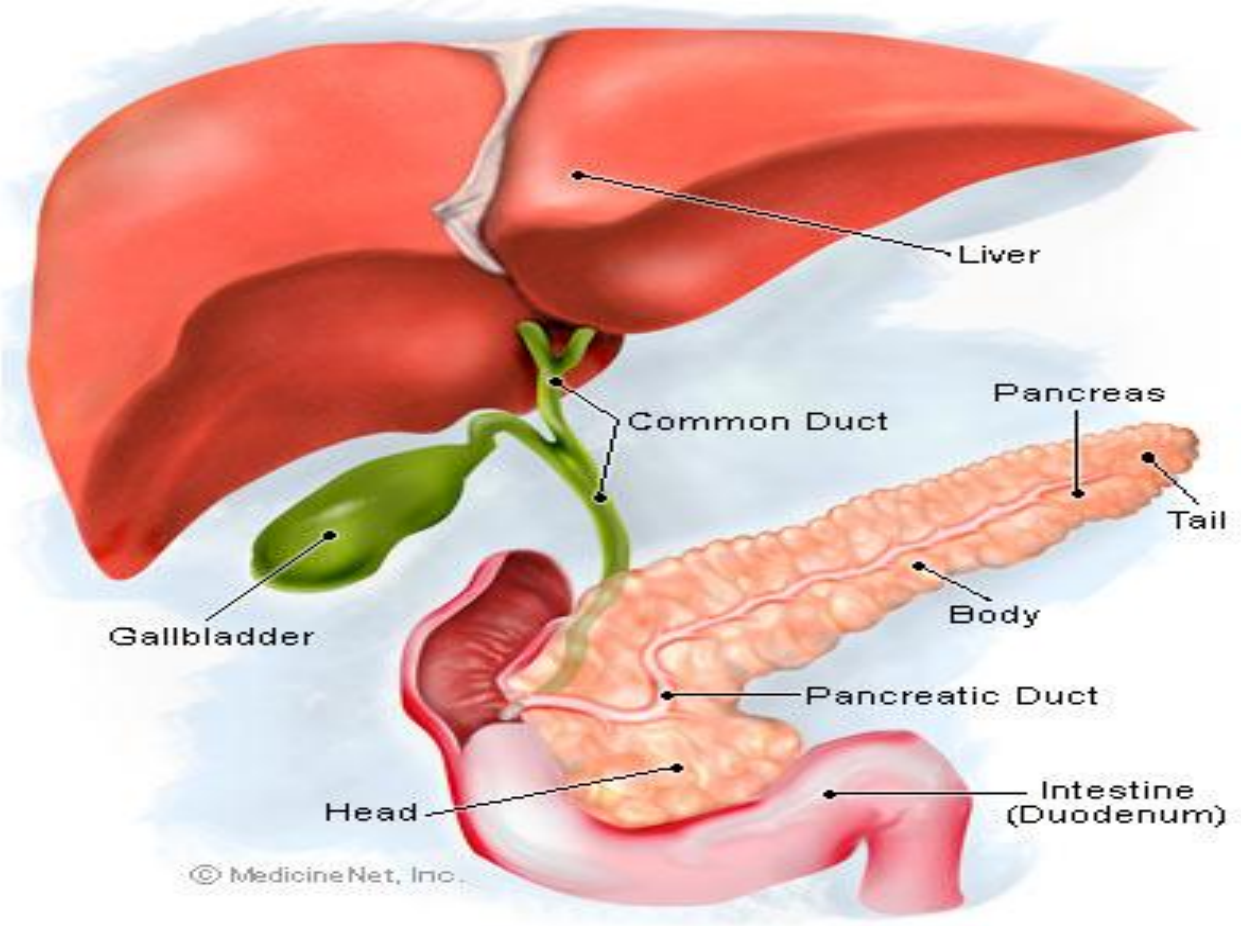
# GIT Block

# 7th Lecture
# Physiology of the Colon




**PHYSIOLOGY TEAM – 430**

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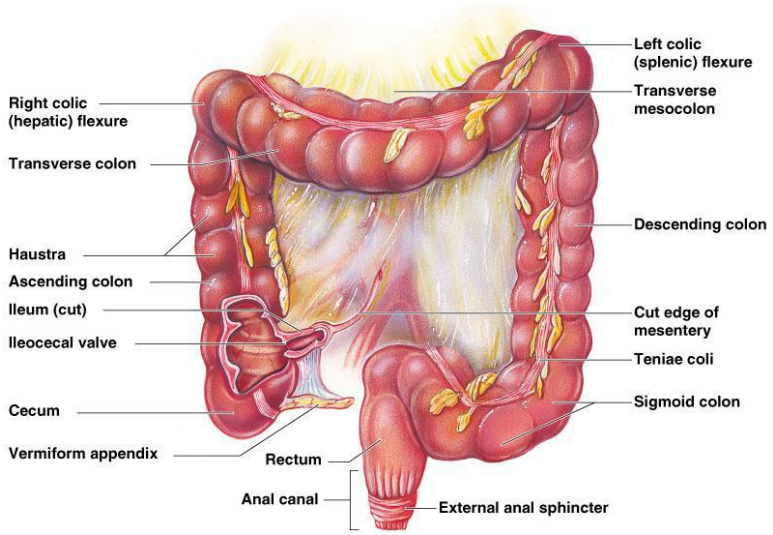
## Introduction:

## Parts of the Large Intestine:

1- **Cecum**
   Saclike first part of the large intestine
2- **Appendix**
   Accumulation of lymphatic tissue that sometimes becomes inflamed (appendicitis) and it hangs from the cecum
3- **Colon**
   Ascending, Transverse, Descending and S-shaped sigmoid
4- **Rectum**
5- **Anus**




## The colon:

The outer longitudinal 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.

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.

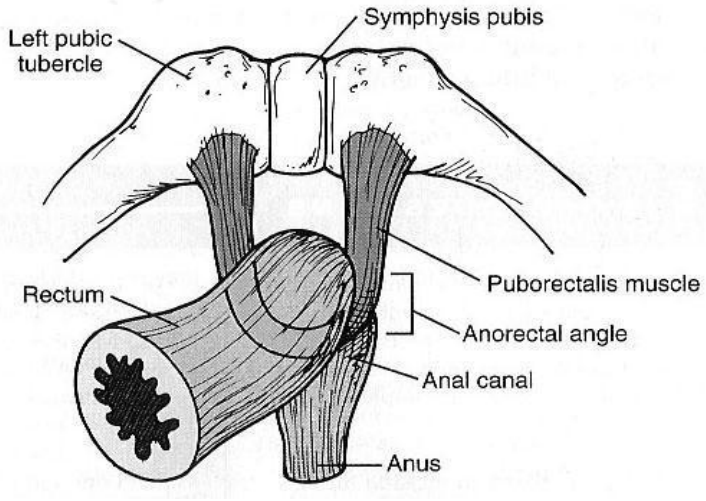
The epithelial cells contain almost no enzymes.

The colon has a length of 150 cm.

The transit of small labeled markers through the large intestine occurs in 36-48 hrs

## The functions of different colon regions:

- The **ascending colon** is specialized for processing Chyme delivered from the terminal ileum.
- The **transverse colon** is specialized for the storage and removal of water and electrolytes from feces.
- **The descending colon** is a conduit between the transverse and sigmoid colon, this region has the neural program for power propulsion that is involved in defecation reflex.
- **The rectosigmoid region, anal canal and pelvic floor musculature** maintains fecal continence**.** **(Voluntary control over fecal discharge.)**
- **The sigmoid and rectum** are reservoirs with a capacity of up to 500 mls; distensibility in this region is an adaptation for temporarily accommodating the mass movements of feces.
- **The puborectalis muscle and external anal sphincter** comprise a functional unit that maintains continence.
- **Fibers of puborectalis** join behind the anorectum and pass around it to form a U-shaped sling (physiological valve). ( see picture below to understand)




## Secretion in the colon:

It is mainly mucus, no digestive enzymes.

The mucus has the following functions

1- It helps to lubricate feces.

