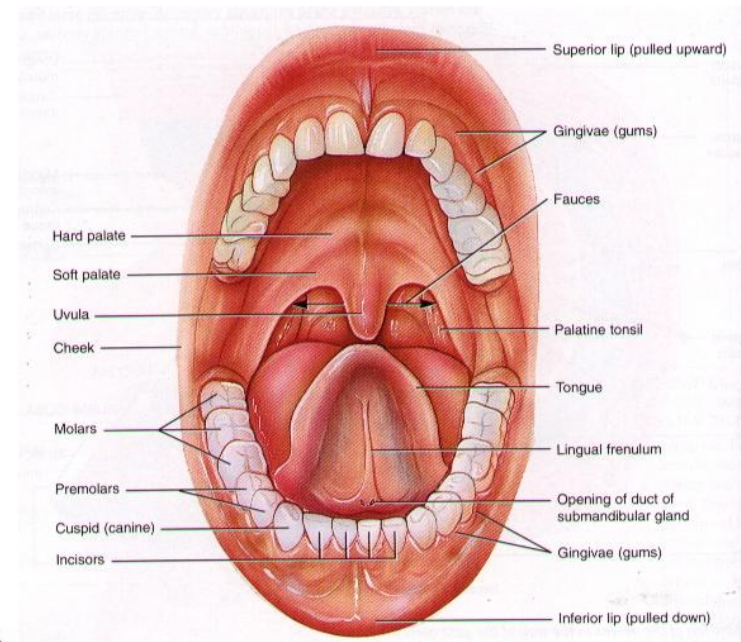
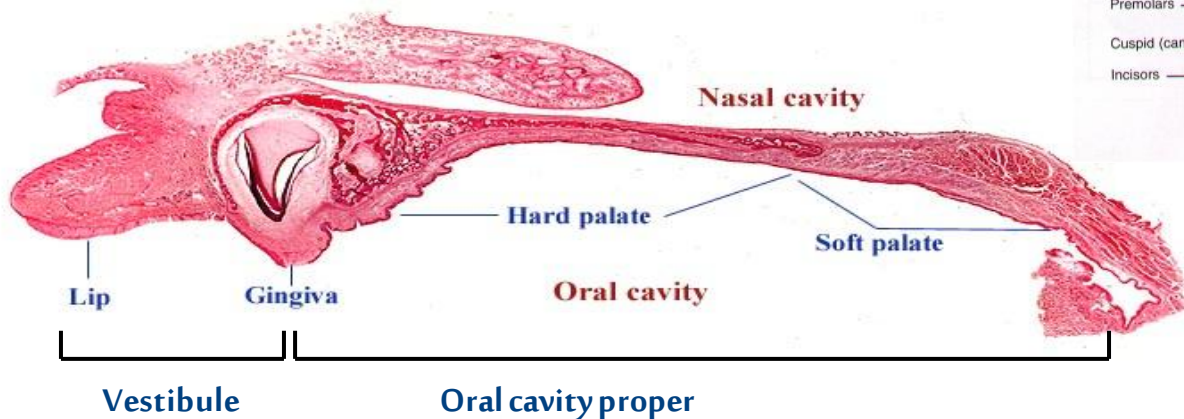


Oral Cavity

Oral Cavity

- The oral cavity consists of two portions:
- the vestibule
- the oral cavity proper

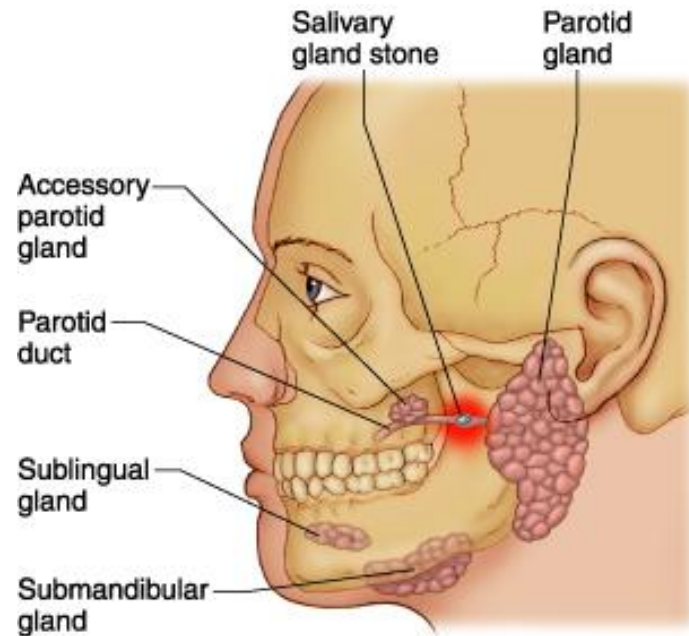
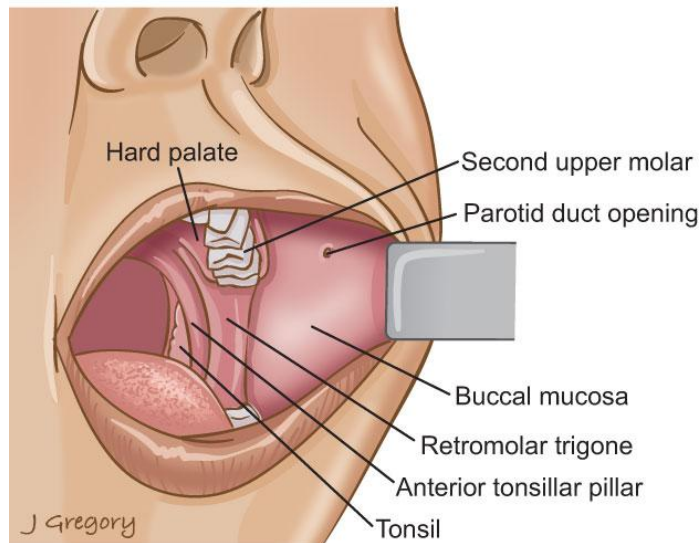


Oral Cavity

- The vestibule is the cleft between the lips and cheeks externally and the gums and teeth internally.

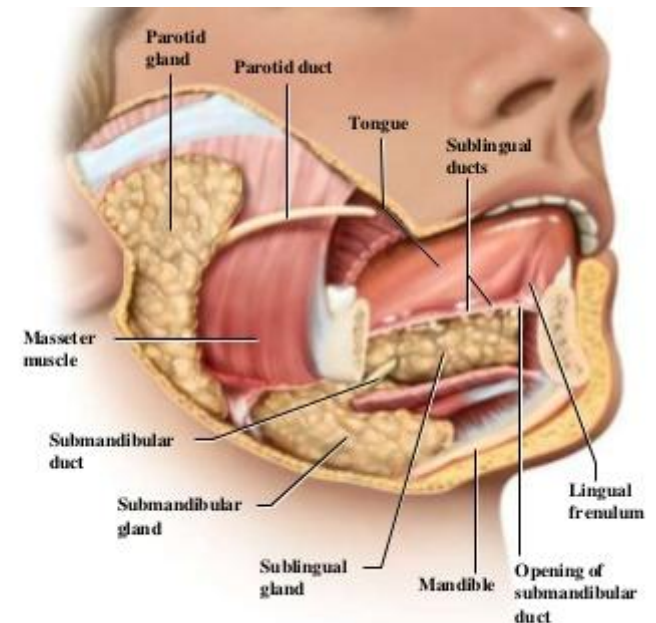
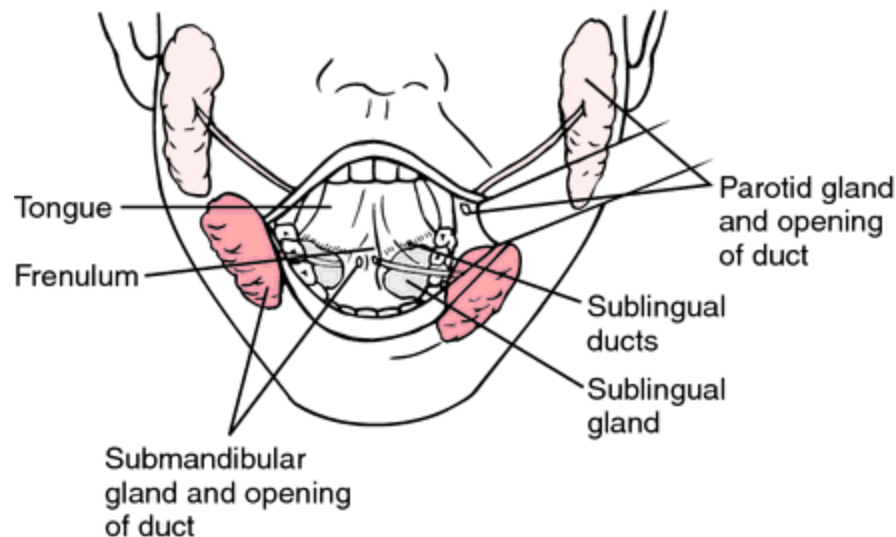
Oral Cavity

- The parotid duct opens opposite the upper second molar.



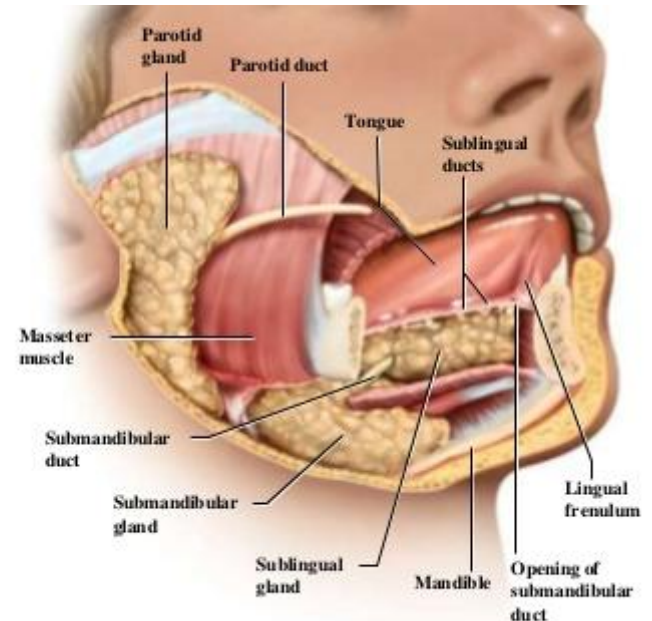
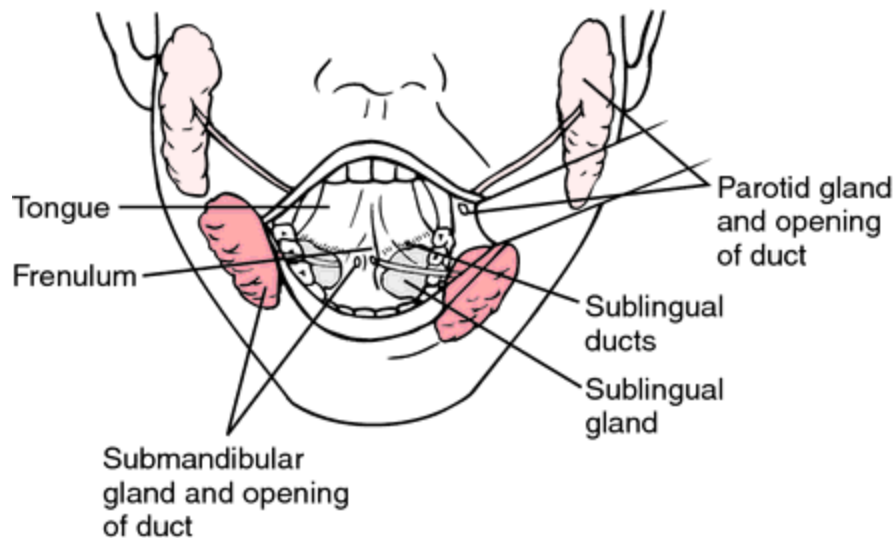
Oral Cavity

- The submandibular duct opens on an elevation, the sublingual papilla, on the sides of the frenulum.



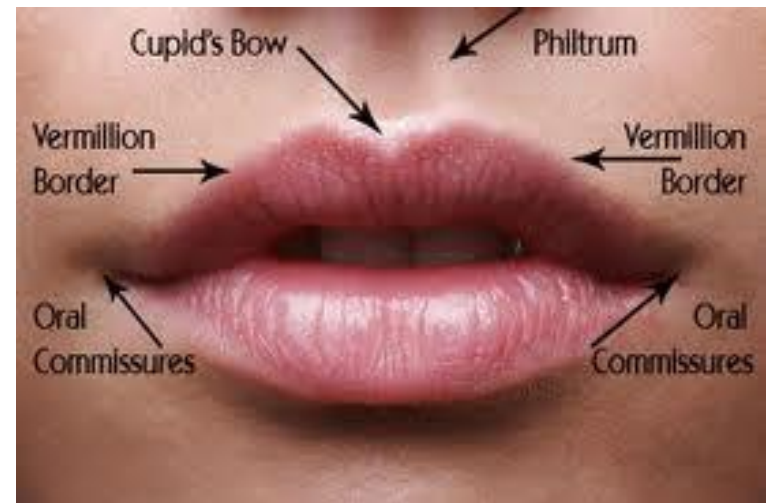
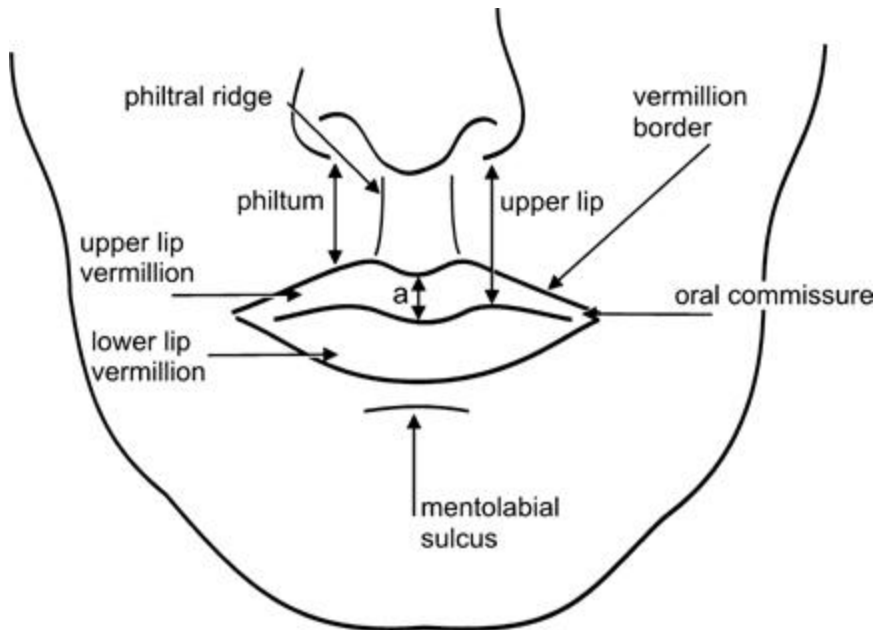
Oral Cavity

- Laterally, the sublingual fold, which is produced by the sublingual gland, contains the openings of the sublingual ducts.



Labia

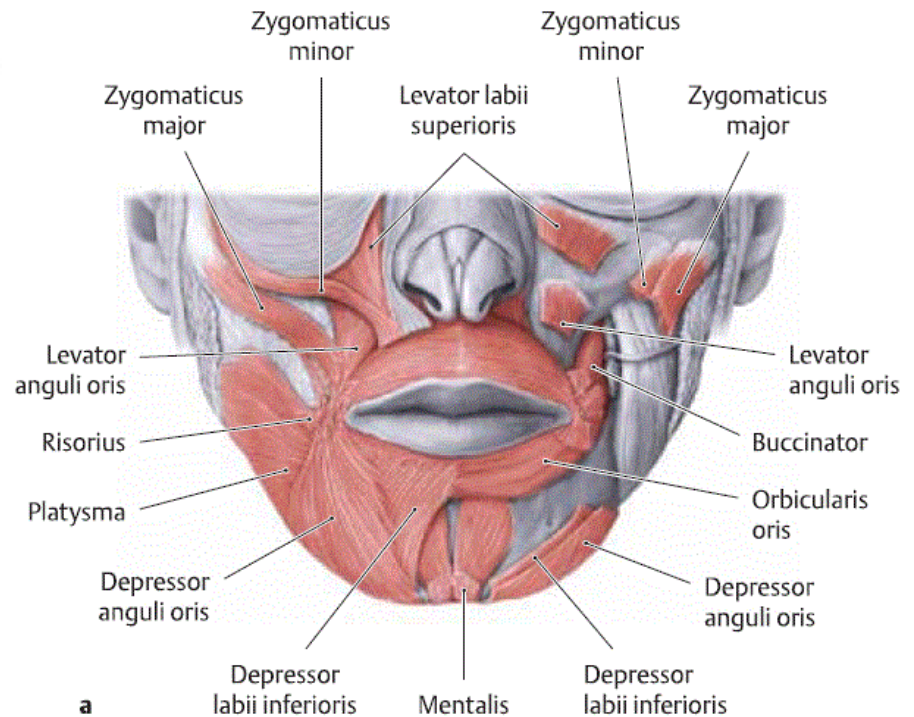
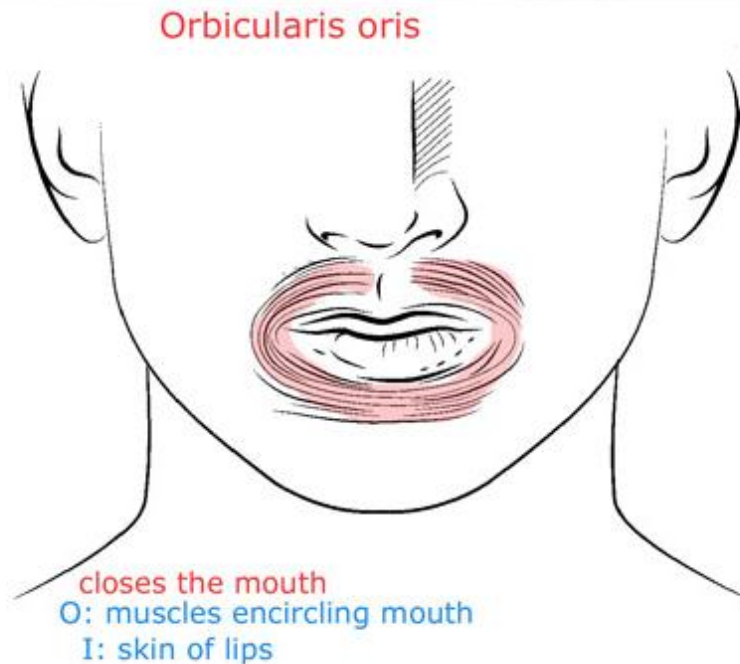
- The folds (superior and inferior) of the integument at the opening of the oral cavity.



