جامعة الملك سعود
King Saud University

MED437
KING SAUD UNIVERSITY

Physiology of The Colon

Objectives:

- Physiological Functions of Different Colon Regions
- Secretion in the Colon
- Nutrient Digestion & Absorption in the Colon
- Bacterial Action in the Colon
- Motility in the Colon
- Defecation Reflex

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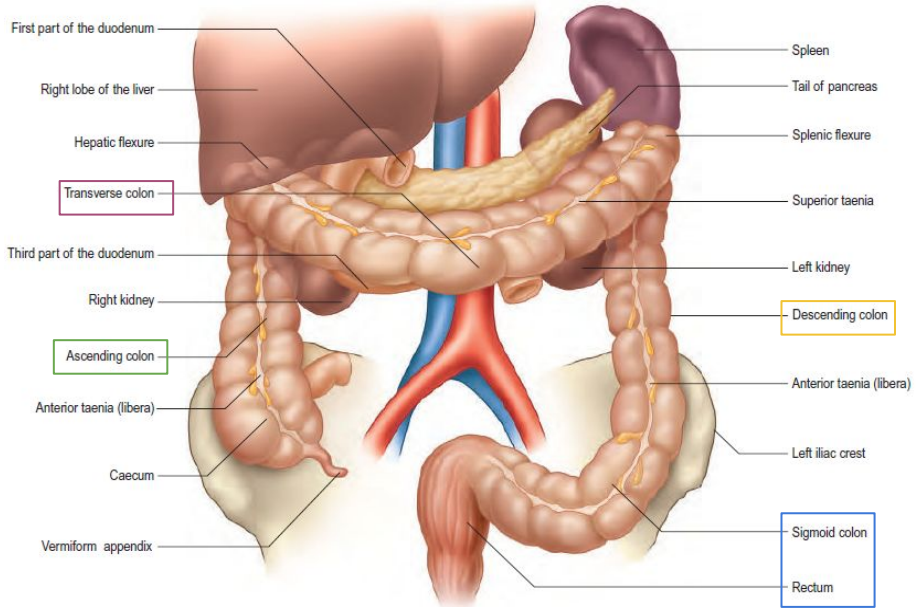
Colour index:
- Important
- Numbers
- Extra

وَأَن لَّيْسَ لِلْإِنسَانِ إِلَّا مَا سَعَىٰ

The Large Intestine



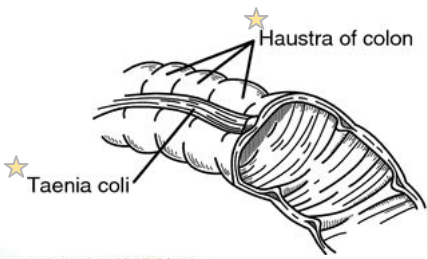
- This is the final digestive structure.
- By the time the digested food (chyme) reaches the large intestine, most of the nutrients have been absorbed.
- The primary role of the large intestine is to convert chyme into feces for excretion.

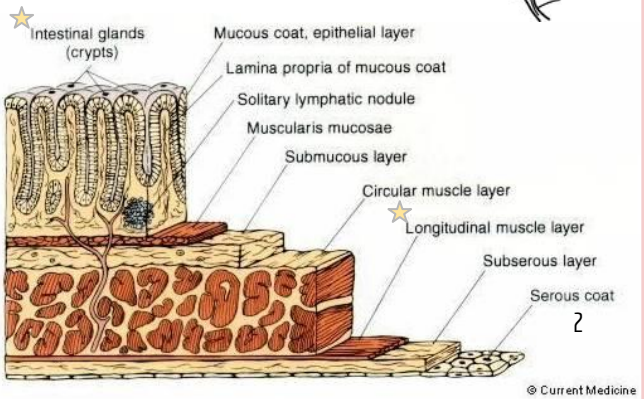
- The colon has a length of about 1.5 meters (one-fifth of the whole length of GIT).
- It consists of the ascending, transverse, descending & sigmoid colon, rectum and anal canal.
- The transit of radiolabeled chyme through the large intestine occurs in 36-48 hrs.

The mucous membrane of the colon:

No intestinal villi, many crypts of Lieberkühn, numerous goblet cells, no digestive enzymes.

- Lacks villi and has many crypts of Lieberkühn.
- They consist of simple short glands lined by mucous-secreting goblet cells (provides an adherent medium for holding fecal matter together). No digestive enzymes.
- 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.



