4th Lecture

In

Anatomy and Physiology

For the

1st Class

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Digestive System (Part II)

Gastrointestinal tract (GIT)

- **Secretary activity of parietal cells and chief cells is initiated and increased by:**

1. Cholinergic nerve ending (parasympathatic stimulation)
2. Histamine
3. Gastrin (affect on parietal cell).

TABLE 23.1 Hormones and Paracrines That Act in Digestion*

HORMONE	SITE OF PRODUCTION	STIMULUS FOR PRODUCTION	TARGET ORGAN	ACTIVITY
Gastrin	Stomach mucosa	Food (particularly partially digested proteins) in stomach (chemical stimulation); acetylcholine released by nerve fibers	Stomach	▪ Causes gastric glands to increase secretory activity; most pronounced effect is on HCl secretion ▪ Stimulates gastric emptying
			Small intestine	▪ Stimulates contraction of intestinal muscle
			Ileocecal valve	▪ Relaxes ileocecal valve
			Large intestine	▪ Stimulates mass movements
Serotonin	Stomach mucosa	Food in stomach	Stomach	▪ Causes contraction of stomach muscle
Histamine	Stomach mucosa	Food in stomach	Stomach	▪ Activates parietal cells to release HCl
Somatostatin	Stomach mucosa; duodenal mucosa	Food in stomach; stimulation by sympathetic nerve fibers	Stomach	▪ Inhibits gastric secretion of all products; inhibits gastric motility and emptying
			Pancreas	▪ Inhibits secretion
			Small intestine	▪ Inhibits GI blood flow; thus inhibits intestinal absorption
			Gallbladder	▪ Inhibits contraction and bile release
Intestinal gastrin	Duodenal mucosa	Acidic and partially digested foods in duodenum	Stomach	▪ Stimulates gastric glands and motility
Secretin	Duodenal mucosa	Acidic chyme (also partially digested proteins, fats, hypertonic or hypotonic fluids, or irritants in chyme)	Stomach	▪ Inhibits gastric gland secretion and gastric motility during gastric phase of secretion
			Pancreas	▪ Increases output of pancreatic juice rich in bicarbonate ions; potentiates CCK's action
			Liver	▪ Increases bile output
Cholecystokinin (CCK)	Duodenal mucosa	Fatty chyme, in particular, but also partially digested proteins	Liver/pancreas	▪ Potentiates secretin's actions on these organs
			Pancreas	▪ Increases output of enzyme-rich pancreatic juice
			Gallbladder	▪ Stimulates organ to contract and expel stored bile
			Hepatopancreatic sphincter (of Oddi)	▪ Relaxes sphincter to allow entry of bile and pancreatic juice into duodenum
Vasoactive intestinal peptide (VIP)	Duodenal mucosa	Chyme containing partially digested foods	Duodenum	▪ Stimulates buffer secretion; dilates intestinal capillaries
			Stomach	▪ Inhibits HCl production
			Small intestine	▪ Relaxes intestinal smooth muscle
Motilin	Duodenal mucosa	Fasting; periodic release every $1\frac{1}{2}$–2 hours by neural stimuli	Proximal duodenum	▪ Stimulates migrating motility complex

*Except for somatostatin, all of these polypeptides also stimulate the growth (particularly of the mucosa) of the organs they affect.

Innervations of the stomach

- By sympathatic and parasympathatic

Contractions of stomach muscles churn up and thoroughly mix up with gastric juice secreted by stomach.

Small Intestine

- The small intestine is the site of the terminal food digestion, nutrient absorption, and endocrine secretion.
- The small intestine consists of three segments:

  - Duodenum

  -Jejunum

  - illium

Histology of small intestine characterized by: Villi, Plica, lieberkuhn glands

- **Lieberkuhn glands or Intestinal glands (Crypts)**

  - simple tubular glands

  - extend into lamina properia

  - empty to the base of villi

  - contain Stem cells goblet cells, absorptive cells, and Panth's cells (a protective cells secret an enzyme that digest cell wall of bacteria).

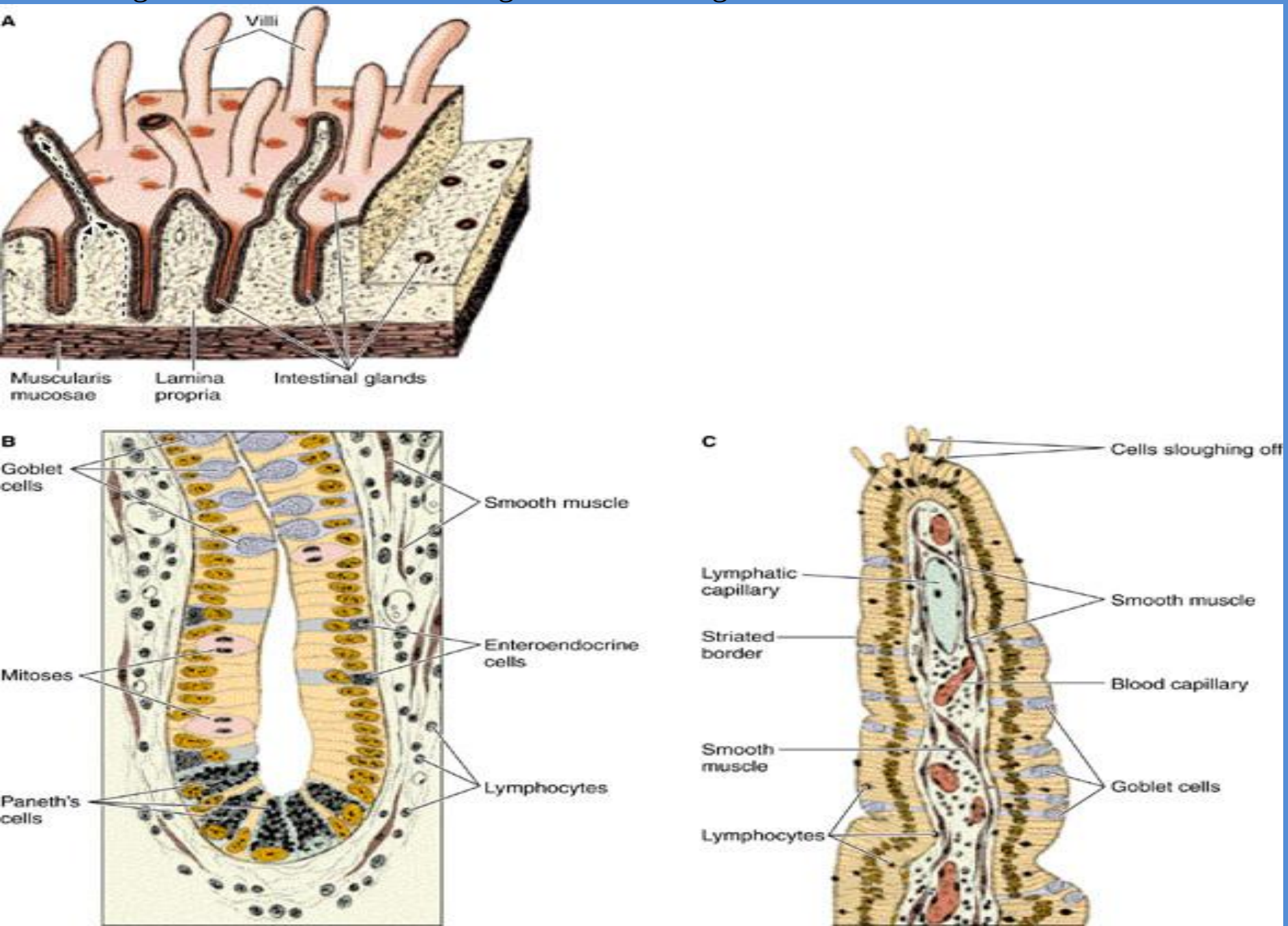
- **Villi**

  - extensions of mucosa into lumen of small intestine.

