PROPULSION AND MIXING MOVEMENT OF GIT

1-Ingestion of Food

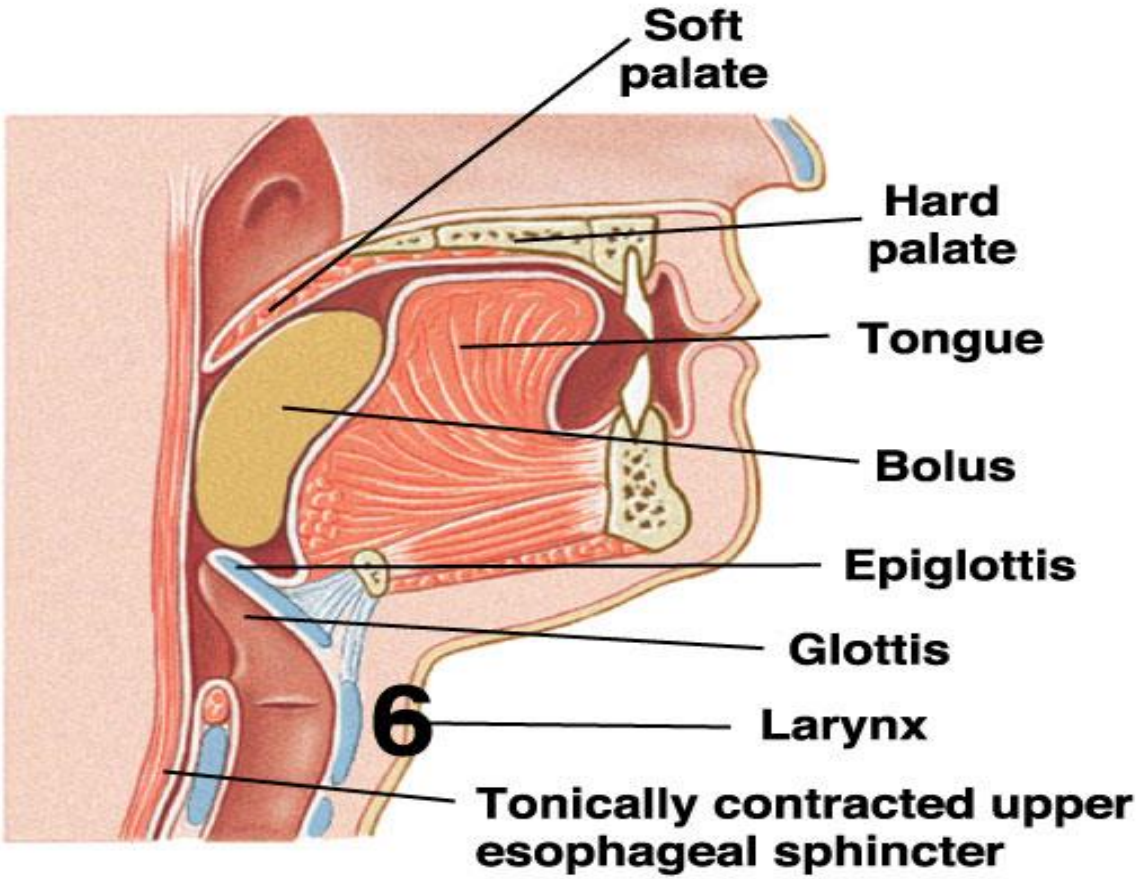
- **Mastication (Chewing) :*chewing reflex***
- ***Swallowing (Deglutition) :***
- ***Buccal Stage (Voluntary Stage)*****which initiates the swallowing process , as tongue pushes the bolus of food to pharynx.**
- ***Pharyngeal Stage*** **which is *Involuntary* and constitutes passage of food through the pharynx into the esophagus.**
- ***Esophageal Stage*** **another *Involuntary* phase that transports food from the pharynx to the stomach.**

Pharyngeal Stage of Swallowing

- **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, the entire process occurring in less than 2 Seconds.**
- ***Afferent nerves*: the sensory portions of the *Trigeminal and Glossopharyngeal* nerves.**
- ***Reflex centre :* The *deglutition* or *swallowing center* in the medulla and lower pons.**
- ***Efferent nerves :* To pharynx and upper esophagus by the *5th, 9th, 10th, and 12th* cranial nerves and even a few of the superior cervical nerves.**

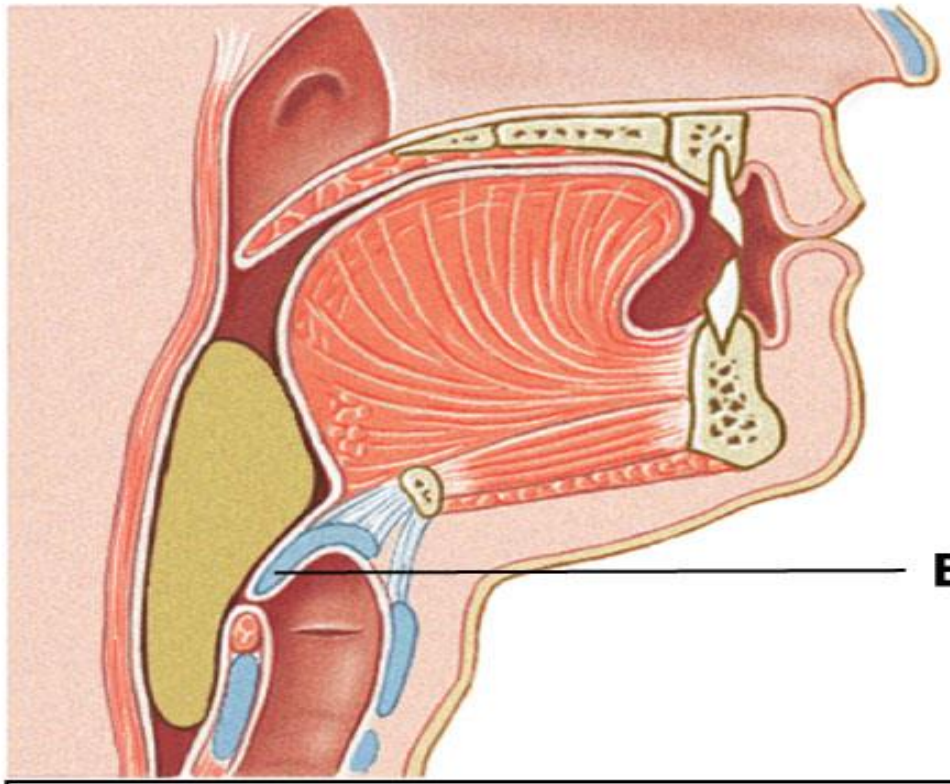
Steps of swallowing

Step 1



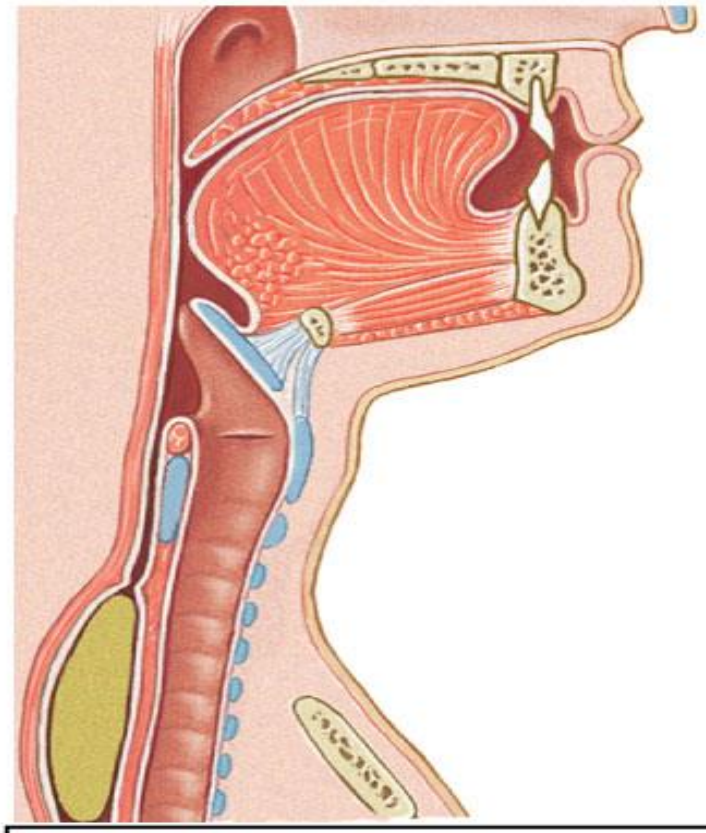
1. Tongue pushes bolus against soft palate and back of mouth, triggering swallowing reflex.

Step 2



2. Upper esophageal sphincter relaxes while epiglottis closes to keep swallowed material out of the airways.

Step 3



3. Food moves downward into the esophagus, propelled by peristaltic waves and aided by gravity.

- **Effect of the Pharyngeal Stage of Swallowing on Respiration.**

- **The entire pharyngeal stage of swallowing usually occurs in *less than 6 seconds,* thereby interrupting respiration for only a fraction of a usual respiratory cycle.**

- **The Swallowing Center specifically inhibits the Respiratory Center of the medulla during this time.**

- ***Esophageal Stage of Swallowing***
- ***Primary peristalsis :*** **is simply continuation of the peristaltic wave that begins in the pharynx and spreads into the esophagus during the pharyngeal stage of swallowing.**
- **This wave passes all the way from the pharynx to the stomach in about 8 to 10 seconds(upright position 5 to 8 seconds).**
- ***Secondary peristaltic waves*** **result from *Distention of the esophagus*** **itself by the retained food , causing stimulation of local axon reflexes**

(Myenteric plexsus) **these waves continue until all the food has emptied into the stomach.**

Receptive Relaxation of the Stomach

- **A wave of relaxation, transmitted through Myenteric inhibitory neurons, precedes the peristalsis.**
- **The entire stomach and, to a lesser extent, even the duodenum become relaxed as this wave reaches the lower end of the esophagus .**
- **Function of the Lower Esophageal Sphincter (Gastro esophageal Sphincter)**
- **This sphincter normally remains tonically constricted with an intraluminal pressure at this point in the esophagus of about 20-*30 mm Hg*, in contrast to the mid portion of the esophagus, which normally remains relaxed.**
- **When a peristaltic swallowing wave passes down the esophagus, there is *"receptive relaxation"* of the LES ahead of the peristaltic wave, which allows easy propulsion of the swallowed food into the stomach. Rarely, the sphincter does not relax satisfactorily, resulting in a condition called *Achalasia.***

stages of swallowing

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2-Motor Functions of the Stomach

Motor functions of the stomach are :

- ***Storage of large quantities*** **of food until the food can be processed in the stomach, duodenum, and lower intestinal tract .**
- ***Mixing of this food with gastric secretions*** **until it forms a semi fluid mixture called *Chyme.***
- ***Slow emptying of the chyme*** **from the stomach into the small intestine at a rate suitable for proper digestion and absorption by the small intestine.**

- ***Secretory Glands :*** **produce digestive enzymes present from Mouth to Terminal ileum.**

- ***Mucus Glands:*** **lubricants from mouth to anus.**

- *Reservoir part*

Fundus + 1/3 corpus

(tonic contraction)

- *Antral pump*

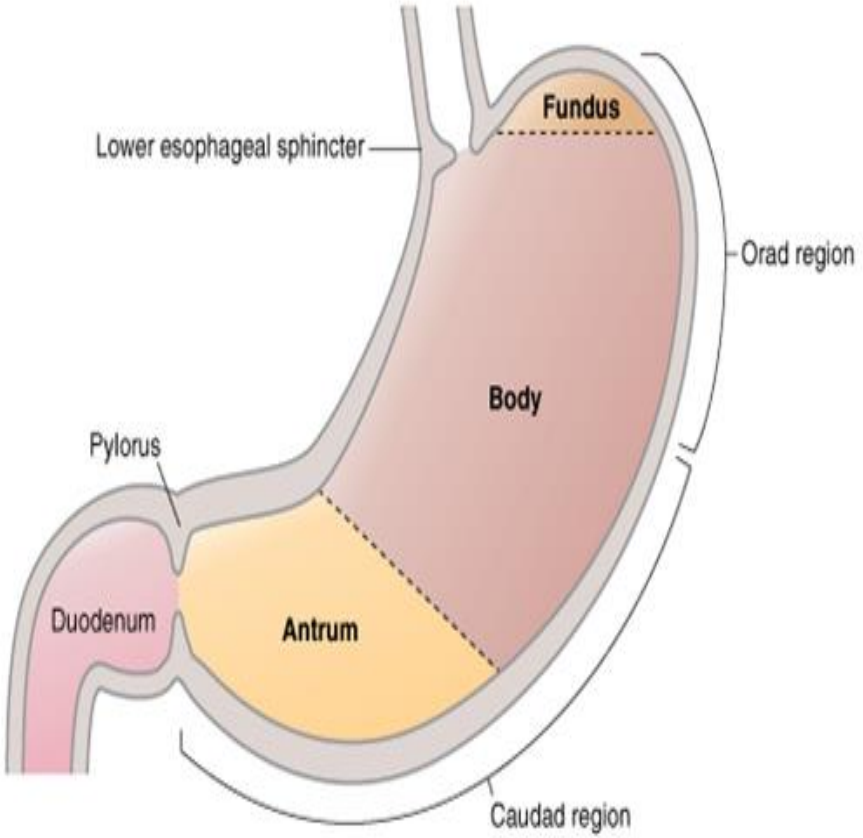
2/3 corpus + antrum & pylorus
(contraction)

- **Physiologically, it is more appropriately divided into**
- *The "Orad" Portion*:

comprising about the first *Two thirds of the body*, **and is thin wall .**

- **The "***Caudad" Portion:* **comprising the remainder**

of the *Body plus the Antrum* **, and is thick wall.**



Relaxation in gastric reservoir

- ***Receptive Relaxation***

  - Triggered by swallowing reflex.

- ***Adaptive Relaxation***

  - Triggered by stretch receptors (vago-vagal reflex) 0.8 to 1.5 liters.

  - lost in vagotomy .

  ⇒ threshold of fullness and pain.

- ***Feedback Relaxation***

  - Triggered by chyme in small intestine.

