PENGANTAR SISTEM PENCERNAAN

Dr. Hanna Cakrawati

Laboratorium FK UMM

SISTEM PENCERNAAN

Introduction

1. The breaking down of larger food molecules into smaller molecules is called digestion.
2. The organs involved in the breakdown of food are collectively known as the digestive system.

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 propulsion 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.

5. Mechanical digestion consists of mastication and movements of the gastrointestinal tract that aid chemical digestion.
6. Chemical digestion is a series of hydrolysis reactions that break down large carbohydrates, lipids, proteins, and nucleic acids in foods into smaller molecules that are usable by body cells.

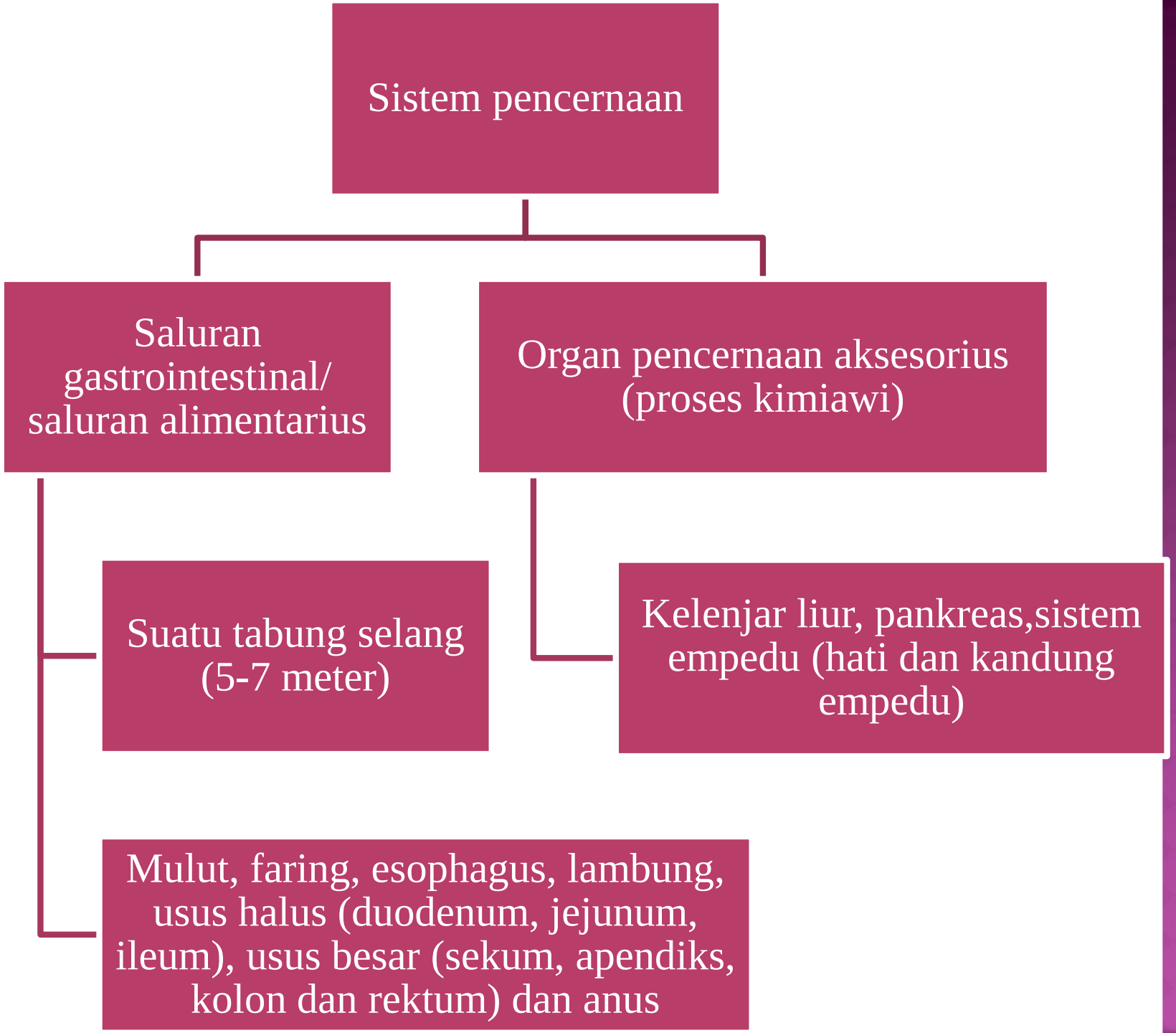
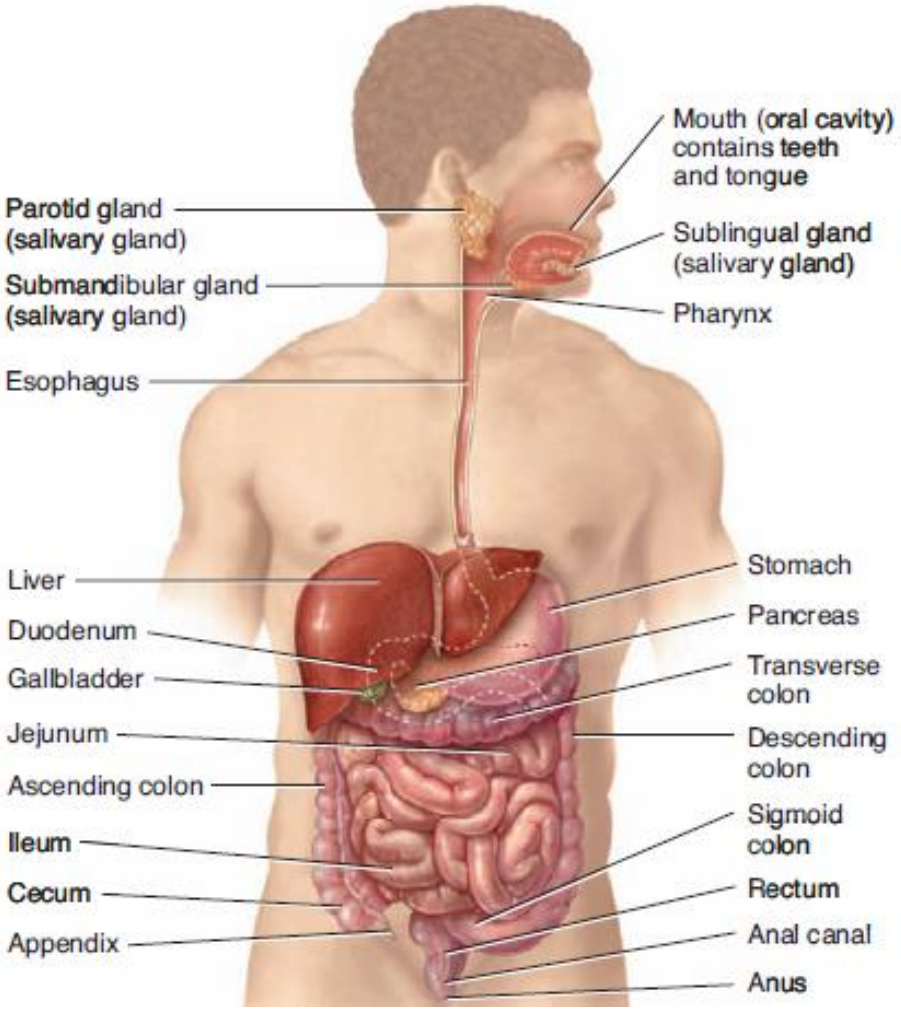

Sistem pencernaan
Saluran gastrointestinal/ saluran alimentarius
Organ pencernaan aksesorius (proses kimiawi)
Suatu tabung selang (5-7 meter)
Kelenjar liur, pankreas,sistem empedu (hati dan kandung empedu)
Mulut, faring, esophagus, lambung, usus halus (duodenum, jejunum, ileum), usus besar (sekum, apendiks, kolon dan rektum) dan anus

Figure 24.1 Organs of the digestive system.

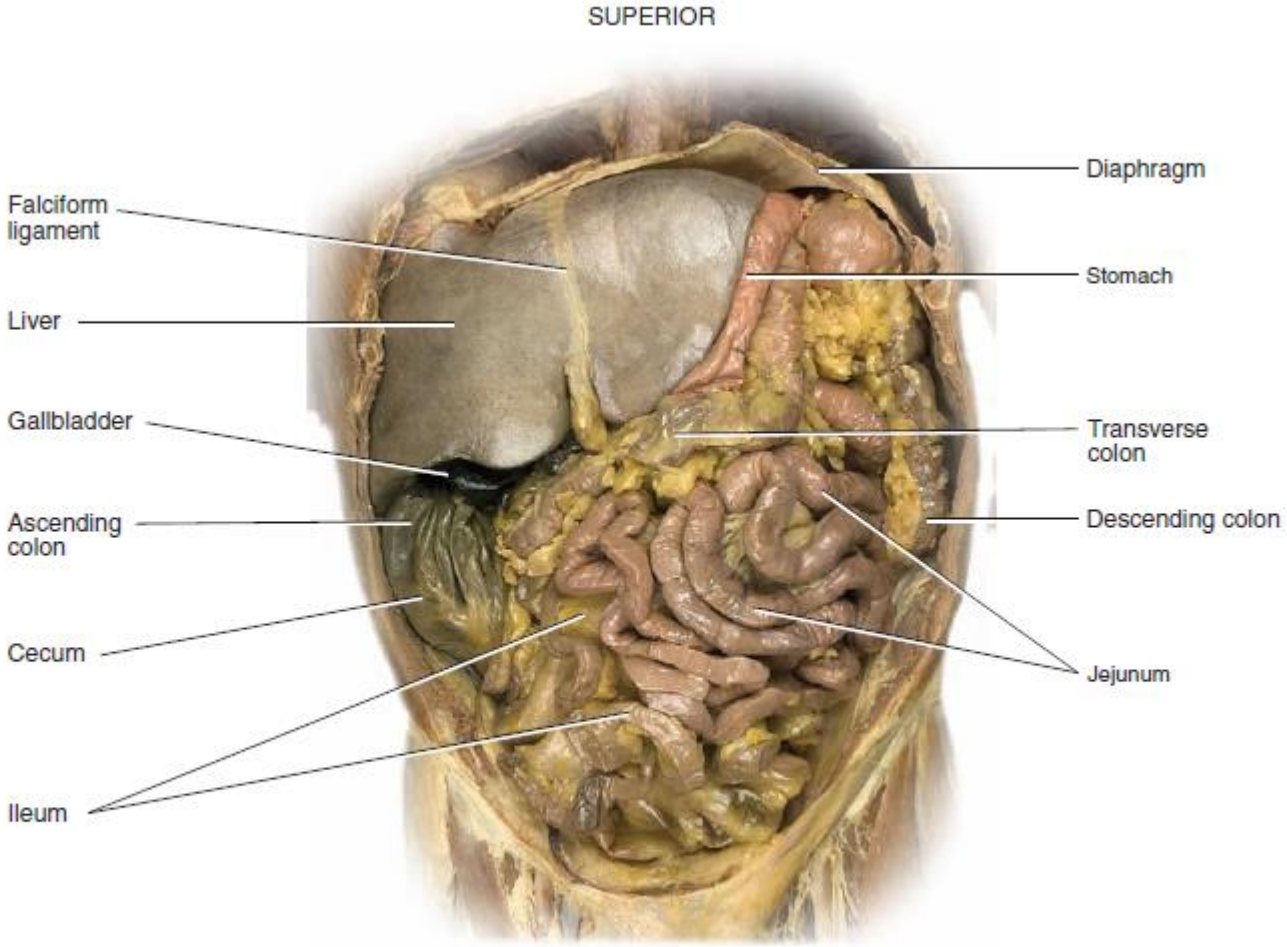
Organs of the gastrointestinal (GI) tract are the mouth, pharynx, esophagus, stomach, small intestine, and large intestine. Accessory digestive organs include the teeth, tongue, salivary glands, liver, gallbladder, and pancreas.



✔ CHECKPOINT

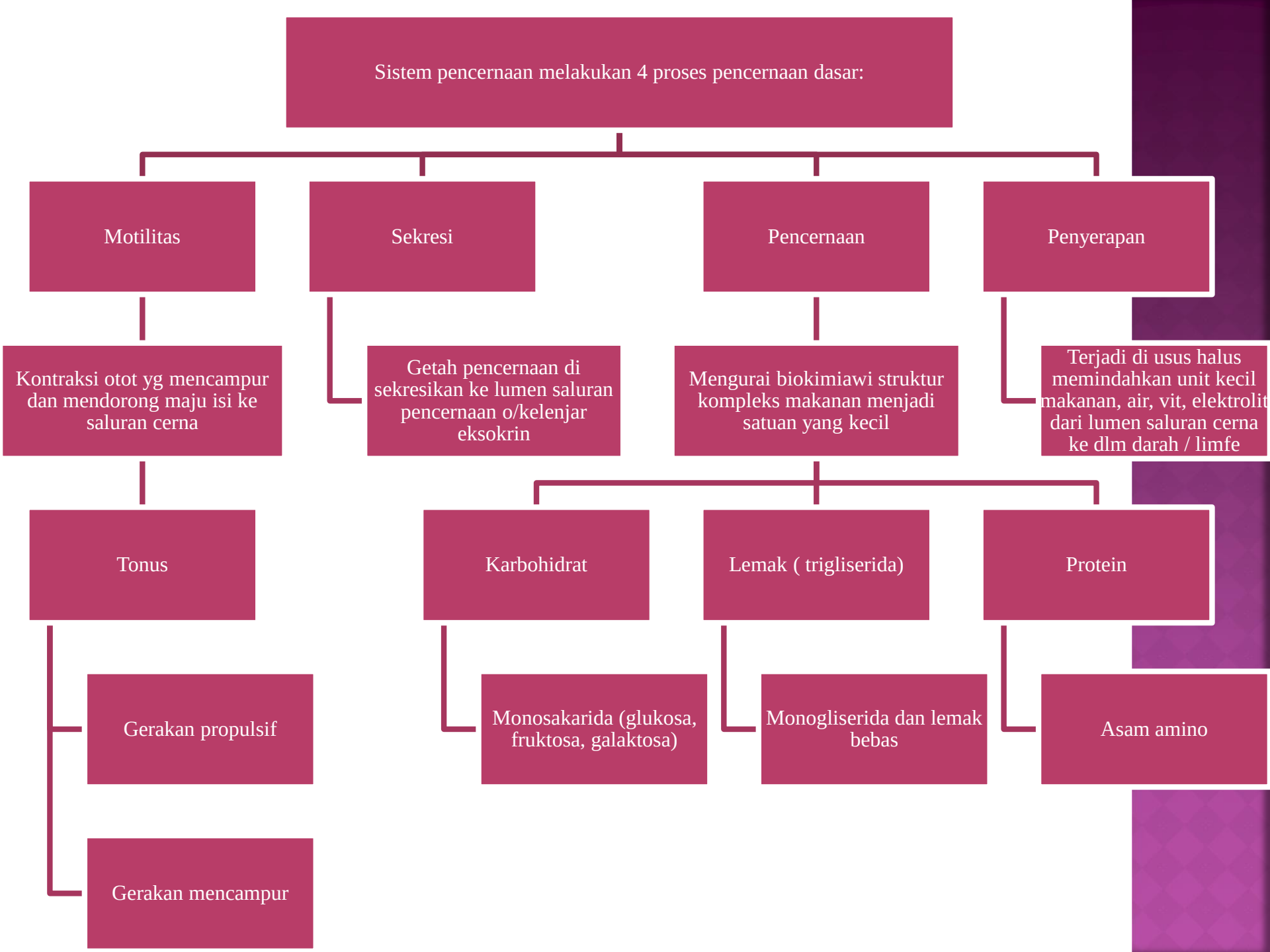
1. Which components of the digestive system are GI tract organs, and which are accessory digestive organs?
2. Which organs of the digestive system come in contact with food, and what are some of their digestive functions?
3. Which kinds of food molecules undergo chemical digestion, and which do not?

