Gastrointestinal Physiology (Lecture 6)

Physiology of The Colon: Motility

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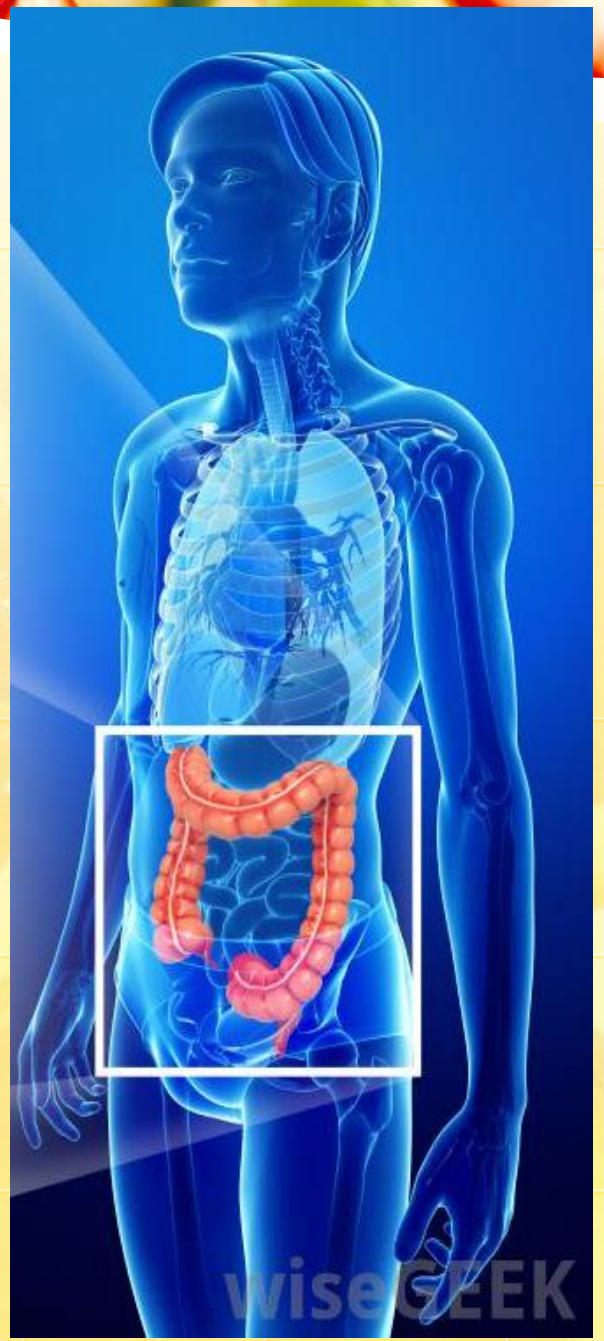
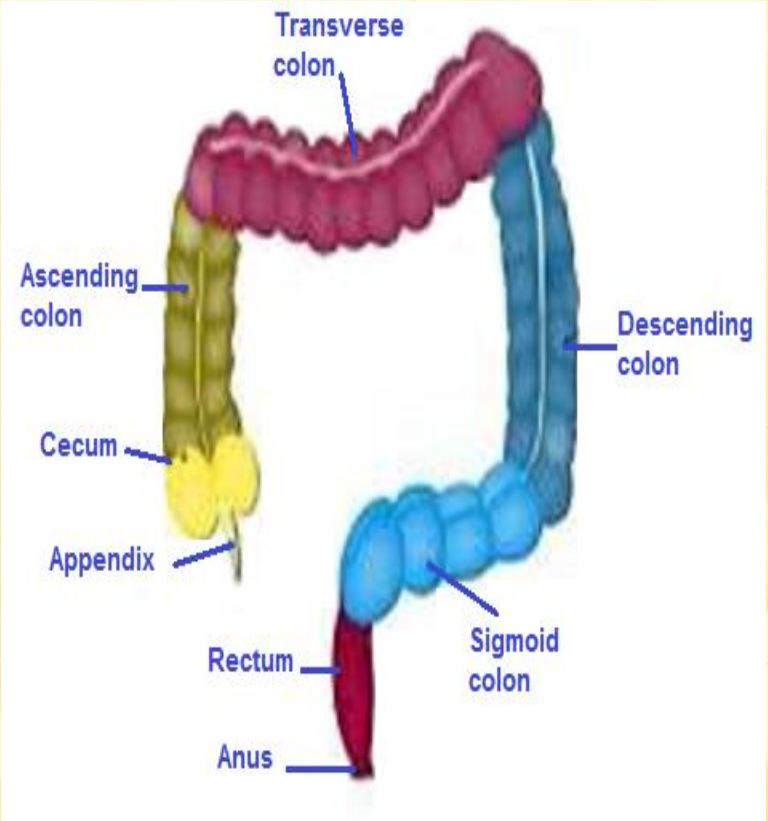


Learning Objectives

1. Physiological Functions of Different Colon Regions
2. Secretion in the Colon
3. Nutrient Digestion & Absorption in the Colon
4. Bacterial Action in the Colon
5. Motility in the Colon
6. Defecation Reflex

