

## #6 Physiology of the colon : motility

### 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

■ Doctors' notes

■ Extra

■ Important



Revised by

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**Resources:** 435 Boys' & Girls' slides | Guyton and\_ Hall 12<sup>th</sup> & 13<sup>th</sup> edition

[Editing file](#)

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## ► The large intestine تكرار من الهستولوجي والآناتومي

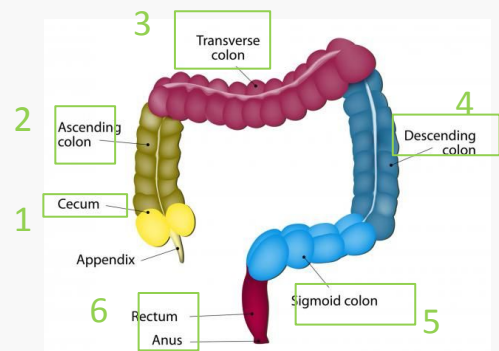
- This is the final digestive structure.
- It **does not** contain villi.
- By the time the digested food (chyme) reaches the large intestine, **most of the nutrients have been absorbed.**
- **The primary role of the large intestine is to convert chyme into feces for excretion.**

## ► Parts of the colon

- The colon has a length of about 150 cm. **( 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.**

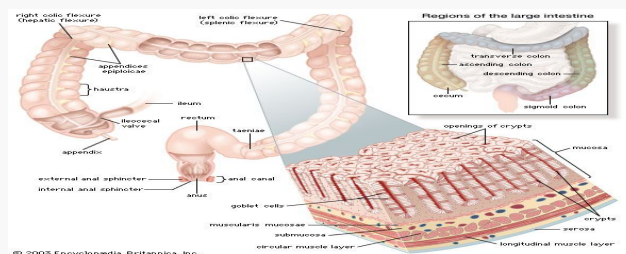
**They know this how?**

**By inserting radioactive chyme.**



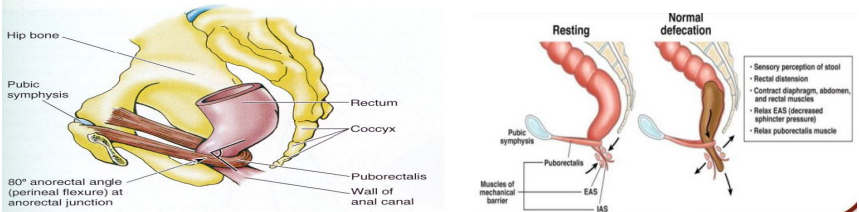
### ❖ Mucous membrane of the colon

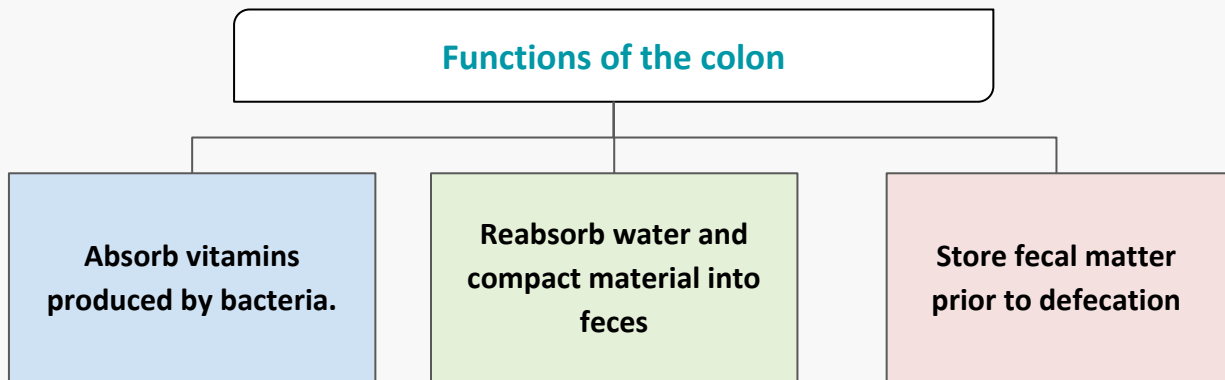
- **Lacks villi** and has many **crypts of lieberkuhn.**
- They consists of simple short glands lined by **mucous-secreting goblet cells.** **Main colonic secretion is mucous, as the colon lacks digestive enzymes.**
- The outer longitudinal muscle layer is modified to form three longitudinal bands called **taenia coli** visible on the outer surface. (Taenia coli: Three thickened bands of muscles.)
- Since the muscle bands are shorter than the length of the colon, the colonic wall is sacculated and forms **haustra.** (Haustra: Sacculatation of the colon between the taenia.)



**Guyton corner :** mucus in the large intestine protects the intestinal wall against excoriation, but in addition, it provides an adherent medium for holding fecal matter together. Furthermore, it protects the intestinal wall from the great amount of bacterial activity that takes place inside the feces, and, finally, the mucus plus the alkalinity of the secretion (a PH of 8.0 caused by large amounts of sodium bicarbonate) provides a barrier to keep acids formed in the feces from attacking the intestinal wall. Page 832

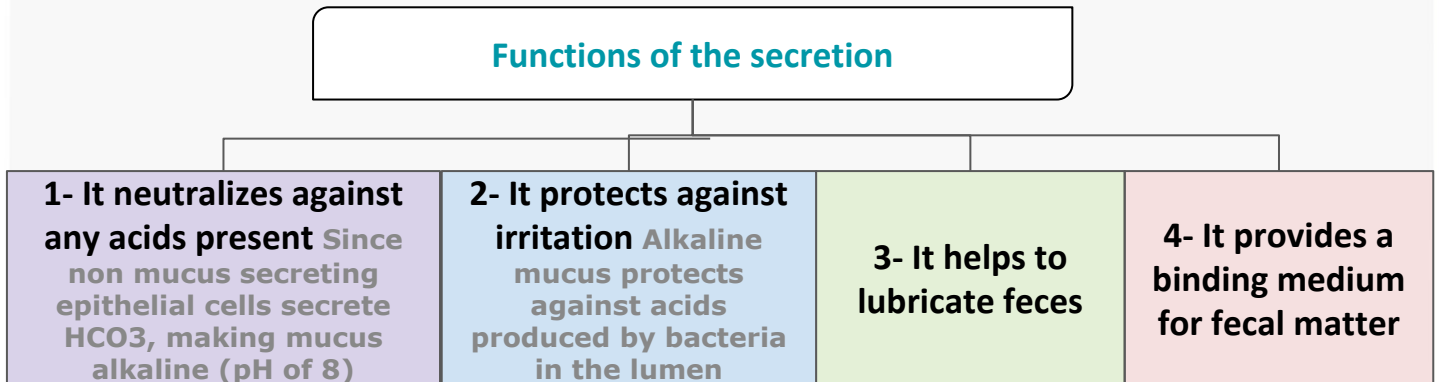
# ► The physiology of different colon regions