Storage Function of the Stomach

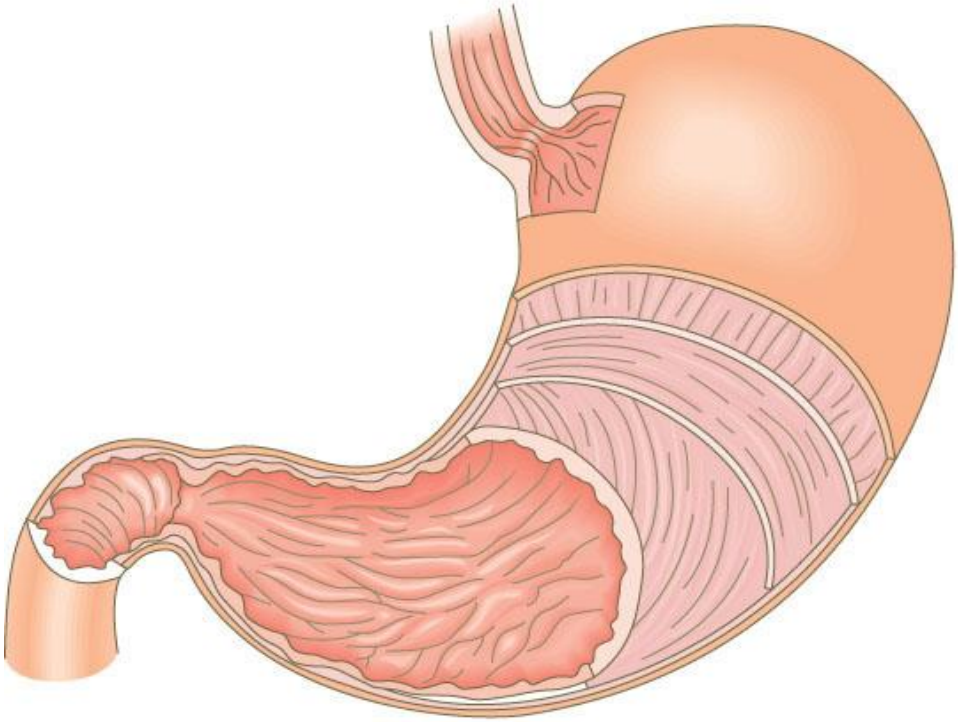
- **As food enters the stomach, it forms concentric circles in the orad portion of the stomach, the newest food lying closest to the esophageal opening and the oldest lying nearest the outer wall of the stomach.**

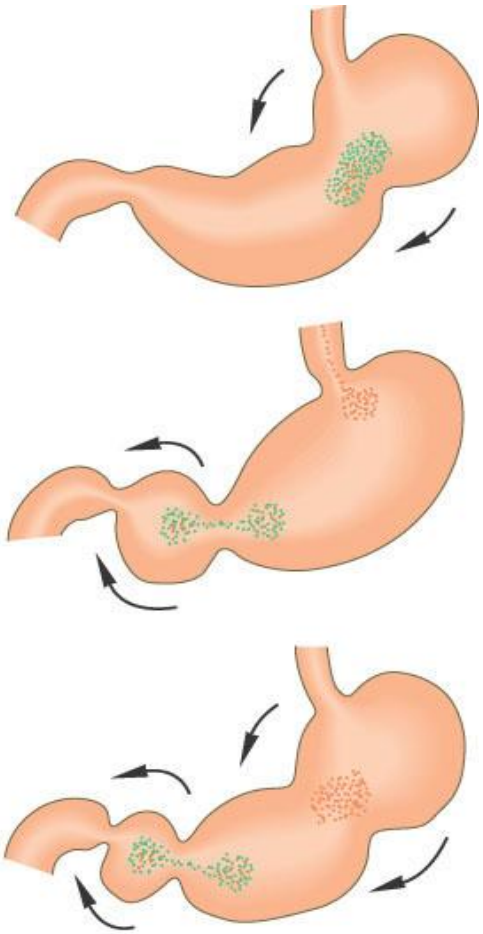
- **Normally, when food stretches the stomach, a *"VagoVagal Reflex"* reduces the tone in the muscular wall of the body of the stomach so that the wall bulges progressively outward, accommodating greater and greater quantities of food up to a limit in the completely relaxed stomach of *0.8 to 1.5 liters.***
- **The pressure in the stomach remains low until this limit is approached.**

Mixing and Propulsion of Food in the Stomach

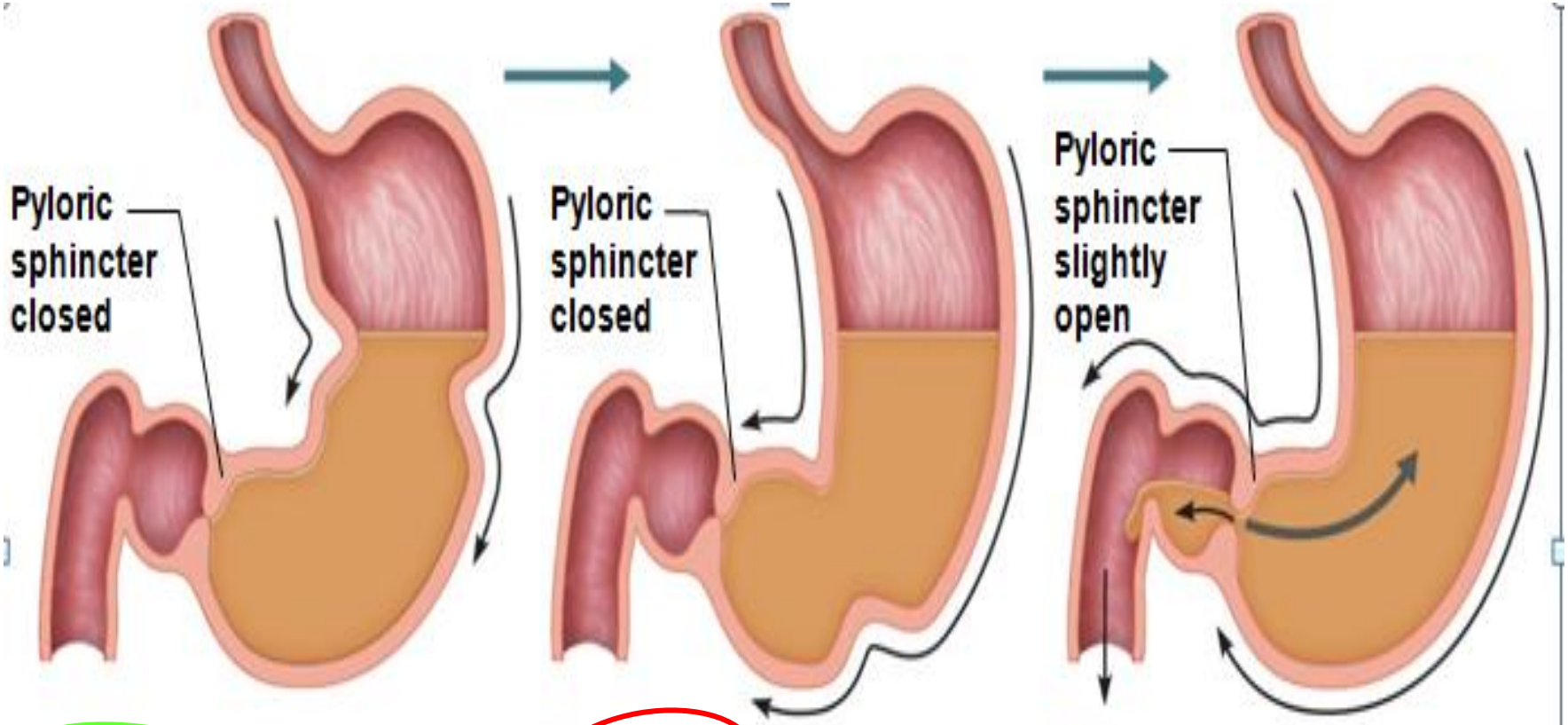
- ***The Basic Electrical Rhythm of the Stomach Wall***
- **As long as food is in the stomach, weak peristaltic *Constrictor Waves* , called *Mixing Waves,* begin in the mid- to upper portions of the stomach wall and move toward the antrum about once every 15 to 20 seconds.**
- **These waves are initiated by the gut wall *Basic electrical rhythm* consisting of electrical "slow waves" that occur spontaneously in the stomach wall.**

- **As the constrictor waves progress from the body of the stomach into the antrum, they become more intense, some becoming extremely intense and providing powerful *peristaltic action potential*–driven constrictor rings that force the antral contents under higher and higher pressure toward the pylorus.**





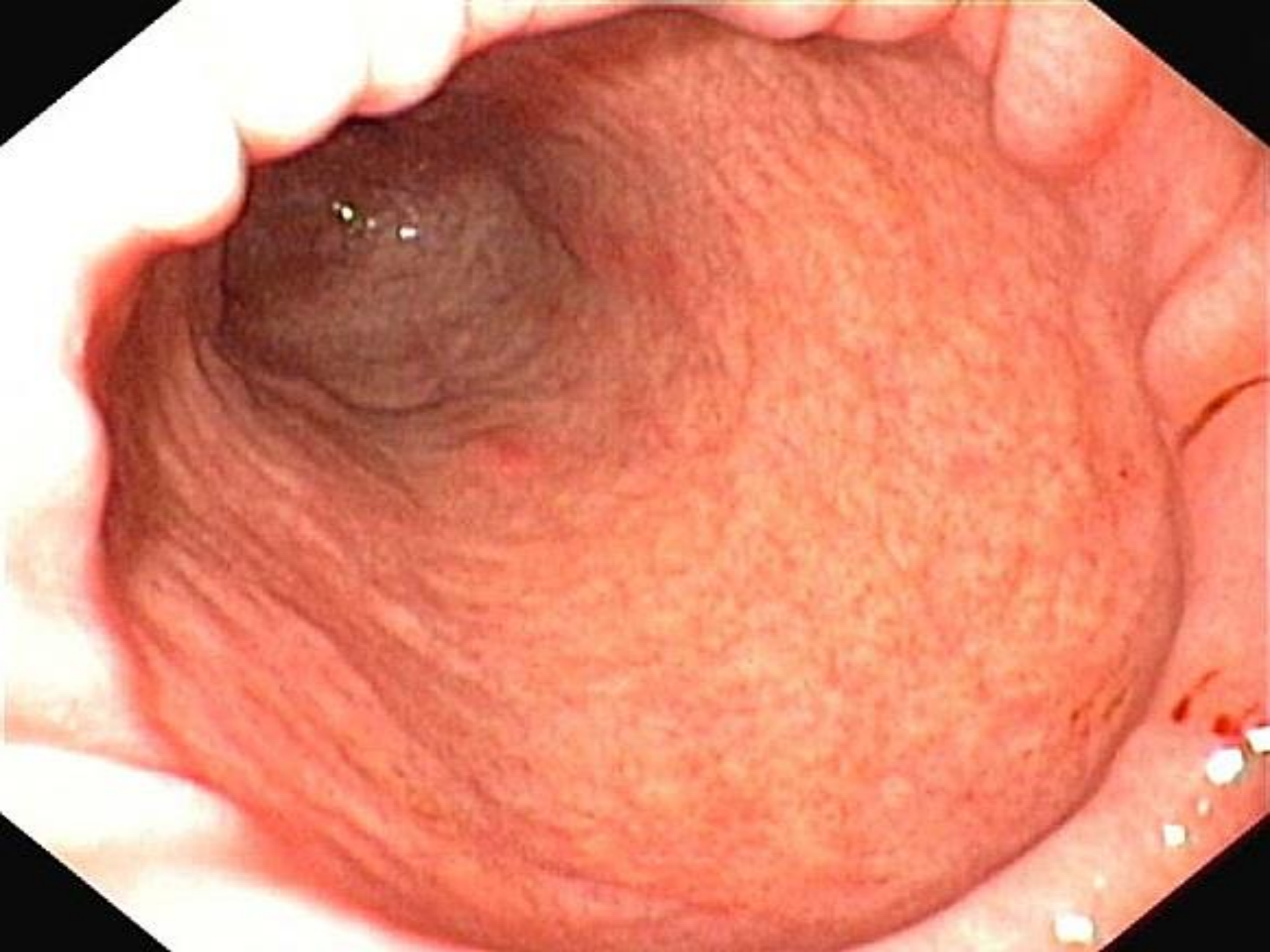
- *These constrictor rings also play an important role in mixing the stomach contents in the following way:*
- **As *peristaltic wave* passes down the Antral wall toward the pylorus, it digs deeply into the food contents in the antrum.**
- **Yet the opening of the pylorus is still small enough that only a few milliliters or less of chyme is expelled into the D1 with each peristaltic wave.**
- **As each peristaltic wave reach the pylorus, the pyloric muscle contracts, which impedes emptying through the pylorus.**
- **So, most of the Antral contents are squeezed upstream through the peristaltic ring toward the body of the stomach, not through the pylorus.**
- *The moving peristaltic constrictive ring, combined with this upstream squeezing action, called "Retropulsion,"* **is an very important *Mixing mechanism* in the stomach.**