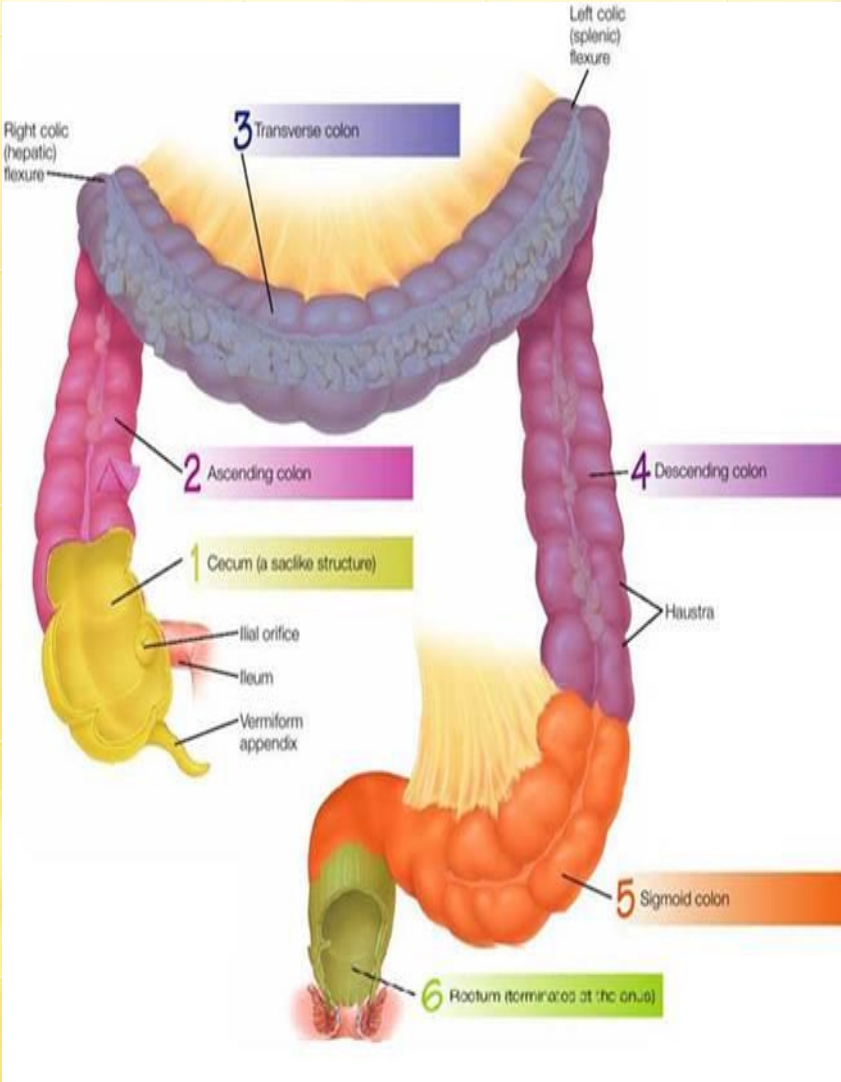
The Large Intestine

- This is the final digestive structure.
- By the time the digested food (chyme) reaches the large intestine, most of the nutrients have been absorbed.
- The primary role of the large intestine is to convert chyme into feces for excretion.

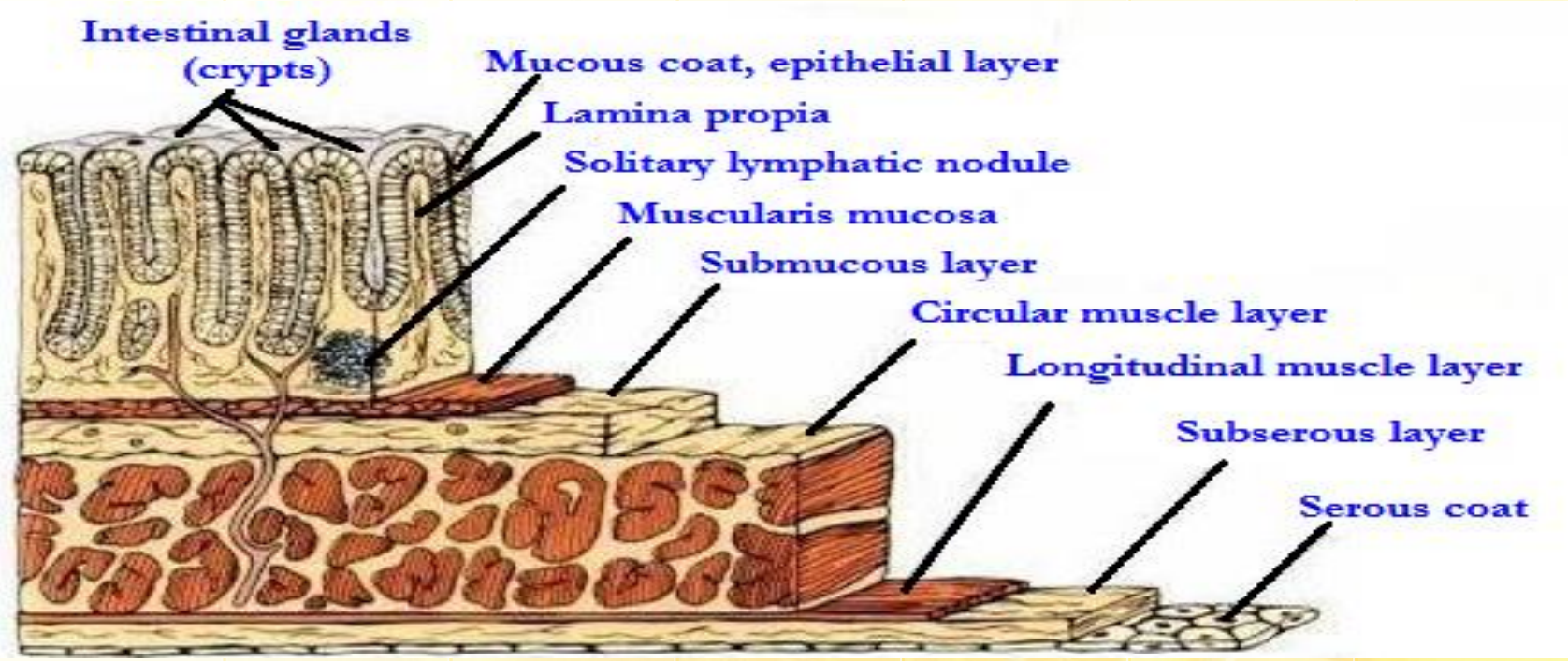


Parts of The Colon

- The colon has a length of about 1.5 meters (one-fifth of the whole length of GIT).
- It consists of the ascending, transverse, descending & sigmoid colon, rectum and anal canal.
- The transit of radiolabeled chyme through the large intestine occurs in 36-48 hrs.