<p>(1) <b>The ascending colon</b></p>	<p>Specialized for processing chyme delivered from the terminal ileum. <b>Reabsorption of some water, mucous secretion and mixing.</b></p>
<p>(2) <b>The transverse colon</b></p>	<p>Specialized for the <b>storage and removal of water &amp; electrolytes</b> from feces. <b>(real water absorption)</b> The labeled material is retained for about 24 hrs. <b>Consume most of the time</b></p>
<p>(3) <b>The descending colon</b></p>	<ul style="list-style-type: none"> <li>• A conduit between the transverse and sigmoid colon.</li> <li>• This region has the neural program for power propulsion that is involved in <b>defecation reflex.</b></li> </ul>
<p>(4) <b>The rectosigmoid region, anal canal, together with pelvic floor musculature</b> <b>Creating a physiological barrier</b></p>	<p>Maintains fecal continence (<b>maintaining fecal material; preventing its loss</b>):</p> <ul style="list-style-type: none"> <li>• The sigmoid and rectum are reservoirs with a capacity of up to <b>500 ml</b>. (<b>80-200 mL of feces are expelled each day</b>)</li> <li>• The puborectalis muscle and external anal sphincter comprise a functional unit that maintain continence. (<b>voluntary</b>)</li> <li>• Fibers of puborectalis pass around the anorectum and join behind it to form a <b>U-shaped sling (physiological valve)</b>. <b>This movement sharpens the angle between the rectum and the anal canal, to trap the fecal material in the rectum.</b></li> </ul> 



## ► Secretion in the colon

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



## ► Effect of parasympathetic stimulation on secretion

- **Stimulation of the pelvic nerves causes:**
  - 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** (because there is no enough time).

## ► Secretion of water and electrolytes

- Whenever a segment of large intestine **becomes irritated** as occurs in **bacterial infection**, the mucosa secretes large amount of :
  - 1- water    2- electrolytes    3- 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 B12 / riboflavin**.

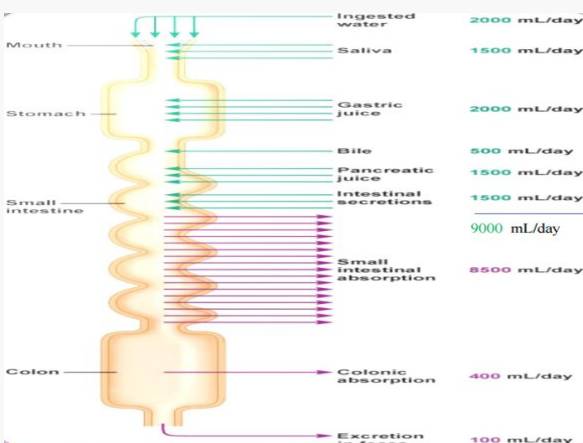
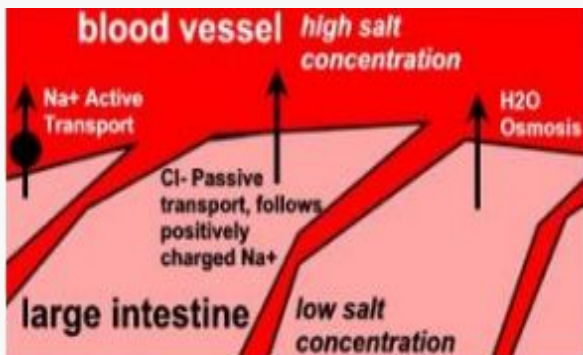
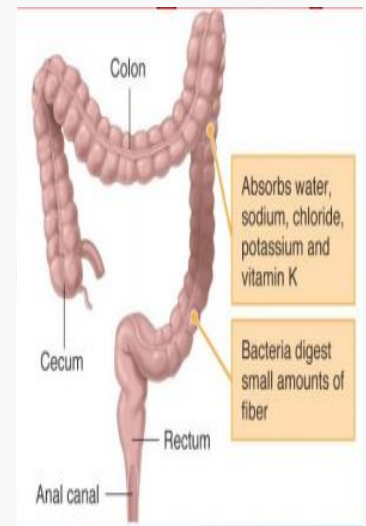
**Guyton corner :** Diarrhea caused by excess secretion of water and electrolytes in response to irritation.

Whenever a segment of large intestine becomes intensely irritated, as occurs when bacterial infection becomes rampant during enteritis, the mucosa secretes extra large quantities of water and electrolytes in addition to the normal viscid alkaline mucus. This secretion acts to dilute the irritating factors and to cause rapid movement of the feces toward the anus. The result is **diarrhea**, with loss of large quantities of water and electrolytes. However, the diarrhea also washes away irritant factors, which promotes earlier recovery from the disease than might otherwise occur. Page 832

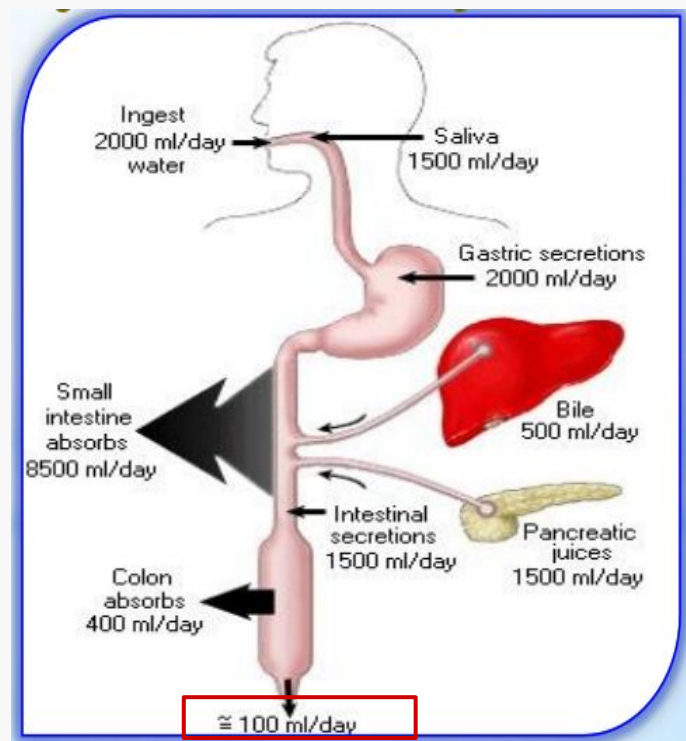
## ► Absorption in the large intestine



- Little absorption occurs in the large intestine (**NO villi**).
- Most of absorption in the colon occurs in the **proximal half (Ascending and ½ of transverse)** of the colon (**absorptive colon**). Whereas the **distal colon** function for storage (**storage colon**).
- In the large intestine, **1 liter** of fluid material (**in the cecum, then as it moves towards the anus the material gradually solidifies**) is gradually reduced to **200 grams** of brown fecal material



