physiology lecture (15)(GI) summarizing

how can the GI system contribute to homeostasis ?

1. breaking down food into forms that can be absorbed
2. eliminates water and wastes

It extends from the mouth to the anus

digestion : foods broke down into molecules that are small enough to enter body cells

main organs :
mouth,
most of the pharynx,
esophagus,
stomach,
small intestine
, large intestine

accessory digestive organs
the teeth,
tongue,
salivary glands,
liver,
gallbladder,
pancreas.

FUNCTIONS OF THE DIGESTIVE SYSTEM

1.Ingestion: taking food into mouth.

2. Secretion: release of water, acid, buffers, and enzymes into lumen of GI tract.

3. Mixing and propulsion: churning and movement of food through GI tract.

4. Digestion: mechanical and chemical breakdown of food.

5. Absorption: passage of digested products from GI tract into blood and lymph.

The four layers of the GI tract :(from deep to superficial)

1. the mucosa
2.submucosa
3. muscularis
4. serosa.

The gastrointestinal tract is regulated by :

1. enteric nervous system :intrinsic set of nerves
2. the autonomic nervous system :extrinsic set of nerves

we have to types of plexuses (ENS)

- myenteric plexus → (between the longitudinal and circular smooth muscle layers of the muscularis) → motor neurons :controls GI tract motility (movement) (increase contraction)
- submucosal plexuses → within the submucosa → motor neurons : increase secretion

interneurons of the ENS interconnect the neurons of the myenteric and submucosal plexuses → two major types of sensory receptors:

- chemoreceptors(certain chemicals in the food present in the lumen)
- mechanoreceptors such as stretch receptors (that are activated when food distends (stretches) the wall of a GI organ)

if sympathetic system activated (emotions) → decrease contraction and secretions in the GI → inhibition to myenteric plexus and submucosal plexuses

if parasympathetic system activated → increase in GI secretion and motility (contraction) → activating to myenteric plexus and submucosal plexuses

how the digestion occur in the mouth:

1. teeth break down the food

2. saliva from salivary glands

there are three types of salivary glands:

1. submandibular gland
2. sublingual gland
3. parotid gland

tongue

- tongue =skeletal muscle covered with mucous membrane (accessory digestive organ)
- floor of the oral cavity = tongue+ associated muscles
- The extrinsic muscles → originate outside the tongue (attach to bones in the area) and insert into connective tissues in the tongue →
  1. move the tongue from side to side and in and out to maneuver food for chewing
  2. shape the food into a rounded mass
  3. force the food to the back of the mouth for swallowing
  4. form the floor of the mouth and hold the tongue in position.
- The intrinsic muscles → originate in and insert into connective tissue within the tongue → They alter the shape and size of the tongue for speech and swallowing

teeth

- a tooth has three major external regions: the crown, neck and root .
- Teeth are anchored in sockets of the alveolar processes of the mandible and maxillae

to have a full digestion we need

1. mechanical digestion
   - chewing, or mastication, in which food is manipulated by the tongue, ground by the teeth, and mixed with saliva
   - to form bolus (soft, flexible, easily swallowed mass)
2. chemical digestion (enzymes)
   - Salivary amylase
     1. secreted by salivary glands
     2. starts his work or activated in mouth
     3. responsible of initiate breaking down of starch
     4. the carbohydrates start breaking down from the mouth (only monosaccharides can be absorbed into the bloodstream) so it all should be broken to monosaccharides
   - lingual lipase
     1. secreted by lingual glands in the tongue
     2. cannot start from the mouth because it needs an acidic environment but it will be transported with the food to start working in the stomach
     3. responsible of breaking down of triglycerides into fatty acids and diglycerides (two fatty acids+glycerol molecule)

pharynx (conduct) → funnel-shaped tube that extends from the internal nares to the esophagus posteriorly and to the larynx anteriorly

pharynx =skeletal muscle and lined by mucous membrane

divided into → nasopharynx → posterior to the nose (only respiration function)

oropharynx → digestive as well as respiratory functions

laryngopharynx → digestive as well as respiratory functions

mouth → oropharynx → laryngopharynx → esophagus → stomach

esophagus → it can't handle an acidic environment because it is a basic environment → secretes mucus and transports food into the stomach. → no digestive enzymes and no absorption

