

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

السلام عليكم

ورحمة الله

وبركاته



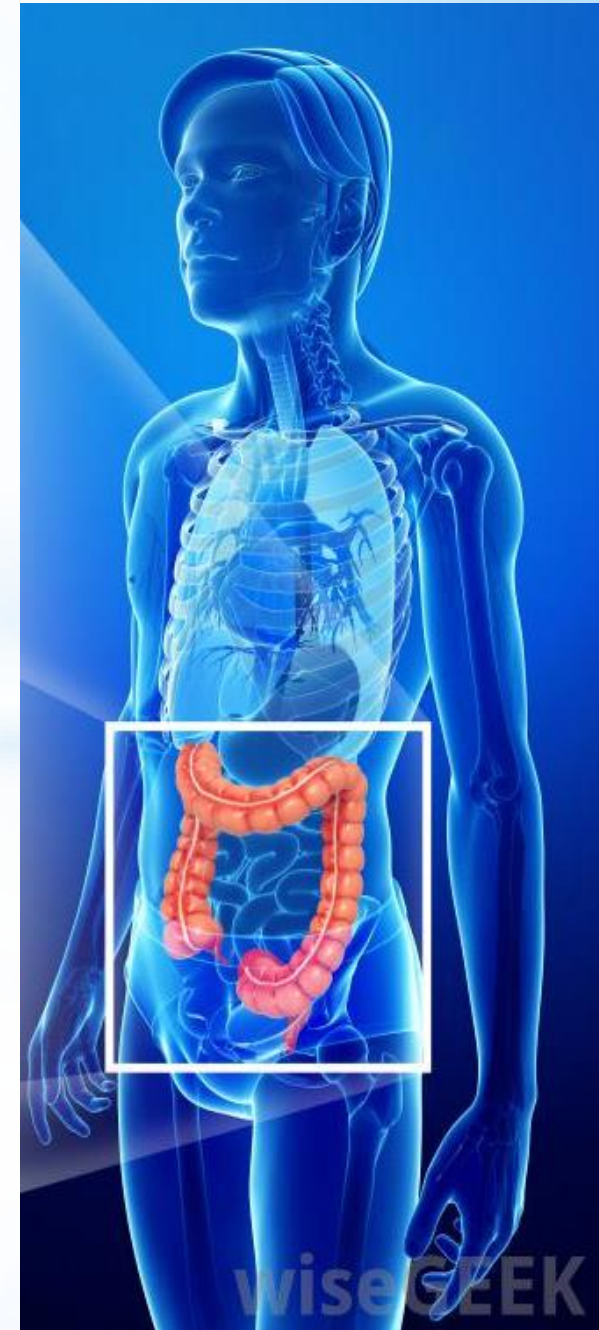
# *Gastrointestinal Physiology (Lecture 6)*

## *Physiology of The Colon: Motility*

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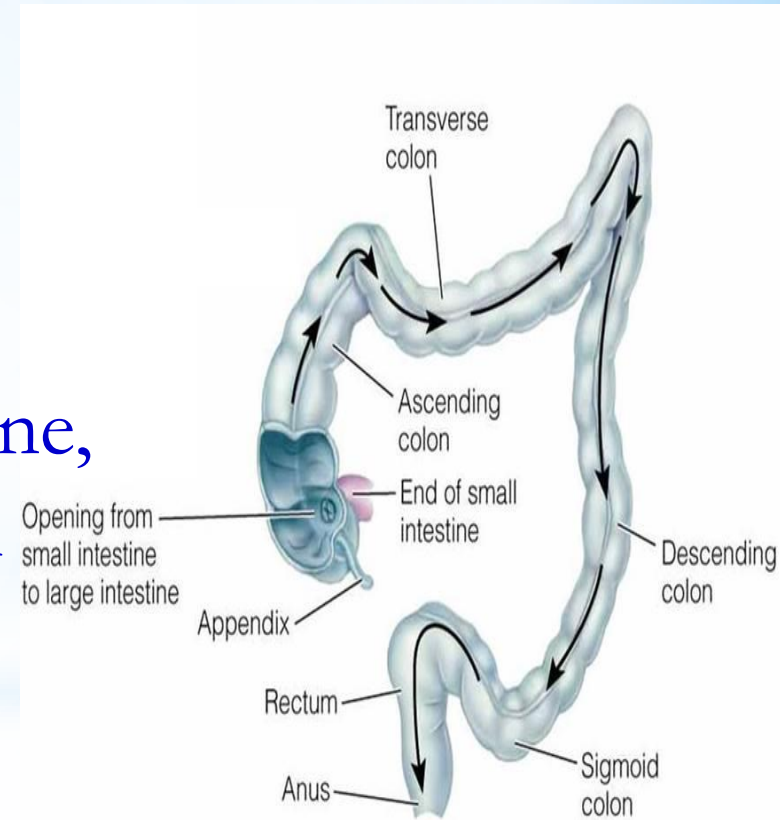


# *Learning Objectives*

- \* Parts of the Colon
- \* Functions of the Colon
- \* The physiology of Different Colon Regions
- \* Secretion in the Colon
- \* Nutrient Digestion in the Colon
- \* Absorption in the Colon
- \* Bacterial Action in the Colon
- \* Motility in the Colon
- \* Defecation Reflex