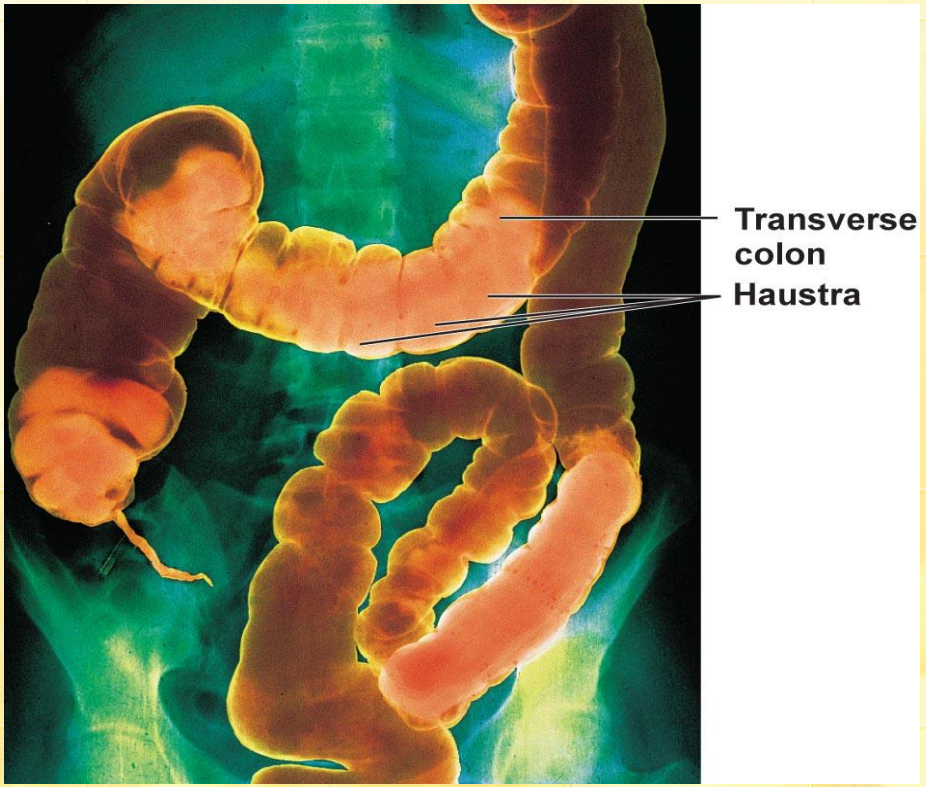


The Mucous Membrane of The Colon



- Lacks villi and has many crypts of Lieberkühn.
- The crypts consist of simple short glands lined by mucous-secreting goblet cells.

- The outer longitudinal muscle 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.