ORGAN SYSTEM PENCERNAAN

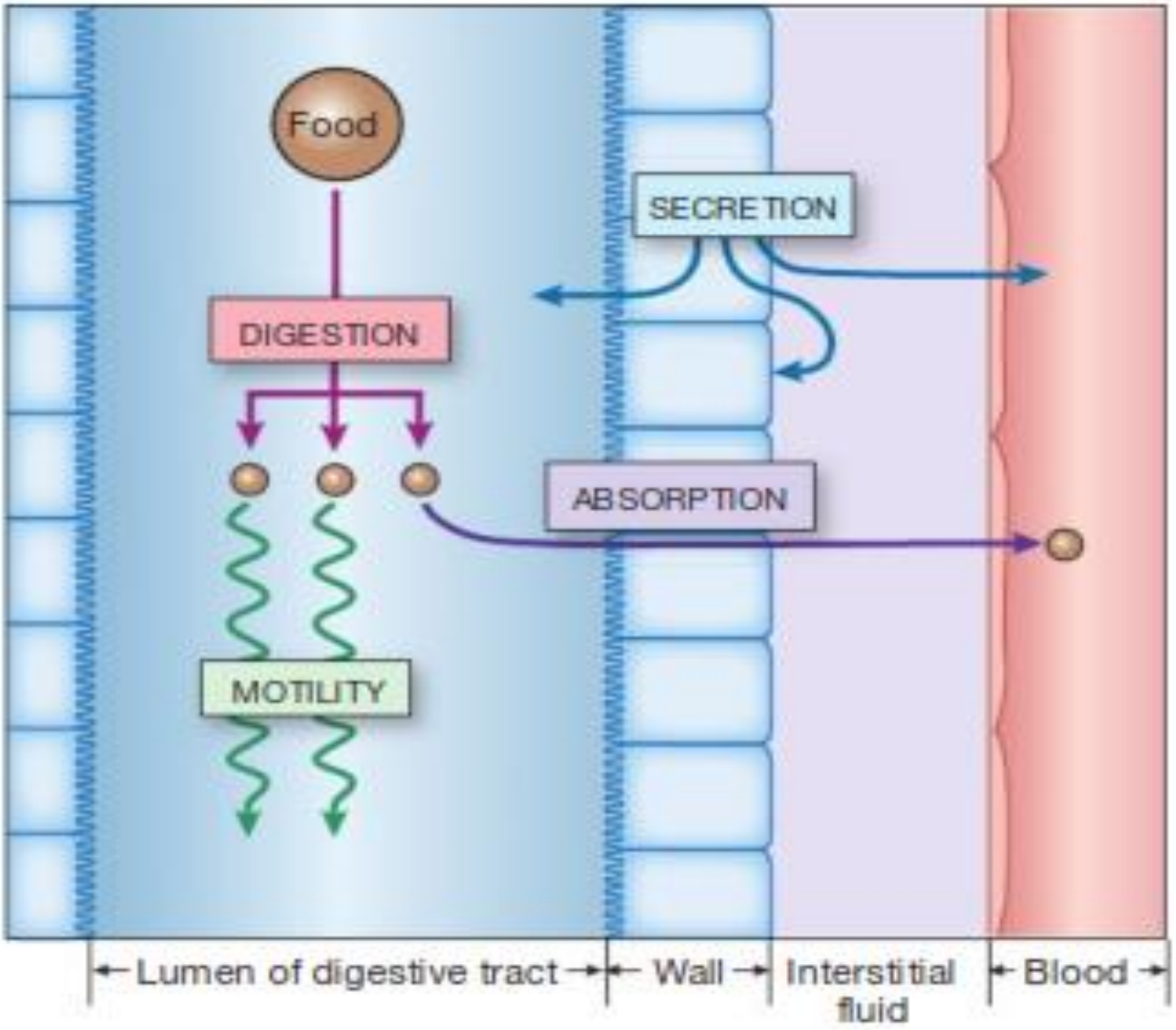


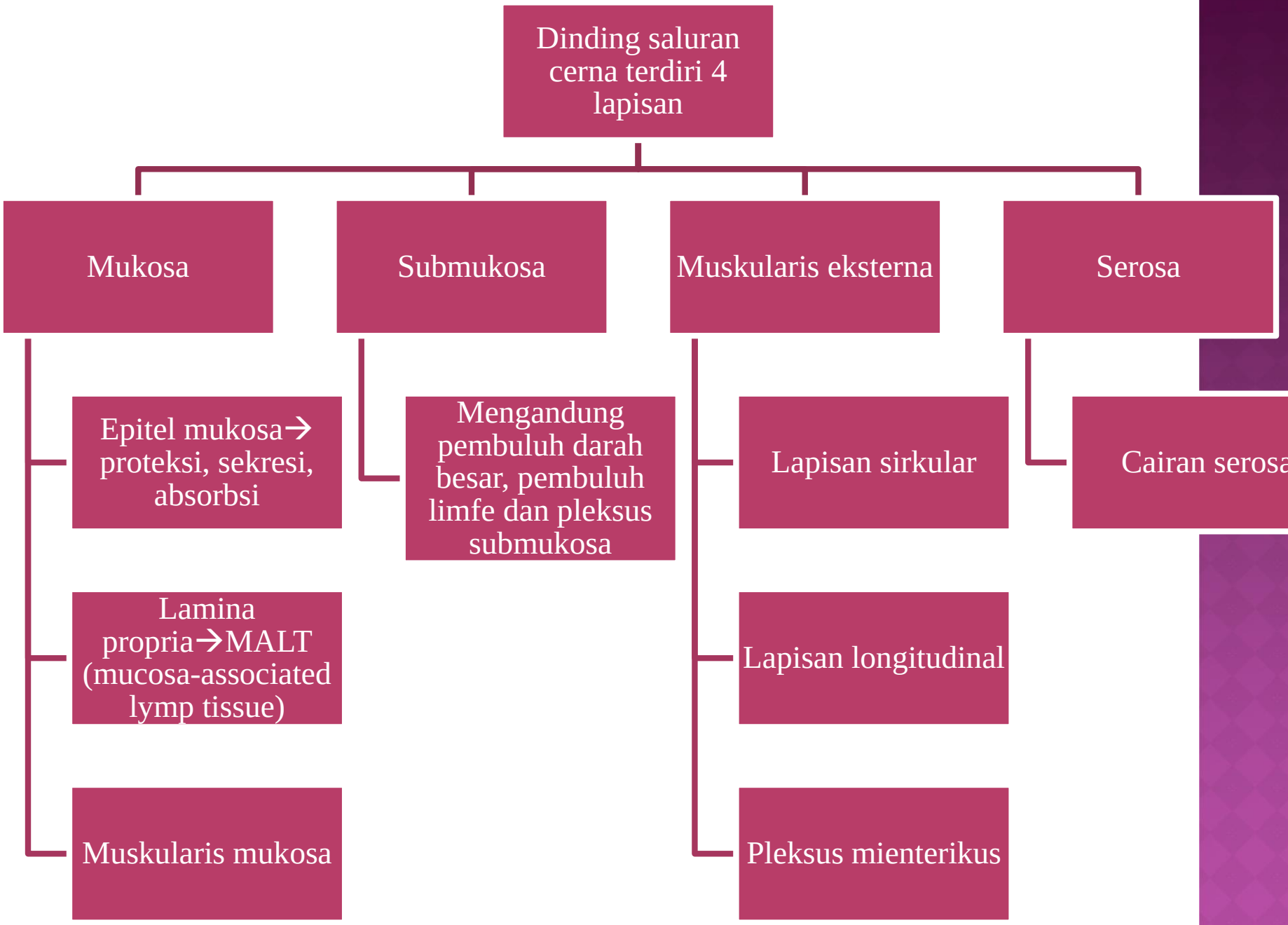
(b) Anterior view

Which structures of the digestive system secrete digestive enzymes?


Sistem pencernaan melakukan 4 proses pencernaan dasar:
Motilitas
Sekresi
Pencernaan
Penyerapan
Kontraksi otot yg mencampur dan mendorong maju isi ke saluran cerna
Getah pencernaan di sekresikan ke lumen saluran pencernaan o/kelenjar eksokrin
Mengurai biokimiawi struktur kompleks makanan menjadi satuan yang kecil
Terjadi di usus halus memindahkan unit kecil makanan, air, vit, elektrolit dari lumen saluran cerna ke dlm darah / limfe
Tonus
Karbohidrat
Lemak (trigliserida)
Protein
Gerakan propulsif
Gerakan mencampur
Monosakarida (glukosa, fruktosa, galaktosa)
Monogliserida dan lemak bebas
Asam amino

Proses dalam Sistem pencernaan :




Dinding saluran cerna terdiri 4 lapisan
Mukosa
Submukosa
Muskularis eksterna
Serosa
Epitel mukosa→ proteksi, sekresi, absorbsi
Lamina propria→MALT (mucosa-associated lymp tissue)
Muskularis mukosa
Mengandung pembuluh darah besar, pembuluh limfe dan pleksus submukosa
Lapisan sirkular
Lapisan longitudinal
Pleksus mienterikus
Cairan serosa

24.2 Layers of the GI Tract

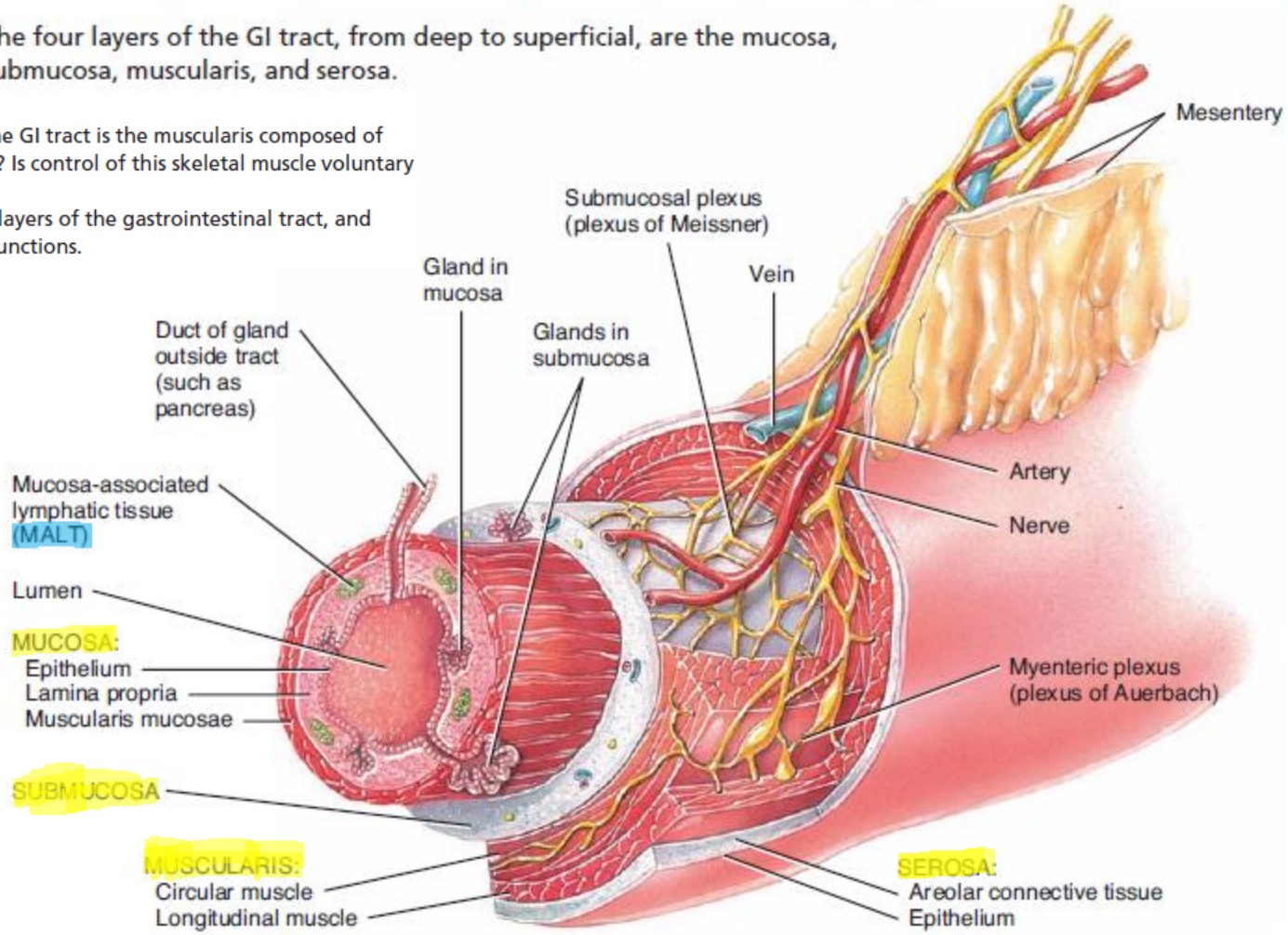
1. The basic arrangement of layers in most of the gastrointestinal tract, from deep to superficial, is the mucosa, submucosa, muscularis, and serosa.
2. Associated with the lamina propria of the mucosa are extensive patches of lymphatic tissue called mucosa-associated lymphoid tissue (MALT).

Figure 24.2 Layers of the gastrointestinal tract. Variations in this basic plan may be seen in the esophagus (Figure 24.9), stomach (Figure 24.12), small intestine (Figure 24.19), and large intestine (Figure 24.24).

The four layers of the GI tract, from deep to superficial, are the mucosa, submucosa, muscularis, and serosa.

CHECKPOINT

4. Where along the GI tract is the muscularis composed of skeletal muscle? Is control of this skeletal muscle voluntary or involuntary?
5. Name the four layers of the gastrointestinal tract, and describe their functions.



? What are the functions of the lamina propria?

PERSYARAFAN SALURAN GI

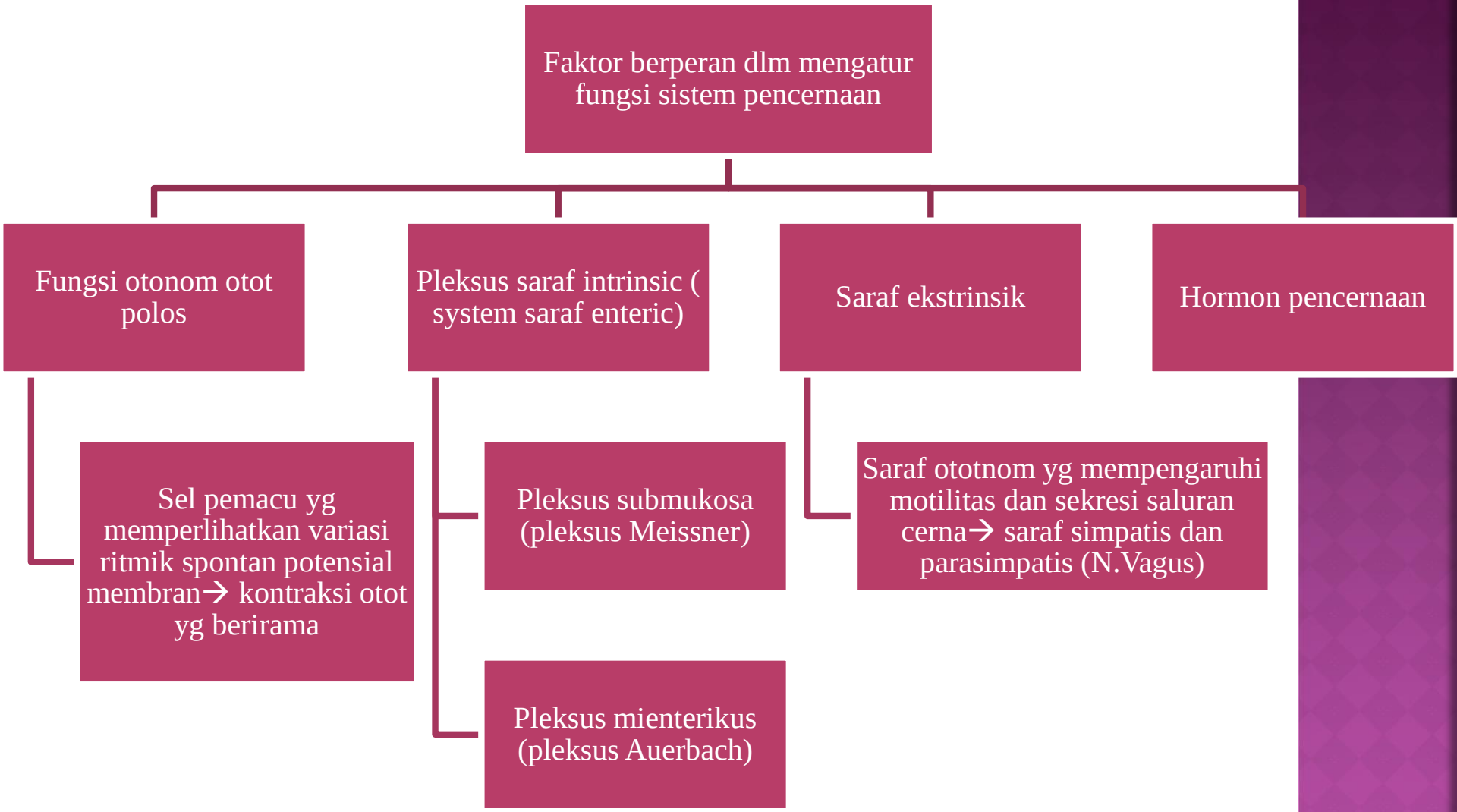
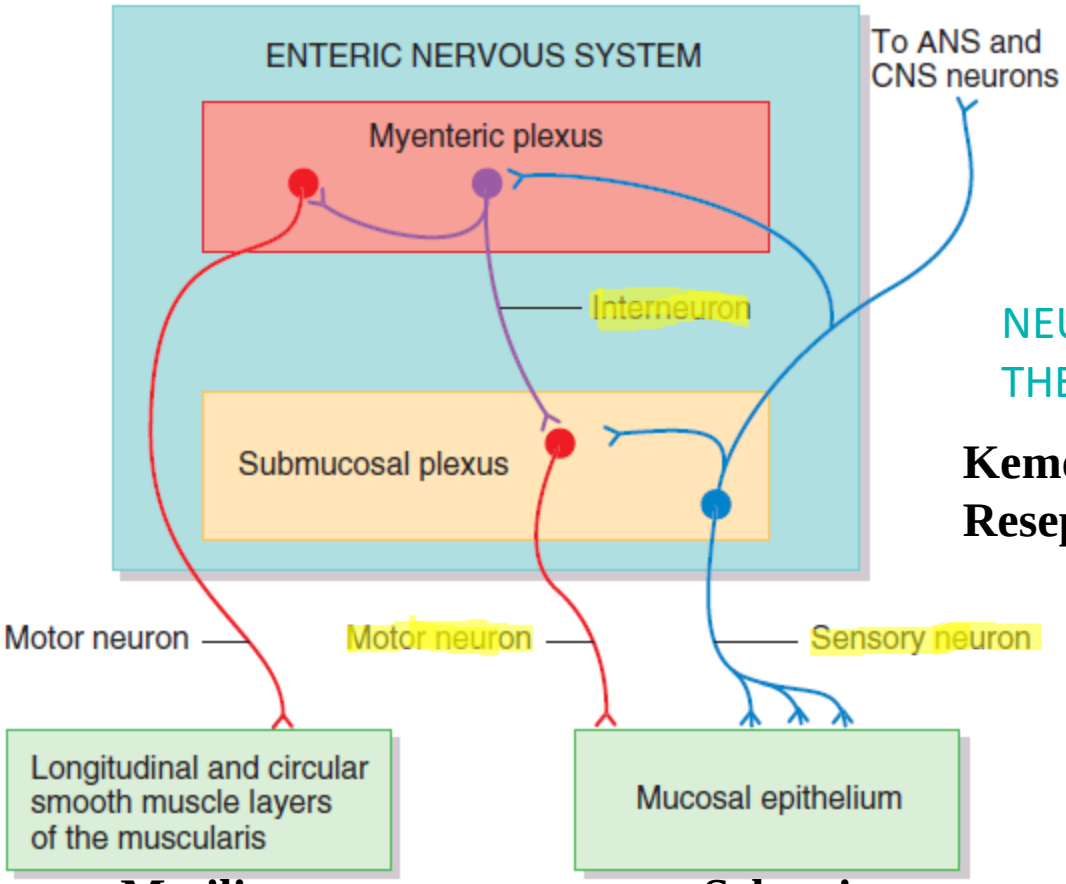


Figure 24.3 Organization of the enteric nervous system.

The enteric nervous system consists of neurons arranged into the myenteric and submucosal plexuses.



Motilitas **Sekresi**

What are the functions of the myenteric and submucosal plexuses of the enteric nervous system?

NEURAL INNERVATION OF THE GI TRACT

Kemoreseptor
Reseptor renggang

MULUT, FARING DAN ESOPHAGUS

Mulut

Pintu masuk ke saluran cerna

Gigi → mengunyah (mastikasi)

- Menggiling & memecah makanan menjadi potongan lbh kecil→ bolus
- Mencampur makanan
- Merangsang kuncup kecap (reseptor gustatorik)

Liur

- Pencernaan karbohidrat di mulut→ amylase lingual (klnjr. Parotis dan submandibular)
- Lipase lingual
- Mempermudah proses menelan
- Lisozim→ enzim yg menghancurkan bakteri tertentu
- Membantu berbicara
- Higiene mulut
- Liur kaya akan bikarbonat

FARING DAN ESOFAGUS

24.6 Pharynx

1. The pharynx is a funnel-shaped tube that extends from the internal nares to the esophagus posteriorly and to the larynx anteriorly.
2. The pharynx has both respiratory and digestive functions.

24.7 Esophagus

1. The esophagus is a collapsible, muscular tube that connects the pharynx to the stomach.
2. It contains an upper and a lower esophageal sphincter.