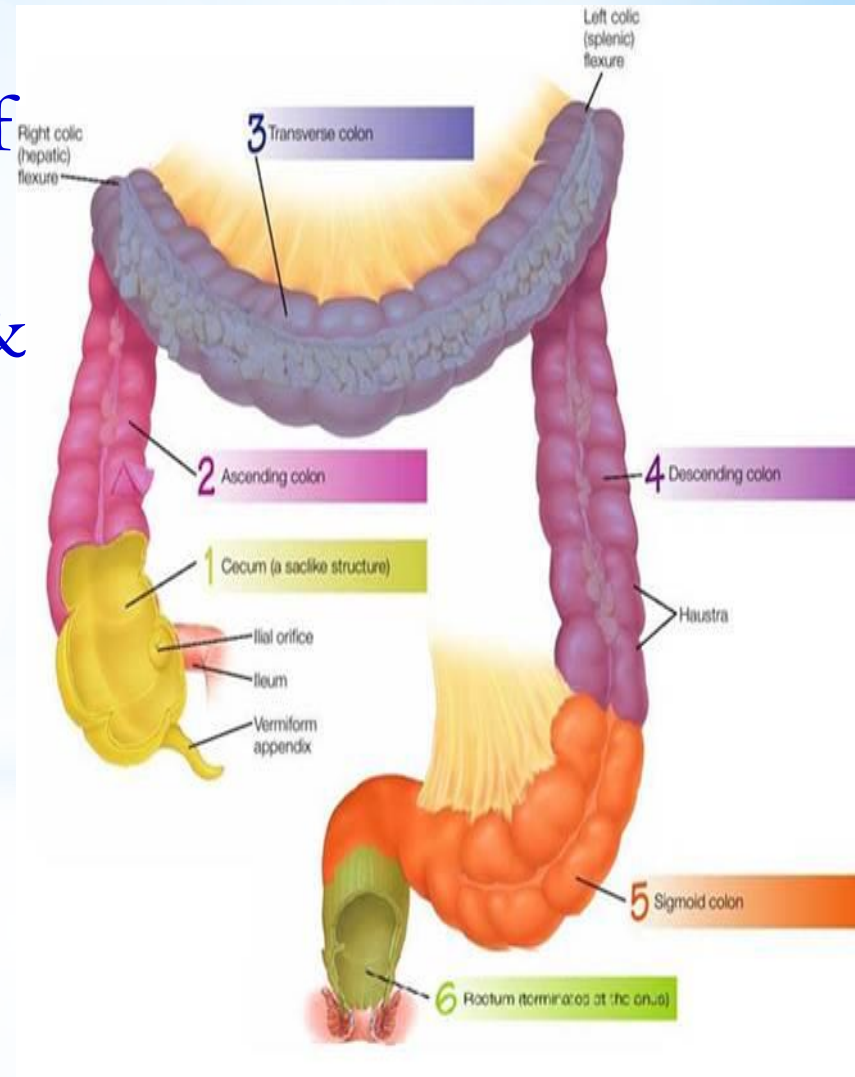
# *The Large Intestine*

- This is the final digestive structure.
- It does not contain villi.
- 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.

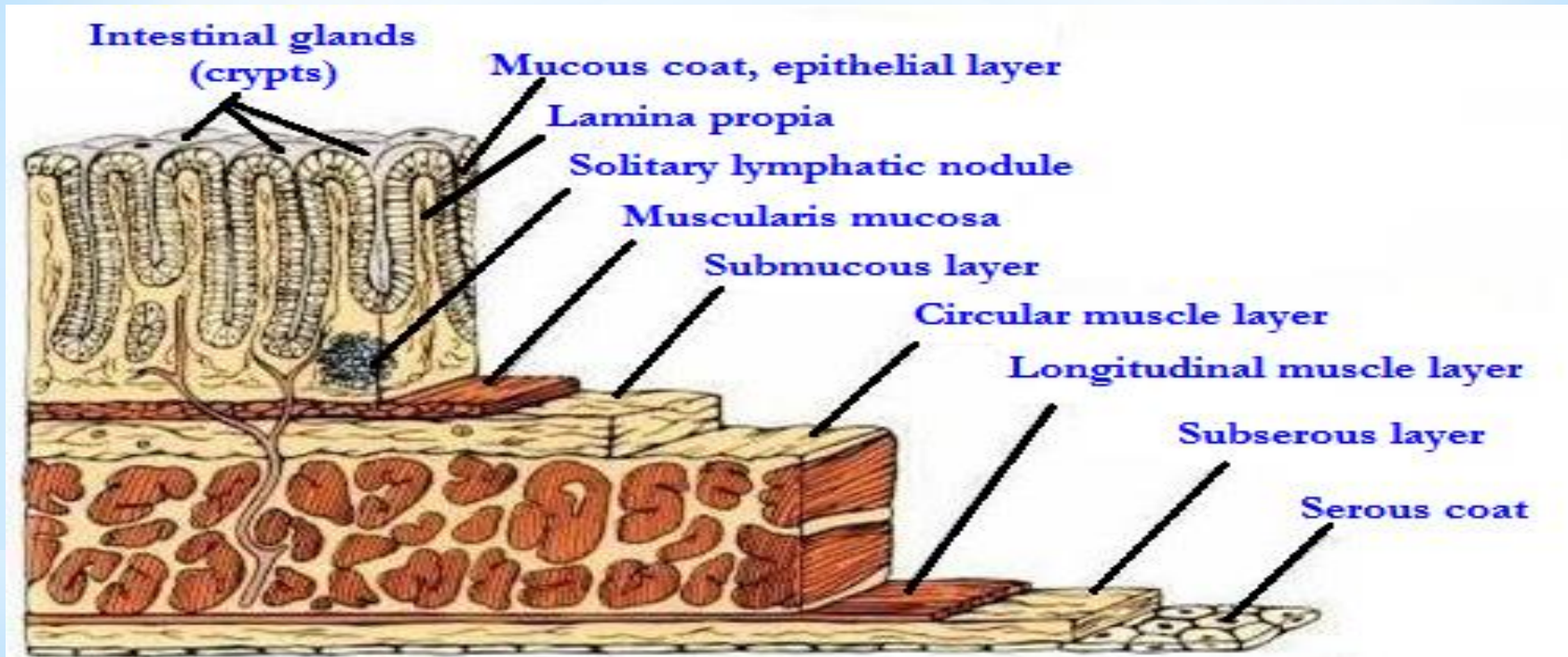


# Parts of The Colon

- ❁ The colon has a length of about 1.5 meters (one-fifth of the whole length of GIT).
- ❁ It consists of the ascending & descending colon, transverse colon, 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