Functions of The Colon

01

Absorb

- Vitamins produced by bacteria

02

Reabsorb

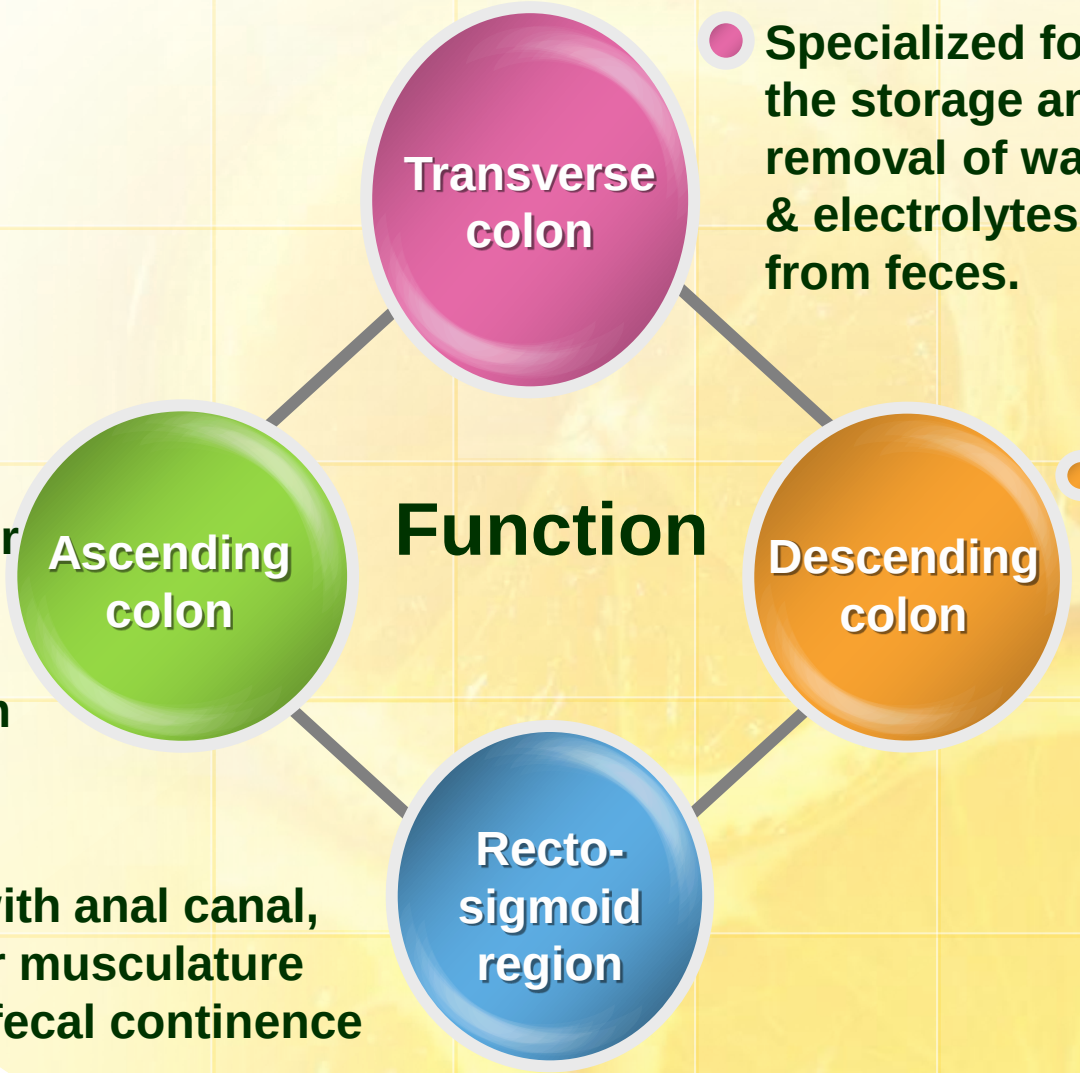
- Water and compact material into feces

03

Store

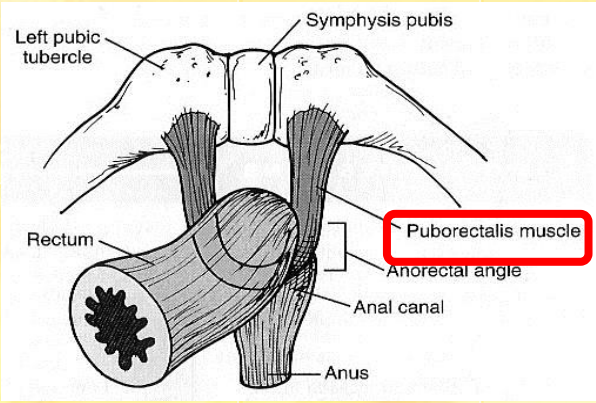
- Fecal matter prior to defecation

The Physiology of Different Colon Regions

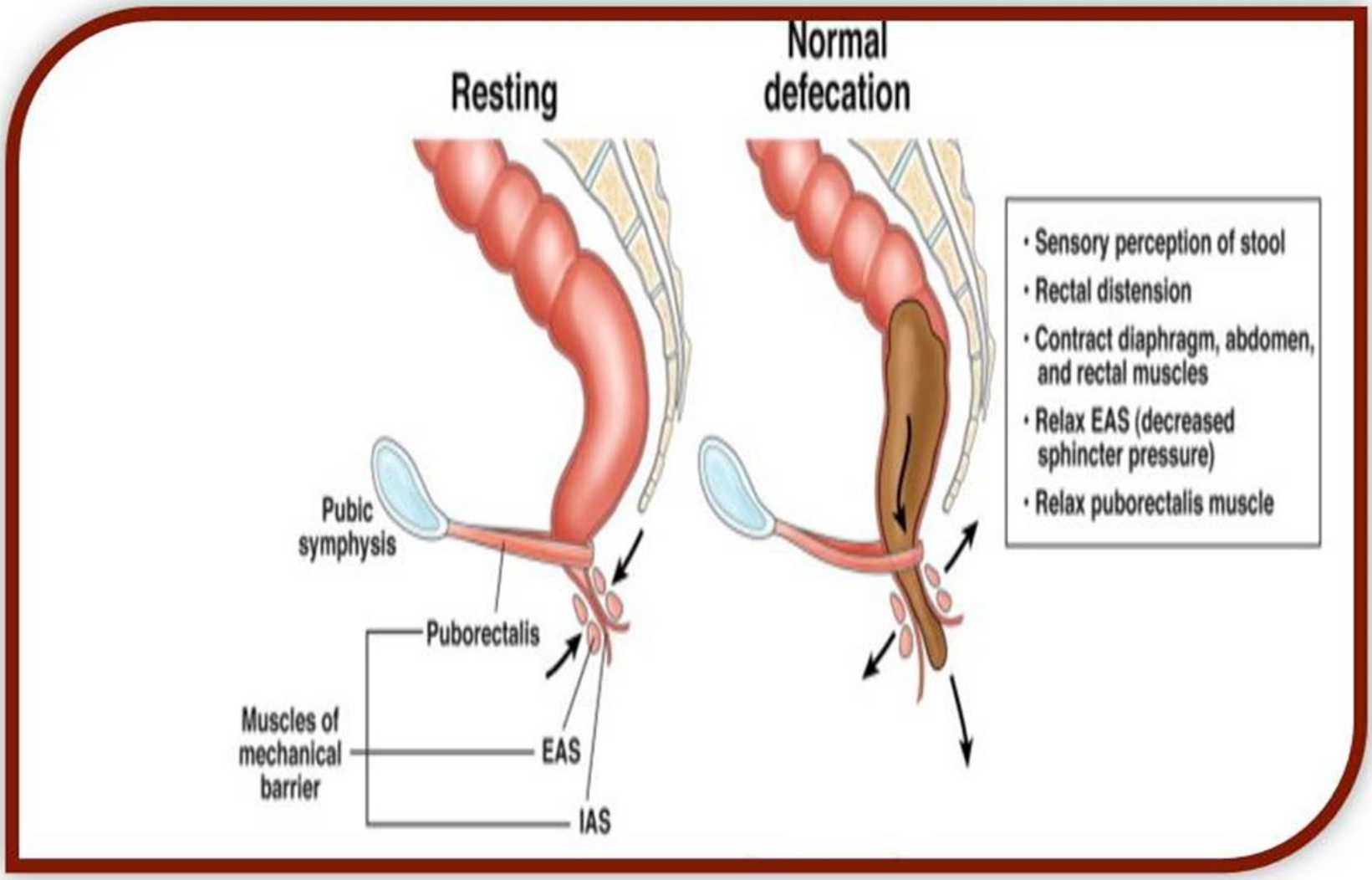


How the rectosigmoid region, anal canal & pelvic floor musculature maintains fecal continence?

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



Fecal Continence



Secretion in The colon

The epithelial cells contain almost no digestive enzymes.

The secretion is mainly mucus, it has the following functions:

1- It neutralizes against any acids present.

2- It protects against irritation.

3- It helps to lubricate feces.

4- It provides a binding medium for fecal matter.

Effect of Parasympathetic Stimulation on Secretion

☆Stimulation of the **pelvic nerves** cause:

- Increase in peristaltic motility of the colon.
- Marked increase in mucus secretion.

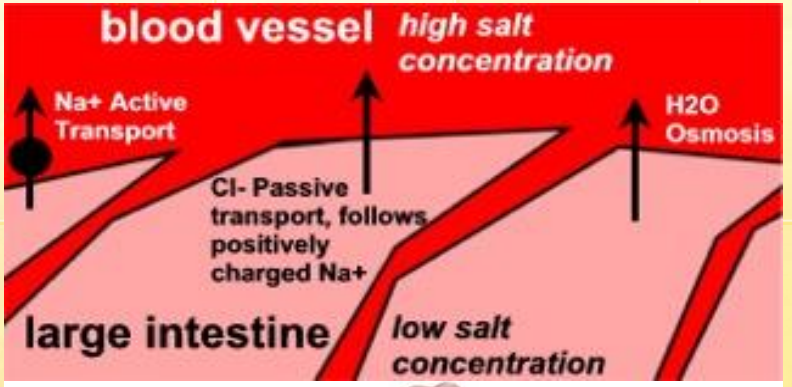
☆ During extreme parasympathetic stimulation, so much mucus can be secreted into the large intestine that the person has a bowel movement of ropy mucus as often as every 30 minutes; this mucus often contains little or no fecal material.