AA ,FA, may be absorbed



Secretion & absorption in the gastrointestinal system

Excretion = 100 ml/day

## ► Absorption in the large intestine

<p>❖ <b>Water Absorption</b></p>	<p><b>About 0.5-1.5 L/day is absorbed</b></p> <ul style="list-style-type: none"> <li>- The net water loss is <b>150-200 ml/day</b></li> <li>- <b>N.B:</b> the large intestine can absorb a maximum of <b>5 to 8 liters of fluid and electrolytes each day.</b></li> <li>- Note that the entire fluid content passing each day is 9L (2L from food, 2L from gastric juice, 3L pancreatic juice and bile, 1L saliva and 2L intestinal secretions. However, more than 90% of the 9L is absorbed by the small intestines.</li> </ul>
<p>❖ <b>in the presence of (Na<sup>+</sup>-K<sup>+</sup> ATPase) at the basolateral membrane :</b></p>	
<p><b>Na<sup>+</sup></b></p>	<p><b>Na<sup>+</sup> is actively absorbed</b>          Note that aldosterone upregulates Na channels and hence, increases K excretion and eventually leading to hypokalemia (Just like the renal tubules)</p>
<p><b>K<sup>+</sup></b></p>	<p><b>K<sup>+</sup> is secreted into the lumen of colon</b></p>
<p>❖ <b>Chloride</b></p>	<p><b>Cl<sup>-</sup> is absorbed in exchange for HCO<sub>3</sub><sup>-</sup> which is secreted.</b>          Sodium follows chloride absorption and water is dragged along with Na</p>
<p>❖ <b>Vitamins</b></p>	<p><b>Vit. K, biotin, B5 , folic acid</b> and some AA and <b>short chain FA</b> resulting from bacterial fermentation of CHO are <b>absorbed.</b>  <b>it does not absorb Vitamin B12</b>          Vit B12 is absorbed in the terminal part of ileum and requires intrinsic factor.</p>
<p>❖ <b>Drugs</b></p>	<p><b>Certain drugs as steroids and aspirin may be absorbed.</b></p>
<p>❖ <b>Toxins</b></p>	<p>can be absorbed</p>
<p>❖ <b>Bile salts and organic wastes</b></p>	<p><b>Bile salts and organic wastes</b> as <b>urobilinogen</b> (reduced bilirubin by gut flora) and <b>stercobilinogen</b> (giving feces its brown colour) can be <b>absorbed.</b>          (metabolites of bile salts)          Stercobilinogen (fecal urobilinogen) is a chemical created by bacteria in the gut. It is made of broken-down hemoglobin. It is further processed to become the chemical that gives feces its brown color.</p>

**Guyton corner :** maximum absorption capacity of the large intestine.

The large intestine can absorb a maximum of 5 to 8 liters of fluid and electrolytes each day. When the total quantity entering the large intestine through the ileocecal valve or by way of large intestine secretion exceeds this amount, the excess appears in the feces as diarrhea. As noted earlier, toxins from cholera or certain other bacterial infections often cause the crypts in the terminal ileum and large intestine to secrete 10 or more liters of fluid each day, leading to severe and sometimes lethal diarrhea. Page 842

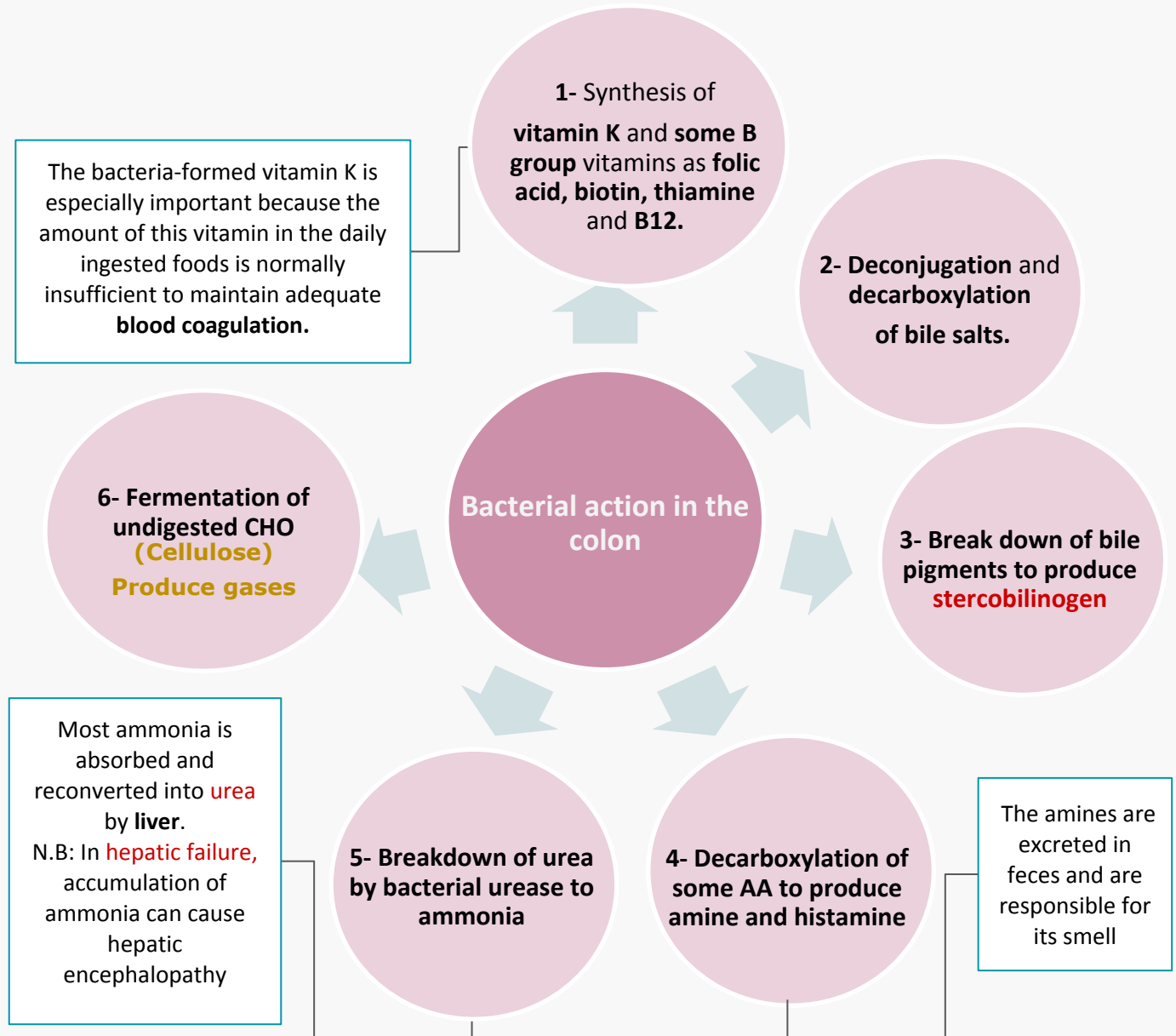
Absorption and secretion of electrolytes and water.

