

Physiology of Colon (Large intestine)

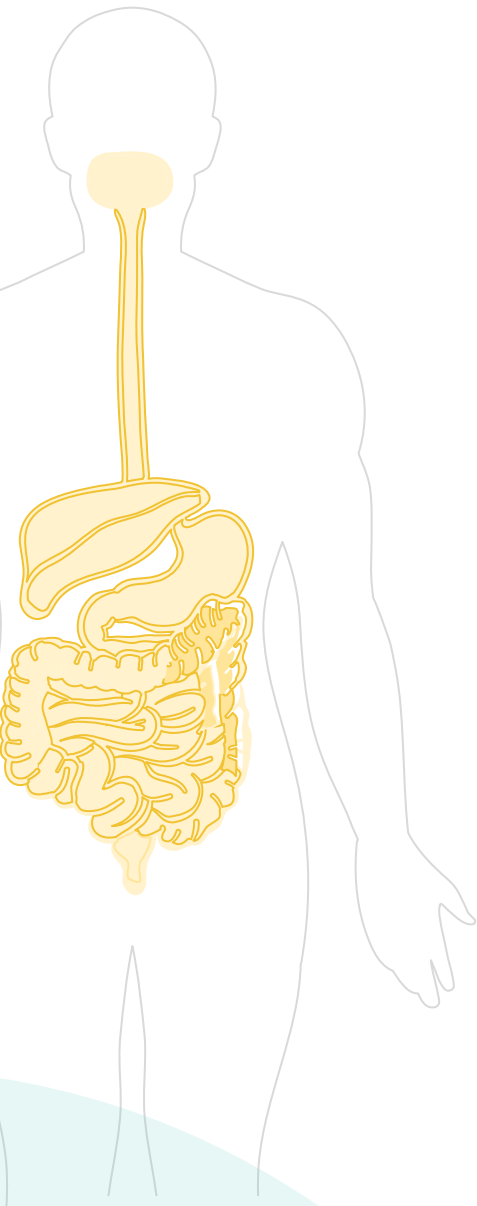
GNT Physiology

This lecture was presented by:
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Objectives



Physiological Functions of Different Colon Regions.



Secretion in the Colon.



Nutrient Digestion & Absorption in the Colon.



Gut Flora (Gastrointestinal Microbiota).



Motility in the Colon.

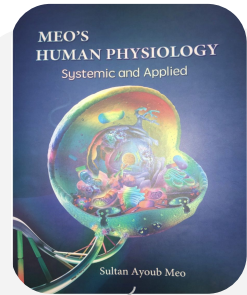
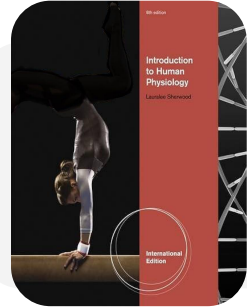
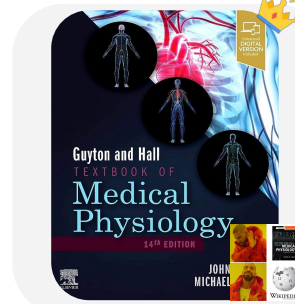


Defecation Reflex.



Resources

Only GI chapters included



This is prof sultan meo!



[Click here](#) for a helpful channel by the team!



For explanation.

﴿ أَمْ حَسِبْتُمْ أَنْ تَدْخُلُوا الْجَنَّةَ وَلَمَّا يَعْلَمِ اللَّهُ الَّذِينَ جَاهَدُوا مِنْكُمْ وَيَعْلَمَ الصَّابِرِينَ ﴾

هذا استفهام إنكاري، أي لا تظنوا ولا يخطر ببالكم أن تدخلوا الجنة من دون مشقة واحتمال المكاره في سبيل الله وابتغاء مرضاته، فإن الجنة أعلى المطالب وأفضل ما به يتنافس المتنافسون، وكلما عظم المطلوب عظمت وسيلته، والعمل الموصل إليه، فلا يوصل إلى الراحة إلا بترك الراحة، ولا يدرك النعيم إلا بترك النعيم، ولكن مكاره الدنيا التي تصيب العبد في سبيل الله عند توطين النفس لها وتمرينها عليها ومعرفة ما تنول إليه، تنقلب عند أرباب البصائر منحا يسرون بها ولا يبالون بها، وذلك فضل الله يؤتيه من يشاء