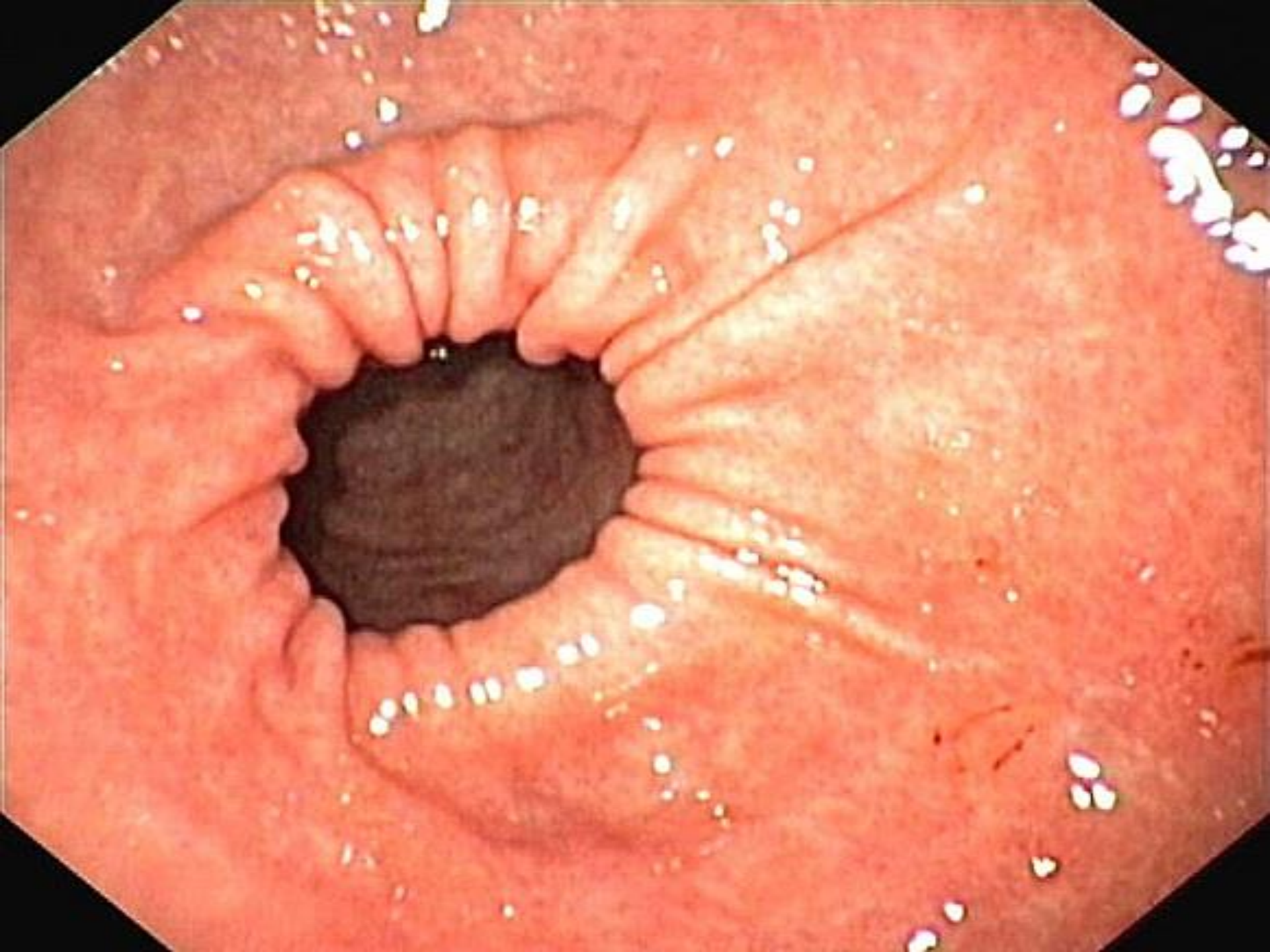


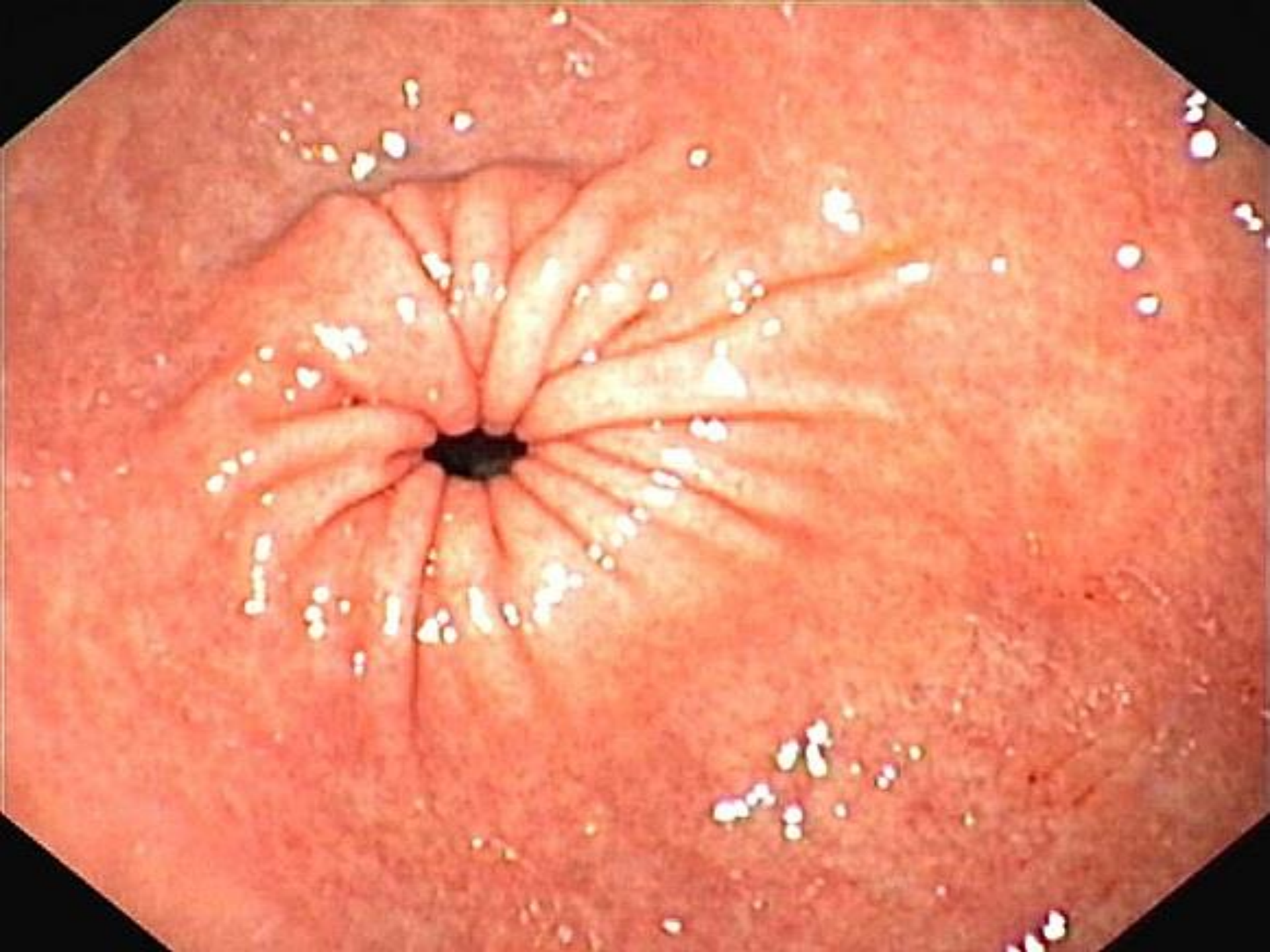
(1) Propulsion: Peristaltic waves move from the fundus to the pylorus.

(2) Grinding: The most vigorous peristalsis and mixing action occur close to the pylorus.

(3) Retropulsion: The pyloric end of the stomach pumps small amounts of chyme into the duodenum, while simultaneously forcing most of its contents backward







- ***Chyme:*** **After food in the stomach has become thoroughly mixed with the stomach secretions, the resulting mixture that passes down the gut is called Chyme.**
- **The degree of fluidity of the chyme depends on the relative amounts of food, water, and stomach secretions and on the degree of digestion that has occurred.**
- **The appearance of chyme is that of a *Murky Semifluid or Paste.***

Stomach Emptying is due to

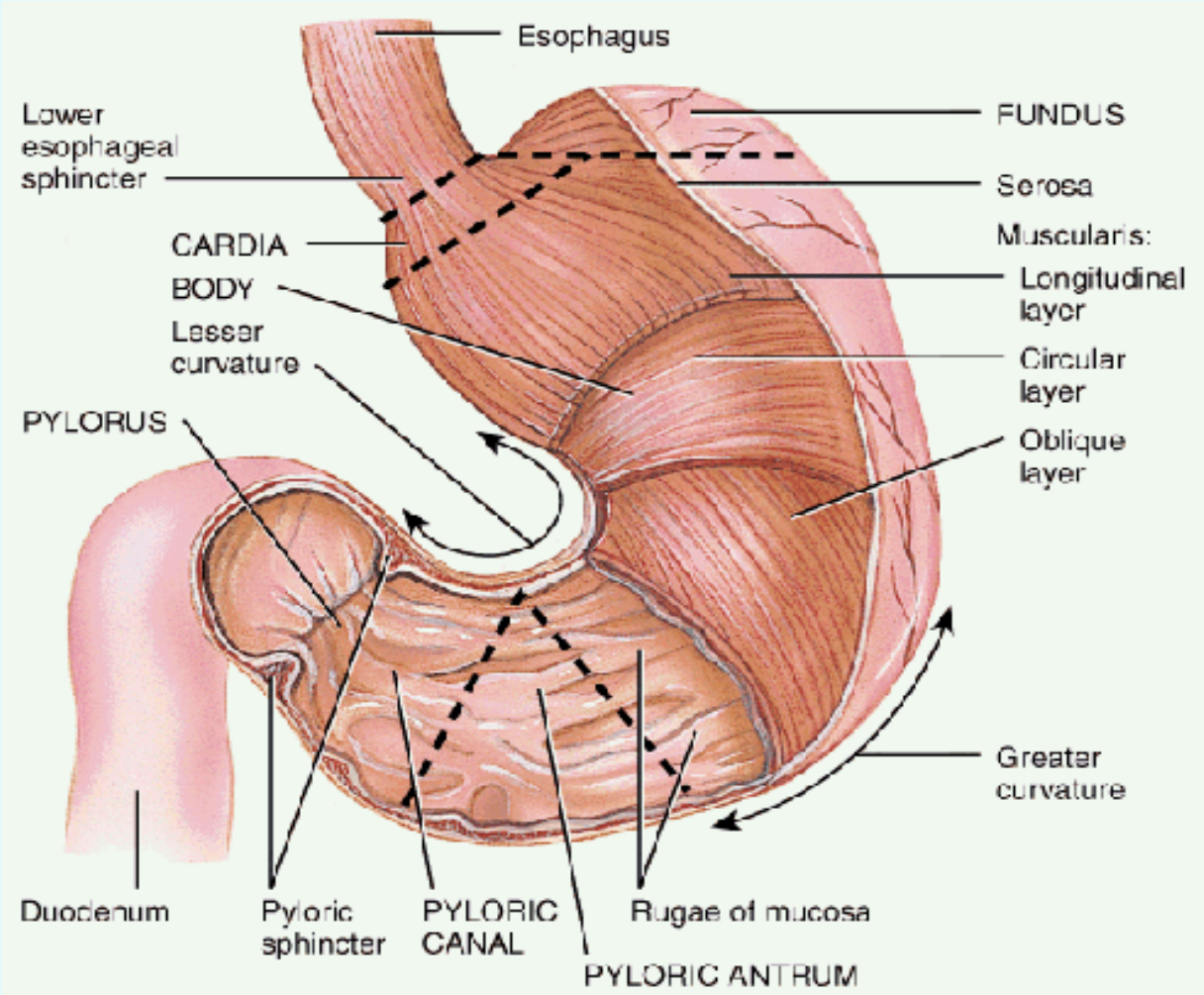
- **Intense Antral Peristaltic Contractions *"Pyloric Pump."***
- **Role of the Pylorus in Controlling Stomach Emptying**
  - **Despite normal tonic contraction of the pyloric sphincter, the pylorus usually is open enough for water and other fluids to empty from the stomach into the duodenum with ease.**
  - **Conversely, the constriction usually prevents passage of food particles until they have become mixed in the chyme to almost fluid consistency.**

EMPTYING OF THE STOMACH (PYLORIC PUMP)

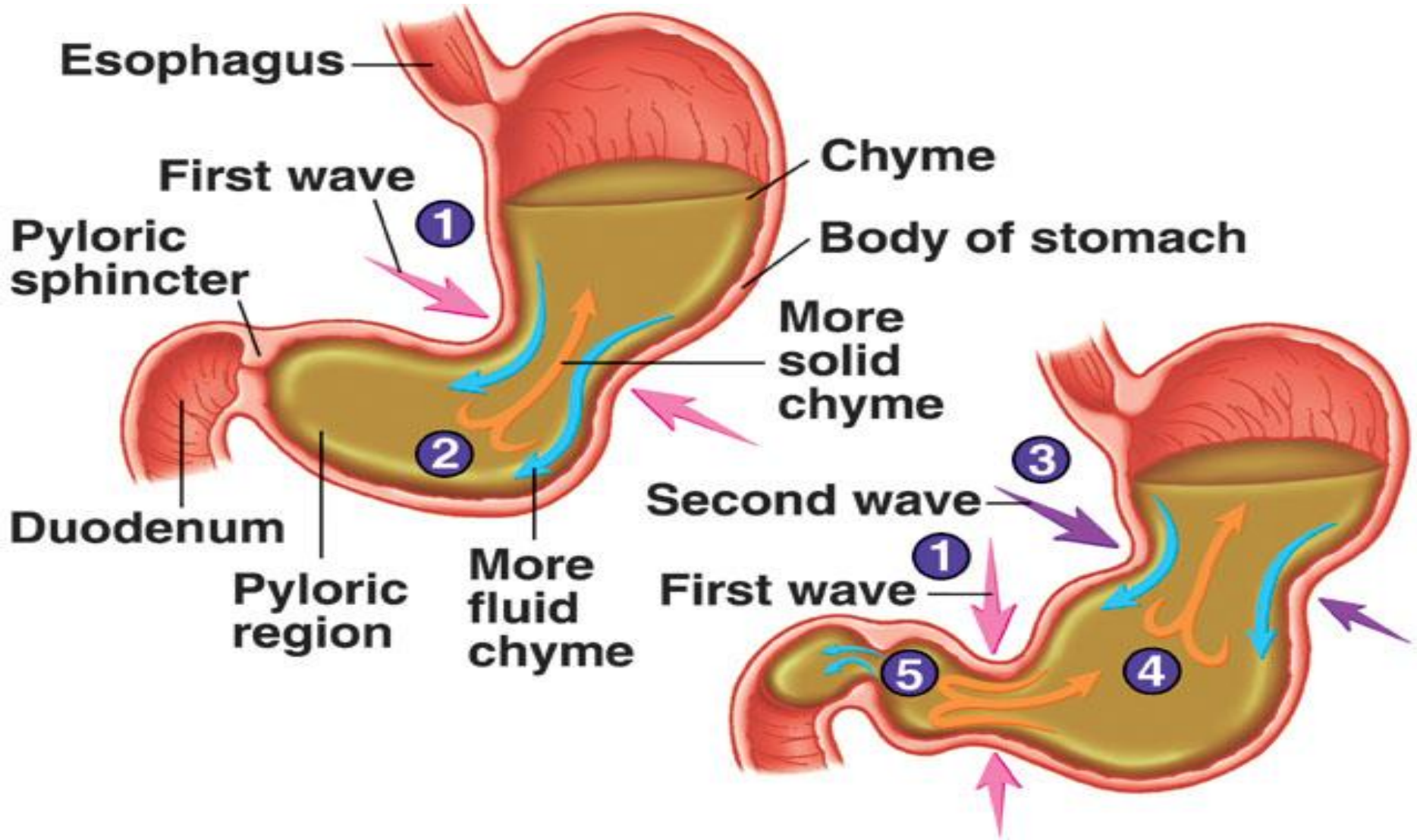
Peristalsis

+

relaxation of pyloric sphincter



(a) Anterior view of regions of the stomach


Esophagus
First wave
1
Pyloric sphincter
Chyme
Body of stomach
More solid chyme
2
Duodenum
Pyloric region
More fluid chyme
3
Second wave
1
First wave
5
4