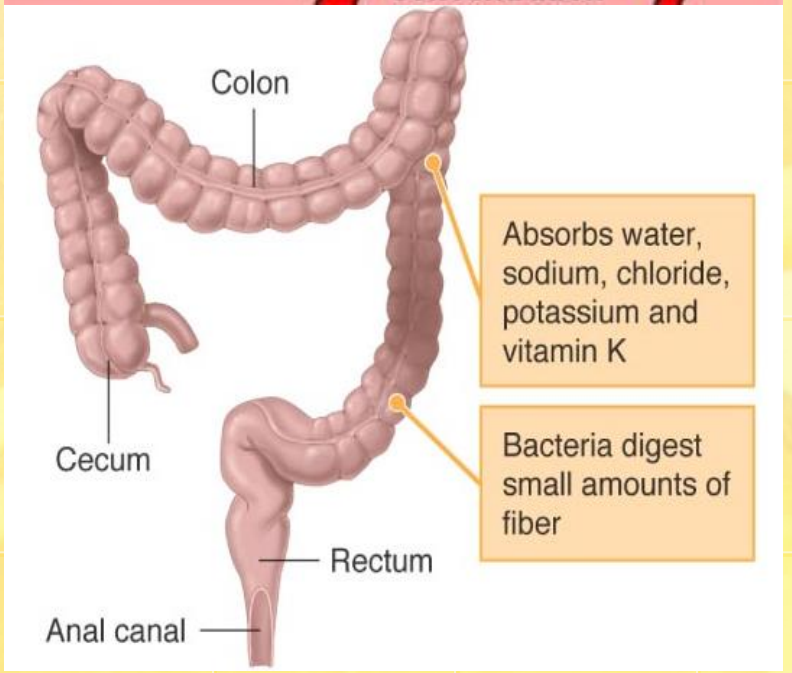
Secretion of Water and Electrolytes

- 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 Large Intestine

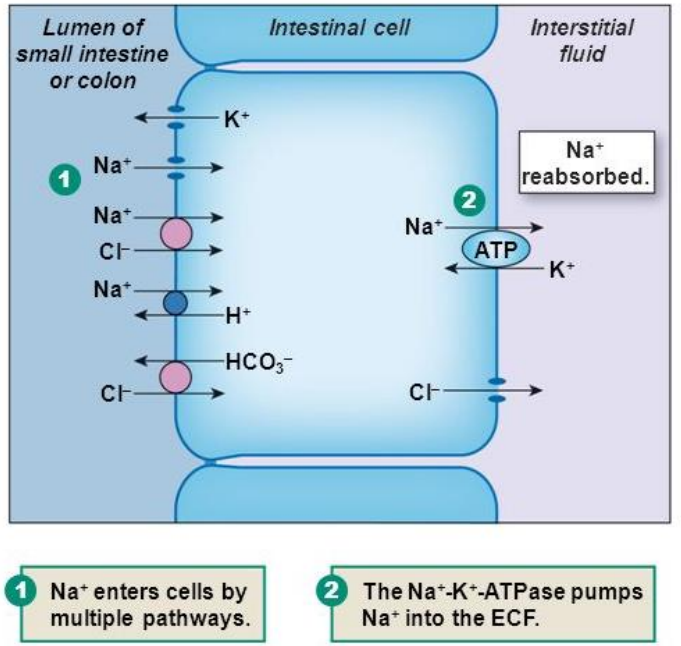
- Little absorption occurs in the large intestine
- Most of absorption occurs in the proximal half of the colon (absorptive colon). Whereas the distal colon function for storage (storage colon).
- About 0.5- 1.5L/day is absorbed. The net water loss is 100-200 ml/day.
- N.B: The large intestine can absorb a maximum of 5 - 8 liters of fluid and electrolytes each day.





Absorption in The Large Intestine (Cont.)

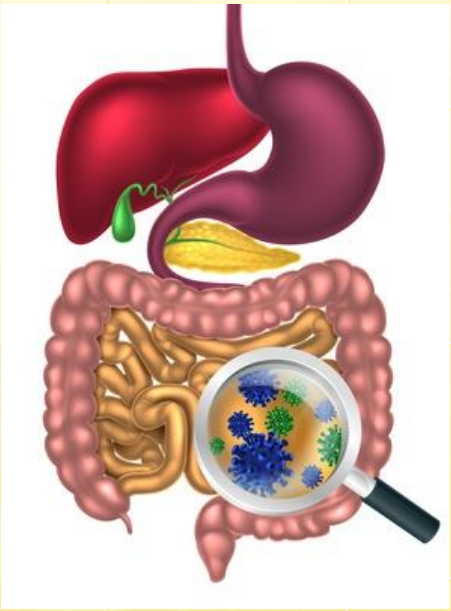
- In the presence of Na^+-K^+ ATPase at the basolateral membrane, Na^+ is actively absorbed and K^+ is secreted into the lumen of colon.
- Cl^- is absorbed in exchange for HCO_3^- which is secreted.



- Vitamins as vit. K, biotin, B_5, folic acid and some AA and short chain FA resulting from bacterial fermentation of CHO are absorbed.
- It does not absorb vitamin B_{12}
- Certain drugs as steroids and aspirin may be absorbed.

Gut flora (gastrointestinal microbiota)

- It is the complex community of microorganisms that live in the digestive tracts. It is established at one to two years after birth.
- Bacterial flora is living in symbiosis with human and its effects are beneficial to the body as follows:



① Synthesis of vitamin K and some B group vitamins as folic acid, biotin, thiamine and B_{12}.

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 Deconjugation and decarboxylation of bile salts.

③ Break down of bile pigments to produce stercobilinogen.

④ Decarboxylation of some AA to produce amine and histamine. The amines are excreted in feces and are responsible for its smell.

⑤ Break down of urea by bacterial urease to ammonia. Most ammonia is absorbed and reconverted into urea by liver.

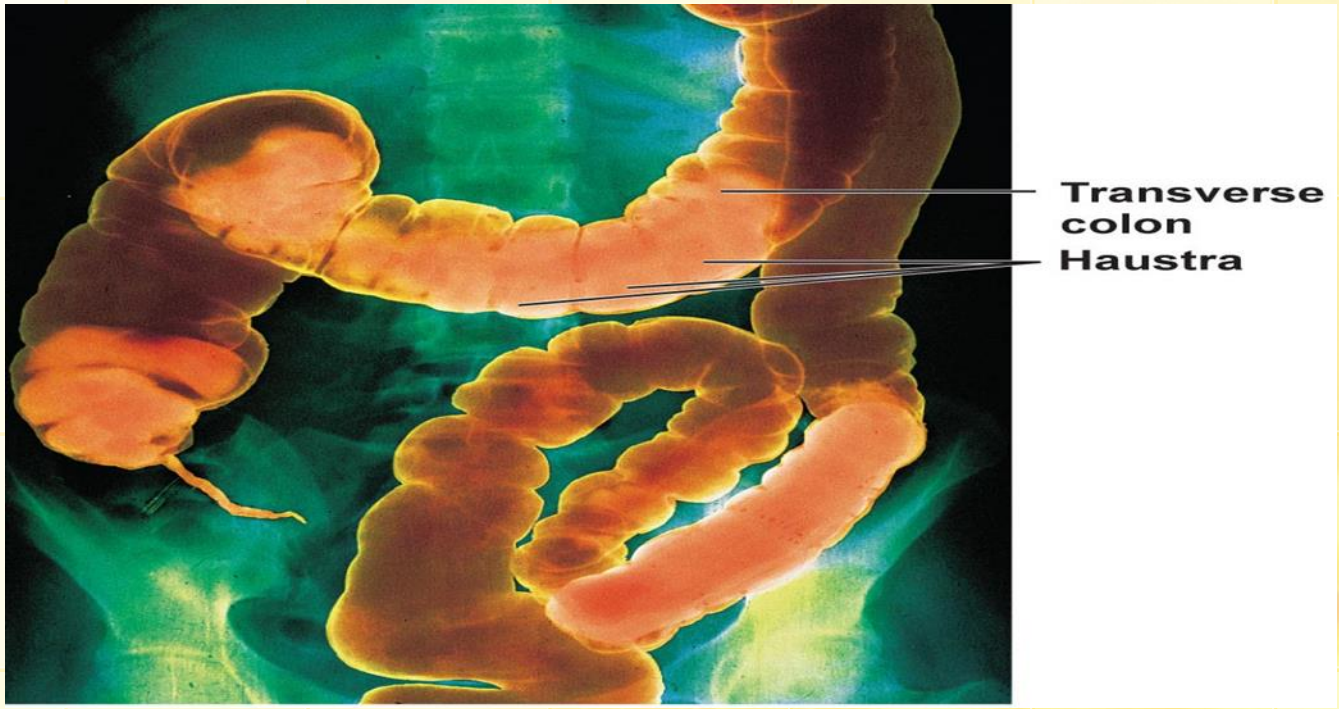
⑥ Fermentation of undigested oligo- saccharides producing gases.

