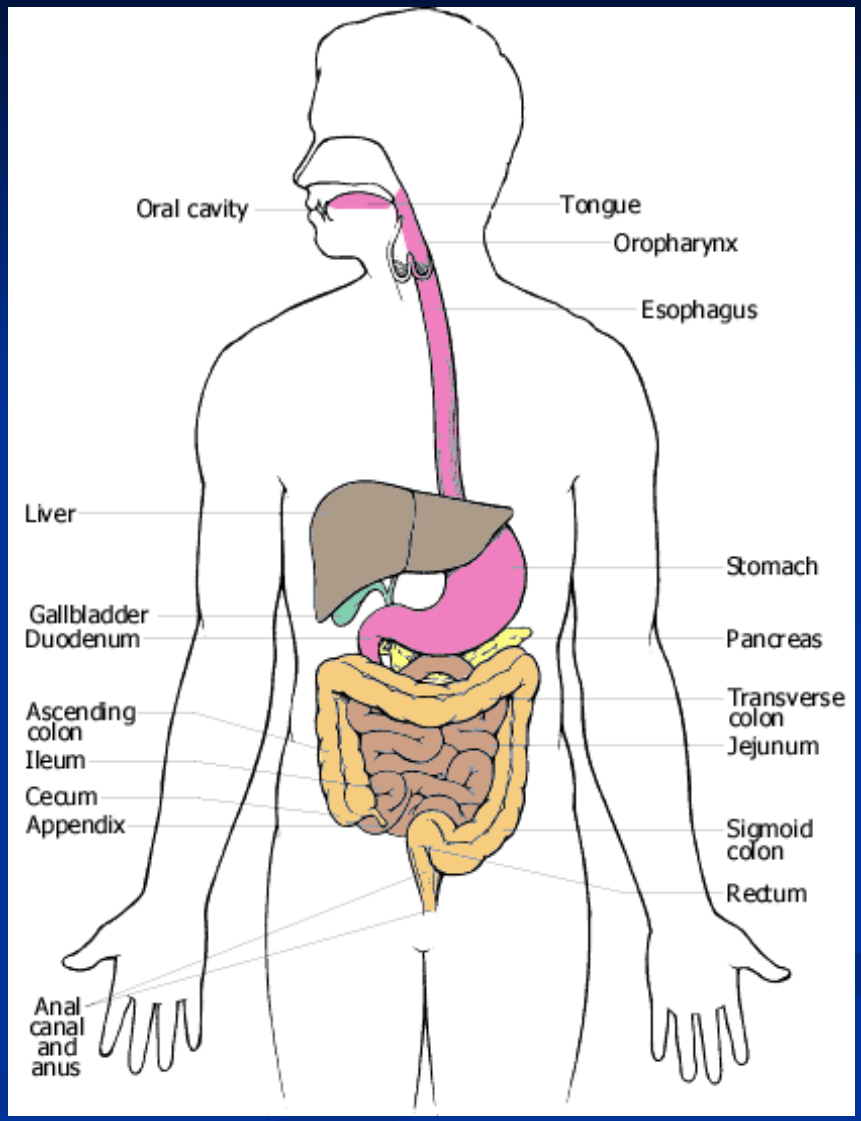
Gastrointestinal Physiology I Part 1 Cont...

Dr Lwiindi
(Medical Physiologist)



MOTILITY OF THE SMALL INTESTINE

Function of Intestinal Motility

(1)To mix chyme with digestive secretion

(2)To bring fresh chyme into contact with the absorptive surface of the microvili

(3)To propel chyme toward the colon

Types of small intestinal movement

1. Tonic contraction: the base of the other contractions
2. Segmentation contractions

(1) def.

When a portion of the small intestine becomes distended with chyme,

the stretch of the intestinal wall elicits a rhythmical contraction and relaxation of localized circular muscles

spaced at intervals along the intestine,

(2) function:

mix the chyme with the digestive juice

increase its exposure to the mucosal surface

Types of small intestinal movement

3. Peristalsis: propels the small intestinal contents towards the large intestines

peristaltic rush ： initiated by the harmful stimulation

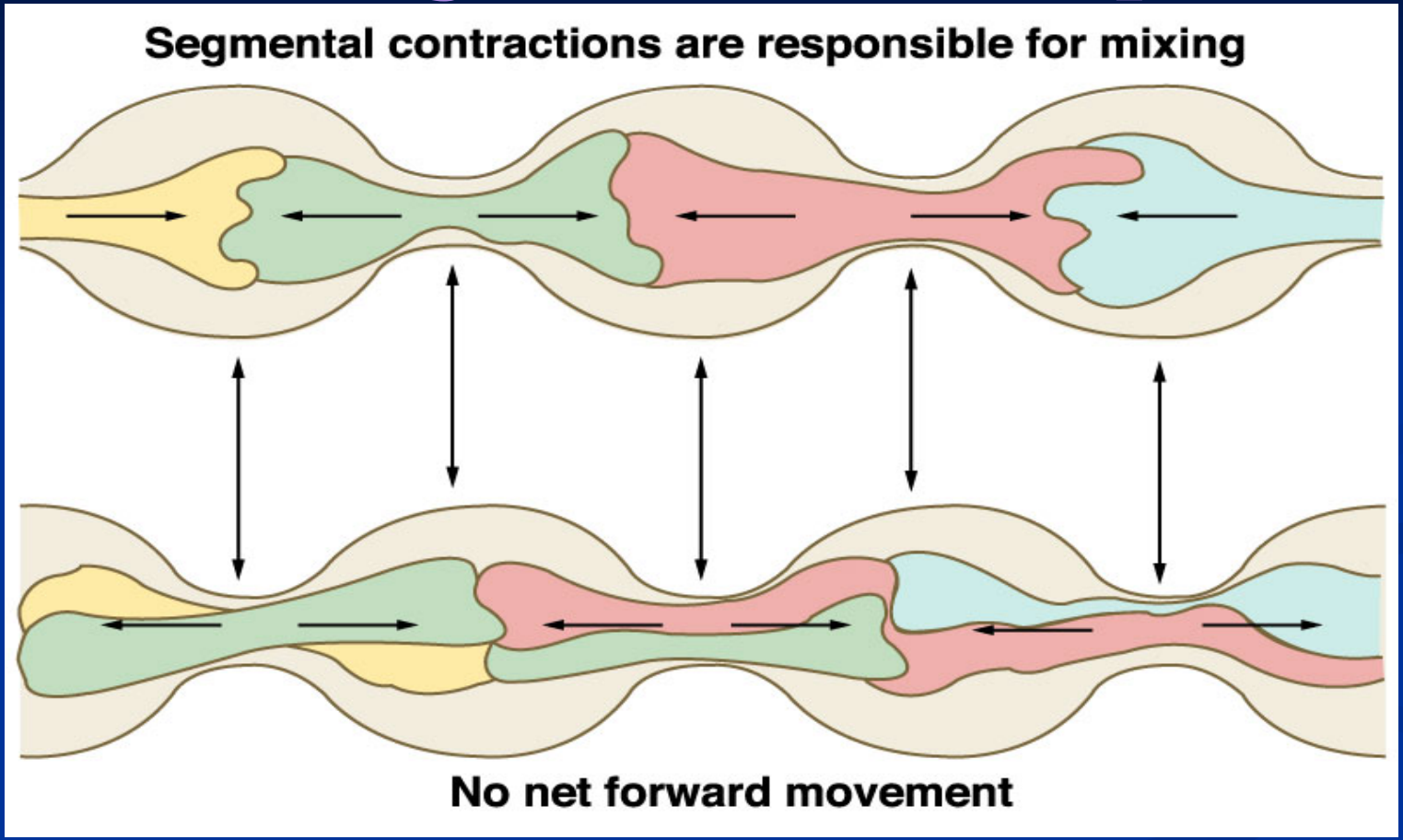
4. MMC:

Occurs during fasting state

moves any undigested material still remaining in the small intestine into the large intestine

prevents bacteria from remaining in the small intestine long enough to grow and multiply excessively