Peristalsis = progression of coordinated contractions and relaxations of the circular and longitudinal layers of the muscularis, pushes the bolus onward يعني بس اسم الحركة

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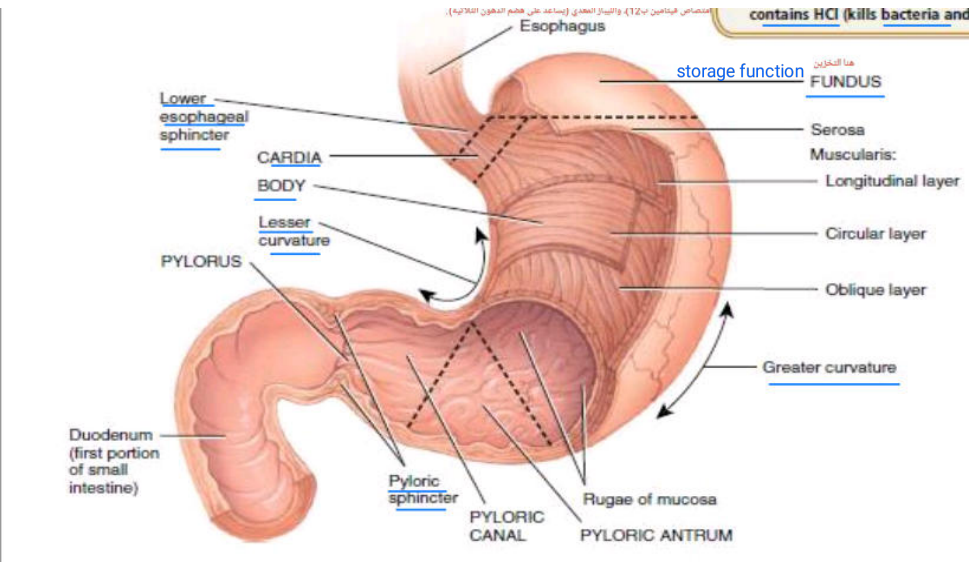
stomach

- J-shaped enlargement of the GI tract directly inferior to the diaphragm in the abdomen. connects the esophagus to the duodenum(the first part of the small intestine).
- The four regions of the stomach are the cardia, fundus, body, and pyloric part.
- serve as a mixing chamber and holding reservoir
- 1.the diaphragm pushes it inferiorly with each inhalation
  2. pulls it superiorly with each exhalation.
  3. it is the most distensible part of the GI tract and can accommodate a large quantity of food
- digestion of starch and triglycerides continues, digestion of proteins begins
- 1. Mixes saliva, food, and gastric juice to form chyme.
  2. Serves as reservoir for food before release into small intestine.
  3. Secretes gastric juice, = HCl (kills bacteria anddenatures proteins) +pepsin (begins the digestion of proteins) + intrinsic factor (aids absorption of vitamin B2) + gastric lipase (aids digestion of triglycerides).
  4. Secretes gastrin into blood.
- pyloric sphincter = smooth muscles sphincter responsible of communication between pylorus and duodenum
- lesser curvature = The concave medial border of the stomach .
  greater curvature = the convex lateral border of the stomach .
- 1. SURFACE MUCOUS CELL (secretes mucus)(simple columnar epithelial cells)
- 2. MUCOUS NECK CELL (secretes mucus)
- 3. PARIETAL CELL (secretes hydrochloric acid and intrinsic factor needed for absorption of vitamin B12)
- 4. CHIEF CELL (secretes pepsinogen and gastric lipase)
- 5. G CELL (secretes the hormone gastrin)



propulsion =Each peristaltic wave moves gastric contents from the body of the stomach down into the antrum

The pyloric sphincter normally remains almost, but not completely, closed.

retropulsion = most food particles in the stomach initially are too large to fit through the narrow pyloric sphincter, they are forced back into the body of the stomach

the final result of propulsion and retropulsion → chyme (gastric contents are mixed with gastric juice, eventually becoming reduced to a soupy liquid) → they can pass through the pyloric sphincter (gastric emptying) (slow process) (3 ml)

HCl secretion by parietal cells can be stimulated by several sources:

- Acetylcholine (ACh) is released by parasympathetic neurons. → stimulate parietal cells to secrete more HCl in the presence of histamine
- Gastrin secreted by G cells → stimulate parietal cells to secrete more HCl in the presence of histamine
- Histamine, a paracrine substance released by mast cells in the nearby lamina propria. → enhancing the effects of acetylcholine and gastrin

Receptors for all substances are present in the plasma membrane of parietal cells.

the hydrochloric acid HCL

- 1. kills many microbes in food 2.denatures (unfolds) proteins ,stimulates the secretion of hormones that promote the flow of bile and pancreatic juice
- pepsinogen (inactive form of pepsin) (secreted by Chief cells) (breaking down proteins into amino acids) → to convert pepsinogen into pepsin it needs contact with hydrochloric acid secreted by parietal cells or active but pepsin molecule pepsin is most effective in acidic environment (2pH)
- the stomach epithelial cells are protected from gastric juices by a layer 1-3 mm thick of alkaline mucus secreted by surface mucous cells and mucous neck cells.

there are three types of lipase:

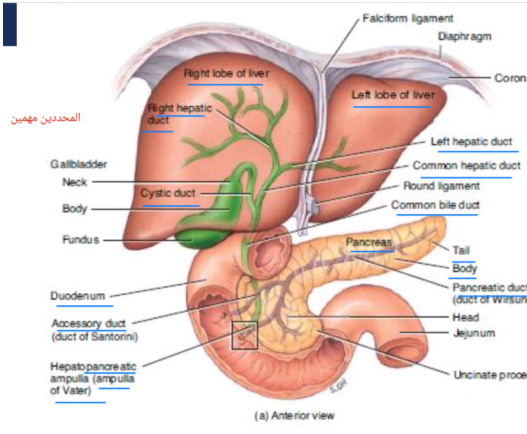
1. lingual lipase (in the mouth)(we talked about it but there is one information left)
(when the salivary amylase inactivated, lingual lipase activated)

2. gastric lipase (from the stomach) → splits triglycerides (fats and oils) in fat molecules (such as those found in milk) into fatty acids + monoglycerides (5-6 pH)

3. pancreatic lipase (from the pancreas into the small intestine)

the arrangement of substances that will exit from the fundus in stomach from the fastest to the slowest →

1. carbohydrates
2. high protein foods
3. fats triglycerides



(a) Anterior view

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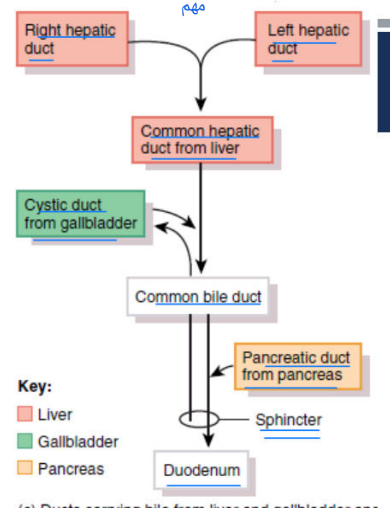

(c) Ducts carrying bile from liver and gallbladder and pancreatic juice from pancreas to the duodenum

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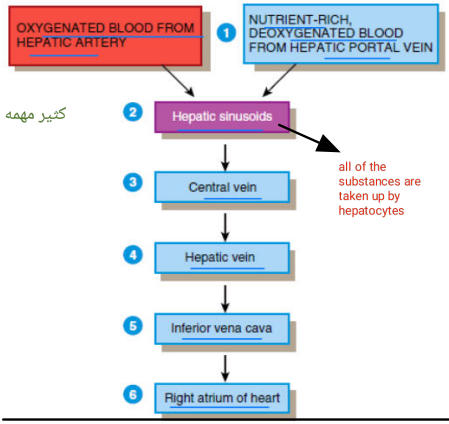
The pancreas → retroperitoneal gland → thick, lies posterior to the greater curvature of the stomach.

- The pancreas consists of a head, a body, and a tail and is usually connected to the duodenum by two ducts
- Trypsin is secreted in an inactive form called trypsinogen.(breaking down protein in the small intestine)
- trypsin inhibitor : (secreted by Pancreatic acinar cells)
  (combines with any trypsin formed accidentally in the pancreas or in pancreatic juice and blocks its enzymatic activity)
- brush-border enzyme called enterokinase: activates trypsinogen when it reaches small intestine by spilts off part of it to convert it to trypsin



the liver
- the heaviest gland of the body
- Of all of the organs of the body, it is second only to the skin in size.
- liver is often a site for metastasis of cancer that originates in the GI tract.