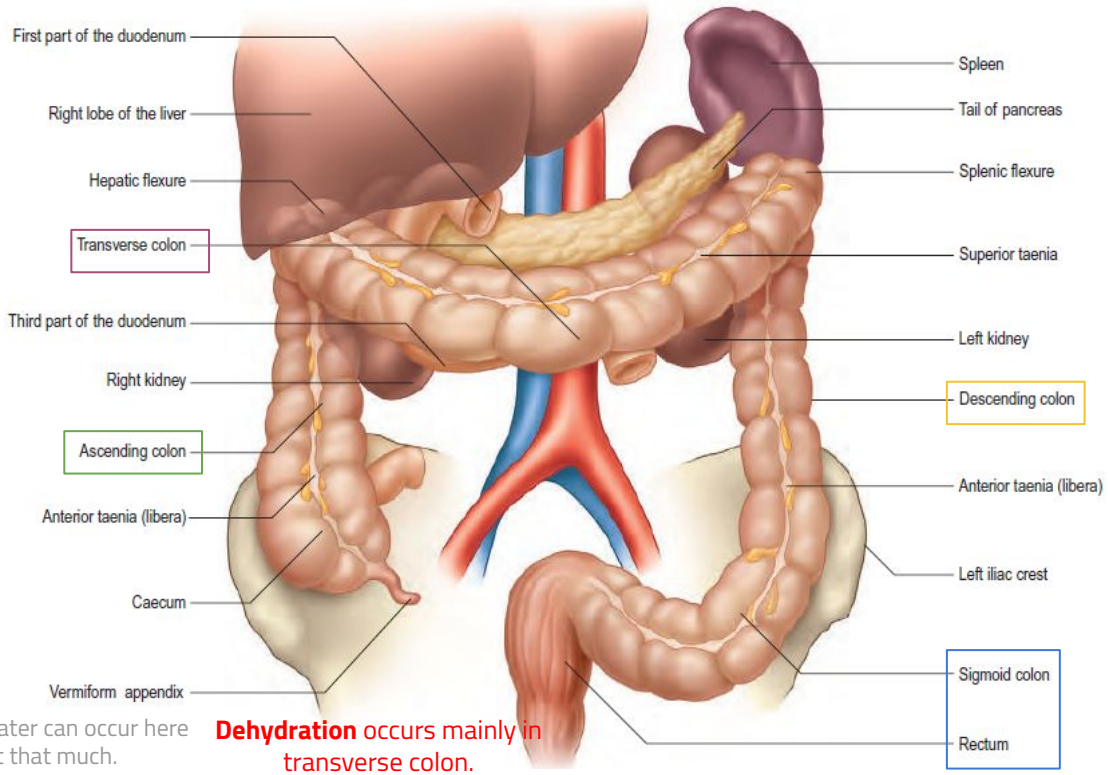


Functions of the colon

1. **Absorb** — Vitamins produced by bacteria. Vit K
2. **Reabsorb** — Water and compact material into feces.
3. **Store** — Fecal matter prior to defecation

Ultimate goal.

The physiology of different colon regions



Removal of water can occur here but not that much.

Dehydration occurs mainly in transverse colon.

Ascending colon

Specialized for processing chyme delivered from the terminal ileum.

The ascending colon is not the primary site of storage

Transverse colon

The transverse colon is the **primary site** for the removal of water and electrolytes and the storage of feces.

Descending colon

A conduit"pipe like "between the transverse and sigmoid colon. Has the neural program for power propulsion, involved in defecation reflex.

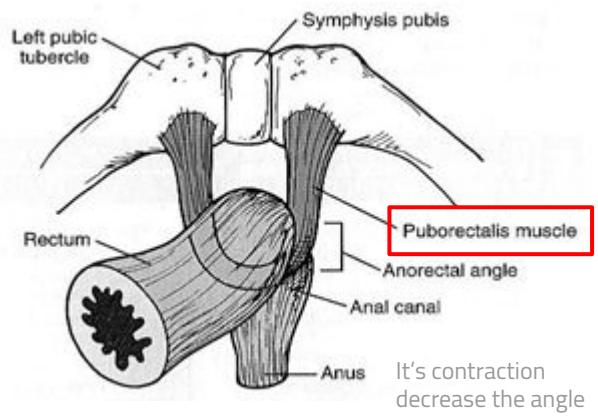
Recto-sigmoid region

Together with anal canal, pelvic floor musculature maintains fecal continence.

Control the passage of feces.