Segmentation: mix contents to promote digestion & absorption

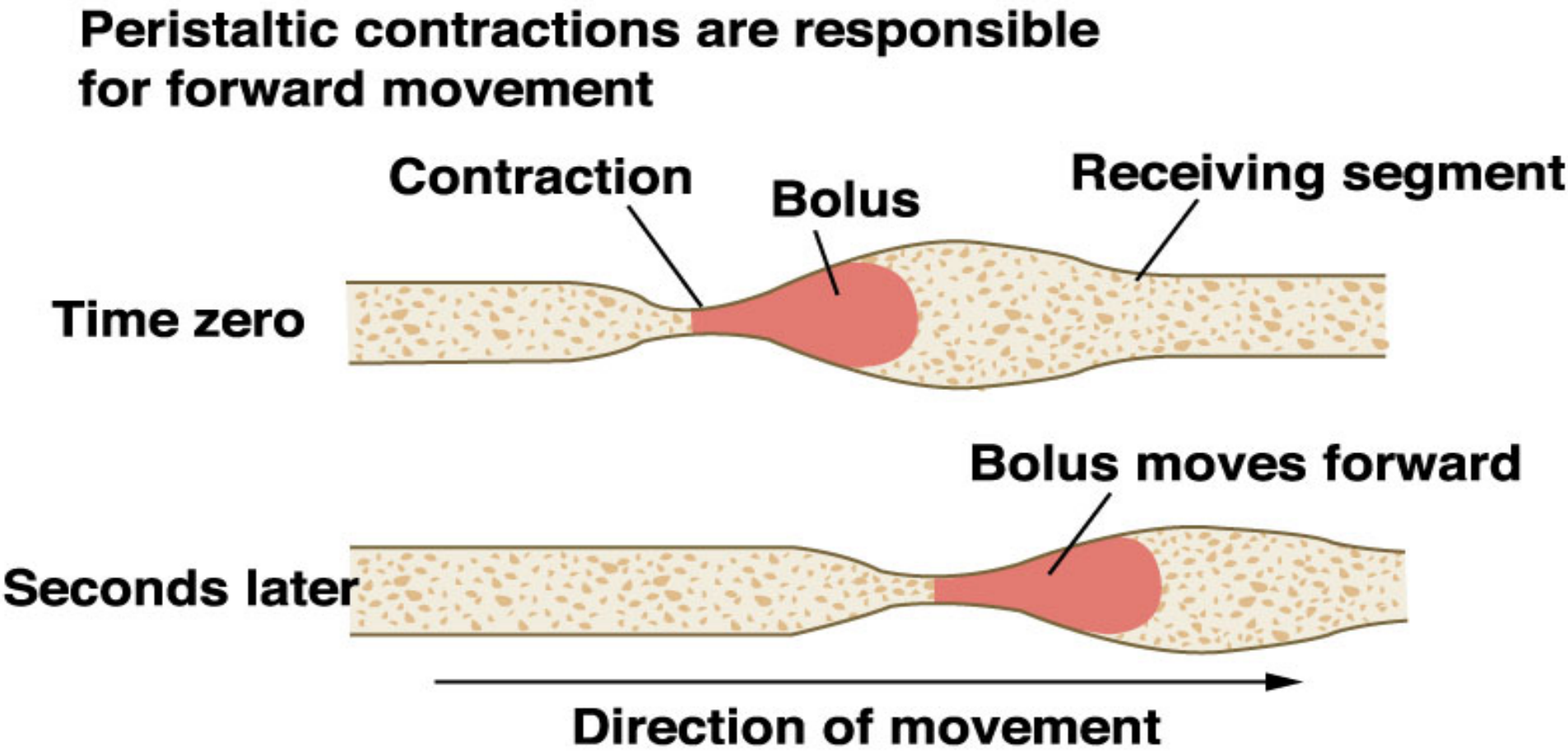


Peristalsis

- Distinctive pattern of smooth muscle contractions that propels foodstuffs distally through the esophagus and intestines
- Mediated by….
  - Local, intrinsic nervous system
  - Ex: peristalsis is not affected to any significant degree by vagotomy or sympathectomy

Small Intestinal Motility

Peristalsis: movement along the tract



Peristalsis

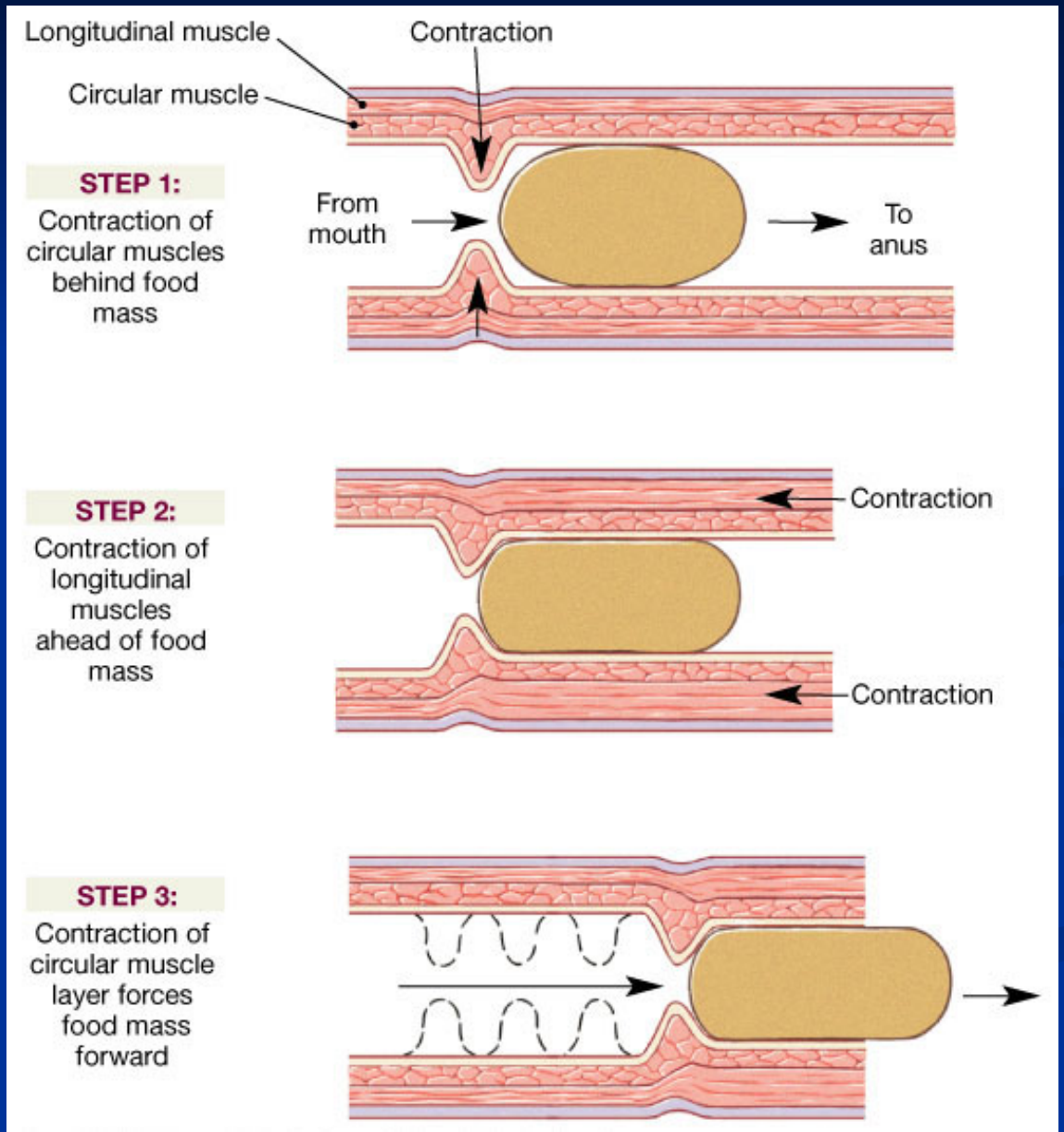


Figure 24.4

peristalsis

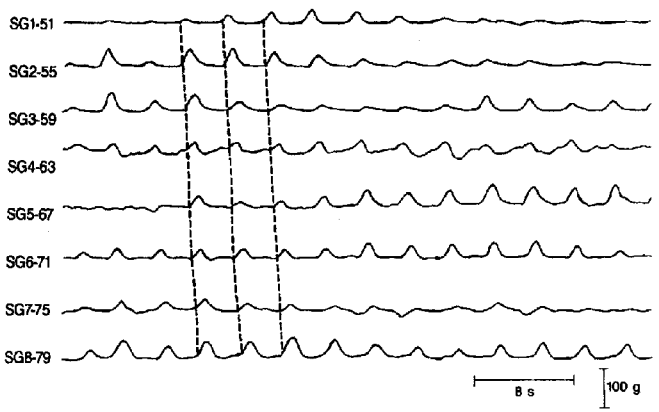


图 1.14 位相性收缩在十二指肠中传播较长距离，推进速度较快。SG，变应仪传感器。图中符号后的数字指的是该传感器距幽门的距离。经允许，引自 Sarna SK, Otterson MF. Small intestine physiology and pathophysiology. Gastroenterol Clin North Am, 1989; 18: 375 – 405.

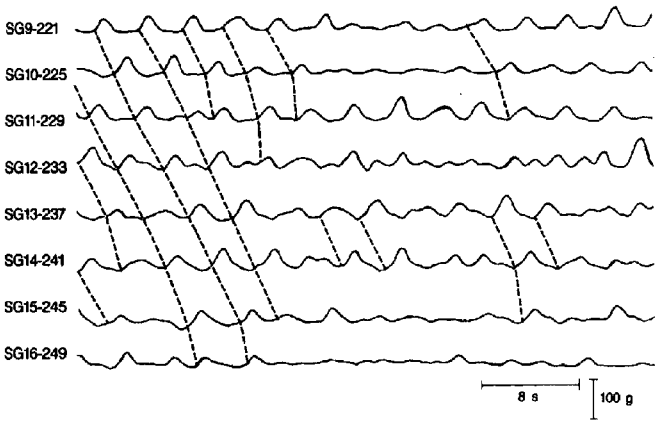


图 1.15 收缩波在小肠中段的传播不如图 1.14 中。SG，变应仪传感器。图中符号后的数字指的是该传感器距幽门的距离。经允许，引自 Sarna SK, Otterson MF. Small intestine physiology and pathophysiology. Gastroenterol Clin North Am, 1989; 18: 375 – 405.

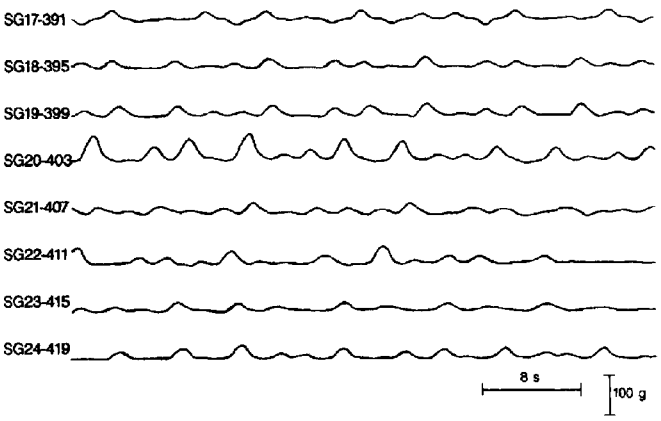
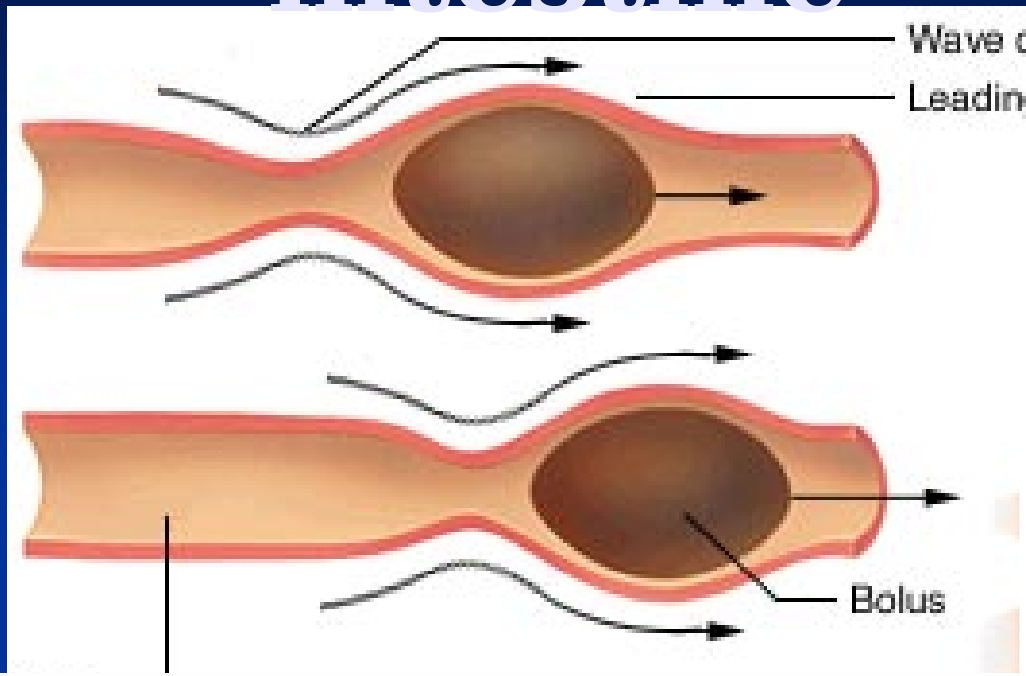
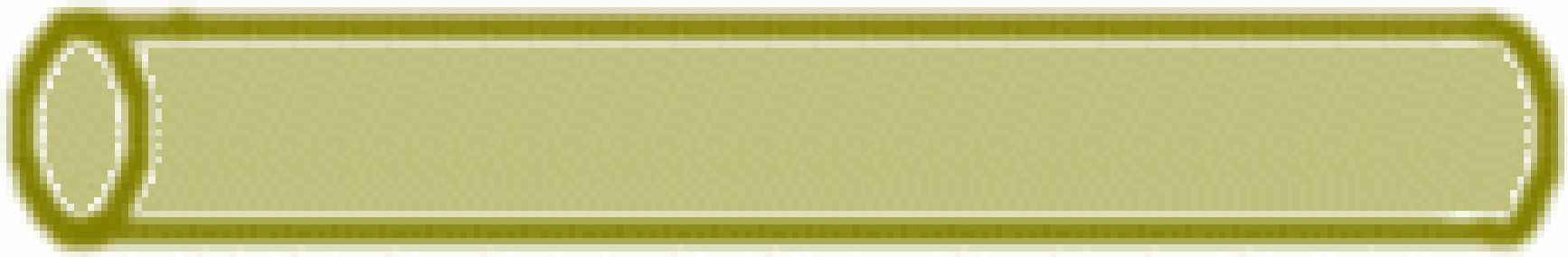