2- It neutralizes against any acids present.

3- It protects against irritation.

4- It provides a binding medium for fecal matter.

## Secretion of water & 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.

## Neural control:

Stimulation of the pelvic nerves 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

## 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 (storage colon).

- **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.
- **Na+ absorption**, about 60 mmol/day is actively absorbed (in the presence of Na+-K+ ATPase) at the basolateral membrane to blood.
- **K+** is secreted into the lumen of colon.
- **Cl-** is absorbed in exchange for **HCO3-** which is secreted.

  **Persistent diarrhea** can result in hypokalemia, dehydration and metabolic acidosis.
- **Folic acid and some AA and short chain FA** resulting from bacterial fermentation of CHO are absorbed.
- **Certain drugs as steroids and aspirin** may be absorbed.

## Intestinal bacteria:

The bacterial flora is living in symbiosis with human and its effects are beneficial to the body.

**Benefits of bacterial flora:**

1- **Vitamin K and some B group vitamins as folic acid, biotin, thiamine and B12** are synthesized by intestinal bacteria.
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- **Bile salts** are deconjugated and decarboxylated by intestinal bacteria.

**Bile pigments** are broken down in intestine to produce **stercobilinogen** which is excreted in stool giving it **brown color**.

3- Intestinal bacteria decarboxylate some **AA** to produce amine and histamine

The **amines** are excreted in feces and are responsible for its **smell.**

4- **Urea** diffuses from blood to colon where it is broken down by its bacterial urease to **ammonia**.

Most ammonia is absorbed and reconverted into urea by liver.

In **hepatic failure**, accumulation of ammonia can cause hepatic encephalopathy.

5- Bacterial **fermentation** of **undigested CHO** may produce short chain FA and gases as CO2.

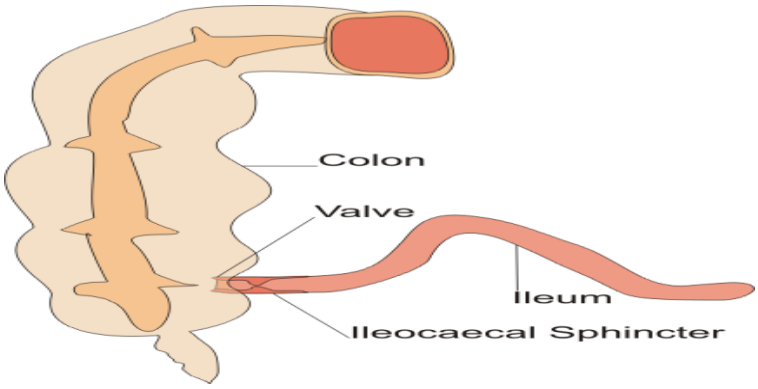
**The ileocaecal valve:**

**Function:** It prevents backflow of contents from colon into small intestine.

It remains closed and open only when an **intestinal peristaltic wave** reaches it.

**Stimulations that contract ileocaecal valve:** Distension of the cecum, Secretin, Ach, alpha adrenergic.

**Stimulations relax ileocaecal valve:** Gastrin, CCK, and B adrenergic.




## Types of colonic movements:

### 1- Mixing Movement (Haustrations)

The same manner that segmentation movements occur in the small intestine, large circular constrictions also occur in the large intestine.

At each of these constrictions points, about 2.5 cm of the circular muscle contracts and at the same time the longitudinal strips contract.

These combined contractions cause the **unstimulated** portion of the large intestine to bulge outward into baglike sacs called **Haustrations.**

The **haustral contraction** once initiated usually reach peak intensity in **30 seconds** and then disappears during the next **60 seconds.**

They also at times **move slowly analward** during their period of contraction especially in the cecum and ascending colon.

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 and fluid is **progressively absorbed**.

**2- Propulsive (mass) Movement**

Peristaltic waves of the type seen in small intestine are rare.

A mass movement is a modified type of peristalsis characterized by 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.

During this process the Haustrations **disappear completely**.

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.