Regulation of Stomach Emptying

Gastric Factors That Promote ↑ Emptying:

- **Effect of *Gastric Food Volume* on Rate of Emptying.**

(Stretching of stomach produce local axon reflex which stimulate contraction of wall and inhibition of pyloric sphincter)

- **Effect of the *Hormone Gastrin* ↑ Stomach Emptying by increase contractility of antrum muscles.**

Powerful Duodenal Factors That *Inhibit* Stomach Emptying

A-*Inhibitory* Effect of *Entero Gastric Nervous Reflexes* from the Duodenum

- **Multiple nervous reflexes are initiated from the duodenal wall:**
  - **Directly from the D1 to the stomach through *ENS* in the gut wall.**
  - **Through *Extrinsic Nerves* that go to the prevertebral sympathetic ganglia and then back through *inhibitory sympathetic nerve .***

All these parallel reflexes have two effects on stomach emptying:

- **First, they strongly *Inhibit the "pyloric pump" propulsive contractions.***
- ***Second, they increase the tone of the pyloric sphincter.***

Factors that initiate Entero Gastric *Inhibitory Reflexes* include the following:

- **The degree of *Distention* of the duodenum .**
- **The presence of any degree of *Irritation* of the duodenal mucosa.**
- **The degree of *Acidity* of the duodenal chyme.**
- **The degree of *Osmolality* of the chyme.**
- **The presence of certain breakdown products in the chyme, especially breakdown products of *Proteins and, perhaps to a lesser extent, of fats.***

***These factors become strongly activated within as little as 30 seconds*.**

B-Hormonal Feedback from the Duodenum Inhibits Gastric Emptying-Role of Fats and the Hormone *Cholecystokinin.*

C-Other possible inhibitors of stomach emptying are the hormones *Secretin and Gastric inhibitory peptide (GIP).*

- **These feedback inhibitory mechanisms work together to slow the rate of emptying when**
- **(1) *Too much chyme* is already in the small intestine or**
- **(2) the chyme is *Excessively Acidic*, contains too much unprocessed protein or fat, is hypotonic or hypertonic, or is irritating.**

Stomach emptying

Gastric factors

VE + + + + +

1- volume of gastric contents

2- gastrin hormone.

Duodenal factors

Ve - - - - -

1 Entero gastric reflex

2 hormones :

CCK ,GIP, Secretin somatostatin

Others

1 chemicals

2 autonomic

Sympathetic and parasymp.

3-emotions

4-consistency

&type of food

Hunger contraction

In empty stomach

Strong peristalsis in the body
after 12-24 h of last meal
Reach its max. 3-4 days
Due to hypoglycemia

If very Strong Fuse Tetanic contraction

“Hunger pain”

3-Movements of the Small Intestine

- ***Mixing Contractions (Segmentation Contractions)***

- **It is the slow waves in the smooth muscle itself that cause the segmentation contraction, (Myogenic) these contractions are not effective without background excitation mainly from the Myenteric nerve plexus.**

- ***Propulsive (Peristalsis)Movements(progression and spread out of chyme)***

0.5 to 2.0 cm/min faster in the proximal intestine and slower in the terminal intestine. (1 cm /min).

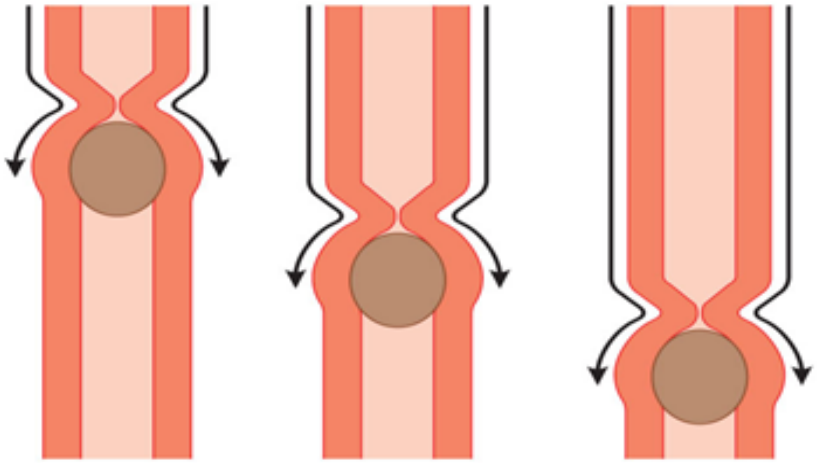
Food need 3-5 h transient time in small bowel

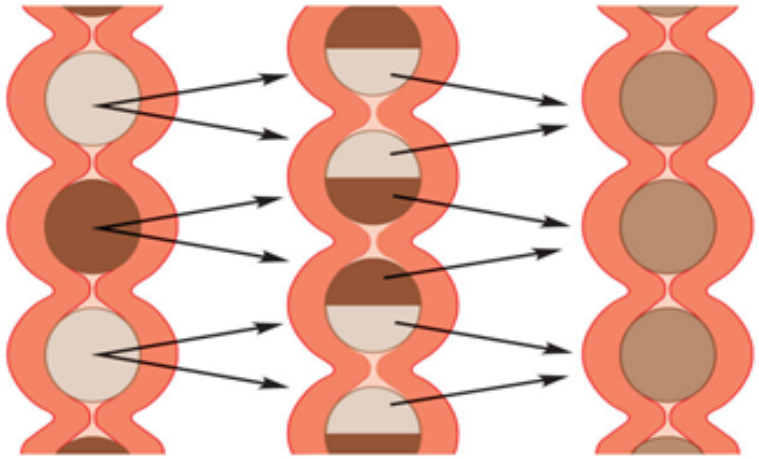
- **Control of Peristalsis by Nervous and Hormonal Signals**

Control of Peristalsis by Nervous and Hormonal Signals

- Peristaltic activity is ↑ after meal.
  Stretch of small bowel by chyme ↑ peristalsis.
- Gastro-enteric reflex ↑ Peristaltic activity in SB.
- Hormones gastrin , Motilin ,CCK ,Insulin ↑ Peristalsis
- Secretin and glucagon ↓ peristalsis.

site	Frequency of BER
Stomach	3/min
Duodenum	12/min
Distal ileum	8/min
Cecum	9/min
sigmoid	3 /min

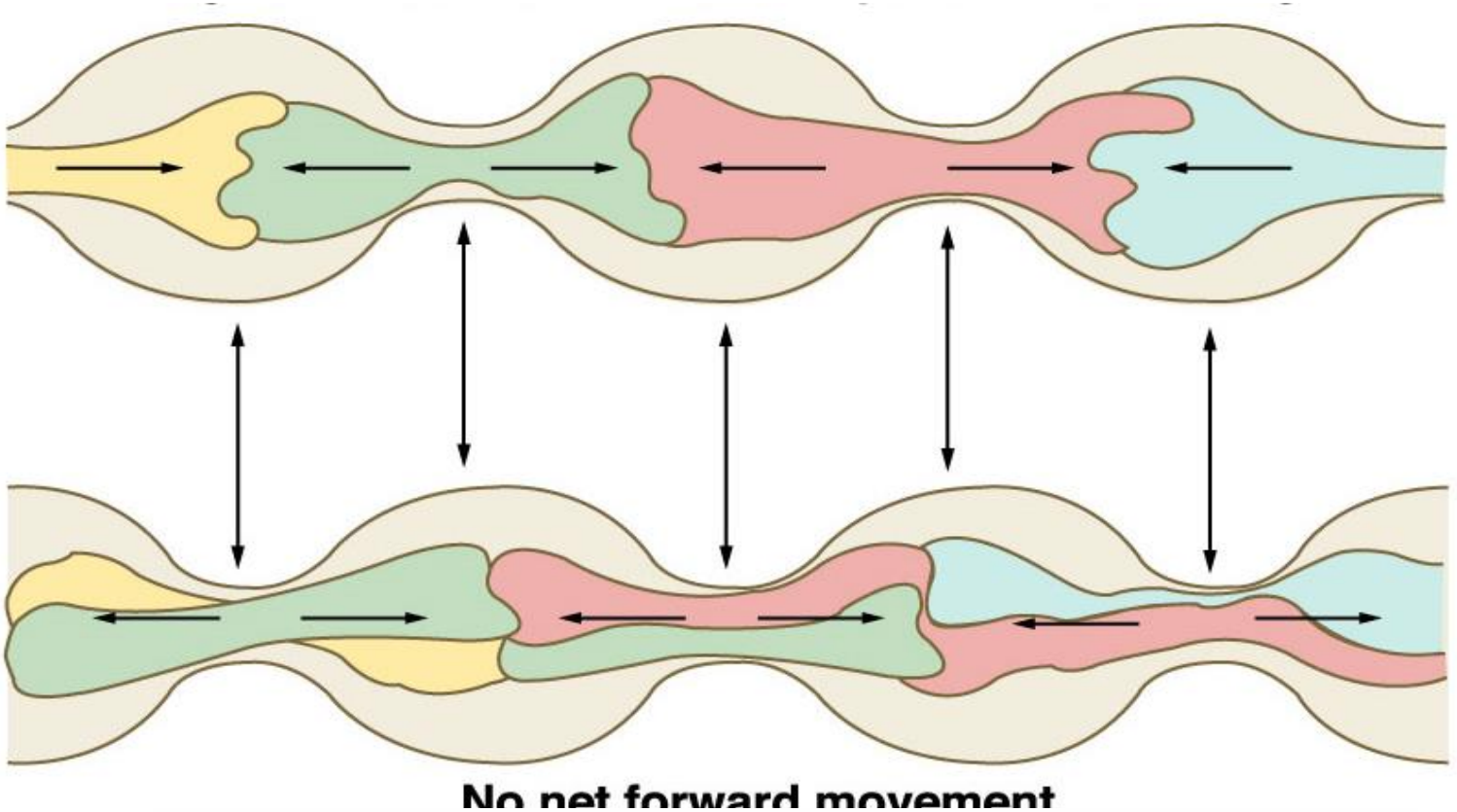


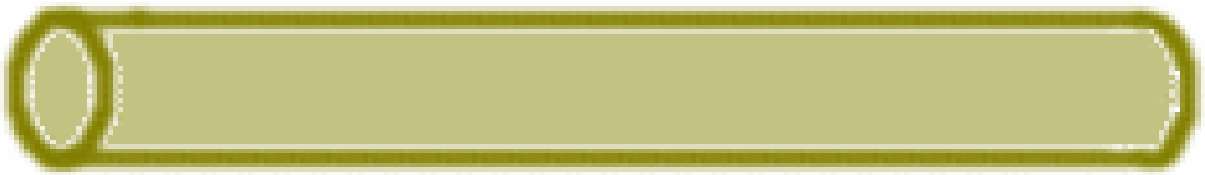


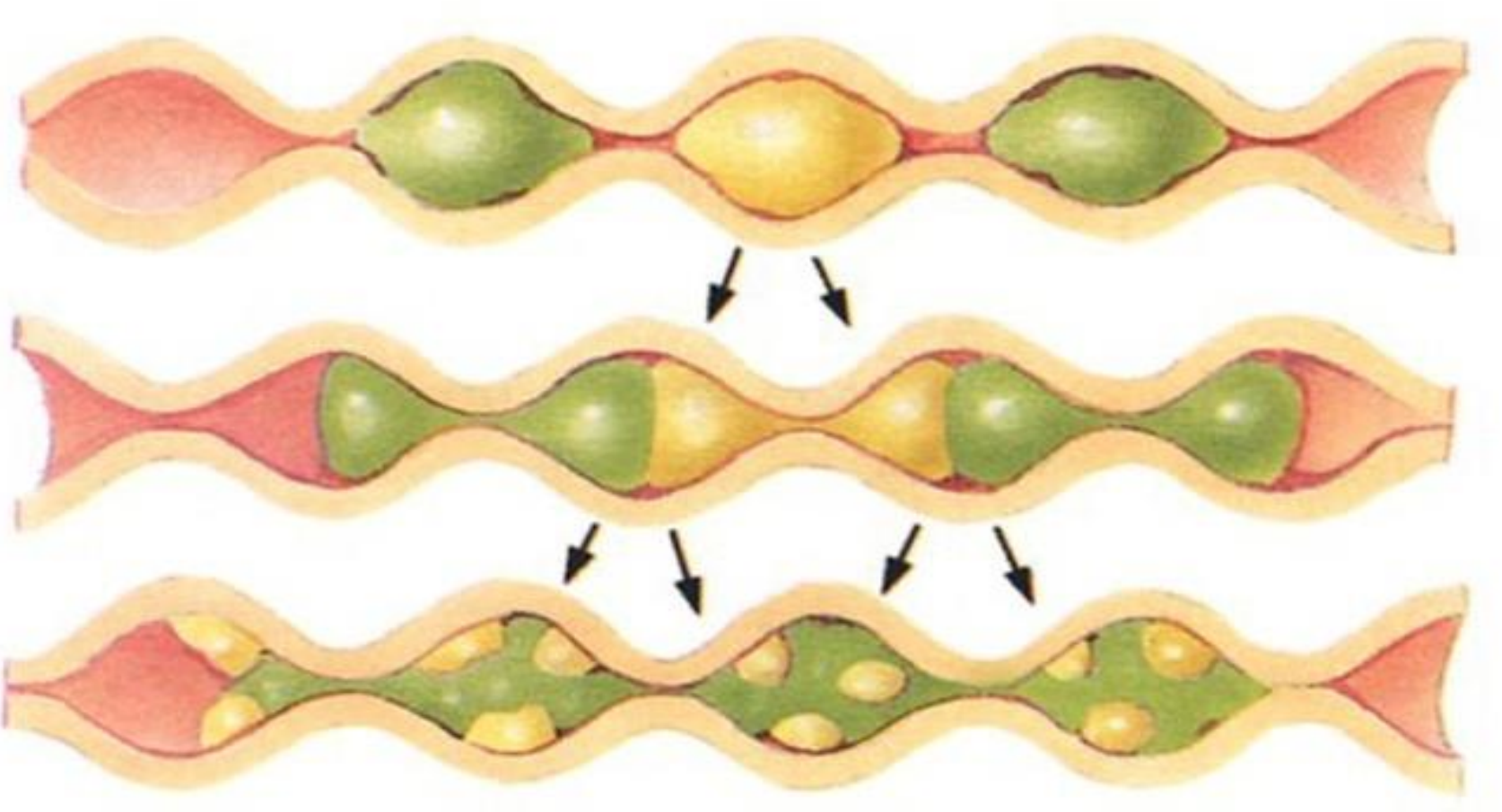
Peristalsis: Adjacent segments of alimentary tract organs alternately contract and relax, which moves food along the tract distally.