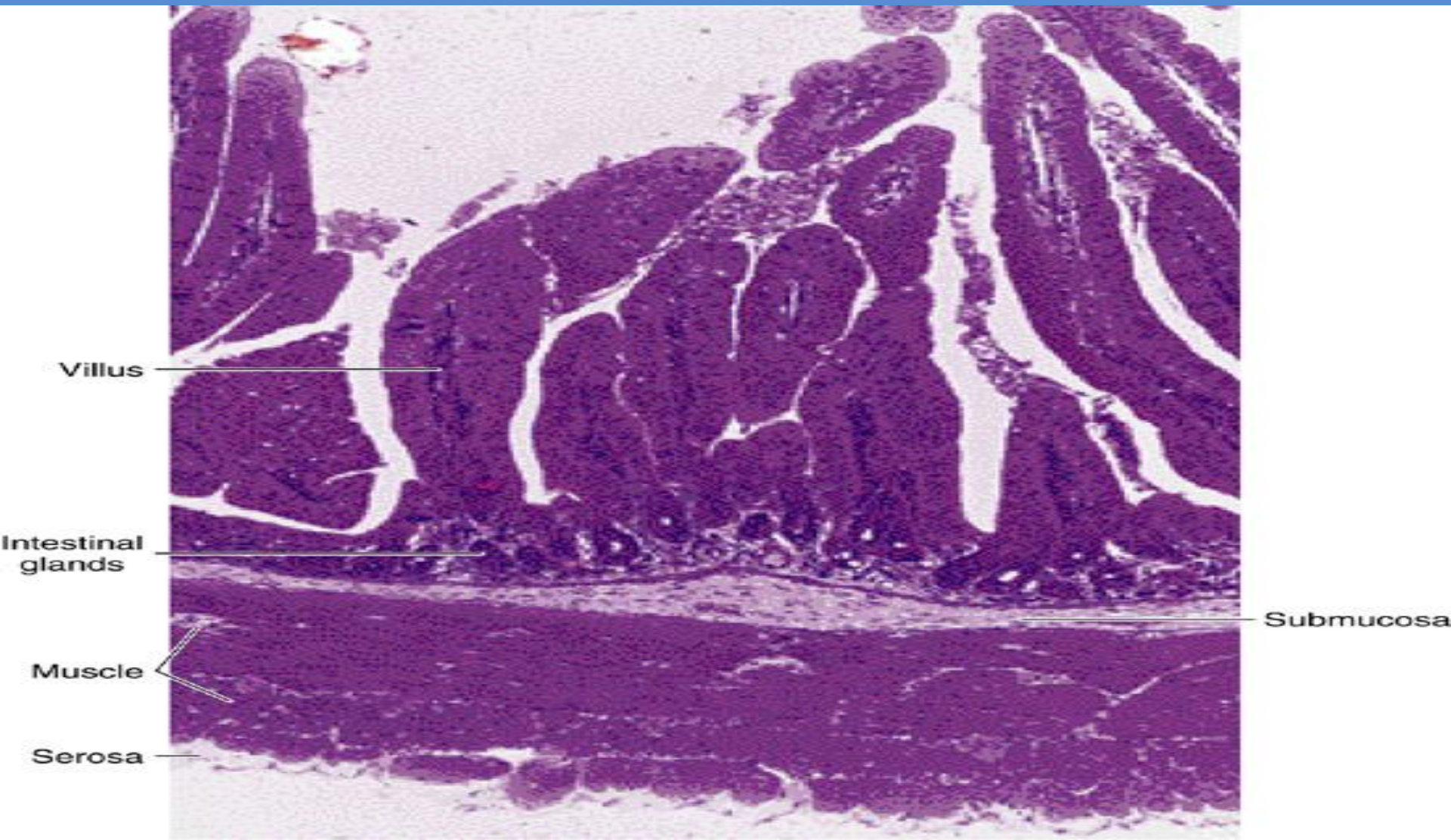
- **Plica**

  The lining of the small intestine shows a series of permanent folds called plicae circulares, consisting of mucosa and submucosa.

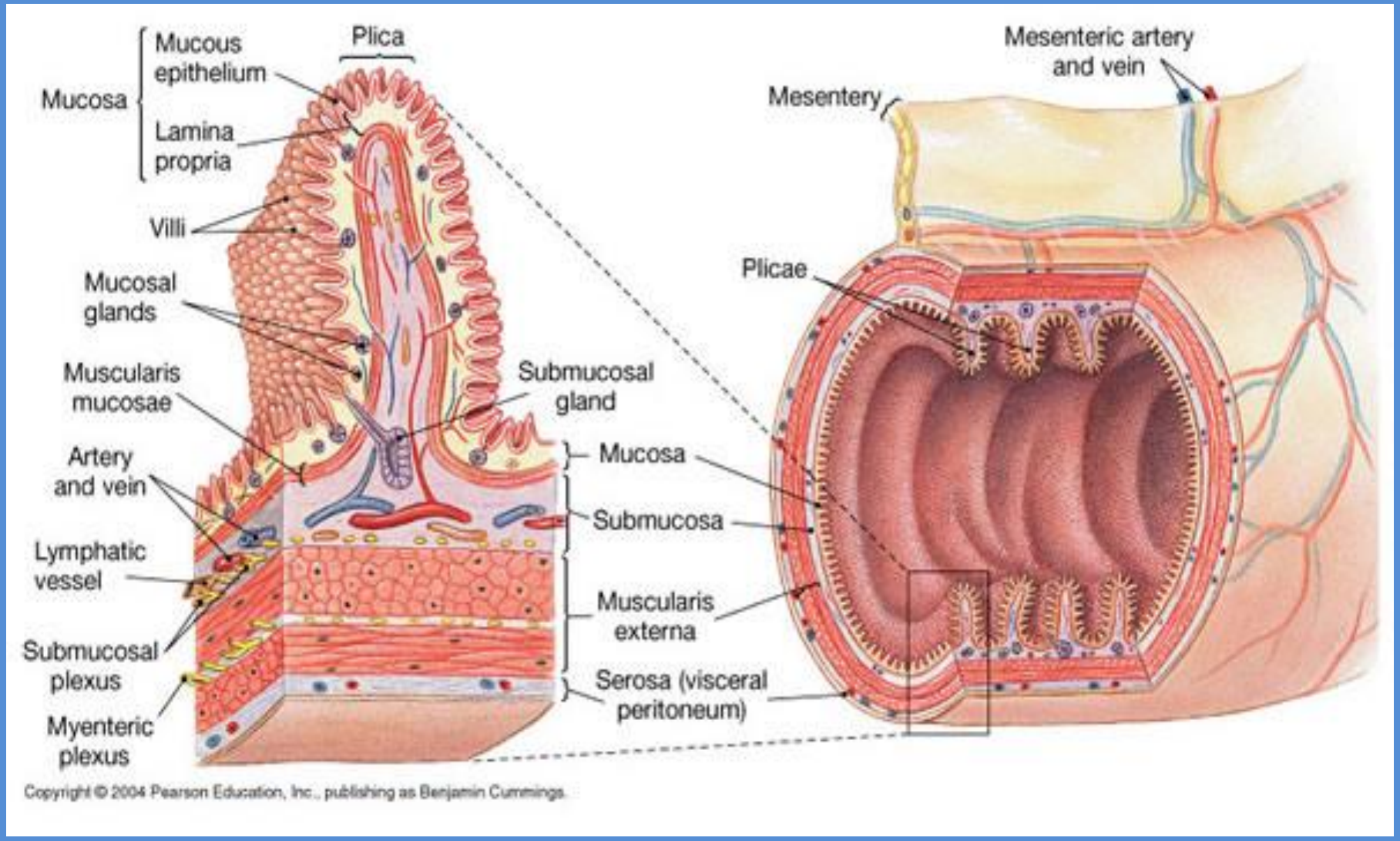
Figure 15—27. Schematic diagrams illustrating the structure of the small intestine.