[تيسير الكريم الرحمن، السعدي]



The Large Intestines

- 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.
- **at this stage the material is mostly waste but we still need to extract some nutrients like vitamins, electrolytes, and water**

The Mucous Membrane of the large intestines /Colon

- **The mucosa of the large intestine has many crypts of Lieberkühn.**
- **Absence of villi.**
- **The crypts consist of simple short glands lined by mucous-secreting goblet cells / presence of goblet cells that secrete mucus (provides an adherent medium for holding fecal matter together).**
- **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.** See pictures

Anatomy

The colon has a length of about 1.5 meters (1/5 of the whole length of GIT).

The areas of the colon are:

- Ascending colon
- Transverse colon
- Descending colon
- Sigmoid colon
- Rectum
- Anal canal

Functions of large intestines /Colon

1. Absorb:

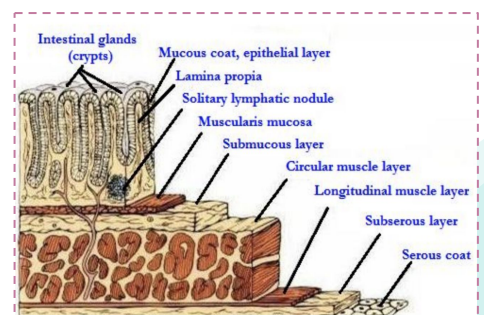
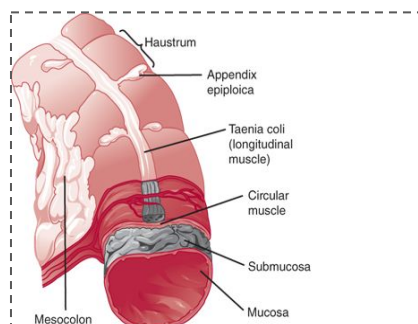
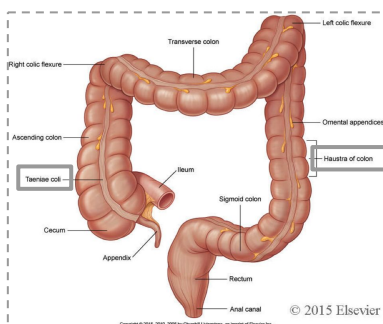
Vitamins produced by bacteria (**gut flora**)

2. Reabsorb

Water & Compact material into feces

3. Store:

Fecal matter prior to defecation



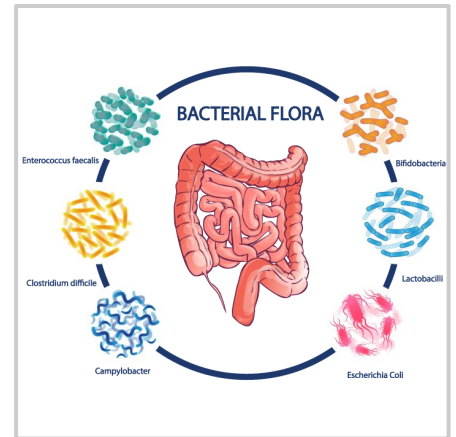


Gastro-Intestinal Microbiota



GUT Flora

- 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.
- **Chronic disruption of the normal flora in the large intestine leads to bruising and excessive bleeding. (vit K deficiency)**



Functions of intestinal Microbiota

Bacterial flora is living in symbiosis with human and its effects are beneficial to the body as follows:

Colon bacilli bacteria are capable of **Digesting of small amounts of cellulose.**

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.

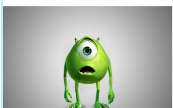
Fermentation of undigested oligo-saccharides producing gases.

Deconjugation and decarboxylation of bile salts: (make it Lipid-soluble= can be reabsorbed)
Break down of bile pigments to produce **stercobilinogen** (responsible for brown color of feces).