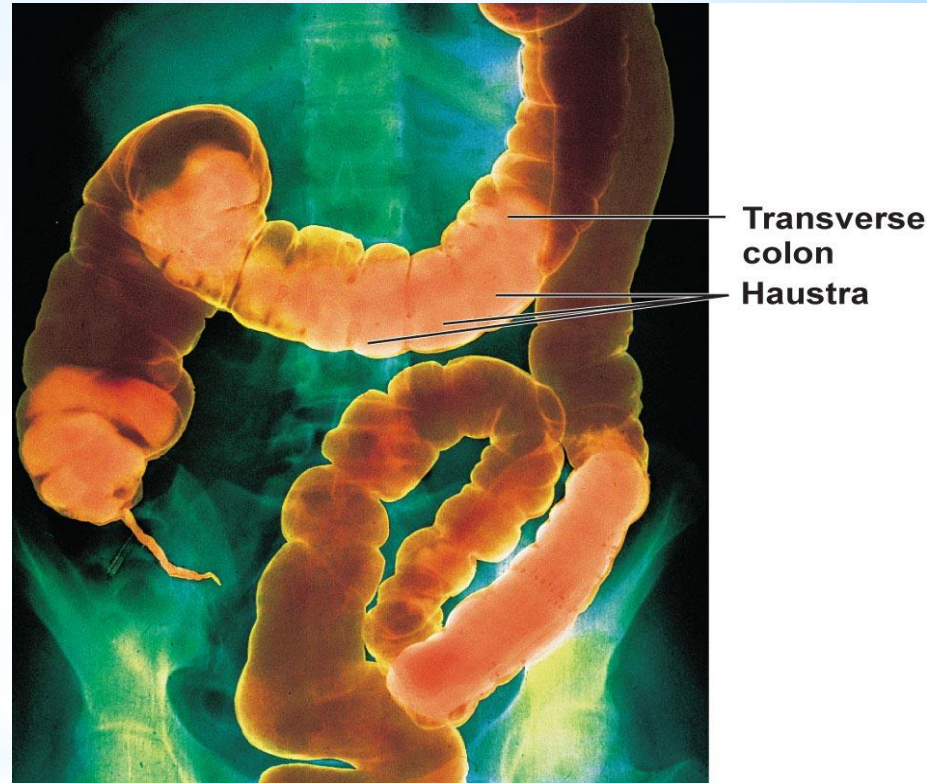


❁ Lacks villi and has many crypts of Lieberkühn.

❁ They 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*

- ✓ Absorb vitamins produced by bacteria
- ✓ Reabsorb water and compact material into feces
- ✓ Store fecal matter prior to defecation



# *The Physiology of Different Colon Regions*

## **1. The ascending colon:**

Specialized for processing chyme delivered from the terminal ileum.

## **2. The transverse colon:**

Specialized for the storage and removal of water & electrolytes from feces.

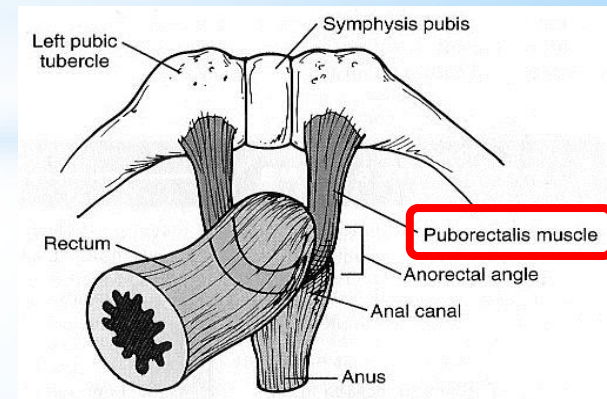
## **3. The descending colon:**

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, together with pelvic floor musculature:

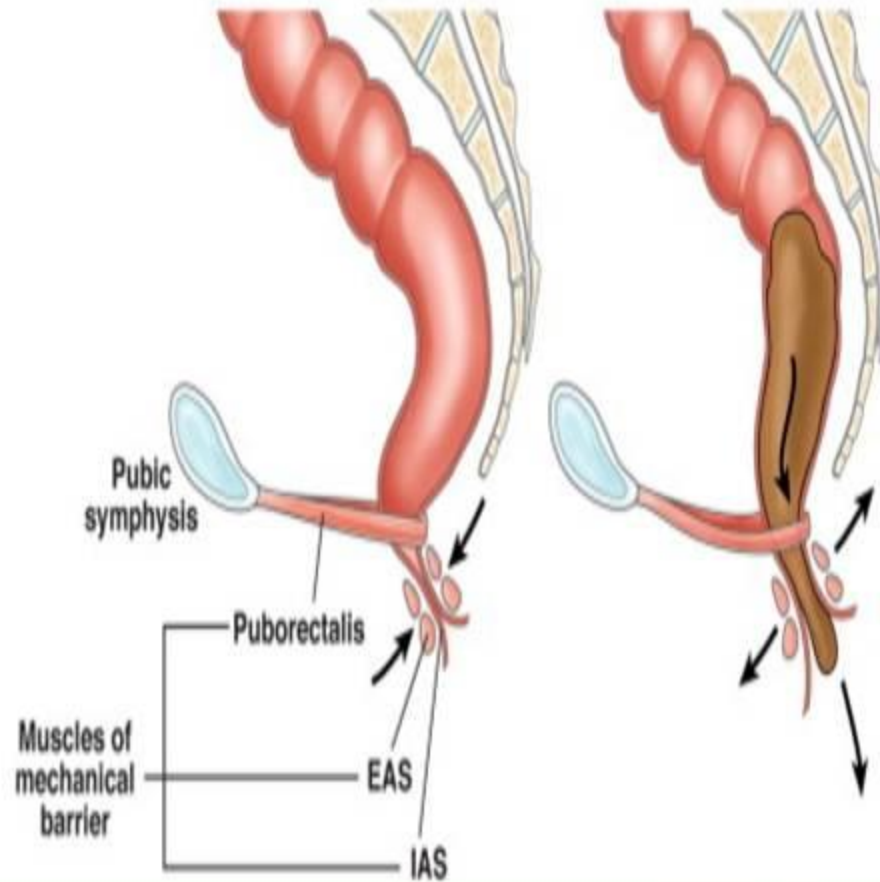
They maintains fecal continence:

- 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 pass around the anorectum and join behind it to form a U-shaped sling (physiological valve).



**Resting**

**Normal defecation**



- Sensory perception of stool
- Rectal distension
- Contract diaphragm, abdomen, and rectal muscles
- Relax EAS (decreased sphincter pressure)
- Relax puborectalis muscle

# *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:

- Marked increase in mucus secretion.
- 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 and Electrolytes*