FARING DAN ESOFAGUS

Menelan

- Bolus didorong lidah ke belakang mulut menuju faring
- Tekanan bolus merangsang reseptor-reseptor tekanan faring
- Mengirim impuls aferen ke pusat menelan (medula batang otak)
- Pusat menelan memicu gelombang peristaltik primer pada otot polos sirkular (mendorong bolus) dan peristaltik kedua & sekresi liur (reseptor tekanan dinding dan mengirim melalui pleksus saraf intrinsik)

Tahap orofaring

- Mulut-esofagus awal (1 detik)
- Lihat gambar

Tahap esofagus

- Sfingter faringoesofagus→ mencegah udara masuk saluran cerna sewaktu bernapas
- Sfingter gastroesofagus→ mencegah refluks isi lambung

DEGLUTITION

24.8 Deglutition

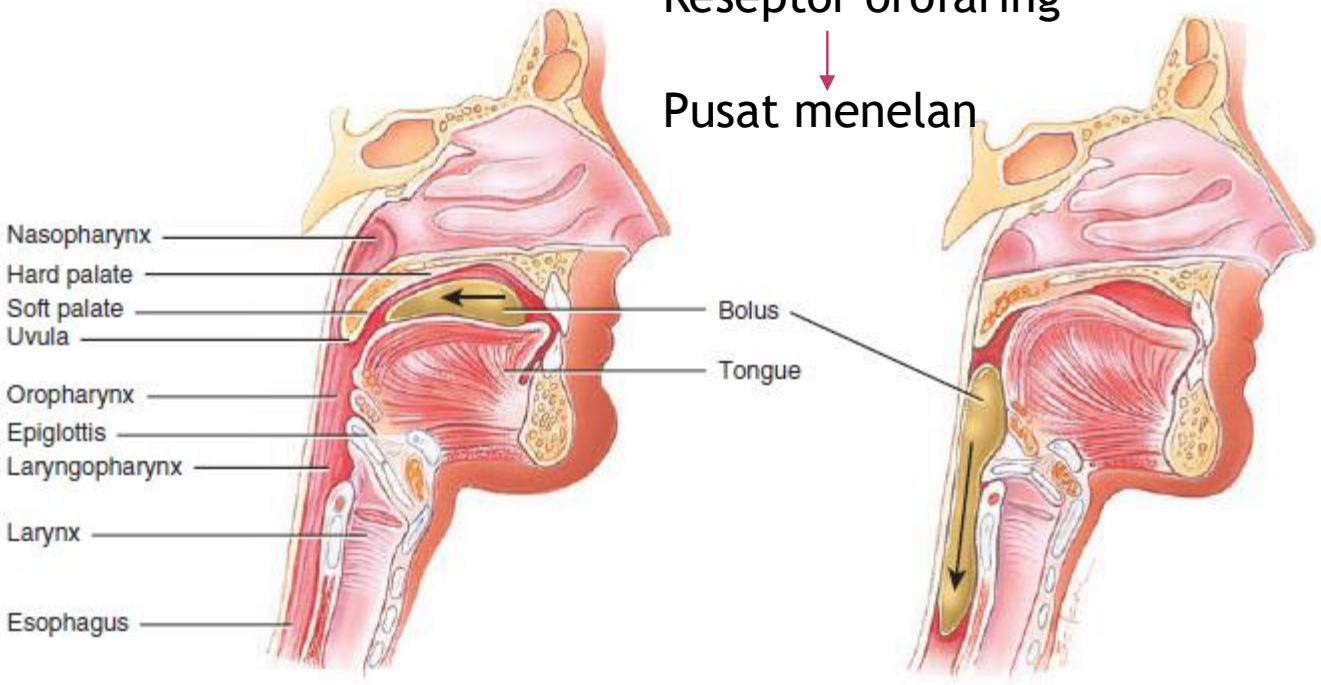
1. Deglutition, or swallowing, moves a bolus from the mouth to the stomach.
2. Swallowing consists of a voluntary stage, a pharyngeal stage (involuntary), and an esophageal stage (involuntary).

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 passed 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.

Reseptor orofaring

Pusat menelan



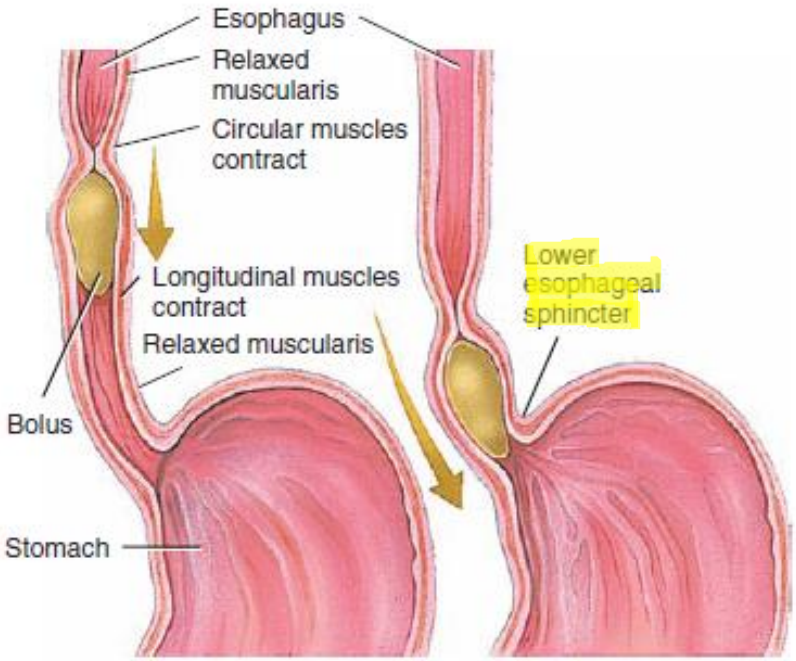
(a) Position of structures before swallowing

(b) During pharyngeal stage of swallowing

Tahap volunter

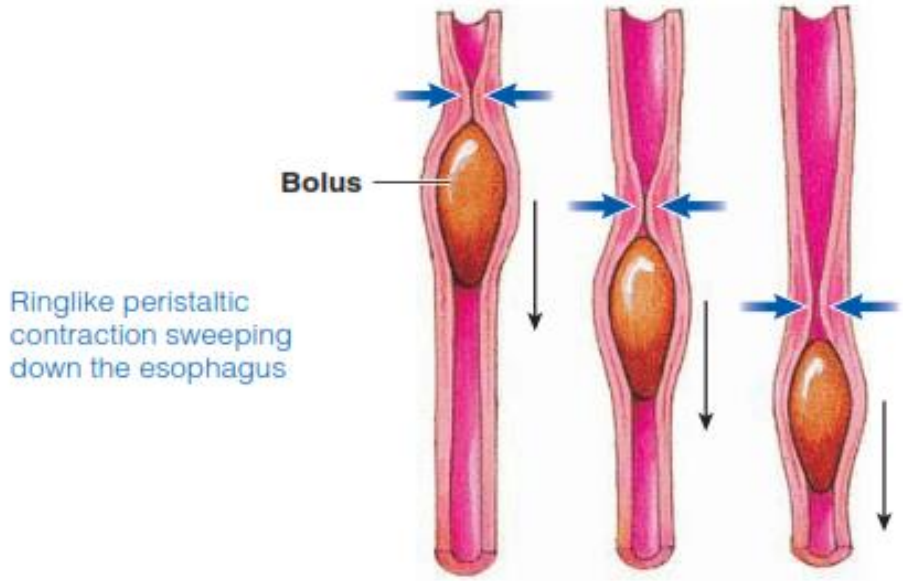
Tahap faringeal

Tahap esophageal

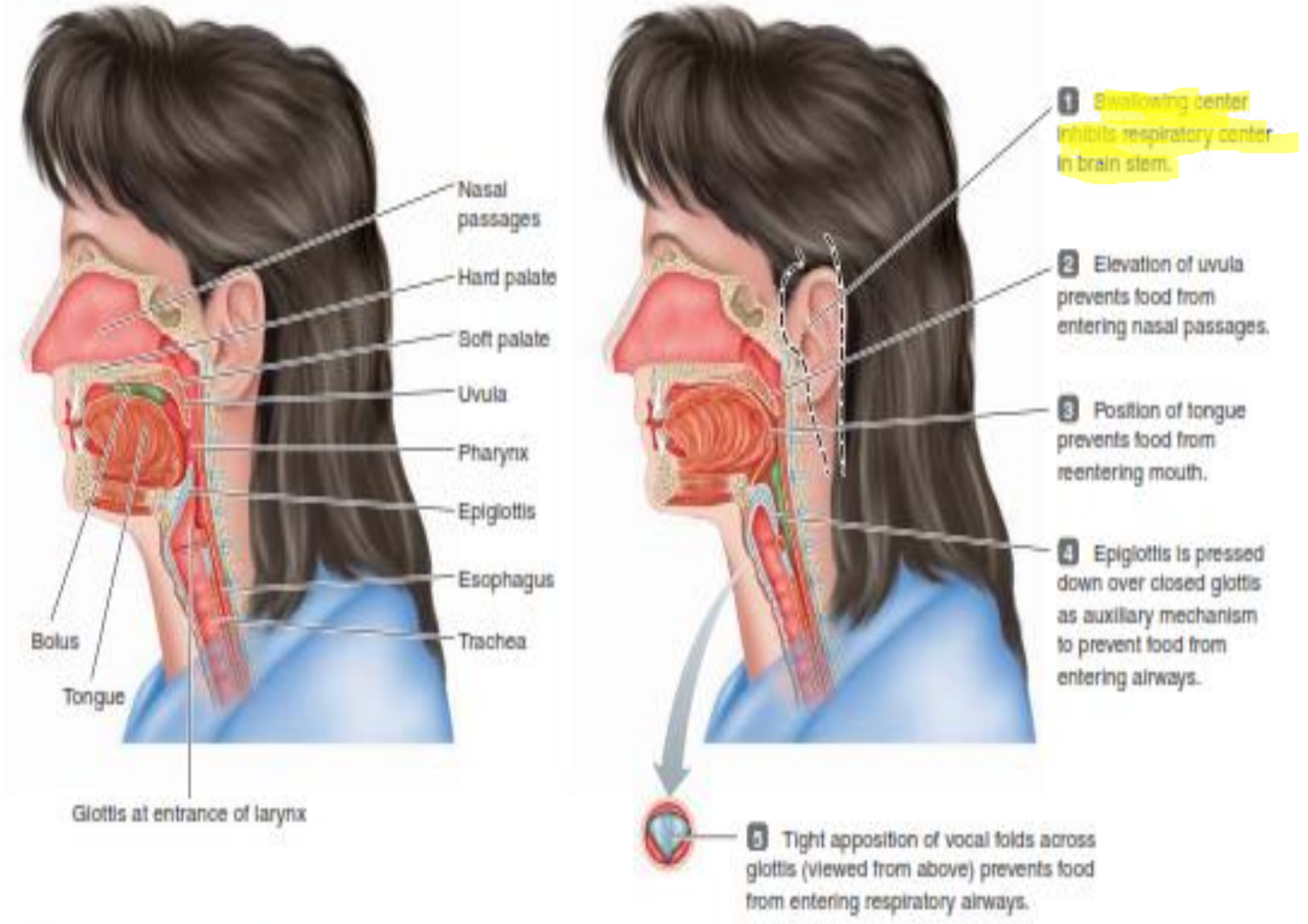


(c) Anterior view of frontal sections of peristalsis in esophagus

? Is swallowing a voluntary action or an involuntary action?



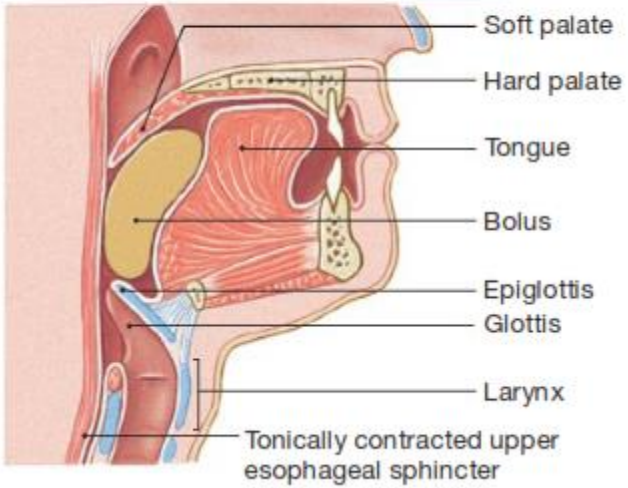
● **FIGURE 16-6 Peristalsis in the esophagus.** As the wave of peristaltic contraction sweeps down the esophagus, it pushes the



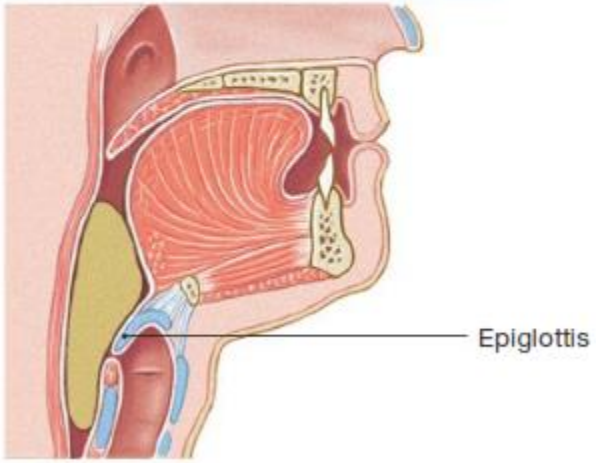
(a) Position of the oropharyngeal structures at rest

(b) Changes during the oropharyngeal stage of swallowing to prevent food from entering the wrong passageways

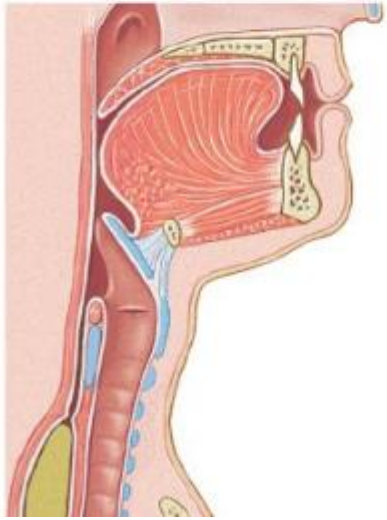
1 Tongue pushes bolus against soft palate and back of mouth, triggering swallowing reflex.

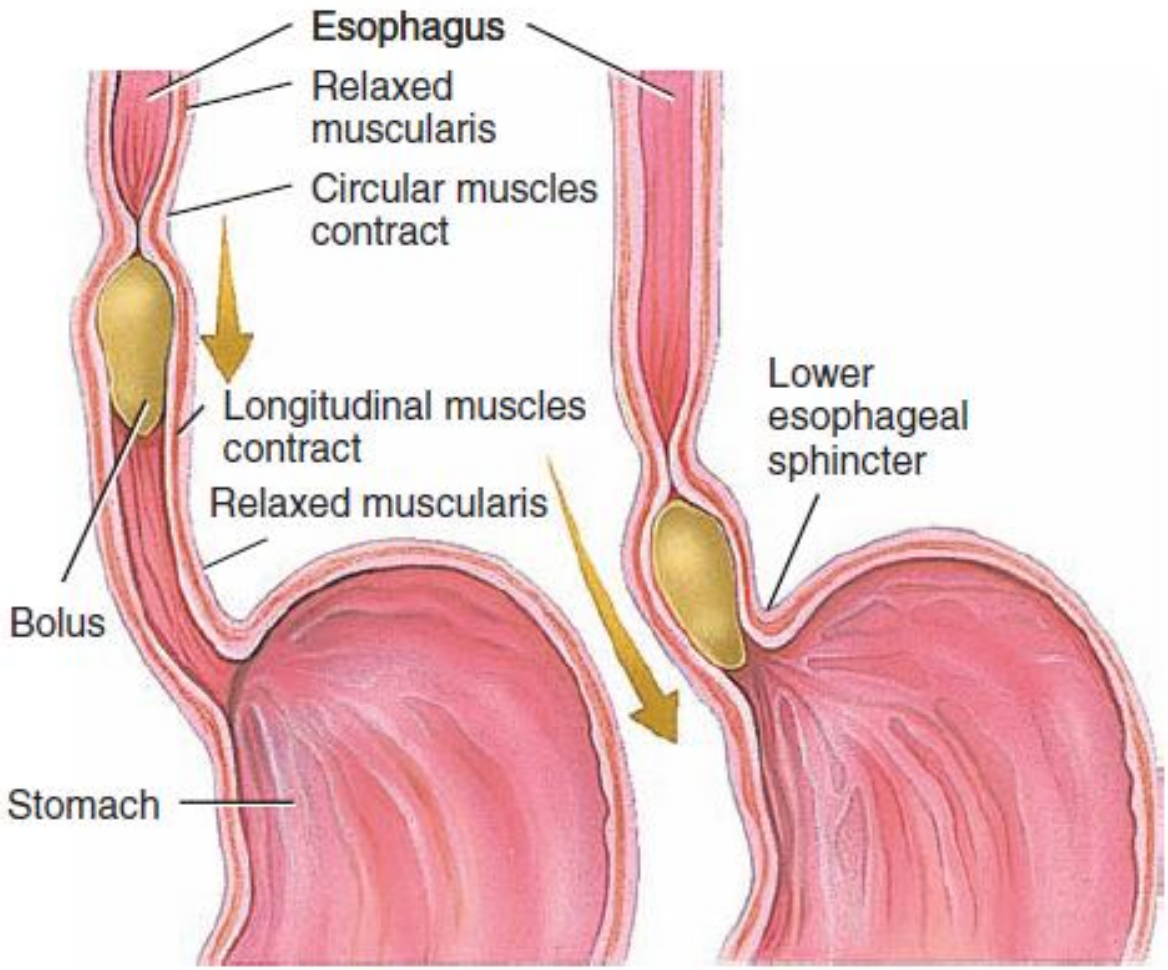


2 Upper esophageal sphincter relaxes while epiglottis closes to keep swallowed material out of the airways.



3 Food moves downward into the esophagus, propelled by peristaltic waves and aided by gravity.





(c) Anterior view of frontal sections of peristalsis in esophagus

Is swallowing a voluntary action or an involuntary action?

