



تفريغ فسيولوجي



موضوع المحاضرة: Gastrointestinal system

رقم المحاضرة : 17

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تفريغ GI System

THE DIGESTIVE SYSTEM

- ❖ The digestive system contributes to homeostasis by breaking down food into forms that can be absorbed and used by body cells. It also absorbs water, vitamins, and minerals, and it eliminates wastes from the body.
- ❖ The food we eat consists of molecules that are too large to be used by body cells. Therefore, foods must be broken down into molecules that are small enough to enter body cells, a process known as digestion.
- ❖ It extends from the mouth to the anus, forms an extensive surface area in contact with the external environment, and is closely associated with the cardiovascular system. The gastrointestinal (GI) tract or alimentary canal is a continuous tube that extends from the mouth to the anus through the thoracic and abdominopelvic cavities.
- ✓ أعضاء أساسية في ال GI system
- ❖ Organs of the gastrointestinal tract include the mouth, most of the pharynx, esophagus, stomach, small intestine, and large intestine.

ال GI system يحافظ على ال Homeostasis من خلال القيام بوظائف معينة. (٤ وظائف)

ال digestive system يبدأ من ال mouth الى ال anus (فتحة الشرج) وبالتالي اول وظيفة له يعمل (Ingestions /إدخال) بيدخل عن طريق ال mouth وبمر عن طريق ال esophagus بوصل لل stomach في ال stomach بصير (Digestion) بتروح لل small intestine وال large intestine وبصير ال (Absorption) والوظيفة الرابعة بيتخلص من الفضلات عن طريق انه يعمل (elimination/secretion) الى خارج الجسم.

THE DIGESTIVE SYSTEM

❖ ^(أعضاء مساعدة) The accessory digestive organs include the teeth, tongue, salivary glands, liver, gallbladder, and 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.
6. Defecation: elimination of feces from GI tract.

معظم ال digestion يحدث في ال stomach .

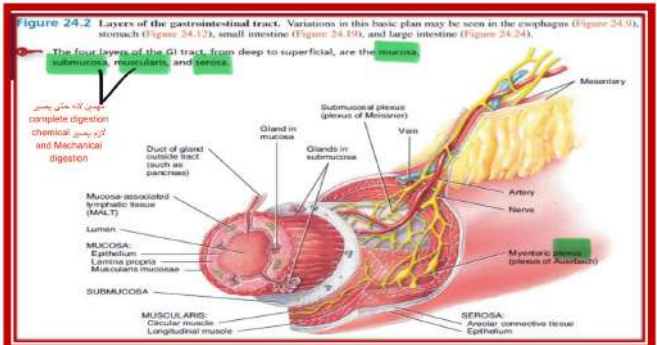
بعض ال digestion يحدث في ال large and

small intestines .

معظم ال absorption يحدث في ال small

intestine وبنسبة ٩٠٪ لكن ١٠٪ من absorption بصير

في ال stomach وال large intestine .



ال chemical digestion عن طريق الافرازات .

ال Mechanical digestion عن طريق

ال contraction.

حتى يصير both digestion عن طريق plexuses .

ال plexus : مجموعة ال neurons الموجودة في ال

GI system.

: Type of plexuses

١- submucosal plexus موجود بمنطقة ال

submucosa هذا مسؤول عن زيادة ال secretion عن

طريق (chemical digestion) .

٢- Myenteric plexus موجود بمنطقة ال

muscularis مسؤول عن زيادة ال contraction عن

طريق mechanical digestion.

يلي بزيد ال contraction هو parasympathetic .

يلي بزيد ال relaxation هو sympathetic .

ال parasympathetic هو يلي مسؤول عن زيادة ال

digestion .

NEURAL INNERVATION OF THE GI TRACT

The gastrointestinal tract is regulated by an **intrinsic set of nerves known as the enteric nervous system** and by an **extrinsic set of nerves that are part of the autonomic nervous system**.



يتم انتاج action potential عن طريق ال myenteric plexus او submucosal plexus
عن طريق ال sensory receptor ال
chemical digestion (chemoreceptor)
ومن ال mechanical digestion يسمى ال receptor
بال mechanoreceptor .

ENTERIC NERVOUS SYSTEM

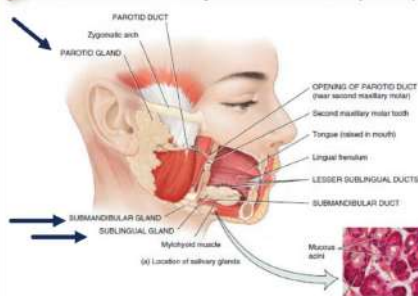
- ❖ The neurons of the ENS are arranged into two plexuses: the myenteric plexus and submucosal plexus.
- ❖ The myenteric plexus is located between the longitudinal and circular smooth muscle layers of the muscularis.
- ❖ The submucosal plexus is found within the submucosa.
- ❖ The plexuses of the ENS consist of motor neurons, interneurons, and sensory neurons.

AUTONOMIC NERVOUS SYSTEM

- ✓ Although the neurons of the ENS can function independently, they are subject to regulation by the neurons of the autonomic nervous system.
- ✓ The vagus (X) nerves supply parasympathetic fibers to most parts of the GI tract, with the exception of the last half of the large intestine, which is supplied with parasympathetic fibers from the sacral spinal cord.
- ✓ The parasympathetic nerves that supply the GI tract form neural connections with the ENS.

Figure 24.6 The three major salivary glands—parotid, sublingual, and submandibular. The submandibular glands, shown in the light micrograph (b), consist mostly of serous acini (serous fluid-secreting portions of glands) and a few mucous acini (mucus-secreting portions of glands); the parotid glands consist of serous acini only; and the sublingual glands consist mostly of mucous acini and a few serous acini.

Saliva lubricates and dissolves foods and begins the chemical breakdown of carbohydrates and lipids.