Breakdown of urea by bacterial urease to ammonia. Most ammonia is absorbed and reconverted into urea by liver.

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

Me: "takes antibiotics to cure an infection"
The bacteria in my intestine that produces vitamin K for me:





physiology of different colon regions

Transverse colon

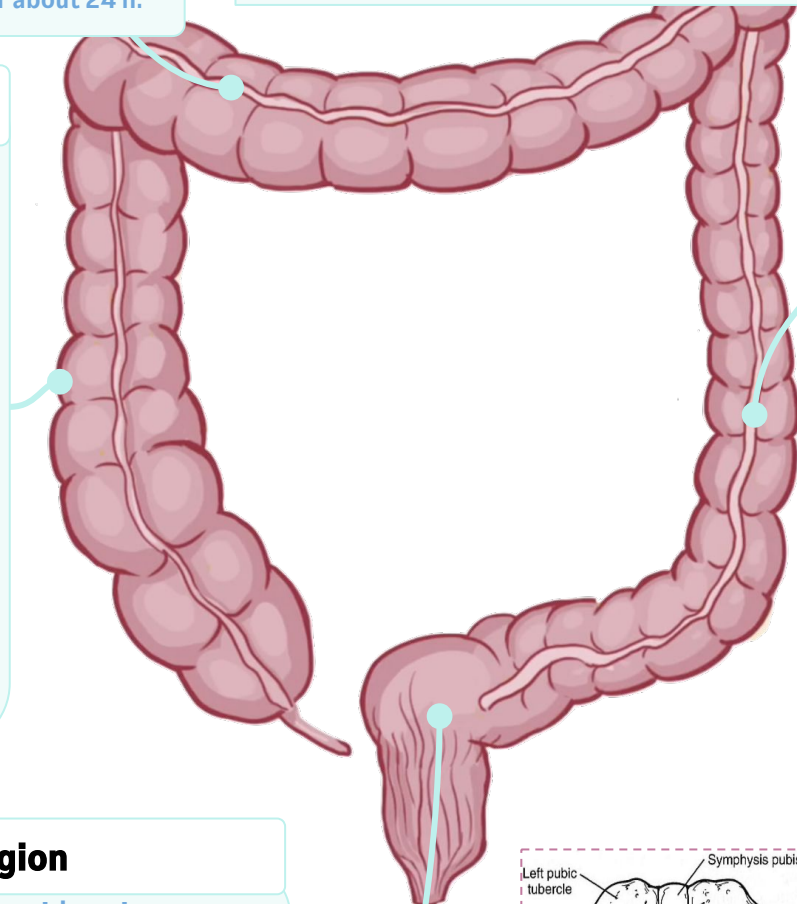
- Specialized for **storage** and **removal of water** & electrolytes from the feces (**Storage & dehydration**).
- It's the **primary site** for the removal of water & electrolyte and the storage of feces.
- The colon decides the limit of water absorption.
- Here is the real absorption of H₂O = Semi-solid.
- The labeled material is retained for about 24 h.

Descending colon

- Has the **neural program** for power propulsion (**mass movement**), **involved in defecation reflex**.
- It is a **conduit between the transverse and sigmoid colon**. It just pipe to carry material, **doesn't keep the material**.
- Labeled feces begin to accumulate in the sigmoid colon about 24 hours after the label is instilled in the cecum.

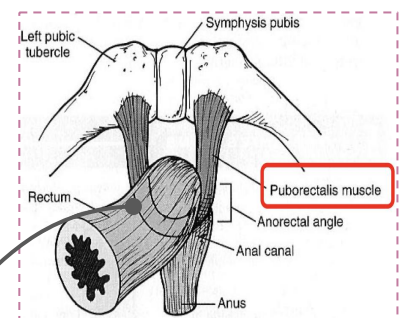
Ascending colon

- Specialized in **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.



