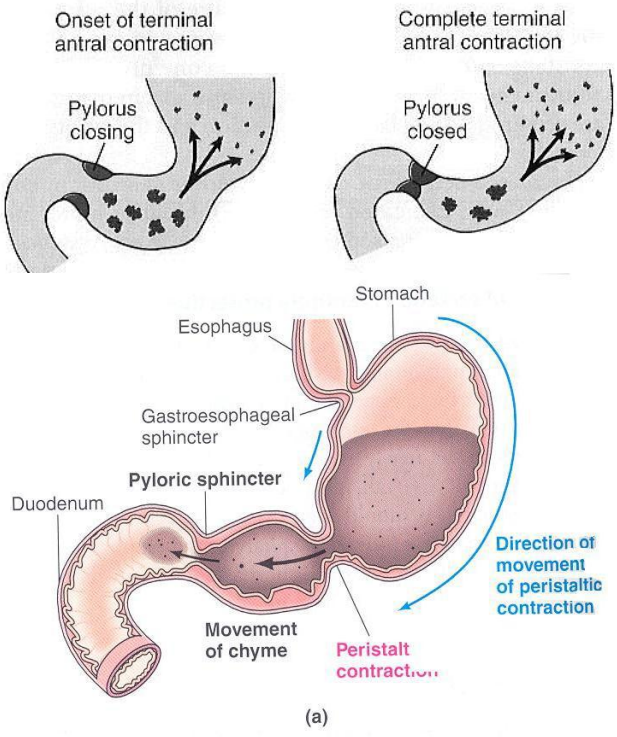
(2) A trailing contraction, of variable amplitude, is associated with the plateau phase.

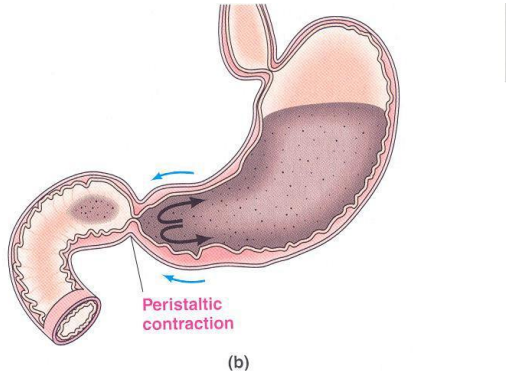
Electrical action potentials in gastrointestinal muscles occur in 4 phases, determined by specific ionic mechanisms.
Phase 0: Resting membrane potential.
Phase 1: Rising phase (upstroke depolarization); activation of voltage-gated Ca^{++} channels and voltage-gated K^{+}channels.
Phase 3: Plateau phase; balance of inward Ca^{++} current and outward K^{+} current.
Phase 4: Falling phase (repolarization); inactivation of voltage-gated Ca^{++} channels and activation of Ca^{++}-gated K^{+}channels.



Retropulsion Phenomena

As the trailing contraction approaches the closed pylorus, the gastric contents are forced into the antral compartment of ever-decreasing volume and progressively increasing pressure. This results in jet-like retropulsion through the pyloric orifice. Repetition at 3 cycles/min reduces particle size from 1-7 mm range that is necessary before a particle can be emptied into the duodenum. These intense peristaltic contractions that cause emptying increase the pressure in the stomach.

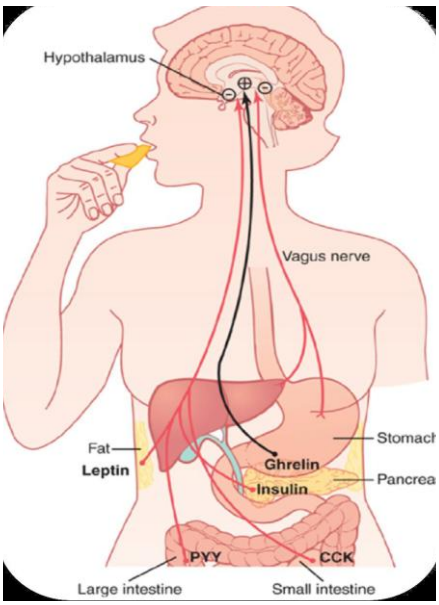




Gastric emptying and mixing as a result of antral peristaltic contraction

Hunger Contractions:

- Hunger contractions occur when the stomach has been empty for several hours.
- These are rhythmical peristaltic contractions that can become very strong and fuse to form a continuing tetanic contraction lasting 2-3 minutes.
- Hunger contractions are intense in young healthy people and increase by low blood glucose levels.
- Hunger pain can begin after 12-24 hr of last food ingestion.