هيك بندرس ال mouth

ال salivary gland بتعمل على افراز saliva وبتعمل

على إفراز 2type of enzymes:

١- salivary amylase مسؤول عن تكسير

الكربوهيدرات (poly saccharide تتحول الى

disaccharide تتحول الى monosaccharide)

🦅 (تكسير الكربوهيدرات يبدأ من ال mouth)

٢- lingual lipase هذا الانزيم ما بيصير active الا لما

يوصل لل acidic pH (لما يوصل للمعدة) وال salivary

amylase بصير active.

TONGUE

- ❑ The tongue is an accessory digestive organ composed of skeletal muscle covered with mucous membrane.
- ❑ Together with its associated muscles, it forms the floor of the oral cavity.
- ❑ The extrinsic muscles of the tongue, which originate outside the tongue (attach to bones in the area) and insert into connective tissues in the tongue.
- ❑ The extrinsic muscles move the tongue from side to side and in and out to maneuver food for chewing, shape the food into a rounded mass, and force the food to the back of the mouth for swallowing. They also form the floor of the mouth and hold the tongue in position.
- ❑ The intrinsic muscles of the tongue originate in and insert into connective tissue within the tongue. They alter the shape and size of the tongue for speech and swallowing.

🦅 ال tongue له وظيفتين : ١- بدخل الاكل ٢- بغير

الشكل

الاكل لما نأكله اللسان بيحاول يغير شكله الى شكل كره

(Bolus) هذه الكره يلي بغيرها وحده من انواع ال

muscles الموجودة باللسان وحده من انواع ال

muscles بتغير الشكل ووحده بتدخل الاكل .

MECHANICAL AND CHEMICAL DIGESTION IN THE MOUTH

- Mechanical digestion in the mouth results from chewing, or mastication, in which food is manipulated by the tongue, ground by the teeth, and mixed with saliva.
- As a result, the food is reduced to a soft, flexible, easily swallowed mass called a bolus.
- Food molecules begin to dissolve in the water in saliva, an important activity because enzymes can react with food molecules in a liquid medium only.
- Two enzymes, salivary amylase and lingual lipase, contribute to chemical digestion in the mouth.
- Salivary amylase, which is secreted by the salivary glands, initiates the breakdown of starch. Dietary carbohydrates are either monosaccharide and disaccharide sugars or complex polysaccharides such as starches. Most of the carbohydrates we eat are starches, but only monosaccharides can be absorbed into the bloodstream. Thus, ingested disaccharides and starches must be broken down into monosaccharides.

MECHANICAL AND CHEMICAL DIGESTION IN THE MOUTH

Saliva also contains lingual lipase which is secreted by lingual glands in the tongue. This enzyme becomes activated in the acidic environment of the stomach and thus starts to work after food is swallowed. It breaks down dietary triglycerides (fats and oils) into fatty acids and diglycerides. A diglyceride consists of a glycerol molecule that is attached to two fatty acids.

🦅 ال lingual lipase مسؤول عن كسر

ال tri saccharide ولكن هذا الانزيم ما بيصير active

إلا بس يوصل للمعدة لانه المعدة هي acidic

acidic environment وبدون ما يبصير environment
 active يعني لما ينتقل الاكل من ال mouth بمشي مع ال
 salivary amylase و lingual lipase و saliva ال
 salivary amylase يبدأ يكسر الكربوهيدرات، ال
 lingual lipase و salivary amylase و saliva بتضل
 ماشيه 🧑🏻 بتوصل لل esophagus (عبارة عن معبر)
 بيعمل على افراز المخاط ليسهل مرور الطعام بينزل
 للأسفل بيوصل لل stomach
 ال salivary amylase بتوقف (inactive)
 وال lingual lipase بصير له (active)
 المهم معرفته : اول digestion يبدأ للكربوهيدرات
 وببدأ نتيجة انزيم ال salivary amylase على الرغم من
 انه ال salivary gland بتعمل على افراز lingual lipase
 إلا انه ما بتبدأ تعمل degradation للدهون الا لما توصل
 للمعدة .

PHARYNX

- When food is first swallowed, it passes from the mouth into the pharynx, a funnel-shaped tube that extends from the internal nares to the esophagus posteriorly and to the larynx anteriorly.
- The pharynx is composed of skeletal muscle and lined by mucous membrane, and is divided into three parts: the nasopharynx, the oropharynx, and the laryngopharynx.
- The nasopharynx functions only in respiration, but both the oropharynx and laryngopharynx have digestive as well as respiratory functions.
- Swallowed food passes from the mouth into the oropharynx and laryngopharynx; the muscular contractions of these areas help propel food into the esophagus and then into the stomach.

ال nasopharynx اله علاقه فقط بال respiration 🧑🏻
 ال oropharynx وال laryngopharynx اله بال respiration وال digestion 🧑🏻

ESOPHAGUS

هو عبارة عن ممر يسهل مرور الغذاء.

The esophagus secretes mucus and transports food into the stomach. It does not produce digestive enzymes, and it does not carry on absorption.

Figure 24.9 Histology of the esophagus. A higher-magnification view of nonkeratinized stratified squamous epithelium is shown in Table 4.1F.

The esophagus secretes mucus and transports food to the stomach.

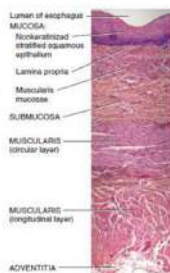


Figure 24.10 Deglutition (swallowing). During the pharyngeal stage (b) the tongue rises against the palate, the nasopharynx is closed off, the larynx rises, the epiglottis seals off the larynx, and the bolus is pressed into the esophagus. During the esophageal stage (c), food moves through the esophagus into the stomach via peristalsis.

Deglutition is a mechanism that moves food from the mouth into the stomach.

The tongue shapes the chewed, lubricated food (bolus) and moves it to the back of the mouth cavity.