图 1.16 远端回肠的运动以非推进性收缩为主（相对于图 1.14 和 1.15）。经允许，引自 Sarna SK, Otterson MF. Small intestine physiology and pathophysiology. Gastroenterol Clin North Am, 1989; 18: 375 – 405.

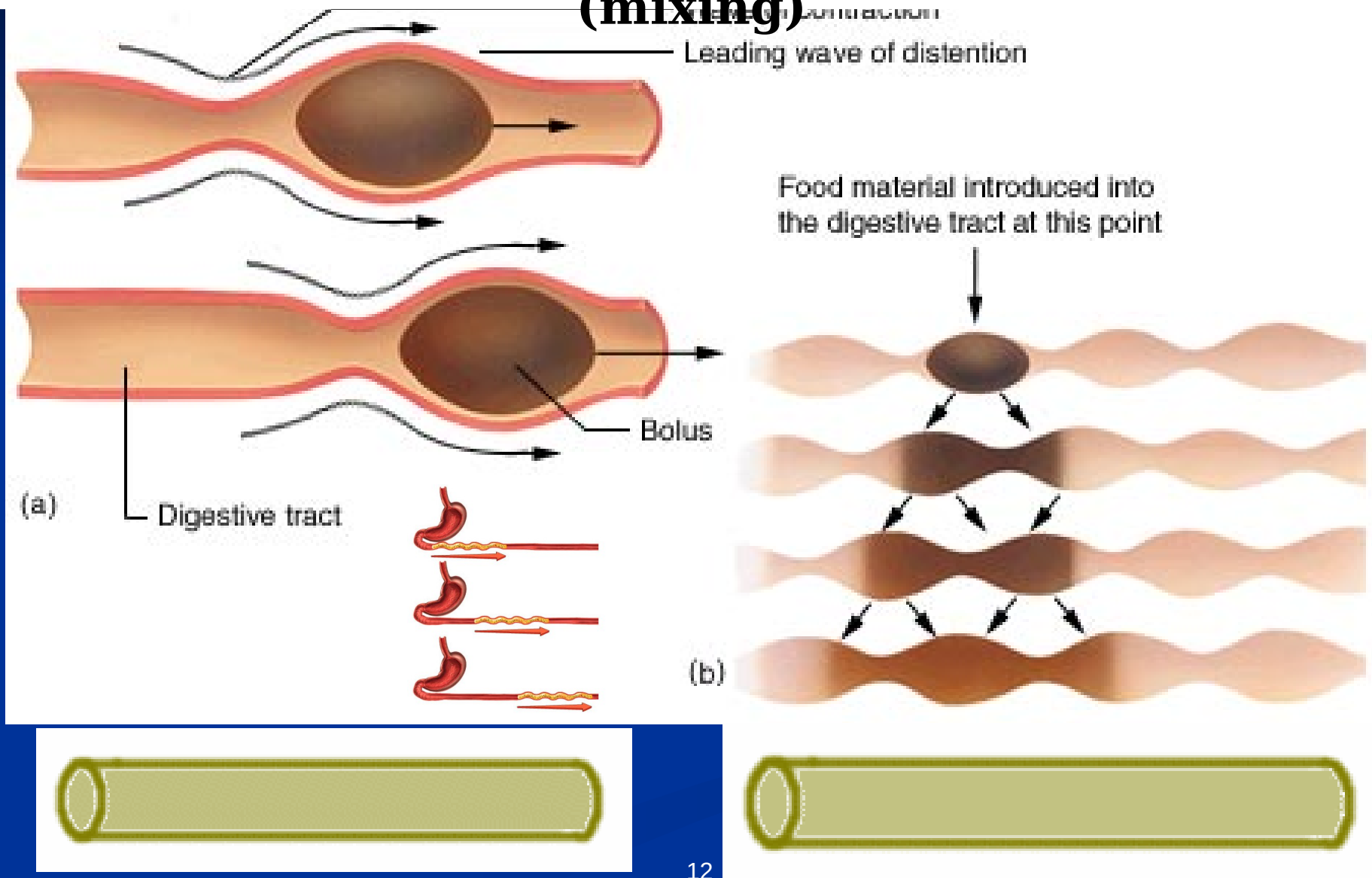
Peristalsis of the small intestine





http://medweb.bham.ac.uk/research/toescu/Teaching/OverviewGITY2.ht

Movement in Small Intestine
Peristalsis (ou propulsivos) end Segmentation (mixing)