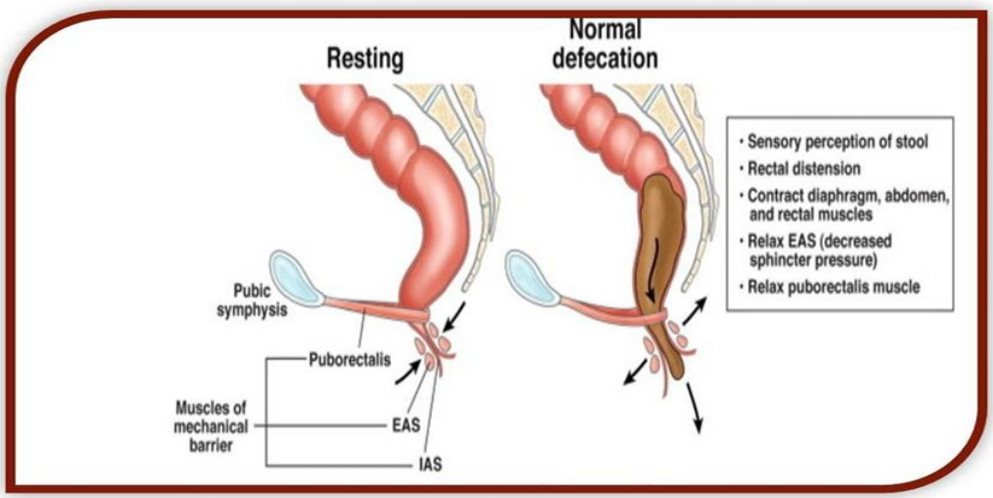
How the rectosigmoid region, anal canal & pelvic floor musculature maintains fecal continence?

- The sigmoid and rectum are reservoirs with a capacity of up to 500 mL.
- Fibers of puborectalis"pelvic floor muscle" 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.



It's contraction decrease the angle between the rectum and anus.

Fecal Continence



Secretion in the colon

- The epithelial cells contain almost no digestive enzymes.
- The secretion is mainly mucus, it has the following functions:

End products of normal flora tend to increase acidity of intestinal lumen.

1-Neutralizes — against any acids present.

3-Helps — to lubricate feces.

2-Protects — Against irritation.

4-Provides — A binding medium for fecal matter.

Effect of parasympathetic stimulation on secretion

Stimulation of the pelvic nerves cause: "Also vagus nerve"

-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 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.

Nutrient digestion in the large intestine

Bacterial action produces nutrients: vitamin K, thiamin, biotin, vitamin B_{12}, riboflavin.

The large population of bacteria digests small amounts of fiber; produce gases and organic acids.

Little digestion occurs in the large intestine

The large intestine is divided into two parts

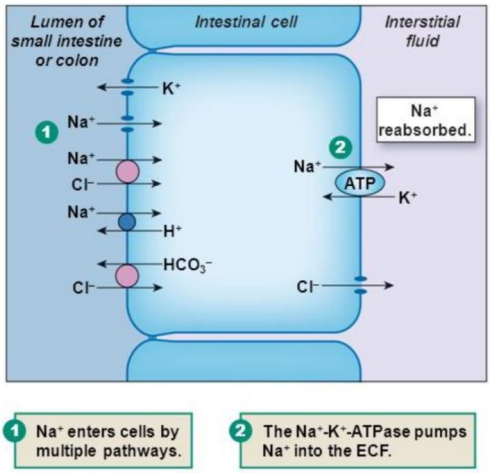
1. Absorbing part including : cecum, ascending colon and prox. half of transverse colon (proximal half of large intestine).
2. Storage part including : distal half of transverse colon till anus (distal half of large intestine)

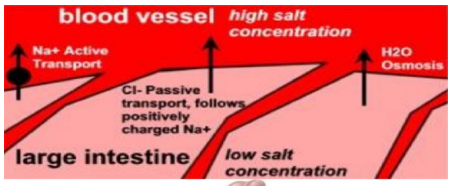
Absorption in the Large Intestine

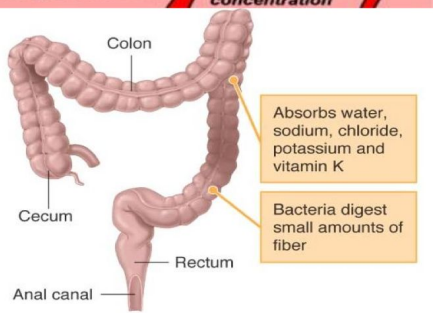
- Little absorption occurs in the large intestine
- Most of absorption occurs in the proximal half of the colon (absorptive colon). Whereas the distal colon function for storage (storage colon).

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

excessive diarrhea will lead to acidosis (HCO_3 loss) and hypokalemia.