Respiration (voluntary stage)

Nasopharynx
 Hard palate
 Soft palate
 Uvula
 Oropharynx
 Epiglottis
 Laryngopharynx
 Larynx
 Esophagus

Bolus

Tongue

Peristalsis, a progression of coordinated contractions and relaxations of the circular and longitudinal layers of the muscularis, pushes the bolus onward.

- The tongue rises against the palate and closes the nasopharynx.
- The uvula and palate seal off the nasal cavity.
- The epiglottis covers the larynx. Breathing is temporarily interrupted.

(a) Position of structures during voluntary stage

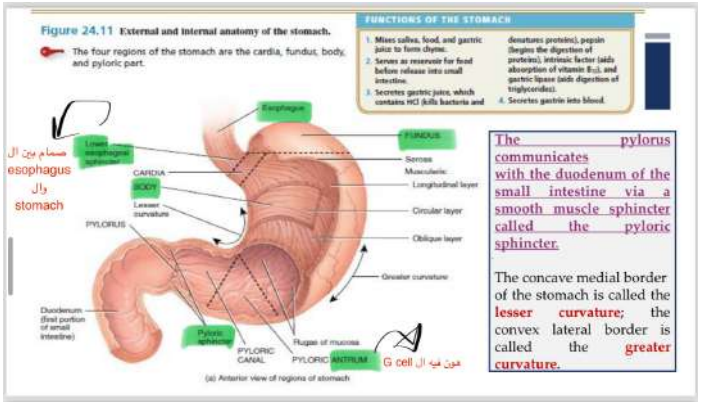
(b) Pharyngeal stage of swallowing

🦋 ال nasopharynx ما الها علاقه بال digestion لانه عند اكل الطعام ال Uvula بتسكر فالاكل ما بيطلع لل nasopharynx .

🦋 عند دخول الطعام اثناء الاكل بحاول اللسان يغير شكله الى كره (Bolus).

🦋 ال tongue اول وظيفة اله بيجير الشكل وبساعد على مرور الاكل .

🦋 ال mouth فيه عباره عن salivary gland (غدد لعابية) فيها saliva (لعاب) بترطب الاكل وفيها عبارة عن انزيمات .



🦋 بين كل جزء والثاني من ال GI فيه sphincter (صمام).

🦋 ال Lower esophageal sphincter هذا الصمام بكون ب one direction اذا صار مشكله بالصمام بصير ارتداد للمريء فهذا الصمام بضل مغلق لحد ما يوصله الغذاء بيفتح ب one direction.

🦋 بعض الناس ممكن يصير عندهم ورم في منطقة ال antrum (وهذا الشي شائع جداً) ممكن هذا الورم يكون حميد او خبيث لانه الورم صار بمنطقة ال antrum وال antrum فيها G cell وال G cell بتعمل على افراز ال gastrin وهو بحفز على افراز ال HCl .

STOMACH

❖ The stomach wall is composed of the same basic layers as the rest of the GI tract, with certain modifications. The surface of the mucosa is a layer of simple columnar epithelial cells called **surface mucous cells**.

روح نأخذها كثير بالادوية

❖ **Parietal cells** produce intrinsic factor (needed for absorption of vitamin B12) and hydrochloric acid.

❖ The **chief cells** secrete **pepsinogen** and **gastric lipase** .

❖ The secretions of the **mucous**, **parietal**, and **chief cells** form gastric juice, which totals 2000–3000 mL per day.

🦋 معلومه مهم نعرفها 🦋

أنواع الخلايا الموجودة في ال stomach وكل وحده

ايش تنتج انواع enzymes يلي بتبدأ تكسر الاكل ؟

1- surface mucous cells

2- mucous neck cells

هذول النوعين من الخلايا بتعمل على افراز المخاط (المخاط هو alkaline (قاعدي)) لانه نسبة ال H+ عالية بال stomach فيحتاج نوع من الحماية ويوجد نوعين من الحماية:

الاولى : انه ال mucous يكون alkaline فيعادل الحموضة الموجودة بالمعدة .

الثانية: انه ال membran المحيط بالمعدة يكون very thick.

parietal cells بتعمل على إفراز HCl وإفراز intrinsic factor وال intrinsic factor امتصاص B12 عشان هيك معظم ال absorption بصير بال small intestine ولكن جزء منه بصير بال stomach وال large intestine وحده من ال absorption يلي بتصير بال stomach عن طريق intrinsic factor. chief cells بتعمل على افراز pepsinogen .

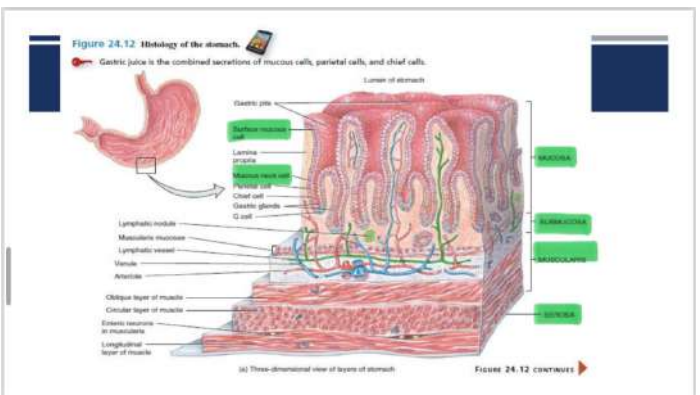
G cells بتعمل على افراز gastrin hormone.

لل lipid فيه ٣ انواع من الانزيمات ؟

1- gastric lipase يعمل على تكسير الدهون.

2- lingual lipase من ال salivary gland.

3- pancreatic lipase من ال pancreas .



صبقات ال GI عبارة عن ٤ طبقات .