The gallbladder
- pear-shaped sac
- typically hangs from the anterior inferior margin of the liver

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bile (secreted by hepatocytes from the liver)
- yellow, brownish, or olive-green liquid. (pH of 7.6-8.6)
  consists mostly of water, bile salts, cholesterol, a phospholipid called lecithin, bile pigments, and several ions
- The principal bile pigment is bilirubin
- The phagocytosis of aged red blood cells liberates iron, globin, and bilirubin (derived from heme).
- The iron and globin are recycled
  the bilirubin is secreted into the bile and is eventually broken down in the intestine.
  One of its breakdown products-stercobilin gives feces their normal brown color .
- partially an excretory product and partially a digestive secretion
- bile salts(sodium salts and potassium salts of bile acids)
  1. play a role in emulsification, the breakdown of large lipid globules into a suspension of small lipid globules .
  2. help pancreatic lipase to more rapidly accomplish digestion of triglycerides .
  3. absorption of lipids following their digestion.
- if Digestion and absorption continue in the small intestine, bile release increases.
- Between meals, after most absorption has occurred, bile flows into the gallbladder for storage because the sphincter of the hepatopancreatic ampulla closes off the entrance to the duodenum. .

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functions of liver and gallbladder
1. secrete bile (needed for absorption of dietary fats)
2. carbohydrates metabolism : stores glucose on glycogen form and when the the glucose is needed at breaks down glucose
3. lipid metabolism : hepatocytes store some triglycerides, synthesize cholesterol and use cholesterol to make bile salts
4. protein metabolism: Hepatocytes deaminate (remove the amino group, NH2, from) amino acids, the resulting toxic ammonia (NH3) is then converted into the much less toxic urea, which is excreted in urine , synthesize most plasma proteins, such as alpha and beta globulins, albumin, prothrombin, and fibrinogen.
5. processing of drugs and hormones : The liver can detoxify substances such as alcohol and excrete drugs such as penicillin, erythromycin, and sulfonamides into bile. It can also chemically alter or excrete thyroid hormones and steroid hormones such as estrogens and aldosterone
6. execration of bilirubin : metabolized in the small intestine by bacteria and eliminated in feces

7.Synthesis of bile salts: (emulsification and absorption of lipids)

8. Storage: A. glycogen,
B. the liver is a prime storage site for certain vitamins (A, B12, D, E, and K)
C. minerals (iron and copper), which are released from the liver when needed elsewhere in the body

9.Phagocytosis : Kupffer cells of the liver phagocytize aged red blood cells, white blood cells, and some bacteria

small intestine

Circular folds, villi, and microvilli Increase the surface area of the small intestine for digestion and absorption.

MicroviIII In the small intestine contain several brush-border enzymes that help digest nutrients.

functions of the small intestine :

1. Segmentations mix chyme with digestive juices and bring food into contact with mucosa for absorption; peristalsis propels chyme through small intestine.

2. Completes digestion of carbohydrates, proteins, andlipids; begins and completes digestion of nucleic acids.

3. Absorbs about 90% of nutrients and water that pass through digestive system.

brush-border enzymes (absorptive cells of the small intestine synthesize several digestive enzymes)

* Intestinal juice contains water and mucus and is slightly alkaline (7.6 pH) due to high concentration of bicarbonate ions

* some enzymatic digestion occurs at the surface of the absorptive cells that line the villi, rather than in the lumen

1. four carbohydrate-digesting enzymes → A. a-dextrinase B. maltase C. sucrase D. lactase

2. protein-digesting enzymes → peptidases (aminopeptidase and dipeptidase)

3. two types of nucleotide-digesting enzymes → nucleosidases and phosphatases

the movement

* the two types of movements in small intestine are governed by the myenteric plexus

1. Segmentations
   - localized, mixing contractions that occur in portions of intestine distended by a large volume of chyme
   - mix chyme with the digestive juices and bring the particles of food into contact with the mucosa for absorption (they do not push the intestinal contents along the tract.)
   - most rapidly in the duodenum(12 times per minute) progressively slow in the ileum to about (8 times per minute)
   - After most of a meal has been absorbed, which lessens distension of the wall of the small intestine, segmentation stops

2. migrating motility complex (MMC)
   - type of peristalsis , starts after segmentation
   - begins in the lower portion of the stomach and pushes chyme forward along a short stretch of small intestine before dying out

absorption = Passage of these digested nutrients from the gastrointestinal tract into the blood or lymph

Absorption of materials occurs via diffusion, facilitated diffusion, osmosis, and active transport.