Water

- About 0.5- 1.5L/day is absorbed
- The net water loss is 100-200 ml/day

Sodium

In the presence of Na+-K+ ATPase, at the basolateral membrane, Na+ is actively absorbed and K+ is secreted into the lumen of colon.

Chloride

Cl- is absorbed in exchange for HCO3- which is secreted.

Vitamins

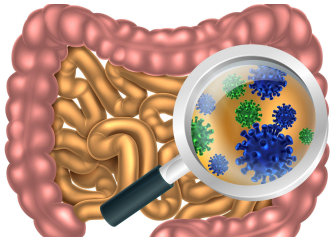
- Vitamins as vitamin K, biotin, B5, folic acid and some AA and short chain FA resulting from bacterial fermentation of CHO are absorbed.
- It does not absorb vitamin B12.

Drugs

Certain drugs as steroids and aspirin may be absorbed.

Rectal suppositories.

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:

Most important

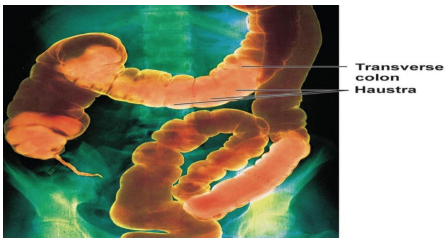
1. Synthesis of vitamin K and some B group vitamins as folic acid, biotin, thiamine and B12.
   The bacteria-formed vitamin K is especially important because the amount of this vit. in the daily ingested foods is normally insufficient to maintain adequate blood coagulation.
   Using antiseptic for long duration >> sterilization >> no synthesis of vitamin K.
2. Deconjugation and decarboxylation of bile salts.
3. Break down of bile pigments to produce stercobilinogen.
   Stercobilinogen is the end result of bilirubin and responsible for the brown color of feces .
4. Decarboxylation of some AA to produce amine and histamine.
   The amines are excreted in feces and are responsible for its smell.
   Ammonia accumulation leads to Hepatic Encephalopathy.
5. Breakdown 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)

It involves cecum ,ascending colon and proximal ⅓ of transverse colon.

- 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 receiving segment on either side remain in their respective state for longer periods.
- In addition, there is uniform repetition of the haustrae along the colon.
- Net forward propulsion occurs when sequential migration of haustra occur along the length of the bowel.



2- Propulsive (mass) movement (Modified peristalsi).

The motor events in transverse & descending colon.
It starts at the middle of transverse colon, 15 min after eating breakfast. After the first meal.

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. Looks like a syringe.

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.

It involves the distal ⅔ of transverse colon until rectum. Usually it starts from middle of transverse colon.

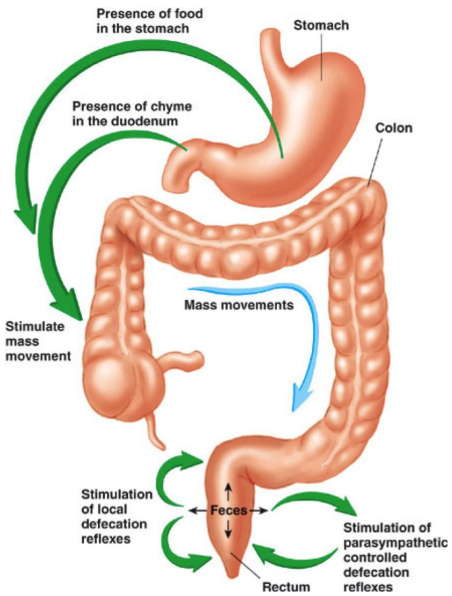
When they have forced a mass of feces into the rectum the desire for defecation is felt.