Segmentation: Nonadjacent segments of alimentary tract organs alternately contract and relax, moving the food forward then backward. Food mixing and slow food propulsion occurs

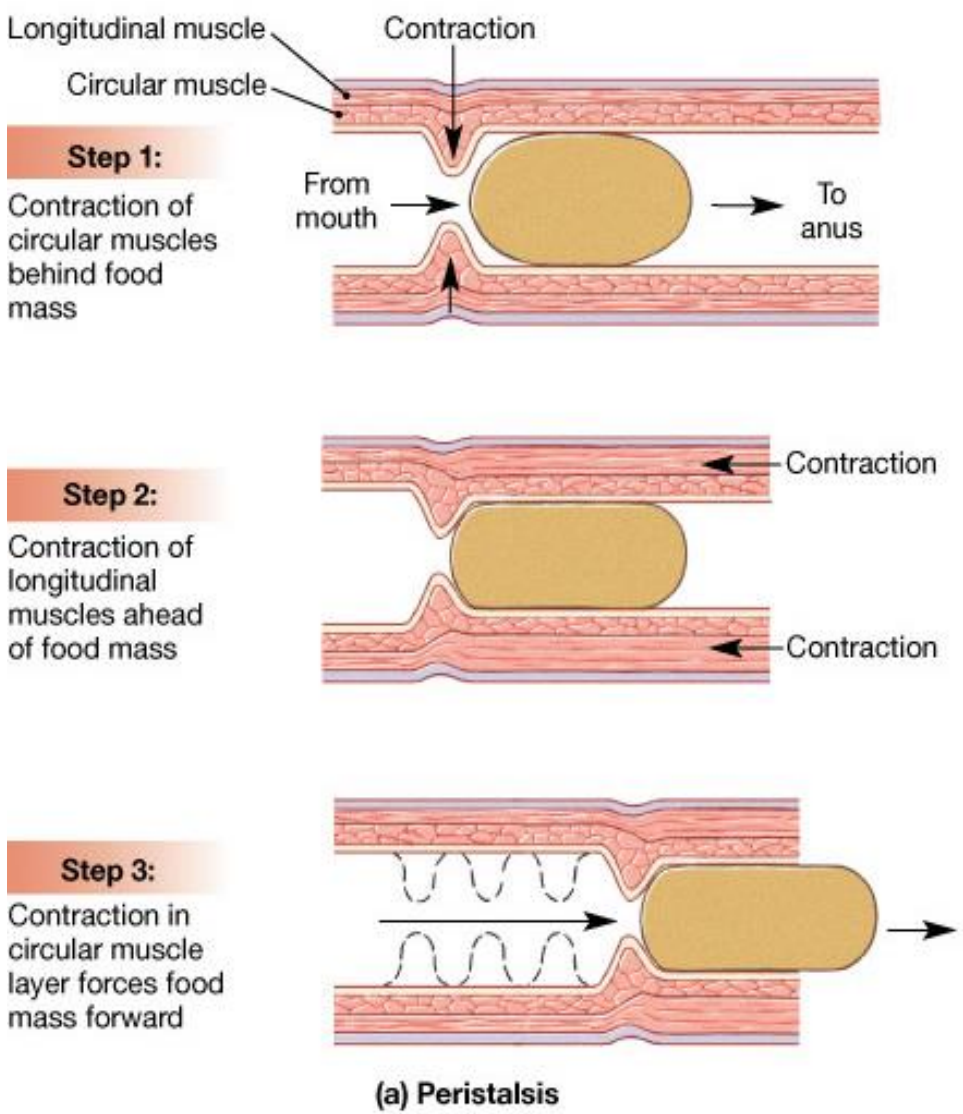
1-Segmentation: **Mix contents to promote Digestion & absorption. It is *Myogenic* i.e. controlled by the basic electric rhythm (BER).**