TABLE 24.2

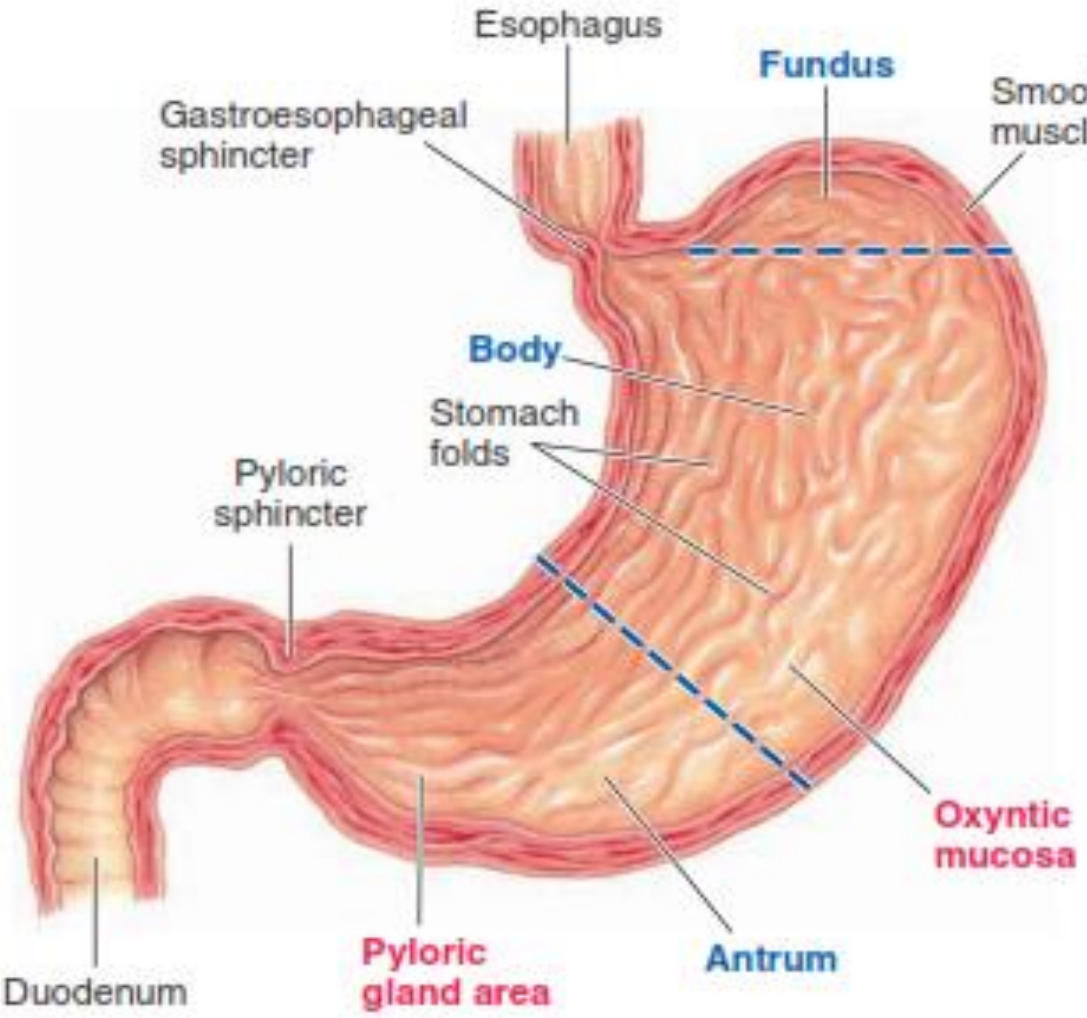
Summary of Digestive Activities in the Pharynx and Esophagus

STRUCTURE	ACTIVITY	RESULT
Pharynx	Pharyngeal stage of deglutition.	Moves bolus from oropharynx to laryngopharynx and into esophagus; closes air passageways.
Esophagus	Relaxation of upper esophageal sphincter.	Permits entry of bolus from laryngopharynx into esophagus.
	Esophageal stage of deglutition (peristalsis).	Pushes bolus down esophagus.
	Relaxation of lower esophageal sphincter.	Permits entry of bolus into stomach.
	Secretion of mucus.	Lubricates esophagus for smooth passage of bolus.

LAMBUNG

24.9 Stomach

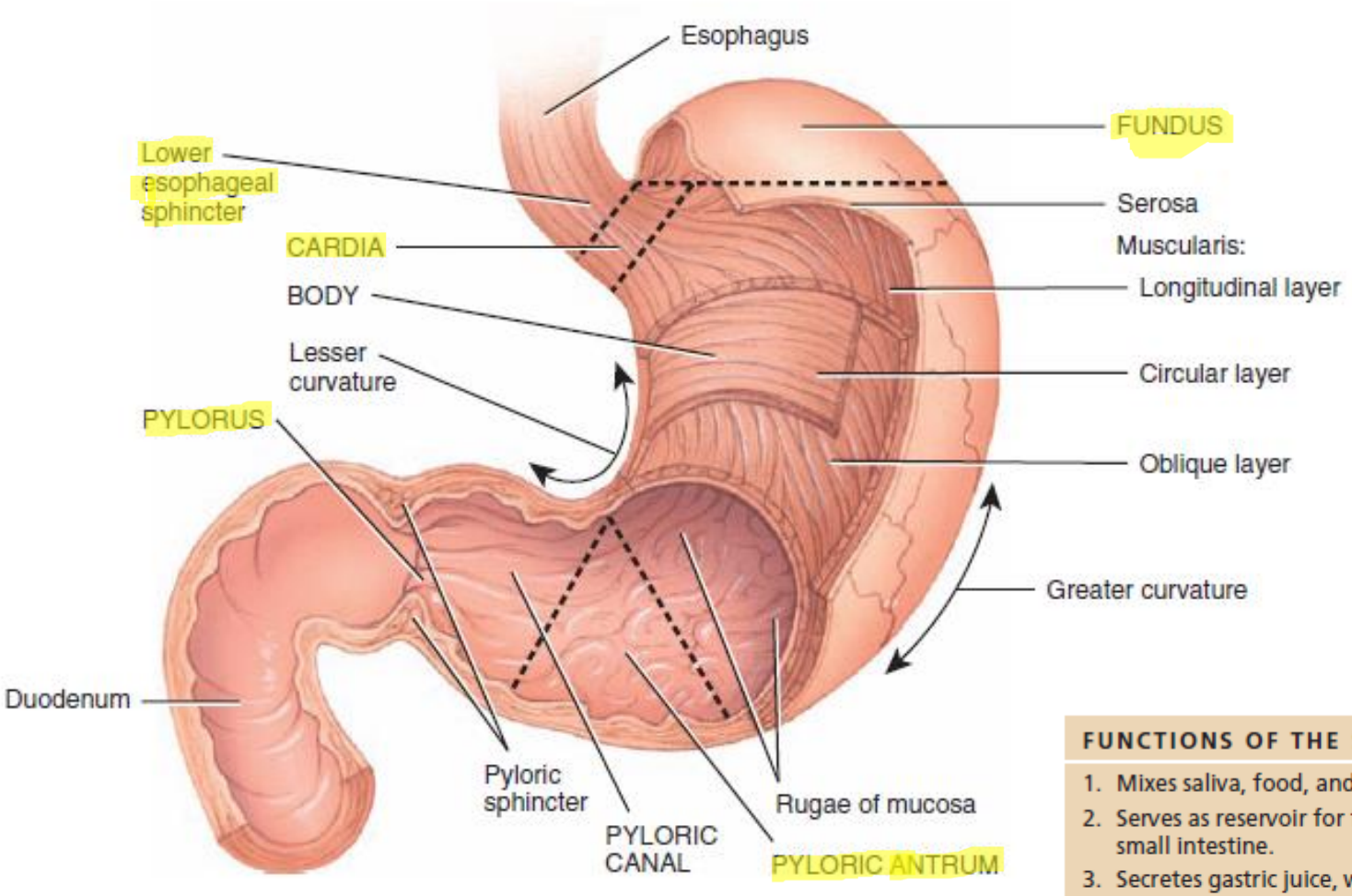
1. The stomach connects the esophagus to the duodenum.
2. The principal anatomical regions of the stomach are the cardia, fundus, body, and pylorus.
3. Adaptations of the stomach for digestion include rugae; glands that produce mucus, hydrochloric acid, pepsin, gastric lipase, and intrinsic factor; and a three-layered muscularis.
4. Mechanical digestion consists of mixing waves.
5. Chemical digestion consists mostly of the conversion of proteins into peptides by pepsin.
6. The stomach wall is impermeable to most substances.
7. Among the substances the stomach can absorb are water, certain ions, drugs, and alcohol.



- Lambung
  - Anatomi
    - Fundus
    - Korpus
    - Antrum
    - Sfingter pilorus

Figure 24.11 External and internal anatomy of the stomach.

The four regions of the stomach are the cardia, fundus, body, and pyloric part.



(a) Anterior view of regions of stomach

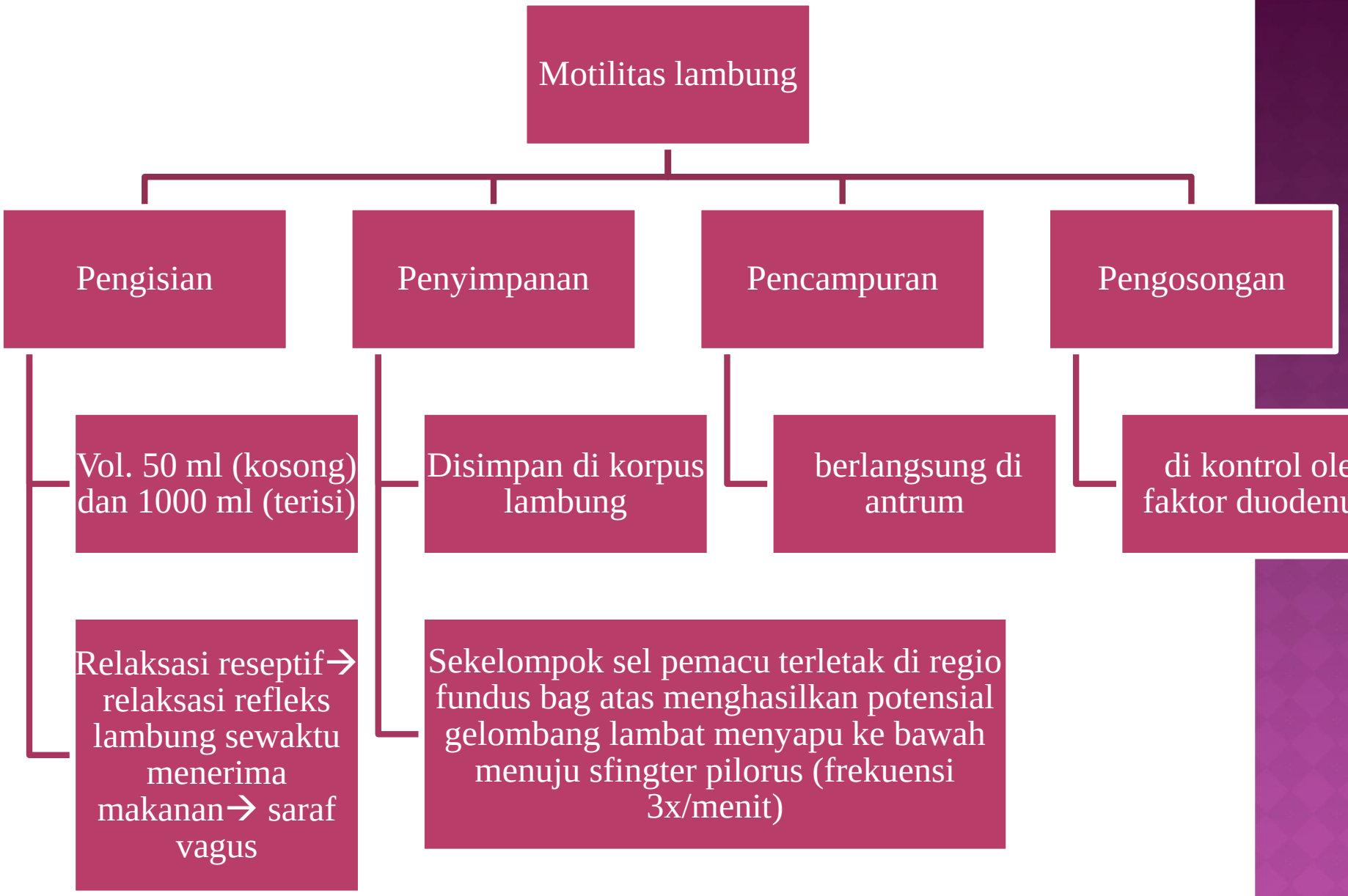
FUNCTIONS OF THE STOMACH

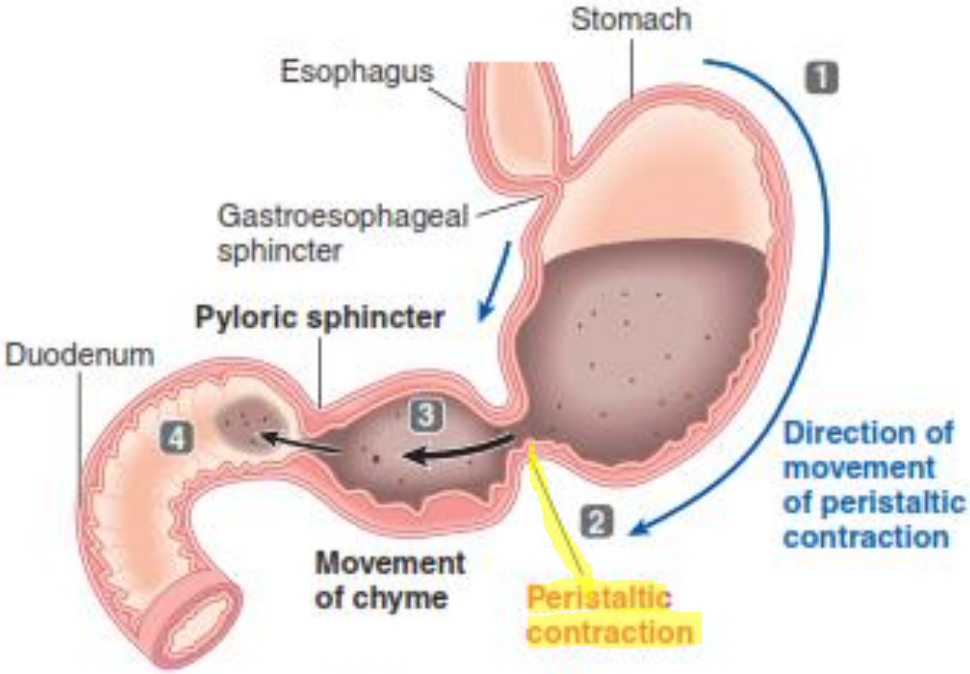
1. Mixes saliva, food, and gastric juice to form chyme.
2. Serves as reservoir for food before release into small intestine.
3. Secretes gastric juice, which contains HCl (kills bacteria and denatures protein), pepsin (begins the digestion of proteins), intrinsic factor (aids absorption of vitamin B_{12}), and gastric lipase (aids digestion of triglycerides).
4. Secretes gastrin into blood.

digestion of triglyceric
4. Secretes gastrin into b

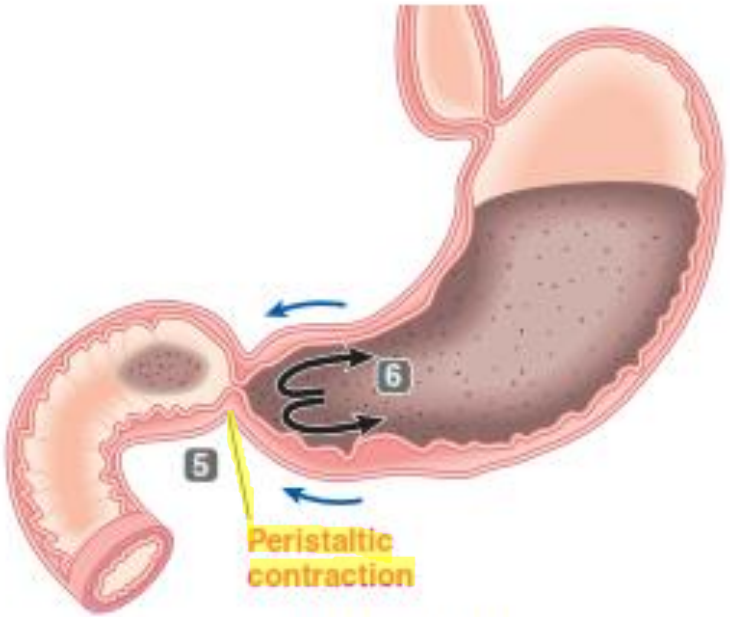
(b) Anterior view of internal anatomy

After a very large meal, does your stomach still have rugae?


Motilitas lambung
Pengisian
Penyimpanan
Pencampuran
Pengosongan
Vol. 50 ml (kosong) dan 1000 ml (terisi)
Relaksasi reseptif→ relaksasi refleks lambung sewaktu menerima makanan→ saraf vagus
Disimpan di korpus lambung
Sekelompok sel pemacu terletak di regio fundus bag atas menghasilkan potensial gelombang lambat menyapu ke bawah menuju sfingter pilorus (frekuensi 3x/menit)
berlangsung di antrum
di kontrol oleh faktor duodenum



Gastric emptying



Gastric mixing

1 A peristaltic contraction originates in the upper fundus and sweeps down toward the pyloric sphincter.

2 The contraction becomes more vigorous as it reaches the thick-muscled antrum.

3 The strong antral peristaltic contraction propels the chyme forward.

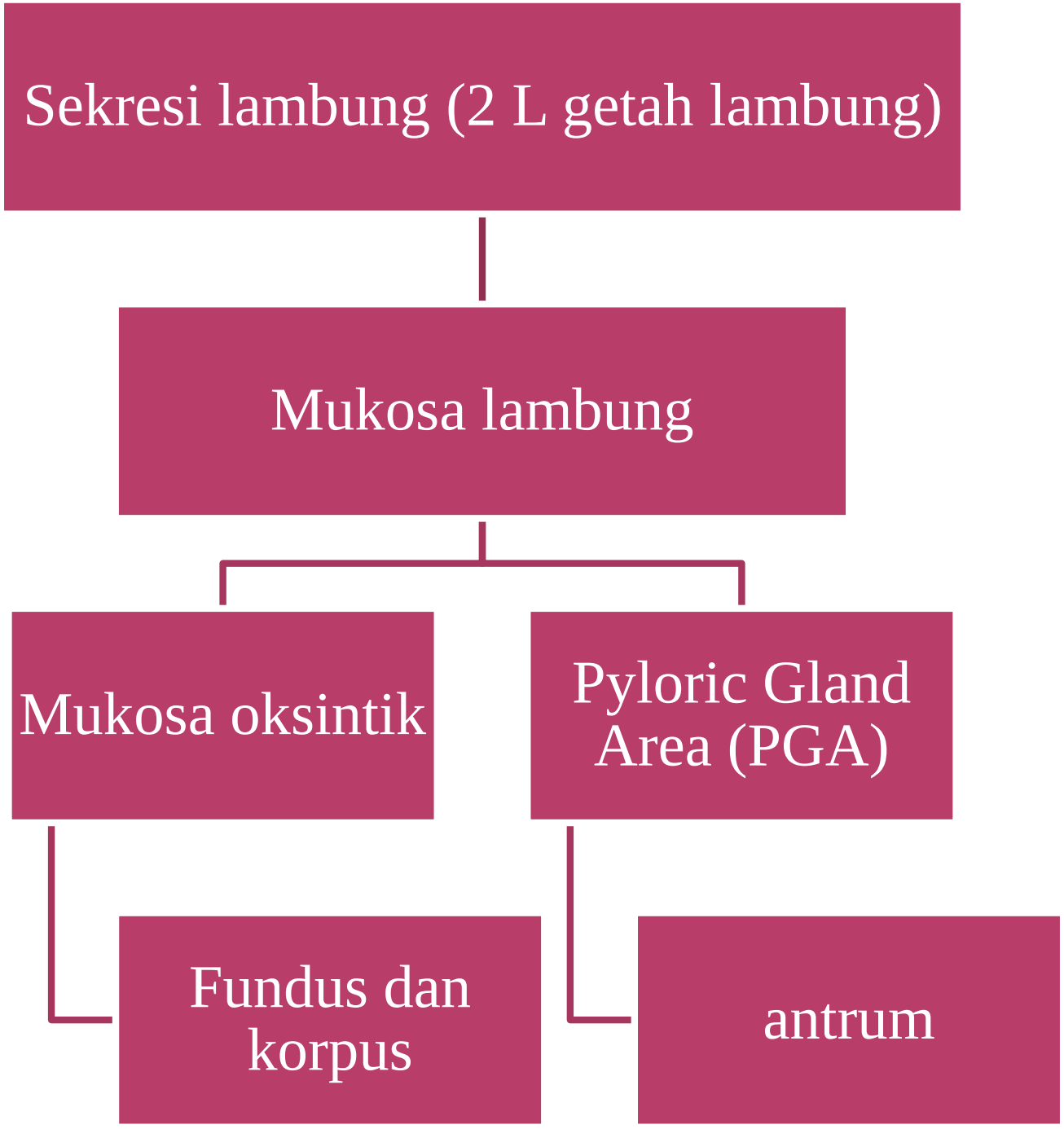
4 A small portion of chyme is pushed through the partially open sphincter into the duodenum. The stronger the antral contraction, the more chyme is emptied with each contractile wave.