Most of the **propulsion** in the cecum and ascending colon results from the **slow, persistent haustral contractions** requiring as many as 8-15 hours to **move** the Chyme only from the **ileocecal valve to the transverse colon** while the Chyme itself becomes **fecal in quality** and also semisolid instead of semifluid.

From **the transverse colon to the sigmoid**, mass movement mainly take over the **propulsive** role.

These movements usually occur only **few times** each day**, most abundantly for 15 min** during the **first hour** after eating **breakfast**. Mass movement can occur in any part of the colon, though **most often they occur in the transverse or descending colon.**

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

**Initiation of Mass Movement:**

- Gastrocolic and duodenocolic reflexes after meals.

  They result from distension of the stomach and duodenum.
- Irritation of the colon example: castor oil.
- Intense stimulation of PNS
- 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 and substance P** as neurotransmitters.
**Inhibitory enteric motor neurons** release **VIP and 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**.

## 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 maintained in a state of **tonic contraction**.

**Stimulation: Gastric or intestinal filling** initiate a mass movement in the colon that pushes feces into rectum (Gastrocolic and duodenocolic reflexes).

The **rectum is distended** and sends signals to **cerebral cortex** producing the **desire to defecate.**

### Defecation Reflex: (picture below)

1. **Distension** of the rectum.
2. **Stimulation** of the **stretch receptors** in the rectum.
3. A,B,C

**3. A short reflex**: Stimulation of **Myenteric plexus** in sigmoid colon and rectum.
**3. B long reflex:** stimulation of **parasympathetic motor** neurons in **sacral** spinal cord.
**3. C** stimulation of **somatic motor neurons**.

4. **Increase local peristalsis**, **relaxation of internal** anal sphincter and **contraction of external** anal sphincter.

**If the surrounding circumstances are suitable:**

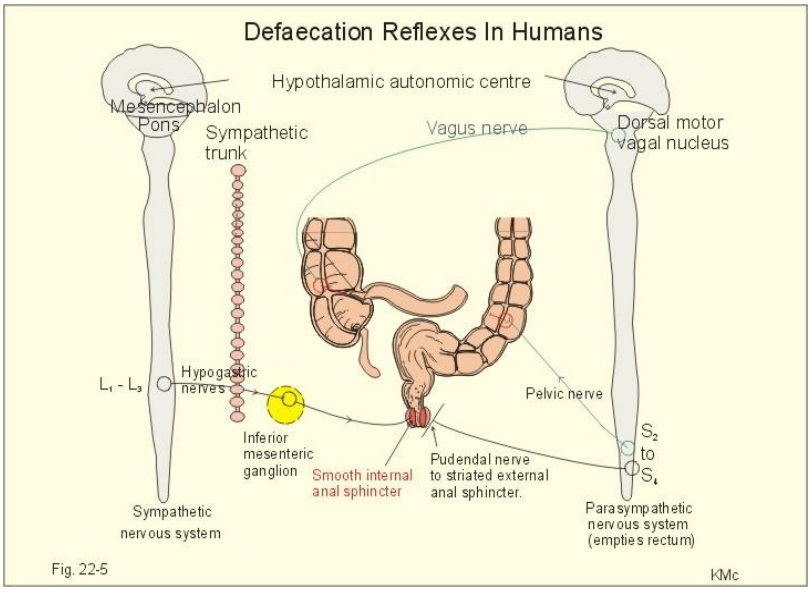
**Defecation** reflex will be **allowed. Stretch of the rectal** wall is signaled to SC by **pelvic nerve**, efferent pelvic impulses cause **reflex contraction of the rectum and relaxation of IAS**, this is followed by **reduction in tonic impulses to EAS,** so it relaxes and **feces leave the rectum** assisted by **voluntary straining** and contraction of pelvic floor muscle.