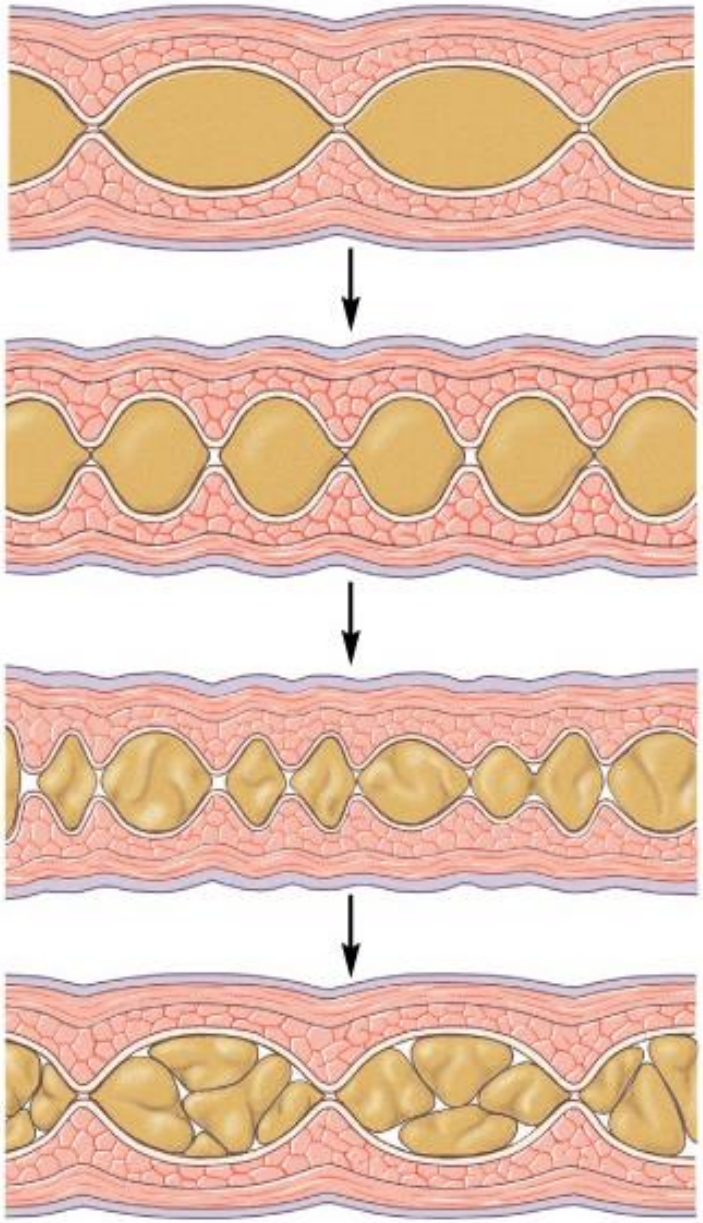


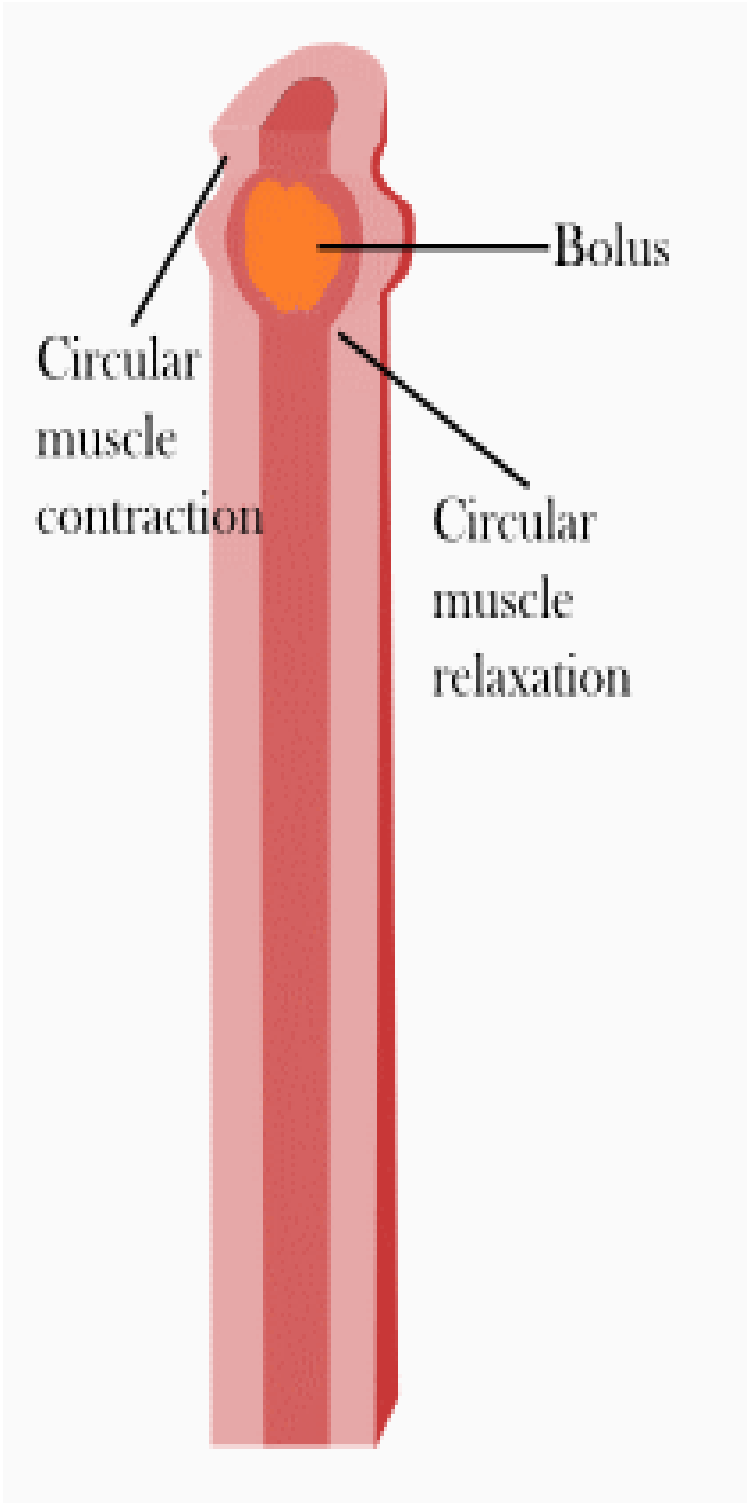


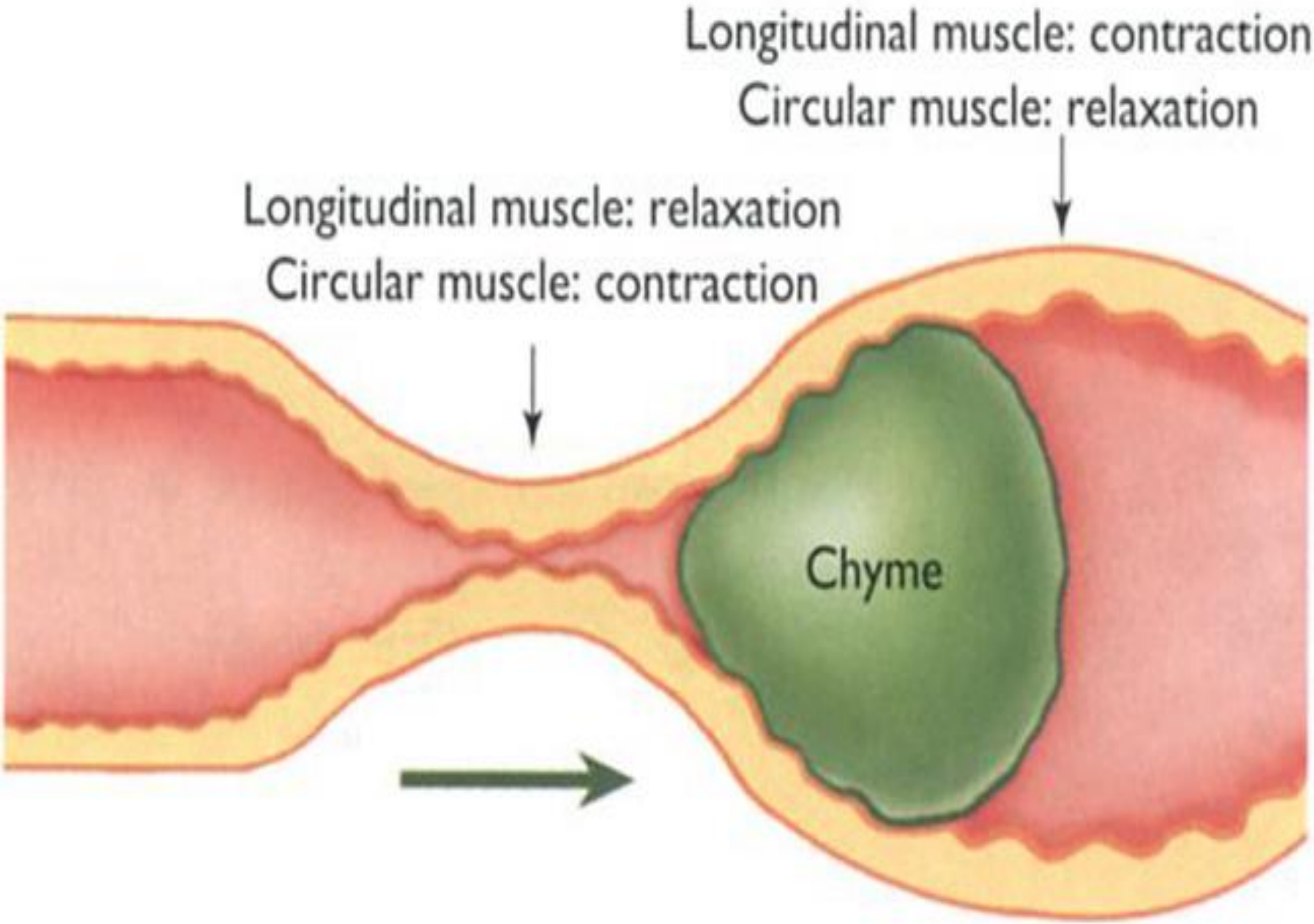


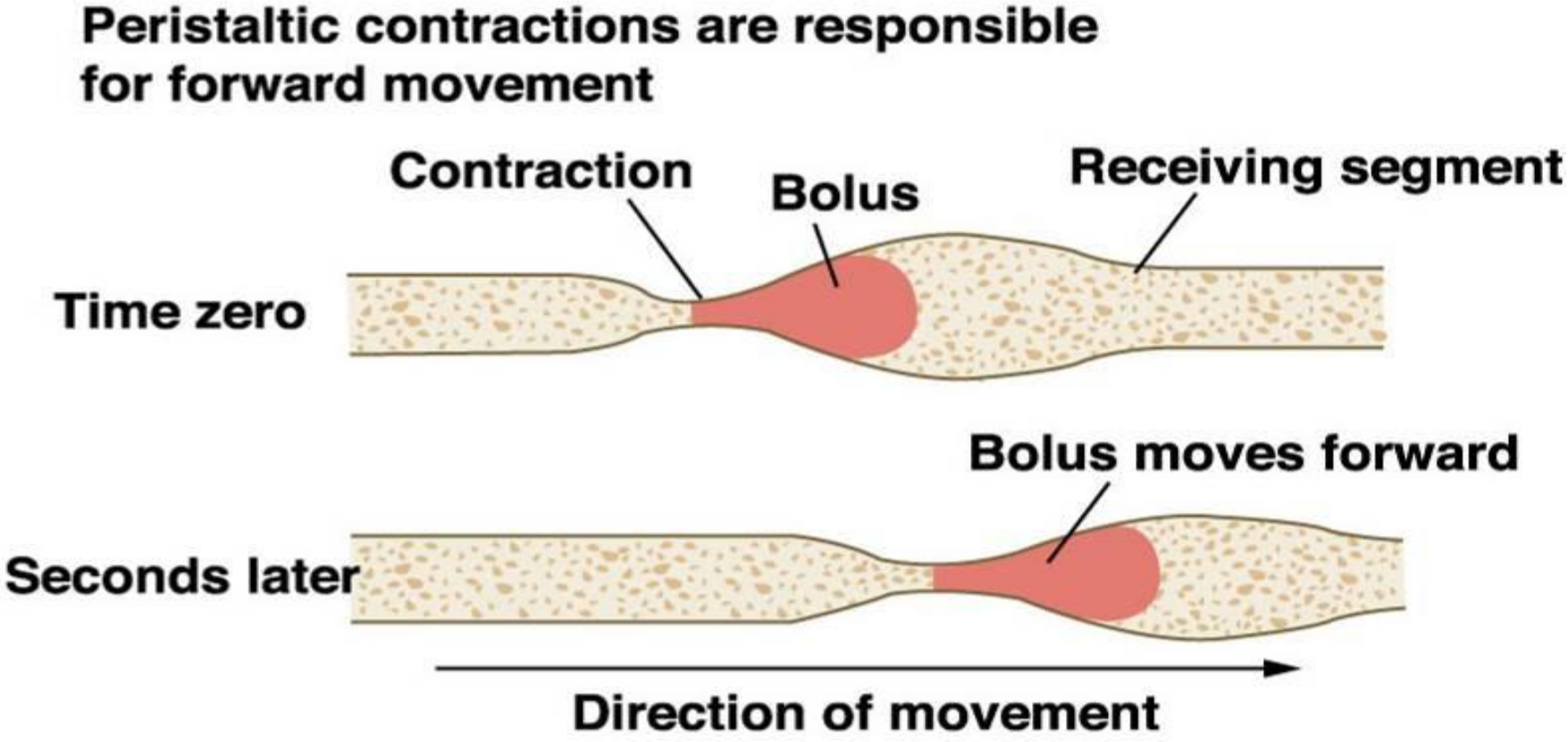
Mixing contraction of the Small Intestine. Rhythmic Segmentations Bring Through Mixing of the Intestinal Content


Longitudinal muscle
Circular muscle
Contraction
Step 1:
Contraction of circular muscles behind food mass
From mouth
To anus
Step 2:
Contraction of longitudinal muscles ahead of food mass
Contraction
Contraction
Step 3:
Contraction in circular muscle layer forces food mass forward
(a) Peristalsis


(b) Segmentation

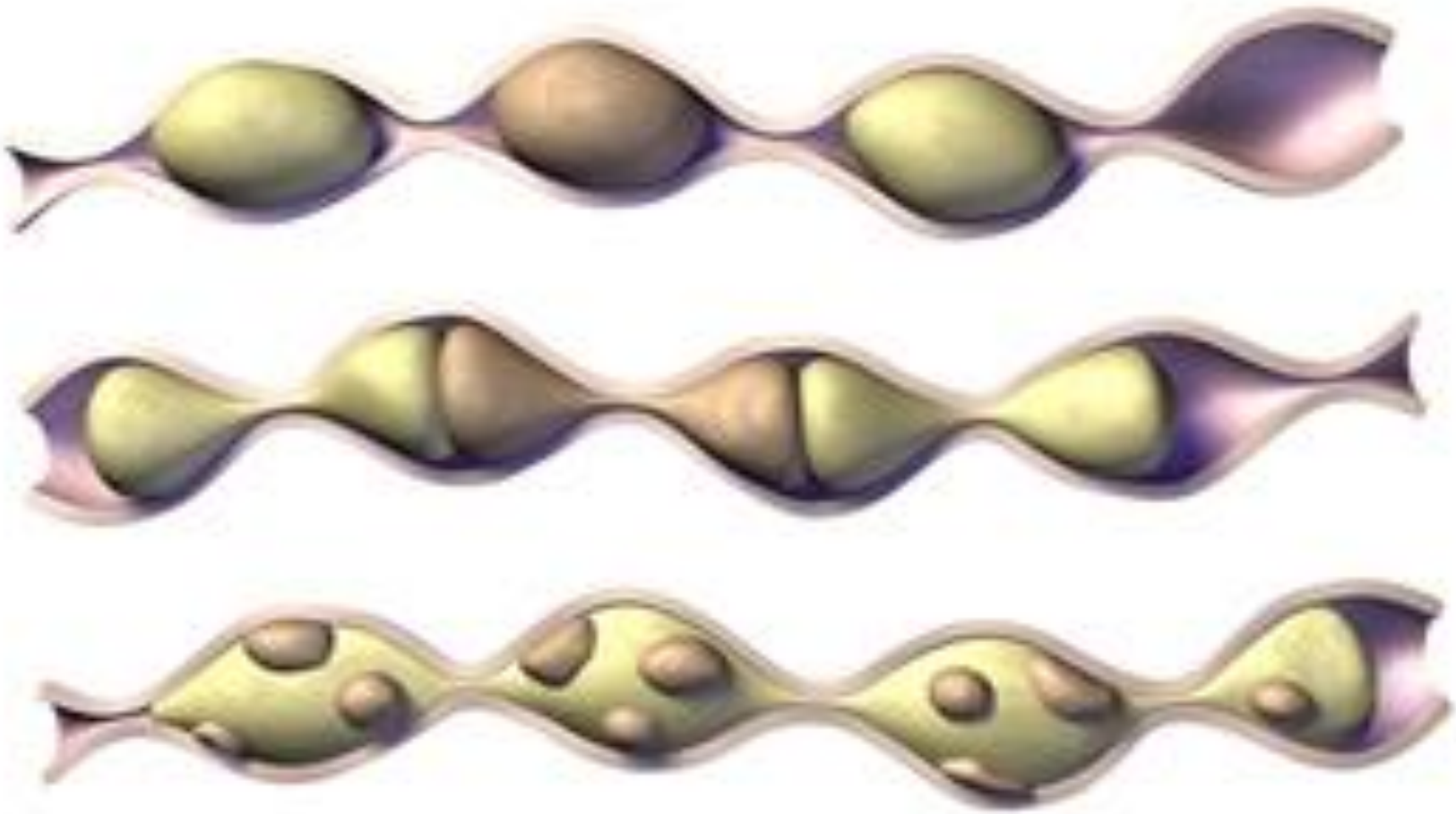

Bolus
Circular muscle contraction
Circular muscle relaxation


Longitudinal muscle: contraction
Circular muscle: relaxation
Longitudinal muscle: relaxation
Circular muscle: contraction
Chyme



"law of the Gut"

- The peristaltic reflex plus the anal direction of movement of the peristalsis is called the law of gut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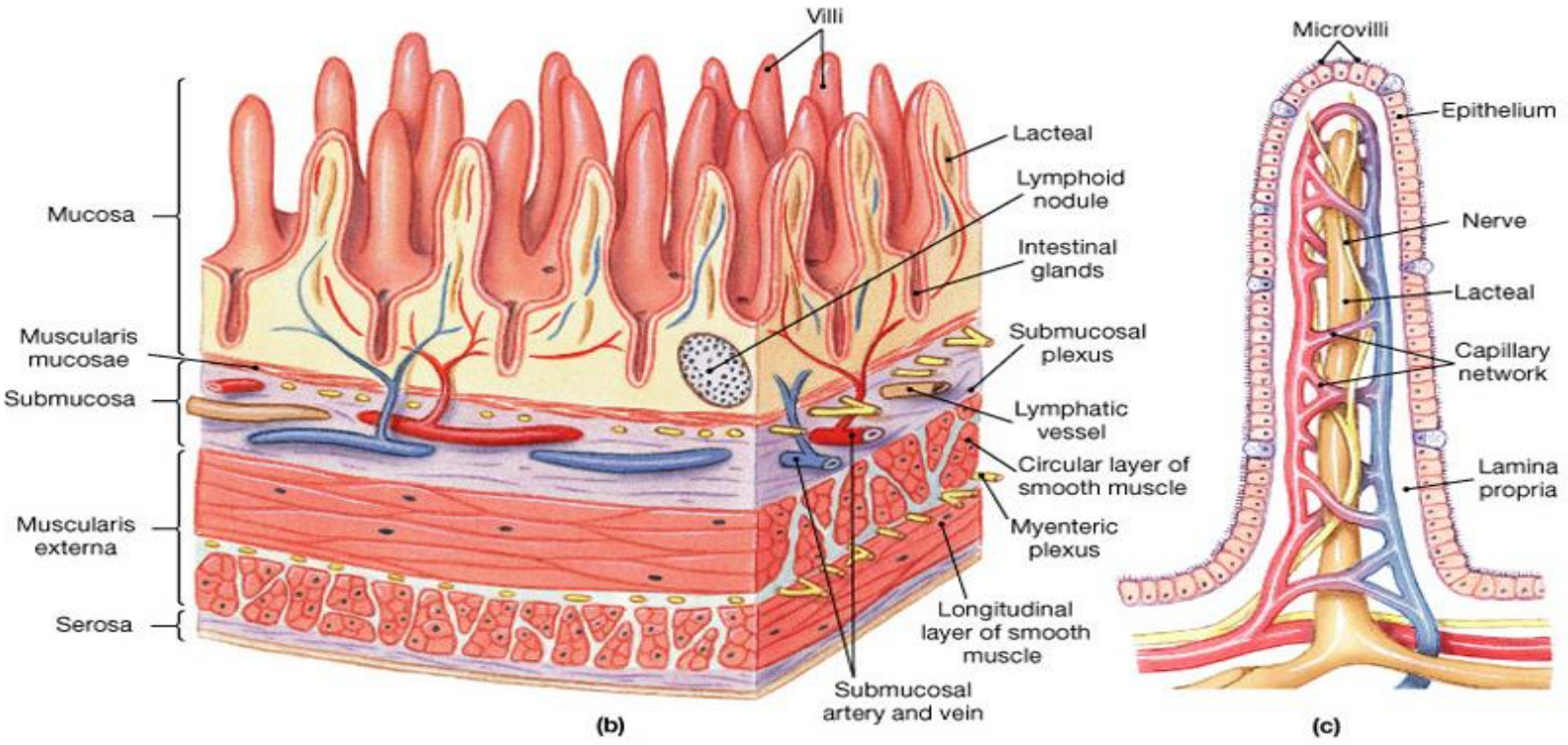
Intestinal Motility

