

# LECTURE 7

## Physiology of colon

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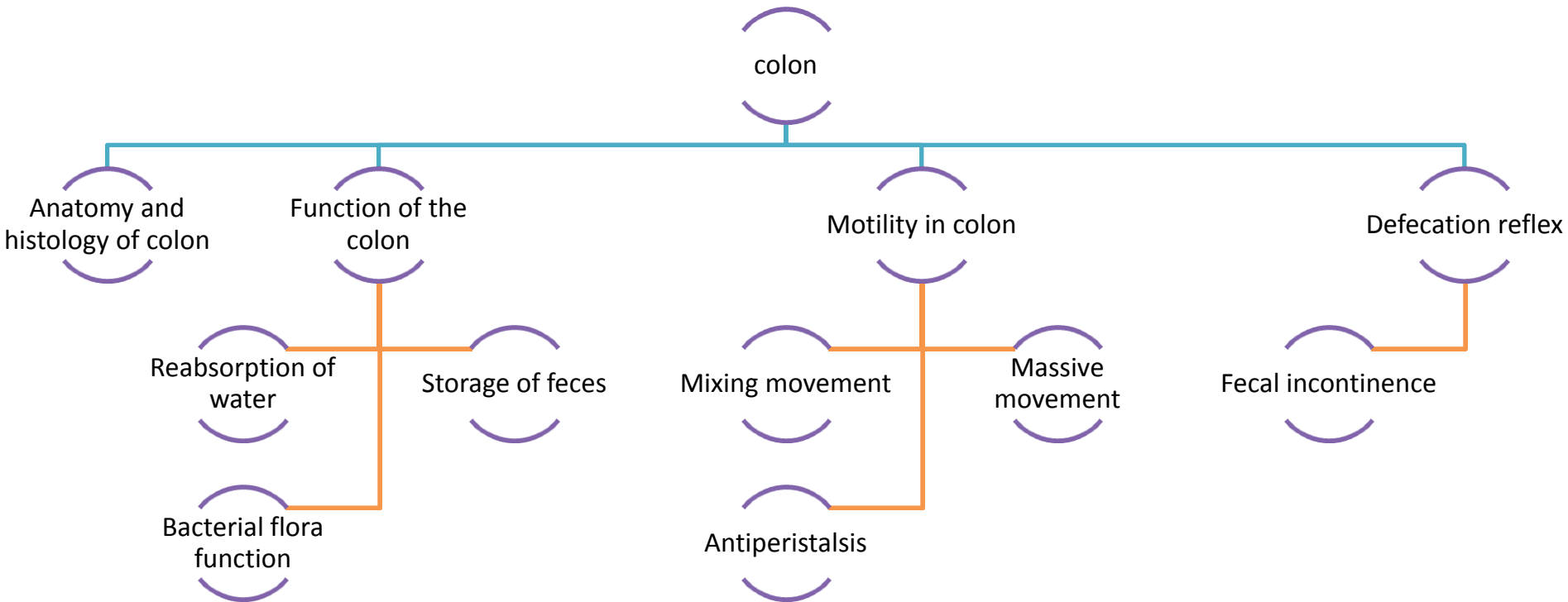
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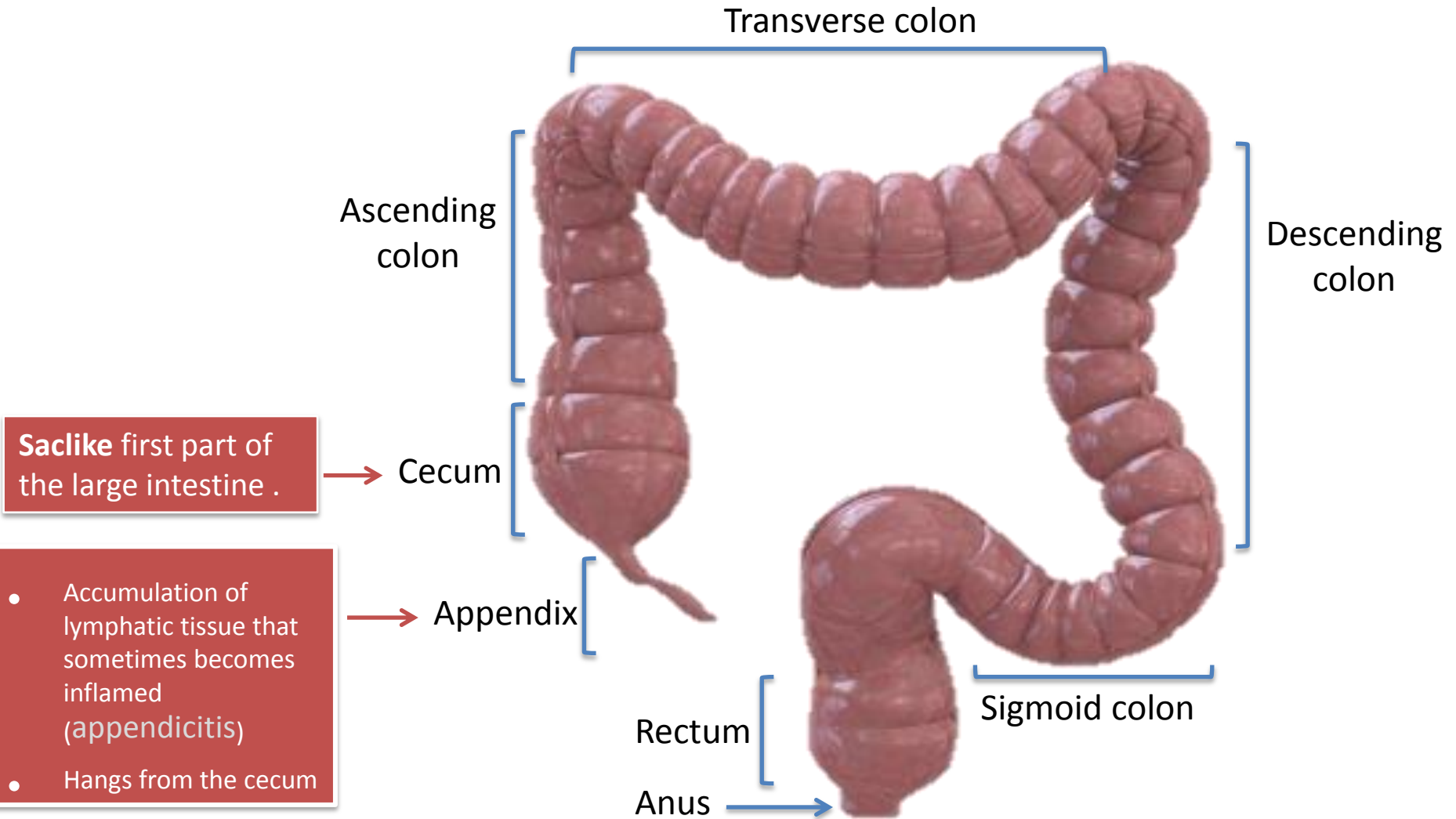


