بسم الله الرحمن الرحيم
السلام عليكم ورحمة الله وبركاته

PHYSIOLOGY OF THE COLON: MOTILITY

By

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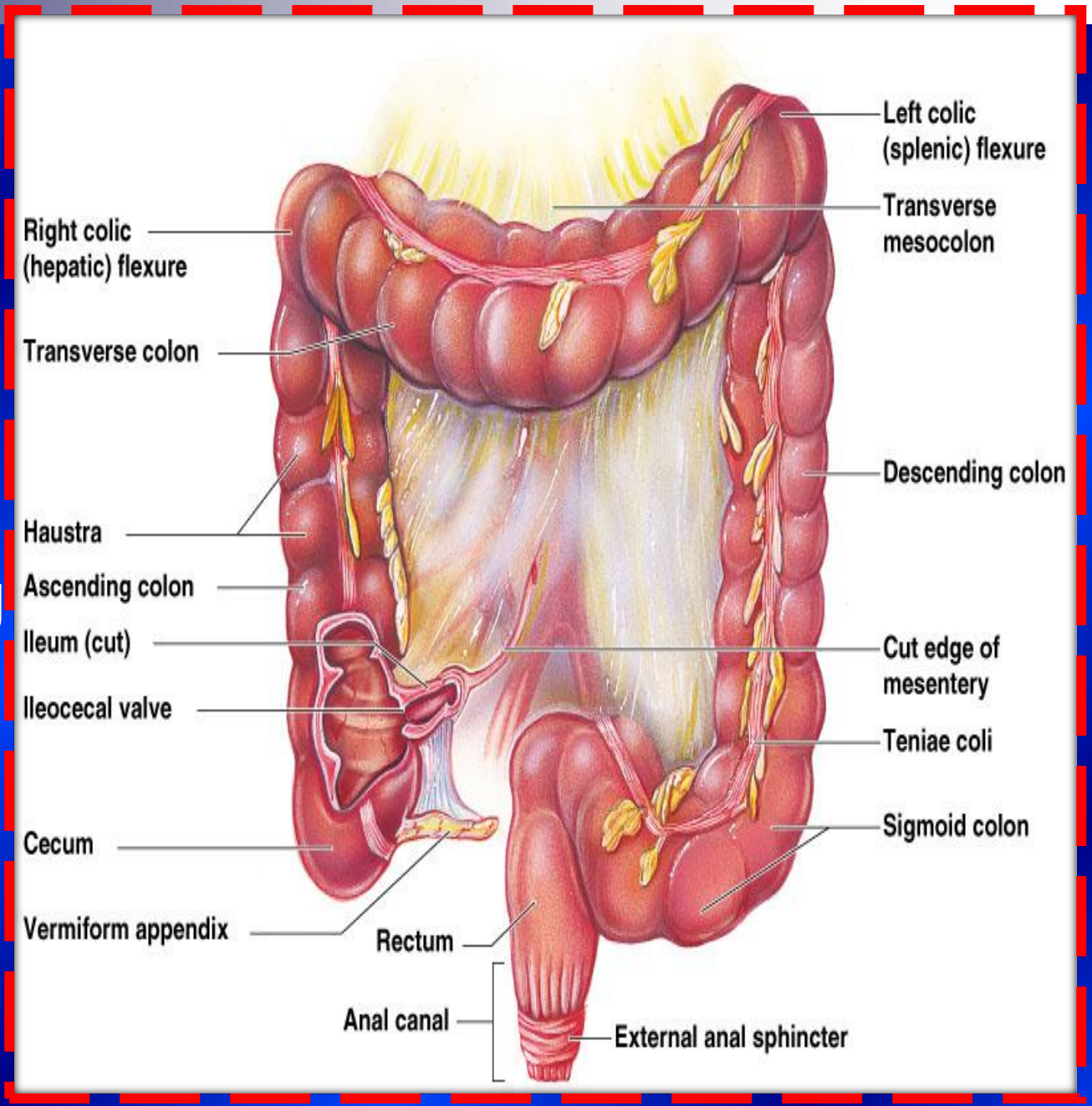
Parts of the Large Intestine