Rectosigmoid region

- **Physiology of the rectosigmoid region** together with anal canal, and pelvic floor musculature **maintains fecal continence** (the ability to voluntarily control fecal discharge).
- Sigmoid and rectum are reservoirs with a capacity of up to **500mL**.
- The **puborectalis** muscle and **external anal sphincter** comprise a functional unit that maintain the fecal continence.
- How do the rectosigmoid region, anal canal & pelvic floor musculature maintain fecal continence?
- Fibers of **puborectalis** **pass around the anorectum** and join behind it to form a U-shaped sling (**physiological valve**).



Team441

25% of its capacity → Internal anal sphincter will relax
Normally the external AS is relaxed, and it gets contracted after 25% of fullness.

ال IAS بعد 25% يخلي مسؤوليته، ويصير ال EAS هو المسؤول عن التحكم.



Secretions of Large intestine

- The epithelial cells contain almost **no enzymes**. **Because there are no villi**.
- The secretion is mainly **mucus (& bicarbonate)**, it has the following functions:

- 1 **Secretes** bicarbonate ions, to neutralize any acids present.
- 2 **Protects** against irritation.
- 3 **Helps** to lubricate feces.
- 4 **Provides** a binding medium for fecal matter.

Mucous attached to HCO_3 to neutralize any acids produced from bacteria of colon



Effect of parasympathetic stimulation on secretion:

Stimulation of the *pelvic nerves* from the spinal cord causes:

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

During **Extreme parasympathetic stimulation**:

- so much mucus secretion into the large intestine that the person has a bowel movement of ropy mucus every 30 minutes; with little or no fecal material. **Excretions of mucus without feces**

Secretion of water and electrolyte during irritation:

Female slides

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

Nutrient digestion in the large intestine :

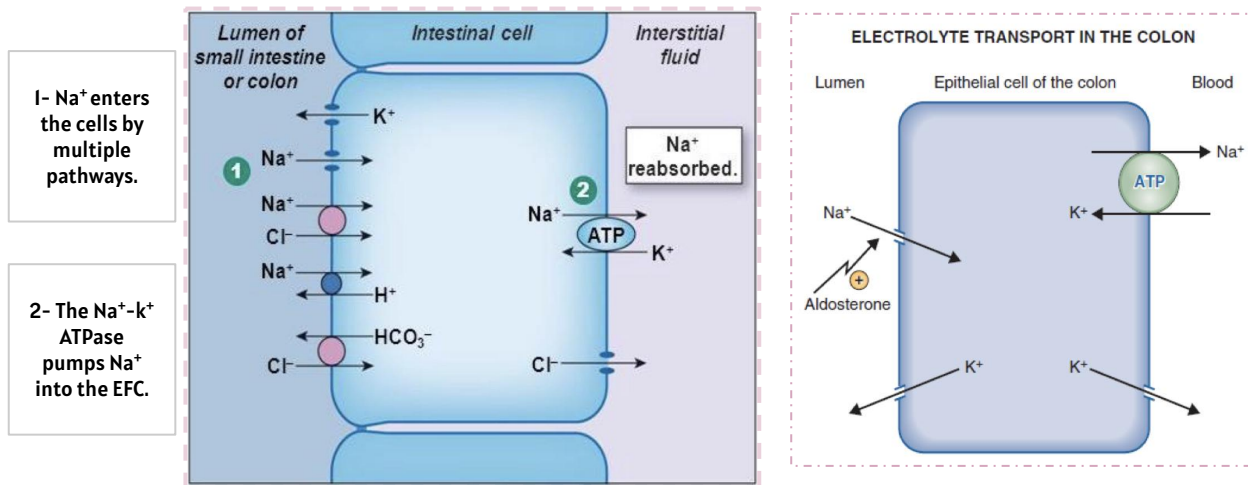
Female slides

- 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 B12, riboflavin.



Absorption in Large intestine

- Little absorption occurs in the large intestine.
- Most of the absorption occur in the **proximal half of the colon** giving this portion the name (**absorptive colon**), Whereas the distal colon function is feces storage **until a propitious time for feces excretion (storage colon)**. (Mainly 2nd part of Transverse Colon & Sigmoid Colon) (Descending Colon only conduct, not for storage)
- The large intestine can absorb a maximum of **5 to 8 liters** of fluid and electrolytes each **day**. **1 liter of fluid material is reduced to 200g of brown fecal matter**.
- The mucosa, like that of the small intestine, has a high capability for **active absorption of sodium, Cl and water**.