## At the end of this lecture, student should be able to describe:

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

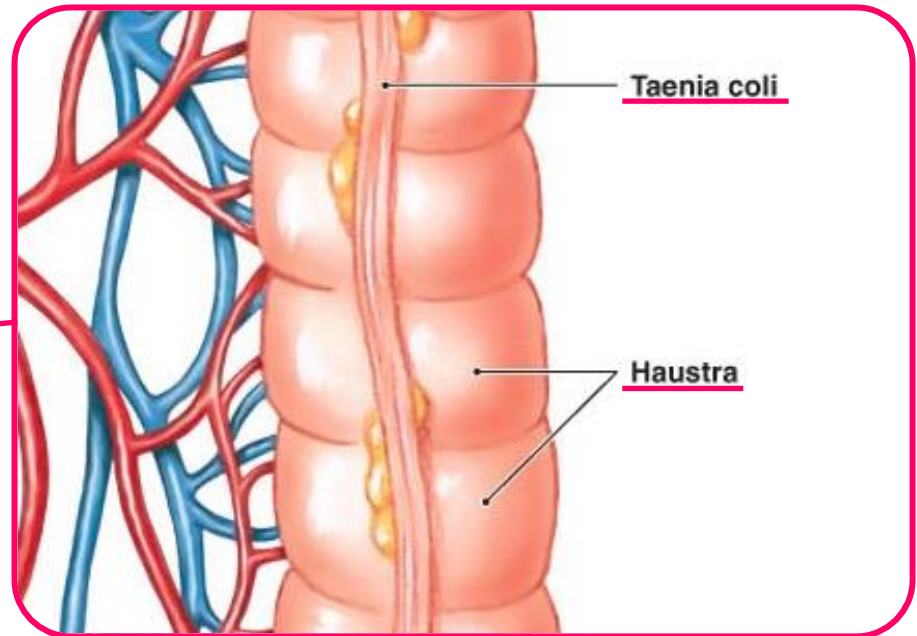
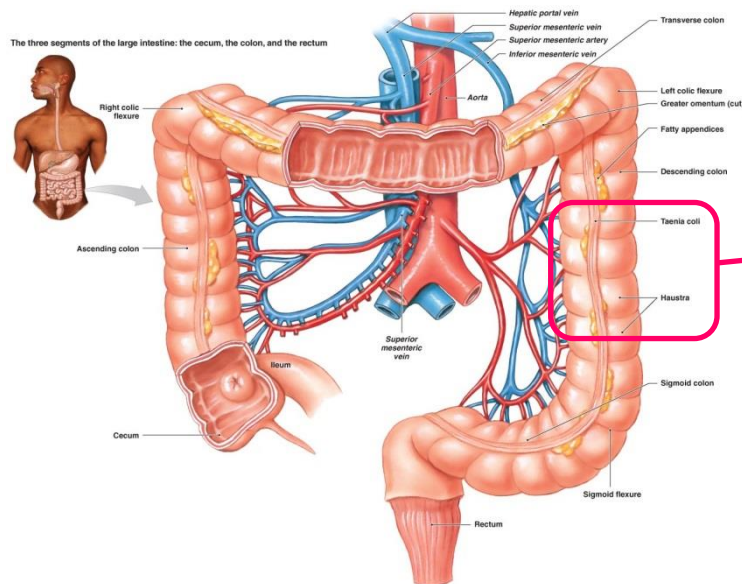