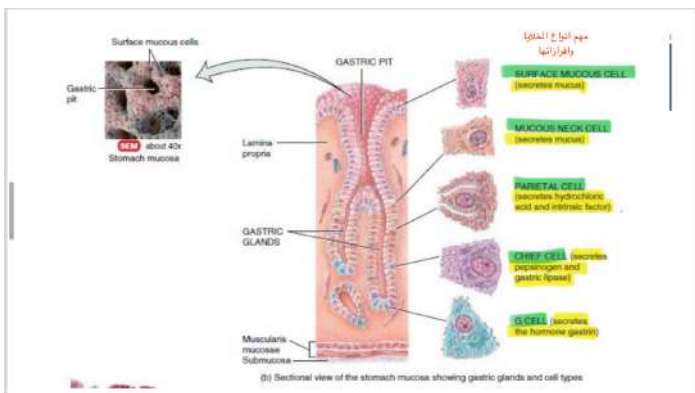
فيه نوعين من ال network of neurons (نوعين من ال plexuses)

1- myenteric plexus بالطبقة الثالثة (مجموعه من

الاعصاب يلي بتأثر على ال contraction وال relaxation)

2- submucosal plexus (مجموعة من الاعصاب

يتكون موجوده بالطبقة الثانية بال GI) مسؤولة عن زيادة ال secretion (زيادة الافرازات) لانه بال digestion فيه نوعين حتى يصير complete digestion للاكل فيه (chemical, mechanical) chemical : بحاجه الى secretion و mechanical بحاجه الى contraction بالبداية الاكل لازم يندمج مع ال secretion بعدين نتيجه ال contraction بصير complete digestion.



بال GI

ال parasympathetic بيزيد من ال contractions لل smooth muscle الموجودة بمنطقة ال Muscularis لكن ال sympathetic يقل فيعمل relaxation لل smooth muscles .

MECHANICAL AND CHEMICAL DIGESTION IN THE STOMACH

- ✓ Several minutes after food enters the stomach, waves of peristalsis pass over the stomach every 15 to 25 seconds.
- ✓ Few peristaltic waves are observed in the fundus, which primarily has a storage function.
- ✓ Instead, most waves begin at the body of the stomach and intensify as they reach the antrum.
- ✓ Each peristaltic wave moves gastric contents from the body of the stomach down into the antrum, a process known as propulsion.
- ✓ The pyloric sphincter normally remains almost, but not completely, closed. Because 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, a process referred to as retropulsion.

MECHANICAL AND CHEMICAL DIGESTION IN THE STOMACH

- ✓ Another round of propulsion then occurs, moving the food particles back down into the antrum. If the food particles are still too large to pass through the pyloric sphincter, retropulsion occurs again as the particles are squeezed back into the body of the stomach. Then yet another round of propulsion occurs, and the cycle continues to repeat.
- ✓ The net result of these movements is that gastric contents are mixed with gastric juice, eventually becoming reduced to a soupy liquid called chyme. Once the food particles in chyme are small enough, they can pass through the pyloric sphincter, a phenomenon known as gastric emptying. Gastric emptying is a slow process: only about 3 mL of chyme moves through the pyloric sphincter at a time.

ال pyloric sphincter صمام موجود بين ال stomach وال small intestine له diameter معين فلما يسير digestion للدهون والبروتينات ما بتتكسر

لقطع بحجم يتناسب مع انها تمر من ال diameter لل pyloric sphincter فبترجع للمعدة وبتضل تكسرها حتى توصل لحجم مناسب انه يطلع من pyloric sphincter وتروح لل small intestine .

عند دخول الغذاء الى المعدة ما يبصير digestion مباشرة اول شي يتم تخزين الغذاء بمكان يسمى fundus يخزن هناك لا يقل عن ساعه . نزول الغذاء يبدأ حسب نوعه (دهون ، بروتينات ، كربوهيدرات) اسهل شي الكربوهيدرات (تتكسر اسرع) ثم البروتين واخر شي الدهون (يحتاج الى وقت اقل هو كربوهيدرات) (وقت متوسط البروتين) (وقت اطول الدهون) يلي مدة وجوده في ال fundus بطول اكثر شي هو الدهون اقل شي هو الكربوهيدرات.



شي مهم بالامتحان (الحركات يلي بتصير بكل جزء من GI)

الحركة العامة لكل أجزاء ال GI اسمها (particles) (general movement) (بكل ال GI) وهذه الحركة لها specific nerves بكل organ بال stomach و small intestine و large intestine بال stomach بتطلع من ال fundus فيه منطقه اسمها cardia بتبدأ تدخل بال Body حركتها عبر ال stomach تسمى (propulsion) اذا حجمها مناسب بتطلع اسم الحركة يلي بتطلع منه من ال pyloric sphincter تسمى (gastric emptying) بنحكيها gastric emptying rate يعني بتطلع بمعدل سرعه معينه الي ما بيطلع لانه حجمه مش مناسب بيرجع رجوع ويسمى (retropulsion) .

اذا حركة الاكل من ال fundus عبر ال stomach حتى يوصل لل pyloric sphincter تسمى (propulsion) .

اذا فتح هذا الصمام والحجم مناسب وطلع الاكل اسم الحركة (gastric emptying) . يلي حجمه مش مناسب بيرجع حركته تسمى (retropulsion) .

MECHANICAL AND CHEMICAL DIGESTION IN THE STOMACH

Foods may remain in the fundus for about an hour without becoming mixed with gastric juice. During this time, digestion by salivary amylase from the salivary glands continues. Soon, however, the churning action mixes chyme with acidic gastric juice, inactivating salivary amylase and activating lingual lipase.

ال stomach مي mixing churning (يعني بخلط الاكل فالاكل المخلوط يسمى chyme) عشان هيك يسمى mixing churning انه هو يعمل mixing holding reserves لانه بيخزن الاكل في ال fundus ما بيطلع الا بعد وقت معين

Figure 24.13 Secretion of HCl (hydrochloric acid) by parietal cells in the stomach.

Proton pumps, powered by ATP, secrete the H^+ ; Cl^- diffuse into the stomach lumen through Cl^- channels.