The mucosa of the large intestine, like that of the small intestine, has a high capability for active absorption of sodium, and the electrical potential gradient created by sodium absorption cause chloride absorption as well. The tight junctions between epithelial cells of the large intestinal epithelium are much tighter than those of the small intestine. This characteristic prevents significant amount of back-diffusion of ions through these junctions, thus allowing the large intestinal mucosa to absorb sodium ions far more completely-that is, against a much higher concentration gradient-- than can occur in the small intestine. This is especially true when large quantities of aldosterone are available because aldosterone greatly enhances sodium transport capability. In addition, as occur in the distal portion of the small intestine, the mucosa of the large intestine secretes bicarbonate ions while it simultaneously absorb an equal number of chloride ions in an exchange transport process already described. The bicarbonate helps neutralize the acidic end products of bacterial action in the large intestine. Absorption of sodium and chloride ions creates an osmotic gradient across the large intestinal mucosa, which in turns causes absorption of water.

## ► Gut flora (gastrointestinal microbiota)

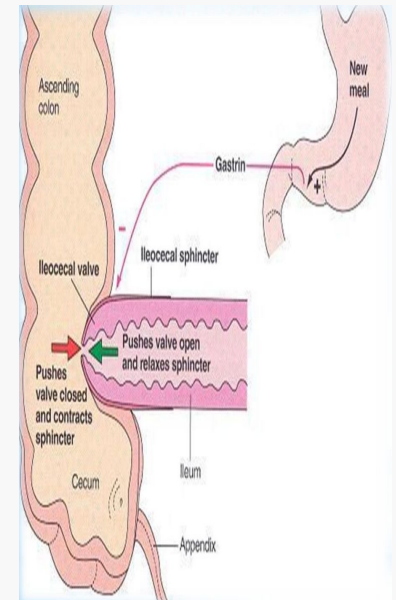
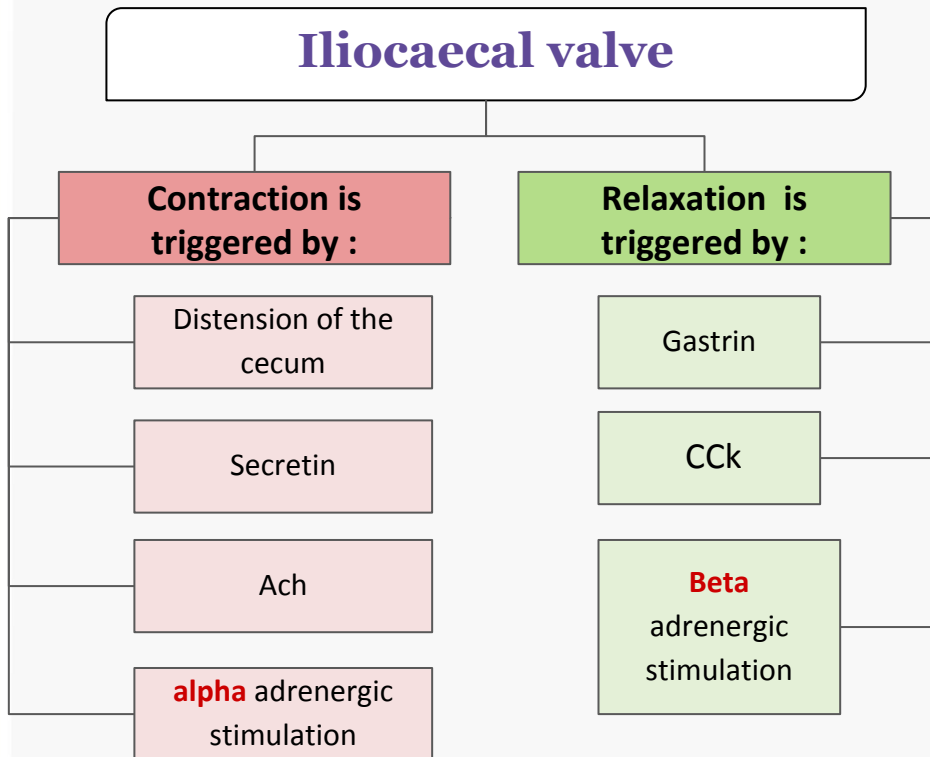
It is the complex community of microorganisms that live in the digestive tracts. It is established at one to two years after birth.

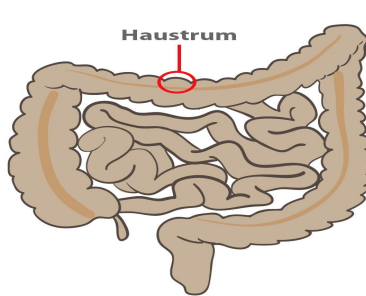
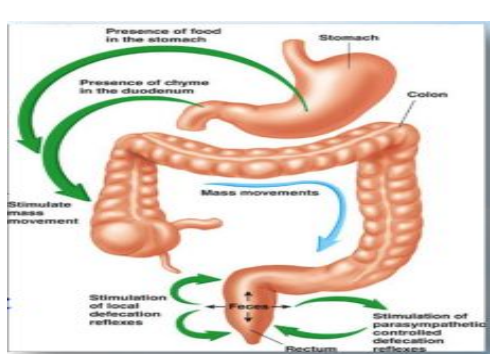
- This bacterial flora is living in **symbiosis** **تعایش** with human and its effects are **beneficial to the body as follows:**



## ► Iliocaecal valve

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



Mixing movement( <b>Haustration</b> )	Propulsive ( <b>mass</b> ) movement
in the cecum and ascending colon	in transverse & descending colon
	

\*food passes through the haustration first then to the propulsive mass movement.

**Guyton corner :** the ileocecal valve itself protrudes into the lumen of the cecum and therefore is forcefully closed when excess pressure builds up in the cecum and tries to push cecal contents backward against the valve lips. The valve usually can resist reverse pressure of at least 50 to 60 centimeters of water. In addition, the wall of the ileum for several centimeters immediately upstream from the ileocecal valve has a thickened circular muscle called the ileocecal sphincter. This sphincter normally remains mildly constricted and slows emptying of ileal contents into the cecum. However, immediately after a meal, a gastroileal reflex (described earlier) intensifies peristalsis in the ileum, and emptying of ileal contents into the cecum proceeds.