Photomicrograph of the small intestine. Note the villi, intestinal glands, submucosa, muscle layers, and serosa. PT stain. Low magnification.



Photomicrograph of the small intestine.



Histology of the small Intestine

- The lining of the small intestine shows a series of permanent folds called plicae circulares, consisting of mucosa and submucosa.
- Plicae well developed in the jejunum, but do not constitute a significant feature of the duodenum and ileum.
- Intestinal villi are mucosa projecting into the lumen of the small intestine.
- Between the villi are small openings of simple tubular glands called intestinal glands(glands of lieberkuhn).

•Therefore the small intestine is modified for dramatically increased surface area.

- The Doudenum has **Brunner's glands** (submucosal doudenal glands secret neutral alkaline mucus). There secretions protect doudenum from erosion by acid entering from stomach.
- The jejunum has many long leaf like villi (plicae circularis). And intermediate number of goblet cells (produce mucus).
- The ileum has numerous goblet cells and Peyer's patchs (aggregation of lymphocytes).

Intestinal submucosal glands increase secretion in response to:

- Local reflex
- Hormones: enterocrinin by enteroendocrine cells
- Parasympathetic stimulation
- Innervation of intestinal glands:

  - **Sympathatic** stimulation leads to decrease intestinal secretions

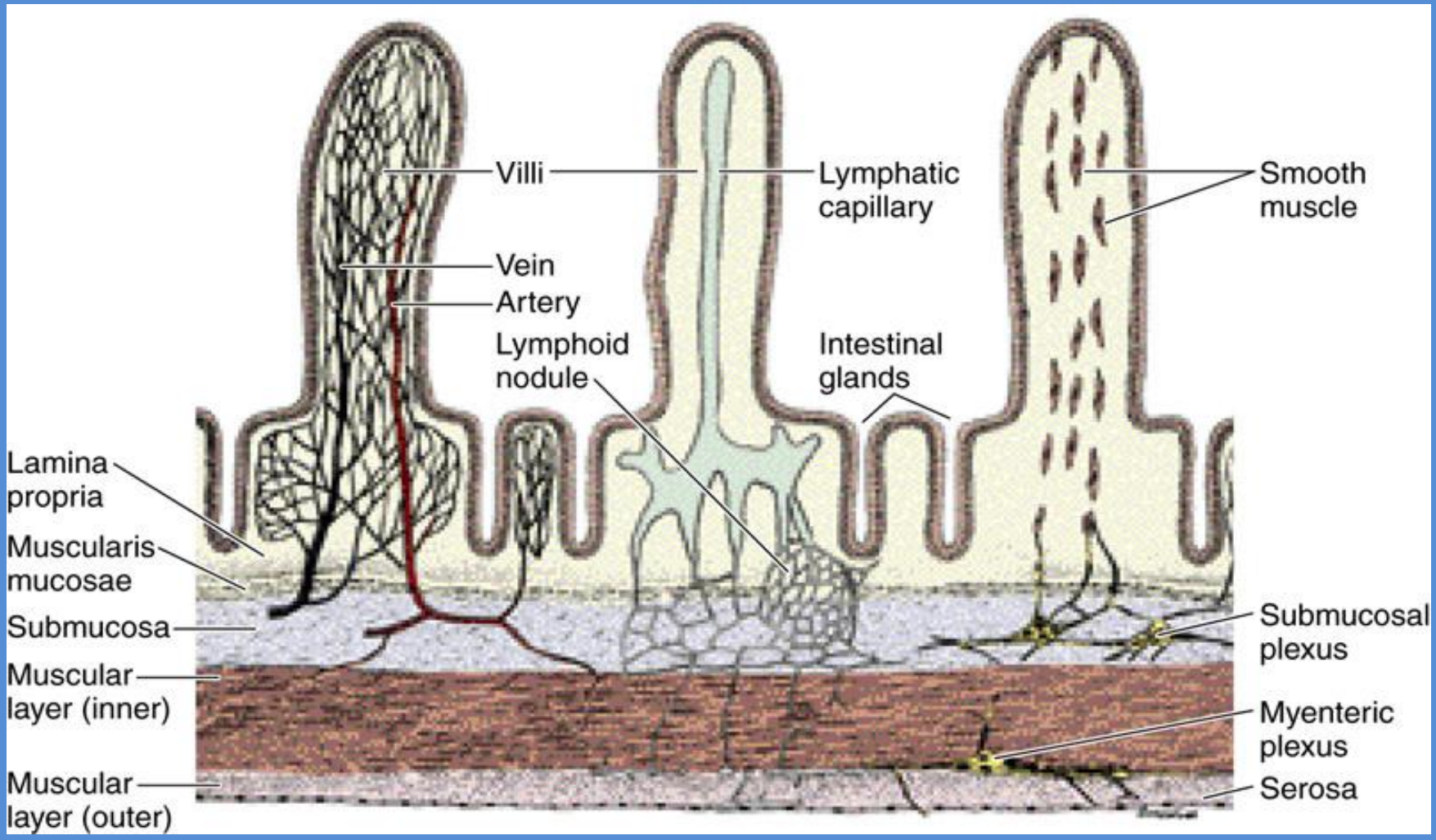
  - **Parasympathatic** stimulation leads to increase intestinal secretions.

Vessels of the small intestine

- The blood vessels that nourish the intestine and remove absorbed products of digestion penetrate the muscularis and form a large plexus in the submucosa. Therefore each villus receives one or more branches that form a capillary network just below its epithelium
- Lacteals (capillary lymphatic vessel of villus).

  - Important for the absorption of lipids because blood circulation does not easily accept the lipoproteins produced by the tall columnar during this process.

Blood circulation (left), lymphatic circulation (center), and innervation (right) of the small intestine. The smooth muscle system for contracting the villi is illustrated in the villus on the right.



- In the duodenum there is a major duodenal papilla in which the bile and pancreatic secretions enter the intestine through Ampulla of Vater.

- **Bile secretion** leads to *emulsify the fats*. Emulsification of fats is important for *fat digestion by lipase enzyme which is produced by pancreas.*

- **Pancreas** secrets **amylase enzyme** (for *carbohydrate digestion*), **lipase enzyme** (for *fat digestion*) and **proteolytic enzymes** (for protein digestion).

Large Intestine

- An organ that the microbial digestion, liquid absorption, and transportation of undigested food to the rectum occurs.
- The junction between the end of ileum and beginning of large intestine is gaurded by **ileocaecal sphincter**.
- Large intestine is much wider than small intestine.
- The wall of large intestine shows a series of sacculations (also called haustrations).