Motility in The Colon

1- Mixing Movement (Haustrations)

- The motor events in ***the cecum and ascending colon***
- Ring-like contractions (about 2.5 cm) of the circular muscle divide the colon into pockets called haustra.
- The contracting segment and relaxing segments 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.

Mixing Movement (Haustrations)

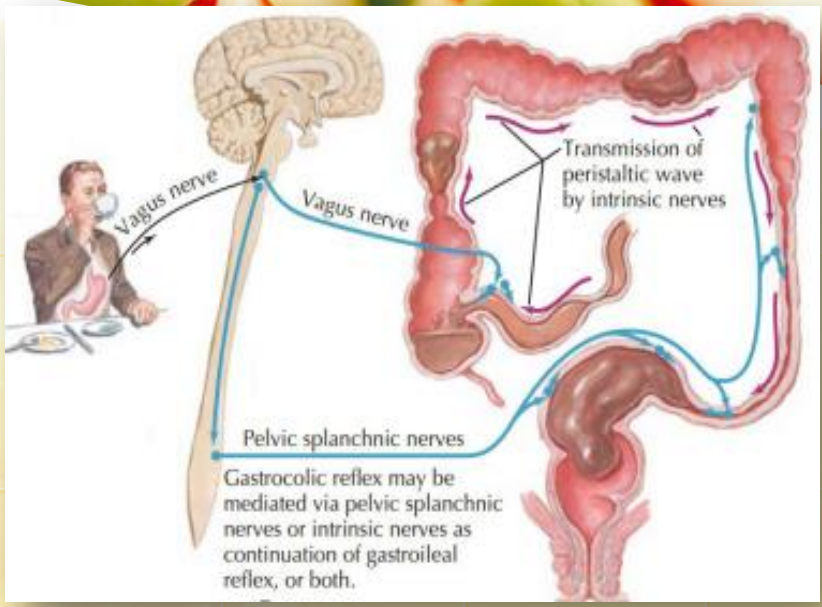


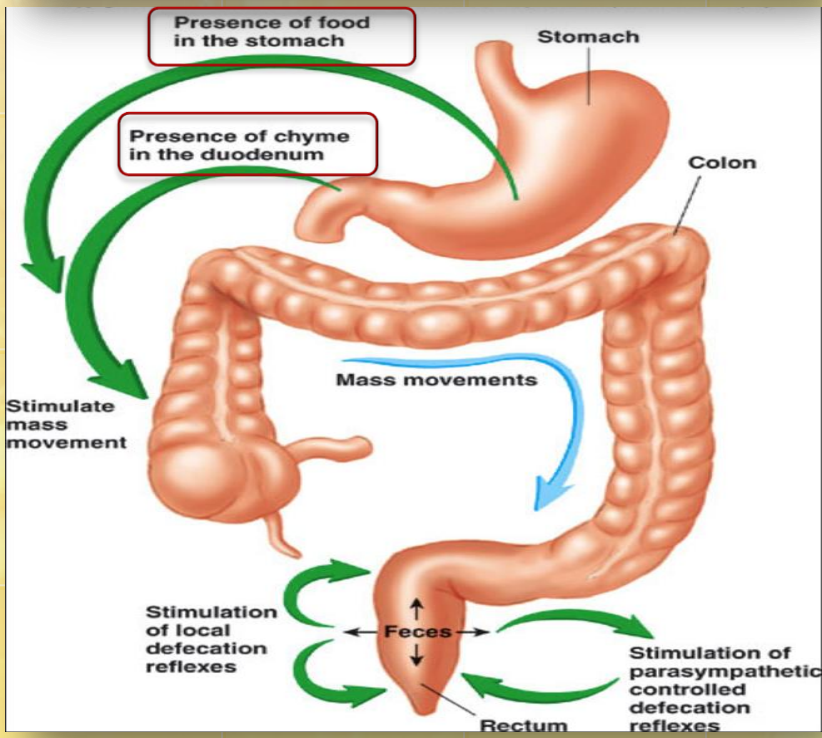
2- Propulsive (mass) Movement

- The motor events in ***transverse & descending colon.***
- It starts at the middle of transverse colon, 15 min after eating breakfast.
- A constrictive ring occurs at a distended point, then 20 cm of the colon distal to the constriction contract almost as a unit forcing the fecal material en mass down the colon.
- It is preceded by relaxation of the circular muscle and the downstream disappearance of haustral contractions.
- It is completed in about 30 sec., another mass movement occur during the next 2 to 3 min.
- The whole series of mass movement persist for only 10-30 min. They will then return after a half day or even a day later.
- When they have forced a mass of feces into the rectum the desire for defecation is felt.

Initiation of Mass Movement:

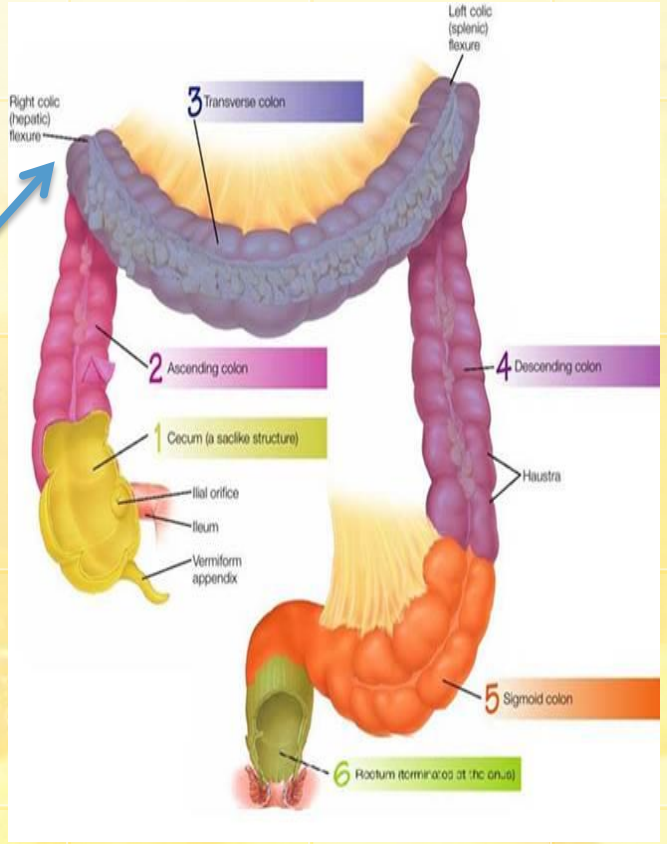
- Gastrocolic & duodenocolic reflexes after meals. They result from distension of the stomach & duodenum.
- Irritation of the colon e.g., castor oil.
- Threatening agents such as parasites and enterotoxins can initiate mass movement