Red margin = vermilion border (extraoral labial cutaneous junction)

Lips

- The lips consist (from external to internal) chiefly of skin, the orbicularis oris muscle, labial glands, and mucosa.



**Vermillion border
(zone)**

**Dilated venules and
veins lacks
salivary glands**

Vermillion Border

internal surface with
stratified squamous ep.

external surface with
Hair Follicles

Oral mucosa:

**St. sq. non-
keratinized
epithelium**

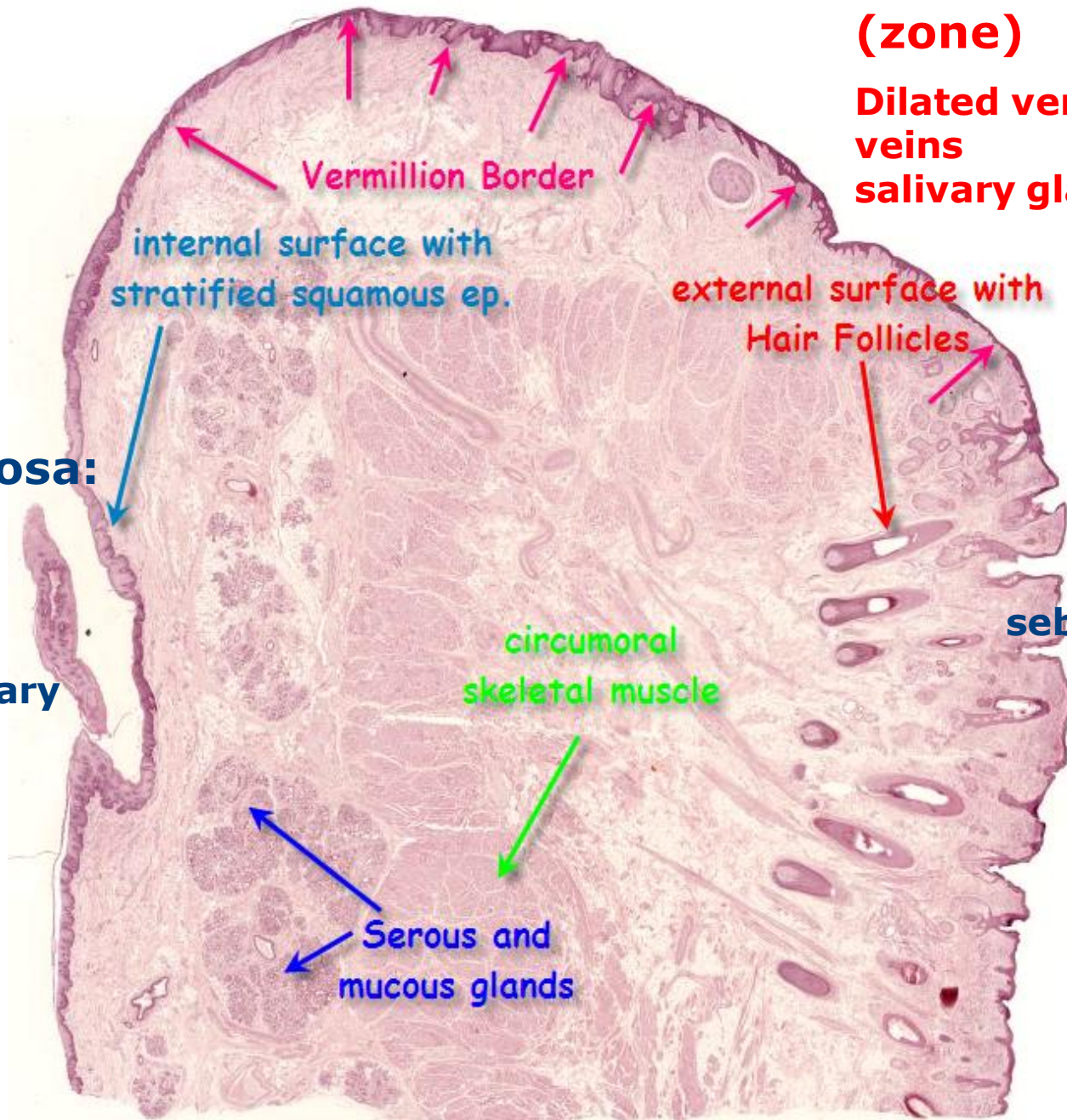
**Labial salivary
glands in
submucosa**

circumoral
skeletal muscle

Serous and
mucous glands

Skin:

**Hair follicles
sebaceous glands
sweat glands**



Oral Mucosa

- **Masticatory Mucosa**

- 25% of total mucosa.
- Gingiva (free, attached and interdental) and hard palate.
- Primary mucosa to be in contact with food during mastication.
- MASTICATORY MUCOSA IS USUALLY KERATINIZED.

- **Lining Mucosa**

- 60% of total mucosa.
- Covers the floor of mouth, ventral (underside) tongue, alveolar mucosa, cheeks, lips and soft palate.
- Does not function in mastication and therefore has minimal attrition.
- Non-keratinized; soft and pliable.

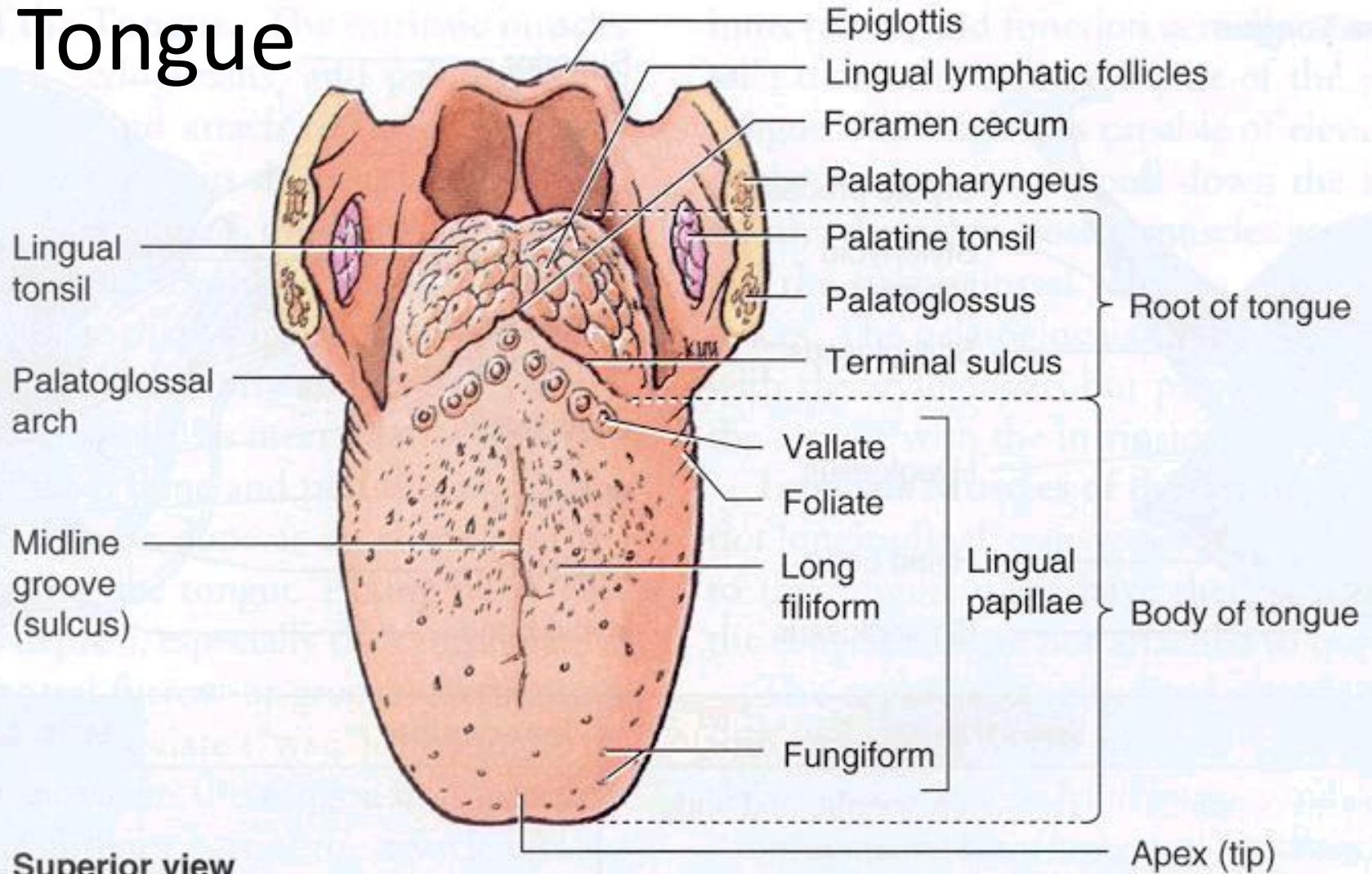
- **Specialized Mucosa**

- 15% of total mucosa.
- Covers dorsal tongue and composed of cornified epithelial papillae.

Functions of Oral Mucosa

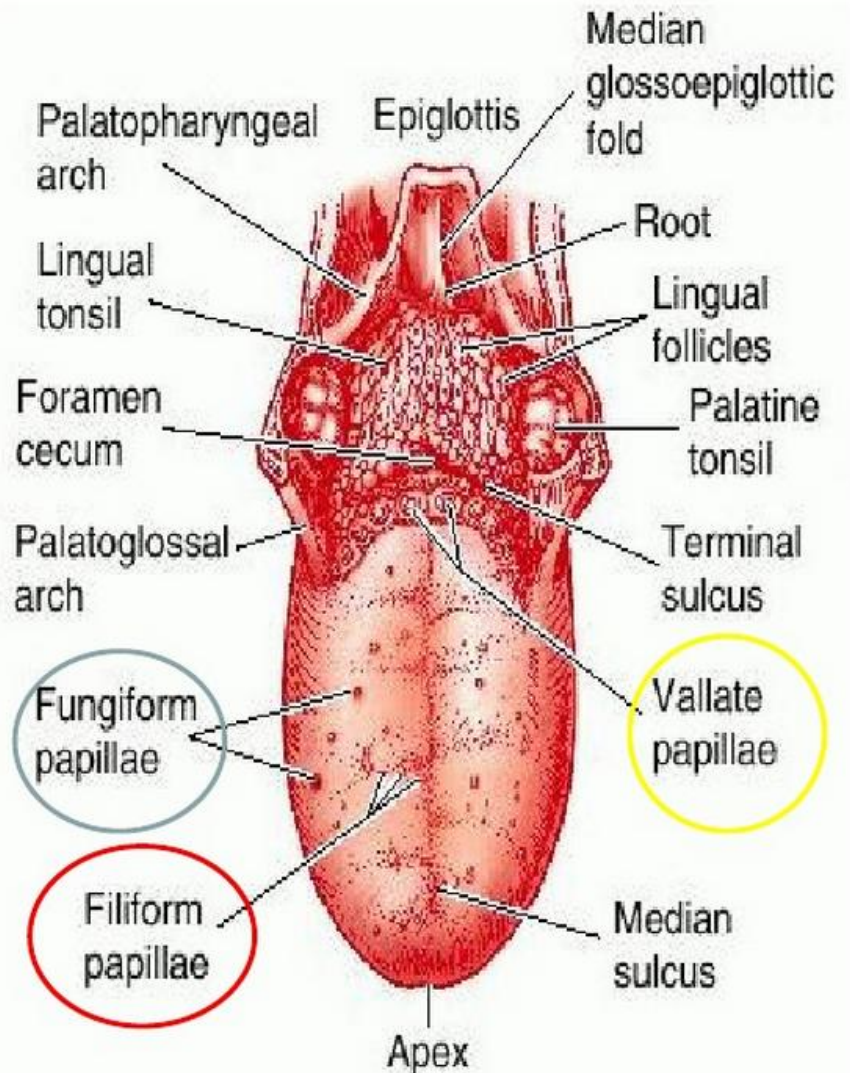
- **Protection:** Barrier for mechanical trauma and microbiological insults
- **Sensation:** Temperature (heat and cold), touch, pain, taste buds, thirst; reflexes such as swallowing, etching, gagging and salivating
- **Secretion:** Salivary secretion
- **Thermal regulation:** Important in dogs not in humans

Tongue



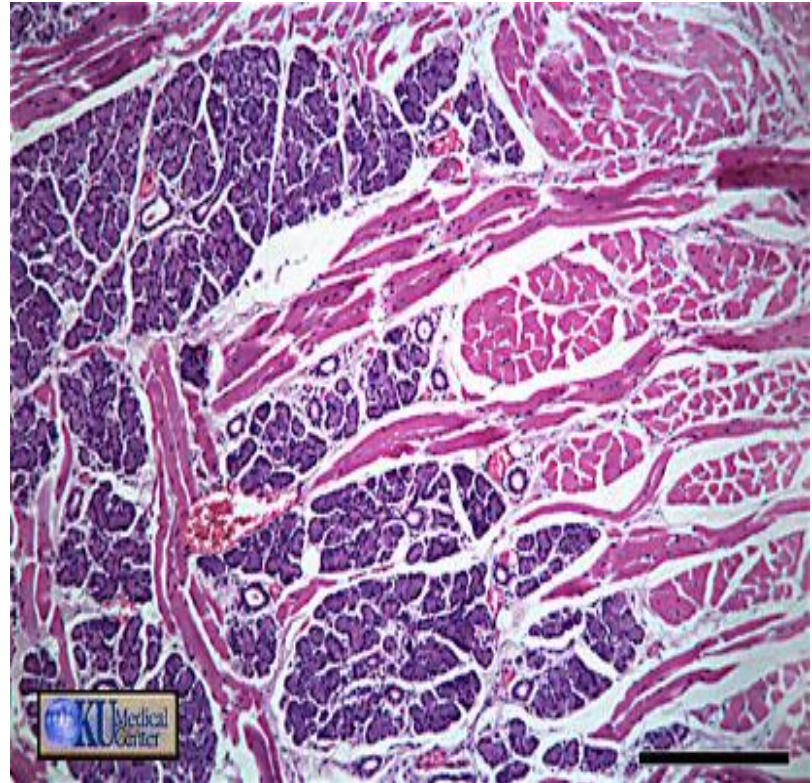
- **Tongue**

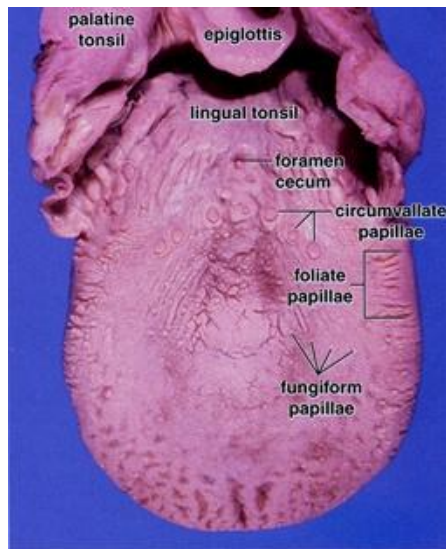
- The tongue situated in the floor of the mouth, is attached by muscles to the hyoid bone, mandible, styloid processes, and pharynx.
- The tongue is important in taste, mastication, swallowing, and speech.
- It is composed chiefly of skeletal muscle, is partly covered by mucous membrane, and presents a tip and margin, dorsum, inferior surface, and root
- The tip, or apex, usually rests against the incisors and continues on each side into the margin.
- The oral part of the dorsum may show a shallow median groove.



Glands in Tongue

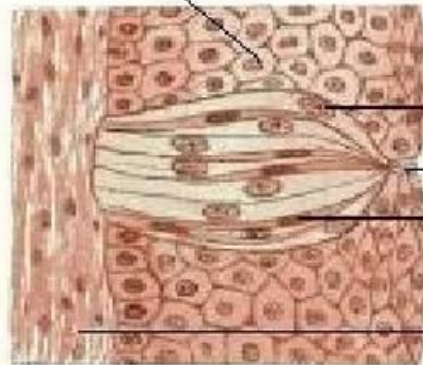
- In basal part: Mucous type and duct of the glands open sulcus terminalis.
- In main part (body): Serous and duct of the glands open anterior of the sulcus terminalis (Ebner bezleri)
- In terminal part: Mix glands and the duct of the glands open surface of the tongue.