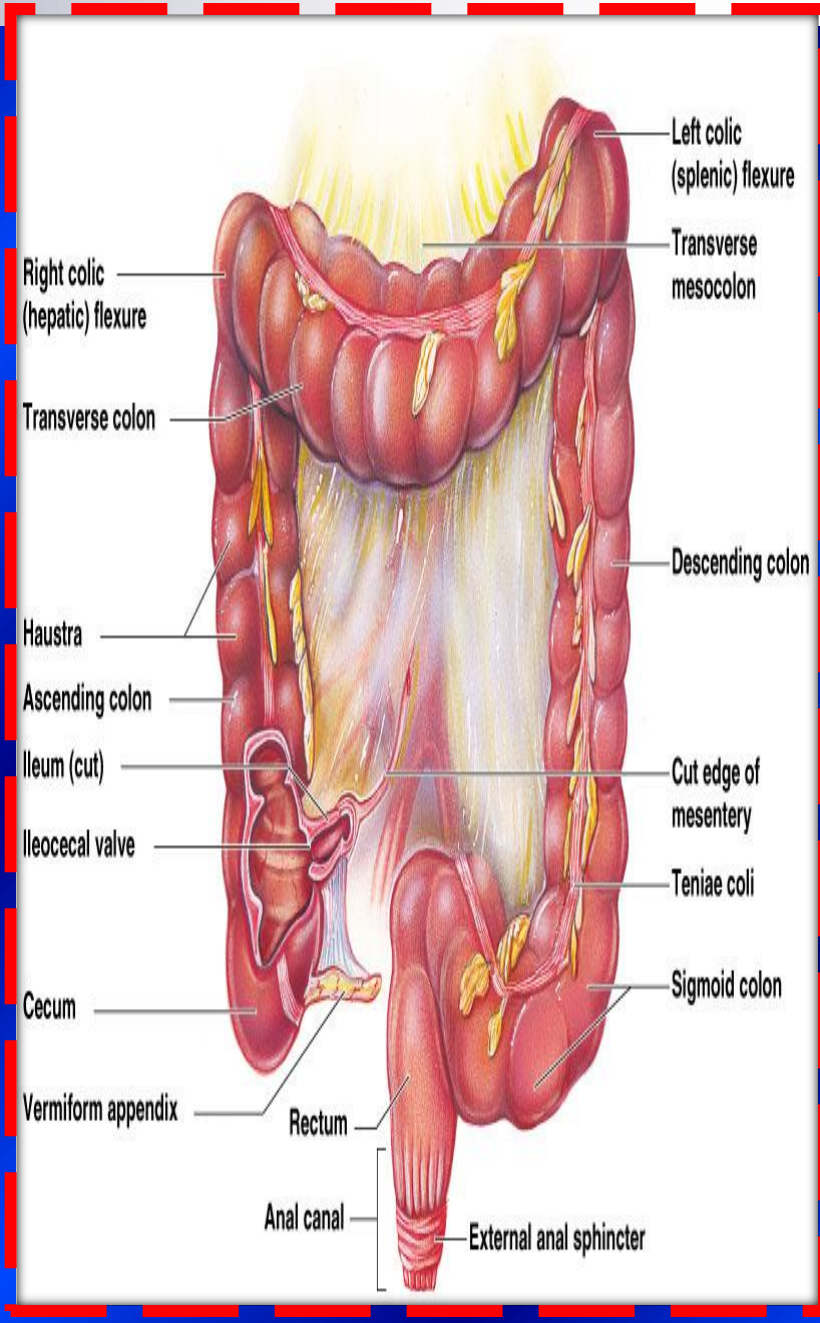
- Cecum
  - Saclike first part of the large intestine
- Appendix
  - Accumulation of lymphatic tissue that sometimes becomes inflamed (appendicitis)
  - Hangs from the cecum

- Colon
  - Ascending
  - Transverse
  - Descending
  - S-shaped sigmoidal
- Rectum
- Anus



The colon

- The outer longitudinal layer is modified to form three longitudinal bands called tenia coli visible on the outer surface.
- Since the muscle bands are shorter than the length of the colon, the colonic wall is sacculated and forms haustra.



- The mucous membrane of the colon lacks villi and has many crypts of Lieberkühn.
- They consist of simple short glands lined by mucous-secreting goblet cells.
- The epithelial cells contain almost no enzymes.
- The colon has a length of 150 cm.
- The transit of small labeled markers through the large intestine occurs in 36-48 hrs.

The physiology of different colon regions

1.The ascending colon is specialized for processing chyme delivered from the terminal ileum.