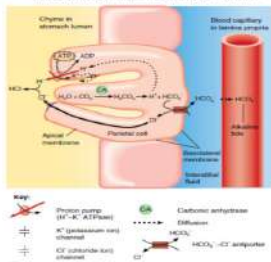
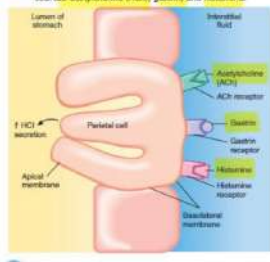


Figure 24.14 Regulation of HCl secretion.

HCl secretion by parietal cells can be stimulated by several sources: acetylcholine (ACh), gastrin, and histamine.



معلومه كثير مهمه في الفارما : (الهرمونات يلي بتأثر على parietal cells حتى تعمل على إفراز HCl).
 يلي بحفز على افراز ال HCl عند ارتباط ACh مع مستقبله او ال gastrin يرتبط مع مستقبله او الهستامين يرتبط مع المستقبل بدخل على ال parietal cell بحفزها انها تخرج H+ فيبطلع عن طريق pump بيطلع كل ال H+.

REGULATION OF HCL SECRETION

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

1. **Acetylcholine (ACh)** is released by parasympathetic neurons.
2. **Gastrin** secreted by G cells.
3. **Histamine**, which is a paracrine substance released by mast cells in the nearby lamina propria.

❖ Acetylcholine and gastrin stimulate parietal cells to secrete more HCl in the presence of histamine. In other words, histamine acts synergistically, enhancing the effects of acetylcholine and gastrin. Receptors for all three substances are present in the plasma membrane of parietal cells.

REGULATION OF HCL SECRETION

- The strongly acidic fluid of the stomach kills many microbes in food.
- HCl partially denatures (unfolds) proteins in food and stimulates the secretion of hormones that promote the flow of bile and pancreatic juice.
- **Enzymatic digestion of proteins also begins in the stomach.**
- **The only proteolytic (protein-digesting) enzyme in the stomach is pepsin, which is secreted by chief cells.**
- Pepsin severs certain peptide bonds between amino acids, breaking down a protein chain of many amino acids into smaller peptide fragments.
- **Pepsin is most effective in the very acidic environment of the stomach (pH 2); it becomes inactive at a higher pH.**

WHAT KEEPS PEPSIN FROM DIGESTING THE PROTEIN IN STOMACH CELLS ALONG WITH THE FOOD?

- ❖ **First, pepsin is secreted in an inactive form called pepsinogen; in this form, it cannot digest the proteins in the chief cells that produce it.**
- ❖ **Pepsinogen is not converted into active pepsin until it comes in contact with hydrochloric acid secreted by parietal cells or active pepsin molecules.**
- ❖ **Second, 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.**

REGULATION OF HCL SECRETION

- Another enzyme of the stomach is **gastric lipase**, which splits triglycerides (fats and oils) in fat molecules (such as those found in milk) into fatty acids and monoglycerides.
- This enzyme, which has a limited role in the adult stomach, operates best at a pH of 5–6. More important than either **lingual lipase** or **gastric lipase** is **pancreatic lipase**, an enzyme secreted by the pancreas into the small intestine.
- Within 2 to 4 hours after eating a meal, the stomach has emptied its contents into the duodenum. Foods rich in carbohydrates spend the least time in the stomach; high-protein foods remain somewhat longer, and emptying is slowest after a fat-laden meal containing large amounts of triglycerides.

gastric lipase يعمل على تكسير الدهون زي ال
lingual lipase (لانه ما بيصير active الا اذا وصل لل
(stomach

في المعدة فيه انزيمات اخرى بيعملوا على تكسير
البروتينات والكربوهيدرات والدهون.
الدهون والبروتينات تكسيرهم يبدأ من ال stomach.
الاكل بضل من ساعتين الى ٤ ساعات حتى يصير له
digestion.

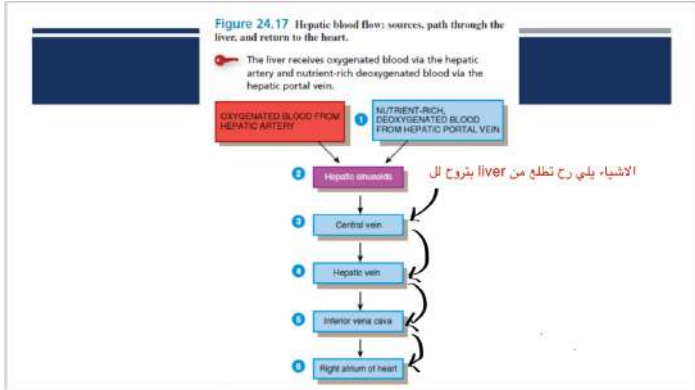
PANCREAS

From the stomach, chyme passes into the small intestine. Because chemical digestion in the small intestine depends on activities of the pancreas, liver, and gallbladder, we first consider the activities of these accessory digestive organs and their contributions to digestion in the small intestine.

(pancreas, gallbladder, liver) هذول بيساعدوا
ال small intestine فال stomach لما تخرج الاكل
بتروح عن طريق duct لل liver وال pancreas وال
gallbladder بعدين كل هاي يلي من ال duct بتطلع
وبتتجمع وبتروح لل small intestine اول جزء من ال
small intestine هو ال duodenum.
مهم نعرف عن ال pancreas شغلتين (بتعمل على
افراز شغلتين):

- ١- pancreatic lipase (يعمل على تكسير ال lipid)
- ٢- تعمل على افراز انزيم يكسر البروتين (وهو عكس ال
pepsinogen ما بيشتغل الا ب ~~acidic~~ pH اسمه
trypsinogen) .