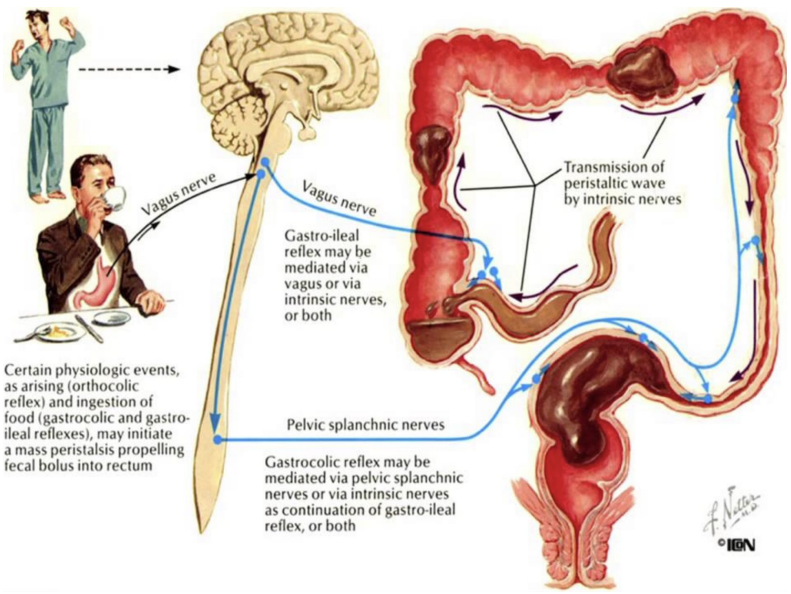
Initiation of mass movement

Gastrocolic & duodenocolic reflexes after meals. They result from distension of the stomach & duodenum.

Irritation of the colon e.g., castor oil. زيت الخروع

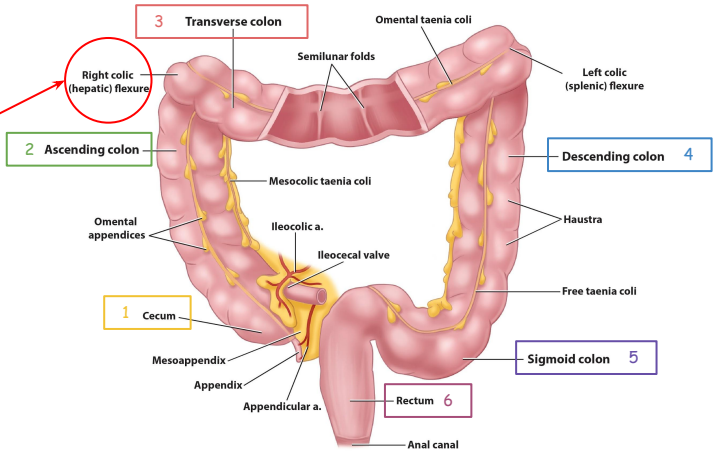
Threatening agents such as parasites and enterotoxins can initiate mass movement





3-Antiperistalsis

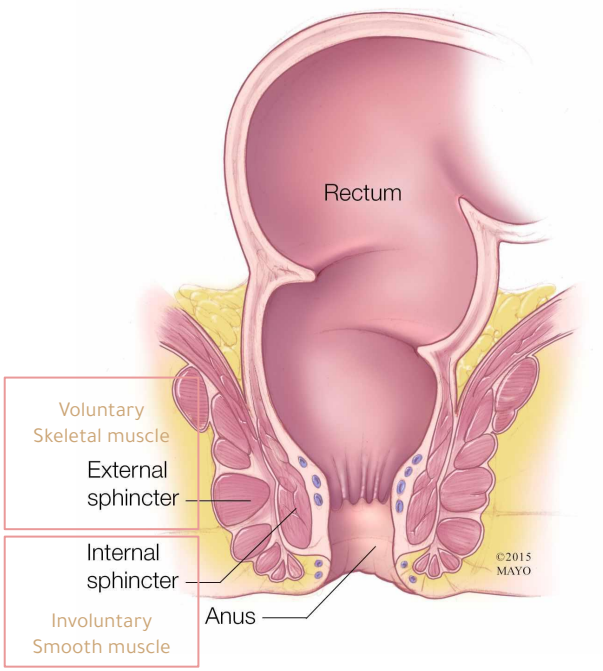
- It starts at the junction of ascending and transverse colon and traveling towards the cecum.
- It mixes contents and help water absorption.



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.

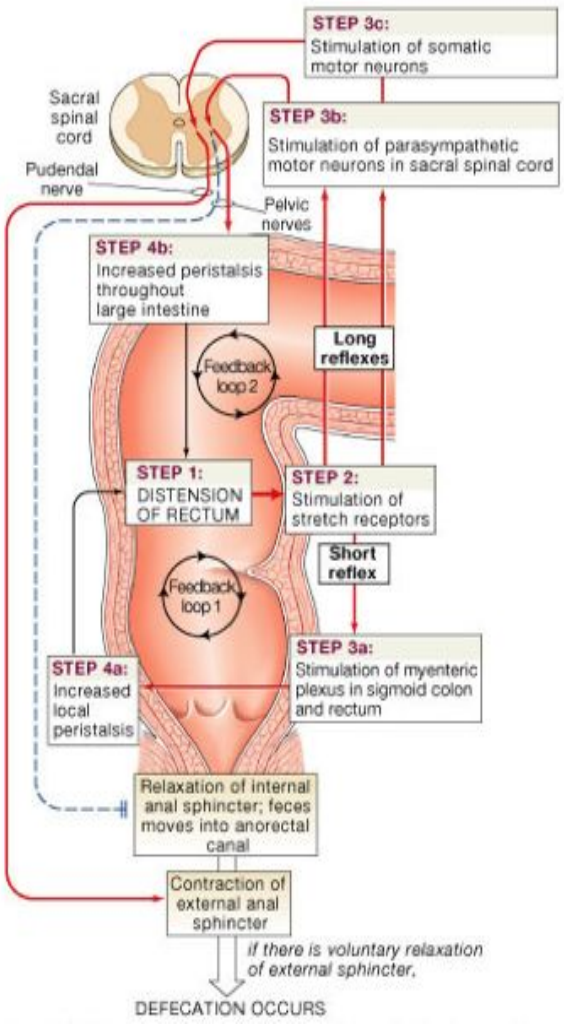
The anal canal in the region of the skin is innervated by somatosensory nerves that transmit pain, temperature and touch signals to CNS.