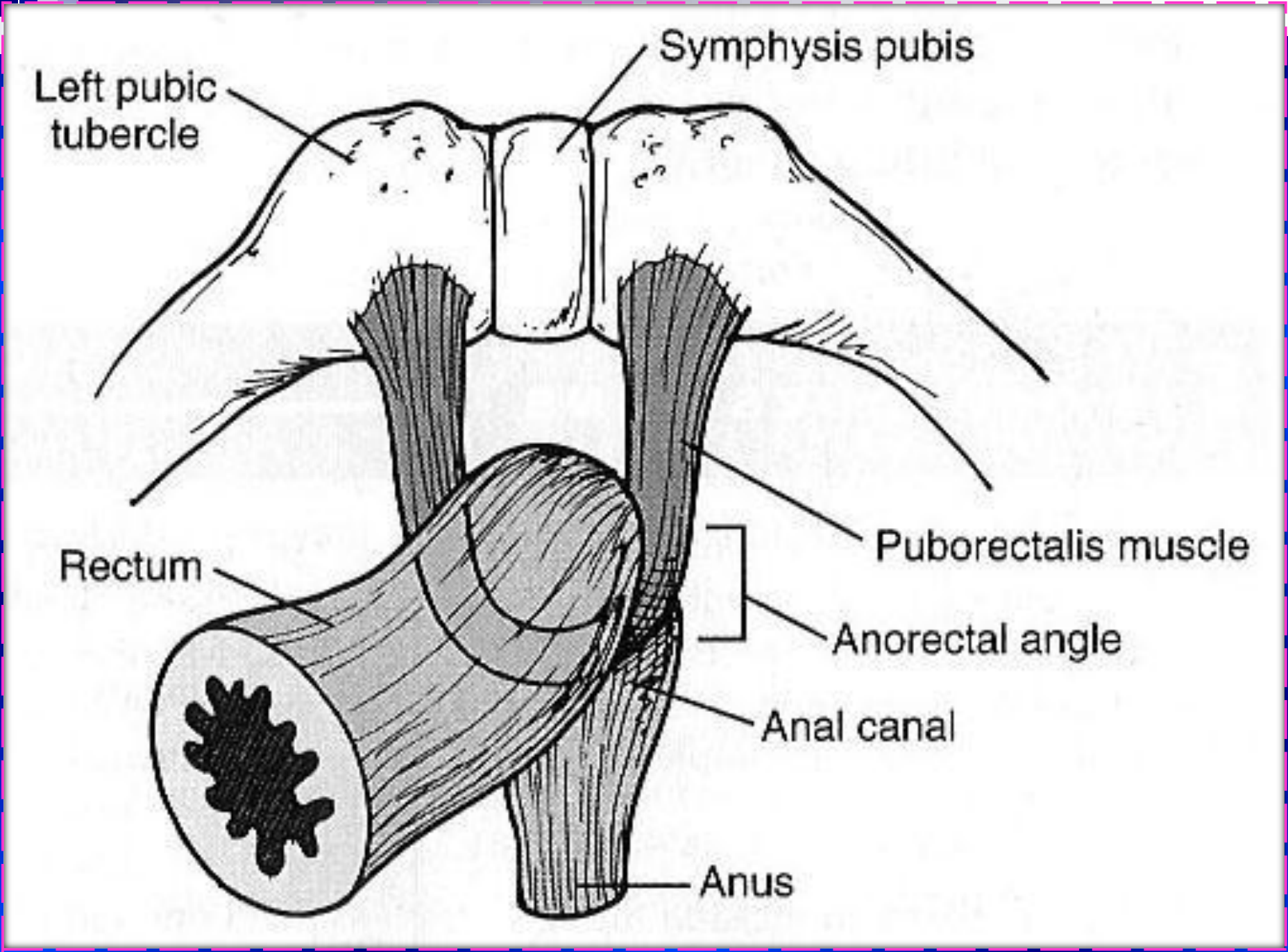
2.The transverse colon is specialized for the storage and removal of water & electrolytes from feces.

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

This region has the neural program for power propulsion that is involved in defecation reflex.

4-The rectosigmoid region, anal canal, and pelvic floor musculature maintains fecal continence.

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


Symphysis pubis
Left pubic tubercle
Puborectalis muscle
Rectum
Anorectal angle
Anal canal
Anus

Secretion in the colon

It is mainly mucus, no digestive enzymes.

The mucus has the following ***functions***

1- It helps to lubricate feces.

2- It neutralizes against any acids present.

3- It protects against irritation.

4- It provides a binding medium for fecal matter.

- Stimulation of the pelvic nerves from the spinal cord can cause marked increase in mucus secretion. This occurs along with increase in peristaltic motility of the colon.
- During extreme parasympathetic stimulation, so much mucus can be secreted into the large intestine that the person has a bowel movement of ropy mucus as often as every 30 minutes; this mucus often contains little or no fecal material.