# Parts of the colon



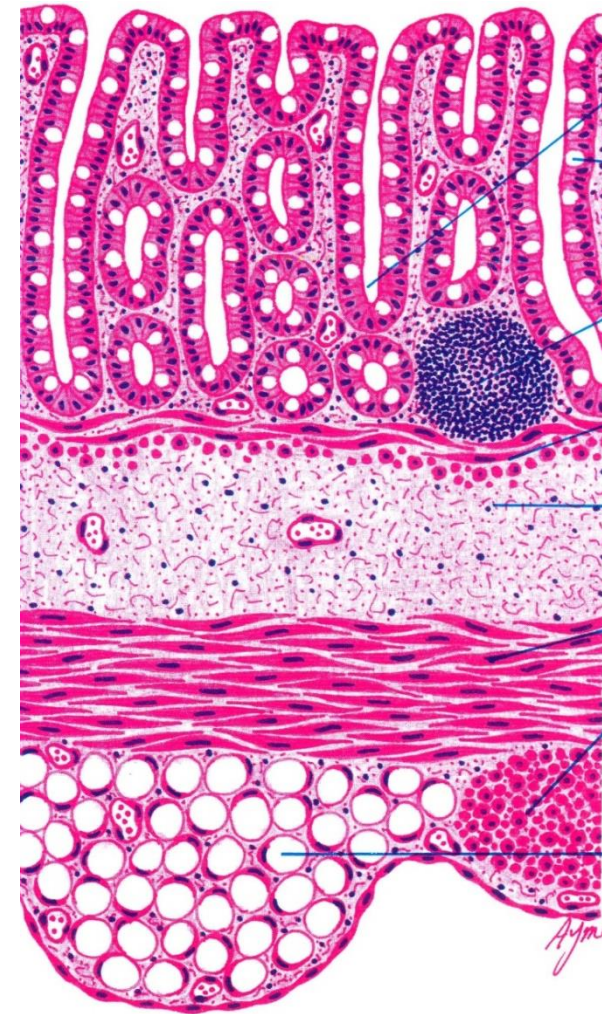
# Characteristics of the colon

- 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**.



# Characteristics of the colon

- The mucous membrane of the colon **lacks villi** and has many **crypts of Lieberkühn** (The main function of the colon is formation of stool not absorption , that's why it lacks villi which their main function is to increase the surface area for absorption).
- 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 passage of chyme from the beginning till the end of colon takes about from one and a half day to two days)



# Function of the large intestine



- Absorb vitamins produced by bacteria.



- Reabsorb water and compact material into feces.



- Store fecal matter prior to defecation.

# The physiology of different colon regions

## Ascending colon

Specialized for **processing chyme** delivered from the terminal ileum

- When radiolabeled chyme is instilled (put gradually) into cecum, half of the instilled volume empties from ascending colon 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 (absorption)

## Transverse colon

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

- The labeled material is retained for about 24 hrs.
- The transverse colon is the **primary** site for the removal of water and electrolytes and the storage of feces.

## 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**

- Labeled feces begin to accumulate in the sigmoid colon about 24 hrs after the label is instilled in the cecum.
- ( 24 → the time that chyme spent it in the transverse colon which means the “ascending” period is short :> )

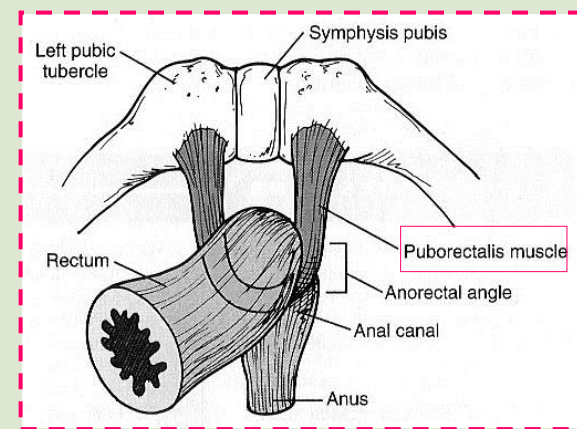


# The physiology of different colon regions

## The rectosigmoid region, anal canal, together with pelvic floor musculature

### → Maintains fecal continence

- The sigmoid and rectum are reservoirs with a capacity of up to 500 mL. (they store feces until the situation is appropriate for defecation).
- The puborectalis muscle and external anal sphincter ( which is under voluntary control unlike the internal 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).



# Secretion in the colon

- It is **mainly mucus**, no digestive enzymes.
- The mucus 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.

## Stimulation

- Stimulation of the pelvic nerves (parasympathic innervation ) 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 and electrolyte

- 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.