3- Antiperistalsis

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



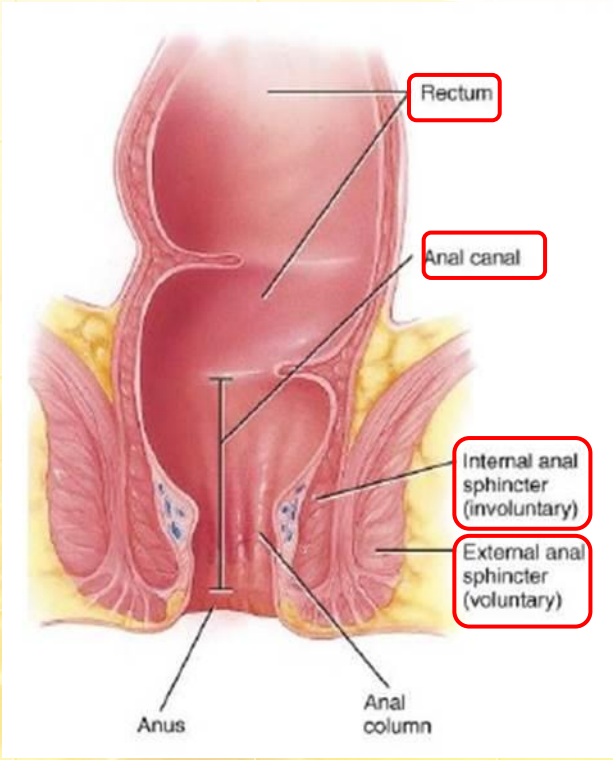
Control of Colonic Motility

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.

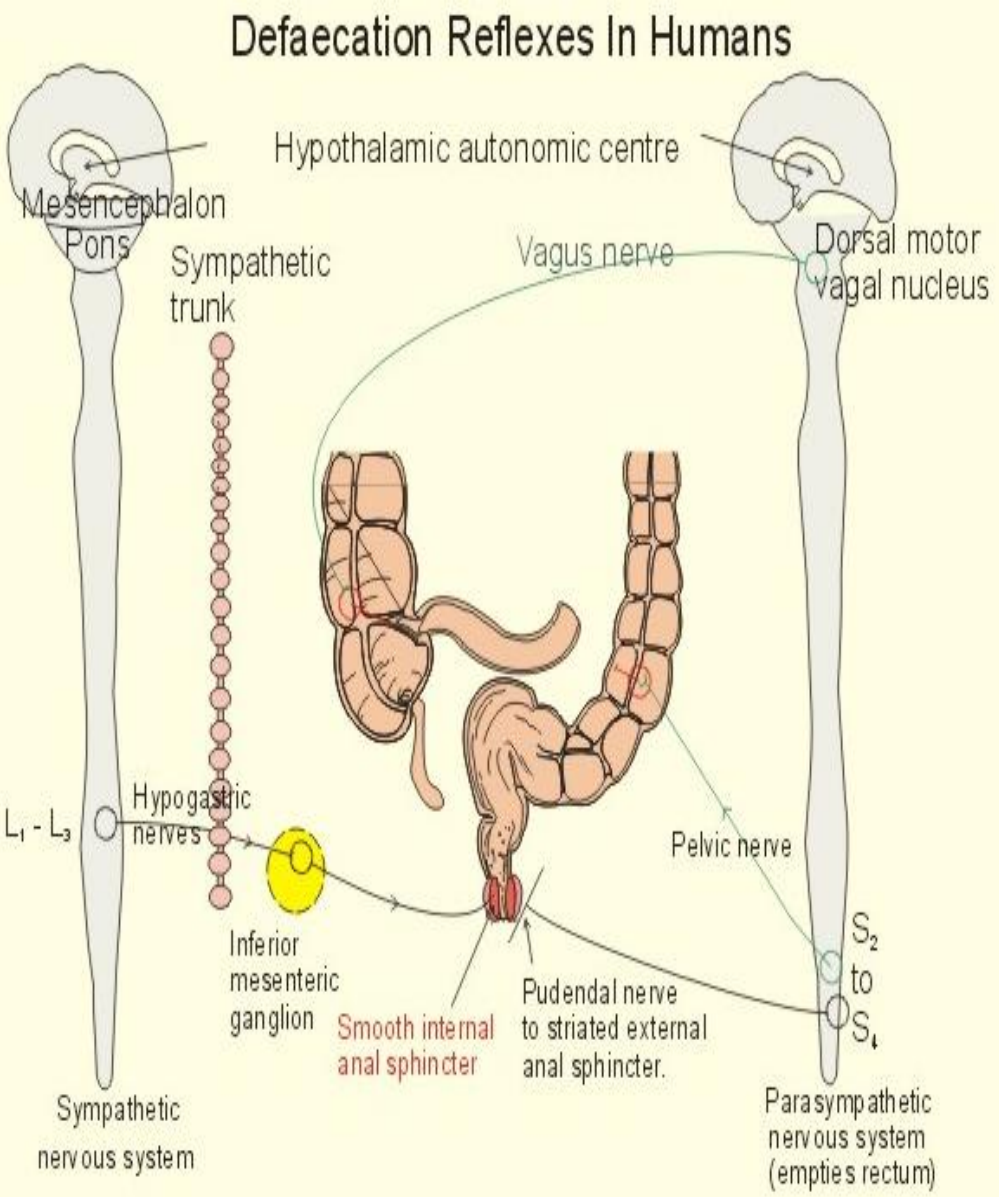
The Rectum & Anal Canal

- The rectum is last portion of the digestive tract that terminates at the anal canal.
- It contains mechanoreceptors that detect distention.
- The anal canal in the region of the skin is innervated by somatosensory nerves that transmit pain, temperature and touch signals to CNS.
- Contraction of anal sphincters and puborectalis muscle blocks the passage of feces and maintains continence.