Reabsorption in the large intestine includes:

Na	<ul style="list-style-type: none"> • In the presence of Na⁺-K⁺ ATPase at the basolateral membrane, Na⁺ is actively absorbed and K⁺ is secreted into the lumen of colon. [1]
Cl	<ul style="list-style-type: none"> • Cl is absorbed in exchange for HCO₃ which is secreted. [2]
H₂O	<ul style="list-style-type: none"> • About 0.5- 1.5L/day is absorbed. • The net water loss is 100-200 ml/day
Vit	<ul style="list-style-type: none"> • Vitamin K, Biotin B₇, vitamin B₅, folic acid and some amino acids and short chain fatty acids resulting from bacterial fermentation of CHO are absorbed. • It doesn't absorb vitamin B12 it's absorbed in terminal ileum
Others	<ul style="list-style-type: none"> • Organic wastes (Urobilinogen and Stercobilinogen). • Bile salts. • Toxins to get detoxified in the liver • Certain drugs as steroids and aspirin may be absorbed.

*in diarrhea: there will be hipokalemia [1], and there will be metabolic acidosis because of HCO₃ excretions [2].



Motility in Large intestine

Important

For each movement know the site, stimulus.

1. Mixing movements (Haustrations):

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

2. Propulsive movements (Mass Movements):

- The motor events occur in the transverse & descending colon. (Distal 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 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 a day later.
- When they have forced a mass of feces into the rectum the desire for defecation is felt
- Destruction of Auerbach's plexus (ENS) Abolishes this movement

Initiation of mass movement could be due to:



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



By the increased delivery of ileal chyme into ascending colon following a meal (gastrocolic reflex).



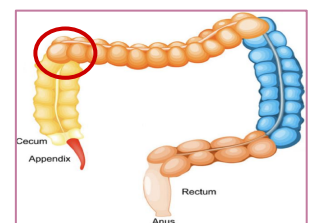
Irritation of the colon e.g. castor oil. stimulation of enteric plexuses



Threatening agents such as parasites & 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. (at asc. colon)





Defecation

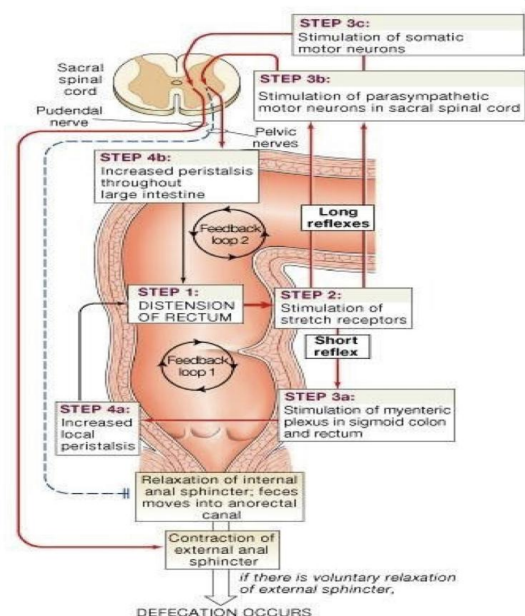
Female slides

- It is a spinal reflex, influenced by higher center.
- Most of the time the rectum is empty.
- **Both** internal and external anal sphincters are maintained in a state of **tonic contraction**. **To Prevent defecation**
- **It is a spinal reflex**, influenced by higher center.
- Gastrocolic & duodenocolic 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.

Important

“ Defecation Reflex “

1. Distension of the rectum and sigmoid. when it's 25% full.
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.
(If it injured defecation will be affected)
C. stimulation of somatic motor neurons.
Contract external sphincter.
4. **Results in:**
 - a. ↑ local peristalsis.
 - b. ↑ peristalsis throughout large intestine.
 - c. Relaxation of internal anal sphincter.
 - d. Contraction of external anal sphincter.