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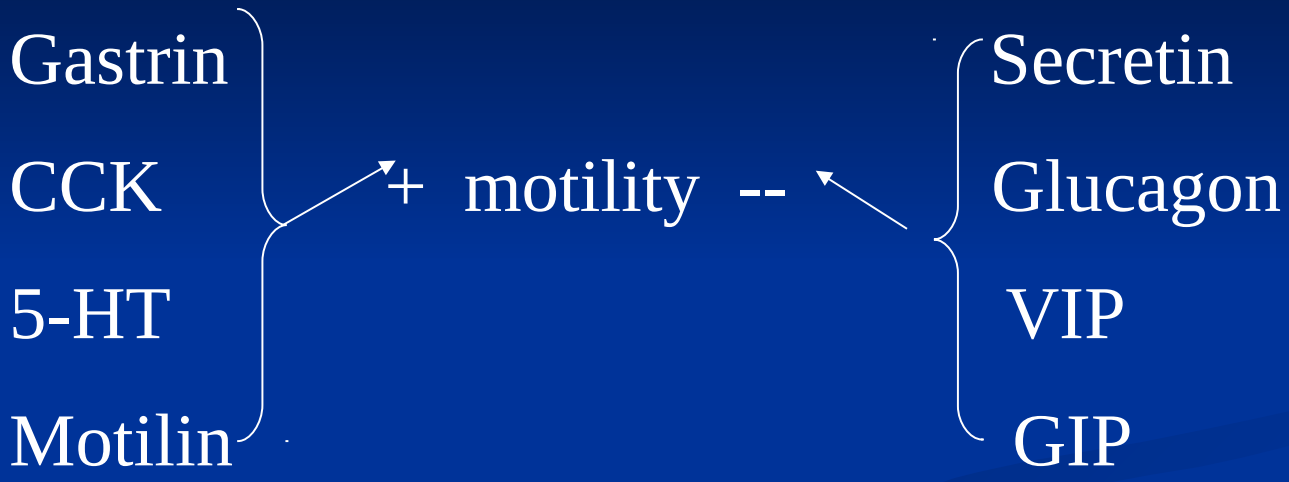
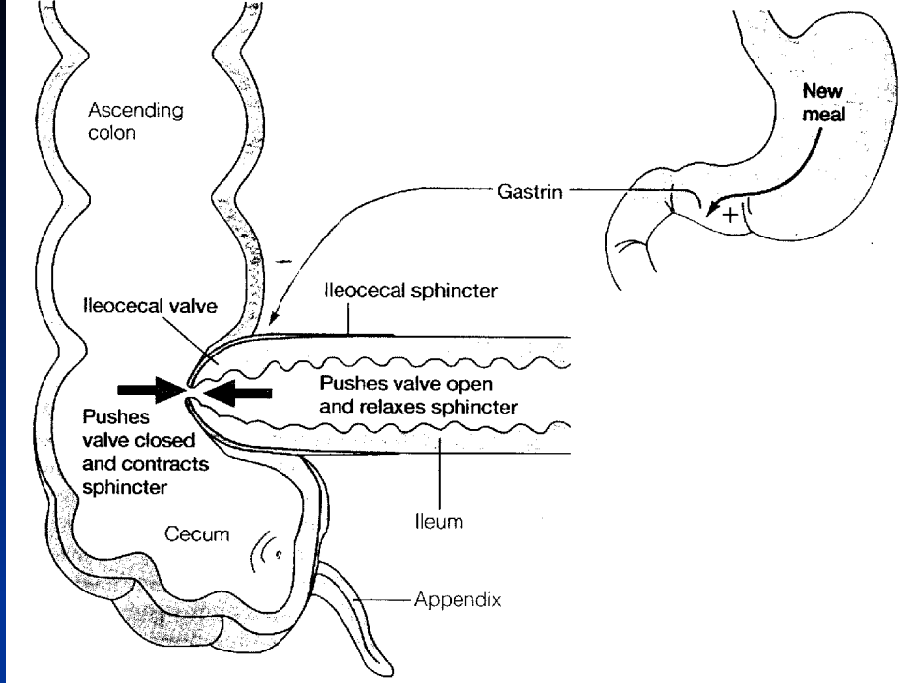
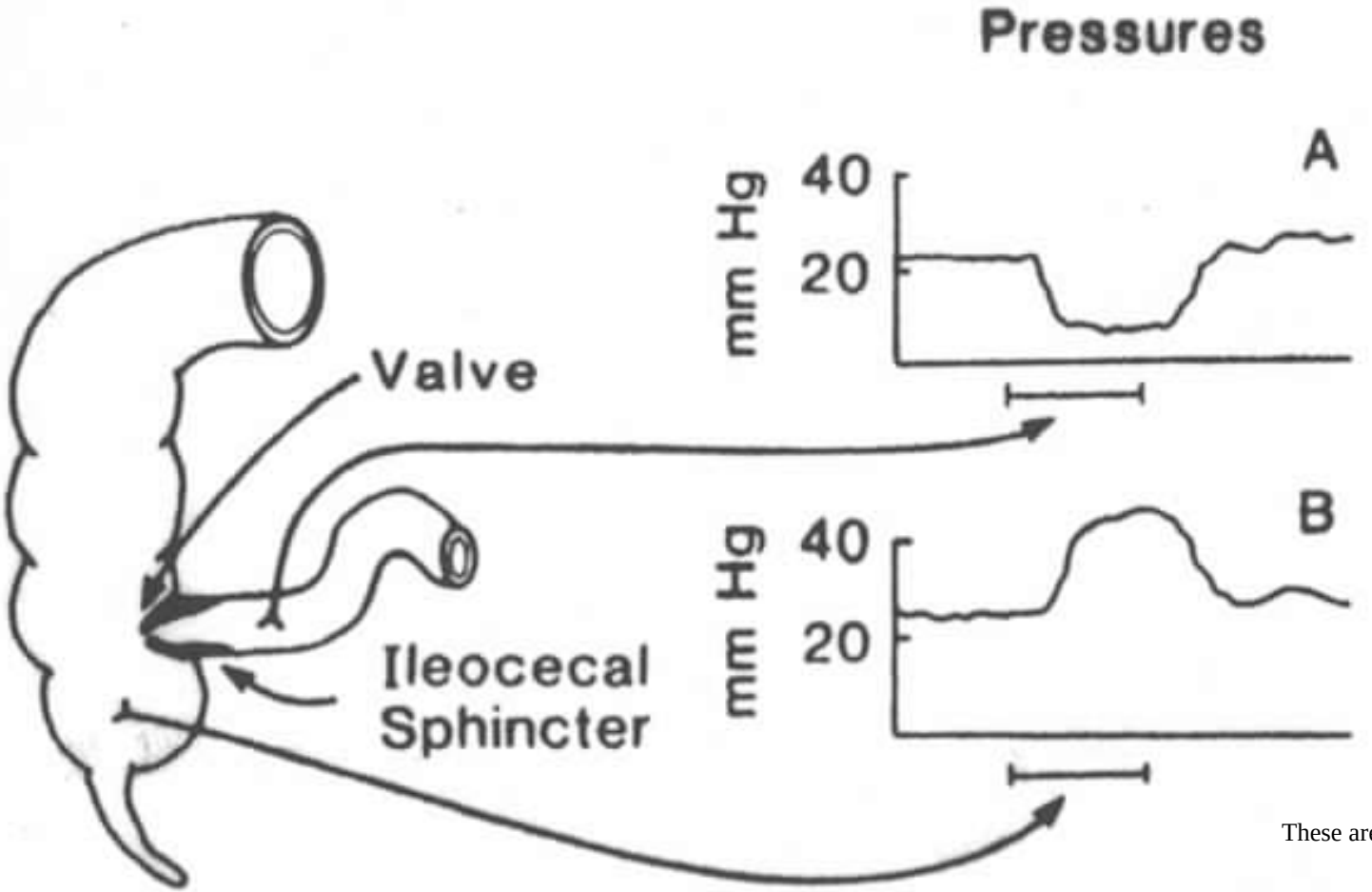
Control of Intestinal Motility – Hormonal



Ileocecal Valve



- What it is
  - Opening to large intestines
- Function: (1) prevent the repulsion (2) control the emptying
- normally closed. Short-range peristalsis in terminal ileum and distension relaxes IC sphincter --> small amount of chyme is squirted into the cecum.
- Distension of cecum contracts IC sphincter.
- Gastro-ileal reflex: enhances ileal emptying after eating.
- The hormone gastrin relaxes ileocecal sphincter.