The Migrating Motor Complex

- It is bursts of depolarization accompanied by peristaltic contraction that occur in empty stomach during interdigestive period.
- MMC moves on a long whole length of small intestine to reach ileocaecal valve after 1.5-2 h where it disappears. A new wave of MMC starts.
- The activity of MMC terminates as soon as food is ingested.
- The function of MMC is to sweep remnants in stomach & small intestine into colon.
- **MMC is many waves peristalsis contractions that start at antral pump region and go down along small intestine until reach ilium**
- **usually happen during fasting and regulated by hormone called motilin and inhibited by CCK**

➢ Stomach emptying:

Results from intense peristaltic antral contractions against resistance to passage of chyme at the pylorus.

- **Role of the Pylorus in Controlling Stomach Emptying:**

The pyloric sphincter is characterized by strong circular muscle (as compared to the antrum) and remains tonically contracted most of the time.

Pyloric constriction is determined by nervous and humoral reflex signals from the stomach and the duodenum.

However, during pyloric constriction, watery chyme can still pass through the pylorus into the duodenum, but not food particles.

▪ Regulation of Stomach Emptying

- The rate of stomach emptying is controlled by signals from the duodenum and stomach.
- The signals from the duodenum are far stronger and control emptying of chyme at a rate that allows the proper digestion and absorption in the small intestines. Duodenal factors are more important than gastric factors

▪ Gastric Factors that Promote Stomach Emptying

1. Gastric Food Volume:

An increase in gastric food volume results in increased stretch in the stomach wall which elicits local myenteric reflexes that increase the activity of the pyloric pump and inhibit the tonic contraction of the pyloric sphincter leading to increased stomach emptying.

2. Gastrin Hormone:

Gastrin is released from the antral mucosa in response to the presence of digestive products of meat. Gastrin promotes the secretion of acidic gastric juices from gastric glands located on the inside surface of the body and fundus of the stomach. Gastrin also increases the activity of the pyloric pump and motor stomach function (moderate effect) and probably promotes stomach emptying.

▪ Duodenal Factors That Inhibit Stomach Emptying

1. Enterogastric Nervous Reflexes from the Duodenum:

When food enters the duodenum, multiple nervous reflexes are initiated from the duodenal wall and pass back to the stomach to regulate stomach emptying depending on the volume of chyme in the duodenum.

These duodenal reflexes are mediated by three routes:

(1) Directly from the duodenum to stomach through the enteric nervous system in the gut wall

(2) Through extrinsic nerves that go to the prevertebral sympathetic ganglia and then back through inhibitory sympathetic nerve fibers to the stomach

(3) Through the vagus nerves reflex to the brain stem to inhibit the normal excitatory signals that are transmitted to the stomach through the vagus nerves. These reflexes inhibit the pyloric pump and increase the tone of the pyloric sphincter thus decreasing stomach emptying.

The duodenal factors that can initiate the enterogastric inhibitory reflexes and inhibit stomach emptying include:

(1) Duodenal distention
(2) Duodenal irritation
(3) Duodenal acidity activates S cells to release Secretin which constricts the antrum
(4) Hyperosmotic chyme in the duodenum
(5) Protein content of the chyme in the duodenum.
(6) Fat (monoglycerides) in the duodenum activates different cells to produce CCK and GIP that delay gastric emptying

2. Hormonal Feedback from the Duodenum Inhibits Gastric Emptying – Role of Fats and the Hormone Cholecystokinin.

• Fat entering the duodenum or acidity of chyme or excess quantities of chyme causes the release of cholecystokinin (CCK), and probably other inhibitory hormones such as secretin and gastric inhibitory peptide, (GIP) from the epithelium of the duodenum and jejunum.

•When released, CCK (and probably secretin and GIP) circulates and inhibit the pyloric pump and increase the tone of the pyloric sphincter thus decreasing stomach emptying. CCK also acts as an inhibitor to block increased stomach motility caused by gastrin.

➢ **Summary Constriction of Pyloric Sphincter**

•Hormones

1.Cholecystokinin (CCK)

2.Secretin

3.Glucose-dependent insulinotropic peptide (GIP)

•Sympathetic innervation

Questions

1- √ or X:

-Electrical syncytial properties of the gastric musculature account for propagation of the action potentials to the gastroduodenal junction.

2- Receptive Relaxation Reflex is triggered by:

A- Vago-vagal reflex
B- Stretch receptors
C- Swallowing reflex.

3- Which of the following is the main function of The Migrating Motor Complex:

A- sweeping remnants in stomach into small intestine.
B- sweeping remnants in stomach & small intestine into colon.
C- Both A & B

4- **Migrating Motor Complex is regulated by**

A- Secretin
B- Motilin
C- Gastrin

ANSWERS: 1- √, 2- C, 3-B, 4-B