If there is voluntary relaxation of external anal sphincter → **DEFECATION OCCURS.**

Female slides

Then, 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.
- Followed by reduction in tonic impulses to EAS, so it relaxes voluntarily and feces leave the rectum assisted by voluntary straining and contraction of pelvic floor muscles.



Non-Suitable

- Defecation reflex will not be allowed.
- The reflex is inhibited by the CC
- Maintained voluntary tonic contraction of EAS.
- Return of tonic contraction of the IAS.
- Accommodation of the rectum to distension.
- **The voluntary contraction of EAS causes temporary inhibition of the defecation reflex**



Control of colonic motility

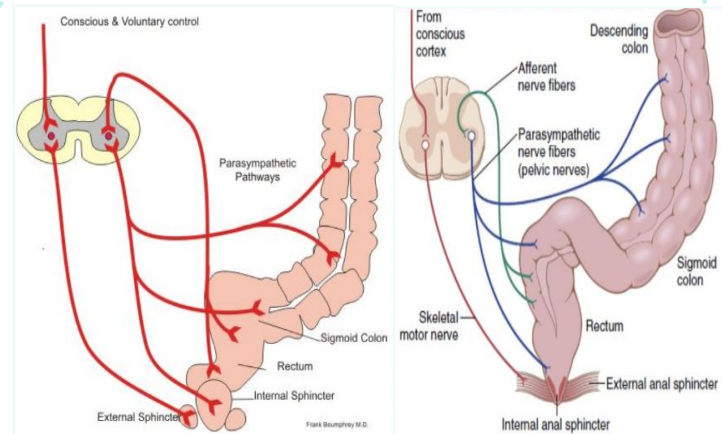
- The intramural plexuses (**enteric plexuses**) directly control the contractile behavior of the colon.
- **Stimulatory** enteric motor neurons use: **acetylcholine** & **substance P** as neurotransmitters.
- **Inhibitory** enteric motor neurons release: **VIP** & **NO** onto colonic smooth muscle cells.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

Female slides

Sensory innervation and continence:

- The rectum is last portion of the digestive tract that terminates at the anal canal.
- Has: **Internal anal sphincter** & **External anal sphincter**.
- It contains: mechanoreceptors that detect distention and supply the 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 internal anal sphincters and puborectalis muscle:
 - Blocks the passage of feces
 - Maintains continence **with small volumes in the rectum**.

Parasympathetic Afferent and Efferent Pathways for: Enhancing the defecation reflex