It divided into:

1. Cecum and appendix
2. Colon: ascending, transverse, descending, segmoid
3. Rectum for storage of waste products.
4. Anus

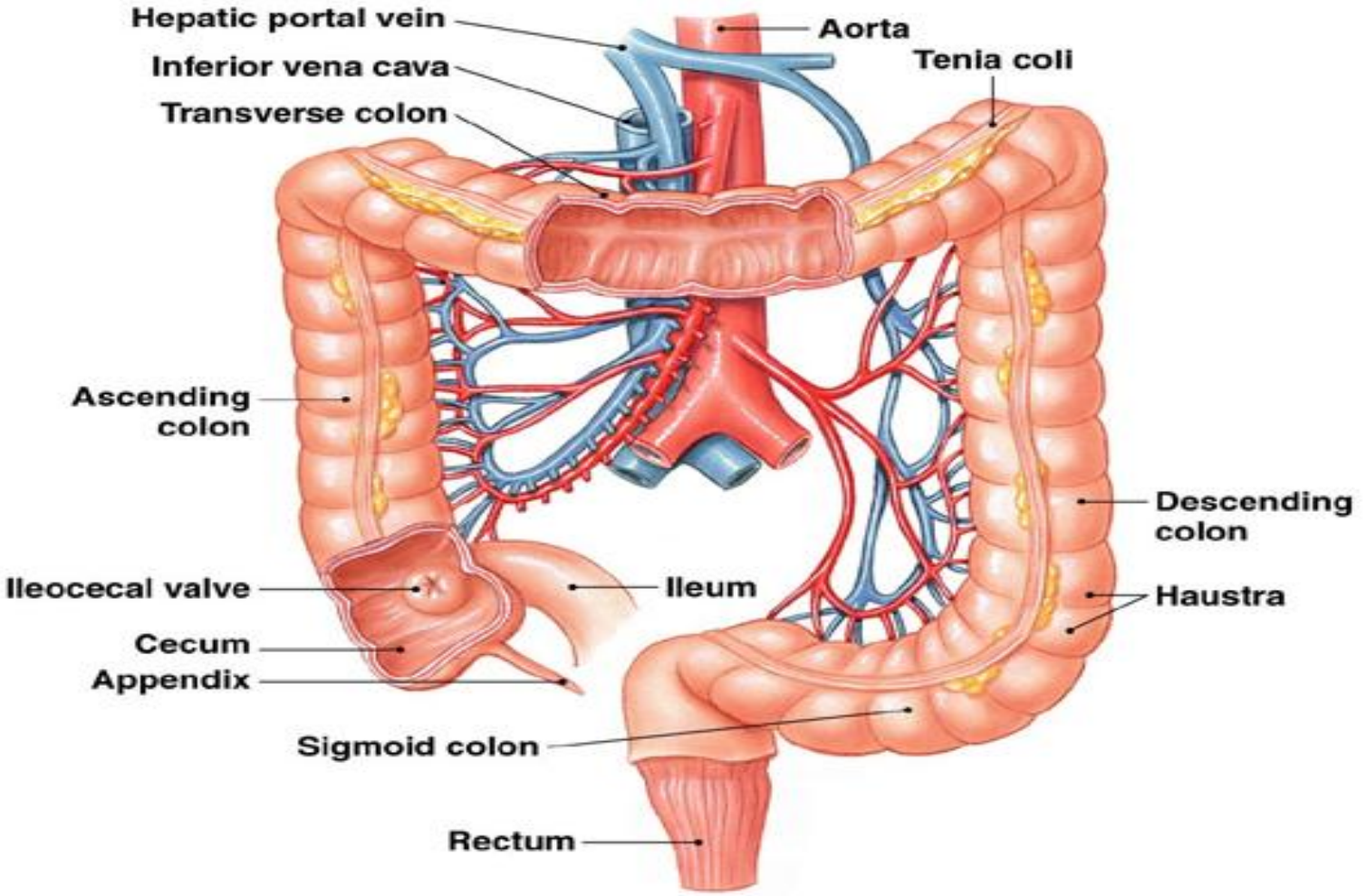


Fig. 21-31

largeintestines

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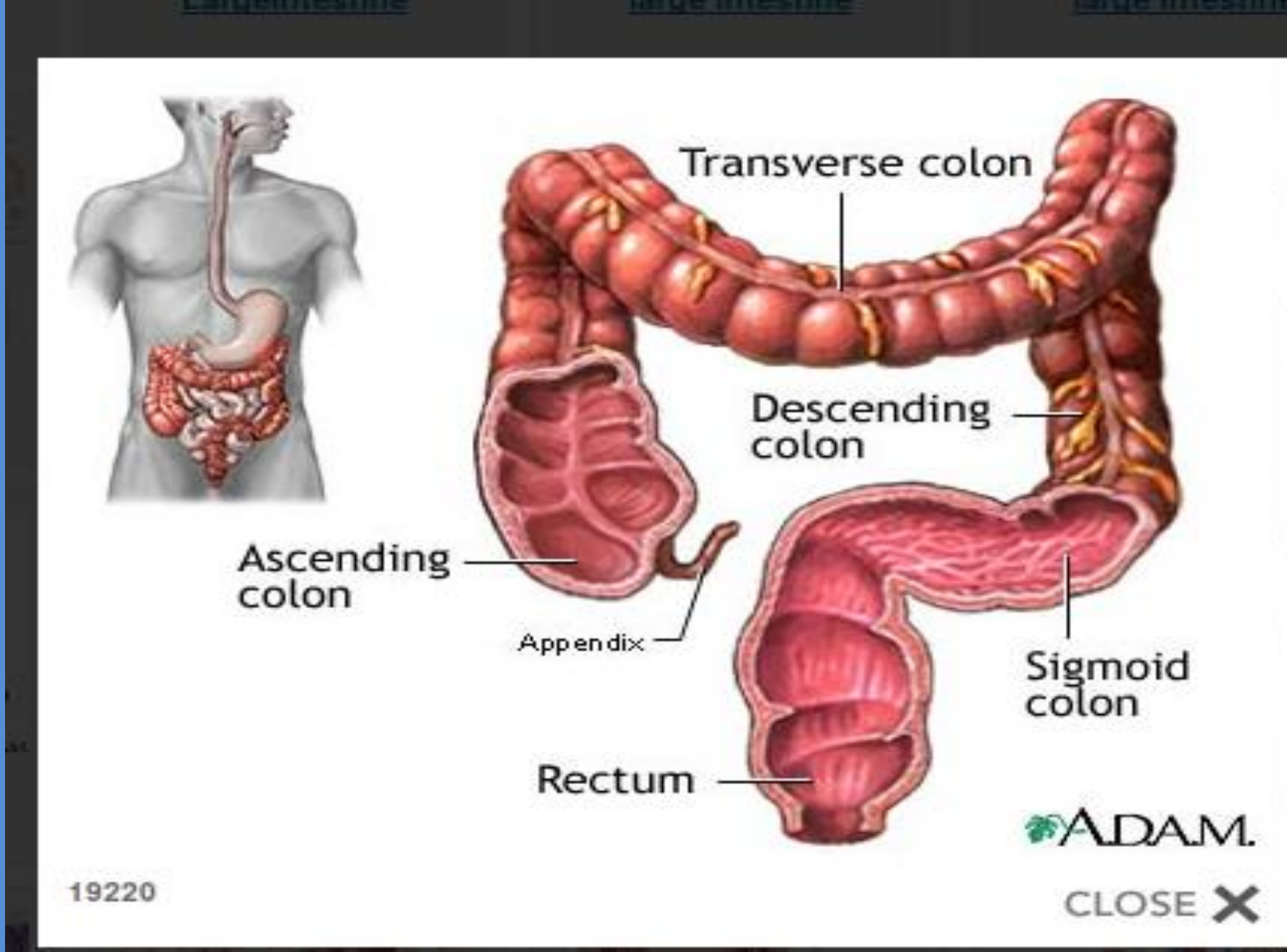
Transverse colon
Descending colon
Ascending colon
Appendix
Sigmoid colon
Rectum
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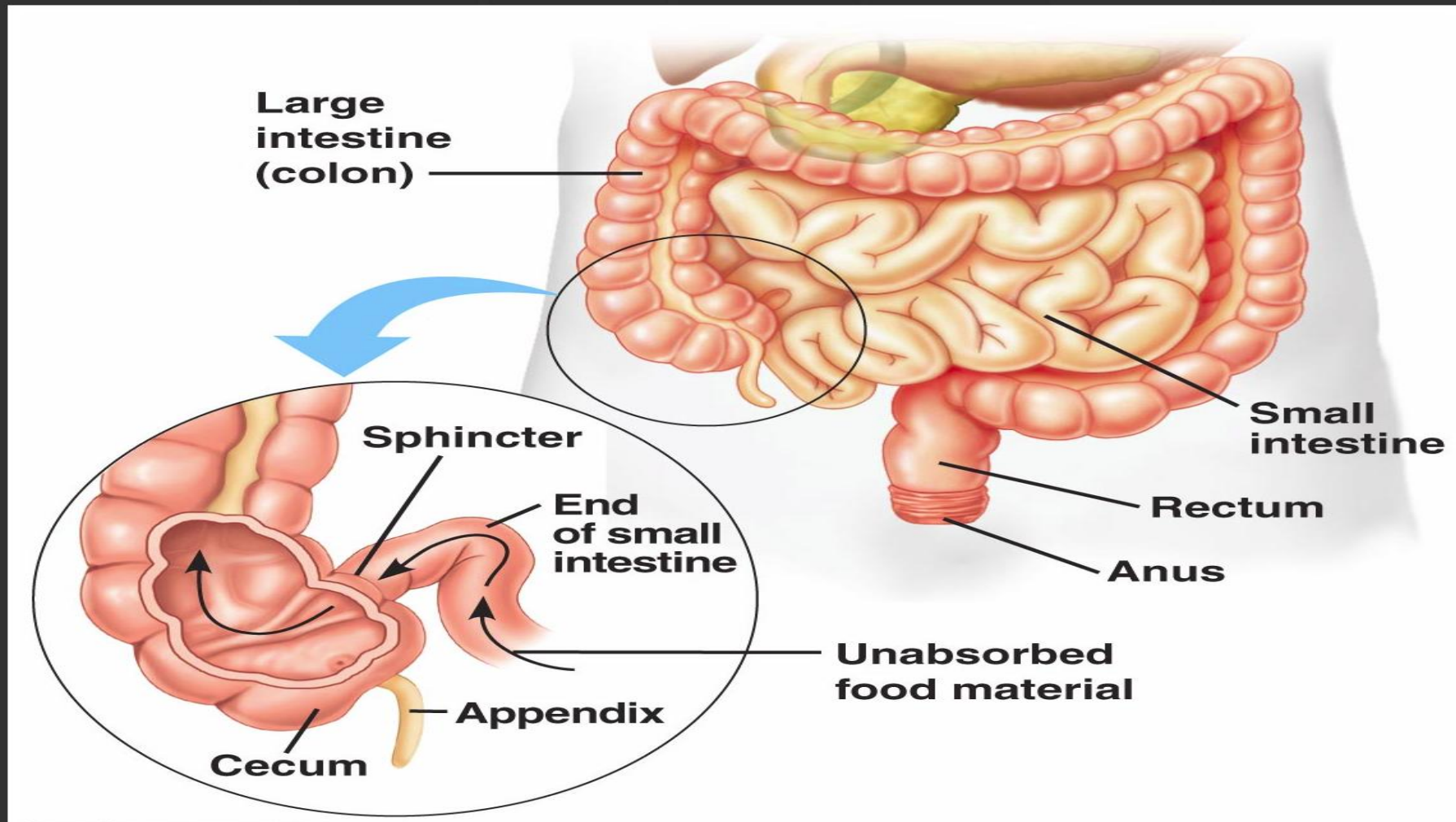
Large intestine (colon)
Small intestine
Rectum
Anus
Sphincter
End of small intestine
Unabsorbed food material
Appendix
Cecum
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21 12SmallLargeIntestine L
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Intestinal movements