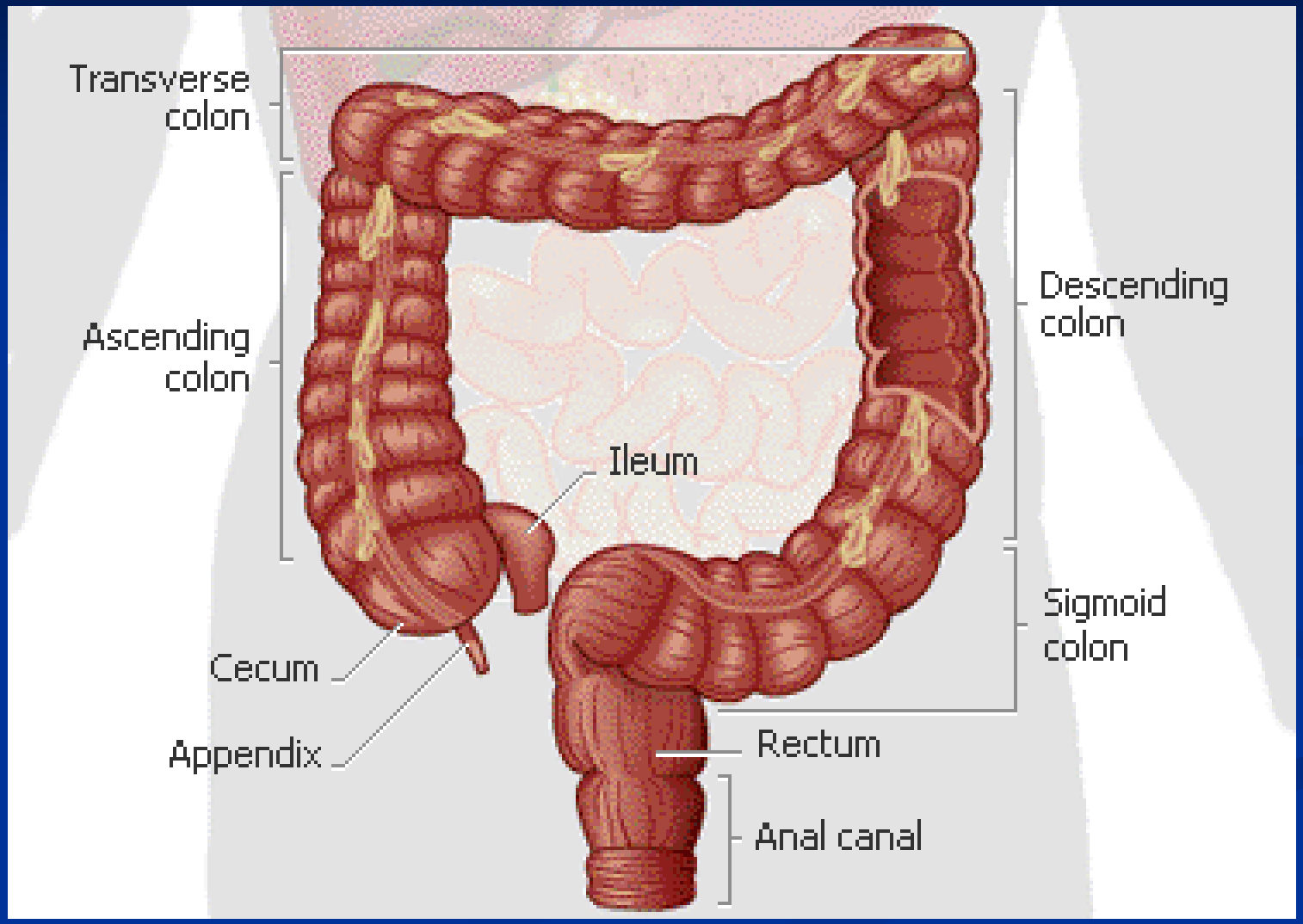
These are local reflexes

in the myenteric plexus

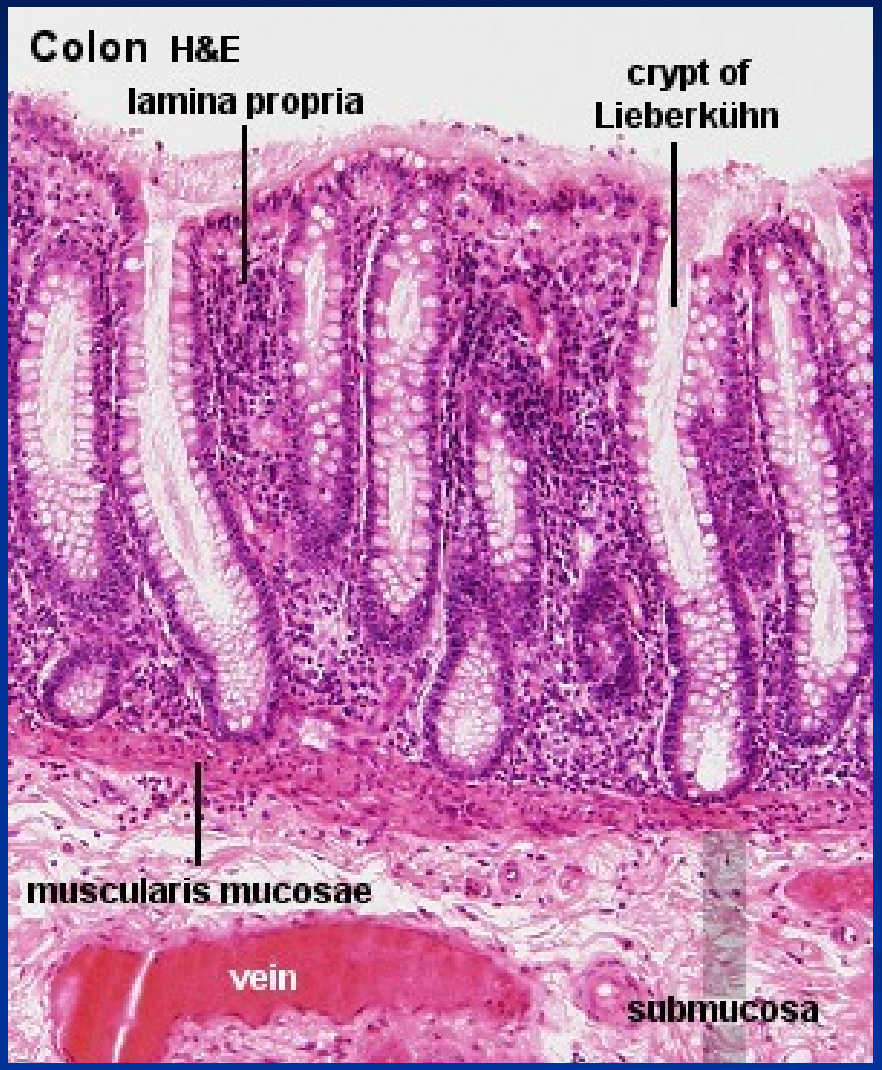
Large intestine

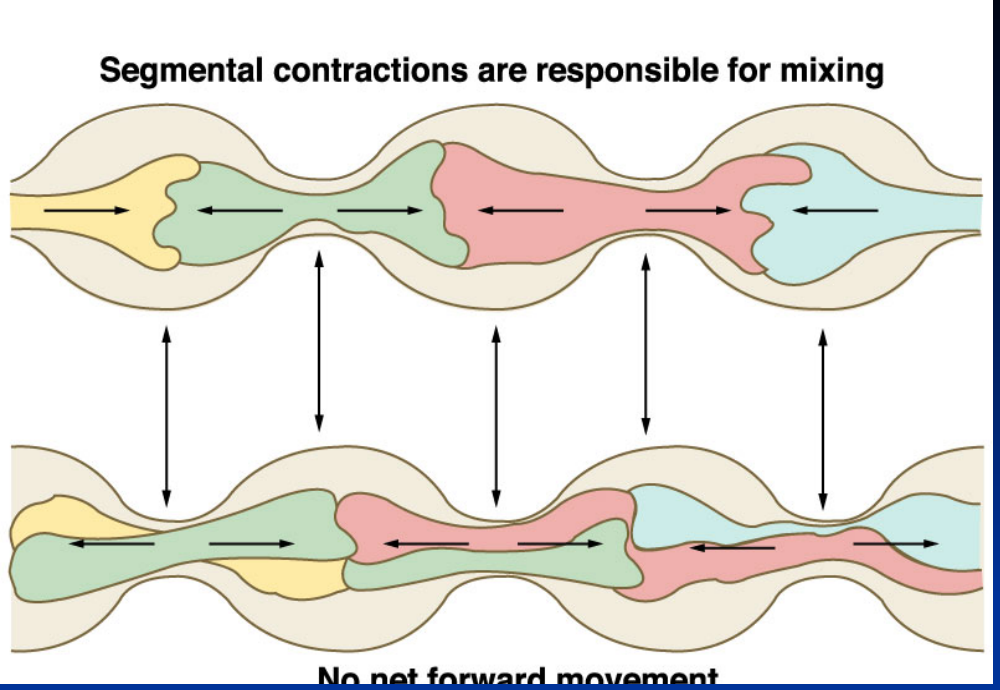
- Functions
  - Absorption of water and electrolytes
  - Storage of feces
  - Eliminates waste
  - NO Villi
  - Mucosa contains numerous tubular glands called **crypts**
  - Responsible for mucus secretion
- Motility patterns
  - Segmentation
  - Antiperistalsis
  - Mass movement