Basic



hepatic oxygenated blood ال  عن طريق
 artery ويوصل ال deoxygenated blood عن طريق
 hepatic portal vein هذول بيصبوا بالخلايا يلي بتكون
 sinusoids ال liver ال liver مقسم على شكل
 فهذا ال artery (يحمل دم مؤكسد) وال vein (يحمل
 دم غير مؤكسد) بيصبوا بال liver وال oxygenated
 blood بتأخذها الخلايا التي تسمى بال hepatocytes
 عشان تقوم بوظائفها وتعمل على افراز البروتين وعوامل
 التخثر (clotting factor) فهي بحاجة الى دم مؤكسد
 حتى تقوم بوظائفها الطبيعیه وبنفس الوقت بيوصلها دم
 غير مؤكسد حتى تعمل detoxification.

FUNCTIONS OF THE LIVER AND GALLBLADDER

- Each day, hepatocytes secrete 800–1000 ml (about 1 qt) of bile, a yellow, brownish, or olive-green liquid. It has a pH of 7.6–8.6 and 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.
- Bile is partially an excretory product and partially a digestive secretion.
- Bile salts, which are sodium salts and potassium salts of bile acids play a role in emulsification, the breakdown of large lipid globules into a suspension of small lipid globules.
- The small lipid globules present a very large surface area that allows pancreatic lipase to more rapidly accomplish digestion of triglycerides. Bile salts also aid in the absorption of lipids following their digestion.

(liver) 

2Type of cells 

١- hepatocytes بتعمل على افراز الماده الصفراوية
 (bile) لما تخلص عملية الهضم تتخزن في ال
 gallbladder وايضا تعمل على افراز cholesterol و
 bile salts.
 ٢- kupffer cells بتعمل بلعمه لل aged red blood
 cell وال aged red blood cell بتعطينا (iron ,
 bilirubin , globin) ال bilirubin يكمل مساره لل
 small intestine لل large intestine بوصل للأمعاء
 الغليظة عندها بكون فيه بكتيريا وهذه البكتيريا بتحول ال
 bilirubin الى ماده هذه الماده هي التي تعطي للفضلات
 اللون البني .

 من مكونات ال bile هو ال cholesterol.

 الجزء المسؤول عن افراز ال cholesterol هو ال
 liver .

 ال cholesterol بصير له metabolism بال liver
 بيعطينا bile salts (أملاح موجودة بالمادة الصفراوية) .

 يوجد ايضا في ال bile ال red blood cell لما تصير
 aged (لما يقرب عمرها الى 120 يوم) لازم يصير لها
 بلعمه (phagocytes) وتتكسر الي بيكسرهما هي خلايا
 ال liver الاولى (خلايا ال liver الثانيه اسمها kupffer

cells) بالتالي يوجد نوعين من الخلايا الاولى فيها cholesterol و bile salt والثانية يلي رح تحطم ال aged red blood cell لما يتحطم ال aged red blood cell بتعطي (iron , globin , bilirubin) (ال iron , globin بيرجعوا لل circulation ال bilirubin ال blood cell بيرجعوا عن طريق ال duct لل small intestine ال large intestine ال large intestine فيها بكتيريا بتحول ال bilirubin الى مركب اسمه stercobilin) وهو بيعطي للفضلات اللون البني .

🕊 ال bile salt الناتج من ال cholesterol بيعمل شغلين :

١- يساعد ال lipase يلي حكيما عنهم (pancreatic lipase) على انه يكسر ال triglycerides او ال fatty acid (lipid) .

٢- يساعد على absorption ال triglycerides .

FUNCTIONS OF THE LIVER AND GALLBLADDER

➤ 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. The sphincter surrounds the **hepatopancreatic ampulla**.

مكان يكون يأخر ال duct . (بعد انتهاء الهضم تغلق فال bile بيرجع ويخزن في ال gallbladder) .
🕊 ال gallbladder مهمته فقط يخزن ال bile

FUNCTIONS OF THE LIVER AND GALLBLADDER

➤ In addition to secreting bile, which is needed for absorption of dietary fats, **the liver performs many other vital functions.**

وظائف ال liver

1. **Carbohydrate metabolism:** The liver is especially important in maintaining a normal blood glucose level. When blood glucose is low, the liver can break down glycogen to glucose and release the glucose into the bloodstream. When blood glucose is high, as occurs just after eating a meal, the liver converts glucose to glycogen and triglycerides for storage.

2. **Lipid metabolism:** Hepatocytes store some triglycerides, synthesize cholesterol, and use cholesterol to make bile salts. lipid ال absorption على ال hepatocytes بتساعد

3. **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. Hepatocytes also synthesize most plasma proteins, such as alpha and beta globulins, albumin, prothrombin, and fibrinogen.

Clotting factor

والدم هو hydrophilic لغرض انه فيه مبرمون او شقه رح تنقل عن طريق ال blood بس هي hydrophobic تنقل عن طريق البروتينات (transport protein) اولا. منهم ال albumin ال albumin يتم انتاجه في ال liver وايضا يتم انتاج عوامل التشنج يلي بتساعد على توقف النزيف

🕊 مهم في الامتحان ال glycogen بيختلف عن ال glucagon .

FUNCTIONS OF THE LIVER AND GALLBLADDER

➤ In addition to secreting bile, which is needed for absorption of dietary fats, **the liver performs many other vital functions.**

4. **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.

5. **Excretion of bilirubin:** As previously noted, bilirubin, derived from the heme of aged red blood cells, is absorbed by the liver. Most of the bilirubin in bile is metabolized in the small intestine by bacteria and eliminated in feces.

6. **Synthesis of bile salts:** Bile salts are used in the small intestine for the emulsification and absorption of lipids.

FUNCTIONS OF THE LIVER AND GALLBLADDER

- In addition to secreting bile, which is needed for absorption of dietary fats, **the liver performs many other vital functions.**
- 7. **Storage:** In addition to glycogen, **the liver is a prime storage site for certain vitamins (A, B12, D, E, and K) and minerals (iron and copper),** which are released from the liver when needed elsewhere in the body.
- 8. **Phagocytosis:** The stellate reticuloendothelial (**Kupffer**) cells of the liver phagocytize aged red blood cells, white blood cells, and some bacteria.
- 9. **Activation of vitamin D:** The skin, liver, and kidneys participate in synthesizing the active form of vitamin D.