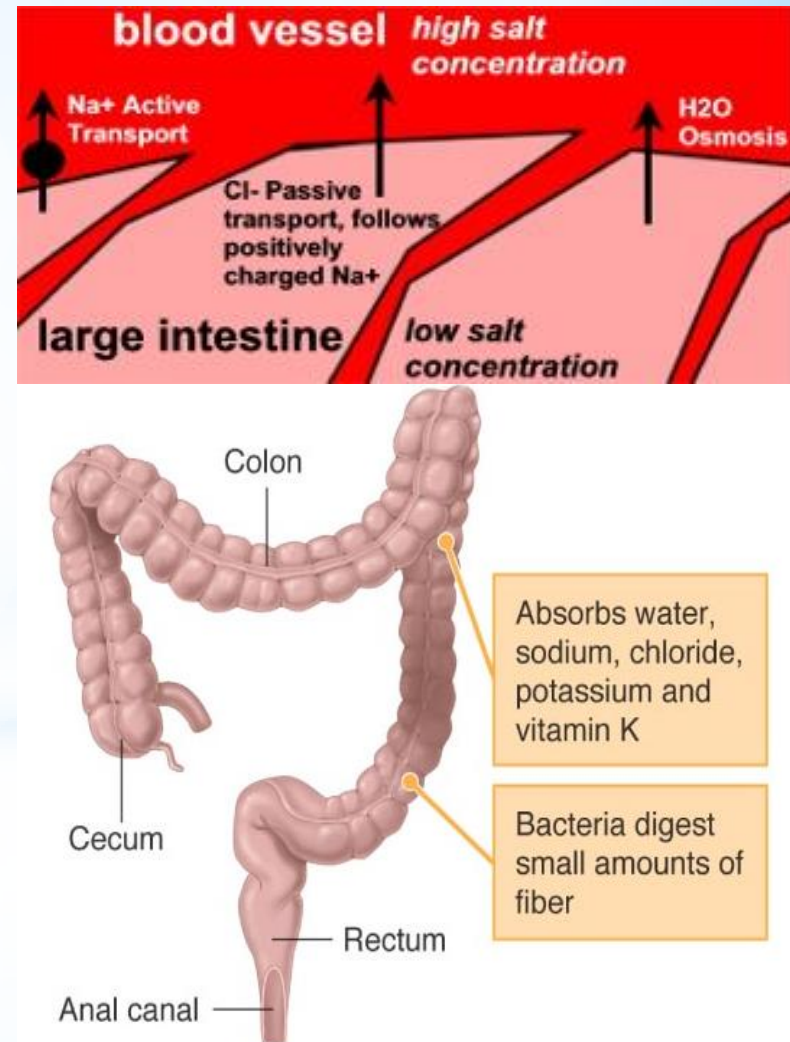
- Whenever a segment of large intestine becomes irritated as occurs in bacterial infection, the mucosa secretes large amount of water & electrolytes in addition to the alkaline mucus.
- This dilute the irritating factors and causes rapid movement of the feces toward the anus.

# *Nutrient Digestion in The Large Intestine*

- Little digestion occurs in the large intestine
- The large population of bacteria digests small amounts of fiber; produce gases and organic acids.
- Bacterial action produces nutrients — vitamin K, thiamin, biotin, vitamin B<sub>12</sub>, riboflavin.

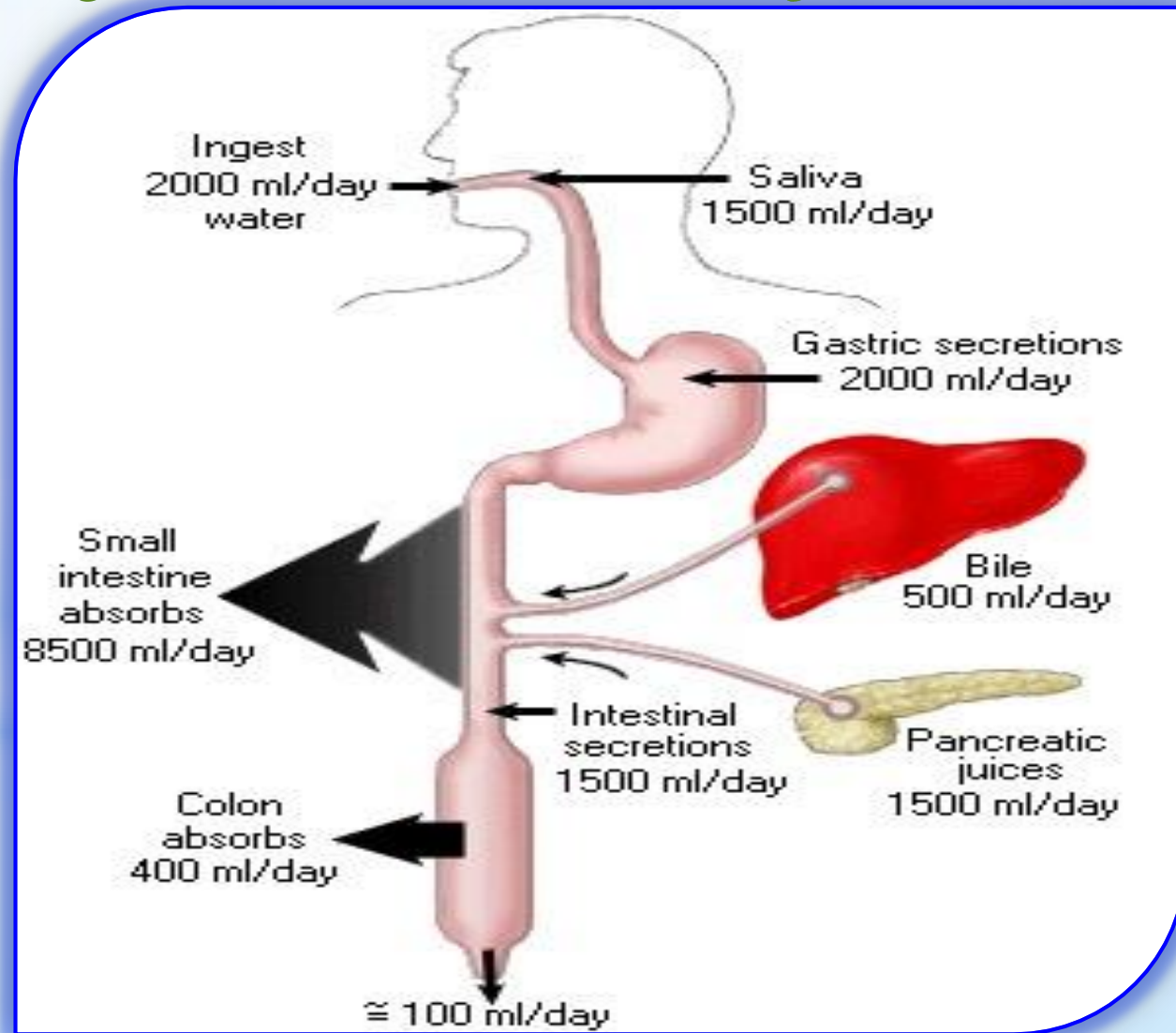
# Absorption in The Large Intestine

- Little absorption occurs in the large intestine
- 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).
- In the large intestine, 1 liter of fluid material is gradually reduced to 200 grams of brown fecal material
- 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.





# Secretion & Absorption in The Gastrointestinal System



- In the presence of  $\text{Na}^+\text{-K}^+$  ATPase at the basolateral membrane,  $\text{Na}^+$  is actively absorbed and  $\text{K}^+$  is secreted into the lumen of colon.