Large Intestine



Large Intestine

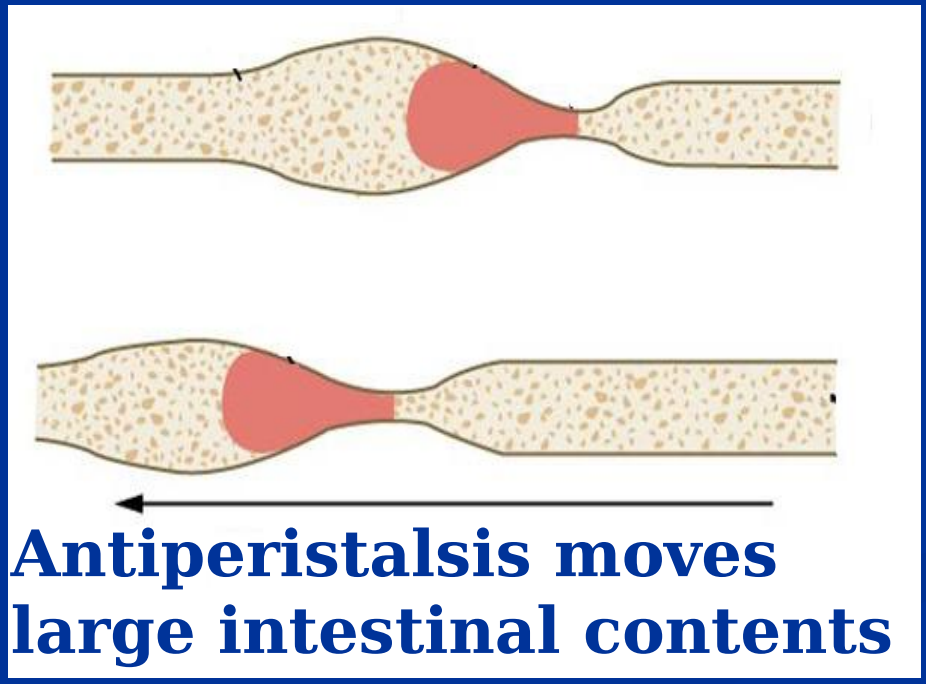




Large intestinal motility patterns

- Segmentation

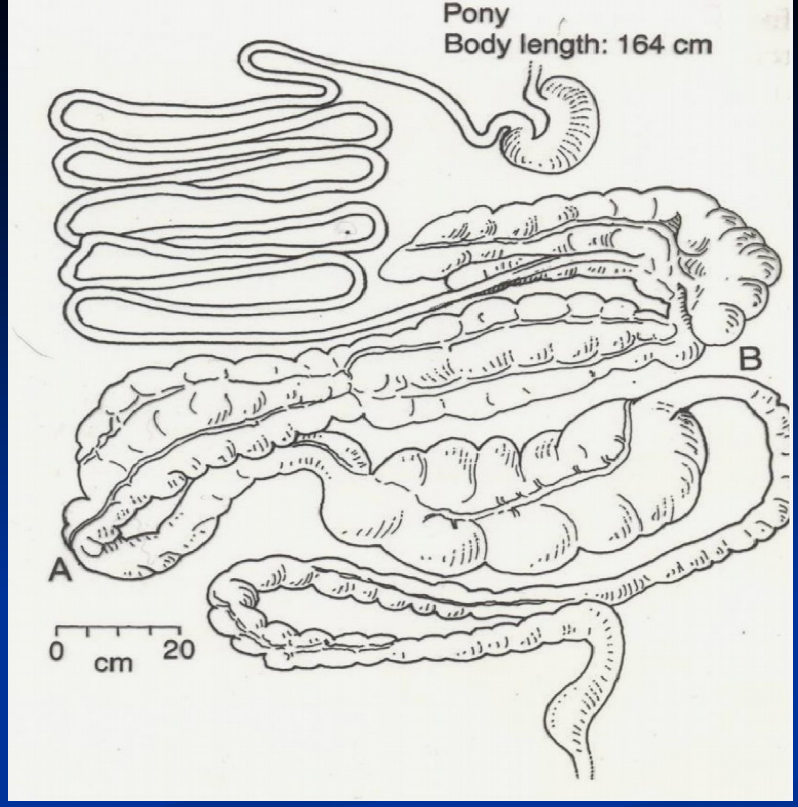
- Antiperistalsis

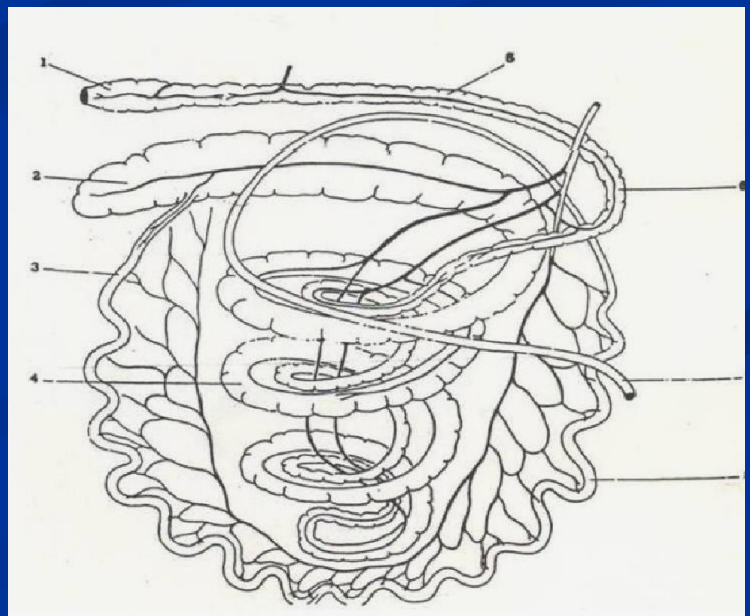


Antiperistalsis moves large intestinal contents

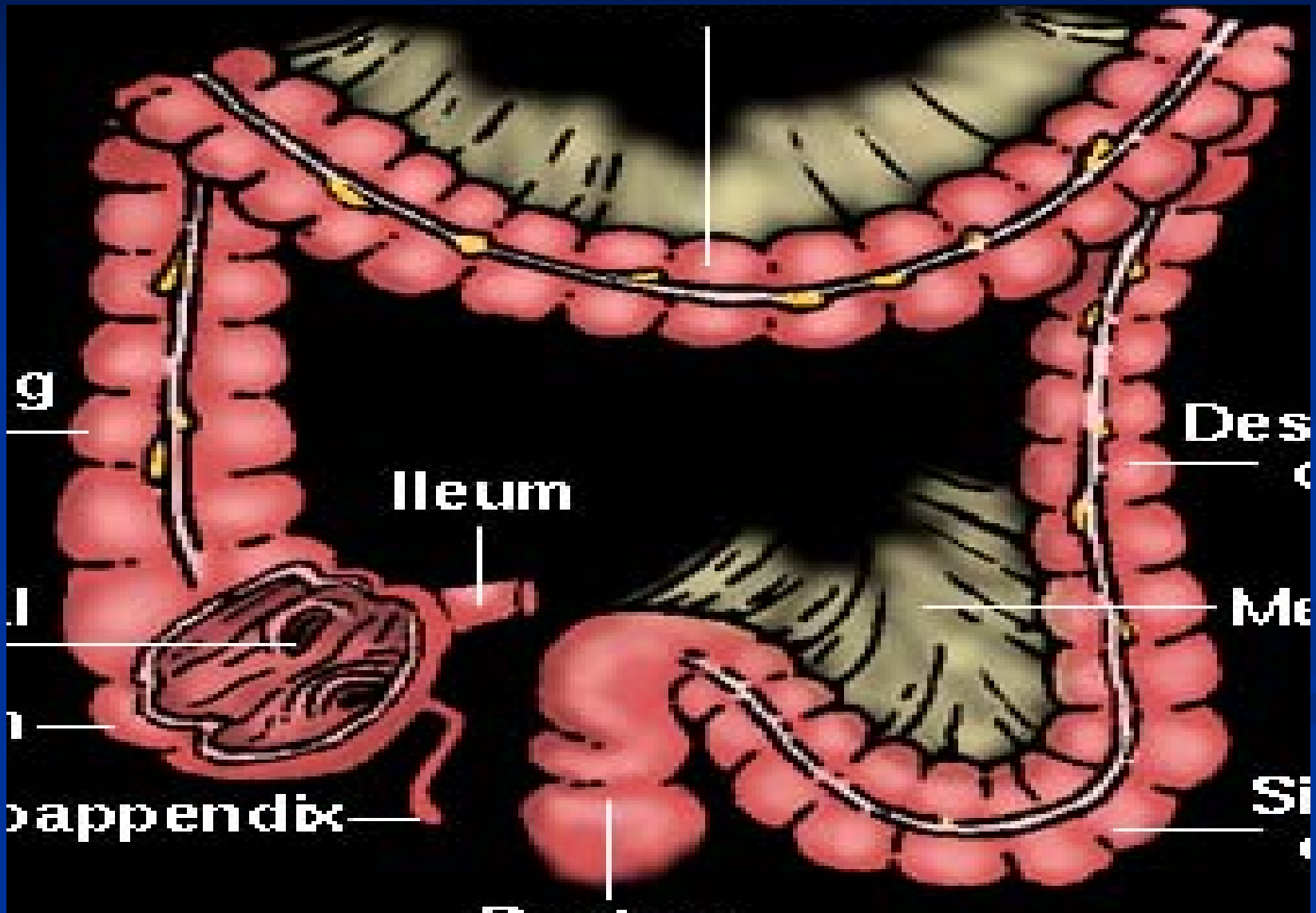
Segmentation in large intestine

- Haustration: （结肠袋） modified form of segmentation in which intense, local contraction of circular muscle causes large intestine to appear to bulge into sacs





MOTILITY OF THE COLON

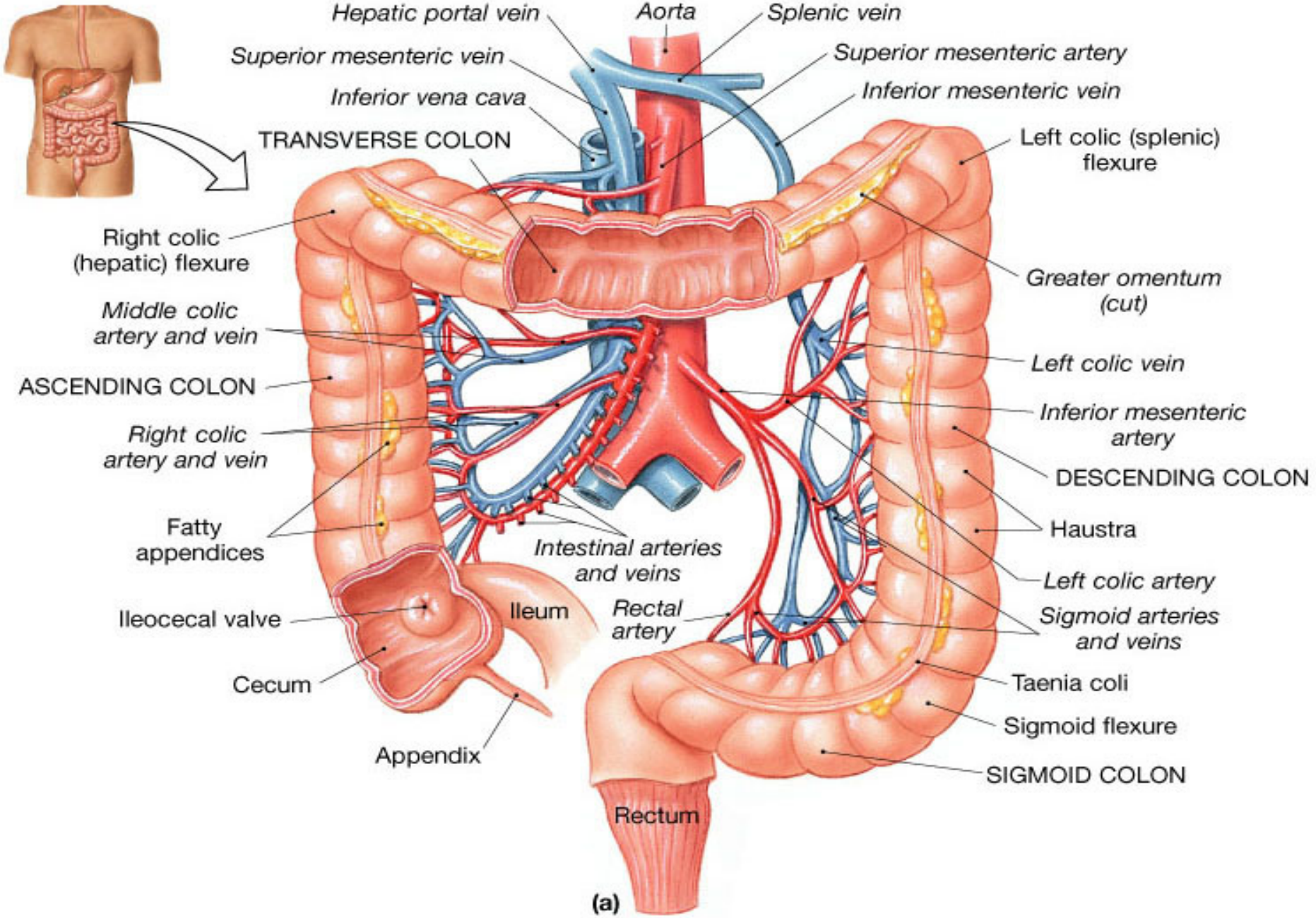


Introduction

- The colon receives 500 to 1500 ml of chyme per day from the ileum. Most of the salts and water that enter the colon are absorbed; the faeces normally contain only about 50 to 100 ml of water each day.
- (1) absorption of water and electrolytes from the chyme to form solid faeces and
- (2) storage of faecal matter until it can be expelled.
- Movements of the colon are normally very sluggish and can be divided into mixing movements and propulsive movements..

Introduction

- The colon serves as a reservoir for the residues of meals that cannot be digested or absorbed .
- Motility in this segment is likewise slowed to allow the colon to absorb water, Na^+, and other minerals.
- By removal of about 90% of the fluid, it converts the 500 to 2000 mL of isotonic chyme that enters it each day from the ileum to about 200 to 250 mL of semisolid feces.
- One to three times daily -propulsive movements (mass)


Hepatic portal vein
Aorta
Splenic vein
Superior mesenteric vein
Superior mesenteric artery
Inferior vena cava
Inferior mesenteric vein
TRANSVERSE COLON
Left colic (splenic) flexure
Right colic (hepatic) flexure
Greater omentum (cut)
Middle colic artery and vein
Left colic vein
ASCENDING COLON
Inferior mesenteric artery
Right colic artery and vein
DESCENDING COLON
Fatty appendices
Haustra
Intestinal arteries and veins
Left colic artery
Ileocecal valve
Ileum
Rectal artery
Sigmoid arteries and veins
Cecum
Taenia coli
Sigmoid flexure
Appendix
SIGMOID COLON
Rectum
(a)

The physiology of different colon regions

1. The ascending colon is specialized for processing chyme delivered from the terminal ileum
- When feacal matter is instilled into the cecum, half of the instilled volume empties in 87 min
- This period is short in comparison with the transverse colon
- The ascending colon is not the primary site of storage, mixing and removal of water

The physiology of different colon regions

2. The transverse colon is specialized for the storage and dehydration of feces

- The transverse colon together with the ascending colon are innervated via the branches of the vagus nerve.
- The transverse colon is the primary site for the removal of water and electrolytes and the storage of feces

The physiology of different colon regions

3. The descending colon is a conduit between the transverse and sigmoid colon

- innervation of the descending, sigmoid colon, rectum and the anal canal is via the pelvic nerves from the sacral spinal cord.
- This region has the neural program for power propulsion

The physiology of different colon regions

4. The physiology of the rectosigmoid region, anal canal, and pelvic floor musculature maintains fecal continence

- The sigmoid and rectum are reservoirs with a capacity of up to 500mL
- The puborectalis muscle and external anal sphincter comprise a functional unit of that maintains continence
- Fibers of puborectalis join behaind the anorectum and pass around it to form a U-shaped sling (physiological valve)

Motility of the Colon

- **Motility of the Cecum and Proximal Colon .**
- Most contractions of the large intestine are segmental
- effective at mixing and circulating the colonic contents than at propelling them.
- The mixing facilitates absorption of salts and water
- Localized segmental contractions divide the colon into neighboring ovoid segments, called **haustra,** thus **haustration.**

Motility Con....

- In the proximal colon, "antipropulsive" patterns predominate. Reverse peristalsis and segmental propulsion toward the cecum both take place.
- Consequently, chyme is retained in the proximal colon, and this retention facilitates the absorption of salts and water.