Secretion of water & electrolytes

- Whenever a segment of large intestine becomes irritated as occurs in bacterial infection, the mucosa secretes large amount of water & electrolytes in addition to the alkaline mucus.
- This dilute the irritating factors and causes rapid movement of the feces toward the anus.

Absorption in the colon

Most of absorption in the colon occurs in the proximal half of the colon (absorptive colon). Whereas the distal colon function for storage (storage colon).

1- Water absorption, about 0.5- 1.5L/day is absorbed. The net water loss is 150-200 ml/day.

N.B: The large intestine can absorb a maximum of 5 to 8 liters of fluid and electrolytes each day.

2- Na^+ absorption, about 60 mmol/day is actively absorbed (in the presence of Na^+-K^+ ATPase) at the basolateral membrane to blood.

3- K^+, Cl^- and HCO_3^-.

- K^+ is secreted into the lumen of colon.
- Cl^- is absorbed in exchange for HCO_3^- which is secreted.
- Persistent diarrhea can result in hypokalemia, dehydration and metabolic acidosis.

4- Folic acid and some AA and short chain FA resulting from bacterial fermentation of CHO are absorbed.

5- Certain drugs as steroids and aspirin may be absorbed.

Intestinal bacteria

This bacterial flora is living in symbiosis with human and its effects are beneficial to the body.

1- Vitamin K and some B group vitamins as folic acid, biotin, thiamine and B_{12} are synthesized by intestinal bacteria.

The bacteria-formed vitamin K is especially important because the amount of this vitamin in the daily ingested foods is normally insufficient to maintain adequate blood coagulation.

2- Bile salts are deconjugated and decarboxylated by intestinal bacteria.

3- Bile pigments are broken down in intestine to produce stercobilinogen which is excreted in stool giving it brown color.

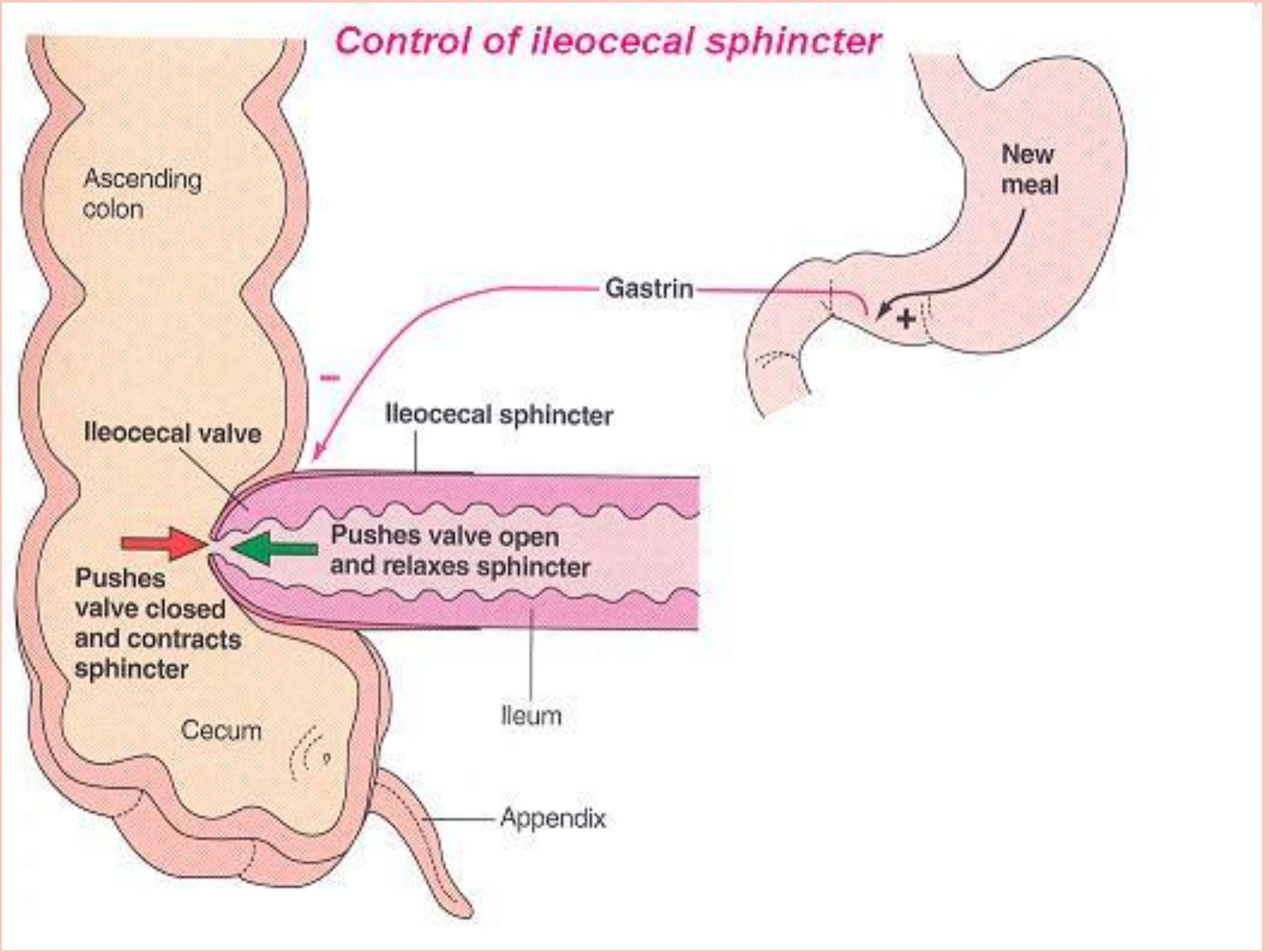
4- Intestinal bacteria decarboxylate some AA to produce amine and histamine. The amines are excreted in feces and are responsible for its smell.