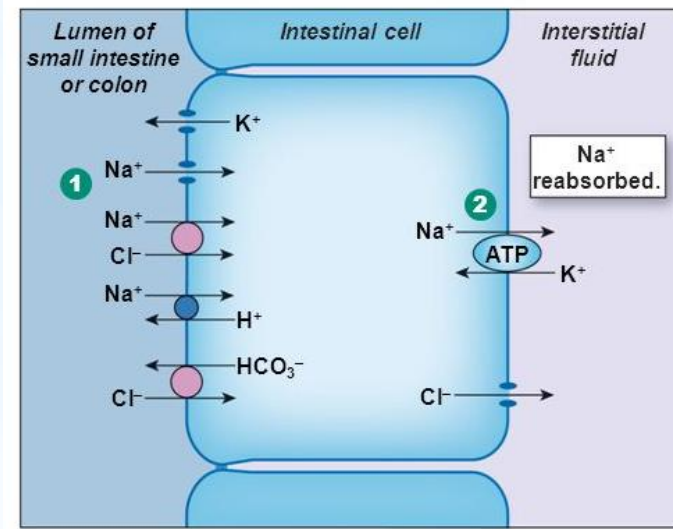
- $\text{Cl}^-$  is absorbed in exchange for  $\text{HCO}_3^-$  which is secreted.

- Vitamins as Vit. K, biotin,  $\text{B}_5$ , folic acid and some AA and short chain FA resulting from bacterial fermentation of CHO are absorbed.

- It does not absorb Vitamin  $\text{B}_{12}$

- Certain drugs as steroids and aspirin may be absorbed.

- Bile salts and organic wastes as urobilinogen and sterobilinogen can be absorbed.



1  $\text{Na}^+$  enters cells by multiple pathways.

2 The  $\text{Na}^+\text{-K}^+\text{-ATPase}$  pumps  $\text{Na}^+$  into the ECF.

# *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<sub>12</sub>.

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.

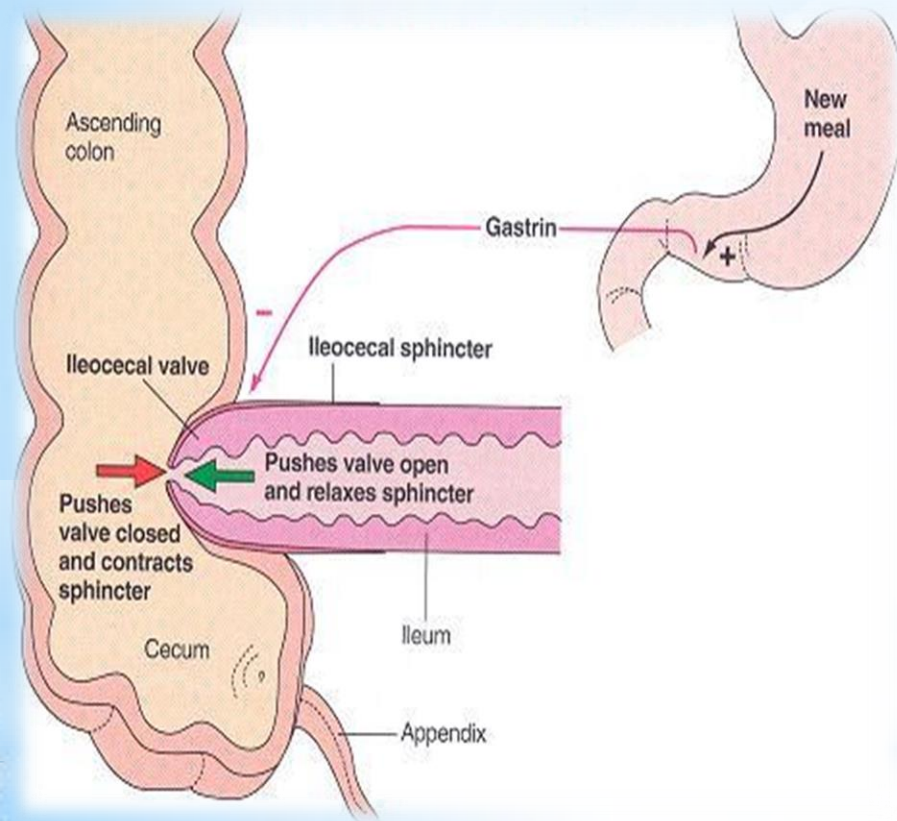
- ② Deconjugation and decarboxylation of bile salts.

- 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.

N.B: In hepatic failure, accumulation of ammonia can cause hepatic encephalopathy.

- ⑥ Fermentation of undigested CHO.