- Movements of small intestine are of two types:
  1. **Segmentation movements** (alternate contraction and relaxation of short segments of intestine) this type of movement is important for *mixing and absorption of food*.
  2. **Peristaltic movements** this type is important for propel intestinal contents.
- Ingestion of food causes increased peristaltic movements in the terminal ileum. This constitutes the ***gastro-ileal reflex.*** The ileocaecal sphincter relaxes and intestinal content enter the caecum.

- **Large intestine** also has **segmentation movements** *(they help in reabsorption of water and salts) and* **peristaltic movements.** These movements are stimulated by ***entry of food into the stomach. This is the gastro-colic reflex.***

TABLE 23.2 Overview of the Functions of the Gastrointestinal Organs

ORGAN	MAJOR FUNCTIONS*	COMMENTS/ADDITIONAL FUNCTIONS
Mouth and associated accessory organs	Ingestion: food is voluntarily placed into oral cavity Propulsion: voluntary (buccal) phase of deglutition (swallowing) initiated by tongue; propels food into pharynx Mechanical digestion: mastication (chewing) by teeth and mixing movements by tongue Chemical digestion: chemical breakdown of starch is begun by salivary amylase present in saliva produced by salivary glands	Mouth serves as a receptacle; most functions performed by associated accessory organs. Mucus present in saliva helps dissolve foods so they can be tasted and moistens food so that tongue can compact it into a bolus that can be swallowed. Oral cavity and teeth cleansed and lubricated by saliva
Pharynx and esophagus	Propulsion: peristaltic waves move food bolus to stomach, thus accomplishing involuntary (pharyngeal-esophageal) phase of deglutition	Primarily food chutes; mucus produced helps to lubricate food passageways
Stomach	Mechanical digestion and propulsion: peristaltic waves mix food with gastric juice and propel it into the duodenum Chemical digestion: digestion of proteins begun by pepsin Absorption: absorbs a few fat-soluble substances (aspirin, alcohol, some drugs)	Also serves as storage site for food until it can be moved into the duodenum. Hydrochloric acid produced is a bacteriostatic agent and activates protein-digesting enzymes. Mucus produced helps lubricate and protect stomach from self-digestion. Intrinsic factor produced is required for intestinal absorption of vitamin B_{12}
Small intestine and associated accessory organs (liver, gallbladder, pancreas)	Mechanical digestion and propulsion: segmentation by smooth muscle of the small intestine continually mixes contents with digestive juices and moves food along tract and through ileocecal valve at a slow rate, allowing sufficient time for digestion and absorption Chemical digestion: digestive enzymes conveyed in from pancreas and brush border enzymes attached to villi membranes complete digestion of all classes of foods Absorption: breakdown products of carbohydrate, protein, fat, and nucleic acid digestion, plus vitamins, electrolytes, and water, are absorbed by active and passive mechanisms	Small intestine is highly modified for digestion and absorption (circular folds, villi, and microvilli). Alkaline mucus produced by intestinal glands and bicarbonate-rich juice ducted in from pancreas help neutralize acidic chyme and provide proper environment for enzymatic activity. Bile produced by liver emulsifies fats and enhances (1) fat digestion and (2) absorption of fatty acids, monoglycerides, cholesterol, phospholipids, and fat-soluble vitamins. Gallbladder stores and concentrates bile; bile is released to small intestine in response to hormonal signals
Large intestine	Chemical digestion: some remaining food residues are digested by enteric bacteria (which also produce vitamin K and some B vitamins) Absorption: absorbs most remaining water, electrolytes (largely NaCl), and vitamins produced by bacteria Propulsion: propels feces toward rectum by peristalsis, haustral churning, and mass movements Defecation: reflex triggered by rectal distension; eliminates feces from body	Temporarily stores and concentrates residues until defecation can occur. Copious mucus produced by goblet cells eases passage of feces through colon

liver

- It is the largest internal organ in the body.
- The nutrient absorbed in the digestive tract are processed (detoxification and metabolism) and stored in the liver for use by other parts of the body. Thus liver is an interface between digestive system and blood.
- All materials absorbed via intestine reach the liver through the portal vein except the complex lipids which transport mainly by lymph vessel.
- It consists of four lobes (1. left lobe 2. right lobe 3. Quadrate lobe 4. Caudate lobe)