5- Urea diffuses from blood to colon where it is broken down by its bacterial urease to ammonia. Most ammonia is absorbed and reconverted into urea by liver. In hepatic failure, accumulation of ammonia can cause hepatic encephalopathy.

6- Bacterial fermentation of undigested CHO may produce short chain FA and gases as CO_2.

The ileocaecal valve

- It prevents backflow of contents from colon into small intestine.
- It remains closed and open only when an intestinal peristaltic wave reaches it.
- Distension of the cecum, Secretin, Ach, alpha adrenergic stimulation contract ileocaecal valve.
- Gastrin, CCk, B adrenergic stimulation relax ileocaecal valve.


Control of ileocecal sphincter
Ascending colon
New meal
Gastrin
+
−
Ileocecal valve
Ileocecal sphincter
Pushes valve open and relaxes sphincter
Pushes valve closed and contracts sphincter
Cecum
Ileum
Appendix

Types of colonic movements

1- Mixing Movement (Haustrations)

- In the same manner that segmentation movement occur in the small intestine, large circular constrictions also occur in the large intestine.
- At each of these constrictions points, about 2.5 cm of the circular muscle contracts.
- At the same time the longitudinal strips contract.

- These combined contractions cause the unstimulated portion of the large intestine to bulge outward into baglike sacs called haustrations.
- The haustral contraction once initiated usually reach peak intensity in 30 seconds & then disappear during the next 60 seconds.
- They also at times move slowly analward during their period of contraction especially in the cecum & ascending colon.

- After another few minute new haustral contractions occur in other areas nearby.
- In this way all fecal material is gradually exposed to the surface of the large intestine & fluid is progressively absorbed.

2- Propulsive (mass) Movement

- Peristaltic waves of the type seen in small intestine are rare. Most of the propulsion in the cecum & ascending colon results from the slow, persistent haustral contractions requiring as many as 8-15 hours to move the chyme only from the ileocecal valve to the transverse colon while the chyme itself becomes fecal in quality & also semisolid instead of semifluid.

♦From the transverse colon to the sigmoid, mass movement mainly take over the propulsive role.

♦ These movements usually occur only few times each day, most abundantly for 15 min during the first hour after eating breakfast.

♦ A mass movement is a modified type of peristalsis characterized by a constrictive ring occurs at a distended or irritated point in the colon. Then rapidly the 20 or more cm of the colon distal to the constriction contract almost as a unit forcing the fecal material en mass down the colon

- During this process the haustrations disappear completely.
- The initiation of contraction is complete in about 30 seconds. During the next 2 to 3 min another mass movement occurs.
- the whole series of mass movement will usually persist for only 10 min to half an hour. They will then return after a half day or even a day later.

- Mass movement can occur in any part of the colon, though most often they occur in the transverse or descending colon.
- When they have forced a mass of feces into the rectum the desire for defecation is felt.

Initiation of Mass Movement:

- Gastrocolic & duodenocolic reflexes after meals. They result from distension of the stomach & duodenum.
- Irritation of the colon e.g., castor oil.
- Intense stimulation of PNS.
- Over distension of a segment of the colon.