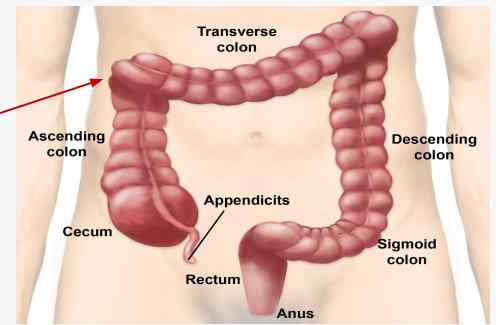


## ► Motility in the Colon (Depending on the function)



<p><b>1- Mixing movement (Haustration)</b> in the cecum and ascending colon <i>harder than segmentation</i></p>	<ul style="list-style-type: none"><li>• The motor events in the <b>cecum</b> and <b>ascending colon</b></li><li>• At constrictions points, <b>2.5 cm</b> of the <b>circular muscle contracts (ring like)</b>, at the same time the <b>longitudinal strips</b> contract.</li><li>• These combined contractions cause the unstimulated portion of <b>large intestine to bulge outward into baglike sacs (haustrations)</b>.</li><li>• They also at times move slowly <b>analward</b> during their period of contraction.</li><li>• After another <b>few minute</b> new haustral contractions occur in other areas nearby.</li><li>• In this way all fecal material is gradually exposed to the surface of the large intestine &amp; <b>fluid</b> is progressively <b>absorbed</b>.</li><li>- The main function of haustrations is to mix fecal material and to expose it to the epithelium. HOWEVER, when haustrations occur along the entire length of the colon, little forward propulsion of food occurs.</li><li>- Contractions lasts 30 seconds followed by 60 seconds of relaxation</li></ul>
<p><b>2- Propulsive (mass) movement</b> in transverse &amp; descending colon</p>	<ul style="list-style-type: none"><li>• The motor events in <b>transverse &amp; descending colon</b>.</li><li>• These movements occur <b>few times each day (1-3)</b>, most abundantly for <b>15 min</b></li><li>• during the <b>first hour</b> after eating breakfast.</li><li>• A mass movement is a <b>modified type of peristalsis</b></li><li>• A constrictive ring occurs at a distended or irritated point in the colon. Then rapidly the <b>20 or more cm</b> of the colon distal to the constriction contract almost as a unit forcing the fecal material mass down the colon.</li><li>• It starts at the middle of transverse colon and is preceded by <b>relaxation</b> of the <b>circular muscle</b> and the downstream <b>disappearance of haustral contractions</b></li><li>• The initiation of contraction is complete in about <b>30 seconds</b>.</li><li>• During the next <b>2 to 3 min</b> another mass movement occurs</li><li>• The whole series of mass movement will usually persist for only <b>10 min to half an hour</b>. They will then return after <b>a half day</b> or even a day later.</li><li>• When they have forced a mass of feces into the rectum the desire for <b>defecation</b> is felt.</li><li>❖ <b>Initiation of mass movement:</b><ul style="list-style-type: none"><li>• <b>Gastrocolic &amp; duodenocolic reflexes</b> after meals. They result from <b>distension</b> of the <b>stomach &amp; duodenum</b>.</li><li>• Irritation of the colon e.g., castor oil <b>زيت الخروع</b> , threatening agents such as parasites and enterotoxins can initiate mass movement.</li><li>• Intense stimulation of <b>parasympathetic NS</b>.</li><li>• Over distension of a segment of the colon.</li></ul></li></ul>
<p><b>3-Antiperistalsis</b></p>	<ul style="list-style-type: none"><li>• It starts at the <b>junction of ascending and transverse colon</b> and traveling towards the <b>cecum</b>.</li><li>• It mixes contents and help <b>water absorption</b>.</li></ul>

**Guyton corner :** Propulsive Movements-"Mass Movements." Much of the propulsion in the cecum and ascending colon results from the slow but persistent haustral contractions, requiring as many as 8 to 15 hours to move the chyme from the ileocecal valve through the colon, while the chyme itself becomes fecal in quality, a semisolid slush instead of semifluid.



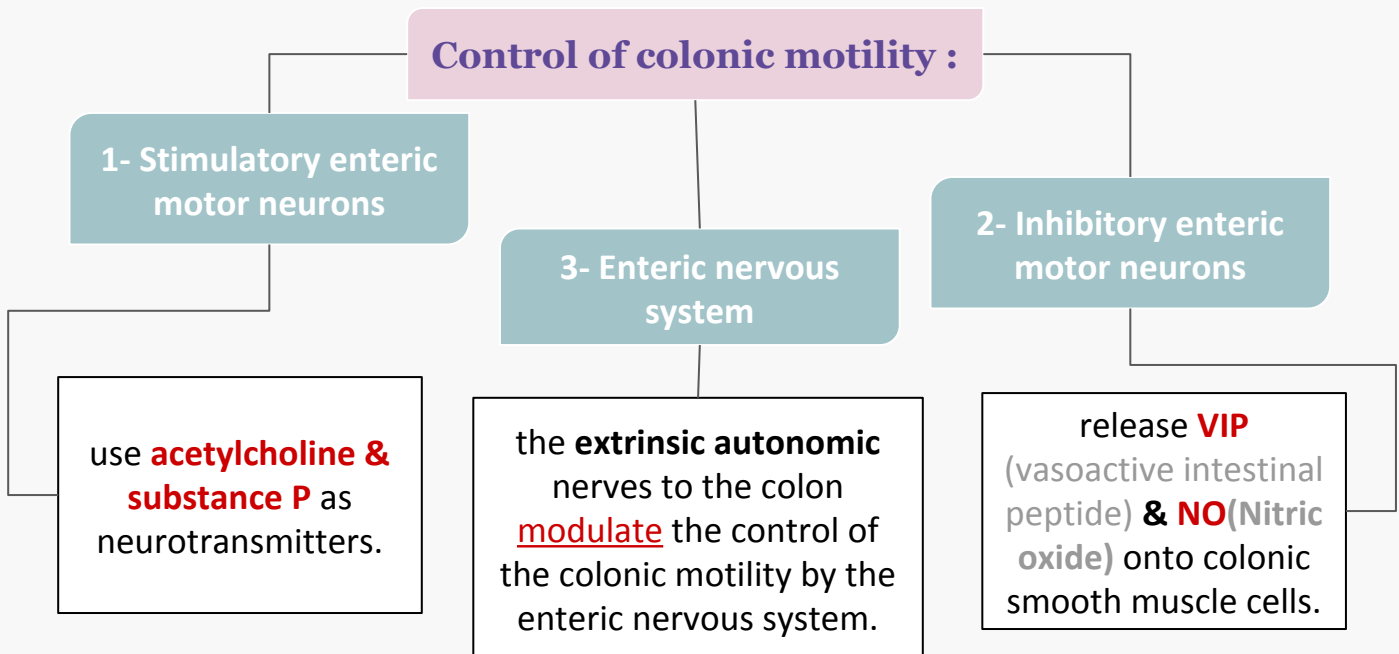
It starts at The **junction of ascending and transverse colon** and traveling towards the **cecum**. (**Antiperistalsis**)