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.
- 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.

Interpretation of image → Two reflexes : short and long

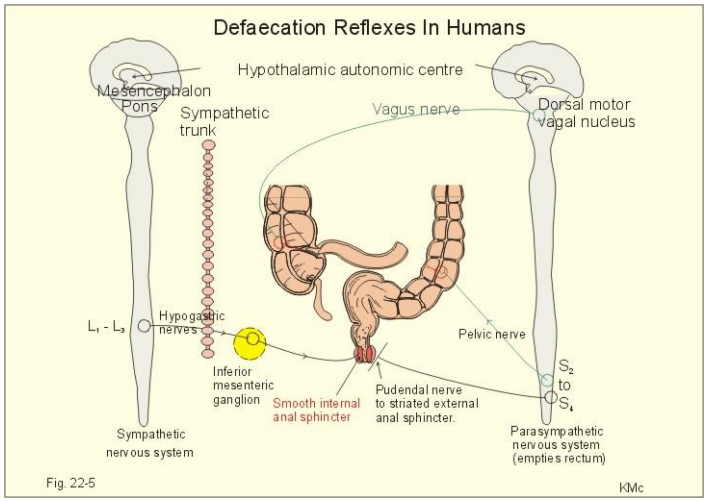


Short reflex has only one action which increases the **local** peristalsis by activation of myenteric plexus." Only within rectum"

Long reflex has two actions.

1. stimulation of parasympathetic neurons in sacral spinal cords that will increase peristalsis throughout large intestine.
2. stimulation of somatic motor neurons in sacral spinal cord that will contract external anal sphincter.

Stimulus : distension of rectum that will stimulate mechanoreceptors " stretch receptors".



Dr's note: The internal anal sphincter is usually tonically contracted, when amount of feces or material exceed 500ml, the internal anal sphincter will relax and contents will move to anus , at that time you will feel urgency of defecation but still can be controlled. This control is due contraction of external anal sphincter beside puborectalis muscles. Usually external anal sphincter and puborectalis muscles are relaxed.

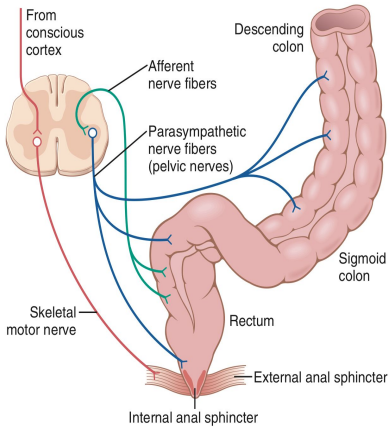


Figure 64-6. Afferent and efferent pathways of the parasympathetic mechanism for enhancing the defecation reflex.

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 <u>not</u> 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.

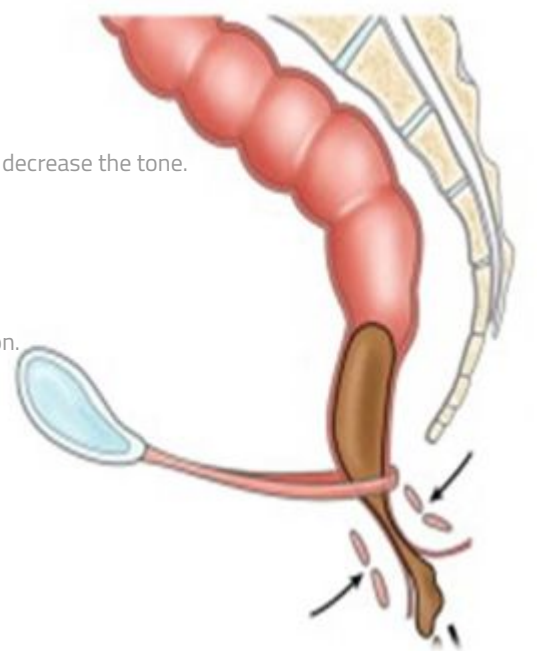
Preventing the defecation for several times is the most common cause of Constipation.