3- Antiperistalsis

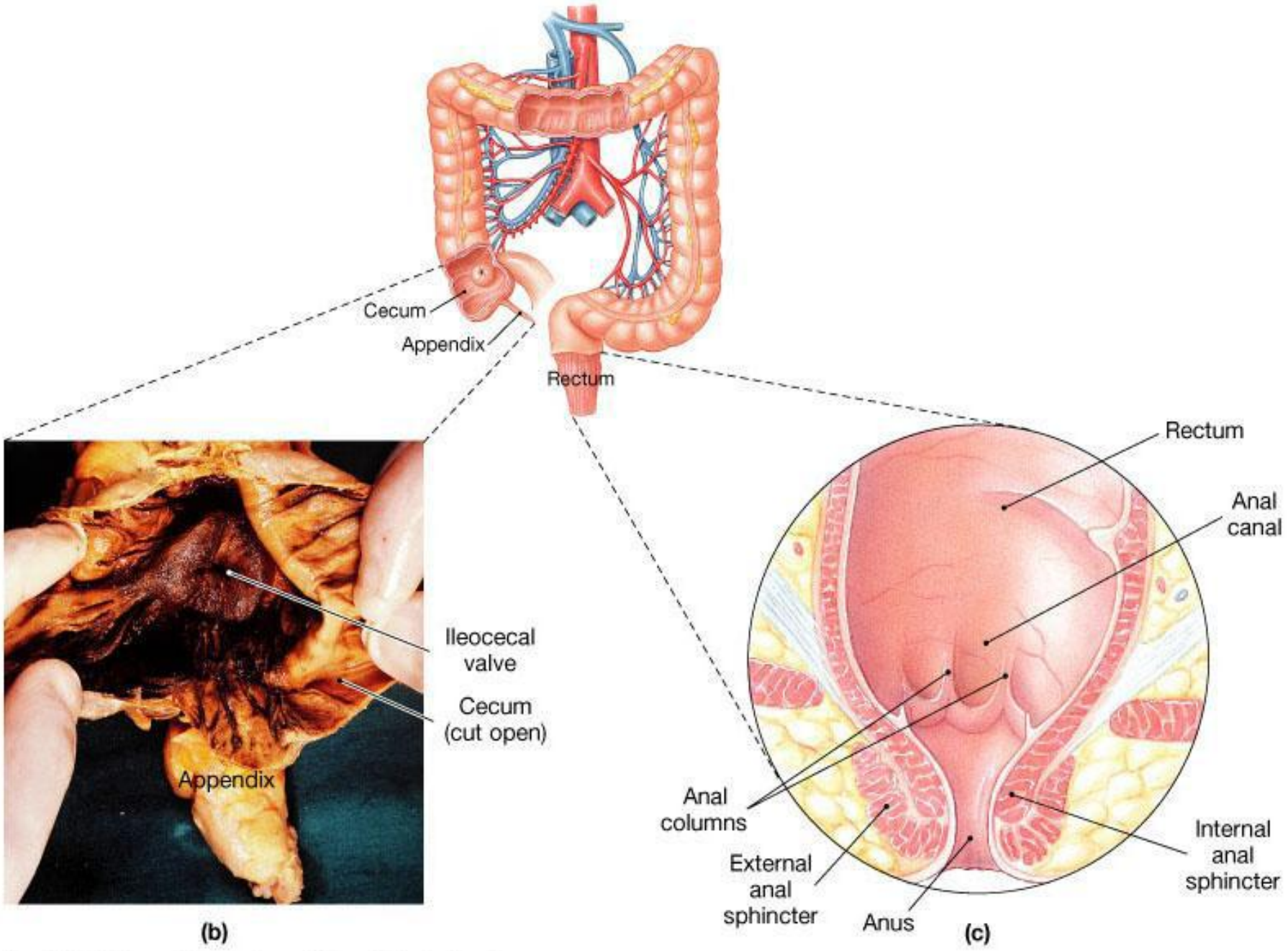
- It starts at the junction of ascending and transverse colon and traveling towards the cecum.
- It mixes contents and help water absorption.