About 90% of all absorption of nutrients occurs in the small intestine; the other 10% occurs in the stomach and large intestine

CHEMICAL DIGESTION IN THE SMALL INTESTINE

في الفم، يحول الأميليز اللعابي النشا (عديد السكاريد) إلى مالتوز (ثنائي السكاريد)، ومالتوتريوز (ثلاثي السكاريد)، وألفا-دكسترينات (شظايا نشا متفرعة قصيرة السلسلة تحتوي على 5-10 وحدات جلوكوز).

1. In the mouth, salivary amylase converts starch (a polysaccharide) to maltose (a disaccharide), maltotriose (a trisaccharide), and α-dextrins (short-chain, branched fragments of starch with 5–10 glucose units).
2. In the stomach, pepsin converts proteins to peptides (small fragments of proteins), and lingual and gastric lipases convert some triglycerides into fatty acids, diglycerides, and monoglycerides.

في المعدة، يحوّل إنزيم البيبسين البروتينات إلى ببتيدات (أجزاء صغيرة من البروتينات)، بينما تحوّل الليبازات اللسانية والمعدية بعض الدهون الثلاثية إلى أحماض دهنية، وثنائية الجليسريد، وأحادية الجليسريد.

3. Thus, chyme entering the small intestine contains partially digested carbohydrates, proteins, and lipids.

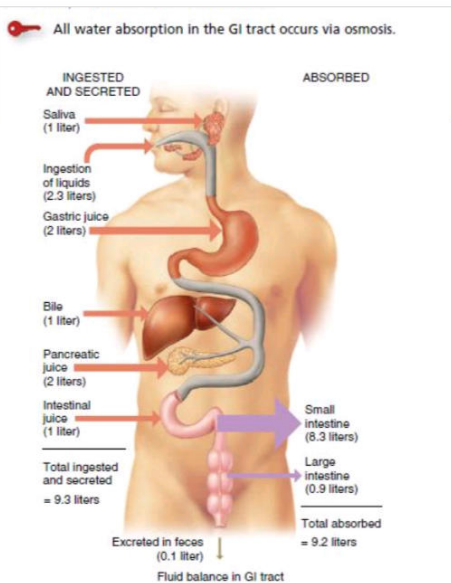
وبالتالي، يحتوي الكيموس الداخل إلى الأمعاء الدقيقة على كربوهيدرات وبروتينات ودهون مهضومة جزئيًا.

4. The completion of the digestion of carbohydrates, proteins, and lipids is a collective effort of pancreatic juice, bile, and intestinal juice in the small intestine.

4. يُعدّ إتمام هضم الكربوهيدرات والبروتينات والدهون جهدًا جماعيًا للعصارة البنكرياسية والصفراء والعصارة المعوية في الأمعاء الدقيقة.

هون اطلعو على الارقام احفظوا

هذا السلايد بس ملخص بسيط



large intestine — is the terminal portion of the GI tract.

Intestinal glands formed by simple columnar epithelial cells and goblet cells extend the full thickness of the mucosa.

overall functions :

1. completion of absorption
2. the production of certain vitamins
3. the formation of feces
4. the expulsion of feces from the body
5. Haustral churning, peristalsis and mass peristalsis drive contents of colon into rectum.
6. Bacteria In large Intestine convert proteins to amino acids. break down amino acids, and produce some B vitamins and vitamin K
7. Defecation (emptying rectum).

type of cells

1. ABSORPTIVE CELL (absorbs water)
2. GOBLET CELL (secretes mucus)

mechanical digestion in the large intestine

The passage of chyme from the ileum into the cecum is regulated by the action of the ileocecal sphincter → partially closed so that the passage of chyme into the cecum usually occurs slowly

after a meal → gastroileal reflex intensifies peristalsis in the ileum and forces any chyme into the cecum → gastrin relaxes the sphincter

Whenever the cecum is distended, the degree of contraction of the ileocecal sphincter intensifies.

movements

gastric emptying time = the time required for a meal to pass into the colon

haustra = Each segment in large intestine

1. haustral churning: (faster)
   - the first move and is starting from cecum and end with the middle of transverse colon
   - the haustra remain relaxed and become distended while they fill up. When the distension reaches a certain point, the walls contract and squeeze the contents into the next haustrum.