5 When the peristaltic contraction reaches the pyloric sphincter, the sphincter is tightly closed and no further emptying takes place.

6 When chyme that was being propelled forward hits the closed sphincter, it is tossed back into the antrum. Mixing of chyme is accomplished as chyme is propelled forward and tossed back into the antrum with each peristaltic contraction.

TABLE 16-2 Factors Regulating Gastric Motility and Emptying

Factors	Mode of Regulation	Effects on Gastric Motility and Emptying
Within the Stomach		
Volume of chyme	Distension has a direct effect on gastric smooth muscle excitability, as well as acting through the intrinsic plexuses, the vagus nerve, and gastrin	Increased volume stimulates motility and emptying
Degree of fluidity	Direct effect; contents must be in a fluid form to be evacuated	Increased fluidity allows more rapid emptying
Within the Duodenum		
Presence of fat, acid, hypertonicity, or distension	Initiates the enterogastric reflex or triggers the release of enterogastrones (secretin, cholecystokinin)	These factors in the duodenum inhibit further gastric motility and emptying until the duodenum has coped with factors already present
Outside the Digestive System		
Emotion	Alters autonomic balance	Stimulates or inhibits motility and emptying
Intense pain	Increases sympathetic activity	Inhibits motility and emptying


Sekresi lambung (2 L getah lambung)
Mukosa lambung
Mukosa oksintik
Pyloric Gland Area (PGA)
Fundus dan korpus
antrum

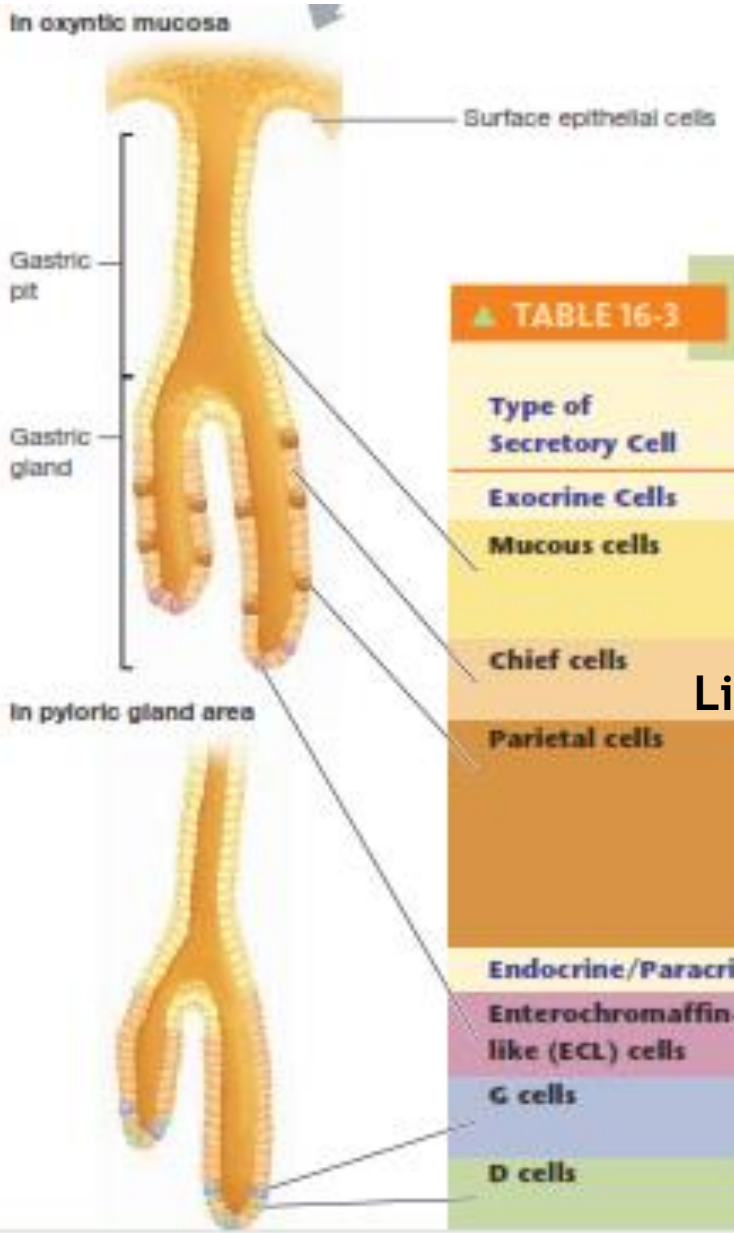


TABLE 16-3 The Stomach Mucosa and the Gastric Glands

Type of Secretory Cell	Product Secreted	Stimuli for Secretion	Function(s) of Secretory Product
Exocrine Cells			
Mucous cells	Alkaline mucus	Mechanical stimulation by contents	Protects mucosa against mechanical, pepsin, and acid injury
Chief cells	Pepsinogen	ACh, gastrin	When activated, begins protein digestion
Parietal cells	Hydrochloric acid	ACh, gastrin, histamine	Activates pepsinogen; breaks down connective tissue, denatures proteins, kills microorganisms
	Intrinsic factor		Facilitates absorption of vitamin B_{12}
Endocrine/Paracrine Cells			
Enterochromaffin-like (ECL) cells	Histamine	ACh, gastrin	Stimulates parietal cells
G cells	Gastrin	Protein products, ACh	Stimulates parietal, chief, and ECL cells
D cells	Somatostatin	Acid	Inhibits parietal, G, and ECL cells

Lipase gastric

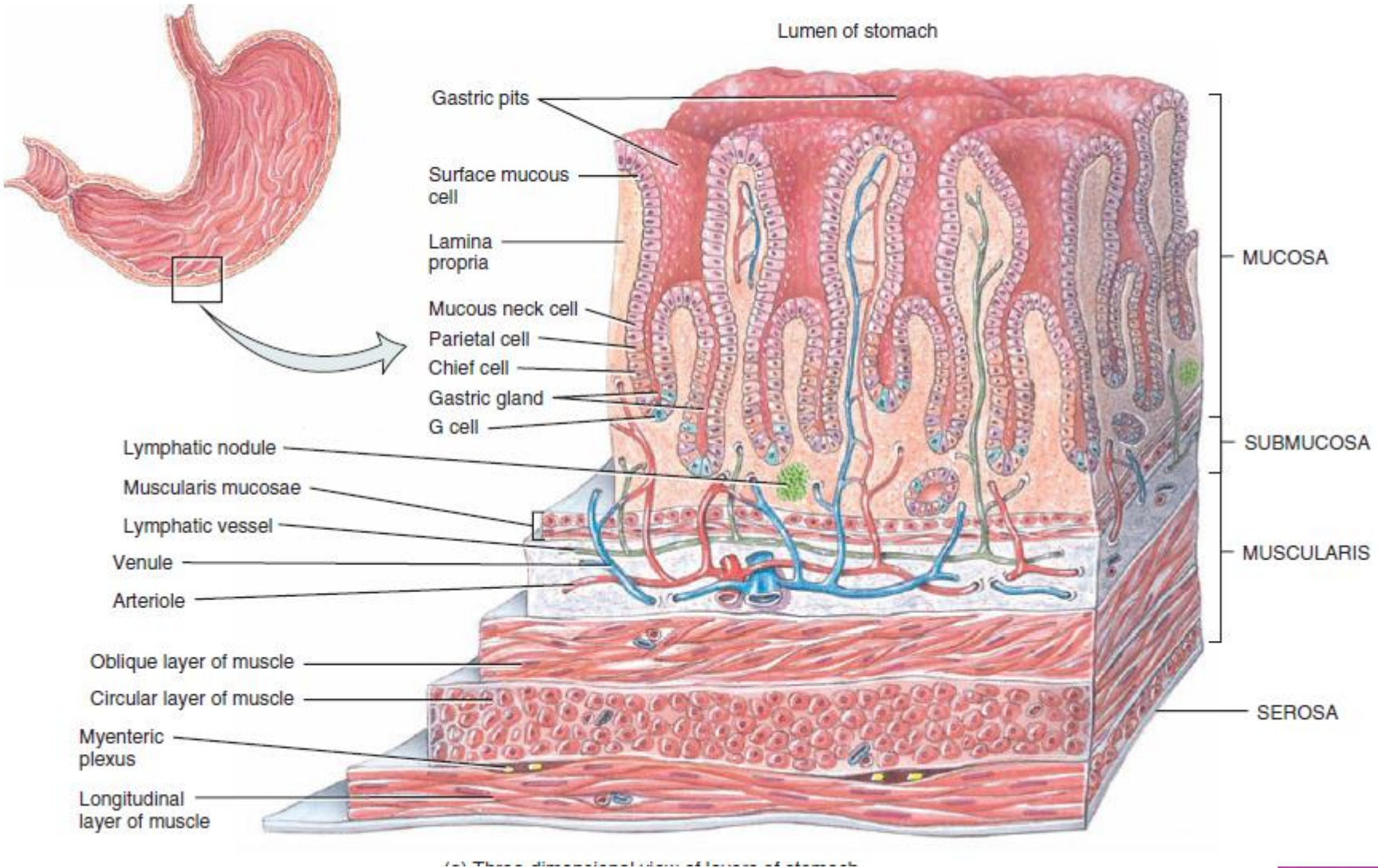
TABLE 24.3

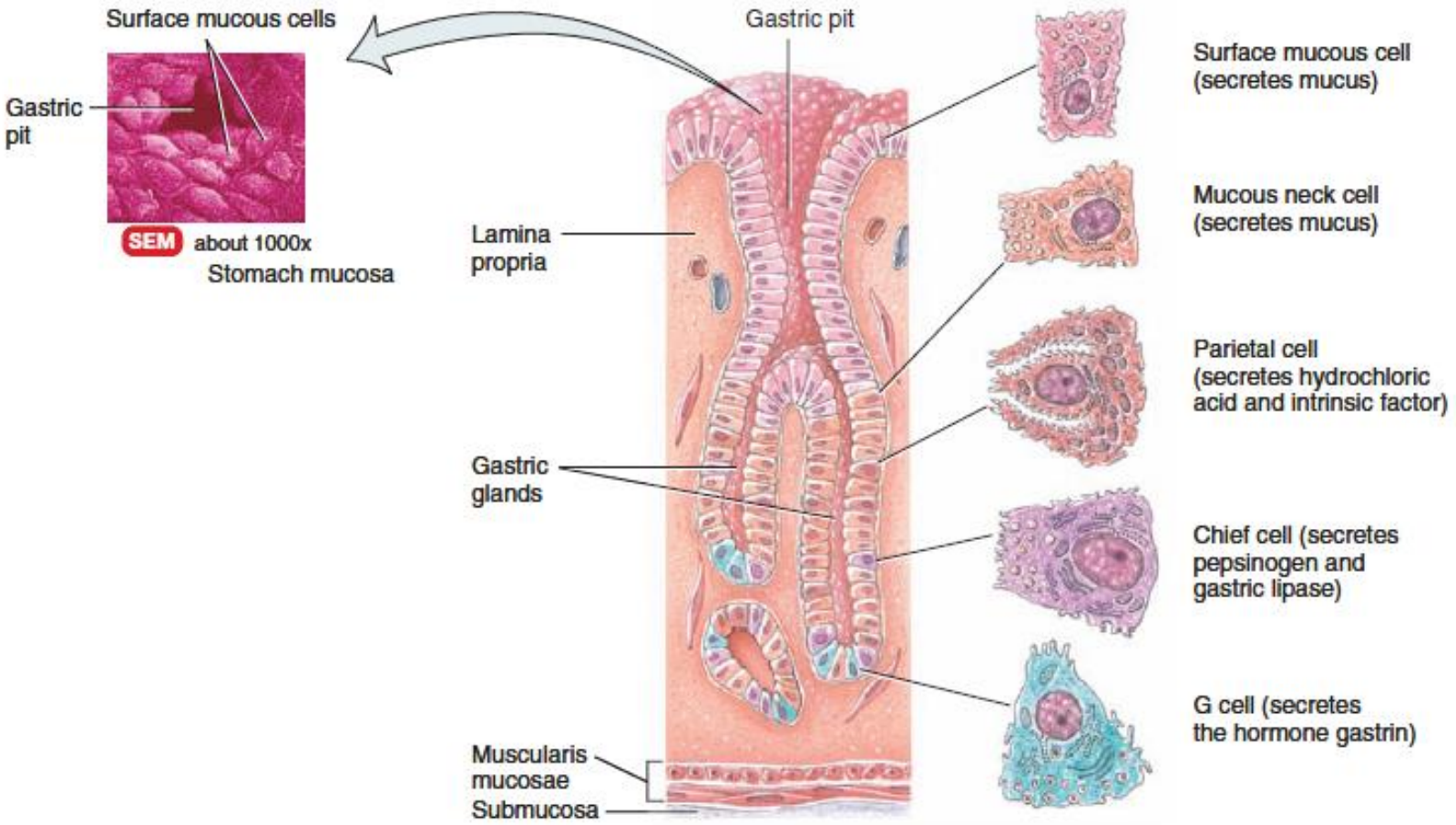
Summary of Digestive Activities in the Stomach

STRUCTURE	ACTIVITY	RESULT
Mucosa		
Surface mucous cells and mucous neck cells	Secrete mucus.	Forms protective barrier that prevents digestion of stomach wall.
	Absorption.	Small quantity of water, ions, short-chain fatty acids, and some drugs enter bloodstream.
Parietal cells	Secrete intrinsic factor.	Needed for absorption of vitamin B_{12} (used in red blood cell formation, or erythropoiesis).
	Secrete hydrochloric acid.	Kills microbes in food; denatures proteins; converts pepsinogen into pepsin.
Chief cells	Secrete pepsinogen.	Pepsin (activated form) breaks down proteins into peptides.
	Secrete gastric lipase.	Splits triglycerides into fatty acids and monoglycerides.
G cells	Secrete gastrin.	Stimulates parietal cells to secrete HCl and chief cells to secrete pepsinogen; contracts lower esophageal sphincter, increases motility of stomach, and relaxes pyloric sphincter.
Muscularis	Mixing waves (gentle peristaltic movements).	Churns and physically breaks down food and mixes it with gastric juice, forming chyme. Forces chyme through pyloric sphincter.
Pyloric sphincter	Opens to permit passage of chyme into duodenum.	Regulates passage of chyme from stomach to duodenum; prevents backflow of chyme from duodenum to stomach.

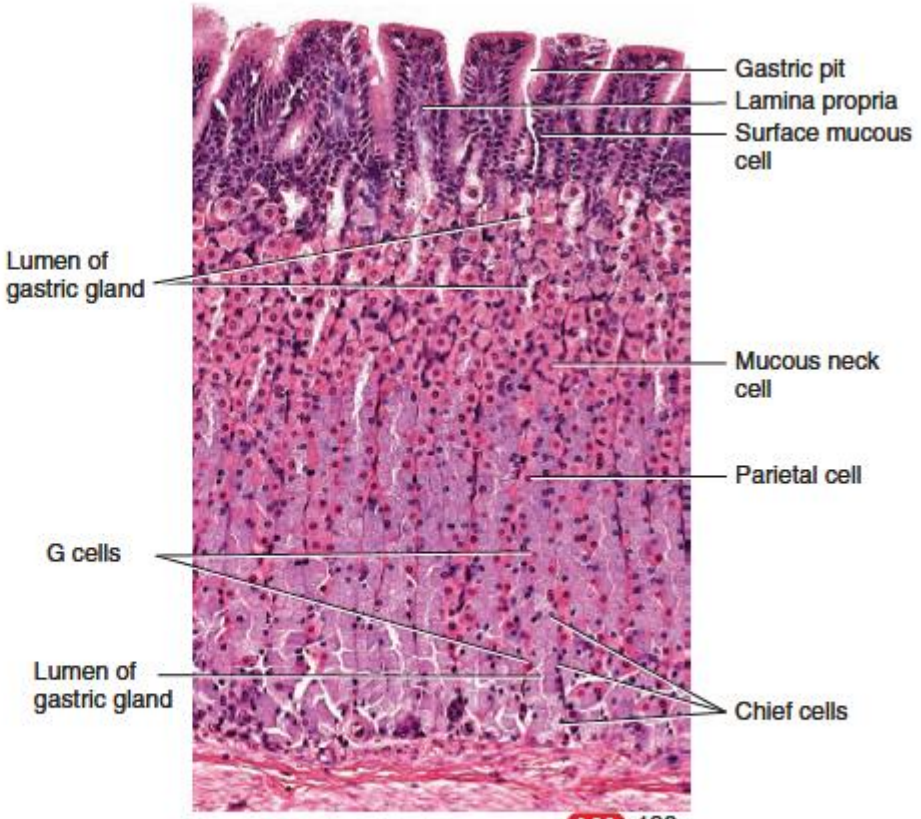
Figure 24.12 Histology of the stomach.

6 Gastric juice is the combined secretions of mucous cells, parietal cells, and chief cells.



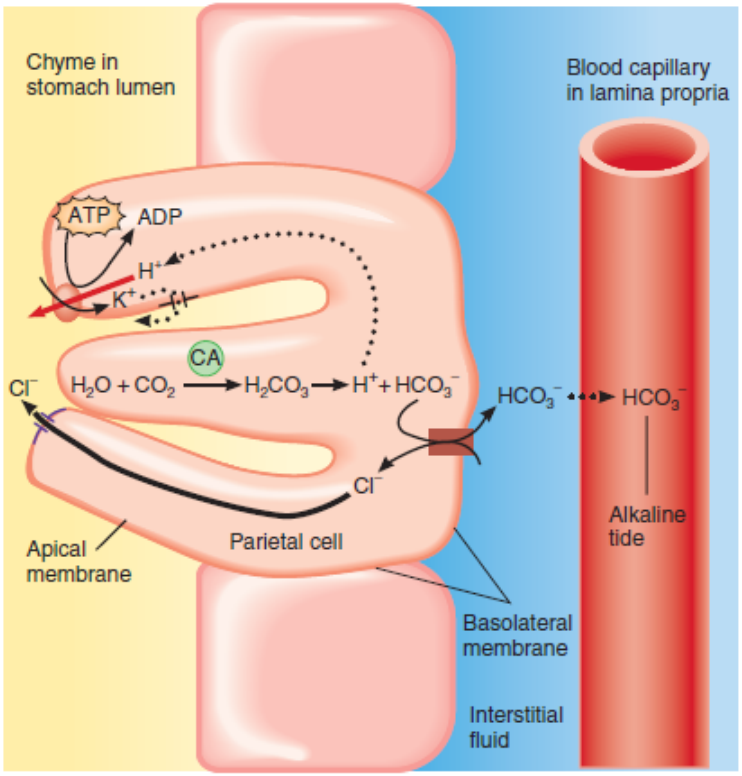


(b) Sectional view of stomach mucosa showing gastric glands and cell types



(c) Fundic mucosa

? **Where is HCl secreted, and what are its functions?**



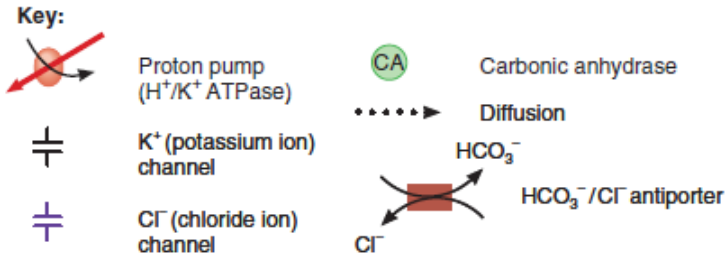
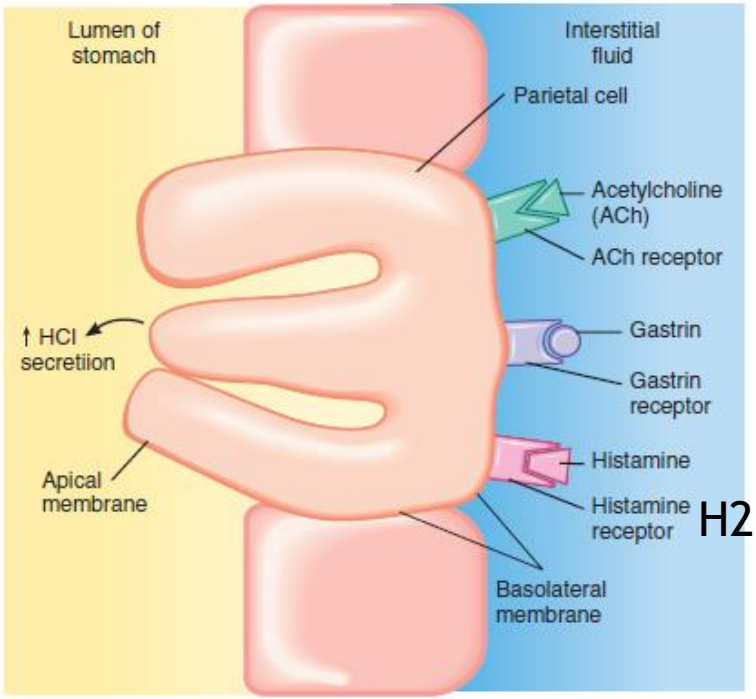


Figure 24.14 Regulation of HCl secretion.