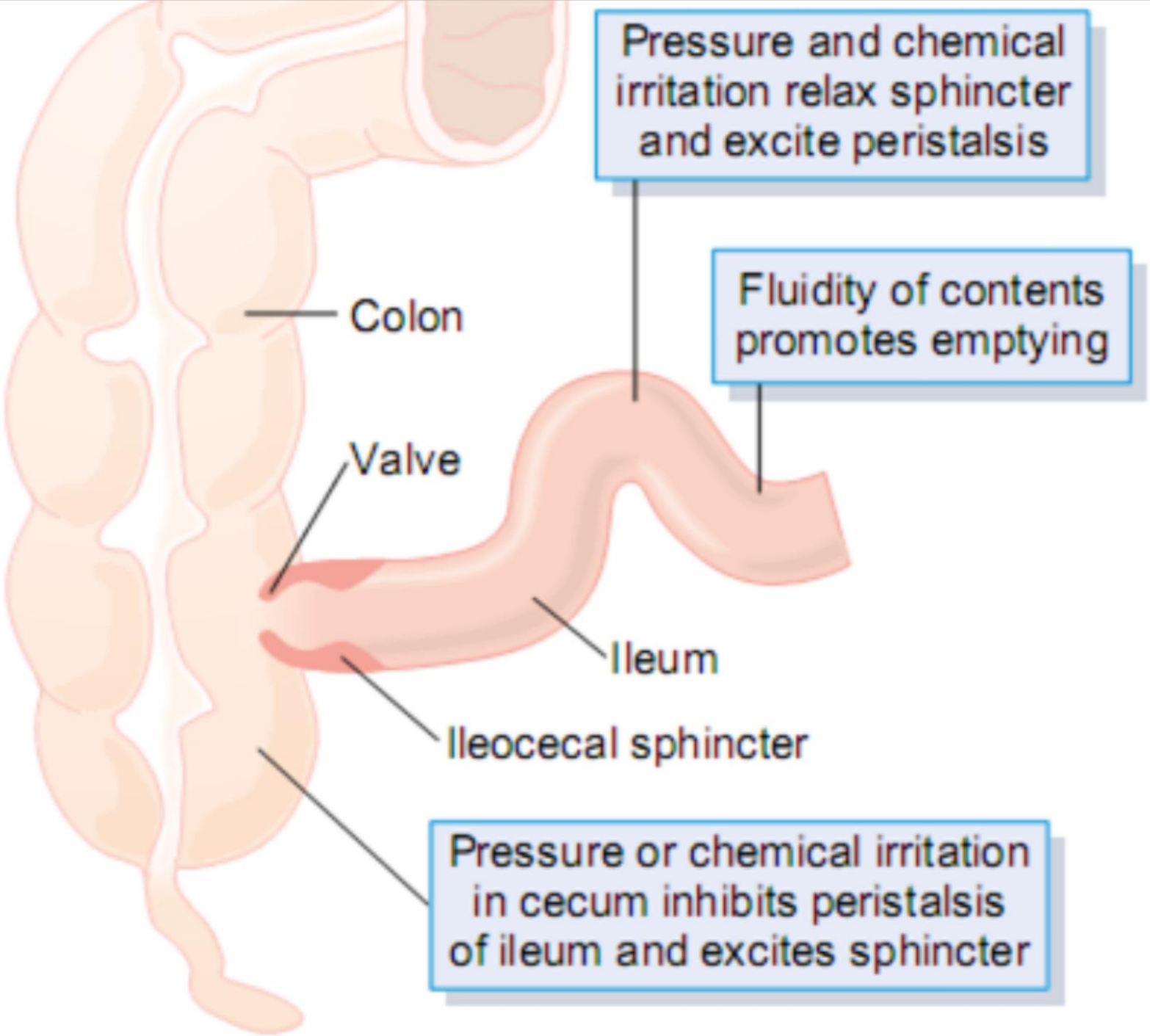
Peristaltic movement	***Segmentation movement***
Stimulus **1-Distension of the duodenum or the stomach (gastro-enteric reflex).** **2- mechanical or physical irritation.**	**Distension with chyme in the small intestine .**
Rate or velocity **Velocity=0.5-2 cm/min slower distally, then die out after few cms.**	**Rate= 11-12 in the duodenum** **8-9 in the terminal ileum**
Control *Neurogenic:* Local Myenteric reflex (law of the gut)	***Myogenic* in nature (slow wave + spike potential on top)**

Movements Caused by the Muscularis Mucosae and Muscle Fibers of the Villi

- **The *muscularis mucosae* can cause short folds to appear in the intestinal mucosa.**
- ***"Milk"* the villi, lymph flows freely from the central lacteals of the villi into the lymphatic system.**
- ***Function of the Ileocecal Valve:* to prevent backflow of fecal contents from the colon**
- **1000 milliliters of chyme empty into the cecum each day.**
- ***Feedback Control of the Ileocecal Sphincter***
- **Reflexes from the cecum(distention& irritation) cont .of sphincter, inhibit peristalsis thus delay emptying.(coloileal reflex).**

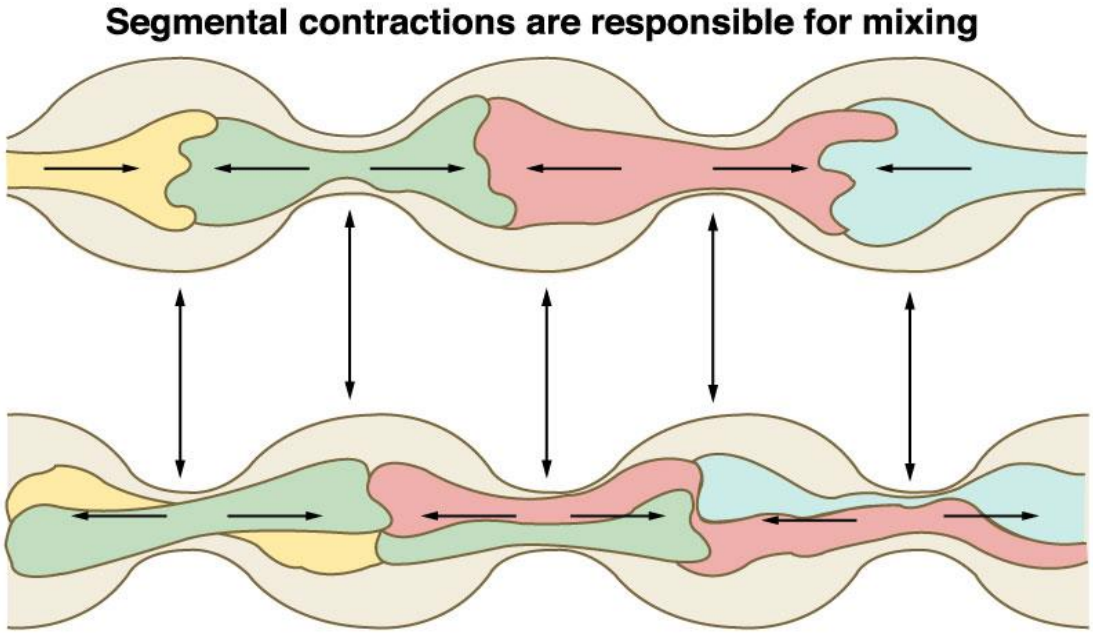
Movement of Villi by Villikinin




Pressure and chemical irritation relax sphincter and excite peristalsis
Fluidity of contents promotes emptying
Colon
Valve
Ileum
Ileocecal sphincter
Pressure or chemical irritation in cecum inhibits peristalsis of ileum and excites sphincter

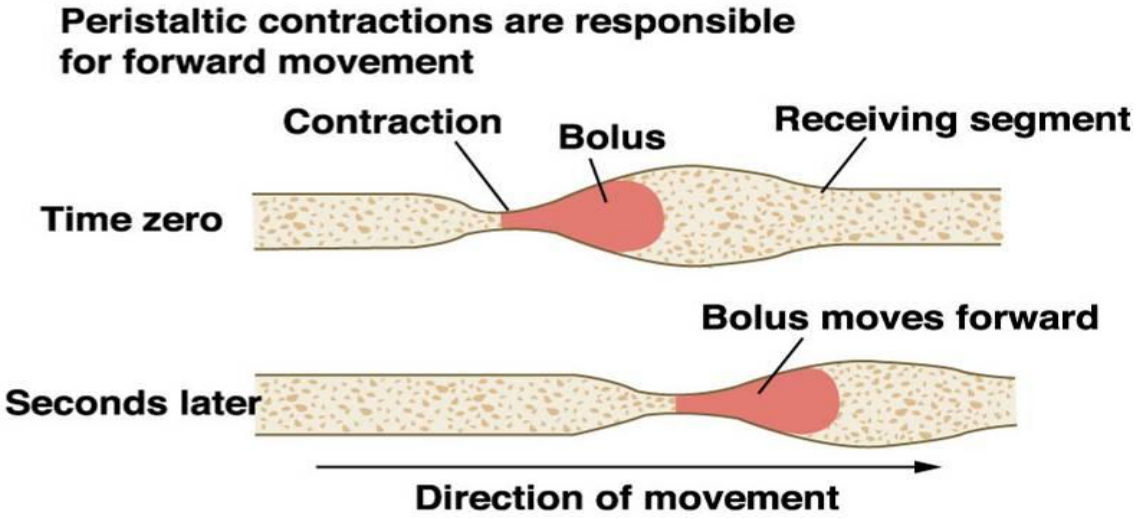
4-Movements of the Colon

- **The principal functions of the colon are :**
- **Absorption of water and electrolytes from the chyme to form solid feces *(Proximal1/2).***
- **Storage of fecal matter until it can be expelled (Distal1/2).**
- ***Mixing Movements-"Haustrations***
- **80 to 200 milliliters of feces are expelled each day.**
- ***Propulsive Movements-"Mass Movements.***
- **Persistent haustral contractions, requiring as many as *8 to 15 hours* to move the chyme from the ileocecal valve through the colon.**
- ***(1-3times daily) After breakfast by one hour.***



Large intestinal motility patterns

- **Segmental contraction *(Haustration)***



- ***Peristalsis***

A Mass Movement : is a Modified Type of Peristalsis Characterized by

- *First, A constrictive ring* **occurs in response to a distended or irritated point in the colon, usually in the Transverse colon.**
- *Then,* **Rapidly, the** *20 or more centimeters* **of colon** ***distal to the constrictive ring*** **lose their Haustrations and contract as a unit, propelling the fecal material in this** *Segment En Masse* **further down.**
- **The contraction develops progressively more force for about 30 seconds, and relaxation occurs during the next 2 to 3 minutes.**
- **A series of mass movements usually persists for** *10 to 30 minutes.* **Then they cease but return perhaps a half day later.**

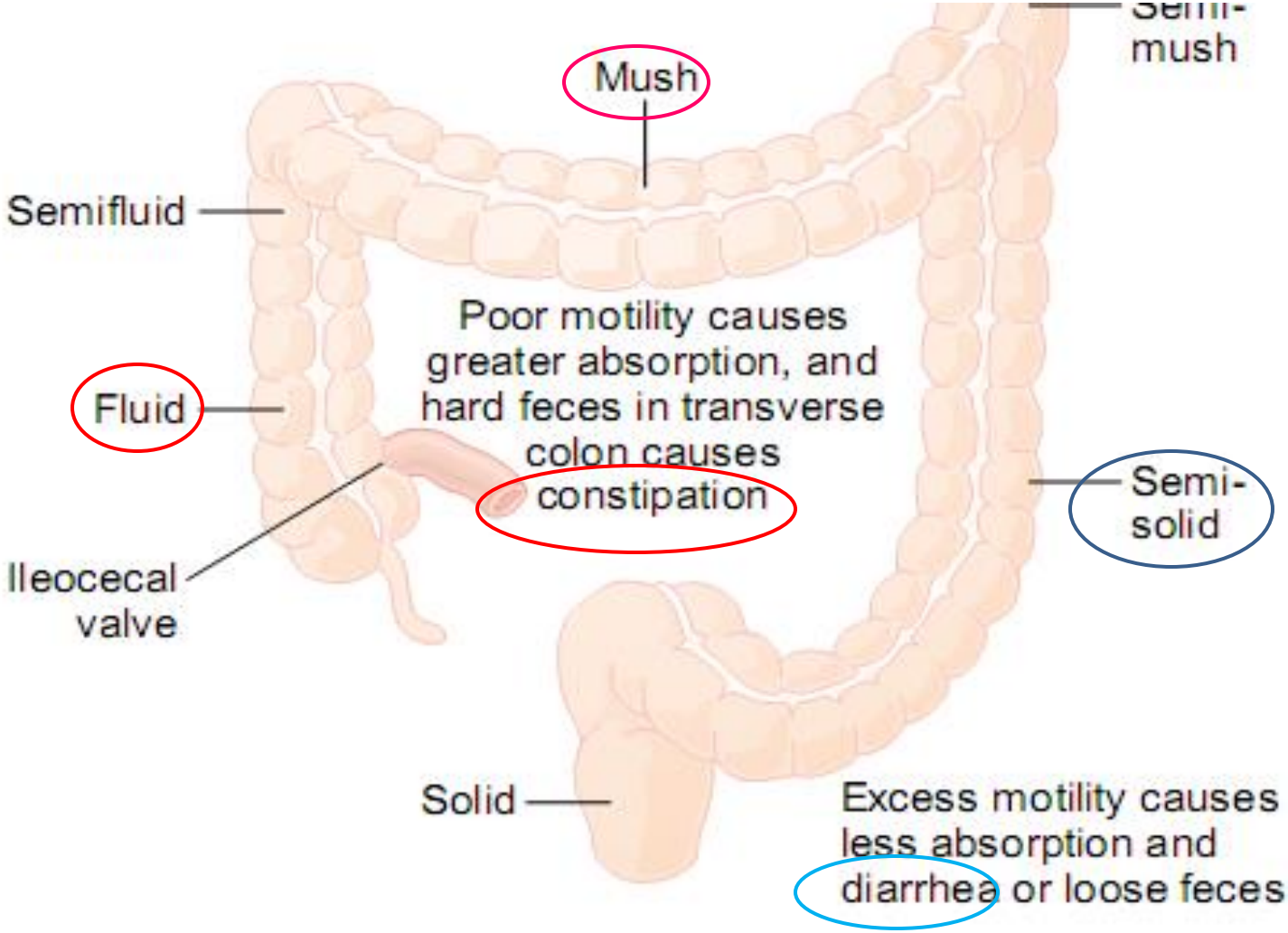

Semi-
mush
Mush
Semifluid
Poor motility causes greater absorption, and hard feces in transverse colon causes constipation
Fluid
Semi-solid
Ileocecal valve
Solid
Excess motility causes less absorption and diarrhea or loose feces

Figure 63–5

- **Initiation of Mass Movements by Gastrocolic and Duodenocolic Reflexes.**

Appearance of mass movements after meals is facilitated by *Gastro Colic and Duodeno Colic reflexes.*