Control of Colonic Motility

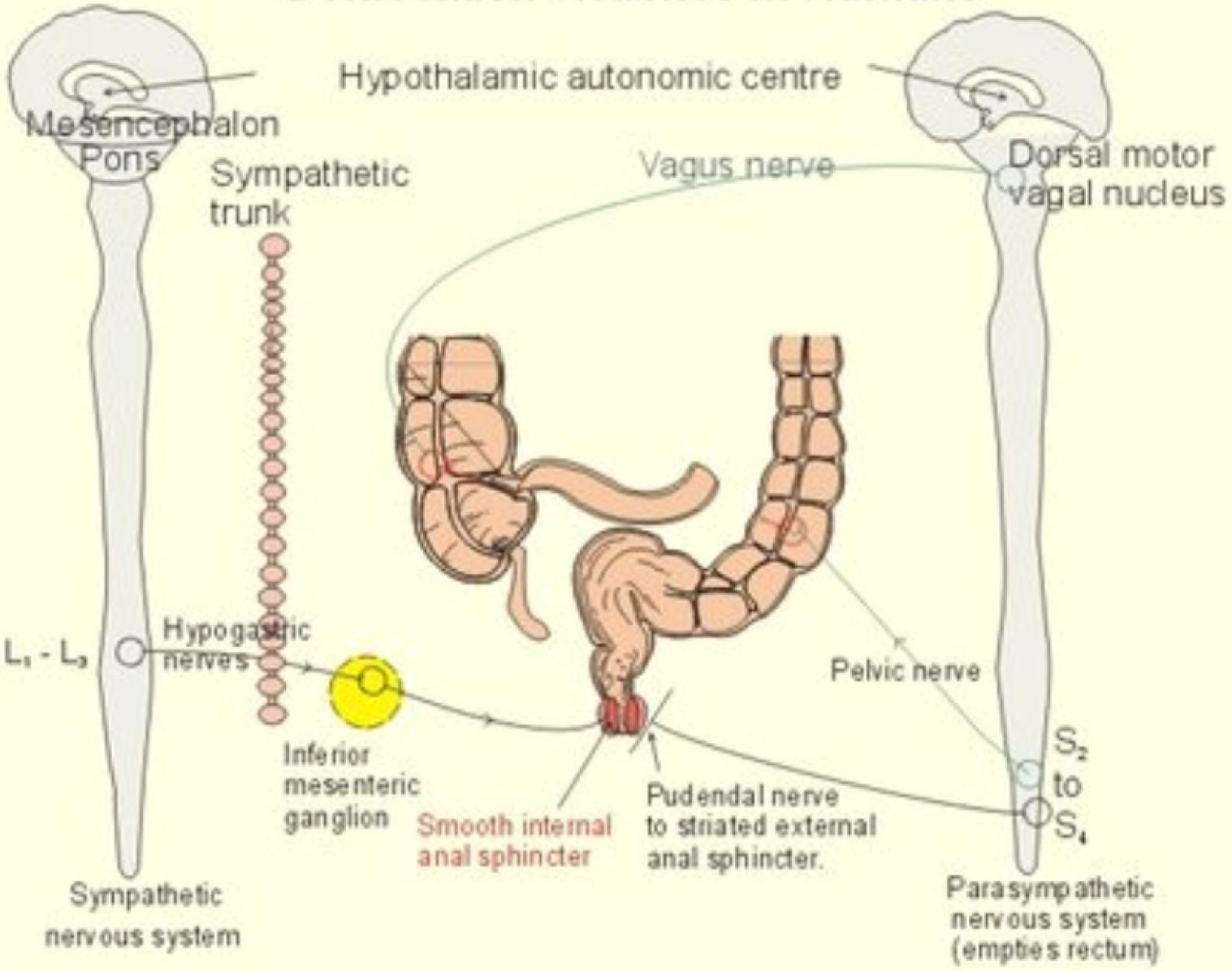
- The intramural plexuses directly control the contractile behavior of the colon.
- Stimulatory enteric motor neurons use acetylcholine & substance P as neurotransmitters.
- Inhibitory enteric motor neurons release VIP & NO onto colonic smooth muscle cells.
- The extrinsic autonomic nerves to the colon modulate the control of the colonic motility by the enteric nervous system.

Defecation

- It is a spinal reflex which is influenced by higher center.
- Most of the time the rectum is empty and both internal and external sphincters are reflexly maintained in a state of tonic contraction.
- Gastric or intestinal filling initiate a mass movement in the colon that pushes feces into rectum (gastrocolic & dudenocolic reflexes).
- The rectum is distended and sends signals to cerebral cortex producing the desire to defecate.


Cecum
Appendix
Rectum
Ileocecal valve
Cecum (cut open)
Appendix
(b)
Rectum
Anal canal
Anal columns
External anal sphincter
Anus
Internal anal sphincter
(c)