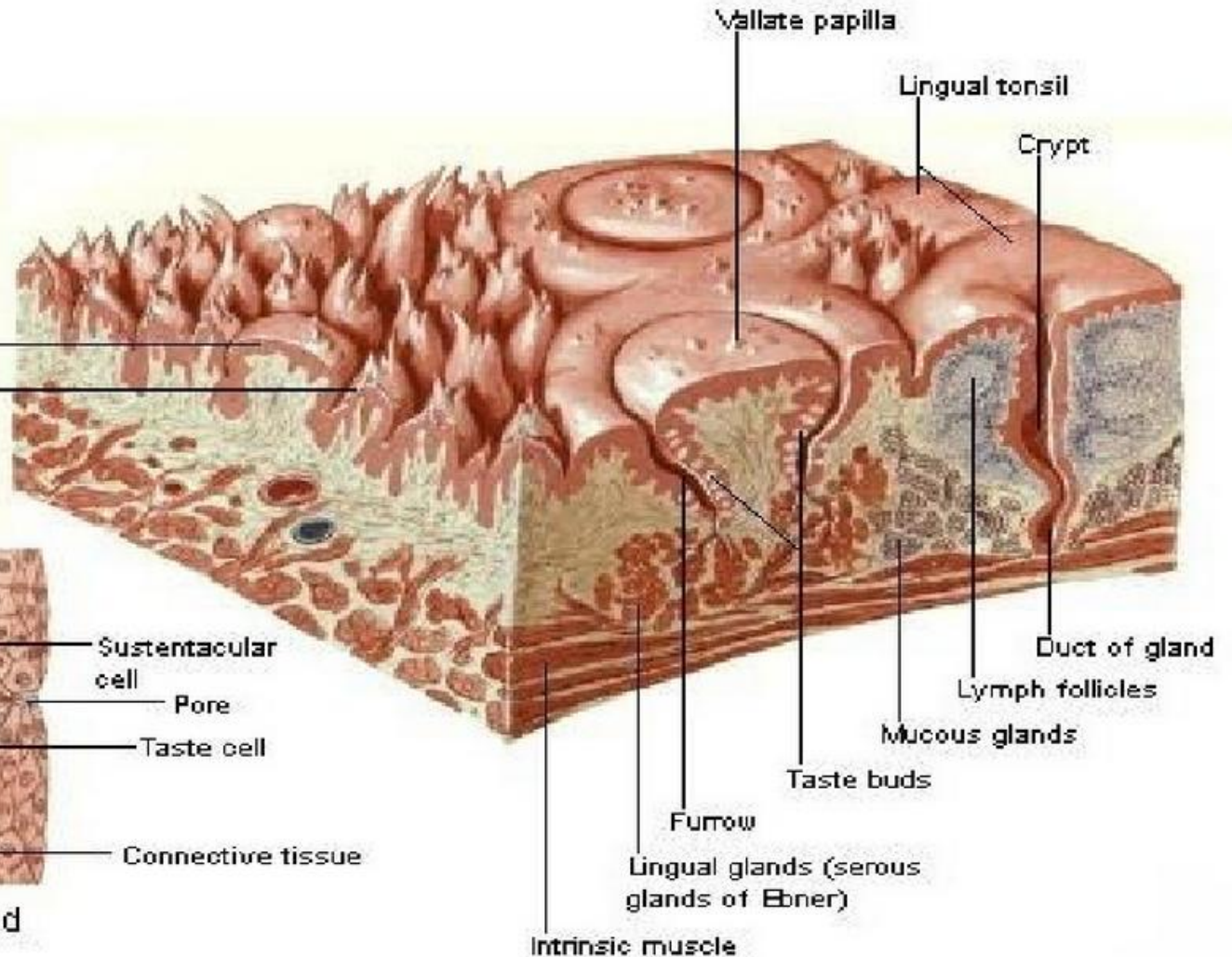


Fungiform papilla
Cornified tip of papilla

Squamous epithelium (stratified)



Section of taste bud

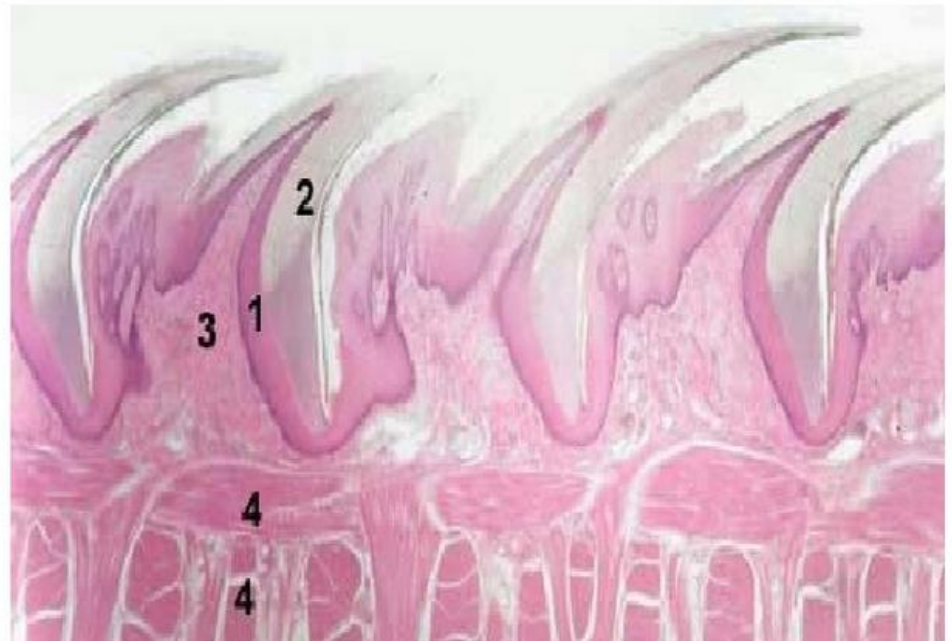
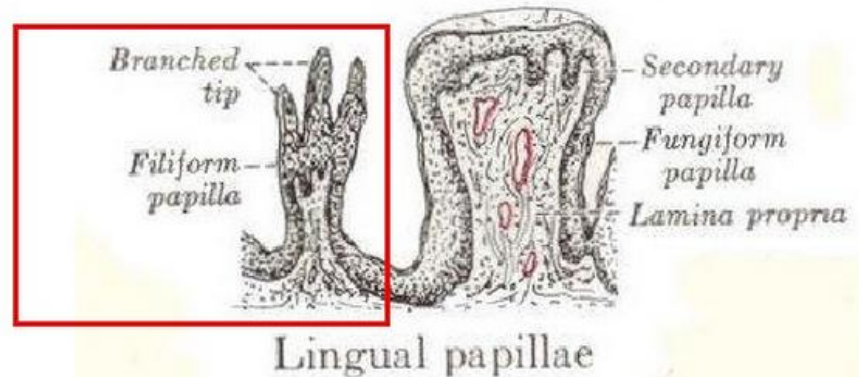


- The mucosa has numerous minute lingual papillae:
- (1) the filiform papillae, the narrowest and most numerous;
Filiform Papillae
- = plush of tongue
- Parallel rows
- Primary columnar elevation of lamina propria
- 5 – 30 tall secondary papillae
- Epithelium over papillae – end in tapered points
- Hard & scaly (not cornified)

• FILIFORM PAPILLAE OF THE TONGUE

Stained with H&E

- 1 - epithelium covering papilla (stratified squamous **keratinizing**)
- 2 - keratinized layer of the epithelium
- 3 - core of the papilla (lamina propria of the mucosa of dorsal surface of the tongue)
- 4 - tongue muscles



(2) **Fungiform Papillae**

the fungiform papillae, with rounded heads and containing taste buds

Knob-like

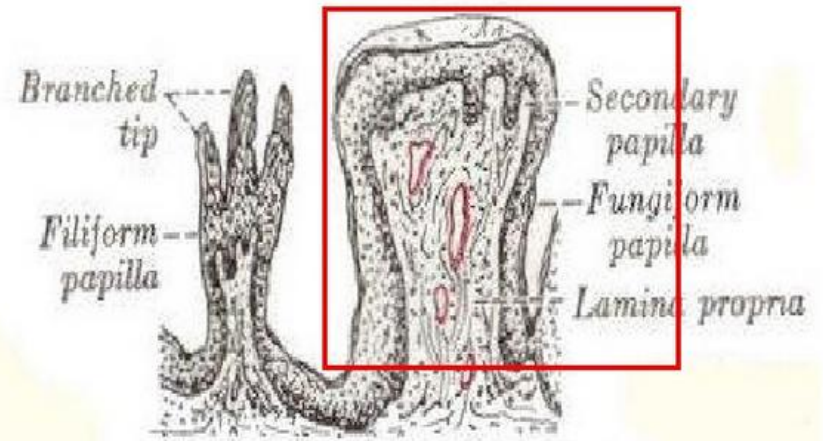
Scattered, single, among filiform papillae

Larger & fewer than filiform papillae

Narrow stalk, rounded top

Size: 1.8 mm. high; 1 mm.

Has 1 to several taste buds

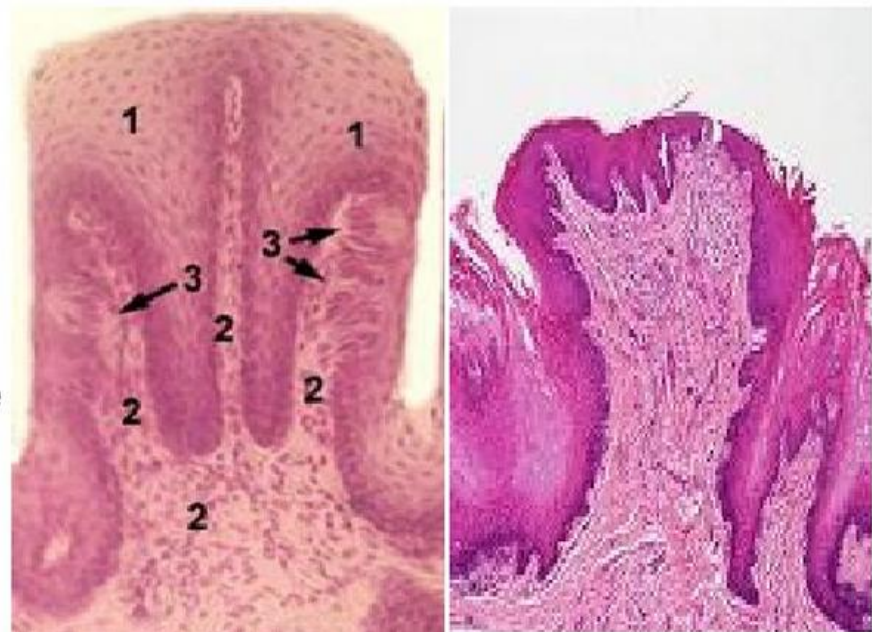


Lingual papillae

Fungiform Papillae

Stained with H&E

- 1 - epithelium covering papilla
(stratified squamous **nonkeratinizing**)
- 2 - core of the papilla (lamina propria
of the mucosa of dorsal surface of the
tongue)
- 3 - taste buds



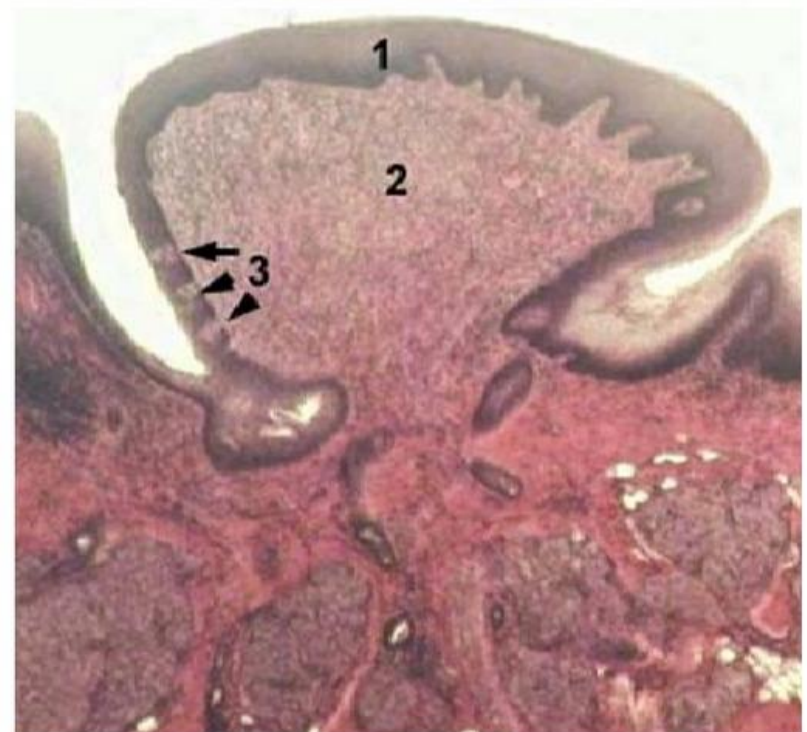
CIRCUMVALLATE PAPILLAE OF THE TONGUE

much larger than any of others
about 8-12 located in post region of tongue, just next to sulcus terminalis
have deep furrow's next to each papillae = where von Ebner's glands open
Von Ebner's glands = serous lingual glands

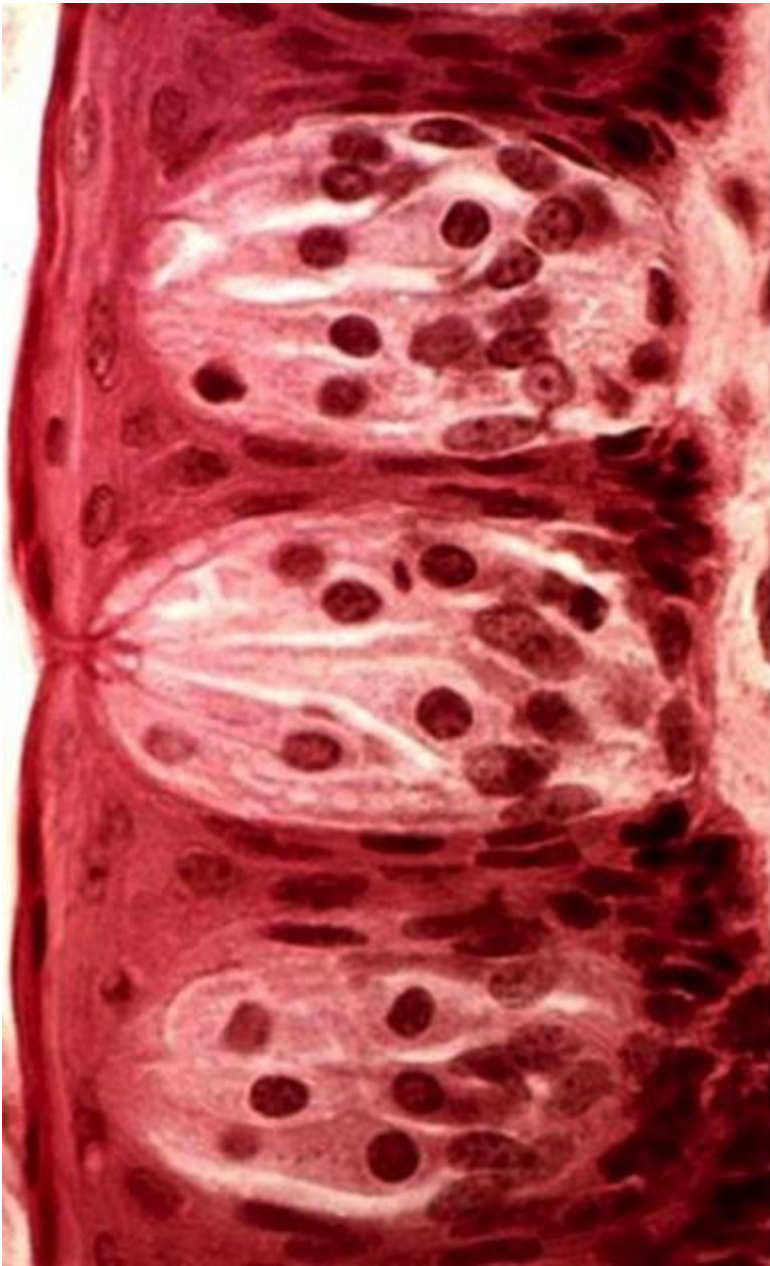
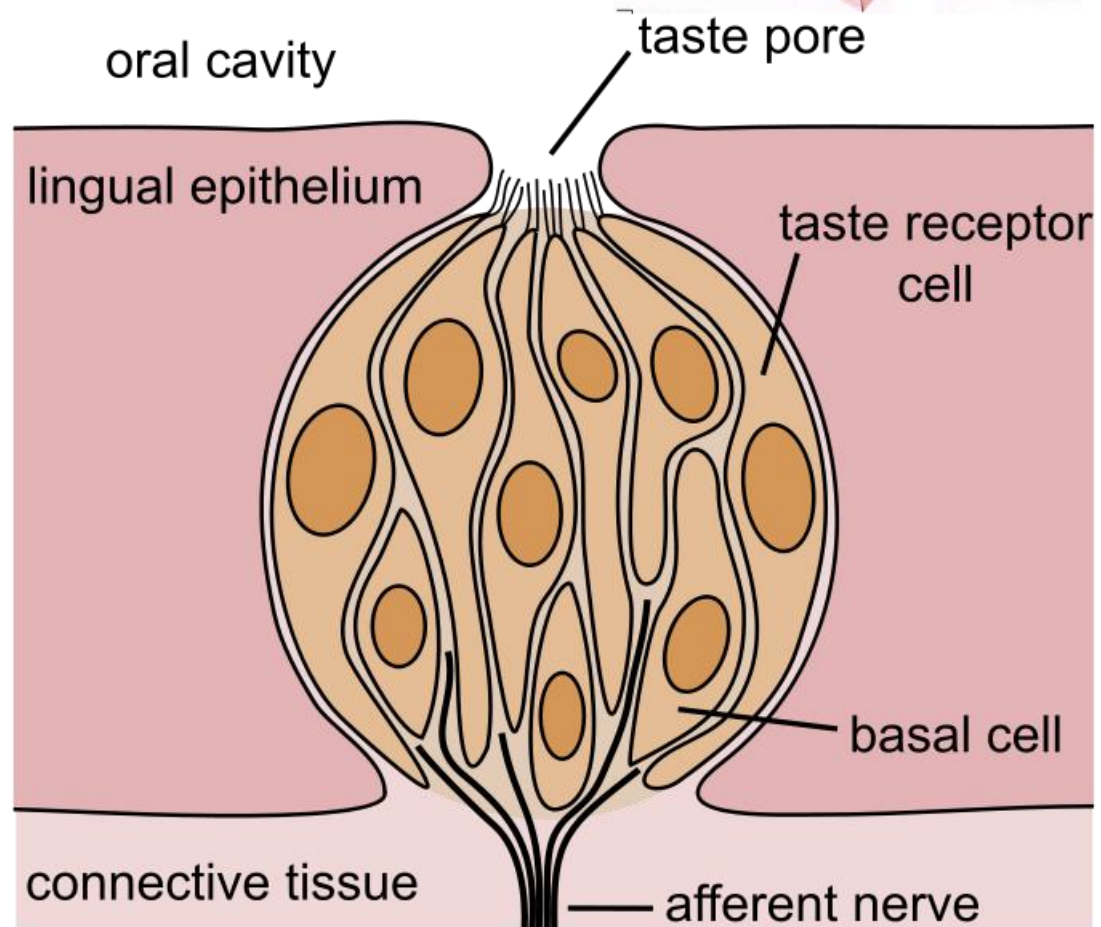
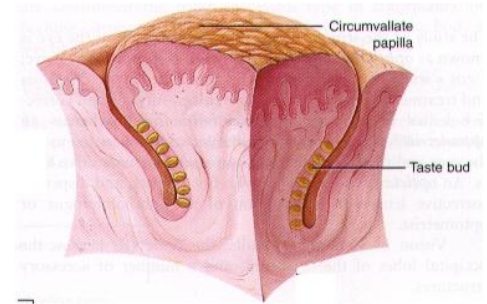


Stained with H&E

- 1 - epithelium covering papilla
(stratified squamous **nonkeratinizing**)
- 2 - core of the papilla (lamina propria of the mucosa of dorsal surface of the tongue)
- 3 - taste buds