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



? Among the sources that stimulate HCl secretion, which one is a paracrine agent that is released by mast cells in the lamina propria?

USUS HALUS

24.12 Small Intestine

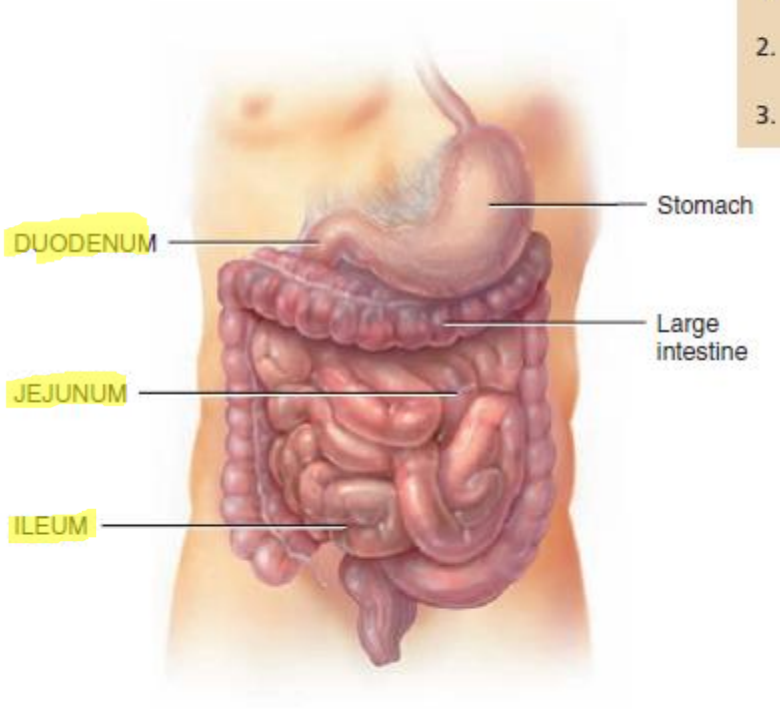
1. The small intestine extends from the pyloric sphincter to the ileocecal sphincter. It is divided into duodenum, jejunum, and ileum.
2. Its glands secrete fluid and mucus, and the circular folds, villi, and microvilli of its wall provide a large surface area for digestion and absorption.
3. Brush-border enzymes digest α-dextrins, maltose, sucrose, lactose, peptides, and nucleotides at the surface of mucosal epithelial cells.
4. Pancreatic and intestinal brush-border enzymes break down starches into maltose, maltotriose, and α-dextrins (pancreatic amylase), α-dextrins into glucose (α-dextrinase), maltose to glucose (maltase), sucrose to glucose and fructose (sucrase), lactose to glucose and galactose (lactase), and proteins into peptides (trypsin, chymotrypsin, and elastase). Also, enzymes break off amino acids at the carboxyl ends of peptides (carboxypeptidases) and break off amino acids at the amino ends of peptides (aminopeptidases). Finally, enzymes split dipeptides into amino acids (dipeptidases), triglycerides to fatty acids and monoglycerides (lipases), and nucleotides to pentoses and nitrogenous bases (nucleosidases and phosphatases).
5. Mechanical digestion in the small intestine involves segmentation and migrating motility complexes.
6. Absorption occurs via diffusion, facilitated diffusion, osmosis, and active transport; most absorption occurs in the small intestine.
7. Monosaccharides, amino acids, and short-chain fatty acids pass into the blood capillaries.
8. Long-chain fatty acids and monoglycerides are absorbed from micelles, resynthesized to triglycerides, and formed into chylomicrons.
9. Chylomicrons move into lymph in the lacteal of a villus.
10. The small intestine also absorbs electrolytes, vitamins, and water.

Figure 24.18 **Anatomy of the small intestine.** (a) Regions of the small intestine are the duodenum, jejunum, and ileum. (b) Circular folds increase the surface area for digestion and absorption in the small intestine.

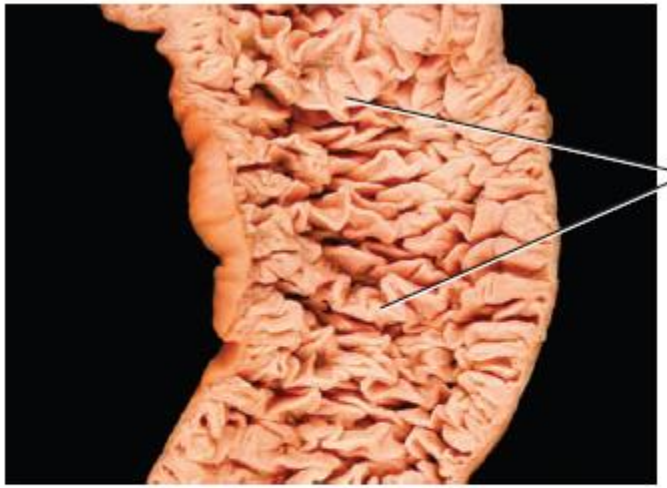
Most digestion and absorption occur in the small intestine.

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, and lipids; begins and completes digestion of nucleic acids.
3. Absorbs about 90% of nutrients and water that pass through digestive system.



(a) Anterior view of external anatomy



(b) Internal anatomy of jejunum

Which portion of the small intestine is the longest?

Figure 24.19 Histology of the small intestine.

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

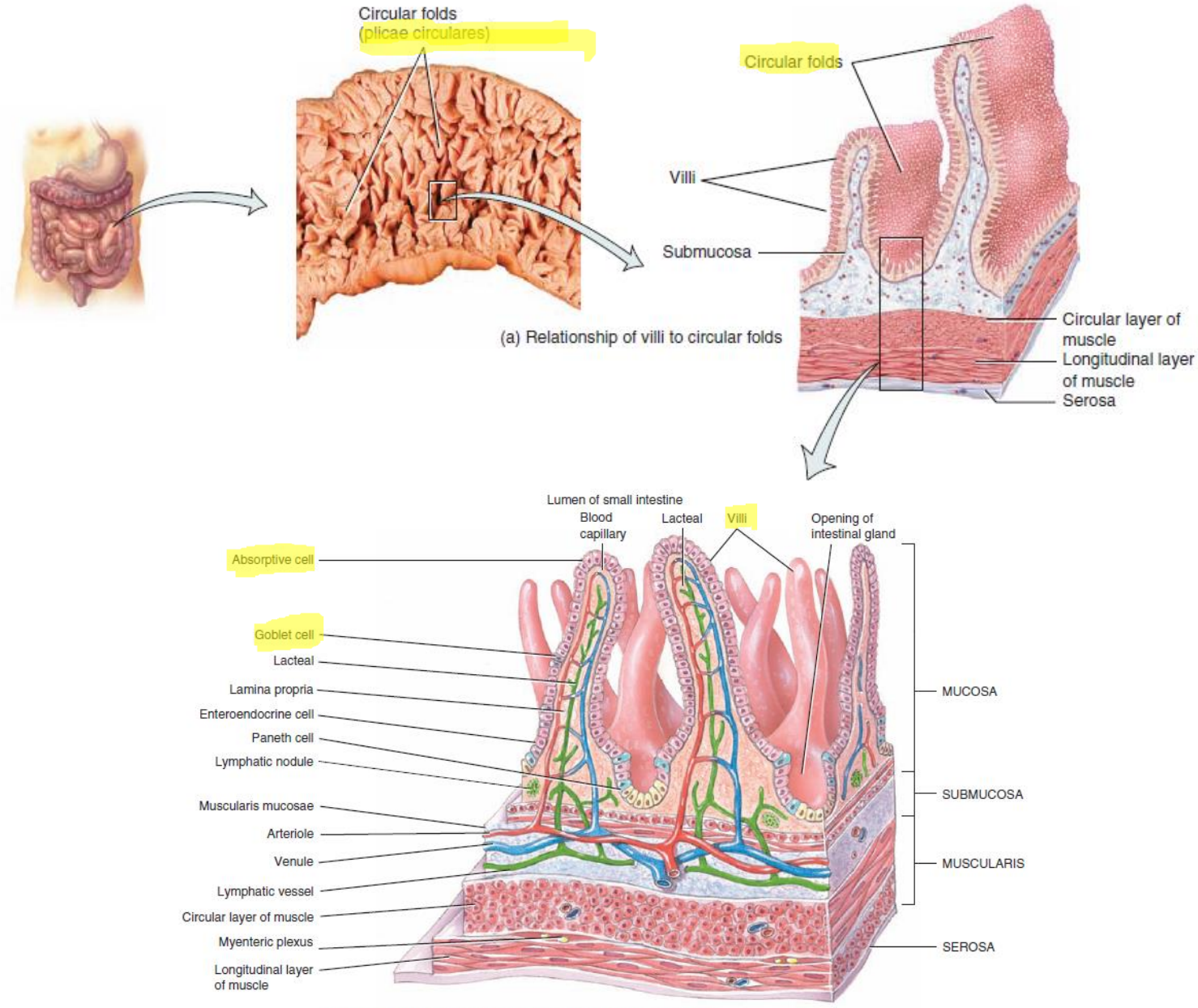
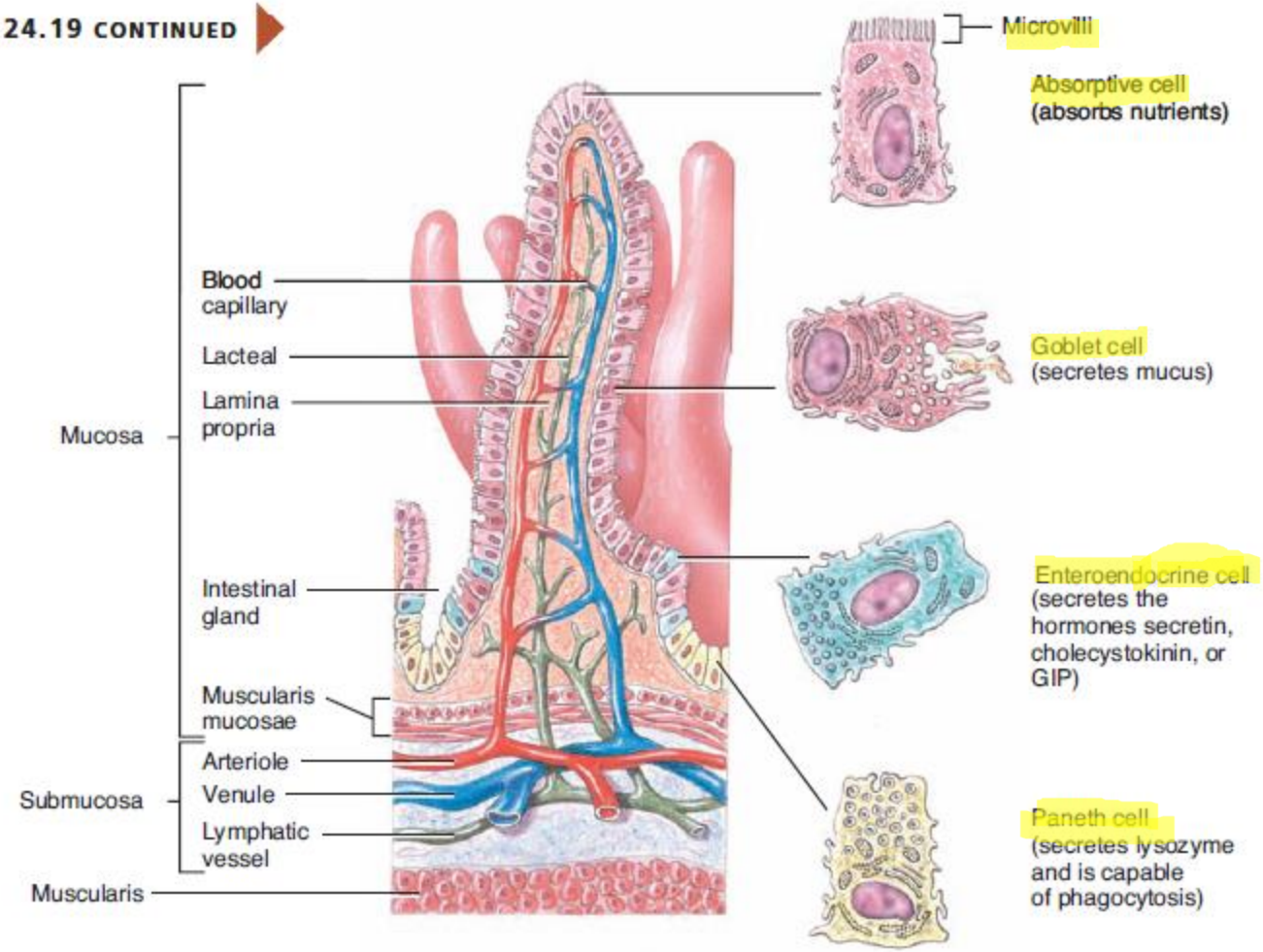


FIGURE 24.19 CONTINUED



(c) Enlarged villus showing lacteal, capillaries, intestinal glands, and cell types

What is the functional significance of the blood capillary network and lacteal in the center of each villus?

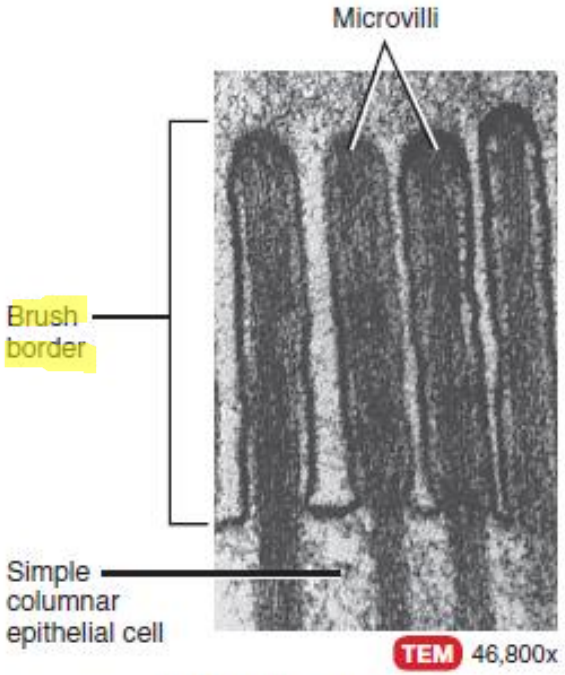
Figure 24.20 Histology of the duodenum and ileum.