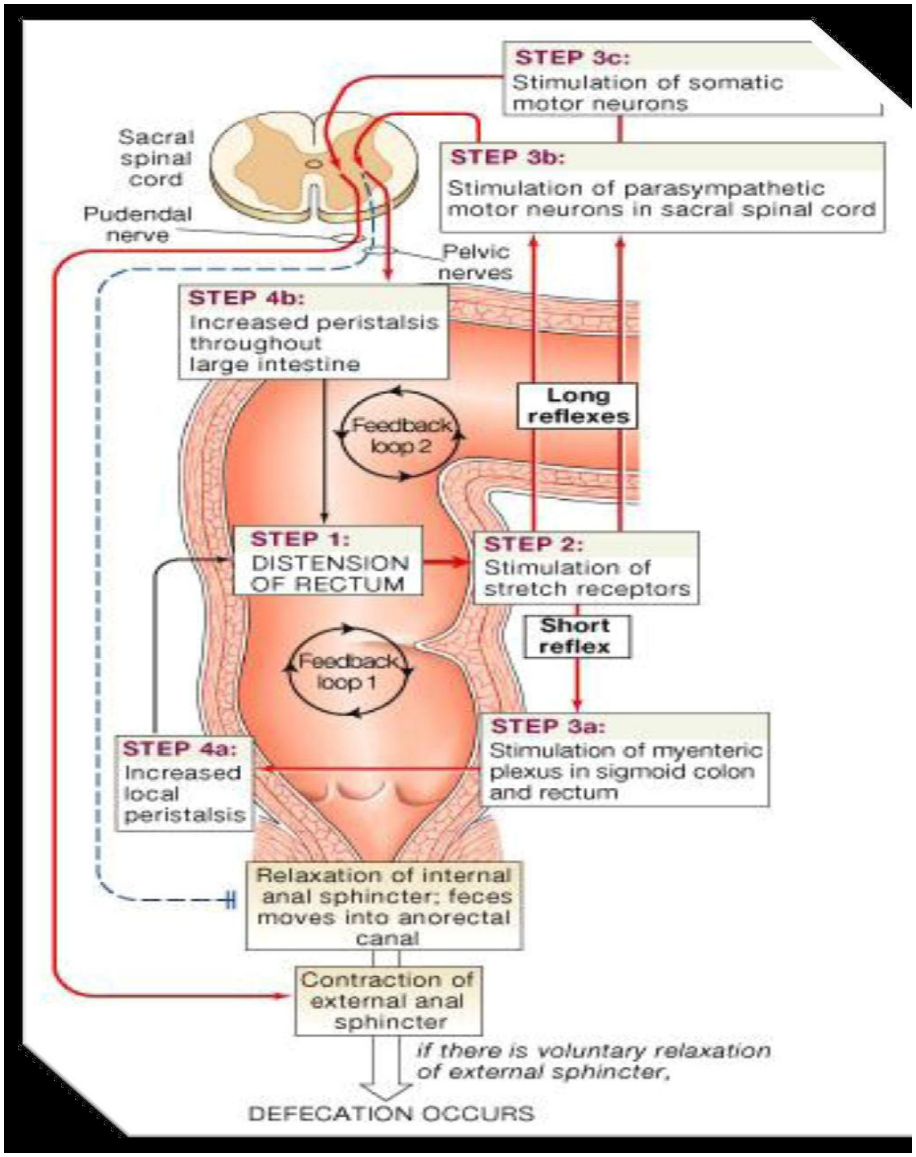
**If situation is not suitable for defecation:**

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.**

**In infants (and in spinal cord lesion**) the spinal reflex of defecation operates **without** interference from **higher centers (fecal incontinence).**




STEP 3c:
Stimulation of somatic motor neurons
Sacral spinal cord
STEP 3b:
Stimulation of parasympathetic motor neurons in sacral spinal cord
Pudendal nerve
Pelvic nerves
STEP 4b:
Increased peristalsis throughout large intestine
Long reflexes
Feedback loop 2
STEP 1:
DISTENSION OF RECTUM
STEP 2:
Stimulation of stretch receptors
Short reflex
Feedback loop 1
STEP 3a:
Stimulation of myenteric plexus in sigmoid colon and rectum
STEP 4a:
Increased local peristalsis
Relaxation of internal anal sphincter; feces moves into anorectal canal
Contraction of external anal sphincter
if there is voluntary relaxation of external sphincter,
DEFECATION OCCURS