## ► Control of colonic motility :

Till min 2:40



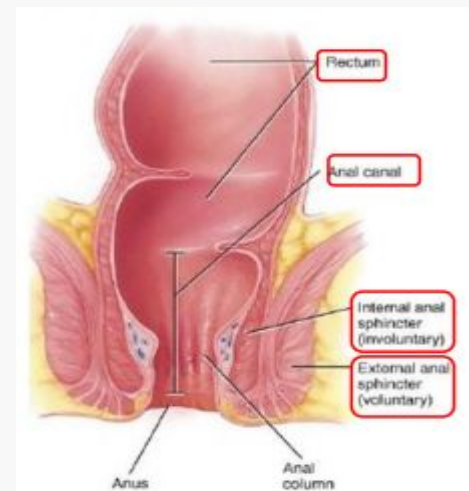
The intramural plexuses **directly** control the **contractile** behavior of the colon.



تتذكرون سالفة (no)؟  
 (: اربطوها هنا بالإنهبتوري والمنع)

## ► 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 **voluntary** 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 : (Girls slides)

- It is a **spinal reflex (center)** 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.

If the surroundings circumstances are suitable

Defecation reflex will be allowed.  
Stretch of the rectal wall is signaled to SC by pelvic nerve.

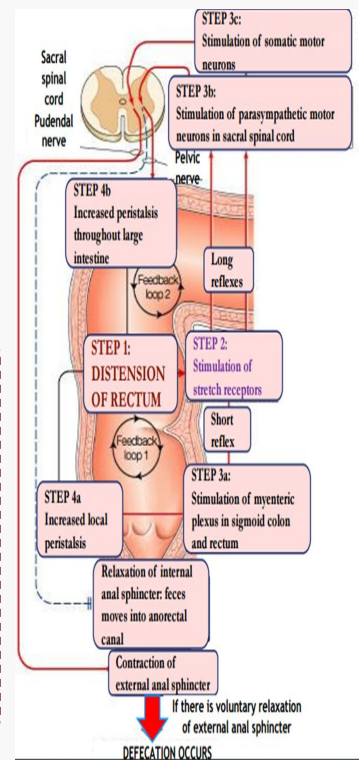
Efferent pelvic impulses cause reflex contraction of the rectum and relaxation of Internal anal sphincter (IAS)

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 the situation is not suitable for defecation

The reflex is **inhibited** by the cerebral cortex.

Tonic contraction of External anal sphincter is voluntary maintained which leads to accommodation of the rectum to distension and return of tonic contraction of the IAS.



### To clarify!

The reflexes involved in defecation are:

#### 1. **Intrinsic (weak/short) reflex:**

**Stimulus:** Distention of the rectal wall.

**Afferents go to:** Myenteric plexus

**Efferents:** - initiate peristalsis in the descending colon, sigmoid and rectum.  
- Inhibit the internal anal sphincter

#### 2. **Parasympathetic (strong/long) reflex:**

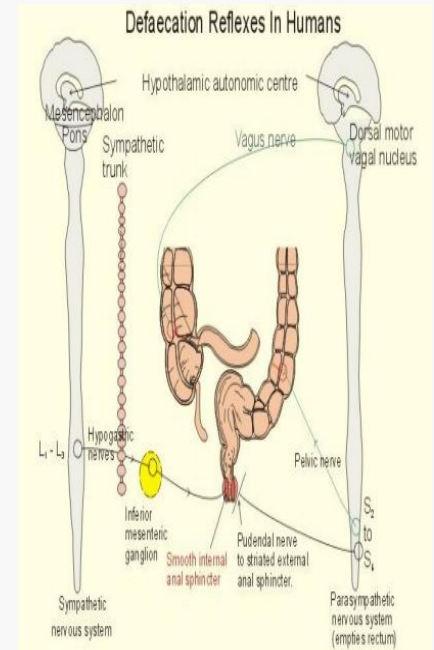
**Stimulus:** Rectal nerve endings.

**Afferents go to:** Spinal cord by means of the pelvic nerves

**Efferents:** - initiate peristalsis THROUGHOUT the length of the colon.  
- inhibits the internal anal sphincter (relaxation)

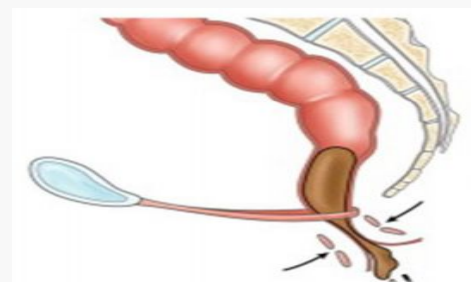
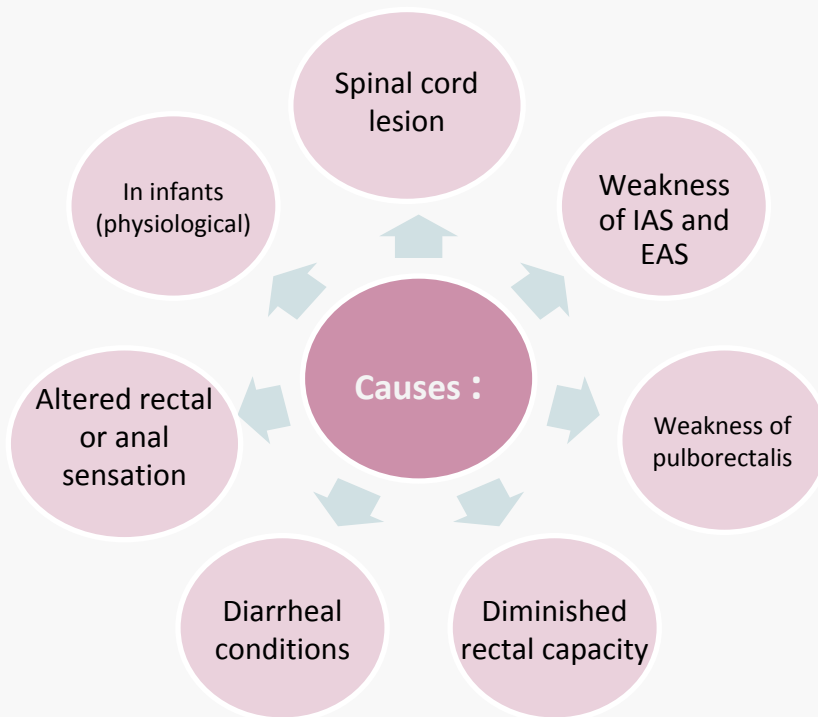
## ► Defecation Reflex : (Boys slides)

- Distension of the **rectum**.
- **Stimulation of the stretch activate two reflexes:**
  - **Short reflex:** Stimulation of myenteric plexus in sigmoid colon and rectum.
  - **long reflex:** stimulation of parasympathetic motor neurons in sacral spinal cord.
- Stimulation of somatic motor neurons,
- Increased local peristalsis. Relaxation of internal anal sphincter **involuntary** and contraction of external anal sphincter.
- Note that repeated somatic inhibition may lead to constipation!