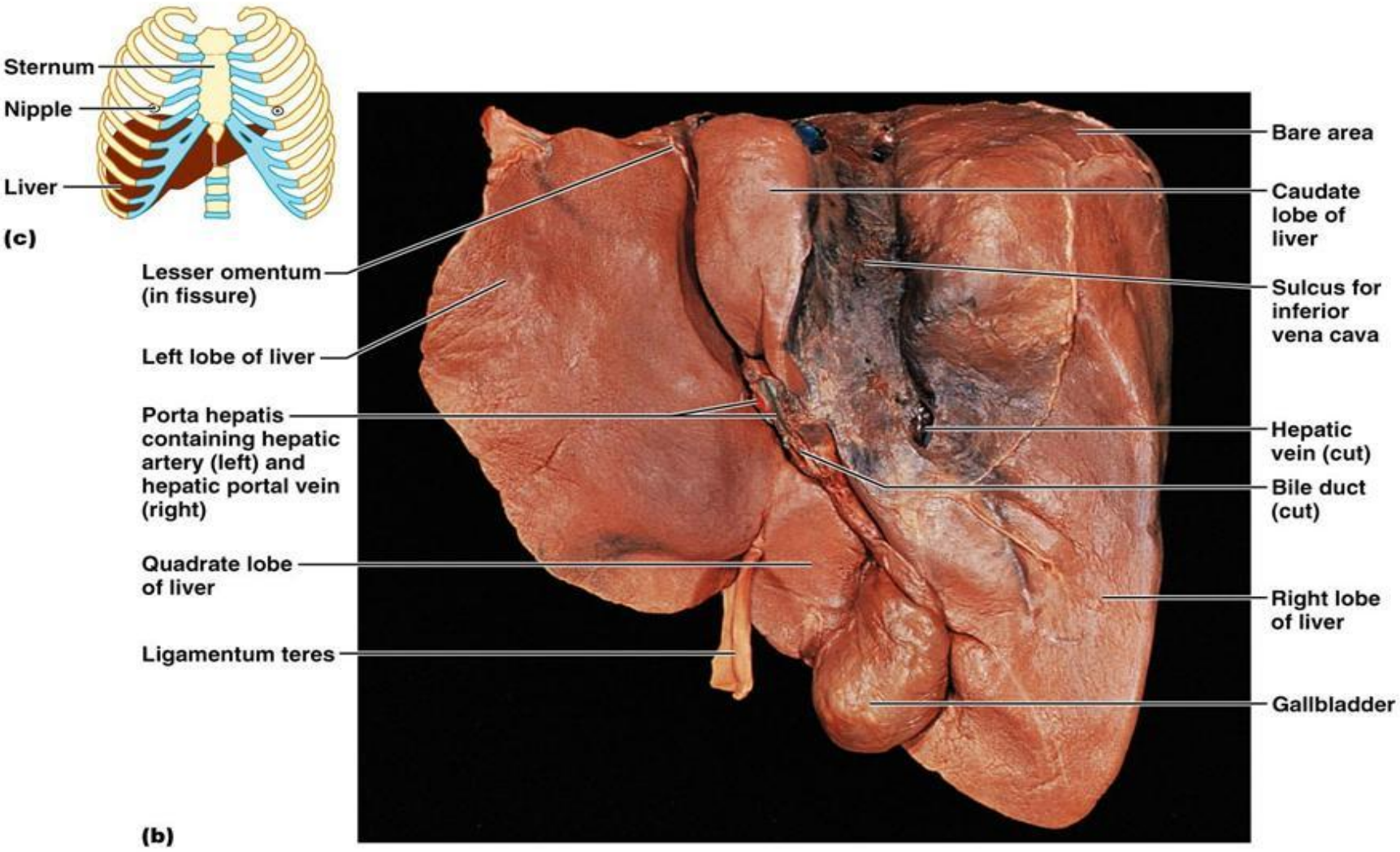


Figure 23.23b, c

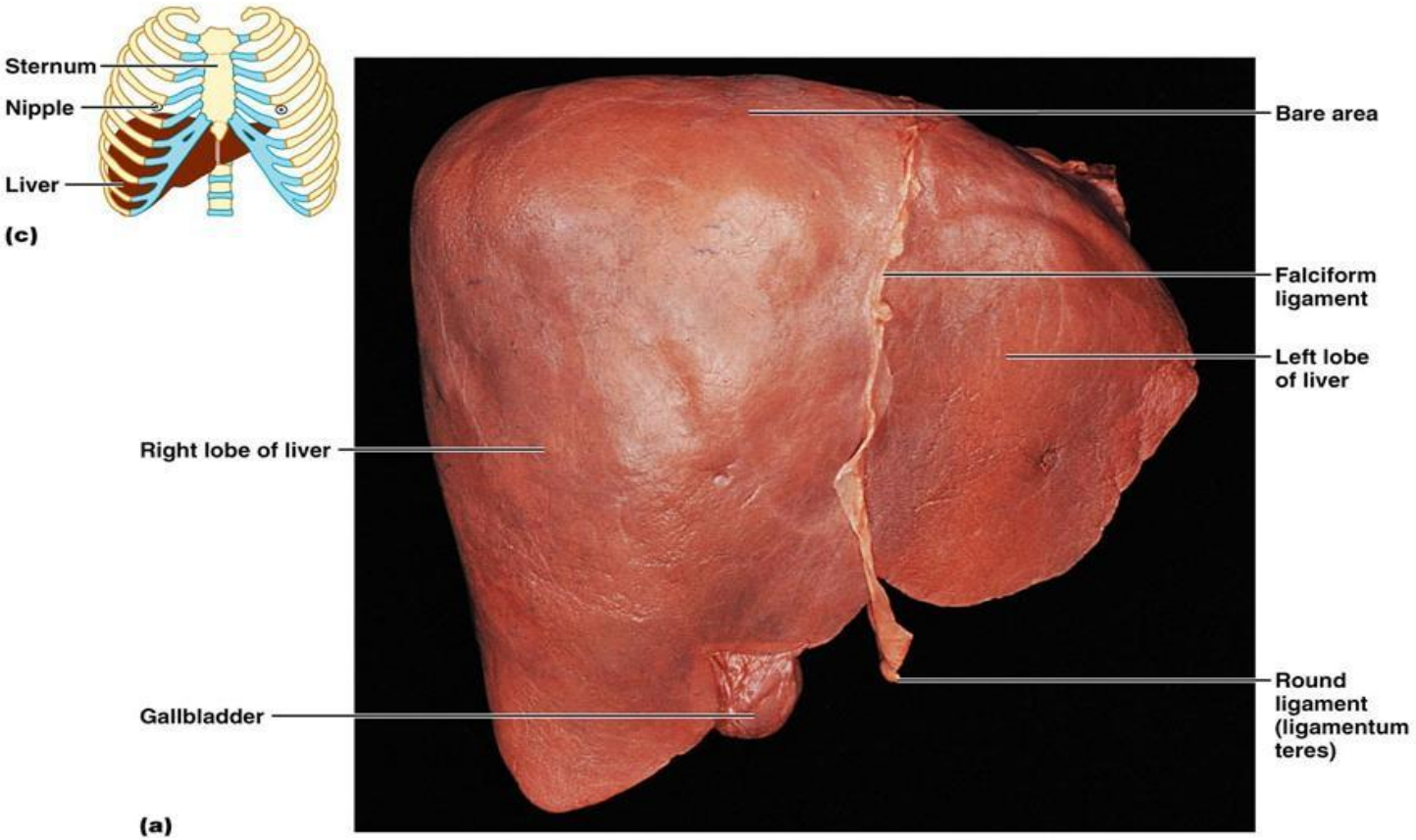
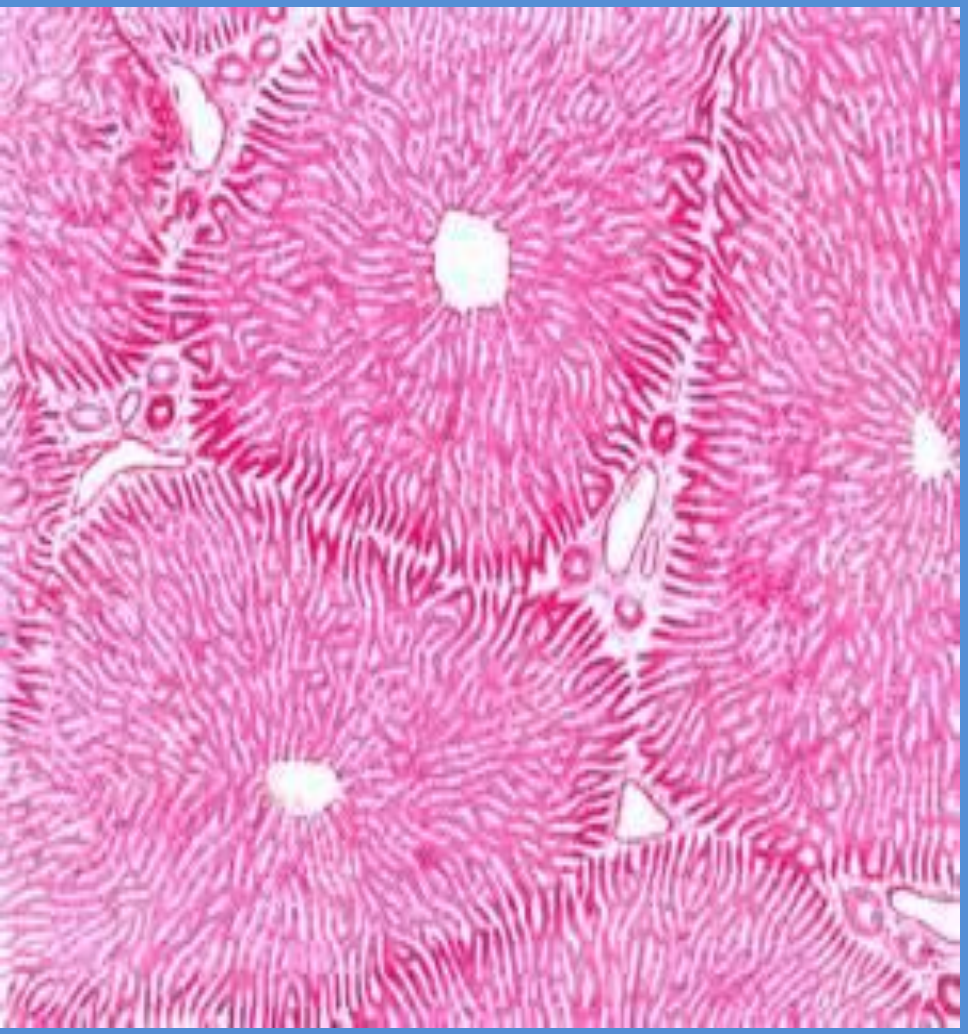
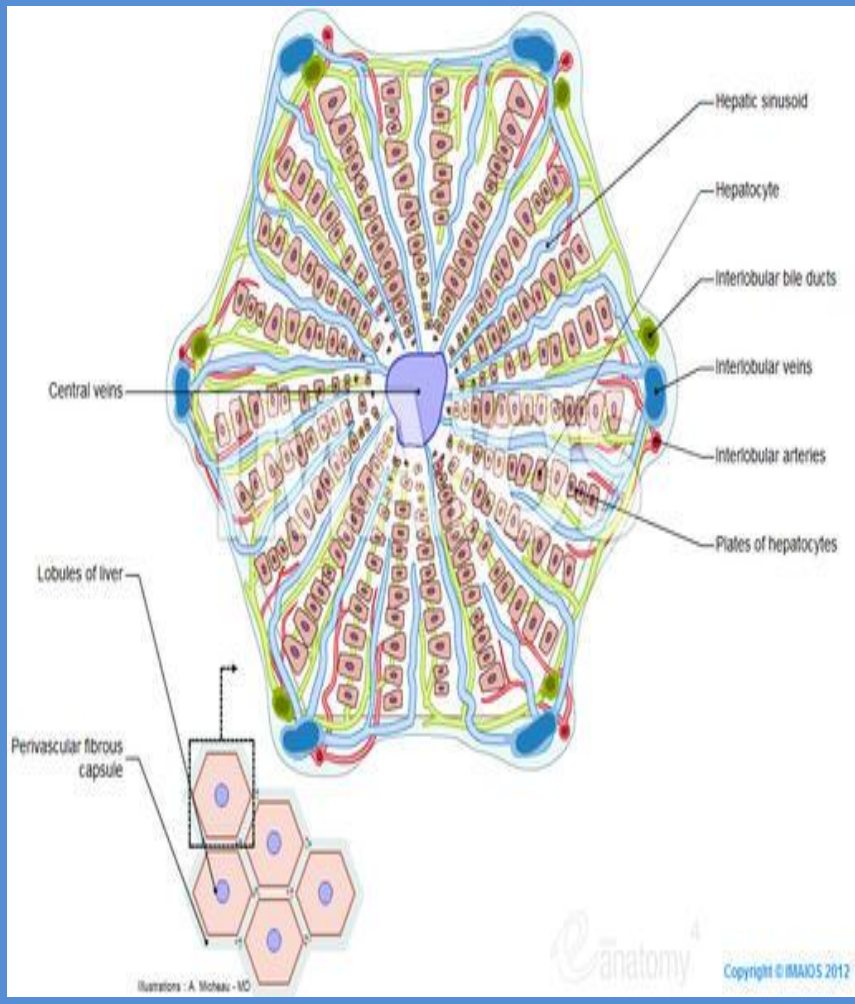


Figure 23.23a, c

HISTOLOGY OF THE LIVER

- Liver mainly consists from a large number of lobules (hexagonal lobule)
- three adjacent lobules form an area called portal area (this area contains blood vessels, bile duct and lymph vessel).
- In the center of each lobule there is central vein.
- Hepatocytes arrange as a cord or plate from central vein to the periphery of lobules.
- Sinusiods carry blood from portal vein and hepatic artery (in the portal area) to the central vein.
- Kupffer’s cells