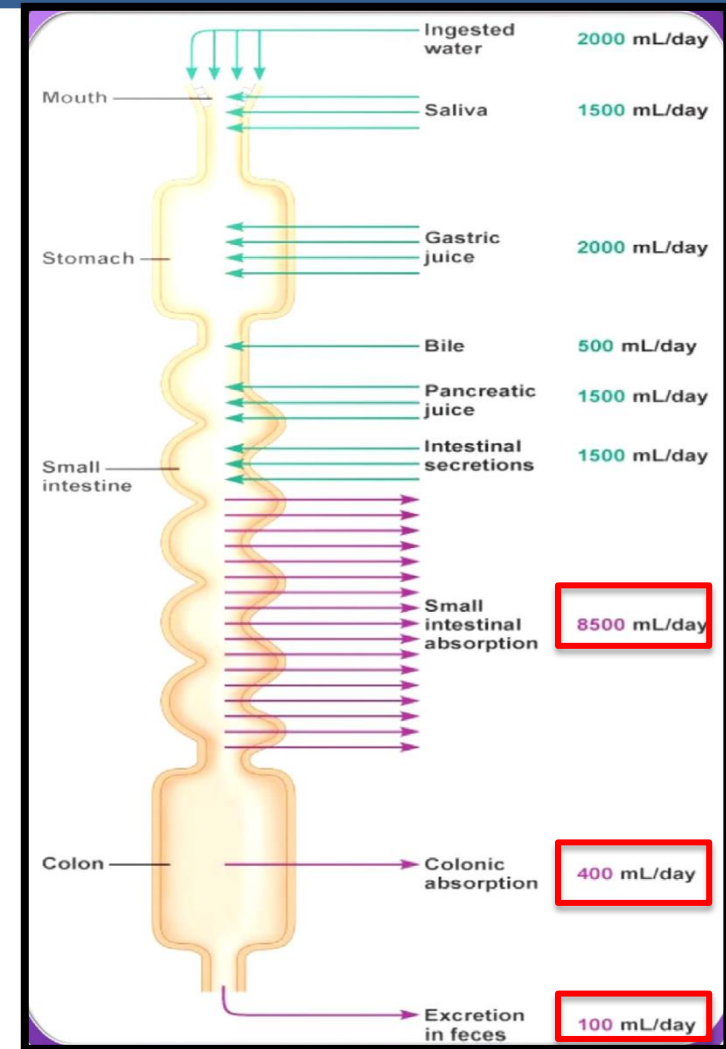
# Absorption in the colon

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

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

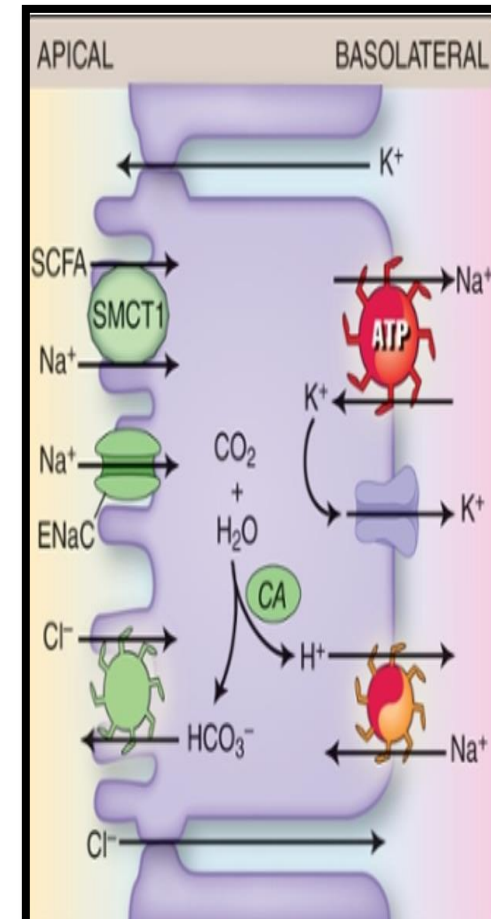
**N.B:** The large intestine can absorb a maximum of 5 to 8 liters of fluid and electrolytes each day.

The mucosa, like the small intestine has a high capability for active absorption of Na, H<sub>2</sub>O, CL and secretion of bicarbonate ions.



# Absorption in the colon

- Na<sup>+</sup>** is **actively** absorbed (in the presence of **Na<sup>+</sup>-K<sup>+</sup> ATPase**) at the **basolateral membrane** to blood.
- K<sup>+</sup>** is **secreted** into the lumen of colon
  - (that's why in diarrhea , **hypokalemia** and can happen)
- Cl<sup>-</sup>** is absorbed in exchange for **HCO<sub>3</sub><sup>-</sup>** which is secreted.
  - ( **acidosis** may happen in sever diarrhea due to loss of bicarbonate )
- Vitamins** as Vit. K, biotin, B5, folic acid and some Amino Acid and short chain Fatty Acid resulting from bacterial fermentation of CHO are absorbed.
- Certain drugs** as steroids and aspirin may be absorbed.
- Bile salt.**
- Organic wastes** – urobilinogens and setrobilinogen.
- Toxins** → then get metabolized in liver.



# Bacterial action in the colon

- This bacterial flora is living in symbiosis (human get benefit from bacteria and vice versa) 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 **B12**. 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 ( **which gives the stool the Dark color** )

4) **Decarboxylation and deamination** 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**.  
*\*In hepatic failure, accumulation of ammonia can cause hepatic encephalopathy.*