SMALL INTESTINE

- Most digestion and absorption of nutrients occur in a long tube called the small intestine.
- ❖ Its length alone provides a large surface area for digestion and absorption, and that area is further increased by circular folds, villi, and microvilli.

معظم ال absorption بصير بال small intestine 
ليش؟! لانه عنده large surface area و عليه شعيرات
اسمها villi او microvilli .

ROLE OF INTESTINAL JUICE AND BRUSH-BORDER ENZYMES

- About 1–2 liters of intestinal juice, a clear yellow fluid, is secreted each day. Intestinal juice contains water and mucus and is slightly alkaline (pH 7.6).
- **The alkaline pH of intestinal juice is due to its high concentration of bicarbonate ions.**
- **The absorptive cells of the small intestine synthesize several digestive enzymes, called brush-border enzymes, and insert them in the plasma membrane of the microvilli.** 

انزيمات بكونوا موجودين على الشعيرات الموجودة 
في ال small intestine .

ROLE OF INTESTINAL JUICE AND BRUSH-BORDER ENZYMES

- Thus, some enzymatic digestion occurs at the surface of the absorptive cells that line the villi, rather than in the lumen exclusively, as occurs in other parts of the GI tract. **Among the brush-border enzymes are four carbohydrate-digesting enzymes called α -dextrinase, maltase, sucrase, and lactase; protein-digesting enzymes called peptidases (aminopeptidase and dipeptidase); and two types of nucleotide-digesting enzymes, nucleosidases and phosphatases.**

بتكسر
الكربوهيدرات

بتكسر الزائد من ال nucleotide
brush border enzyme

انزيمات بتكسر البروتين

MECHANICAL DIGESTION IN THE SMALL INTESTINE

- The two types of movements of the small intestine – segmentations and a type of peristalsis called migrating motility complexes – are governed mainly by the myenteric plexus.

حركته على طول ال small intestine

- Segmentations are localized, mixing contractions that occur in portions of intestine distended by a large volume of chyme. Segmentations 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.

حركاتين بتصير بال small intestine:

- ١- segmentation : ال secretions وصلت لل pancreas وال liver وال gallbladder وراحت على ال small intestine بتختلط مع الاكل (عملية اختلاطهم) كل الافرازات من ال liver وال gallbladder وال pancreas مع الاكل (داخل ال small intestine تسمى segmentation).

MECHANICAL DIGESTION IN THE SMALL INTESTINE

- Segmentations occur most rapidly in the duodenum, about 12 times per minute, and progressively slow to about 8 times per minute in the ileum.
- After most of a meal has been absorbed, which lessens distension of the wall of the small intestine, segmentation stops and peristalsis begins.
- The type of peristalsis that occurs in the small intestine, termed a migrating motility complex (MMC), begins in the lower portion of the stomach and pushes chyme forward along a short stretch of small intestine before dying out.
- The MMC slowly migrates down the small intestine, reaching the end of the ileum in 90–120 minutes. Then another MMC begins in the stomach. Altogether, chyme remains in the small intestine for 3–5 hours.

ال time هون مش مطلوب
بالاستعانة

CHEMICAL DIGESTION IN THE SMALL INTESTINE

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

ABSORPTION IN THE SMALL INTESTINE

- ❑ All of the chemical and mechanical phases of digestion from the mouth through the small intestine are directed toward changing food into forms that can pass through the absorptive epithelial cells lining the mucosa and into the underlying blood and lymphatic vessels.
- ❑ These forms are monosaccharides (glucose, fructose, and galactose) from carbohydrates; single amino acids, dipeptides, and tripeptides from proteins; and fatty acids, glycerol, and monoglycerides from triglycerides.
- ❑ Passage of these digested nutrients from the gastrointestinal tract into the blood or lymph is called absorption.

في هذول السلايدات تلخيص للحكي يلي قبل :

انه ال digestion للكربوهيدرات يبدأ في ال mouth عن طريق salivary amylase .

بعدين ببلش ال digestion لل lipid عن طريق lingual lipase و gastric lipase و pancreatic lipase .

ال digestion للبروتين عن طريق pepsinogen ويتحول الى pepsin عن طريق acidic pH وال trypsinogen يتحول الى trypsin عن طريق basic pH عن طريق الانزيمات يلي بتكون بال small intestine .

ومهم نعرف انه ٩٠٪ من ال digestion بصير في ال stomach (digestion) و ١٠٪ بصير في ال small and large intestines .

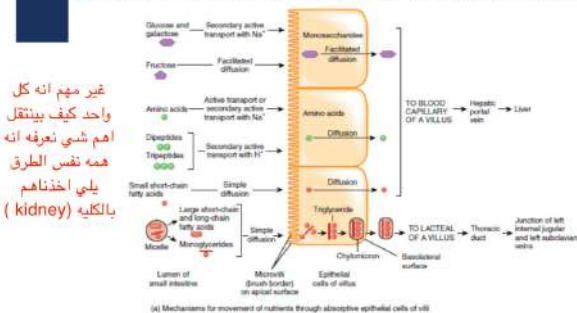
ال absorption ٩٠٪ بصير في ال small intestine و ١٠٪ بصير بال stomach و ال large intestine .

ABSORPTION IN THE SMALL INTESTINE

- 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.**
- **Any undigested or unabsorbed material left in the small intestine passes on to the large intestine.**

Figure 24.21 Absorption of digested nutrients in the small intestine. For simplicity, all digested foods are shown in the lumen of the small intestine, even though some nutrients are digested by brush-border enzymes.

Long-chain fatty acids and monoglycerides are absorbed into lacteals; other products of digestion enter blood capillaries.