6 Microvilli in the small intestine contain several brush-border enzymes that help digest nutrients.

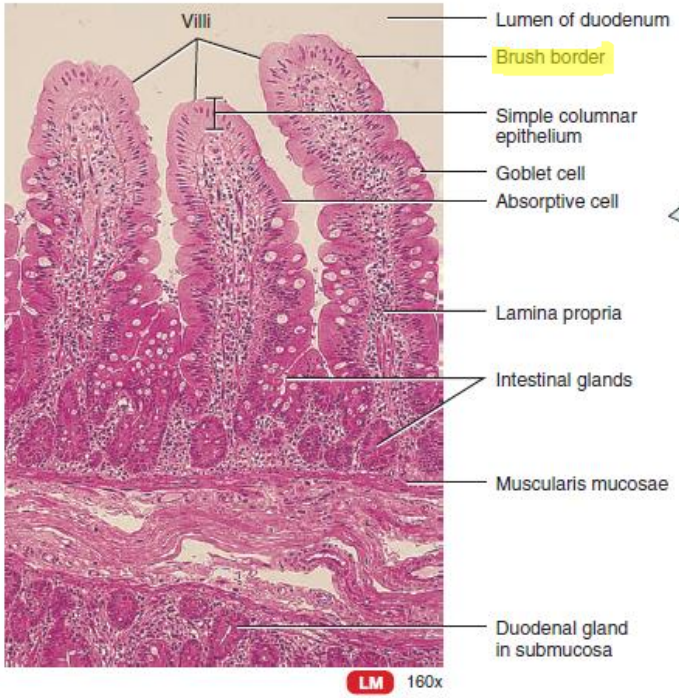
Klnjr. Brunner (duodenum)

(a) Wall of the duodenum

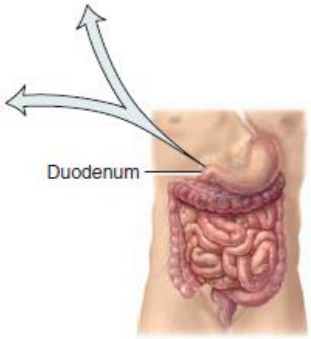
(a) Wall of the duodenum

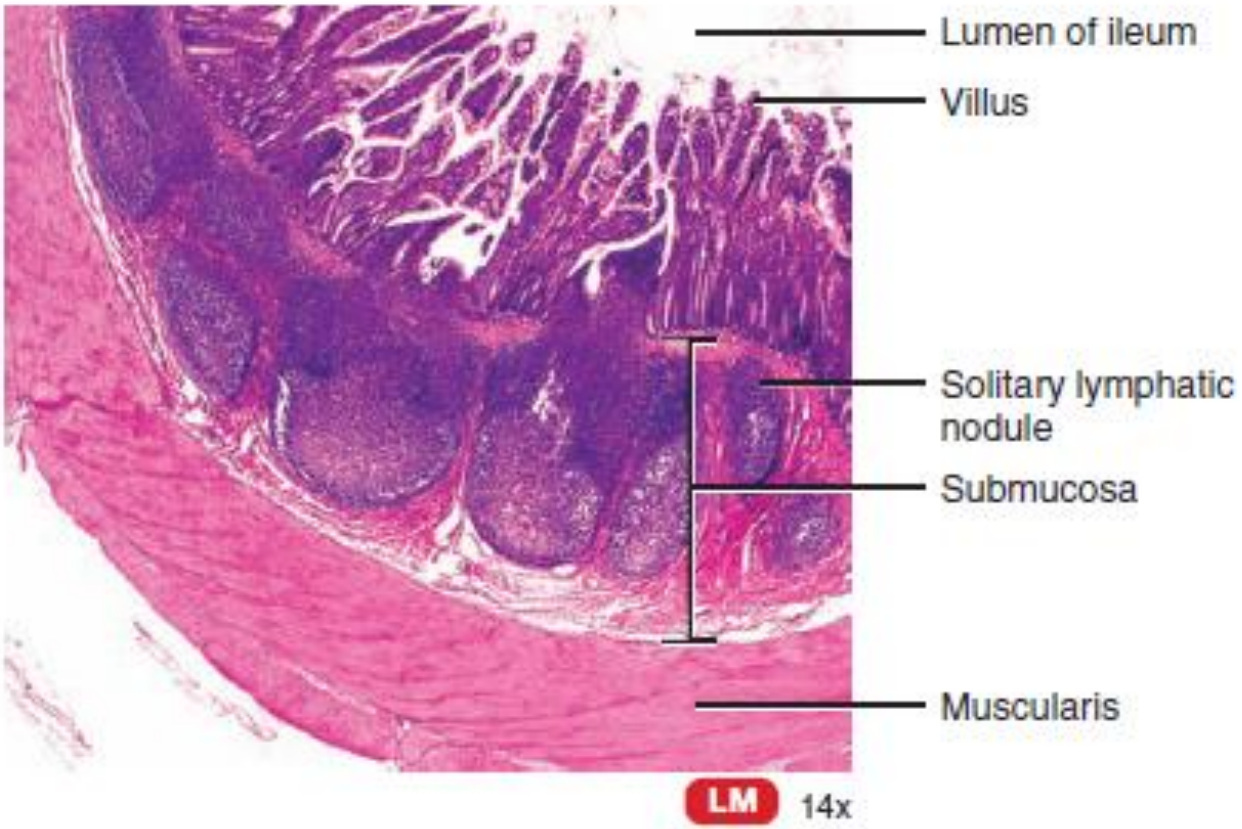


(d) Several microvilli from duodenum



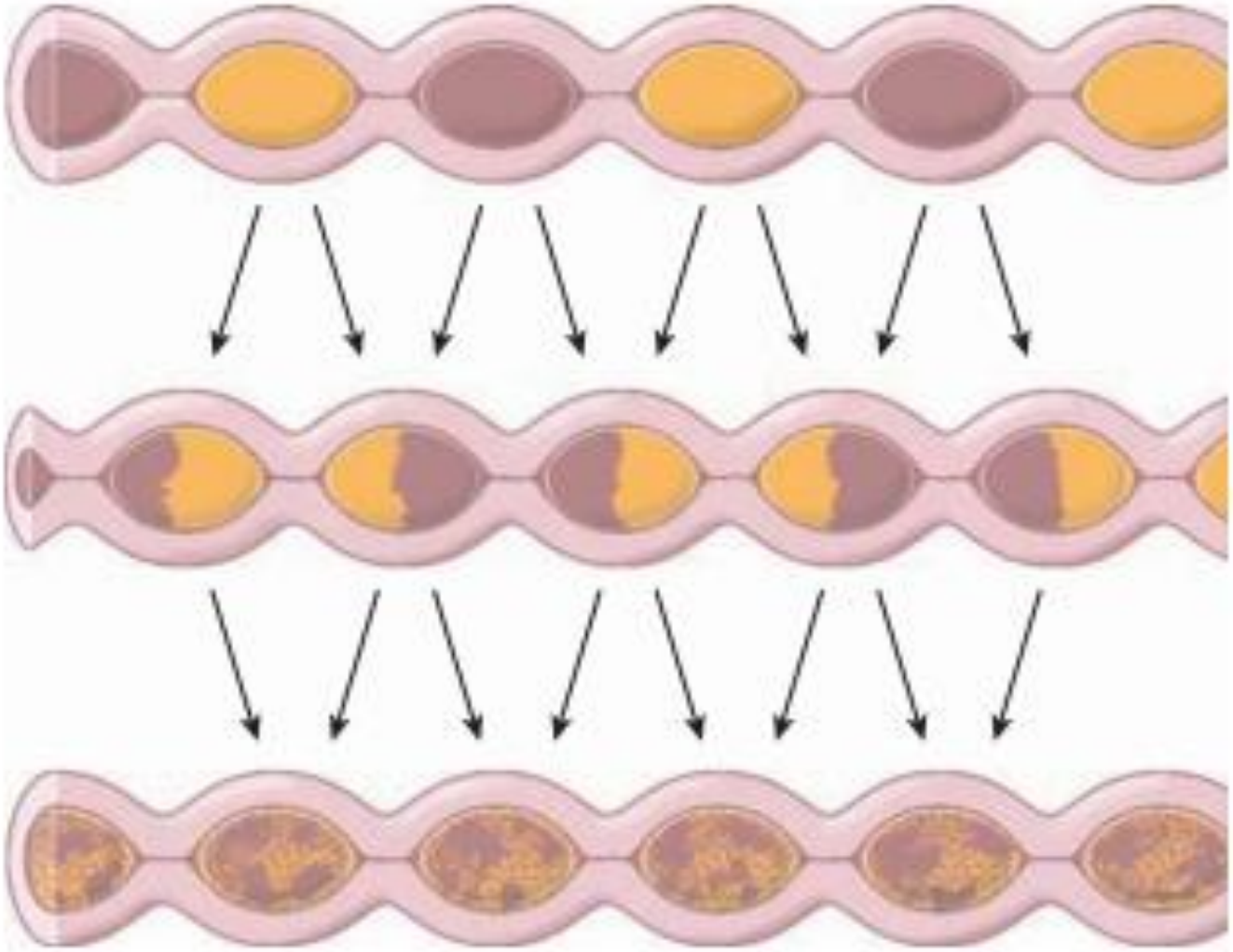
(b) Three villi from duodenum





(c) Lymphatic nodules in ileum

What is the function of the fluid secreted by duodenal (Brunner's) glands?



- **FIGURE 16-19 Segmentation.** Segmentation consists of ring-like contractions along the length of the small intestine. Within a matter of seconds, the contracted segments relax and the previously relaxed areas contract. These oscillating contractions thoroughly mix the chyme within the small-intestine lumen.

TABLE 24.4

Summary of Digestive Activities in the Pancreas, Liver, Gallbladder, and Small Intestine

STRUCTURE	ACTIVITY
Pancreas	Delivers pancreatic juice into duodenum via pancreatic duct to assist absorption (see Table 24.5 for pancreatic enzymes and their functions).
Liver	Produces bile (bile salts) necessary for emulsification and absorption of lipids.
Gallbladder	Stores, concentrates, and delivers bile into duodenum via common bile duct.
Small intestine	Major site of digestion and absorption of nutrients and water in gastrointestinal tract.
Mucosa/submucosa	
Intestinal glands	Secrete intestinal juice to assist absorption.
Absorptive cells	Digest and absorb nutrients.
Goblet cells	Secrete mucus.
Enteroendocrine cells (S, CCK, K)	Secrete secretin, cholecystokinin, and glucose-dependent insulinotropic peptide.
Paneth cells	Secrete lysozyme (bactericidal enzyme) and phagocytosis.
Duodenal (Brunner's) glands	Secrete alkaline fluid to buffer stomach acids, and mucus for protection and lubrication.
Circular folds	Folds of mucosa and submucosa that increase surface area for digestion and absorption.
Villi	Fingerlike projections of mucosa that are sites of absorption of digested food and increase surface area for digestion and absorption.
Microvilli	Microscopic, membrane-covered projections of absorptive epithelial cells that contain brush-border enzymes (listed in Table 24.5) and that increase surface area for digestion and absorption.
Microvilli	Microscopic, membrane-covered projections of absorptive epithelial cells that contain brush-border enzymes (listed in Table 24.5) and that increase surface area for digestion and absorption.
Muscularis	
Segmentation	Type of peristalsis: alternating contractions of circular smooth muscle fibers that produce segmentation and resegmentation of sections of small intestine; mixes chyme with digestive juices and brings food into contact with mucosa for absorption.
Migrating motility complex (MMC)	Type of peristalsis: waves of contraction and relaxation of circular and longitudinal smooth muscle fibers passing the length of the small intestine; moves chyme toward ileocecal sphincter.

Summary of Digestive Enzymes

ENZYME	SOURCE	SUBSTRATES	PRODUCTS
SALIVA			
Salivary amylase	Salivary glands.	Starches (polysaccharides).	Maltose (disaccharide), maltotriose (trisaccharide), and α-dextrins.
Lingual lipase	Lingual glands in tongue.	Triglycerides (fats and oils) and other lipids.	Fatty acids and diglycerides.
GASTRIC JUICE			
Pepsin (activated from pepsinogen by pepsin and hydrochloric acid)	Stomach chief cells.	Proteins.	Peptides.
Gastric lipase	Stomach chief cells.	Triglycerides (fats and oils).	Fatty acids and monoglycerides.
PANCREATIC JUICE			
Pancreatic amylase	Pancreatic acinar cells.	Starches (polysaccharides).	Maltose (disaccharide), maltotriose (trisaccharide), and α-dextrins.
Trypsin (activated from trypsinogen by enterokinase)	Pancreatic acinar cells.	Proteins.	Peptides.
Chymotrypsin (activated from chymotrypsinogen by trypsin)	Pancreatic acinar cells.	Proteins.	Peptides.
Elastase (activated from proelastase by trypsin)	Pancreatic acinar cells.	Proteins.	Peptides.
Carboxypeptidase (activated from procarboxypeptidase by trypsin)	Pancreatic acinar cells.	Amino acid at carboxyl end of peptides.	Amino acids and peptides.
Pancreatic lipase	Pancreatic acinar cells.	Triglycerides (fats and oils) that have been emulsified by bile salts.	Fatty acids and monoglycerides.
Nucleases			
Ribonuclease	Pancreatic acinar cells.	Ribonucleic acid.	Nucleotides.
Deoxyribonuclease	Pancreatic acinar cells.	Deoxyribonucleic acid.	Nucleotides.
BRUSH-BORDER ENZYMES IN MICROVILLI PLASMA MEMBRANE			

BRUSH-BORDER ENZYMES IN MICROVILLI PLASMA MEMBRANE			
α-Dextrinase	Small intestine.	α-Dextrins.	Glucose.
Maltase	Small intestine.	Maltose.	Glucose.
Sucrase	Small intestine.	Sucrose.	Glucose and fructose.
Lactase	Small intestine.	Lactose.	Glucose and galactose.
Enterokinase	Small intestine.	Trypsinogen.	Trypsin.
Peptidases			
Aminopeptidase	Small intestine.	Amino acid at amino end of peptides.	Amino acids and peptides.
Dipeptidase	Small intestine.	Dipeptides.	Amino acids.
Nucleosidases and phosphatases	Small intestine.	Nucleotides.	Nitrogenous bases, pentoses, and phosphates.

TABLE 16-6 Digestive Processes for the Three Major Categories of Nutrients

Nutrients	Enzymes for Digesting Nutrient	Source of Enzymes	Site of Action of Enzymes	Action of Enzymes	Absorbable Units of Nutrients
Carbohydrate	Amylase	Salivary glands	Mouth and (mostly) body of stomach	Hydrolyzes polysaccharides to disaccharides	
		Exocrine pancreas	Small-intestine lumen		
	Disaccharidases (maltase, sucrase, lactase)	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze disaccharides to monosaccharides	Monosaccharides, especially glucose
Protein	Pepsin	Stomach chief cells	Stomach antrum	Hydrolyzes protein to peptide fragments	
	Trypsin, chymotrypsin carboxypeptidase	Exocrine pancreas	Small-intestine lumen	Attack different peptide fragments	
	Aminopeptidases	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze peptide fragments to amino acids	Amino acids and a few small peptides
Fat	Lipase	Exocrine pancreas	Small-intestine lumen	Hydrolyzes triglycerides to fatty acids and monoglycerides	Fatty acids and monoglycerides
	Bile salts (not an enzyme)	Liver	Small-intestine lumen	Emulsify large fat globules for attack by pancreatic lipase	

USUS BESAR

24.13 Large Intestine

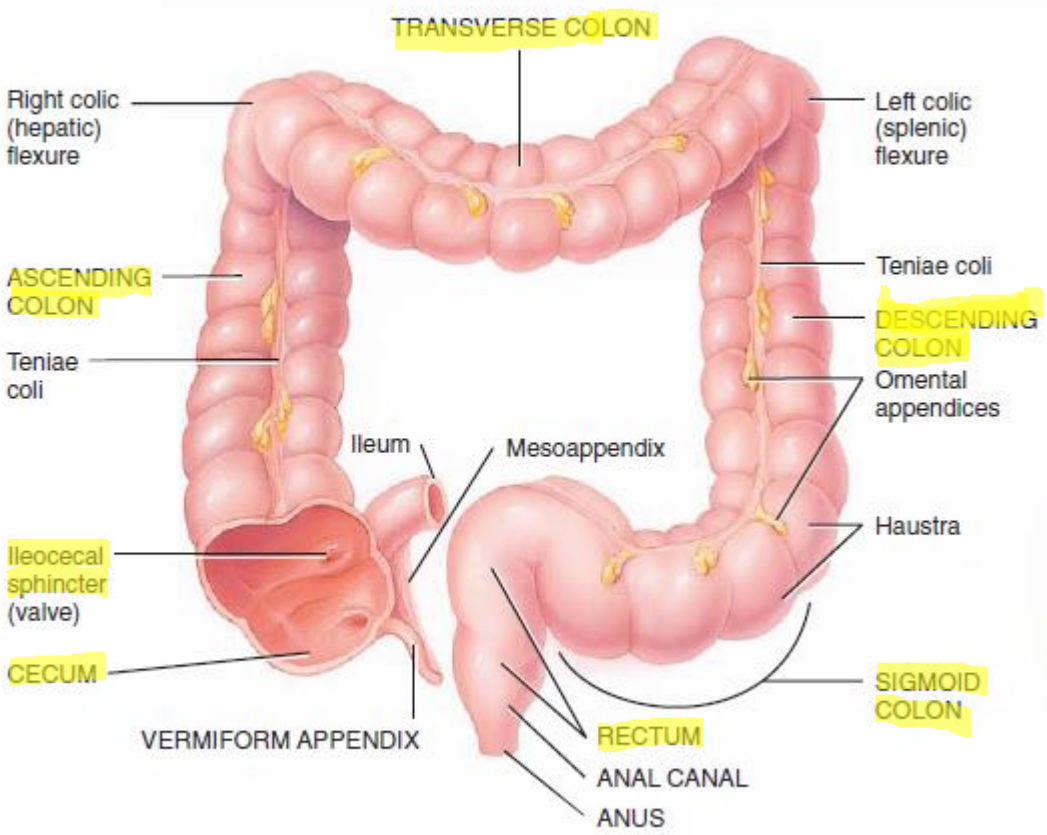
1. The large intestine extends from the ileocecal sphincter to the anus.
2. Its regions include the cecum, colon, rectum, and anal canal.
3. The mucosa contains many goblet cells, and the muscularis consists of teniae coli and haustra.
4. Mechanical movements of the large intestine include haustral churning, peristalsis, and mass peristalsis.
5. The last stages of chemical digestion occur in the large intestine through bacterial action. Substances are further broken down, and some vitamins are synthesized.
6. The large intestine absorbs water, ions, and vitamins.
7. Feces consist of water, inorganic salts, epithelial cells, bacteria, and undigested foods.
8. The elimination of feces from the rectum is called defecation.
9. Defecation is a reflex action aided by voluntary contractions of the diaphragm and abdominal muscles and relaxation of the external anal sphincter.

Usus besar

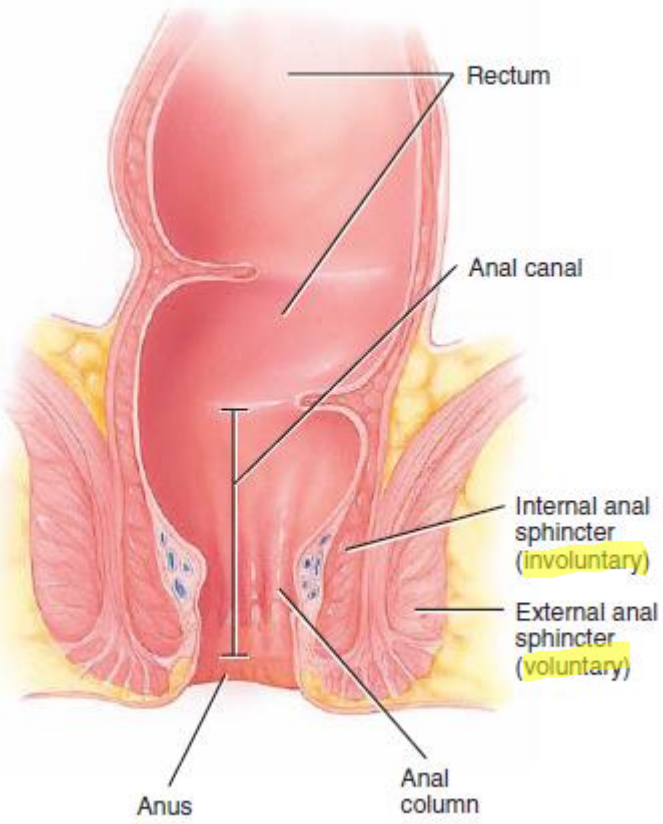
- Kolon, sekum, apendiks dan rektum
- Menerima 500 ml kismus dari usus halus/hari→ residu makanan yg tak tercerna (selulosa), komponen empedu yg tdk diserap dan cairan
- Fungsi utama: menyimpan tinja sebelum defekasi
- Kontraksi haustra→ mengaduk isi kolon maju-mundur secara perlahan

Figure 24.23 Anatomy of the large intestine.