Taste Buds

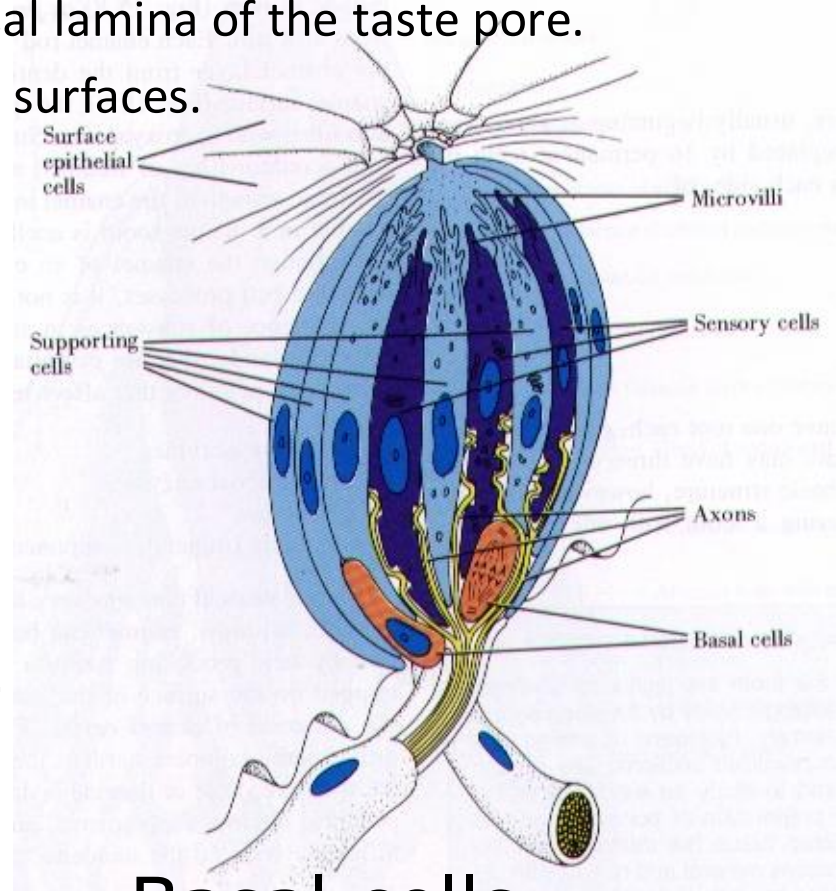


- **Supporting cells (Sustentakular):**

- Less numerous
- Elongated cells that extend from basal lamina of the taste pore.
- They contain microvilli on their apical surfaces.
- They not snaps with nerve cells

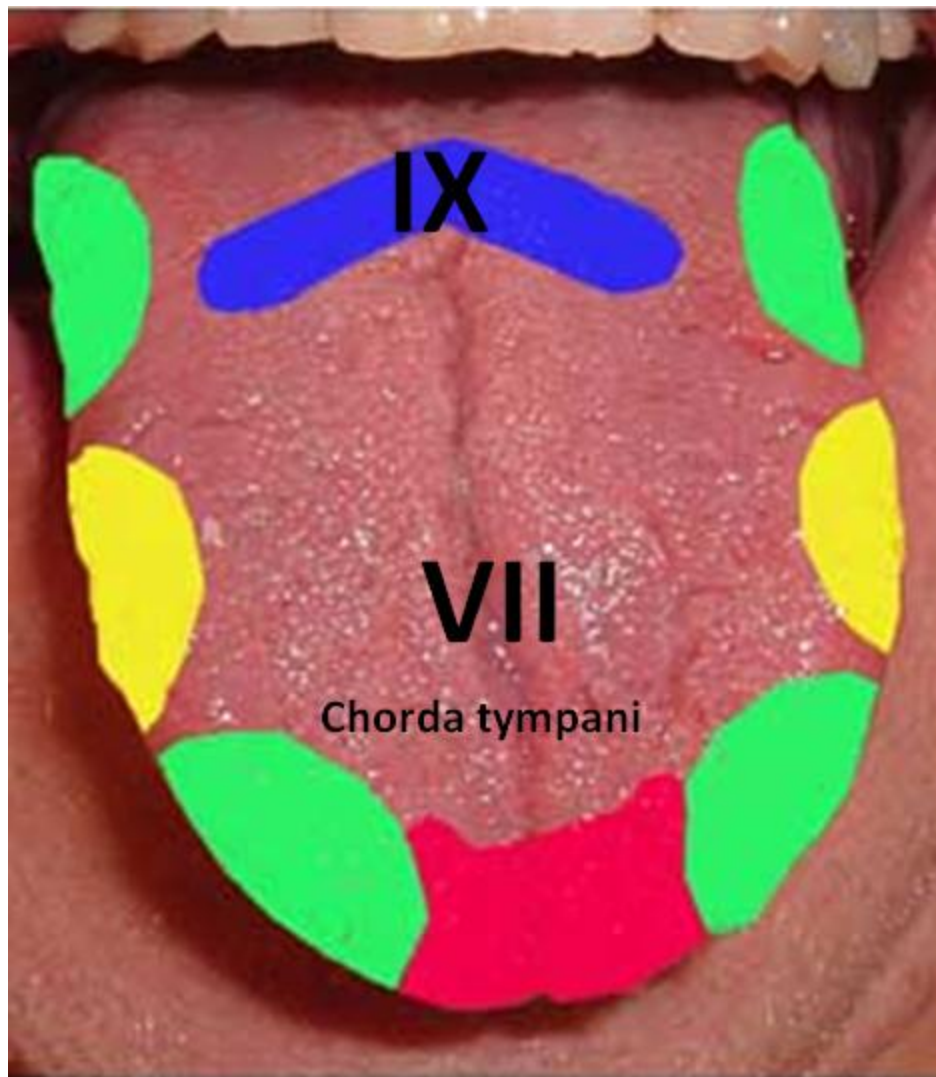
- **Neuroepithelial cells:**

- Most numerous cells (10-14)
- Elongated cells that extend from basal lamina of the taste pore
- They contain microvilli on their apical surfaces.
- They synapse with nerve cells in the base portion of the cells
- The turnover time of neuroepithelial cells is about 10 days.



- **Basal cells**

- Small cells, located in the basal portion
- Stem cells



Areas of Taste Perception

● Salt
● Sweet

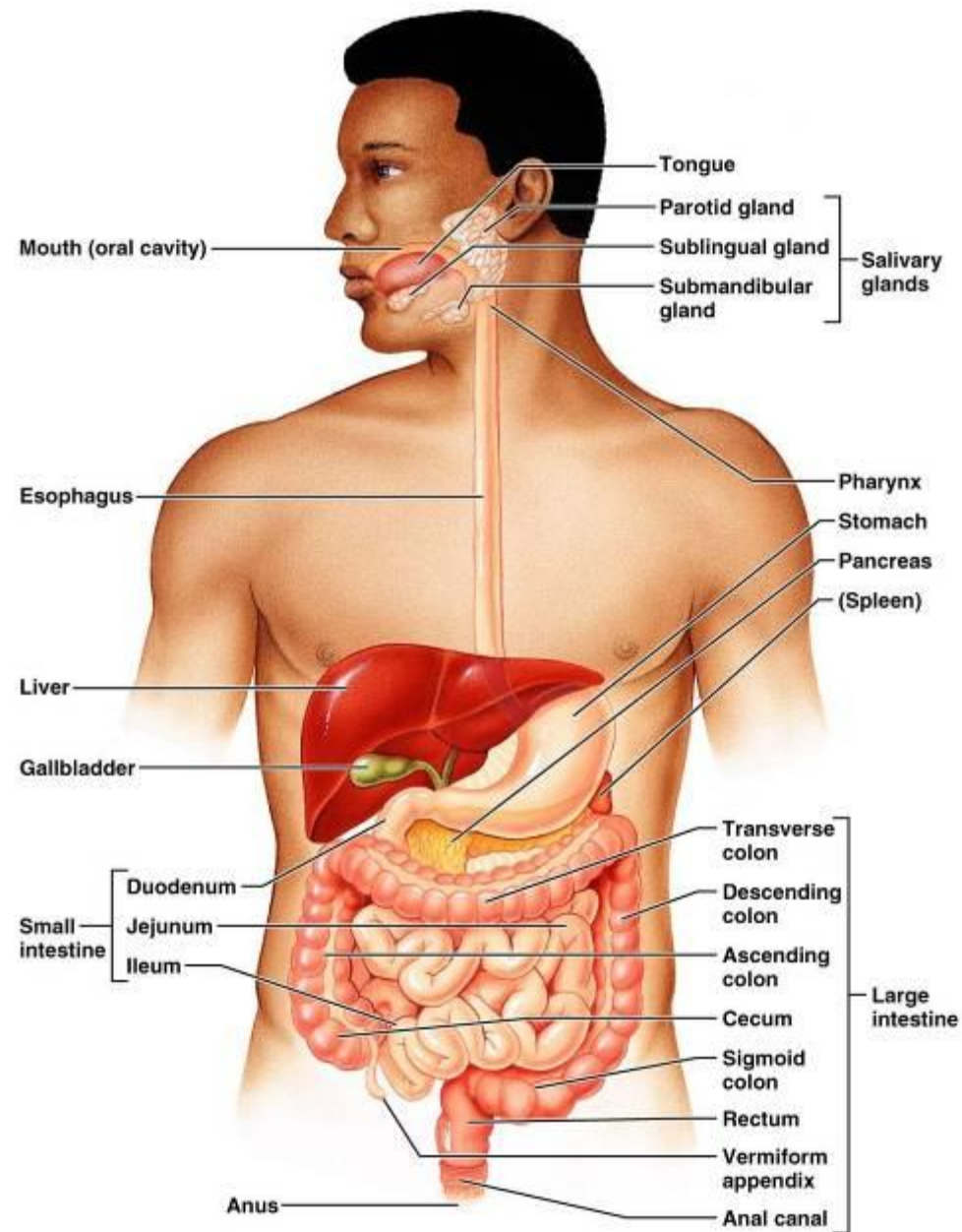
● Sour
● Bitter

Gastrointestinal tract

- Gastrointestinal tract [Alimentary canal] a continuous muscular digestive tube
 - Digests:
 - breaks food into smaller fragments
 - Absorbs:
 - digested material is moved through mucosa into the blood
 - Eliminates:
 - unabsorbed & secreted wastes.

Organ systems

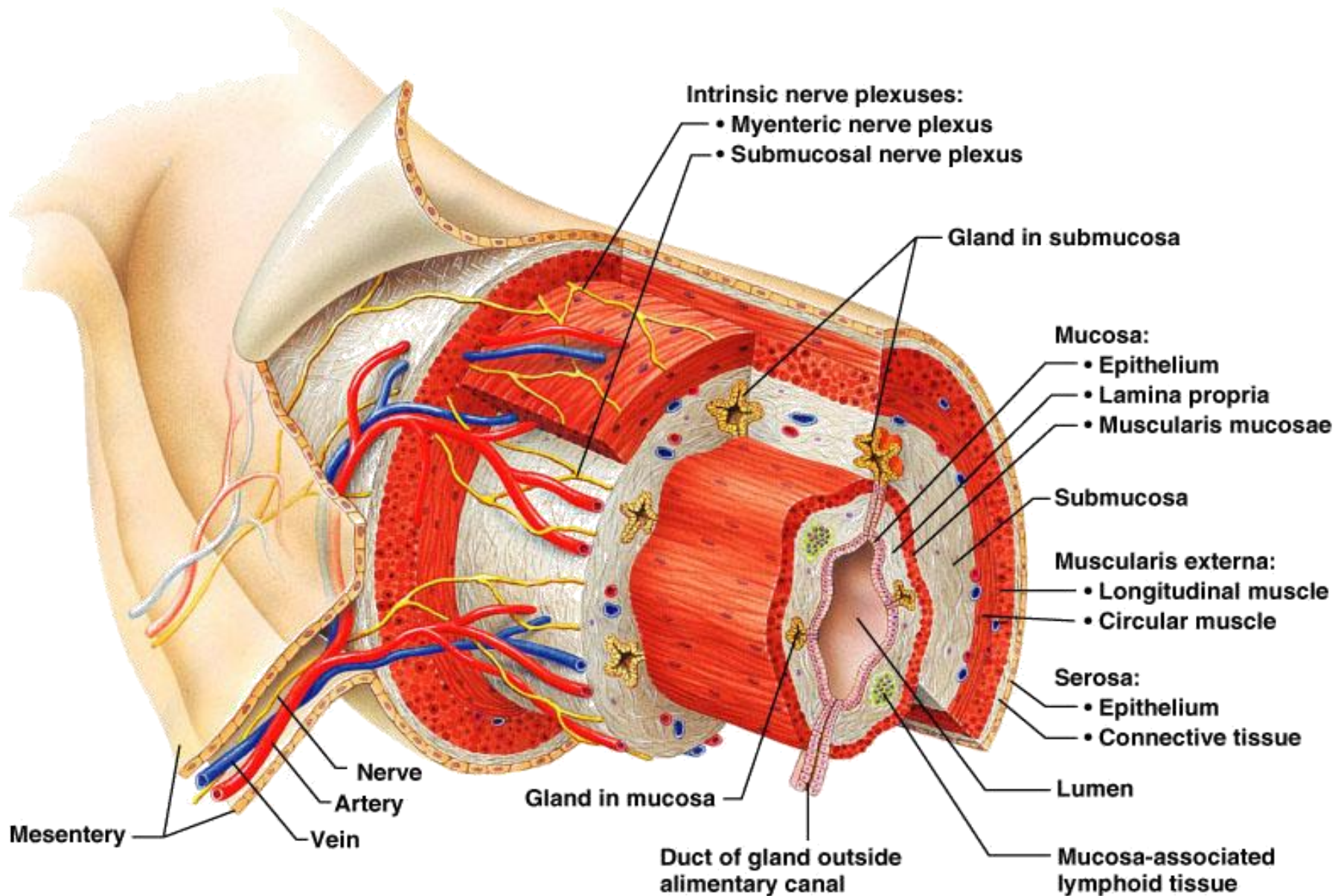
- Includes:
 - Mouth, pharynx & esophagus
 - Stomach
 - Small intestine
 - Large intestine
- Accessory digestive organs: teeth, tongue, gall bladder, salivary glands, liver & pancreas



Histology

- GI tract wall has 4 layers:
 - T. Mucosa
 - T. Submucosa
 - T. Muscularis Externa
 - T. Serosa or Adventitia

Histology of the Alimentary Canal



Histology of the Digestive System

Basic Histological Layers

1. Mucosa

- a. Epithelium
- b. Lamina Propria
- c. Muscularis Mucosae

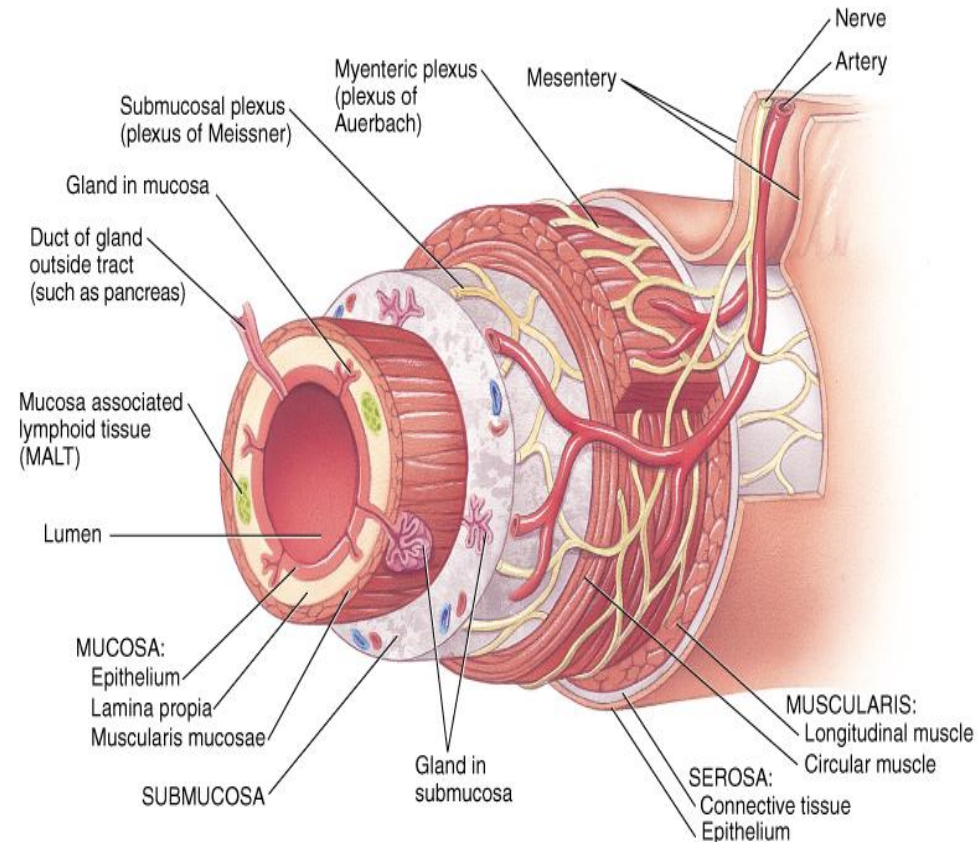
2. Submucosa

- a. Submucosal plexus
“Plexus of Meissner”

3. Muscularis

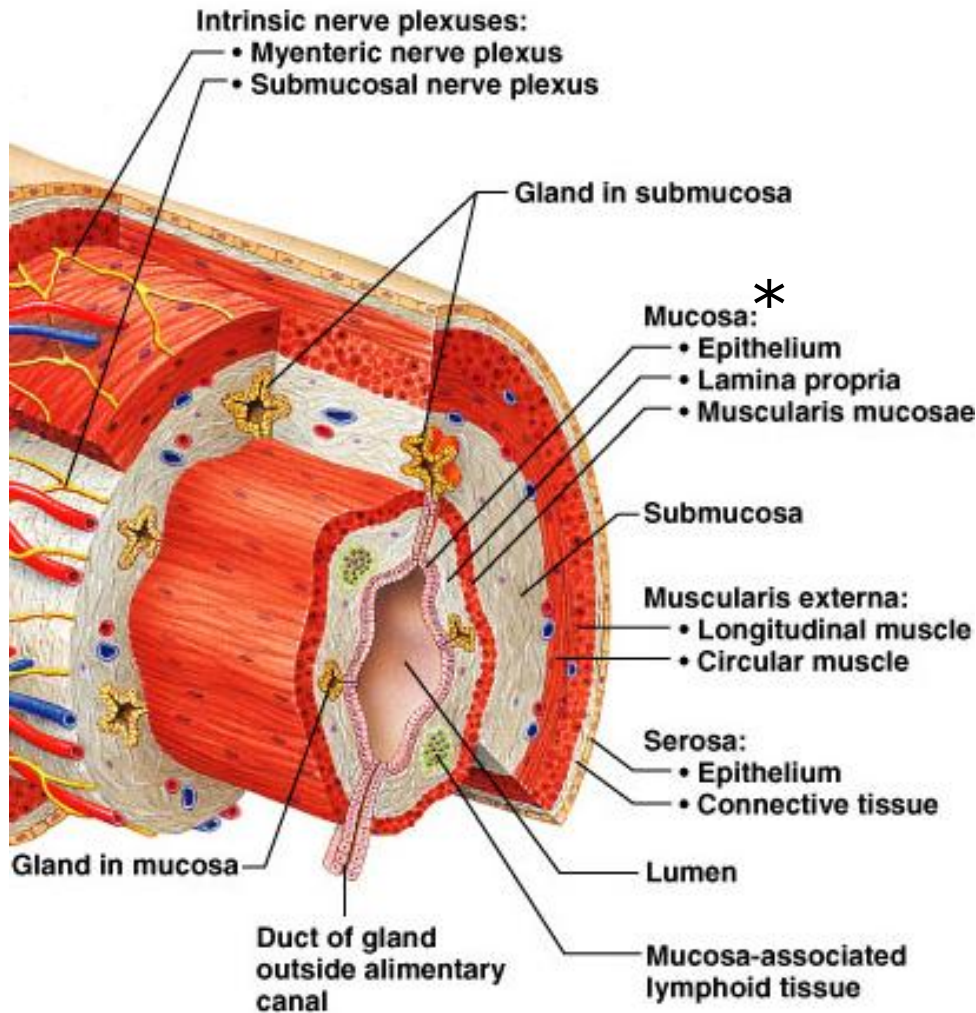
- a. Myenteric plexus
“Plexus of Auerbach”