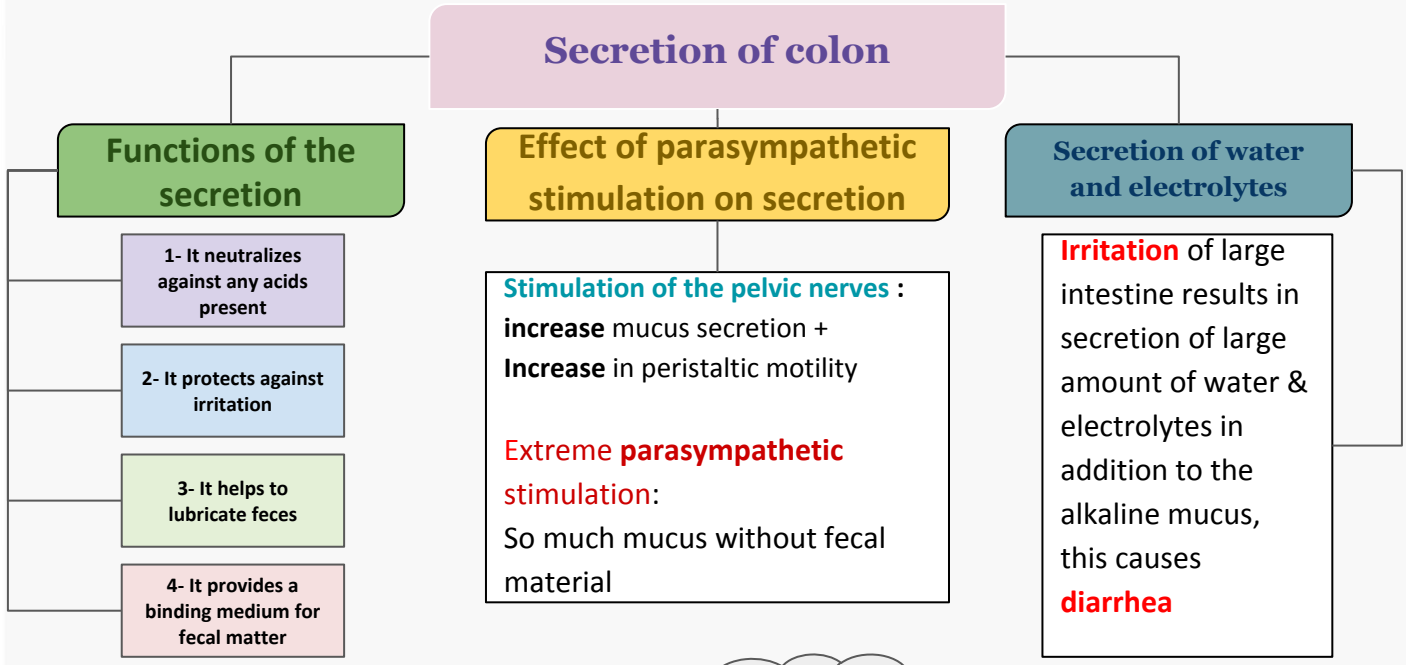
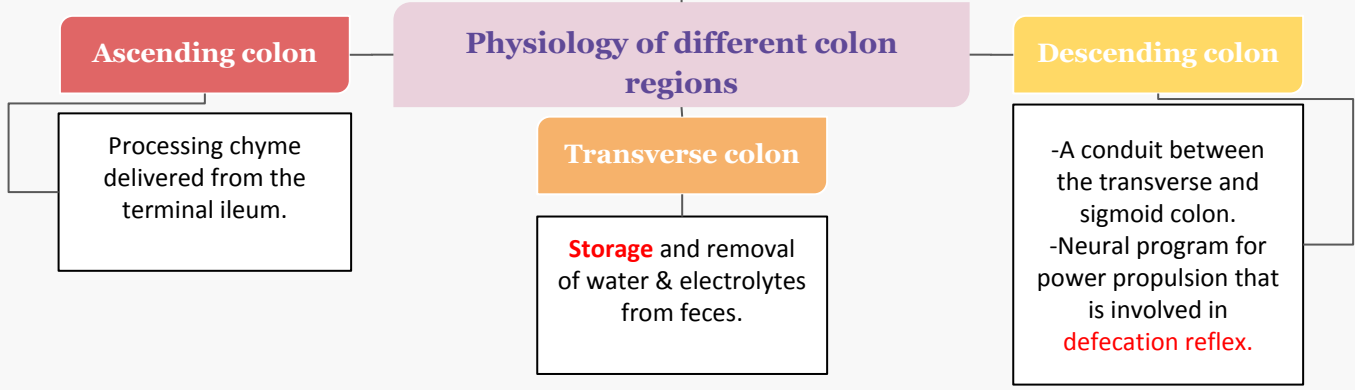
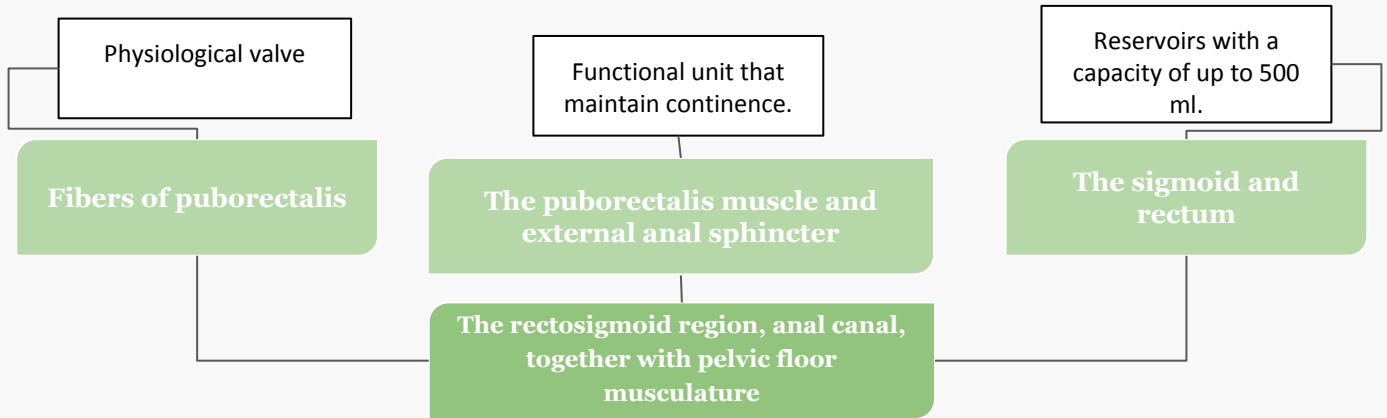