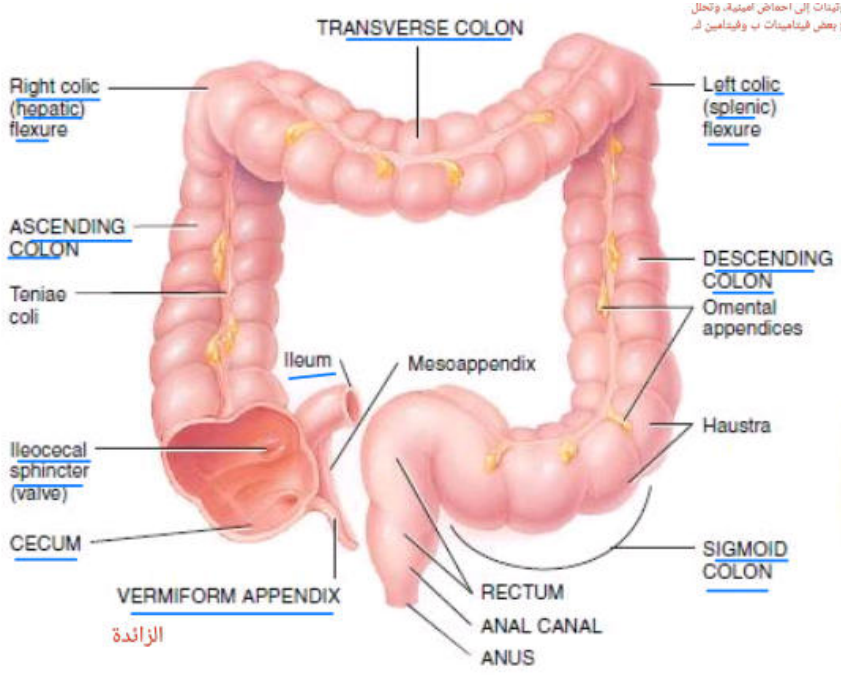
2.mass peristalsis (slower)
   - strong peristaltic wave
   - begins at the middle of the transverse colon and quickly drives the contents of the colon into the rectum
   - mass peristalsis usually takes place three or four times a day, during or immediately after a meal.

chemical digestion in the large intestine

* The final stage of digestion → through the activity of bacteria that inhabit the lumen

Mucus is secreted by the glands of the large intestine — no enzymes are secreted

the bacteria
- ferment any remaining carbohydrates and release hydrogen, carbon dioxide, and methane gases. These gases contribute to flatus (gas) in the colon, termed flatulence when it is excessive
- convert any remaining proteins to amino acids and break down the amino acids into simpler substances: indole, skatole, hydrogen sulfide, and fatty acids.
- decompose bilirubin to simpler pigments, including stercobilin, which gives feces their brown color.
- Bacterial products that are absorbed in the colon include several vitamins needed for normal metabolism, among them some B vitamins and vitamin K.



(a) Anterior view of large intestine showing

Chemically, feces consist of water, inorganic salts, sloughed-off epithelial cells from the mucosa of the gastrointestinal tract, bacteria, products of bacterial decomposition, unabsorbed digested materials, and indigestible parts of food.

The resulting distension of the rectal wall stimulates stretch receptors, which initiates a defecation reflex that results in defecation, the elimination of feces from the rectum through the anus.

The amount of bowel movements that a person has over a given period of time depends on various factors such as diet, health, and stress.

The normal range of bowel activity → varies from two or three bowel movements per day to three or four bowel movements per week.

Diarrhea → increased motility and decreased absorption by the intestines. → increase in the frequency, volume, and fluid content of the feces

Constipation → decreased motility of the intestines → infrequent or difficult defecation