6) **Fermentation of undigested CHO** **to produce gases**

# The ileocaecal valve

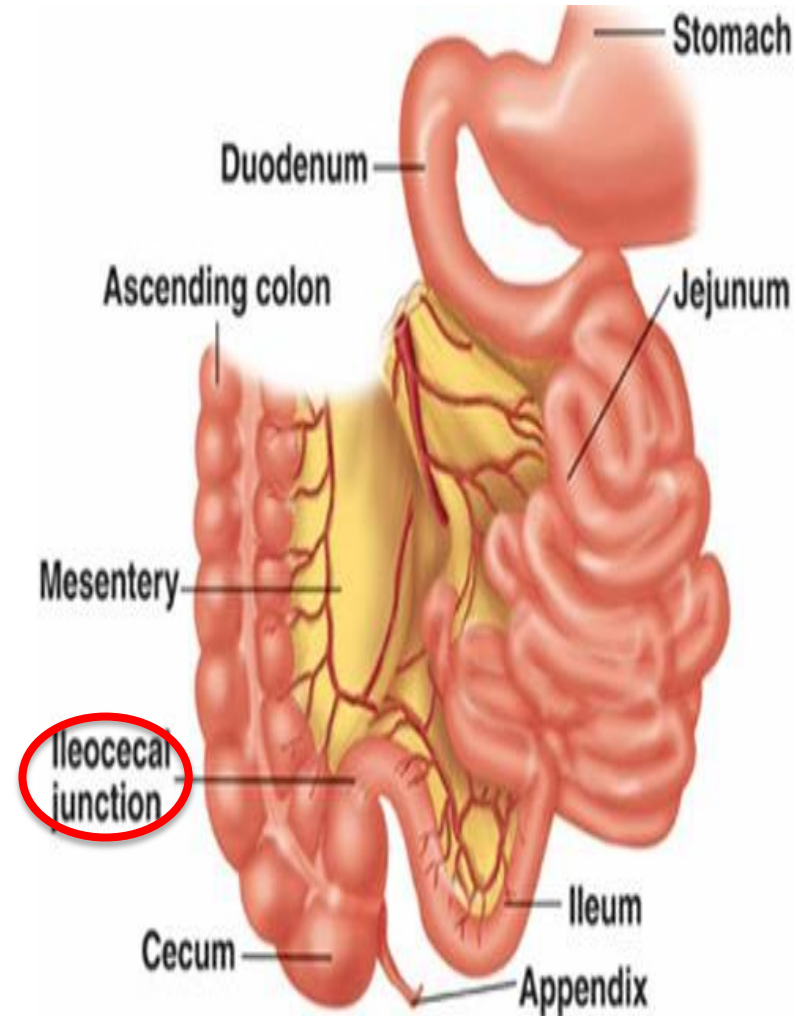
- It **prevents backflow of contents** from colon into small intestine.
- It remains closed and **open only when an intestinal peristaltic wave reaches it.**

Stimulation that **contract** ileocaecal valve

- Distension of the cecum
- Secretin
- Ach
- alpha adrenergic

stimulation that **relax** ileocaecal valve.

- Gastrin
- B adrenergic
- Cck



## Mixing movement ( haustration )

- The motor events **in the cecum and ascending colon**
- Large circular constrictions occur. At each of these 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 called **haustrations**.
- They also at times move slowly anal ward 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**.

## Propulsive ( mass ) movement

- This is the motor **events in the transverse and descending colon**
- 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:**
  1. **constrictive ring occurs** at a distended or irritated point in the colon.
  2. 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. **Until it reaches the rectum**
- It start at the middle of transverse colon and is preceded by relaxation of the circular muscle and the downstream disappearance of haustral contractions
- 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.