# *The Ileocaecal Valve*

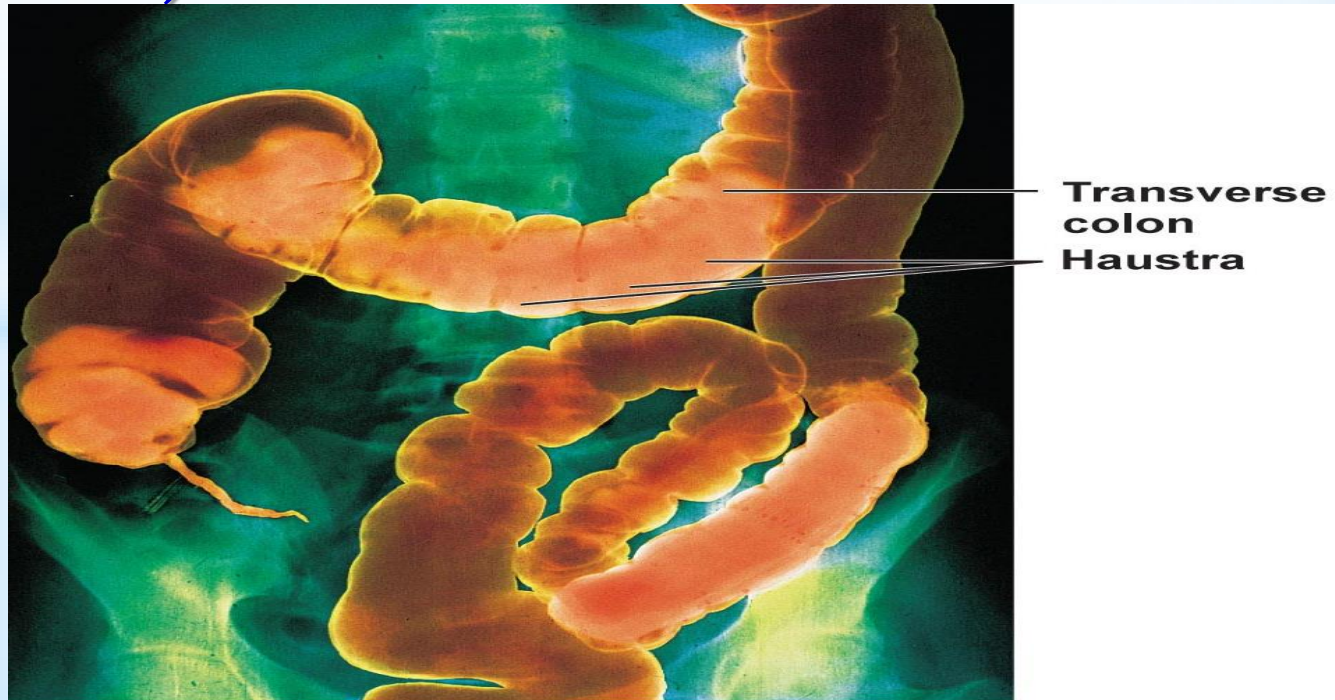


- ★ It prevents backflow of contents from colon into small intestine.
- ★ It remains closed and open only when an intestinal peristaltic wave reaches it.
- ★ Distension of the cecum, secretin, Ach, alpha adrenergic stimulation contract it.
- ★ Gastrin, Cck, B adrenergic stimulation relax it.

# *Motility in The Colon*

## 1- Mixing Movement (Haustrations)

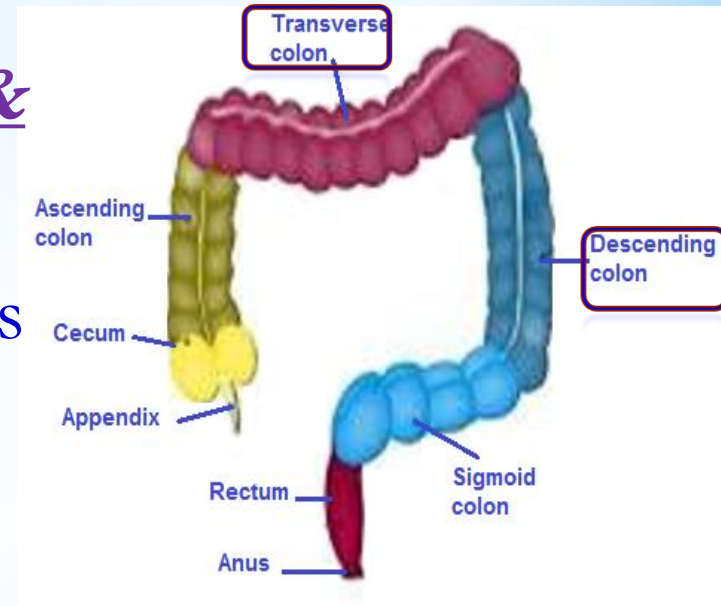
- ➔ The motor events in *the cecum and ascending colon*
- ➔ At constrictions points, 2.5 cm of the circular muscle contracts, at the same time the longitudinal strips contract.
- ➔ These combined contractions cause the unstimulated portion of large intestine to bulge outward into baglike sacs (**haustrations**).



- ➡ They also at times move slowly analward during their period of contraction.
- ➡ 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

- ① The motor events in transverse & descending colon.
- ① These movements occur few times each day, most abundantly for 15 min during the first hour after eating breakfast.
- ① A mass movement is a modified type of peristalsis.
- ① 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.



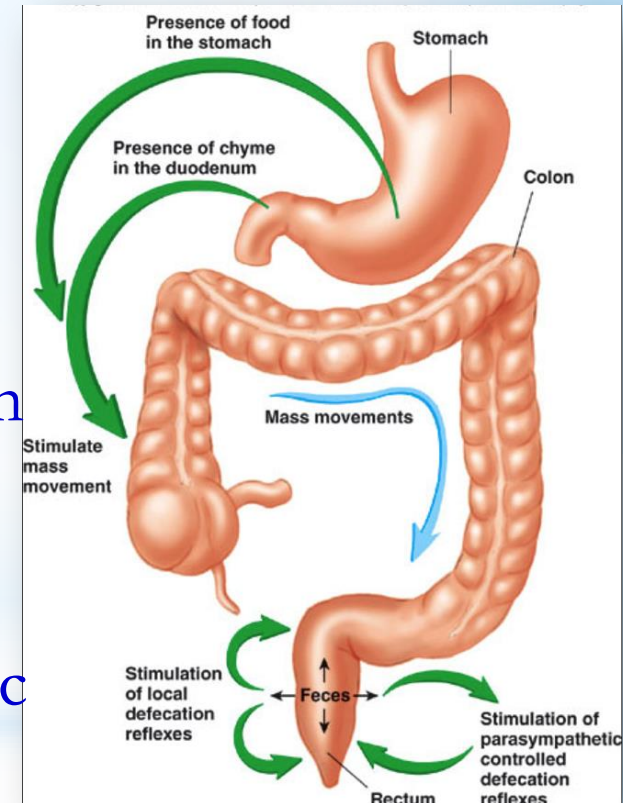


- ① It starts at the middle of transverse colon and is preceded by relaxation of the circular muscle and the downstream disappearance of haustral contractions
- ① The initiation of contraction is complete in about 30 seconds.
- ① During the next 2 to 3 min another mass movement occurs.
- ① The whole 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.

- When they have forced a mass of feces into the rectum the desire for defecation is felt.

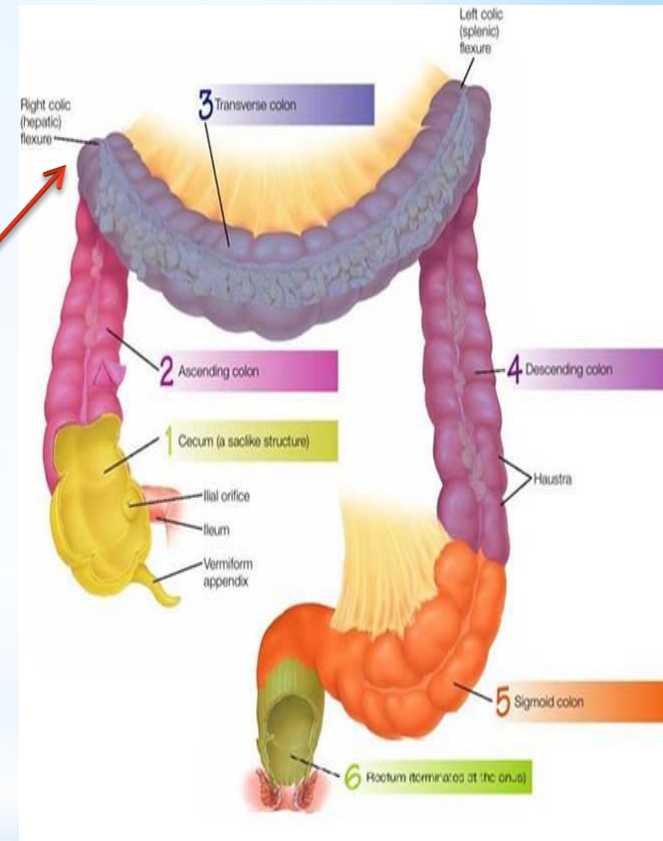
## ➤ Initiation of Mass Movement:

- ♣ Gastrocolic & duodenocolic reflexes after meals. They result from distension of the stomach & duodenum.
- ♣ Irritation of the colon e.g., castor oil.
- ♣ Intense stimulation of parasympathetic NS.
- ♣ 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.