غير مهم انه كل واحد كيف بيتنقل اهم شي نعرفه انه همه نفس الطرق يلي اخذناهم بالكليه (kidney)

LARGE INTESTINE

- The large intestine is **the terminal portion of the GI tract.**
- The overall functions of the large intestine are the **completion of absorption, the production of certain vitamins, the formation of feces, and the expulsion of feces from the body.**

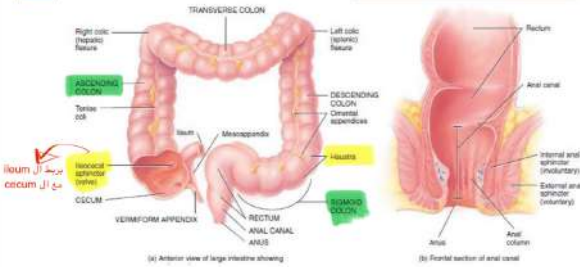
ال large intestine: بتكمل ال absorption وال digestion يلي ما كمل وبتتخلص من الفضلات وبتخزن بعض انواع ال vitamins وبعض انواع ال minerals .

Figure 24.23 Anatomy of the large intestine.

The regions of the large intestine are the cecum, colon, rectum, and anal canal.

FUNCTIONS OF THE LARGE INTESTINE

1. Haustral churning, peristalsis, and mass peristalsis drive contents of chyme into rectum.
2. Absorption of some water, salts, and vitamins.
3. Bacteria in large intestine convert proteins to amino acids, break down amino acids, and produce some B vitamins and vitamin K.
4. Formation of feces.
5. Defecation (emptying rectum).



ال Haustra زي دوائر بكل وحده فيهم بصير زي

mixing حتى تتعبى بس تتعبى بصير contraction لل

smooth muscles عمليه التعبئة هذه تسمى

Haustral churning عشان تعمل contraction وتطلع

لل Haustra الثانيه .

ال Haustral churning بتضل مستمره من ال

ascending colon الى sigmoid colon.

MECHANICAL DIGESTION IN THE LARGE INTESTINE

- Movements of the colon begin when substances pass the ileocecal sphincter.
- Because chyme moves through the small intestine at a fairly constant rate, the time required for a meal to pass into the colon is determined by gastric emptying time.
- As food passes through the ileocecal sphincter, it fills the cecum and accumulates in the ascending colon.
- One movement characteristic of the large intestine is haustral churning. In this process, 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.
- Peristalsis also occurs, although at a slower rate (3–12 contractions per minute) than in more proximal portions of the tract.

Haustral churning



- Each segment in large intestine is called a haustra
- Smooth muscle contractions move contents along (type of peristalsis)
- Water is absorbed in large intestine

MECHANICAL DIGESTION IN THE LARGE INTESTINE

- A final type of movement is mass peristalsis, a strong peristaltic wave that begins at about the middle of the transverse colon and quickly drives the contents of the colon into the rectum.

حركاتها من ال transverse colon الى اخر ال large intestine

- Because food in the stomach initiates this gastrocolic reflex in the colon, 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 occurs in the colon through the activity of bacteria that inhabit the lumen. Mucus is secreted by the glands of the large intestine, but no enzymes are secreted.
- ❑ Chyme is prepared for elimination by the action of bacteria, which 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.
- ❑ Bacteria also convert any remaining proteins to amino acids and break down the amino acids into simpler substances: indole, skatole, hydrogen sulfide, and fatty acids.
- ❑ Bacteria also 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.

ثاني معلومه بعد الحركات مهم نعرفها عن ال large intestine هي البكتيريا انه فيها بكتيريا بتحول ال bilirubin لماده بتعطي اللون البني ولكن هذه البكتيريا بتعمل fermentation لاي شي بزيد مثل الكربوهيدرات وال remaining proteins.

ABSORPTION AND FECES FORMATION IN THE LARGE INTESTINE

- ❑ By the time chyme has remained in the large intestine 3–10 hours, it has become solid or semisolid because of water absorption and is now called feces.
- ❑ 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.
- ❑ Although 90% of all water absorption occurs in the small intestine, the large intestine absorbs enough to make it an important organ in maintaining the body's water balance.
- ❑ The large intestine also absorbs ions, including sodium and chloride, and some vitamins.

فيه cells بال large intestine تسمى absorptive cells هاي بتعمل على امتصاص الماء عشان هيك الفضلات المفروض انها تطلع solid او semisolid (صلبه) ليش؟! لانه هناك بال large intestine بتلعب دور في ال water balance داخل الجسم لانه فيه خلايا مسؤوله عن امتصاص الماء وجودها ساعات طويله من (٣ الى ١٠) ساعات هو يلي بيسمح انه الفضلات بالآخر تطلع solid او semisolid .

THE DEFECATION REFLEX

- ❑ Mass peristaltic movements push fecal material from the sigmoid colon into the rectum.
- ❑ 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 defecation reflex) هاي معناها انه بصير ارتخاء بالعضلات باماكن معينه واماكن ثانيه العكس بصير contraction حسب تأثير ال sympathetic وال parasympathetic فتساعد على خروج الاكل عن طريق فتحة ال anus .

THE DEFECATION REFLEX

- ❖ 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** is an increase in the frequency, volume, and fluid content of the feces caused by increased motility of and decreased absorption by the intestines.
- ❖ **Constipation** refers to infrequent or difficult defecation caused by decreased motility of the intestines.

ال defecation reflex (عمليات الإخراج) بتختلف
من شخص لآخر ولكن الطبيعي انه يكون every day مثلا
إذا حدا عنده ال defecation بالأسبوع ٣ مرات إذا زاد
او قل بكون عنده مشكله إذا زاد عن الطبيعي ال motility
في ال small intestine زادت هذول بصير عندهم
diarrhea (اسهال) ولكن إذا قل عن المستوى الطبيعي
فبصير عندهم constipation (امساك) فبقل عندهم ال
motility.