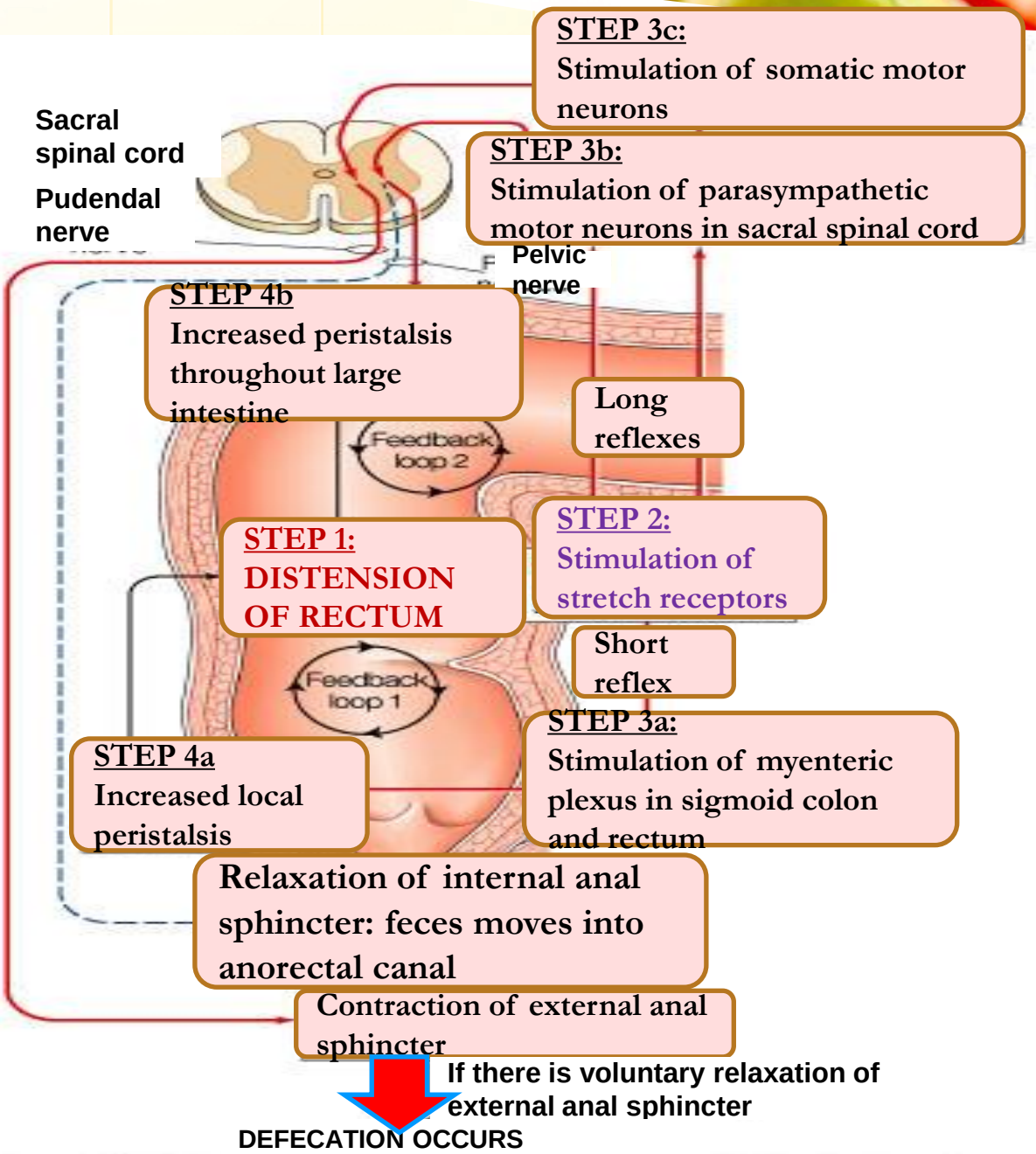
Defecation

- Most of the time the rectum is empty
- Both internal and external anal sphincters are maintained in a state of tonic contraction.



Defecation

- It is a spinal reflex, influenced by higher center.
- Gastrocolic & dudenocolic reflexes initiate a mass movement in the colon that pushes feces into rectum).
- Rectal distension sends signals to cerebral cortex producing the desire to defecate.



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 internal anal sphincter (IAS).
- This is followed by reduction in tonic impulses to external anal sphincter (EAS), so it relaxes voluntarily and feces leave the rectum assisted by voluntary straining and contraction of pelvic floor muscles.

If situation is not suitable for defecation

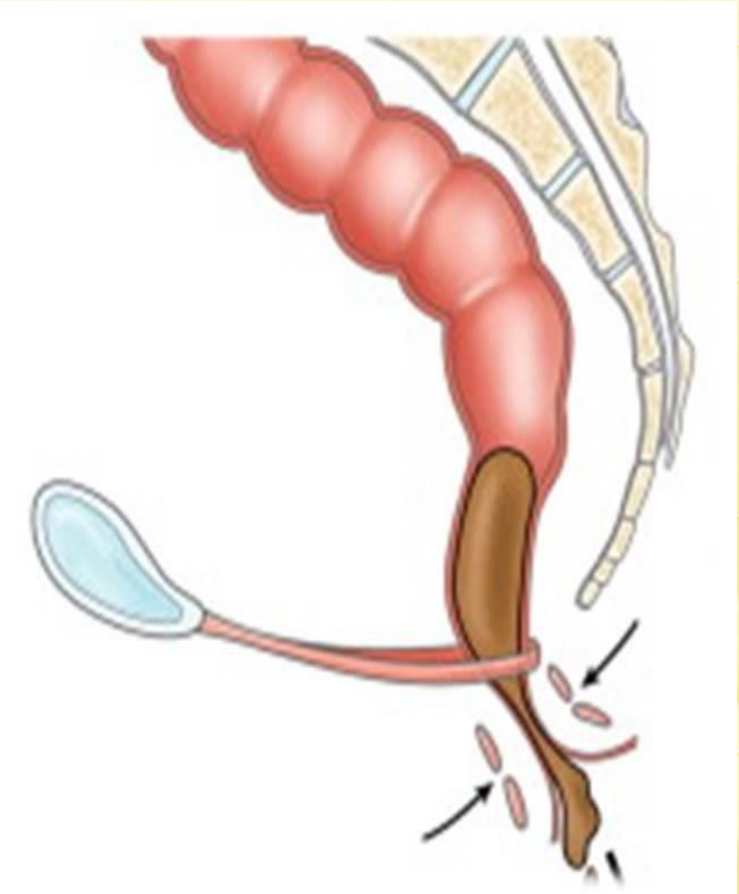
- The reflex is inhibited by the cerebral cortex.
- Maintained voluntary tonic contraction of EAS.
- Return of tonic contraction of the IAS.
- Accommodation of the rectum to distension.

Fecal Incontinence

The spinal reflex of defecation operates without interference from higher centers.

Causes:

- In infants (physiological)
- Spinal cord lesion
- Weakness of IAS and EAS
- Weakness of pulborectalis
- Altered rectal or anal sensation
- Diarrheal conditions
- Diminished rectal capacity



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