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



(a) Anterior view of large intestine showing major regions



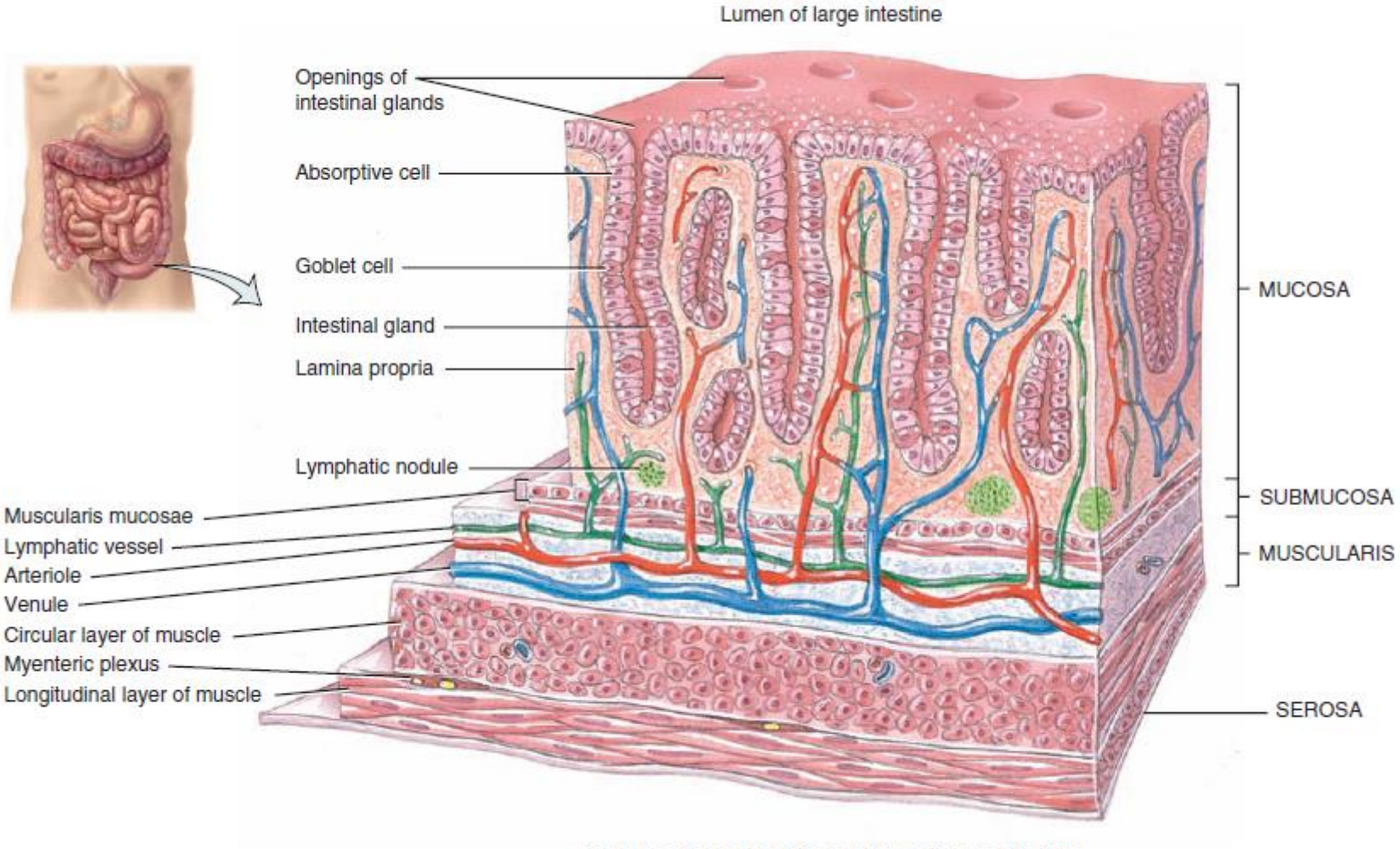
(b) Frontal section of anal canal

FUNCTIONS OF THE LARGE INTESTINE

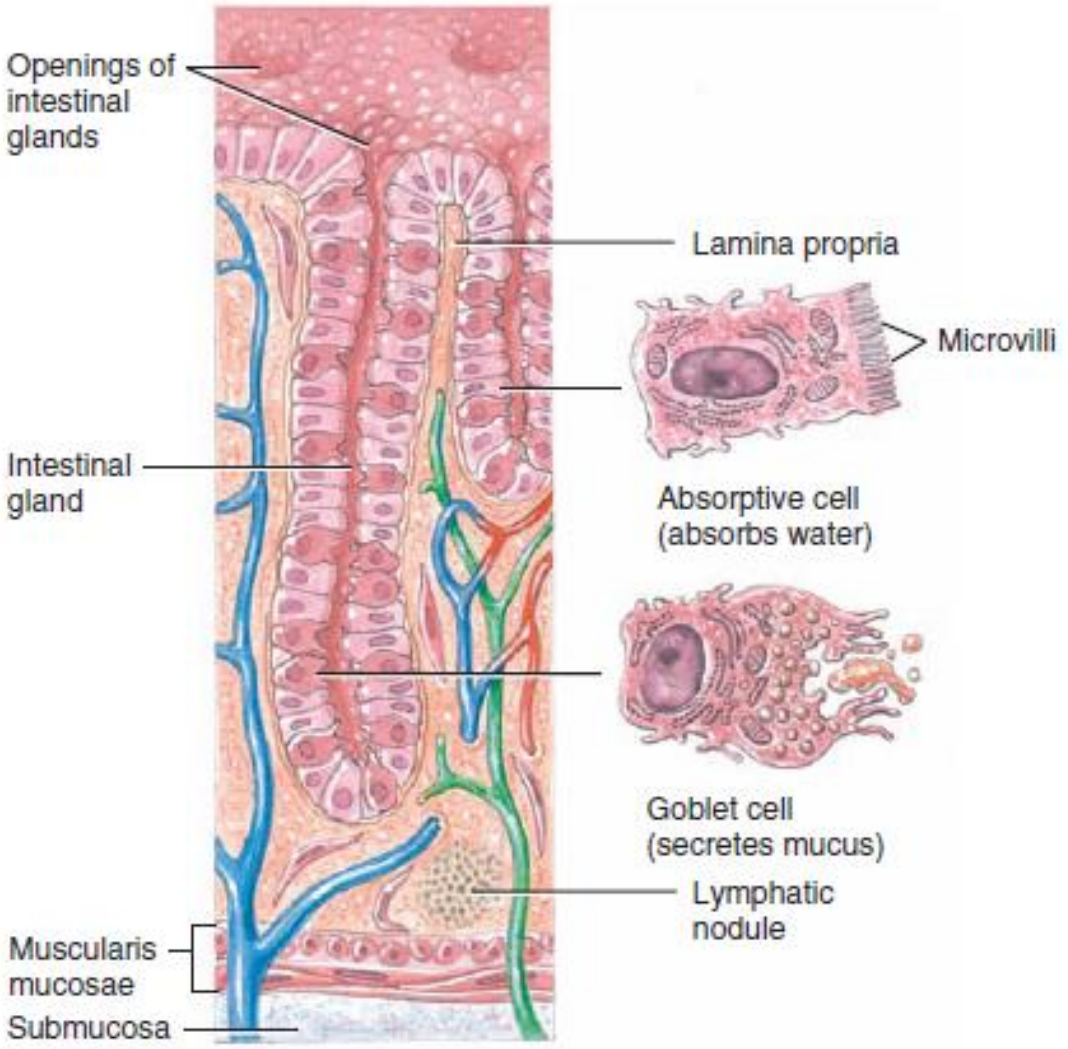
1. Haustral churning, peristalsis, and mass peristalsis drive contents of colon into rectum.
2. Bacteria in large intestine convert proteins to amino acids, break down amino acids, and produce some B vitamins and vitamin K.
3. Absorbing some water, ions, and vitamins.
4. Forming feces.
5. Defecating (emptying rectum).

? Which portions of the colon are retroperitoneal?

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



(a) Three-dimensional view of layers of large intestine



(b) Sectional view of intestinal glands and cell types

FESES DIKELUARKAN O/REFLEKS DEFEKASI

Gerakkan massa di kolon mendorong tinja ke dlm rektum

↓

Perenggangan di rektum

↓

Merangsang reseptor renggang di dinding rektum

↓

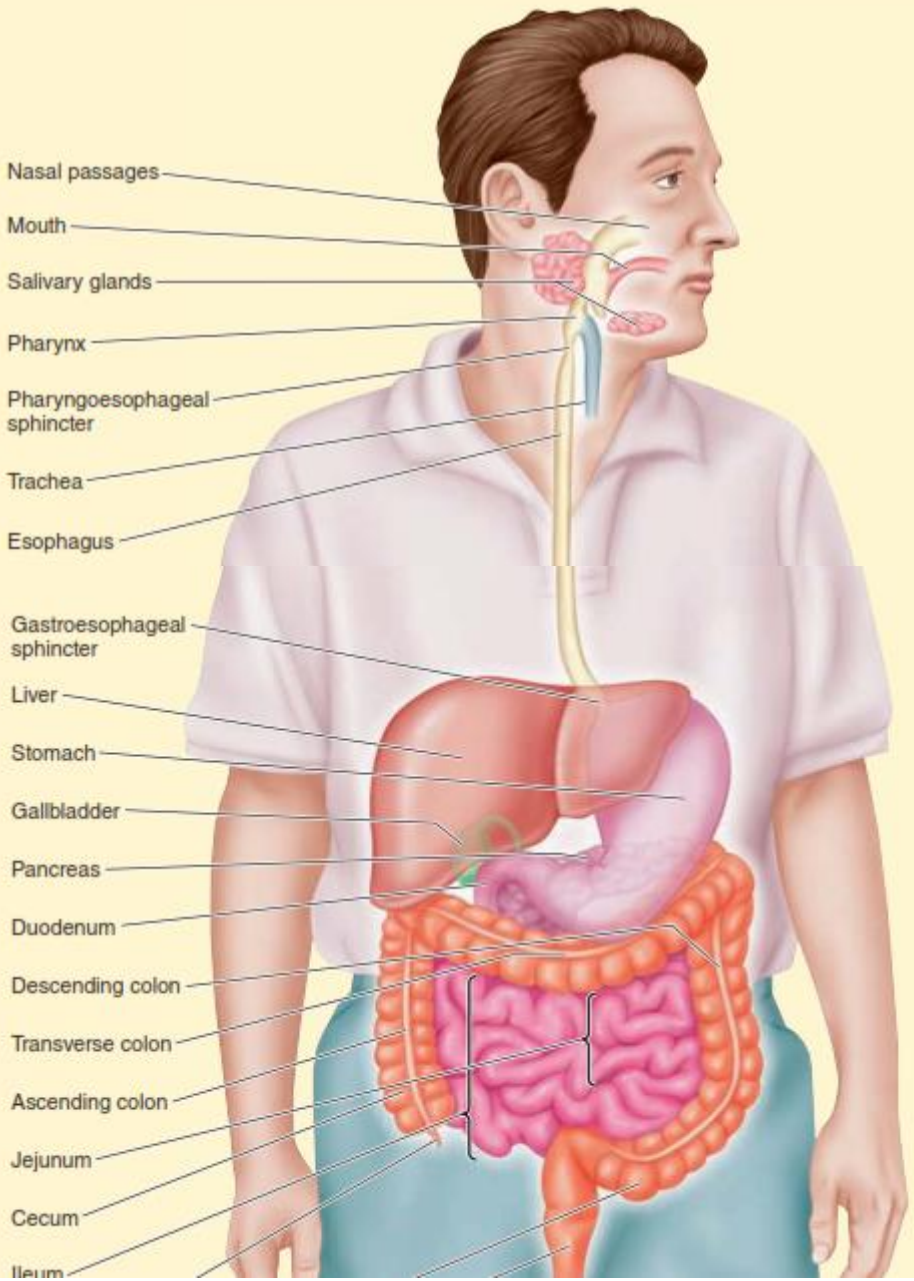
Refleks defekasi

↓

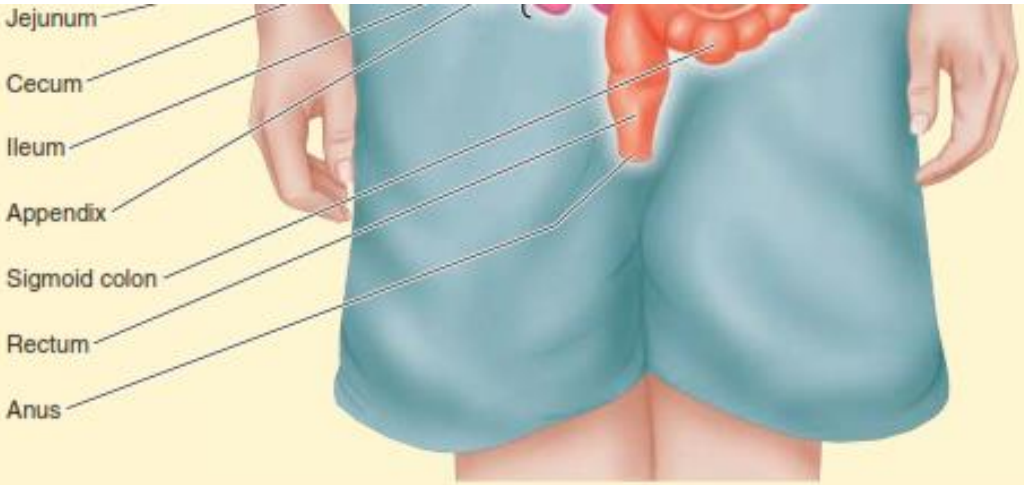
Sfingter ani internus melemas, rektum dan kolon sigmoid berkontraksi lbh kuat, sfingter externus melemas.

KESIMPULAN

TABLE 16-1 Anatomy and Functions of Components of the Digestive System



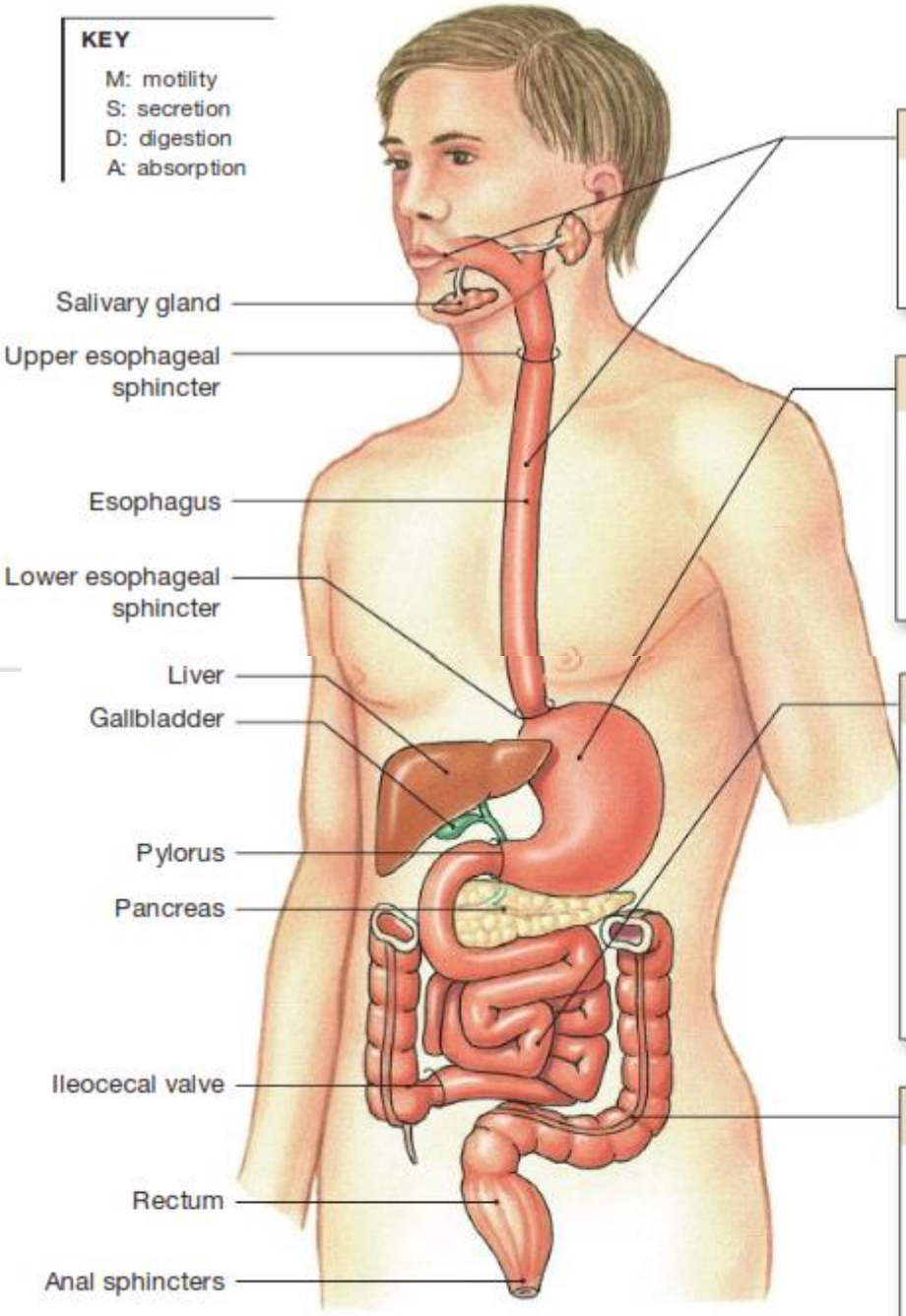
Digestive Organ	Motility
Mouth and Salivary Glands	Chewing
Pharynx and Esophagus	Swallowing
Stomach	Receptive relaxation; peristalsis
Exocrine Pancreas	Not applicable
Liver	Not applicable
Small Intestine	Segmentation; migrating motility complex



Large Intestine	Haustral contractions, mass movements

Secretion	Digestion	Absorption
Saliva ■ Amylase ■ Mucus ■ Lysozyme	Carbohydrate digestion begins	No foodstuffs; a few medications—for example, nitroglycerin
Mucus	None	None
Gastric juice ■ HCl ■ Pepsin ■ Mucus ■ Intrinsic factor	Carbohydrate digestion continues in body of stomach; protein digestion begins in antrum of stomach	No foodstuffs; a few lipid-soluble substances, such as alcohol and aspirin
Pancreatic digestive enzymes ■ Trypsin, chymotrypsin, carboxypeptidase ■ Amylase ■ Lipase	These pancreatic enzymes accomplish digestion in duodenal lumen	Not applicable
Pancreatic aqueous		

Bile ■ Bile salts ■ Alkaline secretion ■ Bilirubin	Bile does not digest anything, but bile salts facilitate fat digestion and absorption in duodenal lumen	Not applicable
Succus entericus ■ Mucus ■ Salt (Small intestine enzymes—disaccharidases and aminopeptidases—are not secreted but function within the brush-border membrane)	In lumen, under influence of pancreatic enzymes and bile, carbohydrate and protein digestion continues and fat digestion is completely accomplished; in brush border, carbohydrate and protein digestion completed	All nutrients, most electrolytes, and water
Mucus	None	Salt and water, converting contents to feces



ORAL CAVITY AND ESOPHAGUS

M: swallowing, chewing
S: saliva (salivary glands), lipase
D: carbohydrates, fats (minimal)
A: none

STOMACH

M: peristaltic mixing and propulsion
S: HCl (parietal cells); pepsinogen and gastric lipase (chief cells); mucus and HCO_3^- (surface mucous cells); gastrin (G cells); histamine (ECL cells)
D: proteins, fats
A: lipid-soluble substances such as alcohol and aspirin

SMALL INTESTINE

M: mixing and propulsion primarily by segmentation
S: enzymes; HCO_3^- and enzymes (pancreas); bile (liver); mucus (goblet cells); hormones: CCK, secretin, GIP, and other hormones
D: carbohydrates, fats, polypeptides, nucleic acids
A: peptides by active transport; amino acids, glucose, and fructose by secondary active transport; fats by simple diffusion; water by osmosis ions, minerals, and vitamins by active transport

LARGE INTESTINE

M: segmental mixing; mass movement for propulsion
S: mucus (goblet cells)
D: none (except by bacteria)
A: ions, water, minerals, vitamins, and small organic molecles produced by bacteria