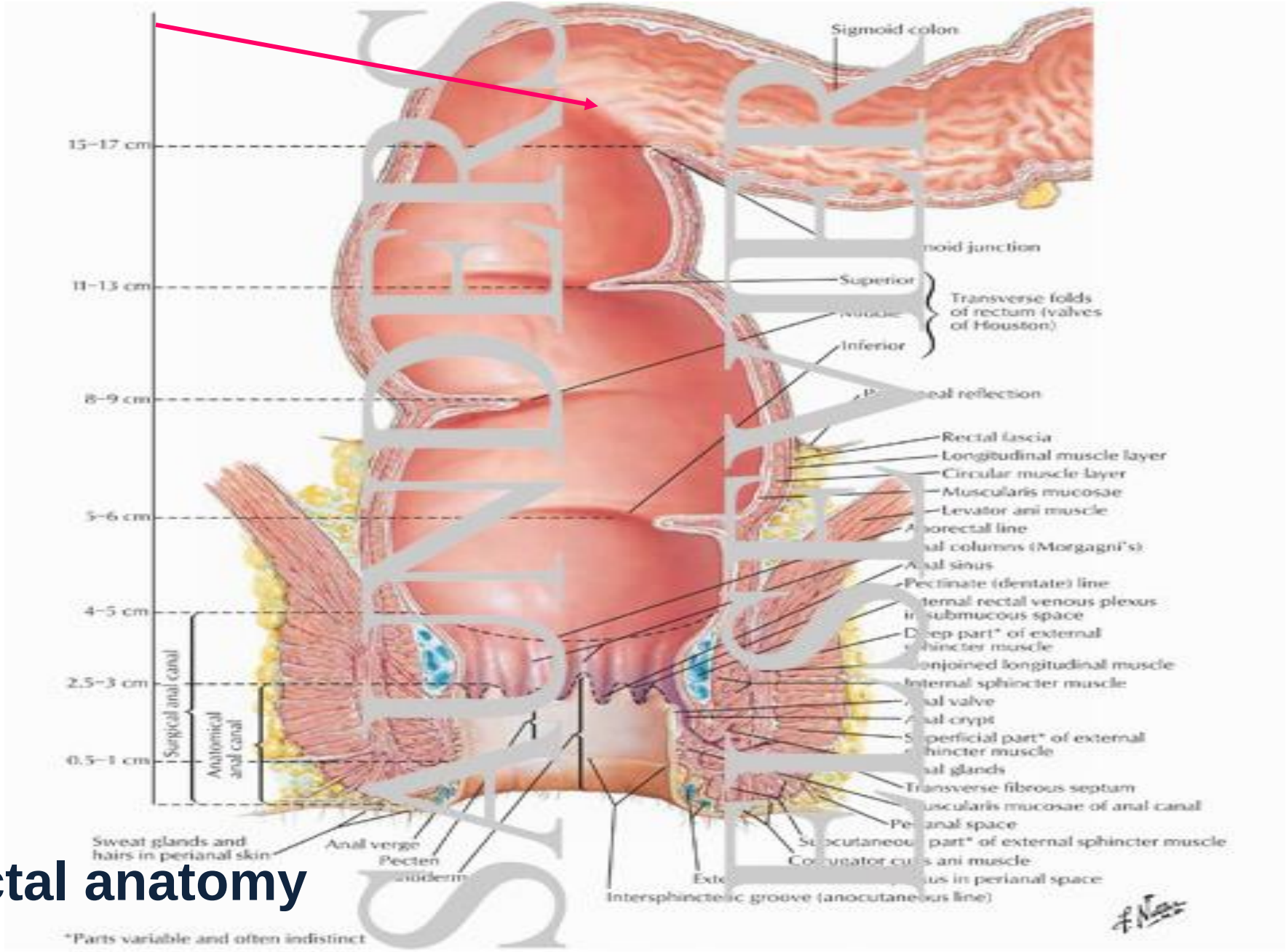
These reflexes result from Distention of the stomach and Duodenum.

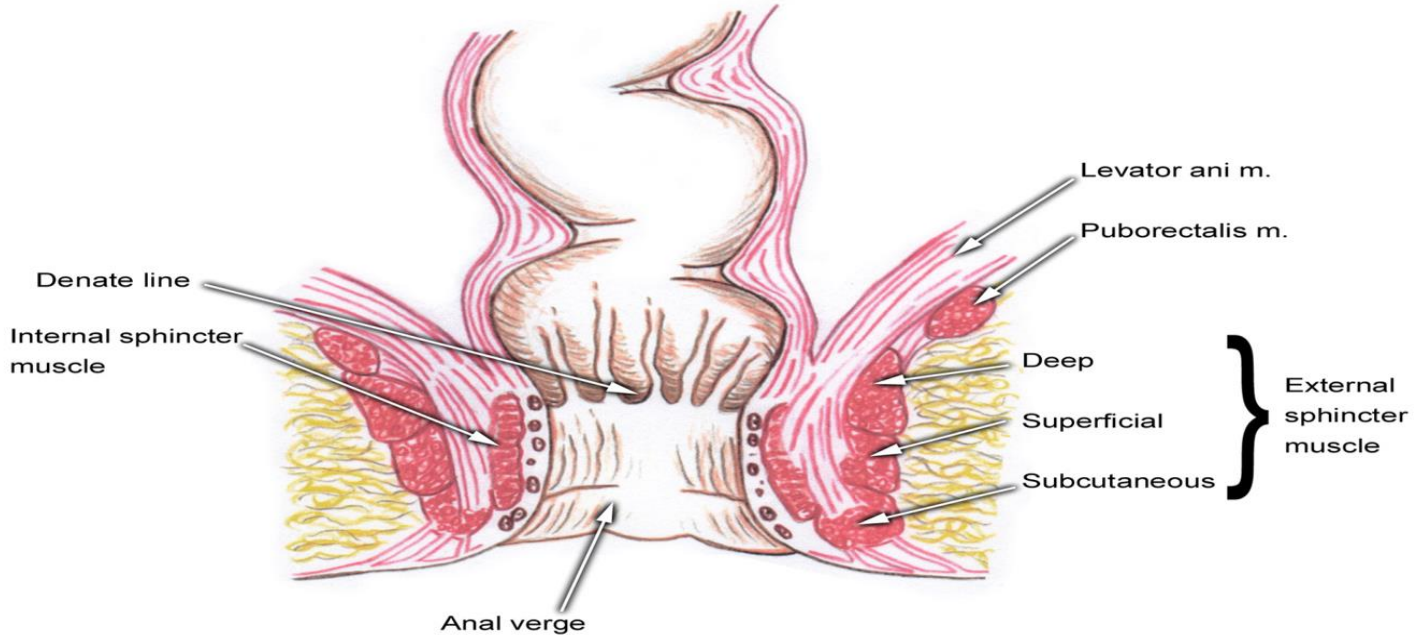
Irritation in the colon can also initiate intense mass movements.(in *ulcerative colitis* mass movements persist almost all the time).

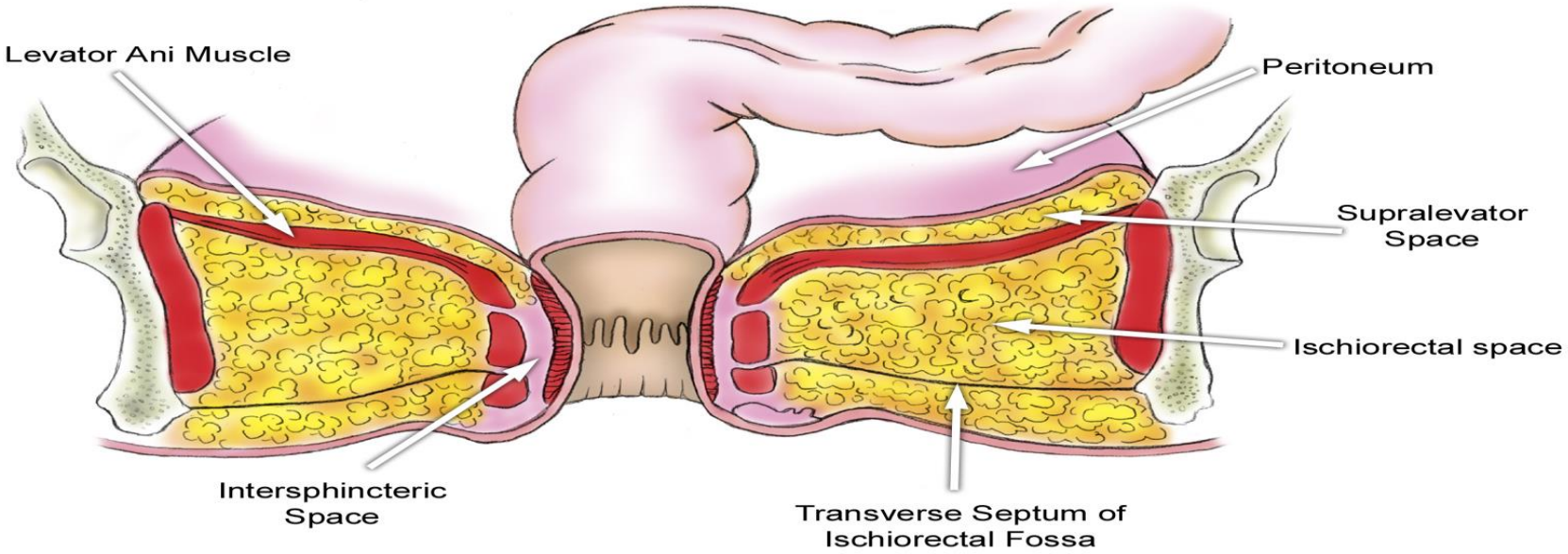
Defecation

- **Most of the time, the rectum is empty of feces as a result of:**
- ***Weak functional sphincter*** **exists about** ***20 cm*** **from the anus at the junction between the sigmoid colon and the rectum.**
- **There is also a** ***Sharp Angulation*** **here that contributes additional resistance to filling of the rectum.**
- ***Defecation Reflexes :***
- ***Intrinsic myenteric reflex:*** **is relatively weak ??.**
- ***Parasympathetic Defecation Reflex:*** **powerful process of defecation .**

ectal anatomy



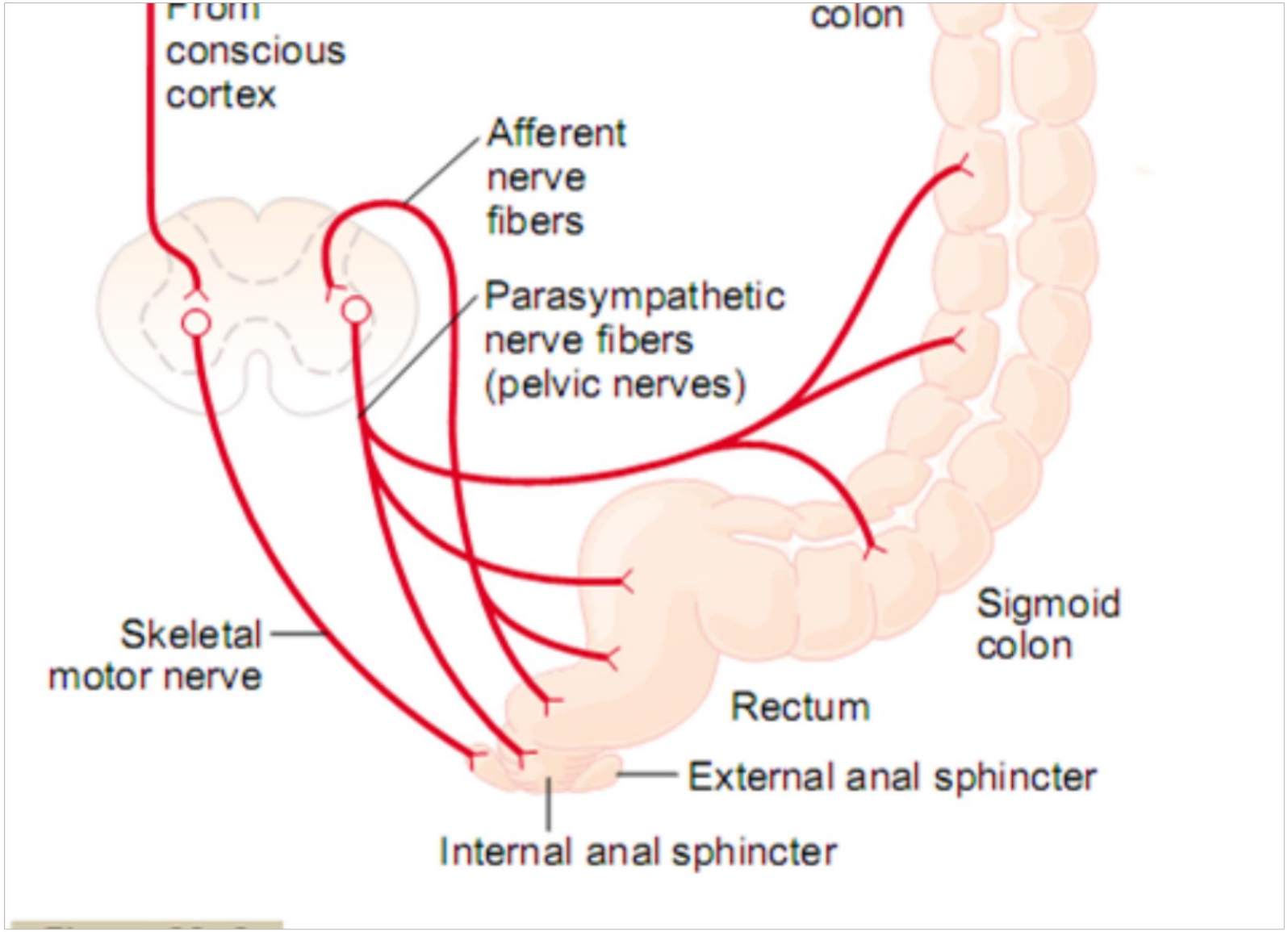

Levator ani m.
Puborectalis m.
Denate line
Internal sphincter muscle
Deep
Superficial
Subcutaneous
External sphincter muscle
Anal verge


Levator Ani Muscle
Peritoneum
Supralevator Space
Ischiorectal space
Intersphincteric Space
Transverse Septum of Ischiorectal Fossa

- ***Defecation signals :*** **entering the spinal cord initiate other effects, such as taking a Deep breath, Closure of the glottis, and Contraction of the abdominal wall muscles to force the fecal contents of the colon downward and at the same time cause the pelvic floor to relax downward and pull outward on the anal ring to evaginate the feces.**
- **People who too often inhibit their natural reflexes are likely to become severely constipated.**

5-Other Autonomic Reflexes That Affect Bowel Activity

- **Peritoneo-intestinal reflex. (peritonitis)**
- **Reno-intestinal reflex.**
- **Vesicoi-ntestinal reflex.**
- **All** ***Inhibit Intestinal Activity***


From
conscious
cortex
colon
Afferent
nerve
fibers
Parasympathetic
nerve fibers
(pelvic nerves)
Skeletal
motor nerve
Sigmoid
colon
Rectum
External anal sphincter
Internal anal sphincter