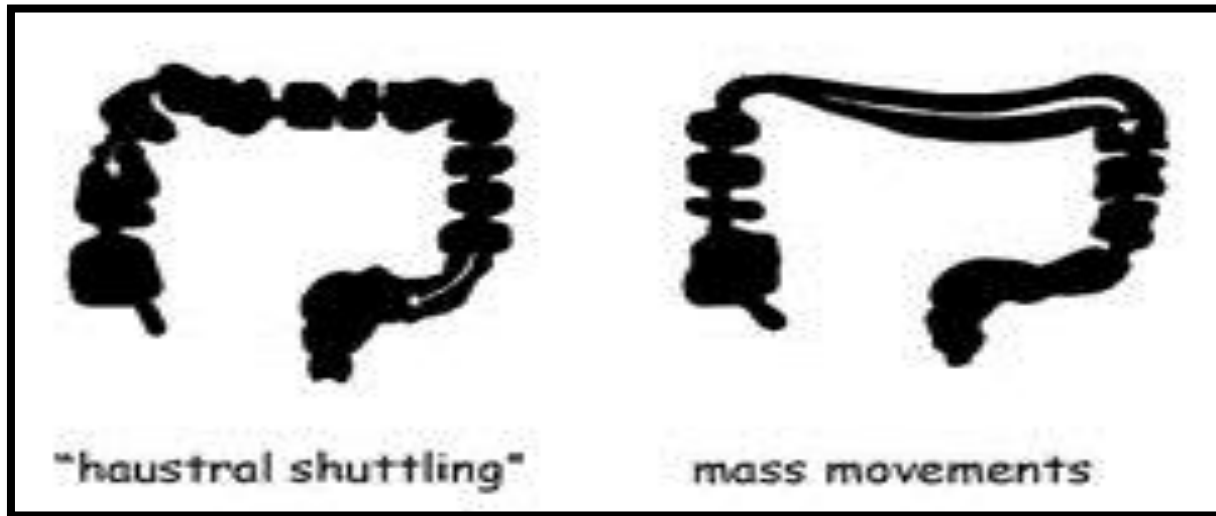
## antiperistalsis

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

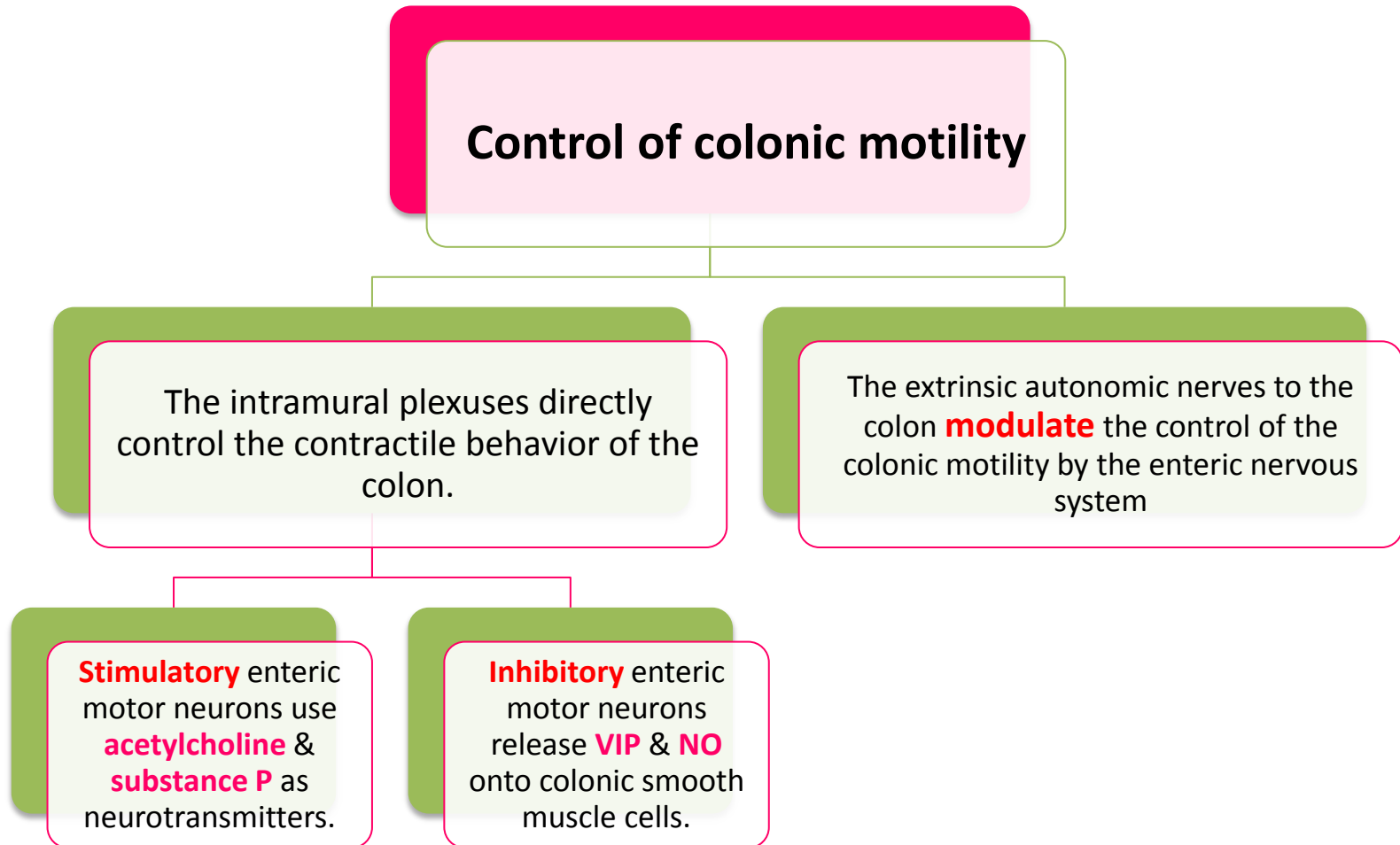


# Initiation of mass movement

1. **Gastrocolic** & **duodenocolic** reflexes after meals. They result from distension of the stomach & duodenum.
2. **Irritation of the colon** e.g., castor oil.
3. **Intense stimulation of parasympathetic** NS.
4. **Over distension** of a segment of the colon.

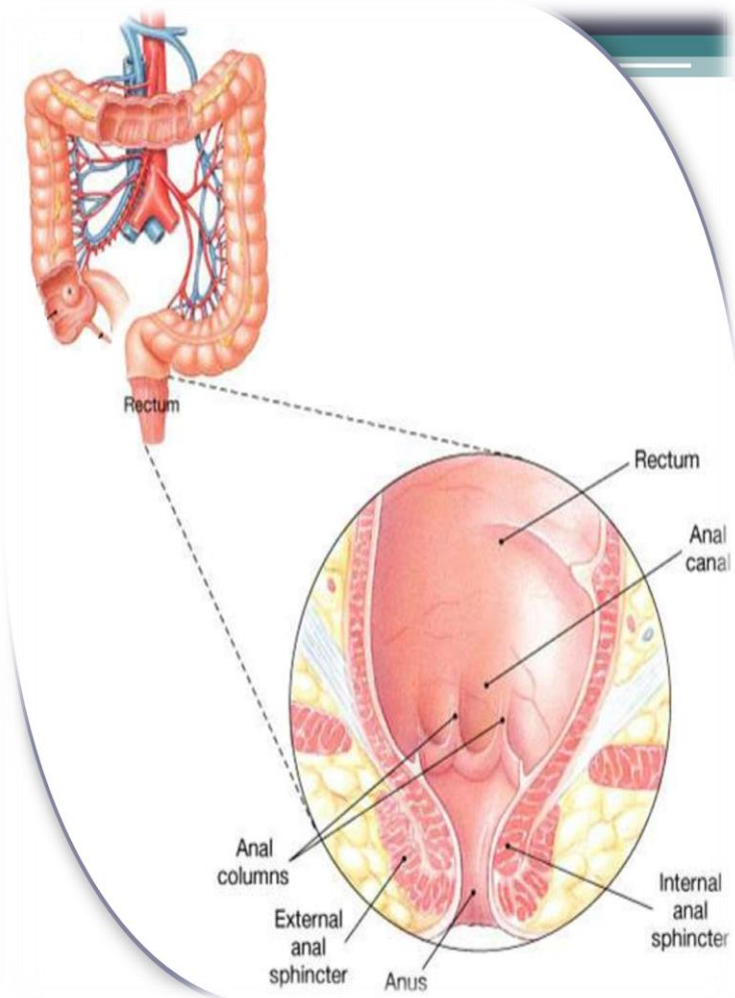


# Control of colonic motility



# The Rectum

- Last portion of the digestive tract that terminates at the anal canal.
- **Mechanoreceptors in the rectum** detect distention and supply the ENS.
- The **anal canal in the region of the skin is innervated by somatosensory** nerves that transmit signals to CNS. This region has sensory receptor of Pain, Temperature and Touch.
- 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 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.