❖ **Motility of the Central and Distal Colon Body**

- Normally, a mass movement fills the central and distal parts of the colon with semisolid feces.
- Segmental haustral contractions knead the feces and thus facilitate the absorption of remaining salts and water.
- Mass movements then sweep the feces toward the rectum

Control of Colonic Motility

- As in other segments of the gastrointestinal tract, the intramural plexuses directly control the contractile behavior of the colon, while the extrinsic innervation plays a modulating role.
- Enteric stimulatory motor neurons use acetylcholine and substance P as neurotransmitters; inhibitory enteric motor neurons release VIP and NO onto colonic smooth muscle cells.
- The extrinsic autonomic nerves to the colon modulate the control of colonic motility by the enteric nervous system.
- The **defecation reflex** (discussed later) is an exception, because *it requires the function of the spinal cord via the pelvic nerves.*

Reflex Control of Colonic Motility

- Distension of one part of the colon causes a relaxation in other parts of the colon (Colonocolonic reflex).
- This **colonocolonic reflex** is mediated partly by the sympathetic fibers that supply the colon.
- Another reflex that functions in the colon is the **gastrocolic reflex**. After a meal enters the stomach, the reflex causes the motility of proximal and distal colon and the frequency of mass movements to increase.
- The gastrocolic reflex depends on the autonomic innervation to the colon; hormones such as CCK and gastrin may also be involved.

Colonic Motility

1. Slow wave frequency variable but highest in transverse colon and the rectum (11/min)

2. Contractions increase after feeding

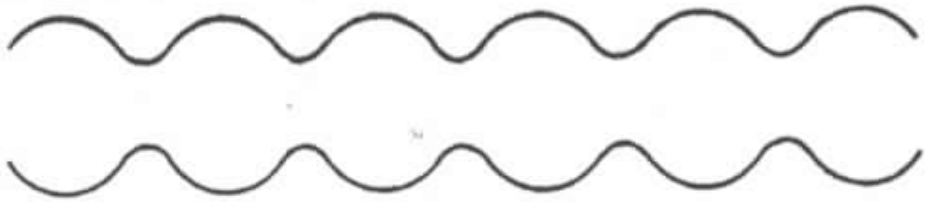
3. Mass Peristalsis after a meal termed the "Gastro-Colic reflex

Motility

- Mixing movements (Haustrations)
  - Ring-like contractions (about 2.5 cm) of the circular muscle divide the colon into pockets called haustra
  - The contracting segment and receiving segment on either side remain in their respective state for longer periods
  - In addition, there is uniform repetition of the haustra along the colon
  - Net forward propulsion occurs when sequential migration of haustra occurs along the length of the bowel

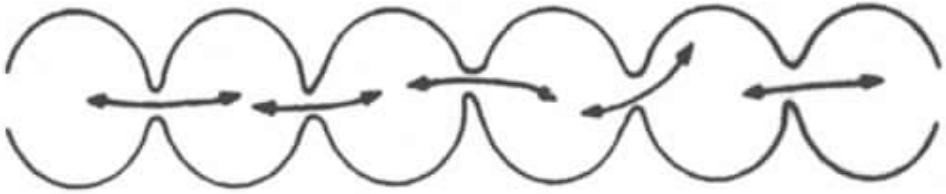
The Process of Haustral Shuttling and Propulsion

A.



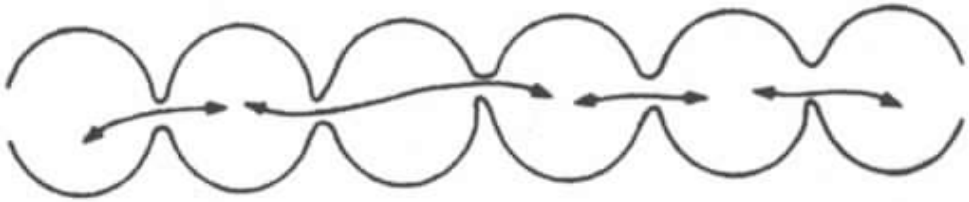
A. A qulescent segment of color

B.



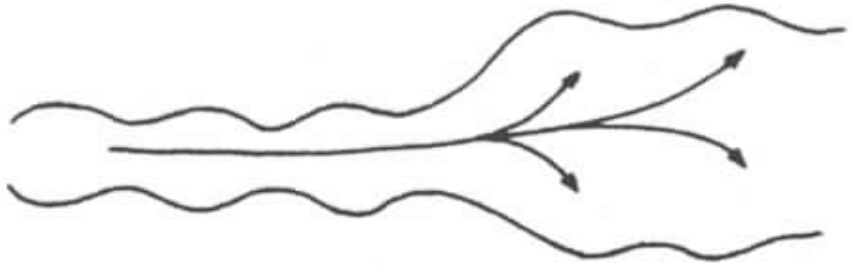
B. Haustral shuttling with no ne
movement of chyme.

C.



C. Haustral shuttling with
propulsion of chyme from
one haustrum to another.

D.



D. Multihaustral propulsion
with movement of chyme
through several haustra.

Motilty

- Propulsive movements (Mass Movements)
  - The motor events in the transverse and descending colon
  - May be triggered by the increased delivery of ileal chyme into ascending colon following a meal (gastrocolic reflex)
  - Irritants, e.g., castor oil, threatening agents such as parasites and enterotoxins can initiate mass movement
  - Starts in the middle of transverse colon and is preceded by relaxation of the circular muscle and the downstream disappearance of haustral contractions

Mass movement

- Occurs in colon;
- Period of intense propulsive activity that moves entire contents of colon distally toward rectum
  - Contractions progress for long distance such that long length of colon contracts as a unit
  - Entry of fecal matter into rectum triggers defecation reflex

GI Reflexes

- Gastrocolic
  - Increase in colonic activity after a meal
  - Distention of the stomach stimulates evacuation of the colon
- Enterogastric
  - Distention and irritation of the small intestine results in suppression of secretion and motor activity in the stomach
- Colocolonic
  - Propels stool caudally by proximal muscle constriction and distal dilatation
  - Mediated by myenteric plexus

- **Rectocolic**
  - Colonic peristalsis due to stimulation of rectum
  - Mediated by pelvic nerve

- **Intestinointestinal Reflex:**
  - When a part of the intestine becomes overdistended or its mucosa becomes excessively irritated, activity in other parts of the intestine is inhibited as long as the distention persists.

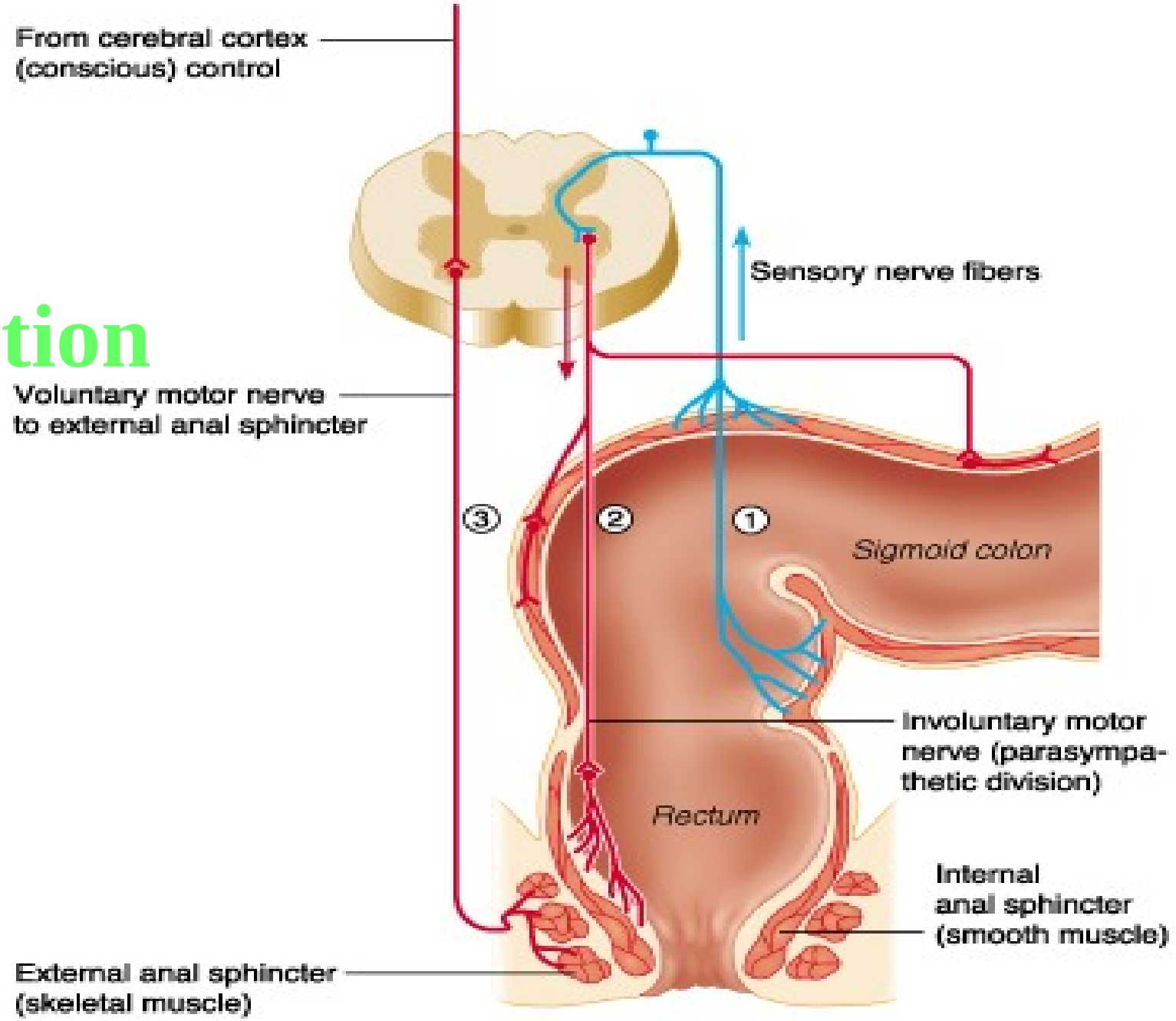
- **Gastroileal Reflex:**
  - An increase in ileal motility and opening of the ileocecal valve when food enters the empty stomach

PHYSIOLOGY OF DEFECATION

Objectives

- Define defecation
- Explain the defecation reflexes and the factors that initiate and regulate them

Defecation



Definition

- Defecation is the evacuation of the colon and the rectum of the waste products of digestion.
- It involves integrated and coordinated senserimotor functions, orchestrated by central, spinal, peripheral (somatic & visceral) and enteric nervous activities acting on a morphologically intact GIT.