Fecal incontinence:

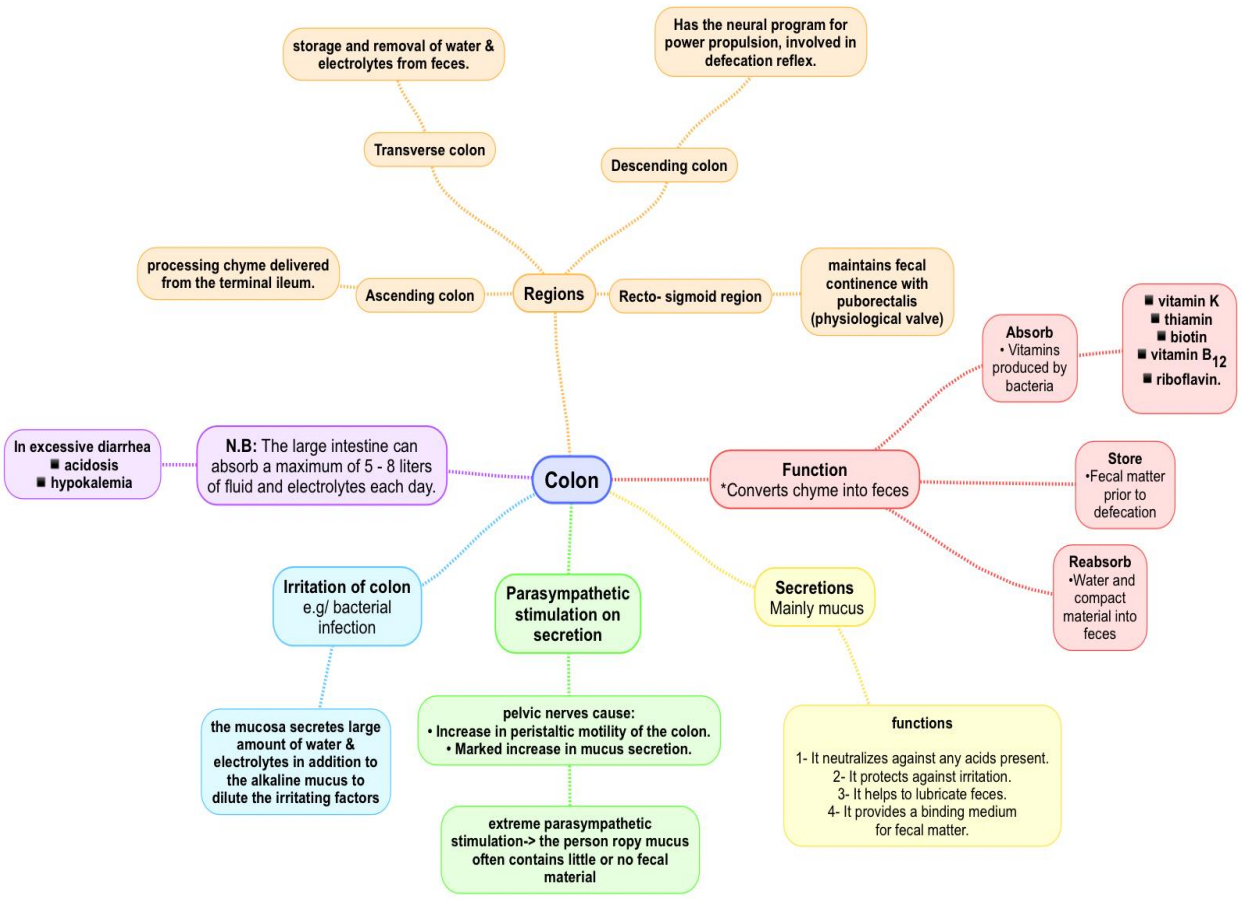
The spinal reflex of defecation operates without interference from higher centers.