# Defecation reflex

1. Distension of the rectum.

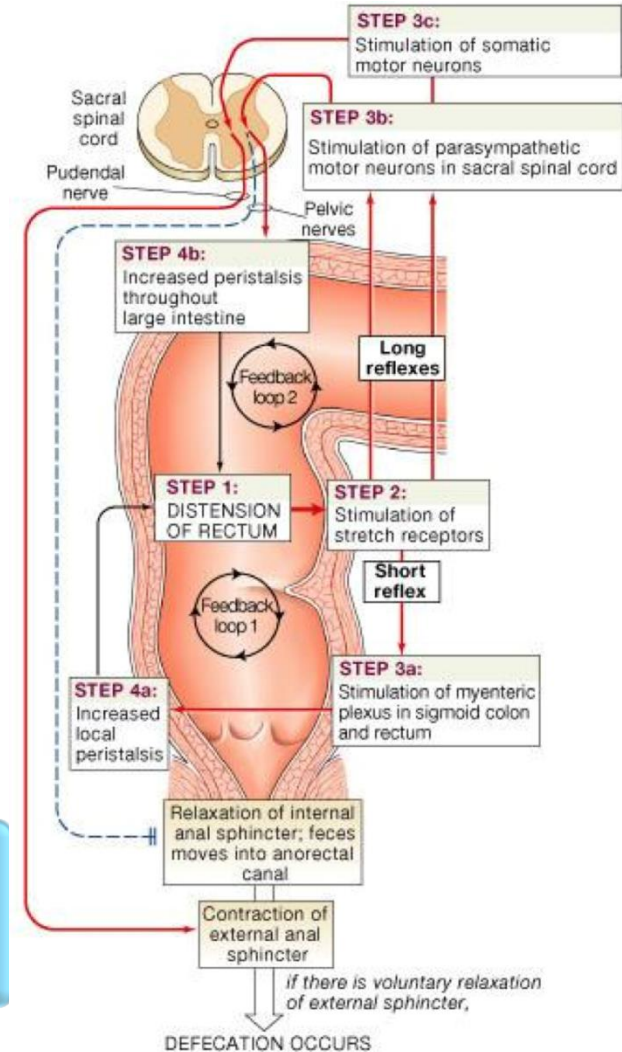
2) Stimulation of the stretch receptors  
in the rectum

3) A- Short reflex: **Stimulation of myenteric plexus** in sigmoid colon and rectum.

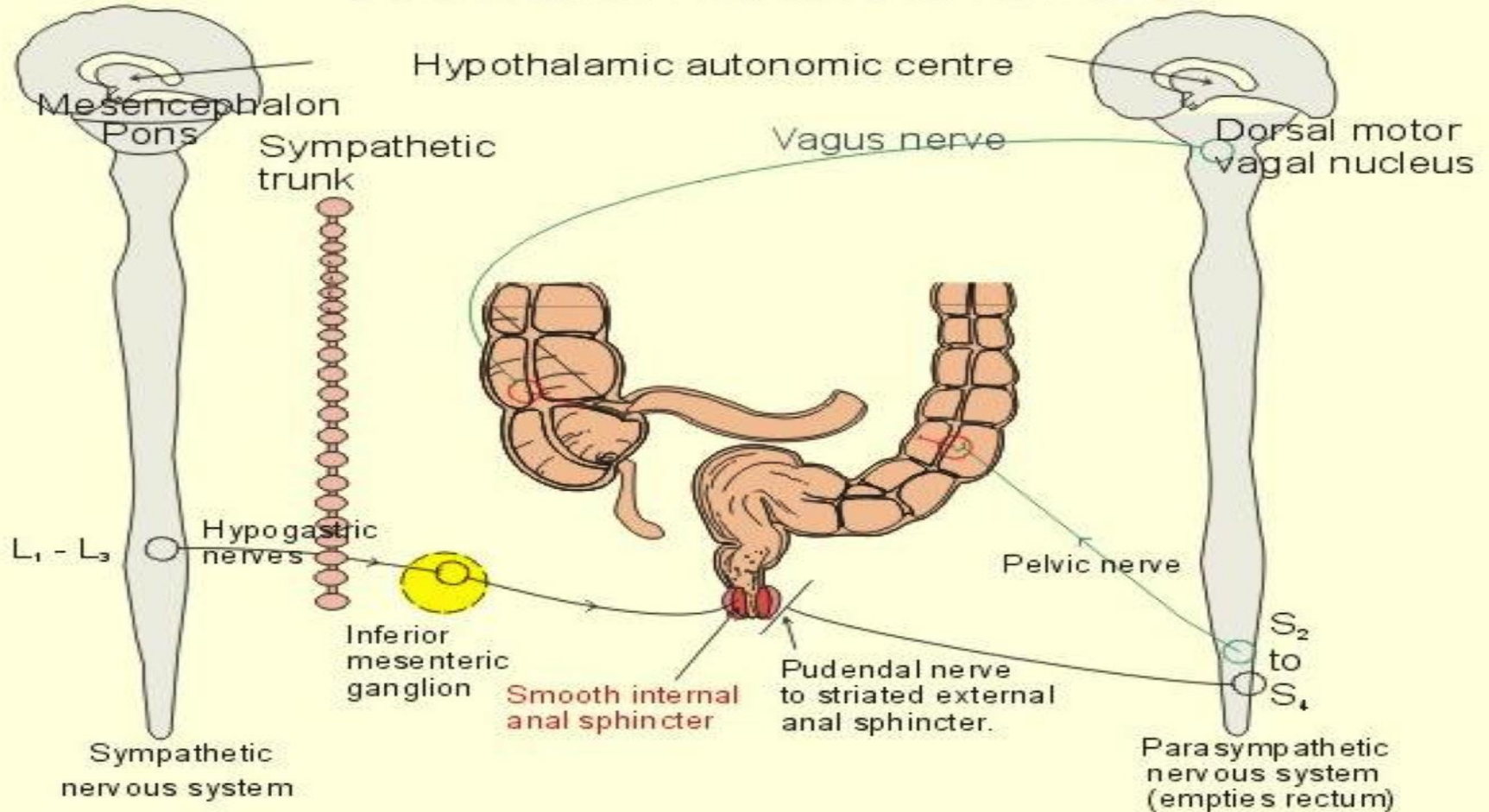
B- long reflex: **stimulation of parasympathetic motor neurons** in sacral spinal cord.