Cont'd

- Distention of the rectum with faeces initiates reflex contractions of its musculature and the desire to defecate.
- When the rectum fills with faecal material, it contracts and the internal and sphincters relaxes (rectosphincter reflex)

Defecation

- Once the rectum is filled to about 25% of its capacity, there is an urge to defecate.
- Defecation is prevented because the external anal sphincter is tonically contracted.
- When it is convenient to defecate, the external anal sphincter is relaxed voluntarily and the smooth muscle of the rectum contracts to create pressure forcing the feces out of the body.
- Intra-abdominal pressure may be increased by expiring against a closed glottis (valsalva maneuver)

Cont'd

- When mass movement forces feces into the rectum
  - Immediate desire to defecate
  - Reflex contraction of rectum
  - Relaxation of anal sphincter
- Approx. 80 to 200 mL of fecal matter expelled daily

Defecation and the Parasympathetic Nervous Syst

- Signals transmitted into spinal cord
- Reflex back to descending colon, sigmoid, rectum and anus (pelvic nerves)
- Intensify peristalisis
- Relax internal anal sphincter

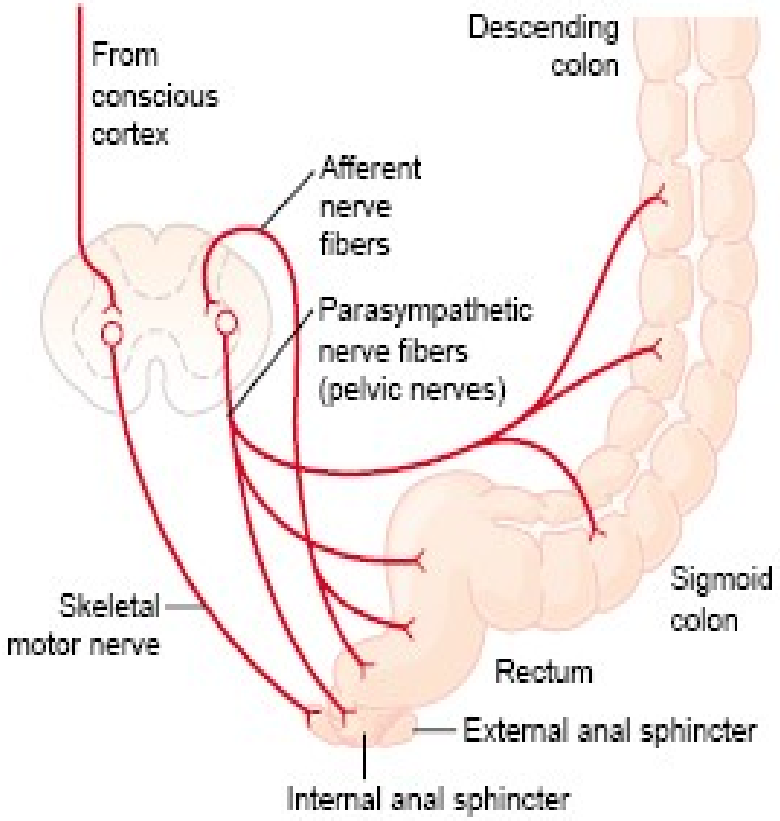
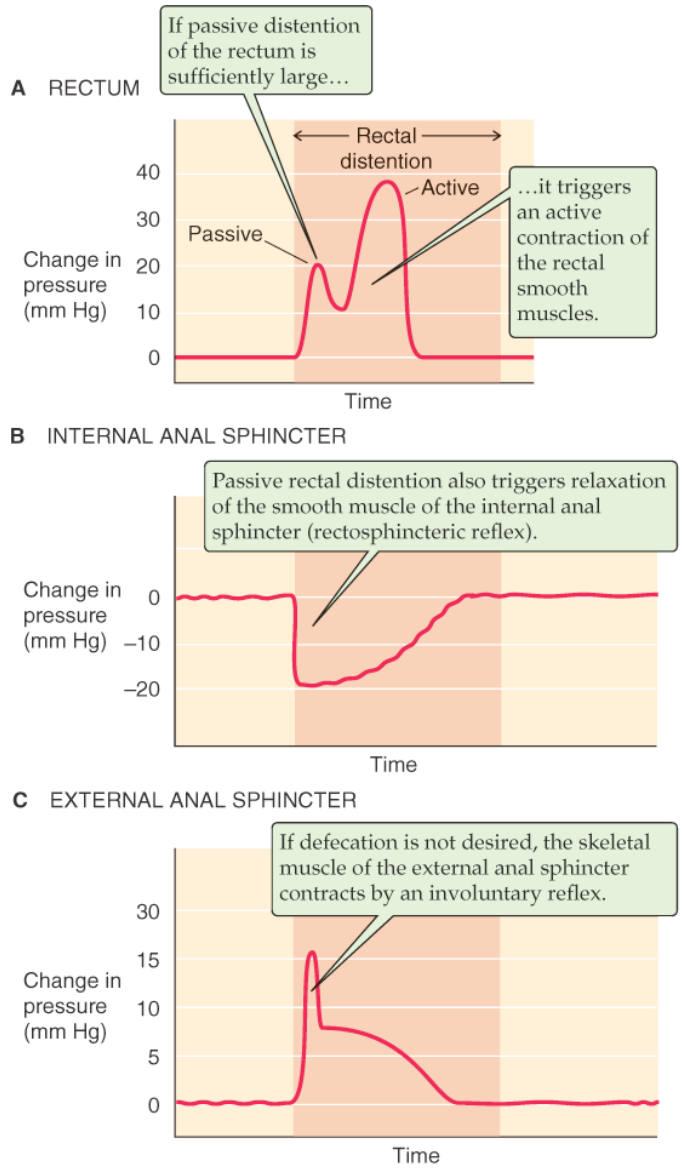


Figure 63–6

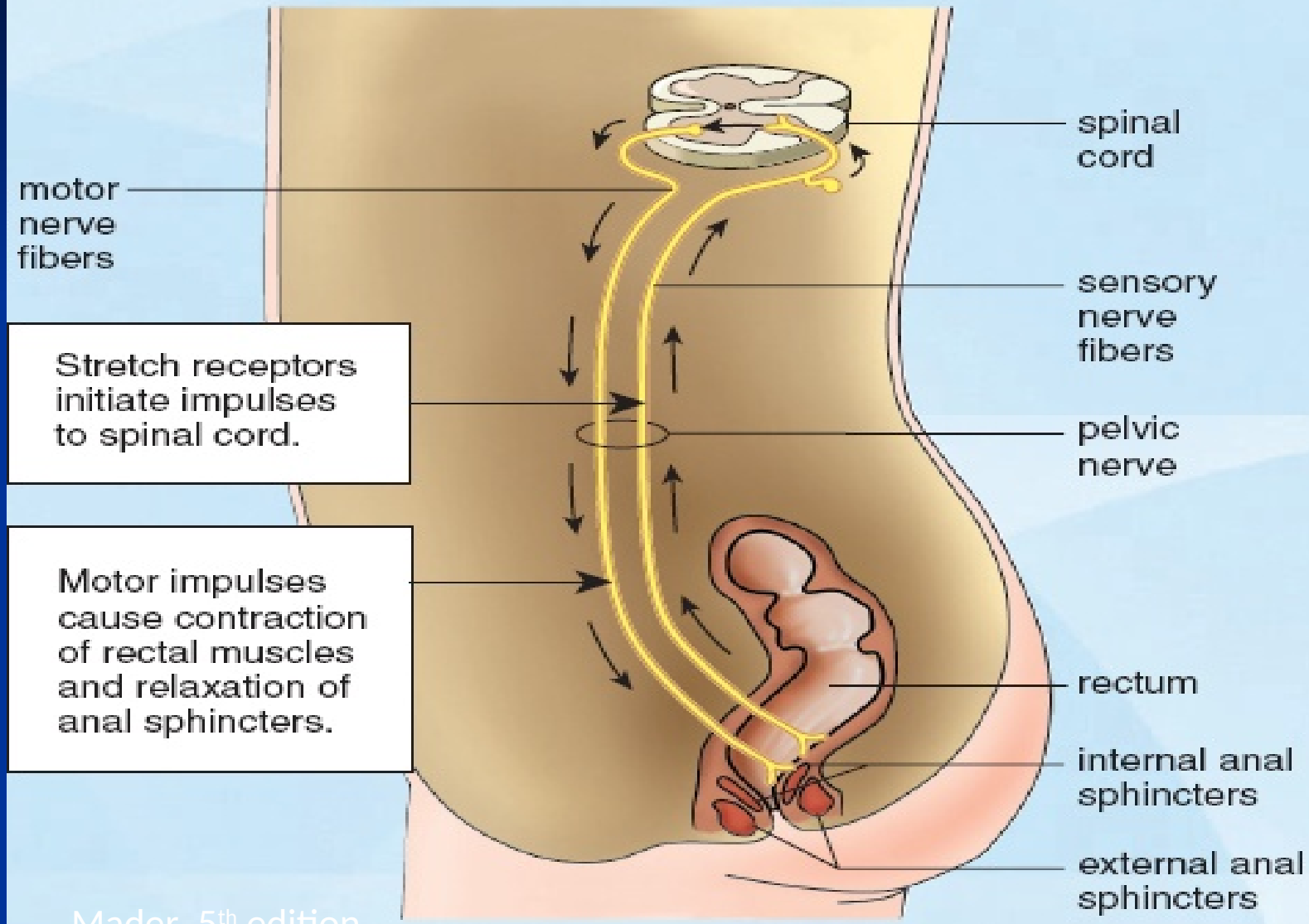
Afferent and efferent pathways of the parasympathetic mechanism for enhancing the defecation reflex.

② Initiation of Defecation: Filling



- Initiation of defecation is accomplished by
  - mass movements (gastrocolic reflex, hormones), or
  - small movements in sigmoid (distension/enema), or
  - emptying of sigmoid (increase in abdominal pressure).
- Result is filling of *ampulla recti*.
- Touch and/or pressure receptors signal via *n. erigentes* (*plexus pelvicus* - para-sympathetic; S_2 - S_4) a feeling of urge.
- Elicits either
  - recto-anal inhibitory reflex (B; ENS & ANS; leads to defecation), or
  - recto-anal contractile reflex (C; CNS; suppresses defecation).

Figure 15B Defecation reflex. The accumulation of feces in the rectum causes it to stretch, which initiates a reflex action resulting in rectal contraction.



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