4. Serosa



Inner layer: the mucosa*

(mucous membrane)



Three sub-layers

1. Lining epithelium
2. Lamina propria
3. Muscularis mucosae

More about the mucosa

- Epithelium: absorbs nutrients, secretes mucus
 - Continuous with ducts and secretory cells of intrinsic digestive glands (those within the wall)
 - Extrinsic (accessory) glands: the larger ones such as liver and pancreas
- Lamina propria
 - Loose connective tissue with nourishing and absorbing capillaries
 - Contains most of mucosa-associated lymphoid tissue (MALT)
- Muscularis mucosae
 - Thin layer of muscle producing only local movements

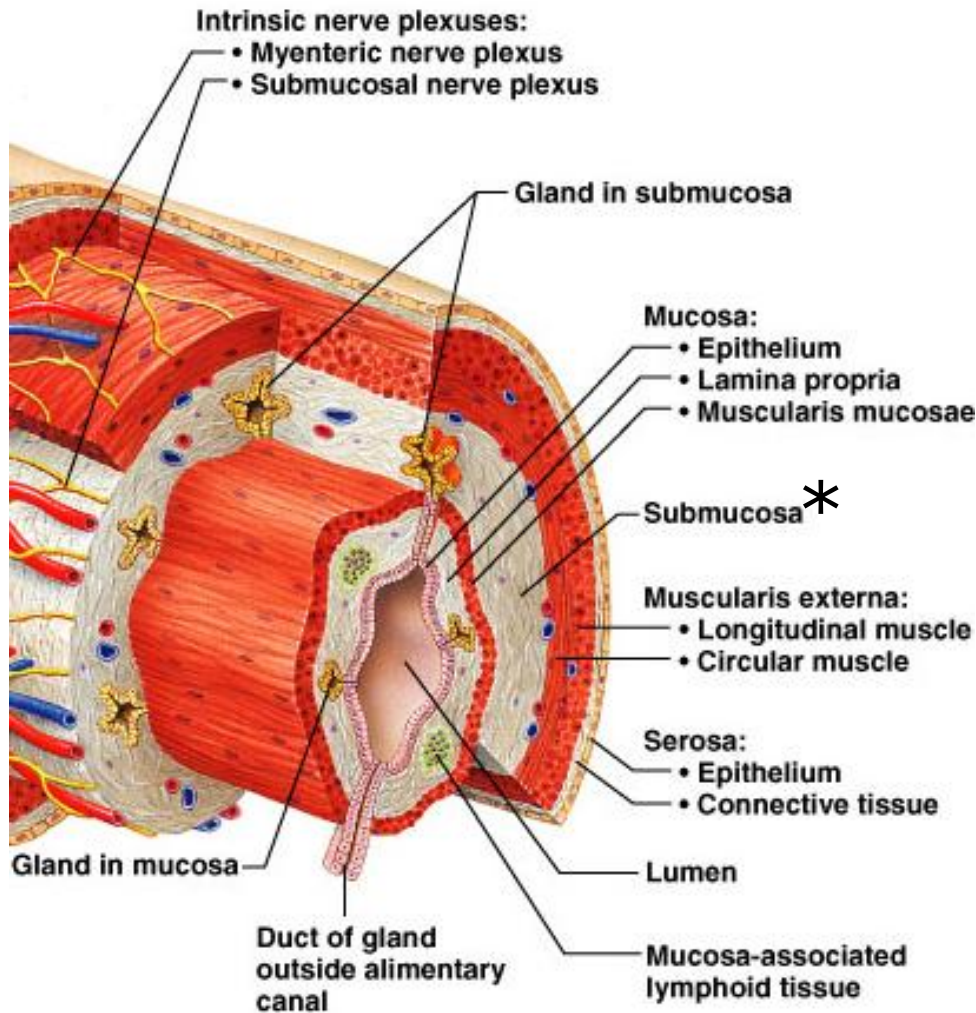
Histology of the Mucosa

Organ	Epithelium
Mouth	Nonkeratinized Stratified Squamous
Pharynx	Nonkeratinized Stratified Squamous
Esophagus	Nonkeratinized Stratified Squamous
Stomach	Simple Columnar
Small Intestine	Simple Columnar
Large Intestine	Simple Columnar
Anus	Nonkeratinized Stratified Squamous

Histology of the Mucosa

Organ	Folds of the epithelium
Esophagus	none
Stomach	L: Rugae, S: gastric pits
Small Intestine	L: Plicae circulares, Villi S: Crypts of Lieberkuhn, microvilli
Large Intestine	L: Haustra S: Intestinal glands

Second layer: the submucosa*

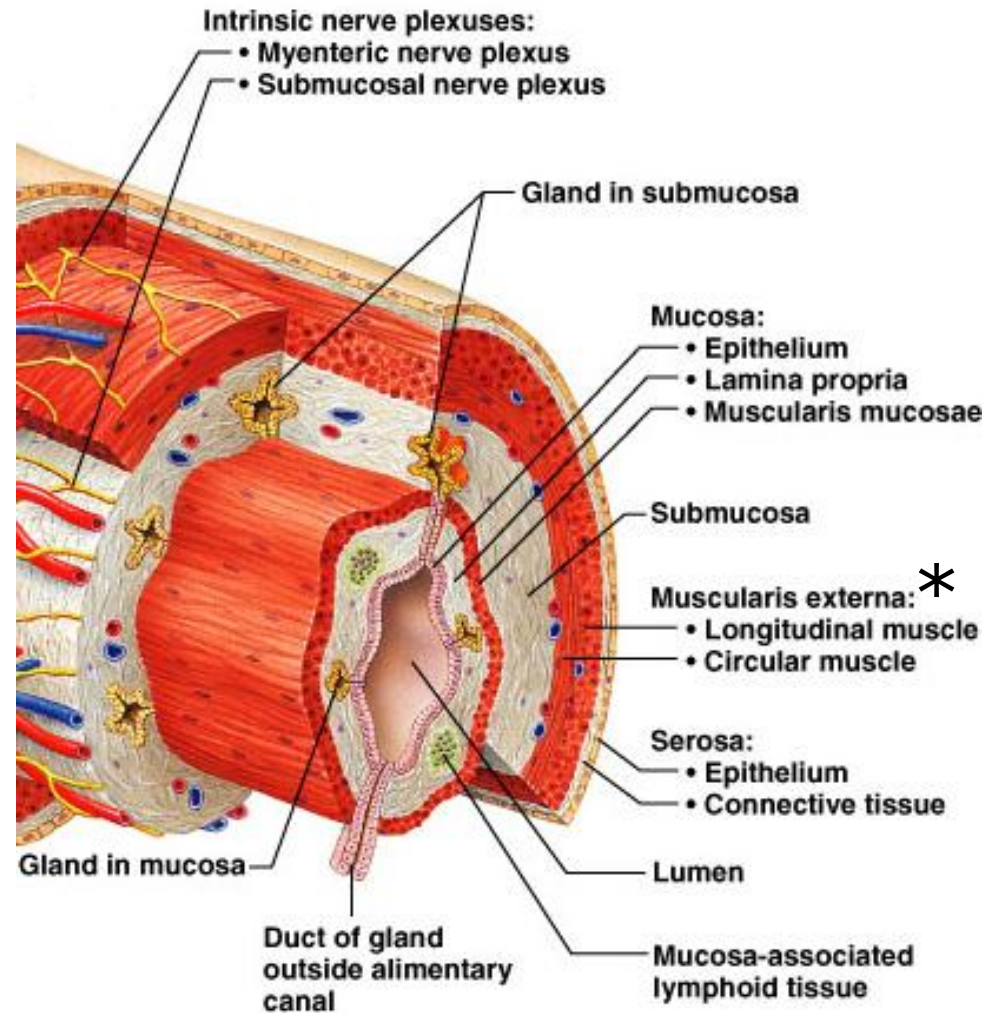


- Connective tissue containing major blood and lymphatic vessels and nerves
- Many elastic fibers so gut can regain shape after food passes

Histology of the Submucosa

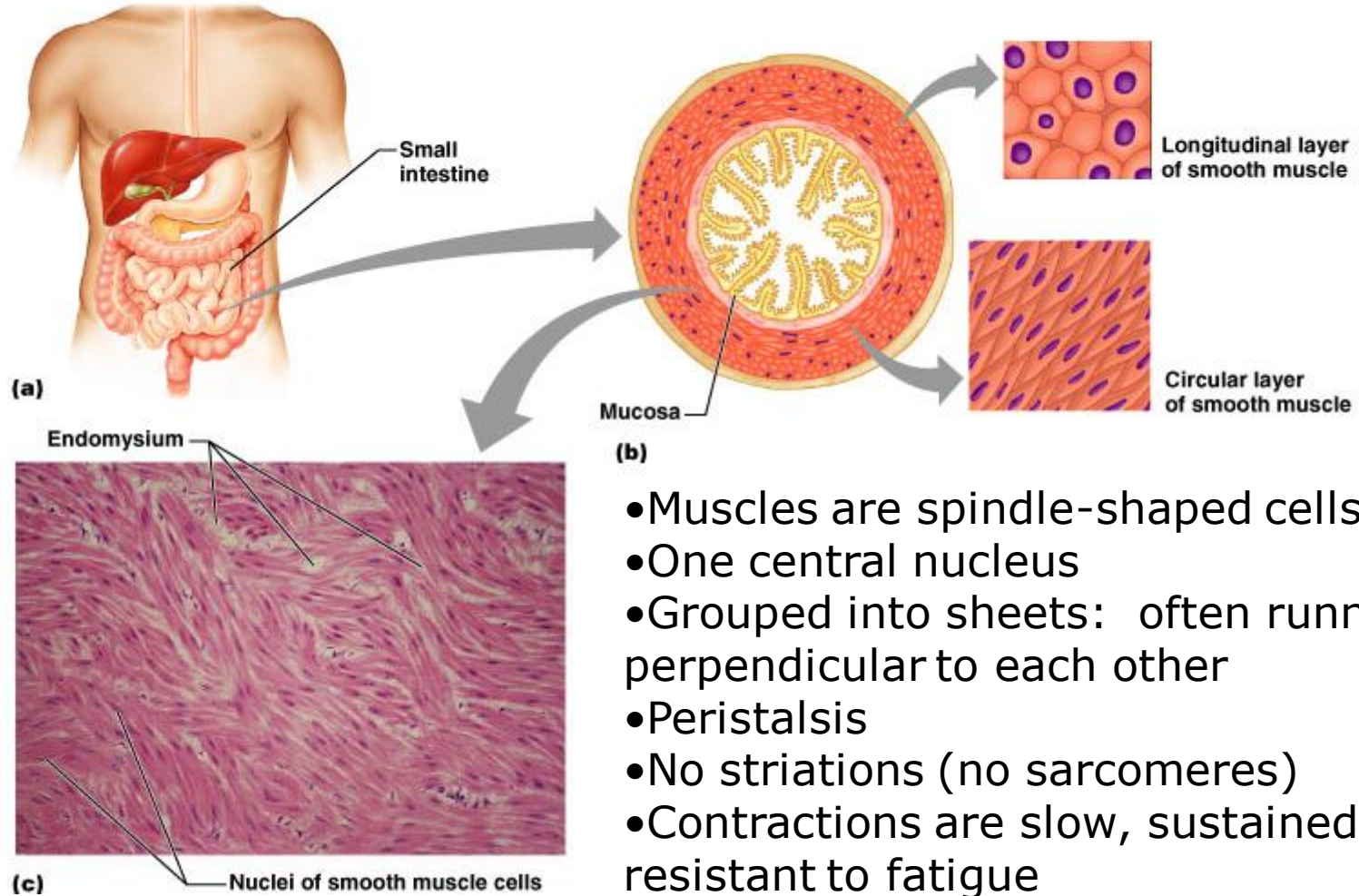
Organ	Specialized structures
Esophagus	Submucosal mucous glands
Stomach	None
Duodenum	Brunner's glands
Ileum	Peyer's Patches
Large Intestine	None

Next in, the muscularis externa* (AKA just “muscularis”)



- Two layers of smooth muscle responsible for peristalsis and segmentation
 - Inner circular layer (circumferential)
 - Squeezes
 - In some places forms sphincters (act as valves)
 - Outer longitudinal layer: shortens gut

Smooth muscle



- Muscles are spindle-shaped cells
- One central nucleus
- Grouped into sheets: often running perpendicular to each other
- Peristalsis
- No striations (no sarcomeres)
- Contractions are slow, sustained and resistant to fatigue
- Does not always require a nervous signal: can be stimulated by stretching or hormones

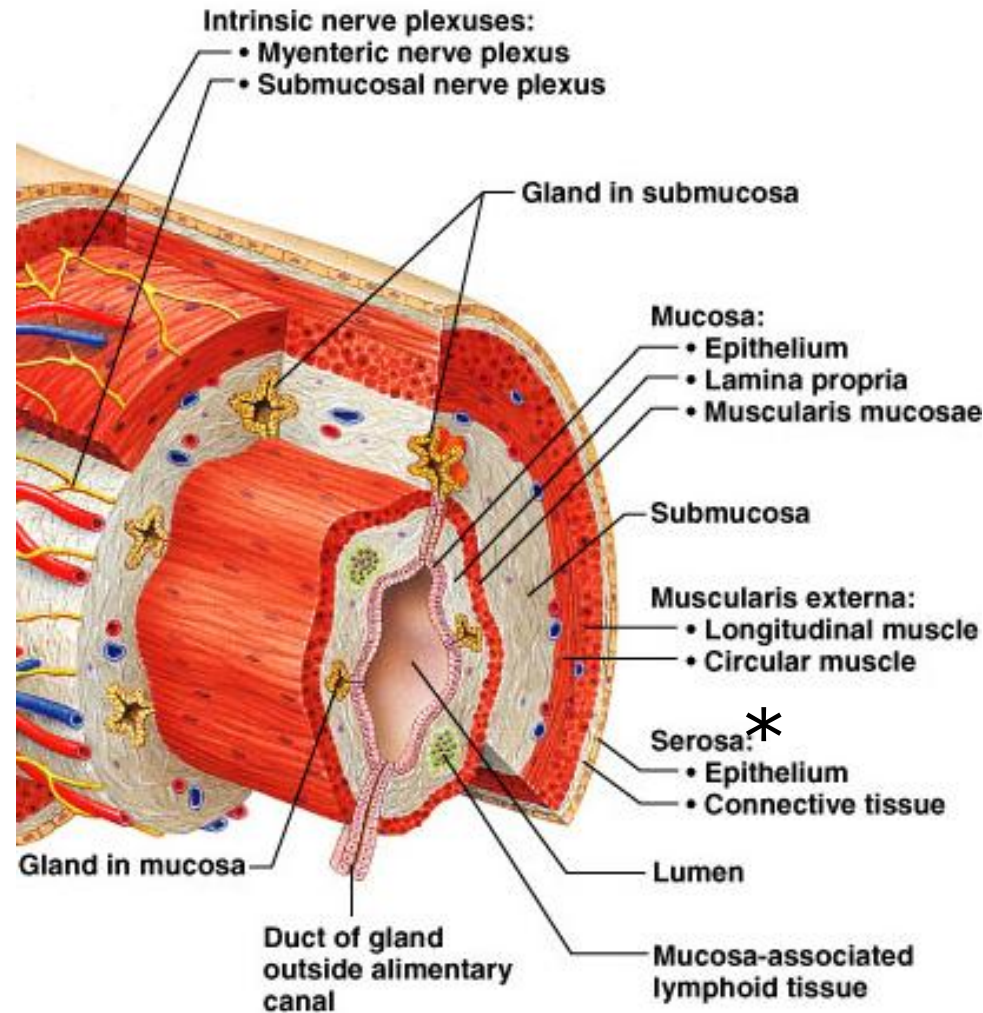
6 major locations:

1. inside the eye
2. walls of vessels
3. respiratory tubes
4. digestive tubes
5. urinary organs
6. reproductive

Histology of the Muscularis

Organ	Smooth muscle layers
Esophagus	2, circular and longitudinal
Stomach	3, oblique, circular, and longitudinal
Small Intestine	2, circular and longitudinal
Large Intestine	2, circular and longitudinal

Last (outer), the serosa* (the **visceral peritoneum**)



- Simple squamous epithelium (mesothelium)
 - Thin layer of areolar connective tissue underneath
- Exceptions:
 - Parts not in peritoneal cavity have adventitia, lack serosa
 - Some have both, e.g. retroperitoneal organs

Histology of the Serosa

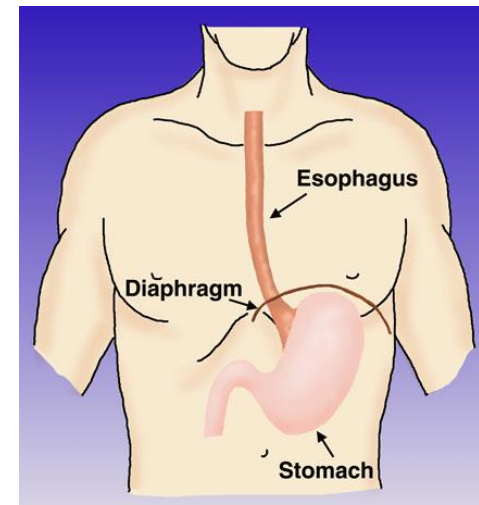
Organ	Serosa
Esophagus	Adventitia due to the fact that the esophagus is not in a cavity
Stomach	Visceral Peritoneum
Small Intestine	Visceral Peritoneum
Large Intestine	Visceral Peritoneum
Anus	Adventitia