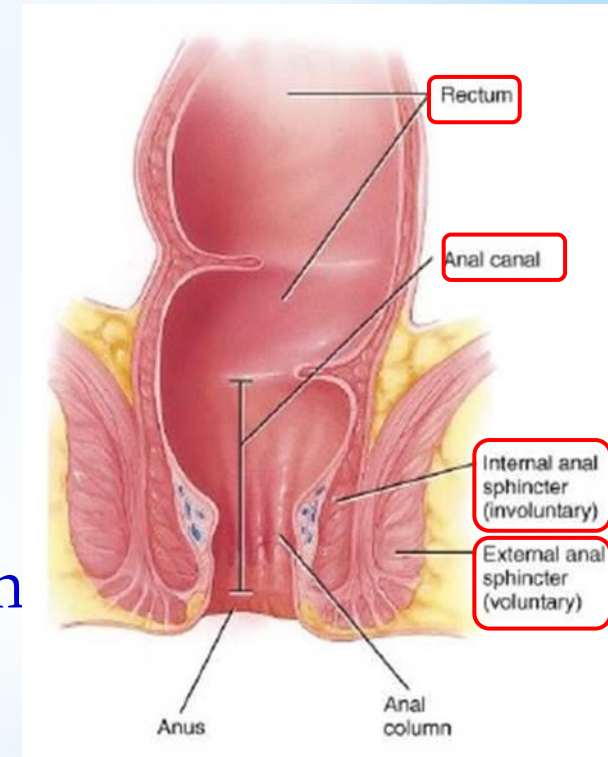
# *Control of Colonic Motility*

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.

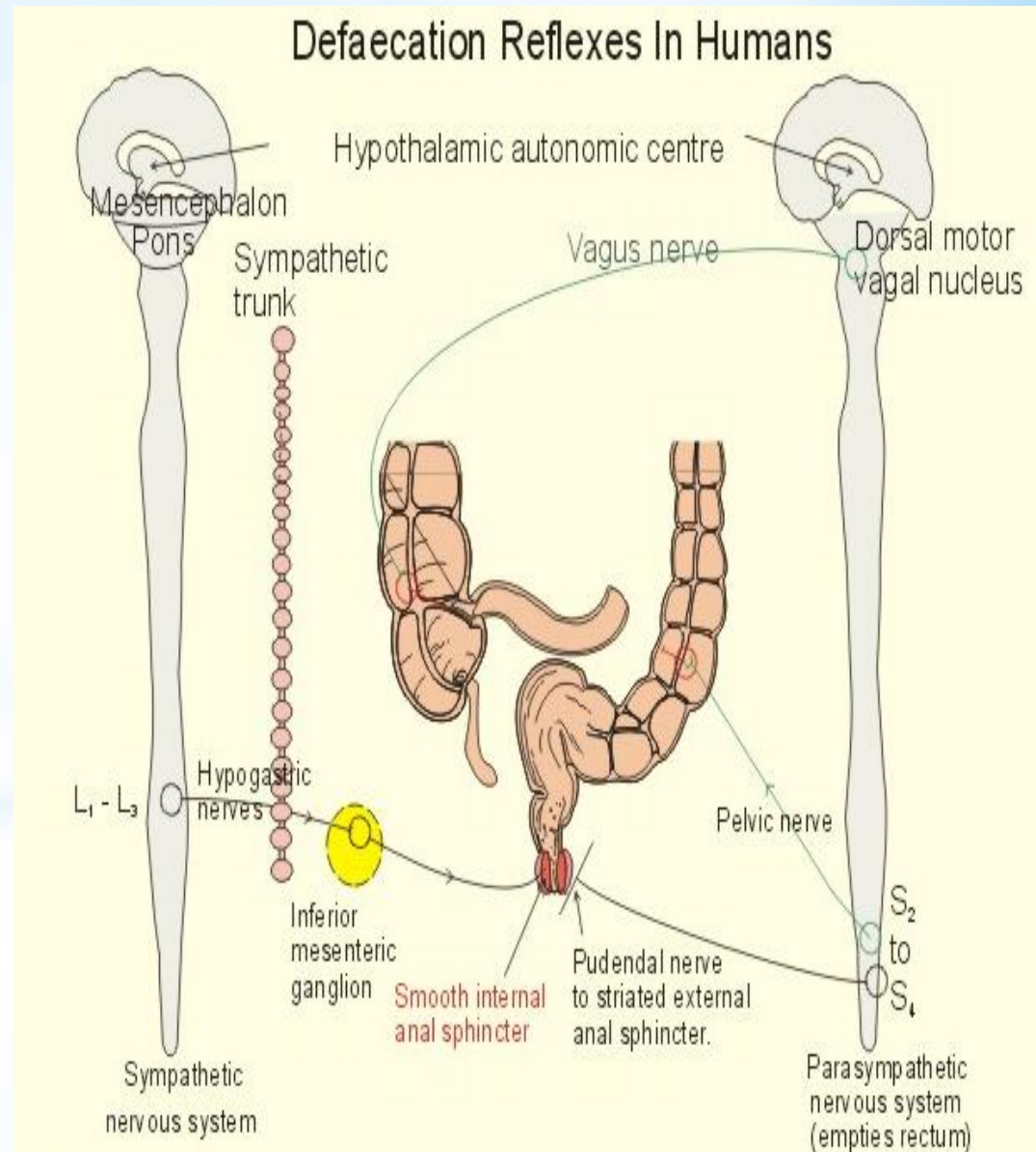
# *The Rectum & Anal Canal*

- ❧ The rectum is last portion of the digestive tract that terminates at the anal canal.
- ❧ It contains mechanoreceptors that detect distention and supply ENS.
- ❧ 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.