Defaecation Reflexes In Humans



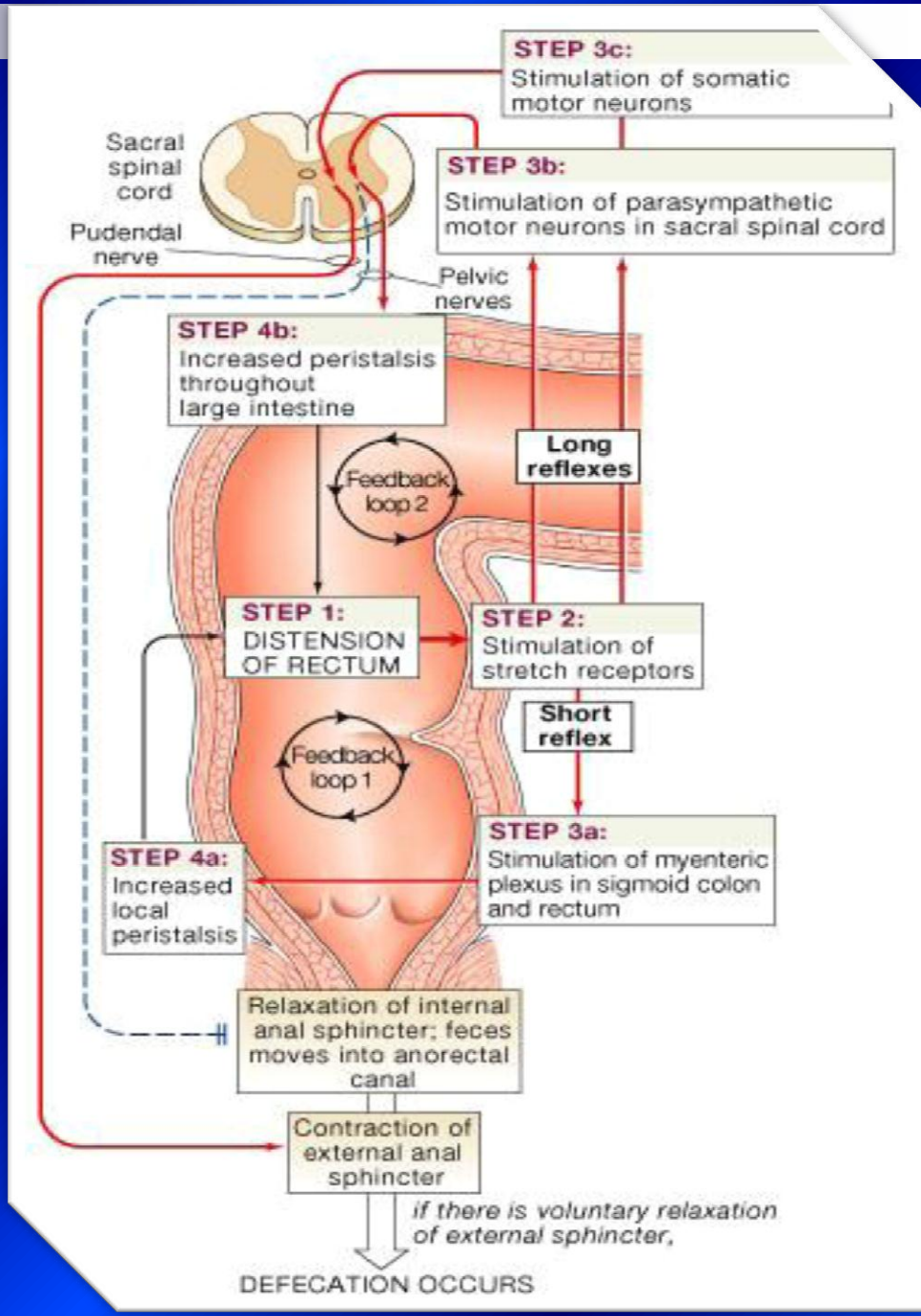
KMc

* If the surrounding circumstances are suitable

- Defecation reflex will be allowed. Stretch of the rectal wall is signaled to SC by pelvic nerve. Efferent pelvic impulses cause reflex contraction of the rectum and relaxation of IAS.
- This is followed by reduction in tonic impulses to EAS, so it relaxes and feces leave the rectum assisted by voluntary straining and contraction of pelvic floor muscle.

Defecation Reflex

1. Distension of the rectum.
2.Stimulation of the stretch receptors in the rectum.
3.A. Short reflex: Stimulation of myenteric plexus in sigmoid colon and rectum.
3.B. long reflex: stimulation of parasympathetic motor neurons in sacral spinal cord.
3.C. stimulation of somatic motor neurons.
4.Increased local peristalsis, relaxation of internal anal sphincter and contraction of external anal sphincter.



* If situation is not suitable for defecation

- The reflex is inhibited by the cerebral cortex. Tonic contraction of EAS is voluntary maintained which leads to accommodation of the rectum to distension and return of tonic contraction of the IAS.
- In infants (and in spinal cord lesion) the spinal reflex of defecation operates without interference from higher centers (fecal incontinence).

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