Nerves

- Enteric nervous system: the gut's own
 - Visceral plexuses within gut wall controlling the muscles, glands and having sensory info
 - Myenteric: in muscularis
 - Submucosal
 - 100 million neurons! (as many as the spinal cord)
- Autonomic input: speeds or slows the system
 - Parasympathetic
 - Stimulates digestive functions
 - Sympathetic
 - Inhibits digestion
- Largely automatic

Esophagus

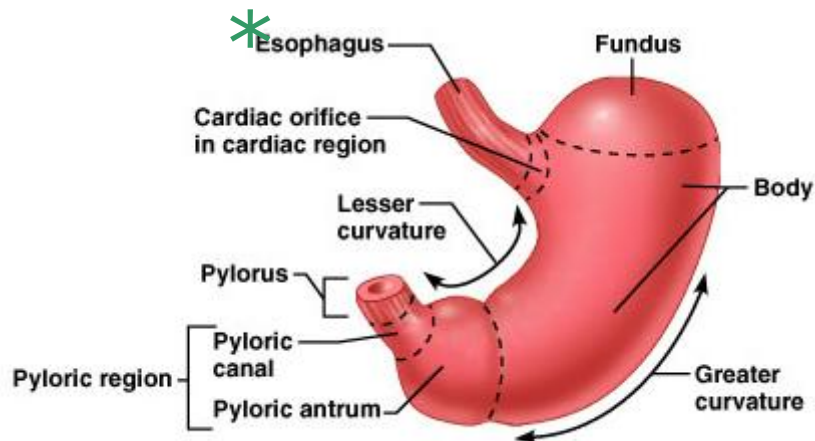
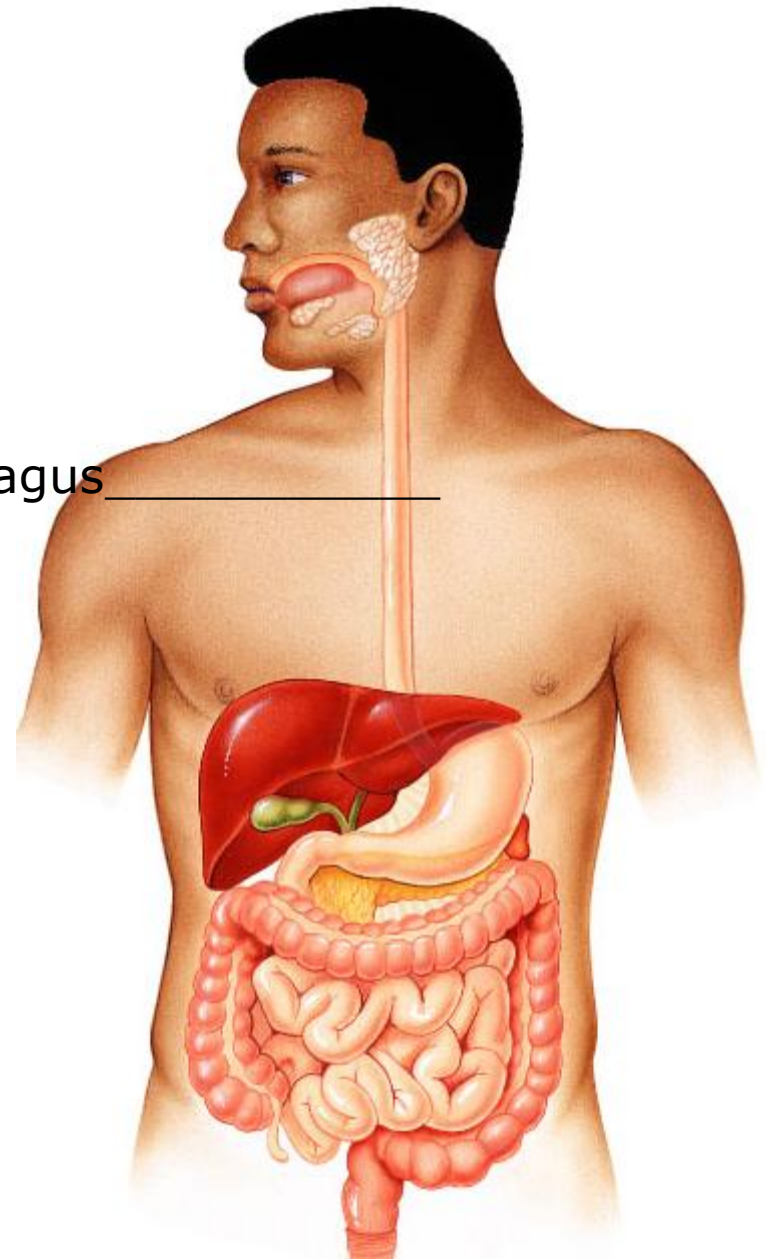
- Muscular 25cm tube from laryngopharynx to stomach
- Passes through the diaphragm at the esophageal hiatus
- Gastroesophageal (cardiac) sphincter: A physiologic sphincter that helps keep esophagus closed when empty



Esophagus

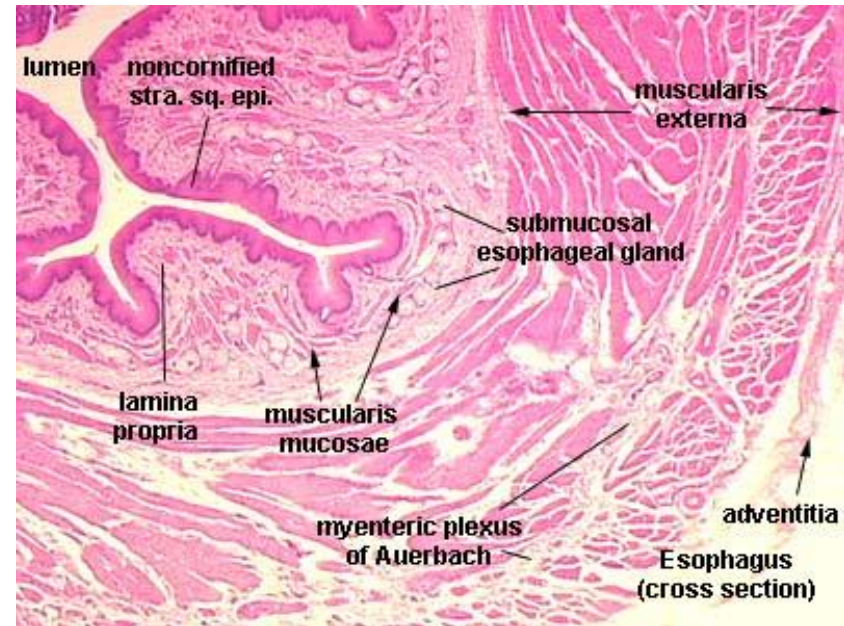
- Continuation of pharynx in mid neck
- Muscular tube collapsed when lumen empty
- Descends through thorax
 - On anterior surface of vertebral column
 - **Behind** (posterior to) trachea

Esophagus



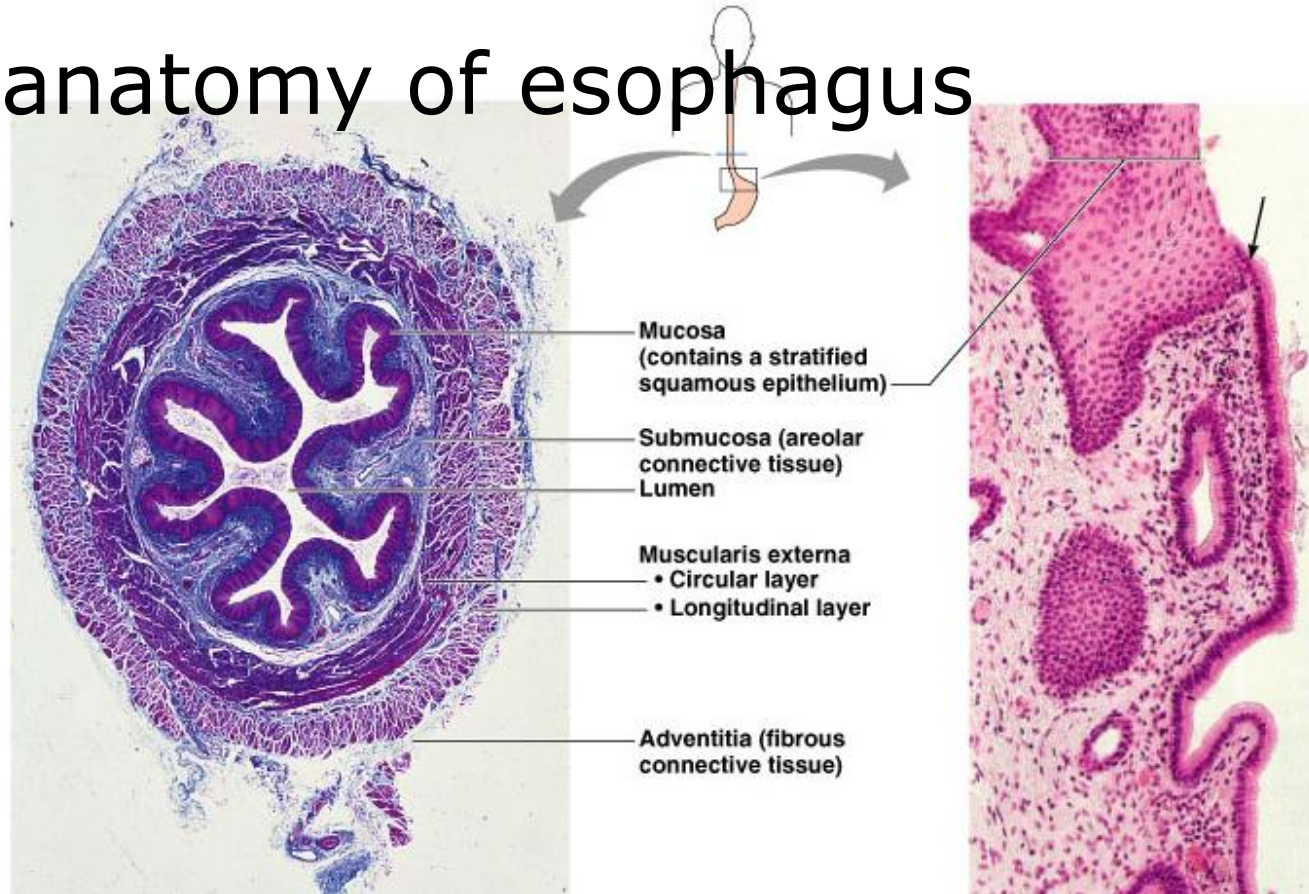
Esophagus

- Wall has all 4 GI tract tunics:
 - Epithelial layer changes at the junction with the stomach from stratified squamous epithelium to simple columnar epithelium
 - Esophageal mucous glands lubricate food bolus
 - Muscularis externa
 - Superior 1/3 of muscularis externa is skeletal muscle
 - Middle 1/3 is mixed skeletal & smooth
 - Lower 1/3 is smooth muscle
 - Adventitia: external covering



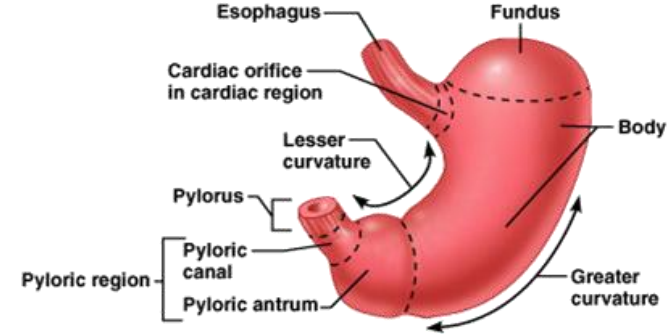
Microscopic anatomy of esophagus

Contains all 4 layers (see right)

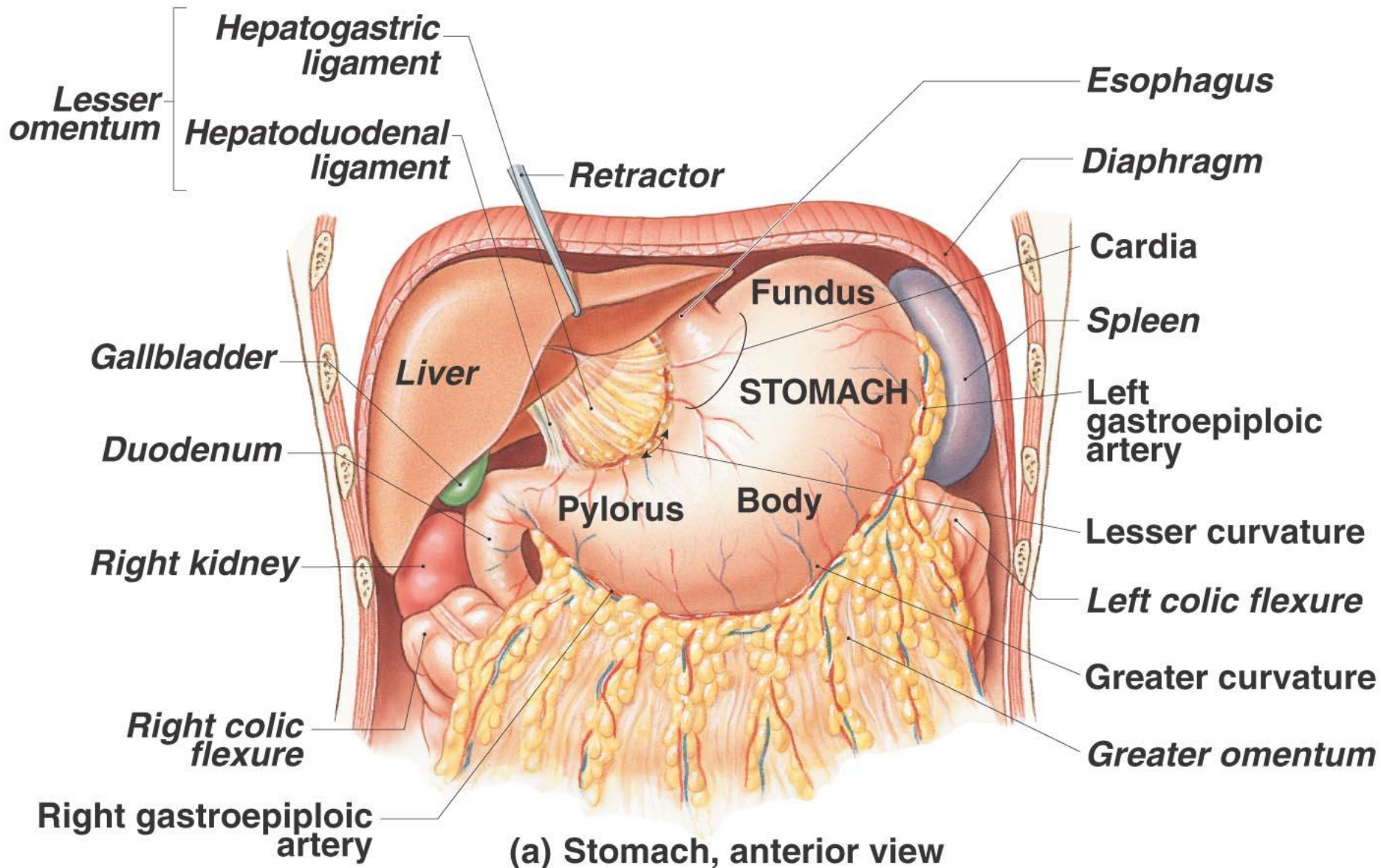


- Epithelium: nonkeratinized stratified squamous epithelium
 - At GE junction – thin simple columnar epithelium
- Mucus glands in wall
- Muscle (muscularis externa) changes as it goes down
 - Superior 1/3 of esophagus: skeletal muscle (like pharynx)
 - Middle 1/3 mixture of skeletal and smooth muscle
 - Inferior 1/3 smooth muscle (as in stomach and intestines)
- When empty, mucosa and submucosa lie in longitudinal folds

Stomach

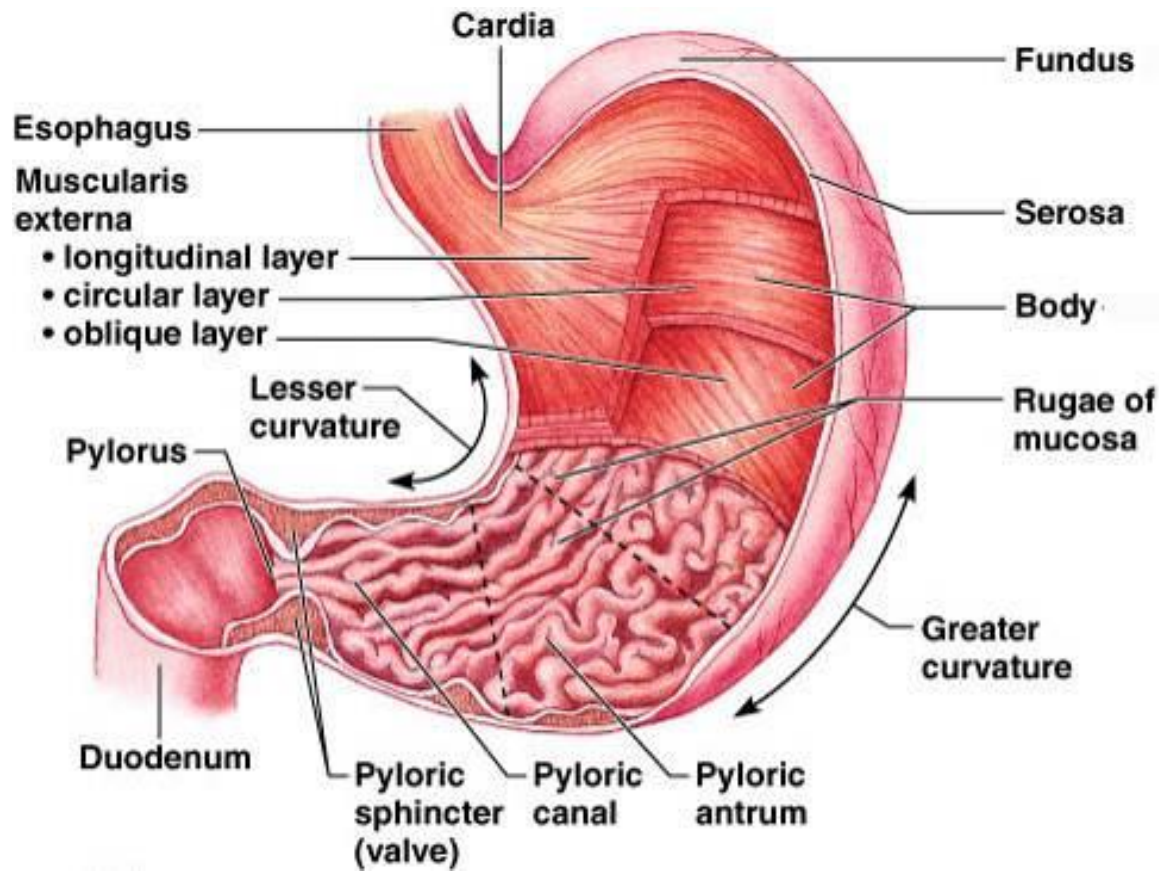


- J-shaped; widest part of alimentary canal
- Temporary storage and mixing – 4 hours
 - Into “*chyme*”
- Starts food breakdown
 - Pepsin (protein-digesting enzyme needing acid environment)
 - HCl (hydrochloric acid) helps kill bacteria
 - *Stomach tolerates high acid content but esophagus doesn't – why it hurts so much when stomach contents refluxes into esophagus (heartburn; GERD)*
- Most nutrients wait until get to small intestine to be absorbed; exceptions are:
 - Water, electrolytes, some drugs like aspirin and alcohol (absorbed through stomach)