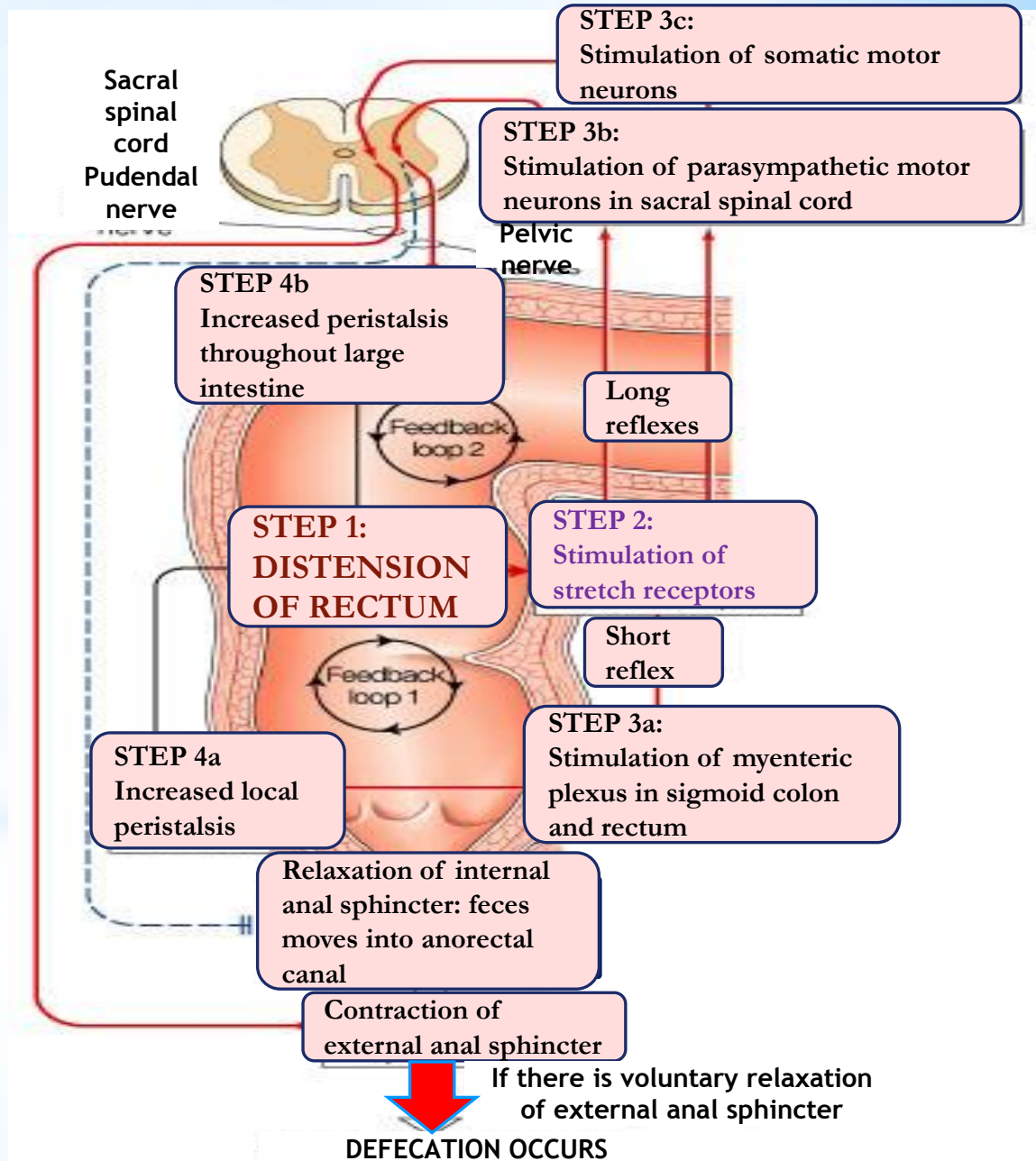
# Defecation

- ◆ It is a spinal reflex which is influenced by higher center.
- ◆ Most of the time the rectum is empty and both internal and external anal sphincters are 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.



## *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 and feces leave the rectum assisted by voluntary straining and contraction of pelvic floor muscle.



## *If situation is not suitable for defecation*

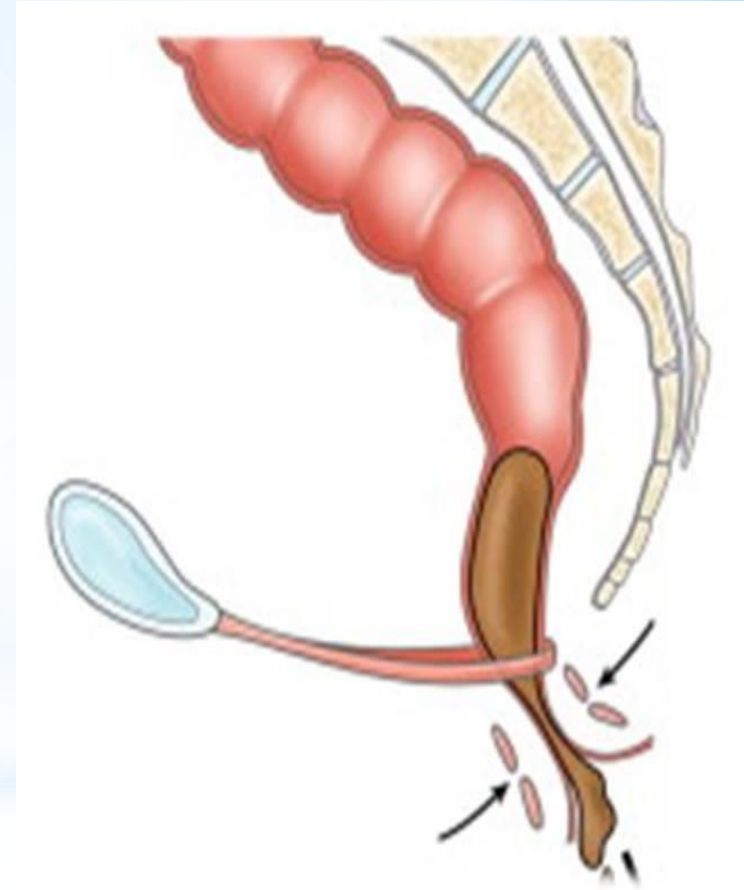
- ❧ The reflex is inhibited by the cerebral cortex.
- ❧ Tonic contraction of EAS is voluntary maintained which leads to accommodation of the rectum to distension and return of tonic contraction of the IAS.

# *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 puborectalis
- Altered rectal or anal sensation
- Diarrheal conditions
- Diminished rectal capacity





*Thank You*