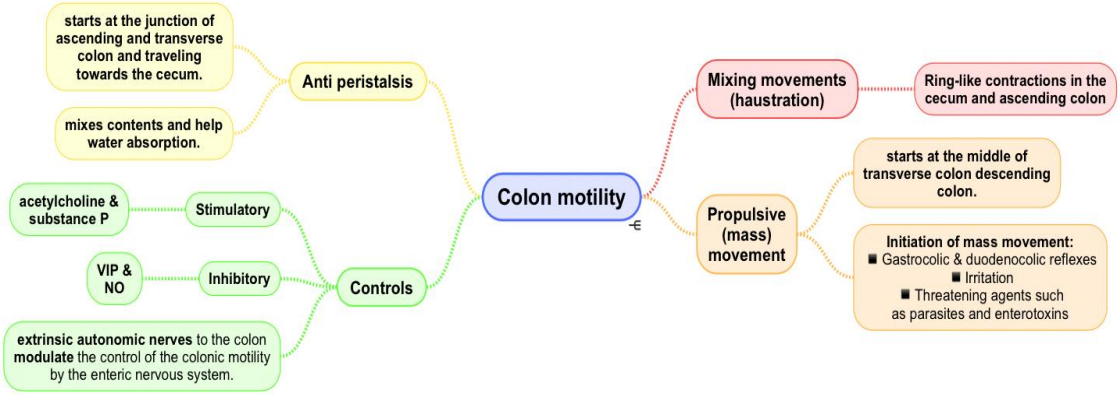
Causes:

- In infants (physiological)
- Spinal cord lesion
- Weakness of IAS and EAS Muscle rupture > decrease the tone.
- Weakness of pulborectalis
- Altered rectal or anal sensation
- Diarrheal conditions
- Diminished rectal capacity Tumor, obstruction.



Summary


storage and removal of water & electrolytes from feces.
Has the neural program for power propulsion, involved in defecation reflex.
Transverse colon
Descending colon
processing chyme delivered from the terminal ileum.
Ascending colon
Regions
Recto- sigmoid region
maintains fecal continence with puborectalis (physiological valve)
Absorb
• Vitamins produced by bacteria
vitamin K
thiamin
biotin
vitamin B12
riboflavin.
In excessive diarrhea
acidosis
hypokalemia
N.B: The large intestine can absorb a maximum of 5 - 8 liters of fluid and electrolytes each day.
Colon
Function
*Converts chyme into feces
Store
•Fecal matter prior to defecation
Reabsorb
•Water and compact material into feces
Irritation of colon
e.g/ bacterial infection
Parasympathetic stimulation on secretion
Secretions
Mainly mucus
the mucosa secretes large amount of water & electrolytes in addition to the alkaline mucus to dilute the irritating factors
pelvic nerves cause:
• Increase in peristaltic motility of the colon.
• Marked increase in mucus secretion.
extreme parasympathetic stimulation-> the person ropy mucus often contains little or no fecal material
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.


starts at the junction of ascending and transverse colon and traveling towards the cecum.
Anti peristalsis
mixes contents and help water absorption.
Mixing movements (haustration)
Ring-like contractions in the cecum and ascending colon
acetylcholine & substance P
Stimulatory
Colon motility
Propulsive (mass) movement
starts at the middle of transverse colon descending colon.
VIP & NO
Inhibitory
Controls
Initiation of mass movement:
Gastrocolic & duodenocolic reflexes
Irritation
Threatening agents such as parasites and enterotoxins
extrinsic autonomic nerves to the colon modulate the control of the colonic motility by the enteric nervous system.

MCQs

1) Which one of the following best describes colonic function?

A. Absorption of Na+ in the colon is under hormonal control by aldosterone.
B. Net absorption of bicarbonate occurs in the colon.
C. Net absorption of K+ occurs in the colon.
D. Bile acids enhance absorption of water from the colon.

2) Gas within the colon is primarily derived from which of the following sources?

A. Air pockets in diverticula
B. CO2 liberated by the interaction of bicarbonate and H+
C. Fermentation of undigested oligosaccharides
D. Swallowed atmospheric air

3) which one of the following reflexes is results in the urge to defecate when the stomach is stretched?

A. Duodenocolic reflex
B. Entrogastric reflex
C. Gastrocolic reflex
D. Intestino-intestinal reflex

4) Mass movement can lead to which one of the following?

A. Gastric movement
B. Bowel movement
C. Hausturation
D. Esophageal contraction

5) Which one of the following area is the primary site of dehydration of the feces?

A. Cecum
B. Ascending colon
C. Descending colon
D. Transverse colon

6) Mass movement can cause which one of the following?

A. Contraction of internal anal sphincter
B. Duodenal peristalsis
C. Rectal distention
D. Gastric retropulsion

SAQ

7) Write three causes of fecal incontinence.

1. Spinal cord lesion
2. Internal and external anal sphincter weakness
3. Diminished rectal capacity

Answers: 1. A 2. C 3. C 4. B 5. D 6. C