C- Stimulation of somatic motor neurons.

Increased local peristalsis. **Relaxation of internal anal sphincter and contraction of external anal sphincter.**



## Defaecation Reflexes In Humans



## If the surrounding circumstances are suitable

1) 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**.

2) 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**

## 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**.

Repeated inhibition of defecation reflex is a major cause of constipation



Anal Canal

### Internal canal sphincter:

- Involuntary control
- Smooth muscle
- Contracted at normal condition

### External canal sphincter:

- Voluntary control
- Striated muscle
- Relaxed at normal condition

With activation of defecation reflex, the internal anal sphincter get relaxed by the effect of ENS, so if you don't want to defecate → the external anal sphincter get contracted voluntary to stop defecation :>



# Fecal incontinence

the spinal reflex of defecation operates without interference from higher centers  
**(fecal incontinence)**

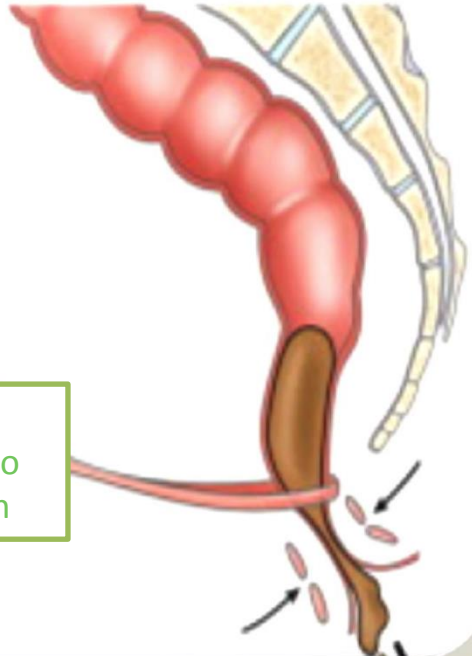
In infants

In Spinal cord lesion



### Incontinence

- Low resting and/or low squeeze sphincter pressures (weak IAS and EAS)
- Weakness of puborectalis
- Neuropathy
- Altered rectal or anal sensation
- Diarrheal conditions → In infectious diarrhea due to peristaltic rush
- Diminished rectal capacity



<http://www.youtube.com/watch?v=MxLh6tBfrhw>

■ Slides

■ Important

■ Females' Notes

■ Explanation

■ Males' Notes

- The colon is divided into appendix ,cecum , ascending , transverse , descending , sigmoid , rectum and finally anus.
- Tenia coli and haustra are characteristic to the colon
- The mucous membrane of the colon lacks villi
- Pelvic nerves (parasympathic) increase the mucus secretion
- Most of absorption occur in proximal half of the colon
- The distal colon function is storage
- About 0.5 L of water is absorbed daily from the colon
- Na<sup>+</sup> and Cl<sup>-</sup> are absorbed
- K<sup>+</sup> and HCO<sub>3</sub><sup>-</sup> are secreted
- Vit. K, biotin, B5 and folic acid resulting from bacterial fermentation of CHO are absorbed
- The ileocecal valve prevents backflow of contents from colon
- Gastrin and CCK relaxes the ileocecal valve unlike the secretin

Mixing movements (haustration)	Propulsive ( mass) movement	antiperstalsis
predominant	Programmed for defecation	Give sufficient time for absorption
For absorption		
Cecum + ascending colon	Transverse + descending colon	In the orad direction

- Mass movement is mainly initiated by Gastrocolic and duodenocolic reflex
- Defecation is a spinal reflex which is influenced by higher center that's why a person with spinal cord injury have fetal incontinence

# QUESTIONS

**1 ) which of these vitamins are produced by the bacterial flora ?**

- A- Vit A
- B- Vit C
- C- Vit K
- D- Vit D

C  
D  
A  
A

**2) which one of these stimulants relaxes the ileocecal valve ?**

- A- Ach
- B- alpha adrenergic
- C- Secretin
- D- beta adrenergic

**3) A Type of movement occur in the colon which is responsible mainly for the absorption ?**

- A- Haustration
- B- Massive movement
- C- Antiperistalsis

**4) In the defecation reflex which of these sphincter will be relaxed ?**

- A- internal anal sphincter
- B- external anal sphincter



**THE END**

**If there are any Problems or Suggestions,  
Feel free to contact us:**

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**THANK YOU**

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