Hepatic sinusoid
Hepatocyte
Interlobular bile ducts
Interlobular veins
Central veins
Interlobular arteries
Plates of hepatocytes
Lobules of liver
Perivascular fibrous capsule
Illustrations : A. Michaux - MD
Anatomy
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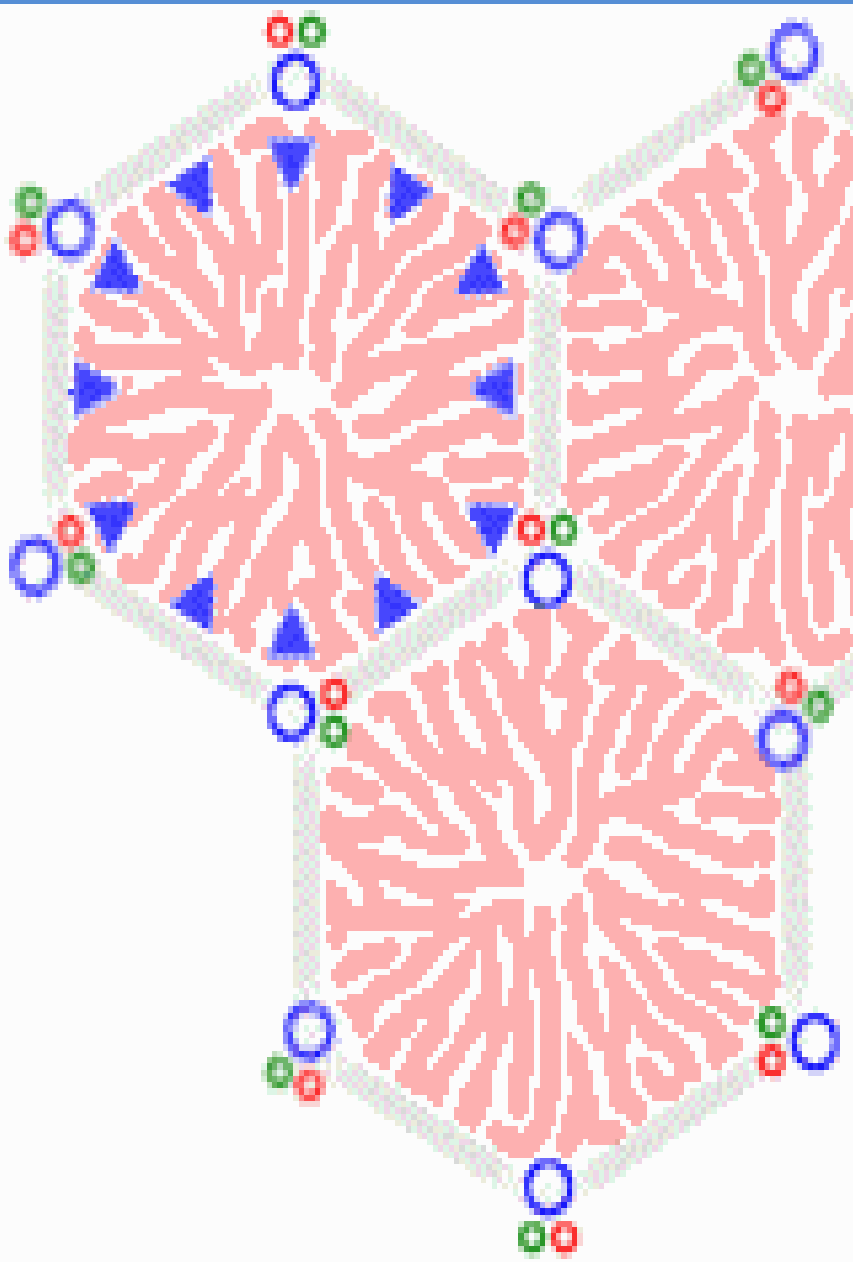


"Classical" liver lobule: the unit drained by a central vein

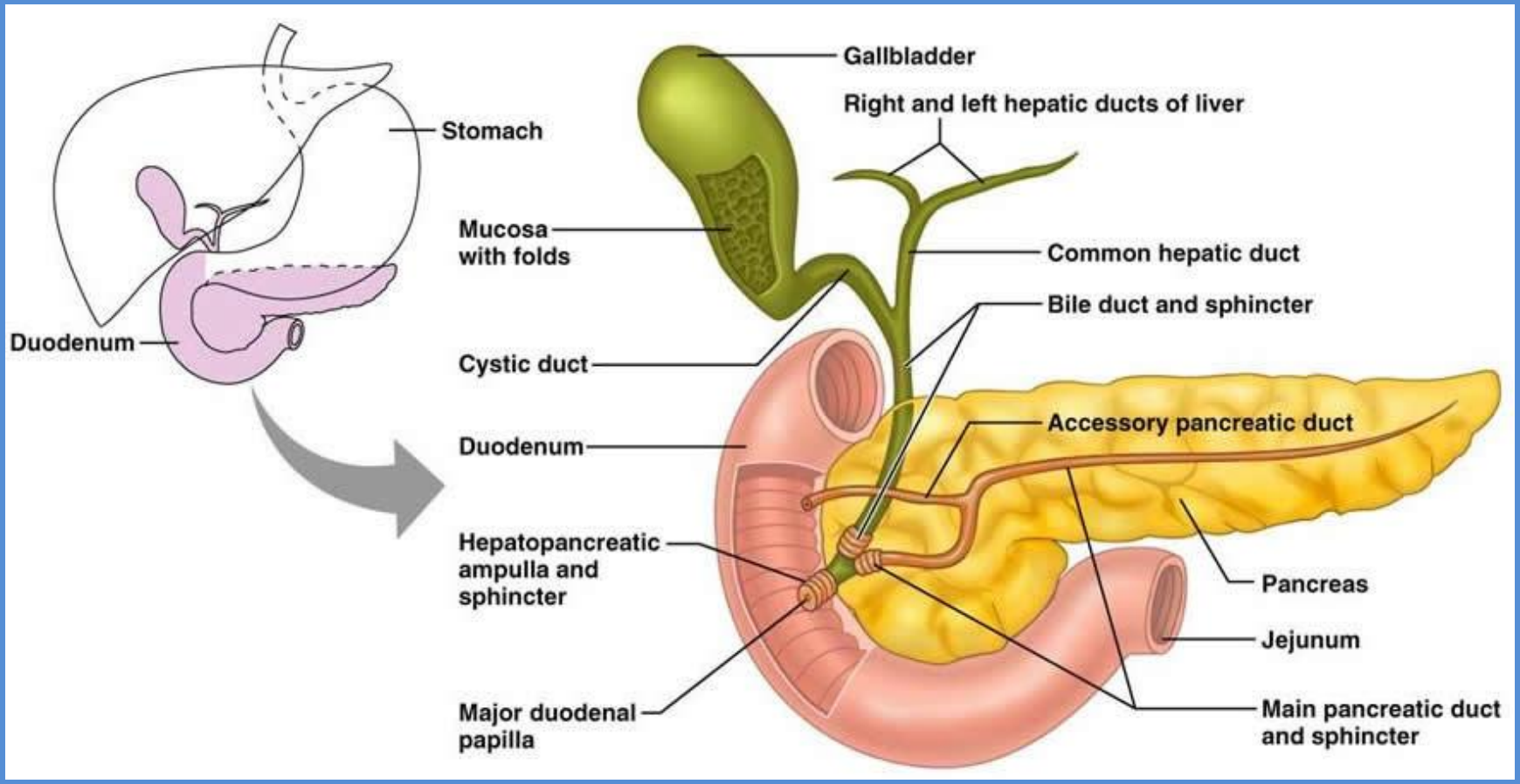
Pancreas

- It is an exocrine and endocrine gland.
- Exocrine secretion are amylase, lipase, and proteolytic enzymes.
- Anatomically pancreas consist from:

1. Head
2. Body
3. Tail

- Secretion of pancreas carry by main pancreatic duct.
- The main pancreatic duct units with common bile duct to form ampula of vater

Pancreas


Stomach
Duodenum
Gallbladder
Right and left hepatic ducts of liver
Mucosa with folds
Common hepatic duct
Bile duct and sphincter
Cystic duct
Accessory pancreatic duct
Duodenum
Hepatopancreatic ampulla and sphincter
Pancreas
Jejunum
Major duodenal papilla
Main pancreatic duct and sphincter

Pancreatic secretion is controlled by:

1. **Hormones** mainly **secretin** and **cholecystokinin** are produced by *enteroendocrine cells of duodenal mucosa.*
2. **Parasympathatic stimulation**