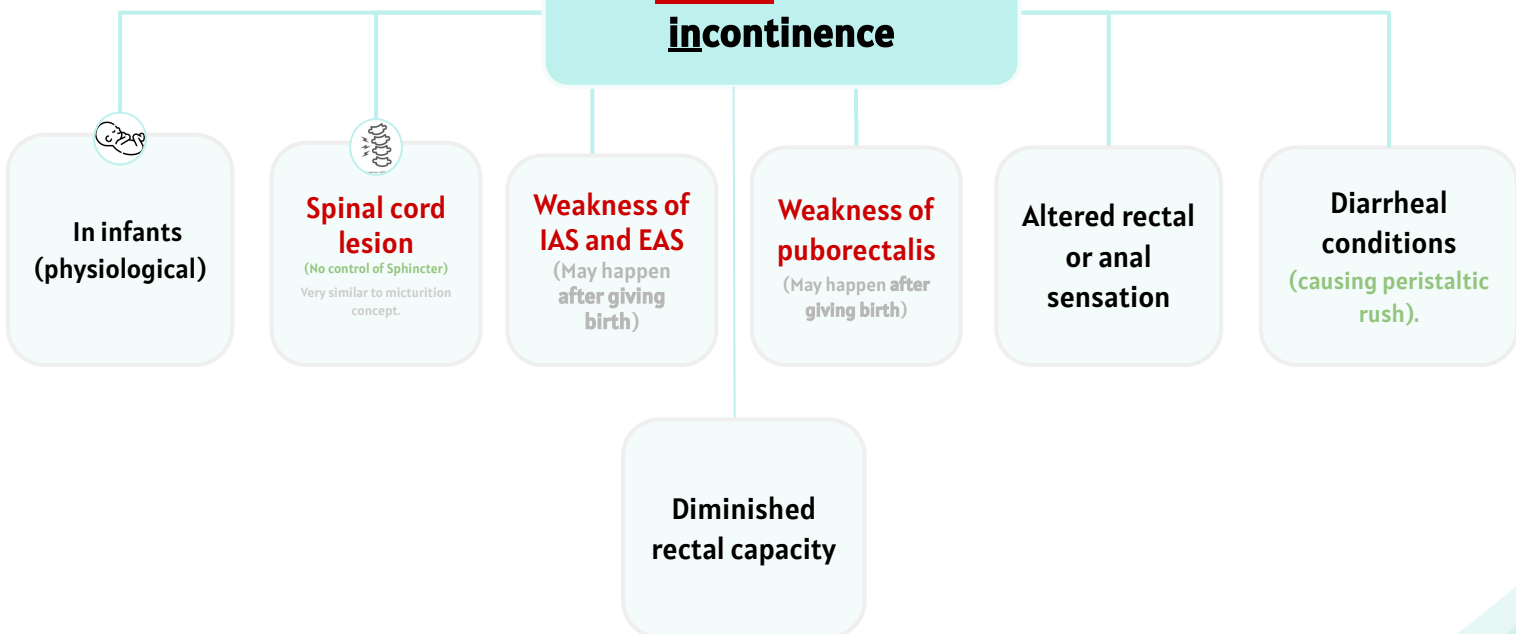
Fecal incontinence

Important

“The spinal reflex of defecation operates without interference from higher centers.”
lose the ability to control defecation



Causes of fecal incontinence



TEST YOURSELF !

MCQ:

Q1) Both internal and external anal sphincters are maintained in a state of

A) tonic relaxation

B) hypotonic relaxation

C) tonic contraction

D) hypotonic contraction

Q2) Most of the absorption in the Colon occurs in?

A) distal half of the colon

B) proximal half of the colon

C) proximal one third of the colon

D) distal one third of the colon

Q3) What is the most likely movement in the distal half of large intestine?

A) AntiPeristalsis

B) Haustral contraction

C) Mixing movement

D) Mass movement

Q4) which one of the following vitamins is not absorbed through the large intestine?

A) Vitamin B5

B) Vitamin B12

C) Vitamin B7

D) Vitamin K

Answers: Q1:C | Q2:B | Q3:D | Q4:B

SAQ:

Q1) What are the three functions of the colon? And What does reabsorption in the large intestine include?

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

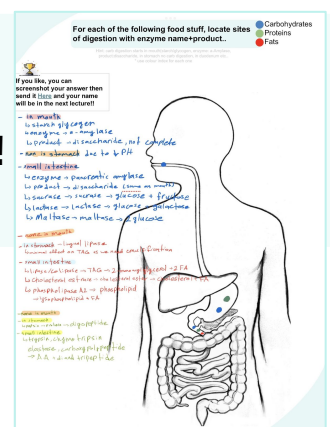
-reabsorption includes: Na, cl, Water, vitamins, bile salts, and toxins.

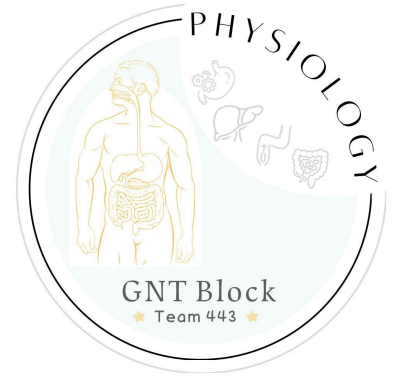
Q2) Enumerate 4 causes of fecal incontinence?

1. Spinal Cord lesion
2. Weakness of IAS and EAS
3. Altered rectal or anal sensation
4. Diarrheal conditions

Our Hero for last Lecture's challenge!!!

 Remas Mohammed





The BEST

Team Leaders

EVER..


Rafan Alhazzani


Fahad Almughaiseeb

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 Sarah Alshahrani


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 Nazmi A Alqutub

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