Stomach

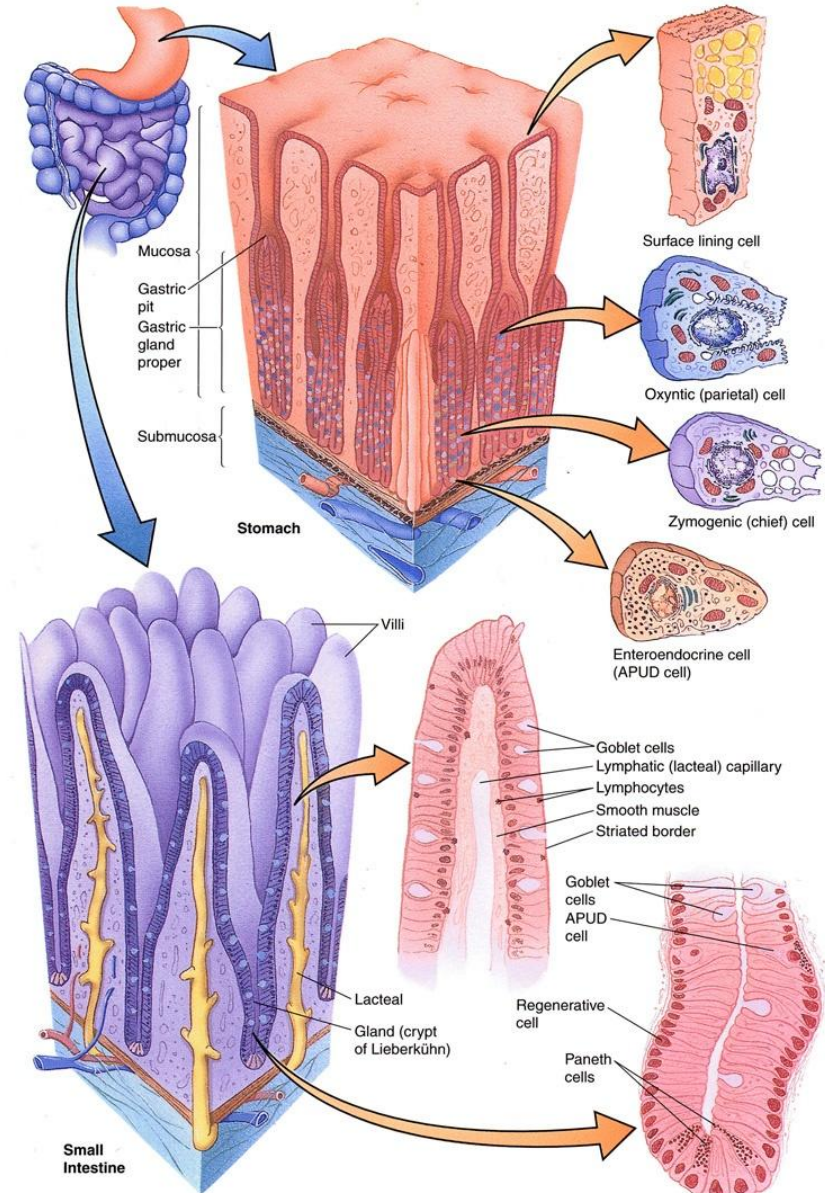
- Cardiac region: narrow, receives food bolus
- Fundus: bulge that extends supero-laterally to the cardia, reaches the diaphragm
- Body: mid-portion
- Pyloric antrum : funnel shaped portion narrows to form the;
- Pyloric canal →
- Pylorus →
- Pyloric sphincter →
- small intestine
- Rugae
 - longitudinal mucosal folds
- volume about 4L



Stomach

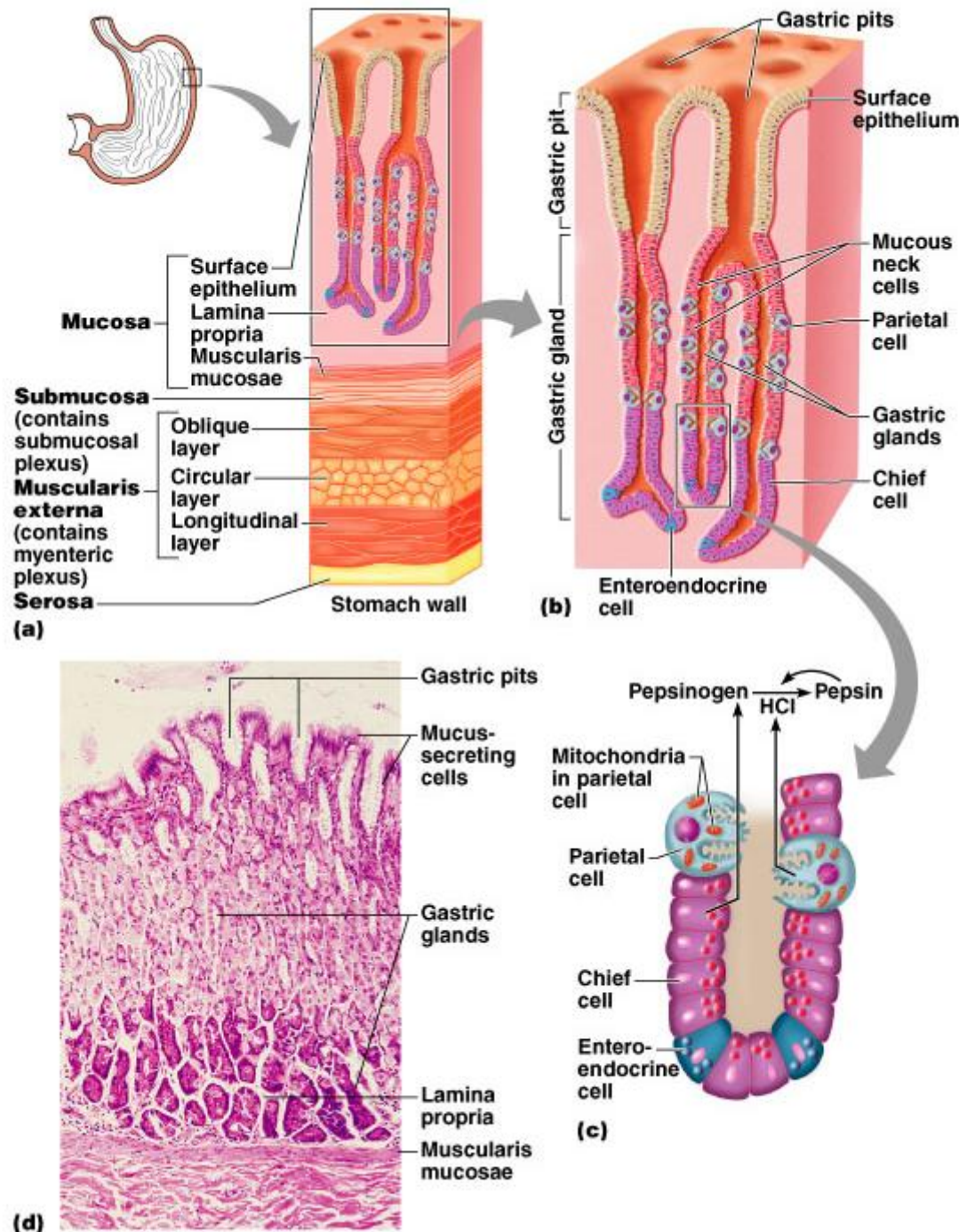
- **Stomach:** has the 4 tunics of the GI tract.
 - Epithelium: Simple columnar epithelium (goblet cells-mucous);
 - Muscularis externa has an additional oblique layer of muscle (allows another dimension of contraction).

GRAPHIC 14-1. Stomach and Small Intestine



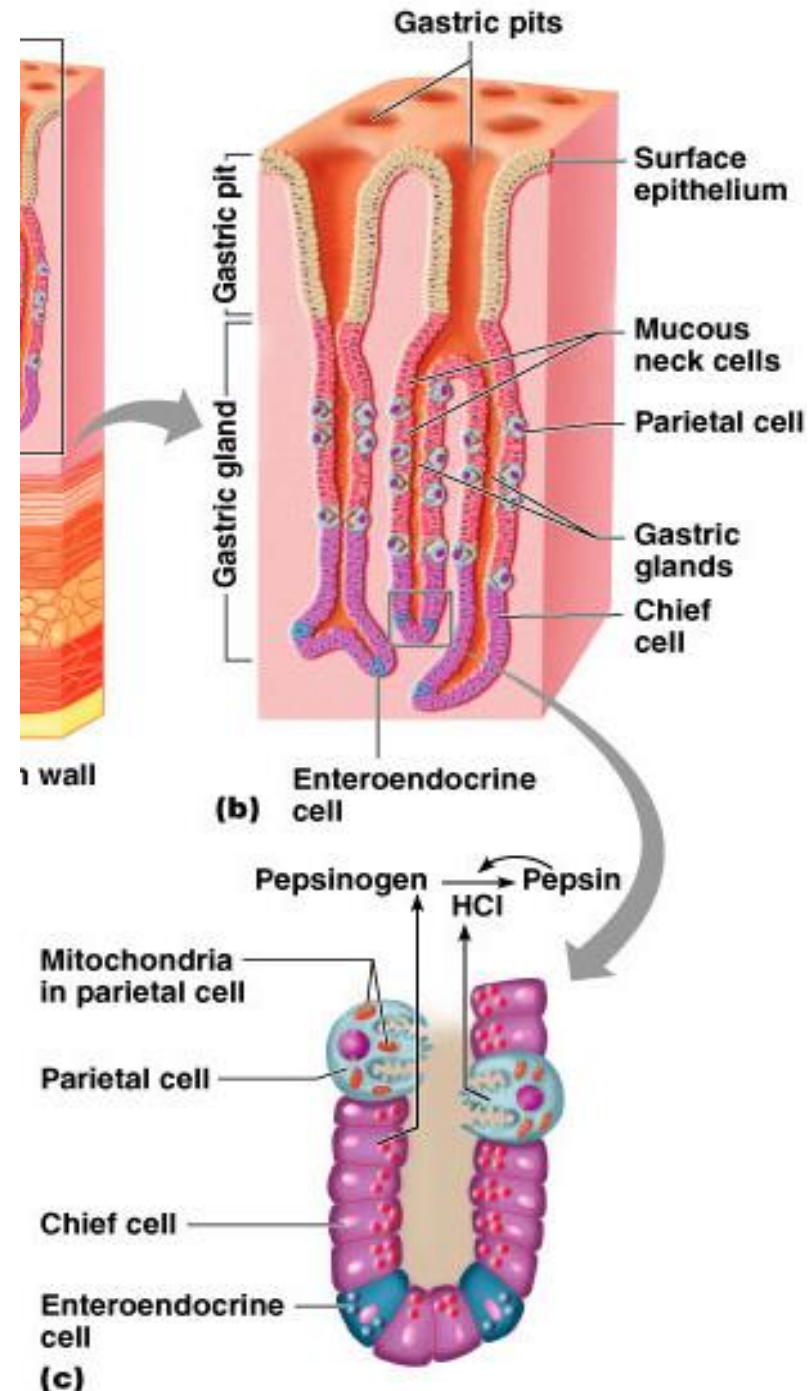
Histology of stomach

- Simple columnar epithelium: secrete bicarbonate-buffered mucus
- Gastric pits opening into gastric glands
 - *Mucus neck cells*
 - *Parietal cells*
 - **HCL**
 - **Intrinsic factor** (for B12 absorption)
 - *Chief cells*
 - **Pepsinogen** (activated to pepsin with HCL)
 - Stimulated by **gastrin**: a stomach hormone



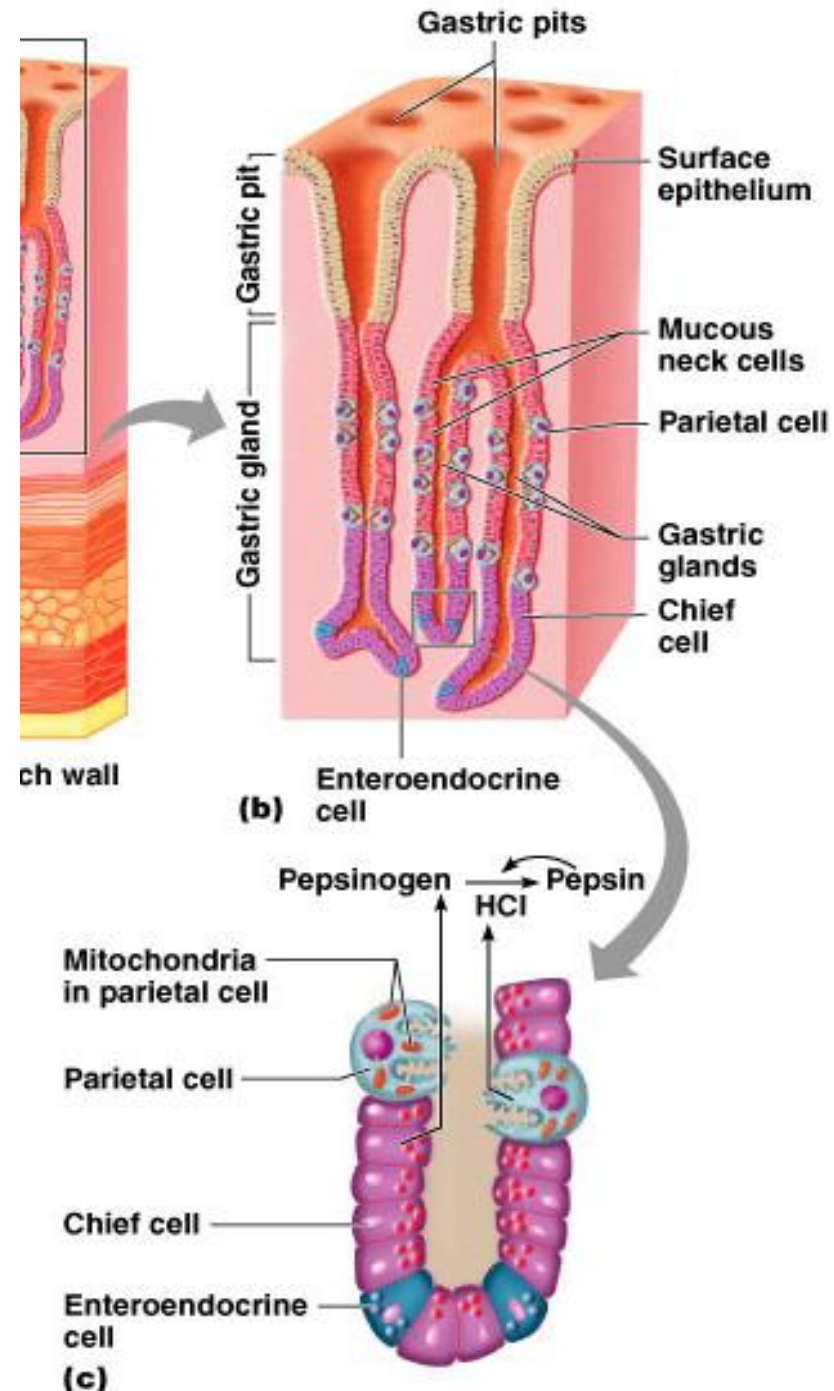
Stomach

- Gastric glands secrete gastric juices
 - **Mucous neck cells:** in the duct portion
 - **Parietal cells:** mid portion of glands secrete HCl & intrinsic factor
 - **Chief cells:** base of gland; secretes pepsinogen a precursor molecule to pepsin (an enzyme that digests protein)