## ► Fecal incontinence : الإخراج اللاإرادي

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



# SUMMARY

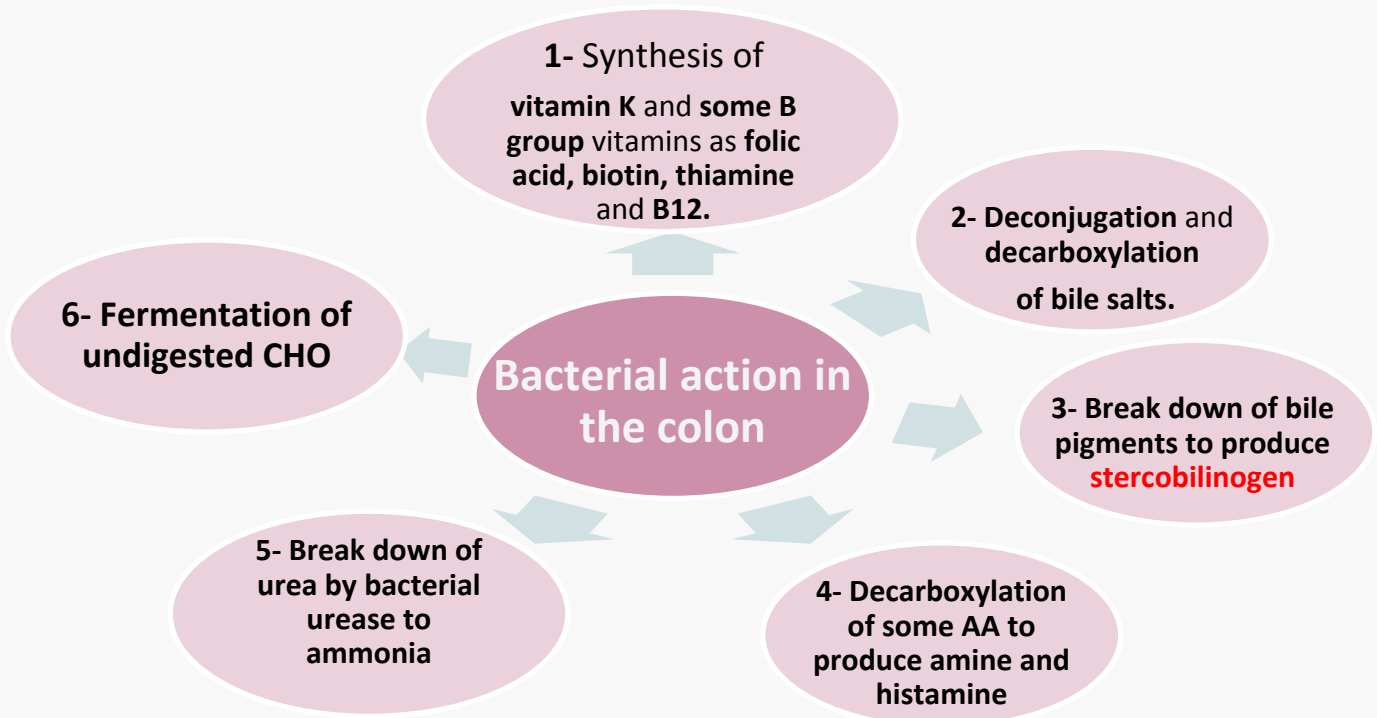


Mostly occurs in the proximal half of the colon

## Absorption of colon

Water About 0.5-1.5 L/day.  $\text{Na}^+$  is actively absorbed.  $\text{Cl}^-$  is absorbed in exchange for  $\text{HCO}_3^-$ . Vitamins. Certain drugs. Bile salts and organic wastes..Toxins

# SUMMARY



## Iliocaecal 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:

Mixing movement(Haustration)	Propulsive (mass) movement
in the cecum and ascending colon	in transverse & descending colon

## Antiperistalsis :

It mixes contents and help water absorption.

## Defecation Reflexes :

- Short reflex.
- long reflex.

## Fecal incontinance :

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

# MCQs

**1-The bacterial flora in large intestine synthesize:**

- A- Vit c
- B- Vit k
- C- Vit a
- D- Potassium

**2-Which of the following Type of movements occur in the colon which is responsible mainly for the absorption:**

- A- Mass movement
- B- Haustrations movement
- C- Migrating motor movement
- D- Antiperistalsis

**3-stimulation of somatic motor neurons lead to:**

- A- Contraction of internal anal sphincter
- B- relaxation of internal anal sphincter
- C- Contraction of external anal sphincter
- D- relaxation of external anal sphincter

**4-defecation reflex performed by which of the following nerves:**

- A- vagus
- B- superior mesentry
- C- pelvic
- D- none of the

**5-defecation reflex is triggered mainly by distention of:**

- A- ascending colon
- B- transverse colon
- C- descending colon
- D- rectum

**6-which one of the following is secreted in colon:**

- A- Sodium
- B- WATER
- C- Bicarbonate
- D- Chloride

**7-In Defecation Reflex, The Short Reflex Stimulate:**

- A- Myenteric Plexus
- B- Submucosal plexus
- C- Vagus
- D- Pelvic

**8-Ring-like contractions (about 2.5 cm) of the circular muscle divide the colon into pockets:**

- A- Propulsive Movement
- B- Mixing contraction (Haustration)
- C- Rush Movement
- D- Antiperistalsis Movement

عمر آل سليمان  
عبدالعزیز الحماد  
عبدالرحمن السیاری  
محمد أبونیان  
عبدالرحمن البركه  
إبراهیم النفیسه  
محمد البشر  
عمر العتیبي  
حمزة الفعر  
عبدالله الجعفر  
عبدالله الضحیان  
حسن البلادي  
حسن الشماسي  
عبدالله الضبیب  
محمد الفواز  
محمد السحیباتي  
وائل العود  
رواف الرواف  
عمر الشهري

خولة العمّاري  
نجدود الحیدري  
نورة الطویل  
لولوة الصغیر  
لجین السواط  
رزان السبتي  
ربی السليمي  
دیما الفارس  
خولة العرینی  
ملاك الشریف  
منيرة الحسینی  
مروج الحربي  
أفنان المالكي  
دلال الحزيمي  
رناد القحطاني  
سارة الخليفة  
فرح مندوزا  
می العقيل  
نورة الخراز  
سارة الخليفة  
نورة الخيال  
رغد النفیسة  
منيرة السلولي  
نوف العبدالكريم  
سها العنزي  
نورة القحطاني