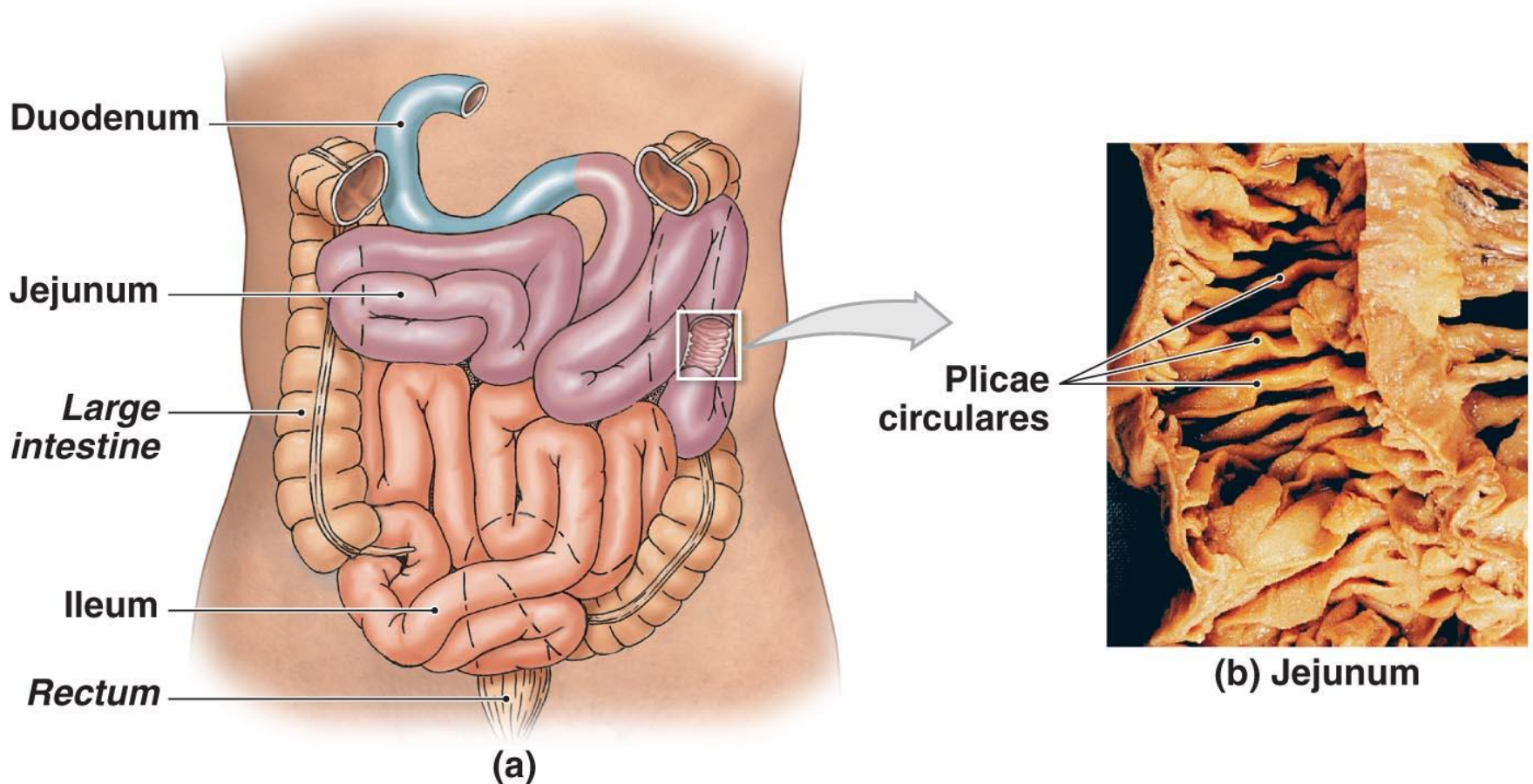
Stomach

- **Enteroendocrine cells:** secrete multiple hormonal products;
 - Gastrin, histamine, endorphins, serotonin, cholecystokinin, & somatostatin, which influence several digestive system organs



Small Intestine

- 90% of absorption occurs in the small intestine



Small Intestine

- 6-7m long: from pyloric sphincter to the ileocecal valve
- 3 subdivisions:
 - Duodenum
 - Jejunum
 - Ileum

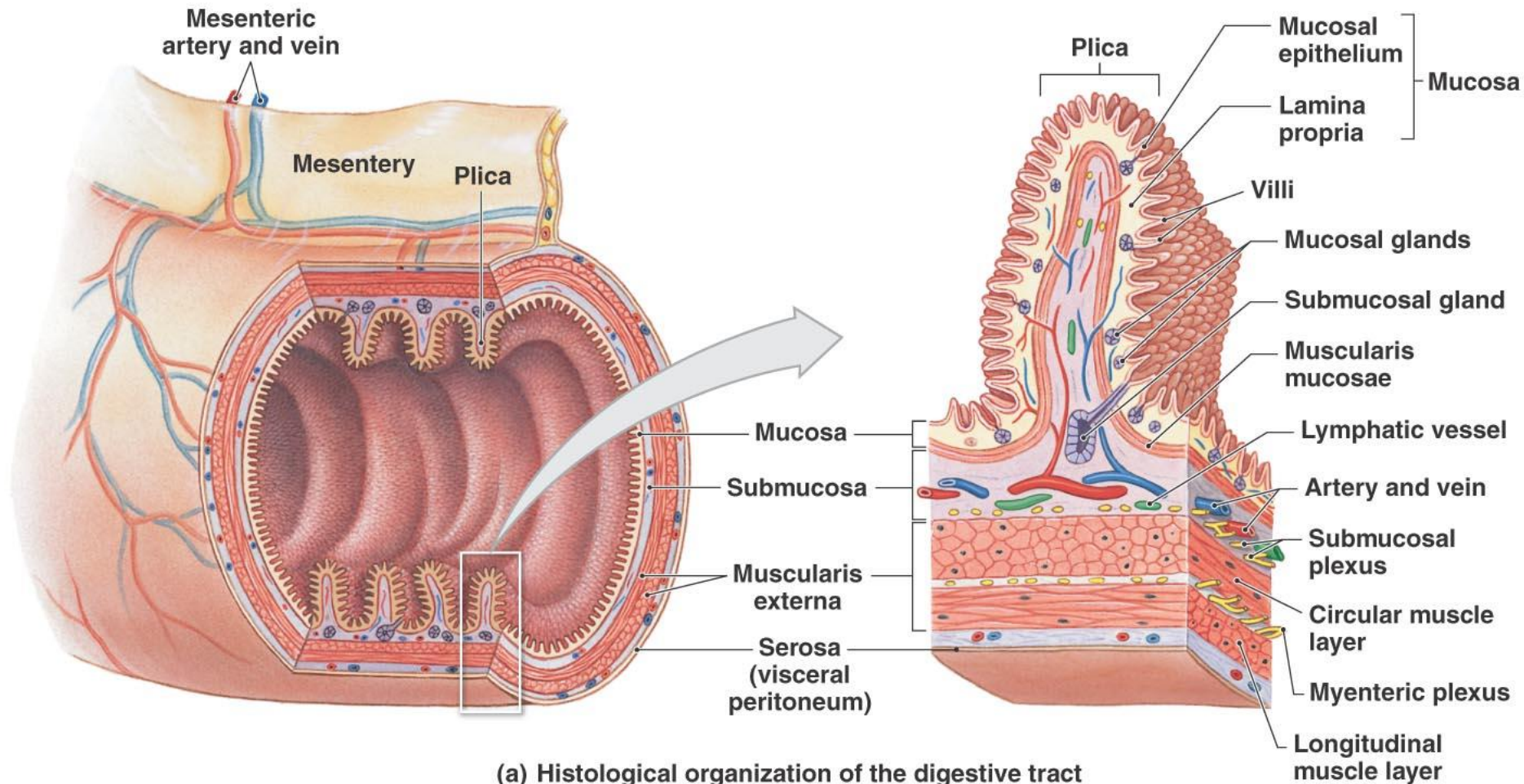
Small intestine

- Longest part of alimentary canal (2.7-5 m)
- Most enzymatic digestion occurs here
 - Most enzymes secreted by *pancreas*, not small intestine
- Almost all absorption of nutrients
- 3-6 hour process

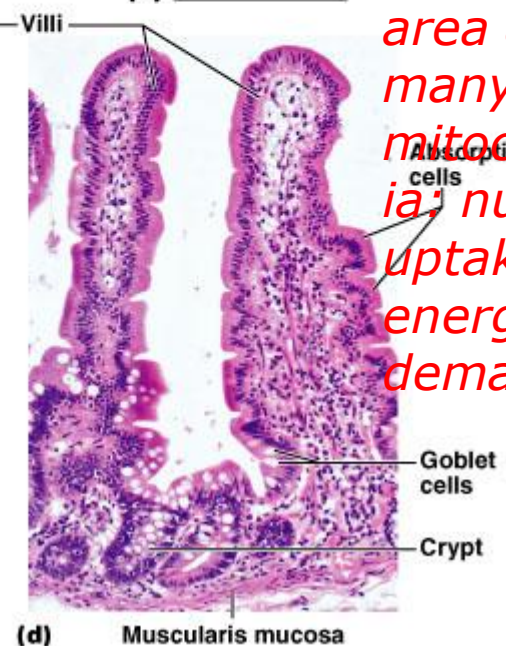
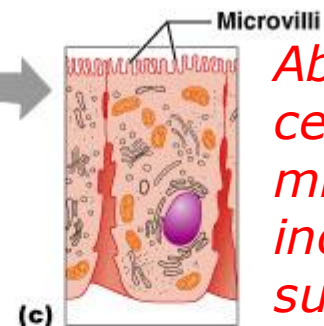
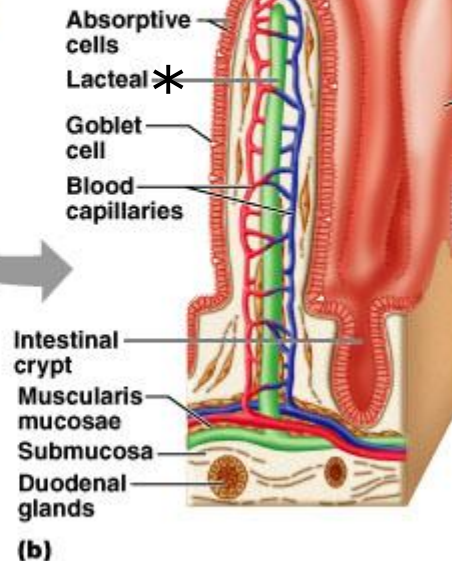
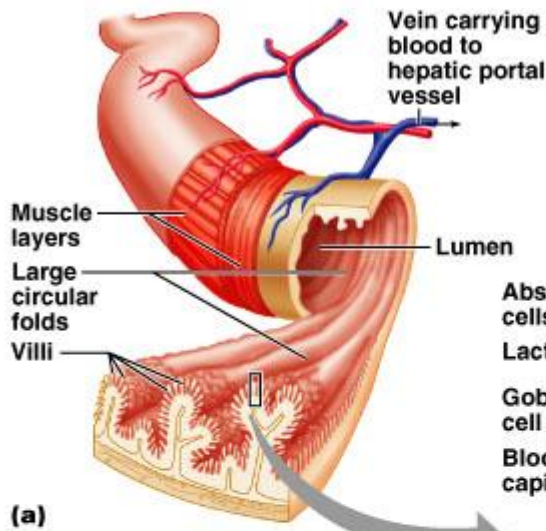
Small intestine



General histology of digestive tract



- Small intestine designed for absorption
 - Huge surface area because of great length
 - Structural modifications also increase absorptive area
 - Circular folds (plicae circulares)
 - Villi (fingerlike projections) 1 mm high – simple columnar epithelium: velvety
 - Microvilli

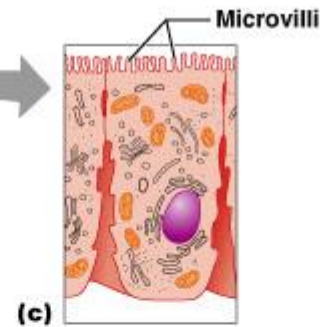
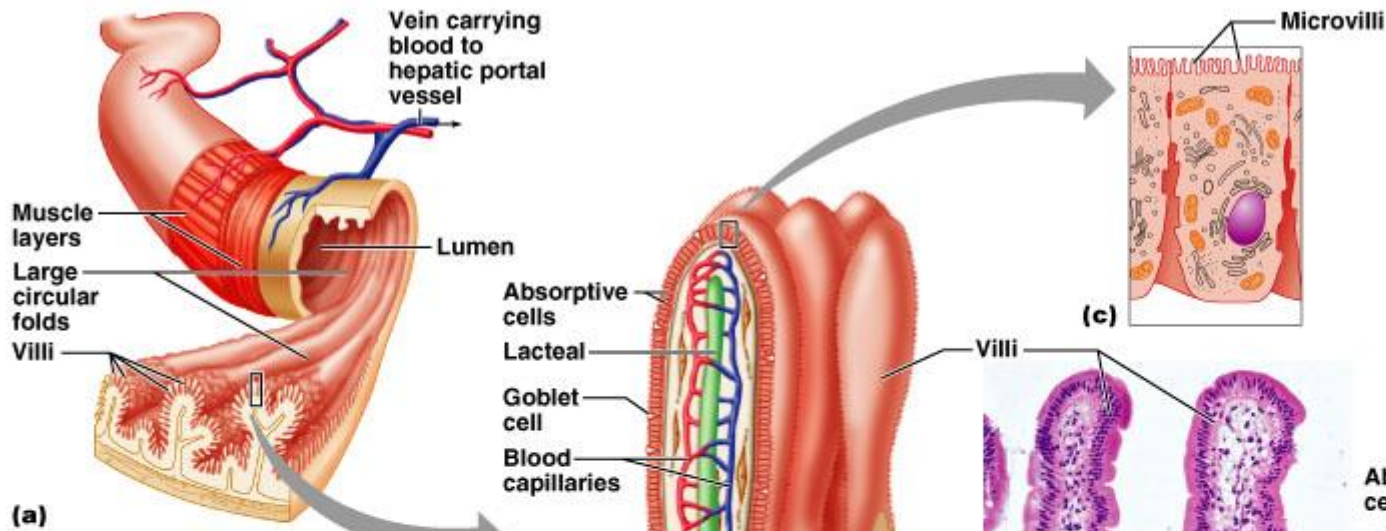


Absorptive cell with microvilli to increase surface area & many mitochondria; nutrient uptake is energy-demanding

Lacteal*: network of blood and lymph capillaries

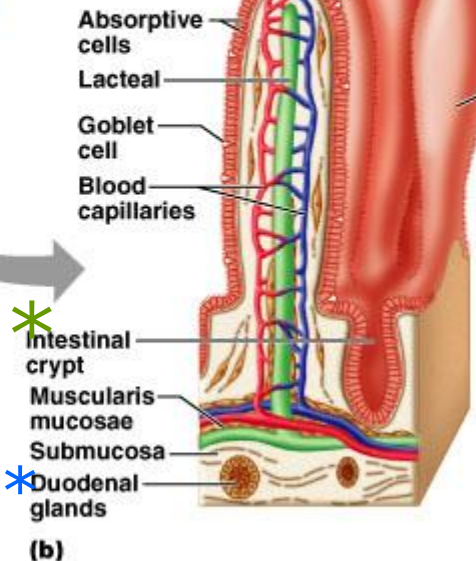
-Carbs and proteins into blood to liver via hepatic portal vein
 -Fat into lymph: *fat-soluble toxins e.g. pesticides circulate systemically before going to*

- **Intestinal crypts** * (of Lieberkuhn) in between villi
 - Cells here divide every 3-6 days to renew epithelium (most rapidly dividing cells of the body)
 - Secrete watery intestinal juice which mixes with chyme (the paste that food becomes after stomach churns it)
- **Intestinal flora** – the permanent normal bacteria
 - Manufacture some vitamins, e.g. K, which get absorbed

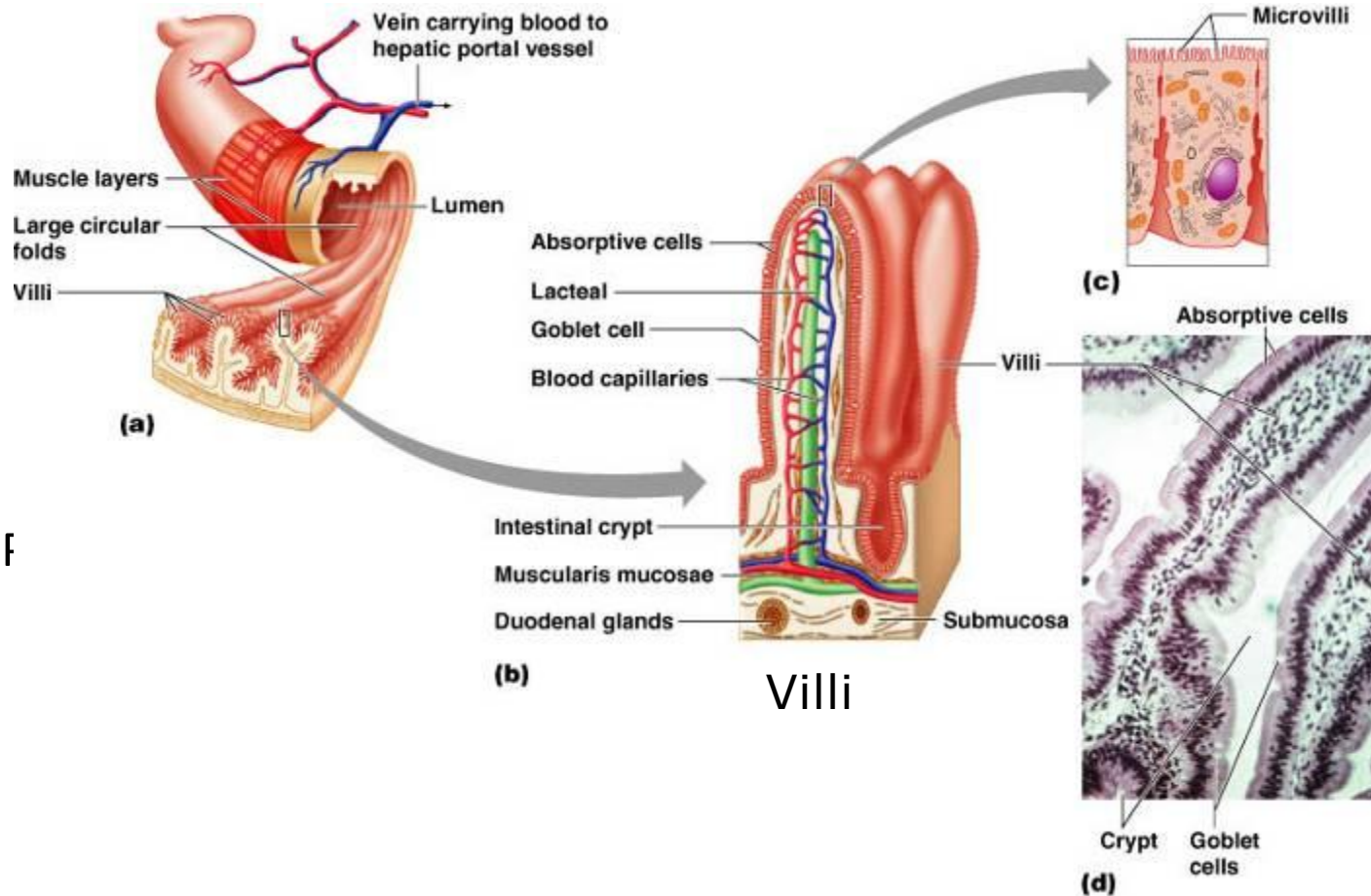


- Duodenal glands *
- Mucus to counteract acidity from stomach
 - Hormones:

Cholecystokinin (stimulates GB to release stored bile, also pancreas)
Secretin (stimulates pancreatic ducts to release acid neutralizer)

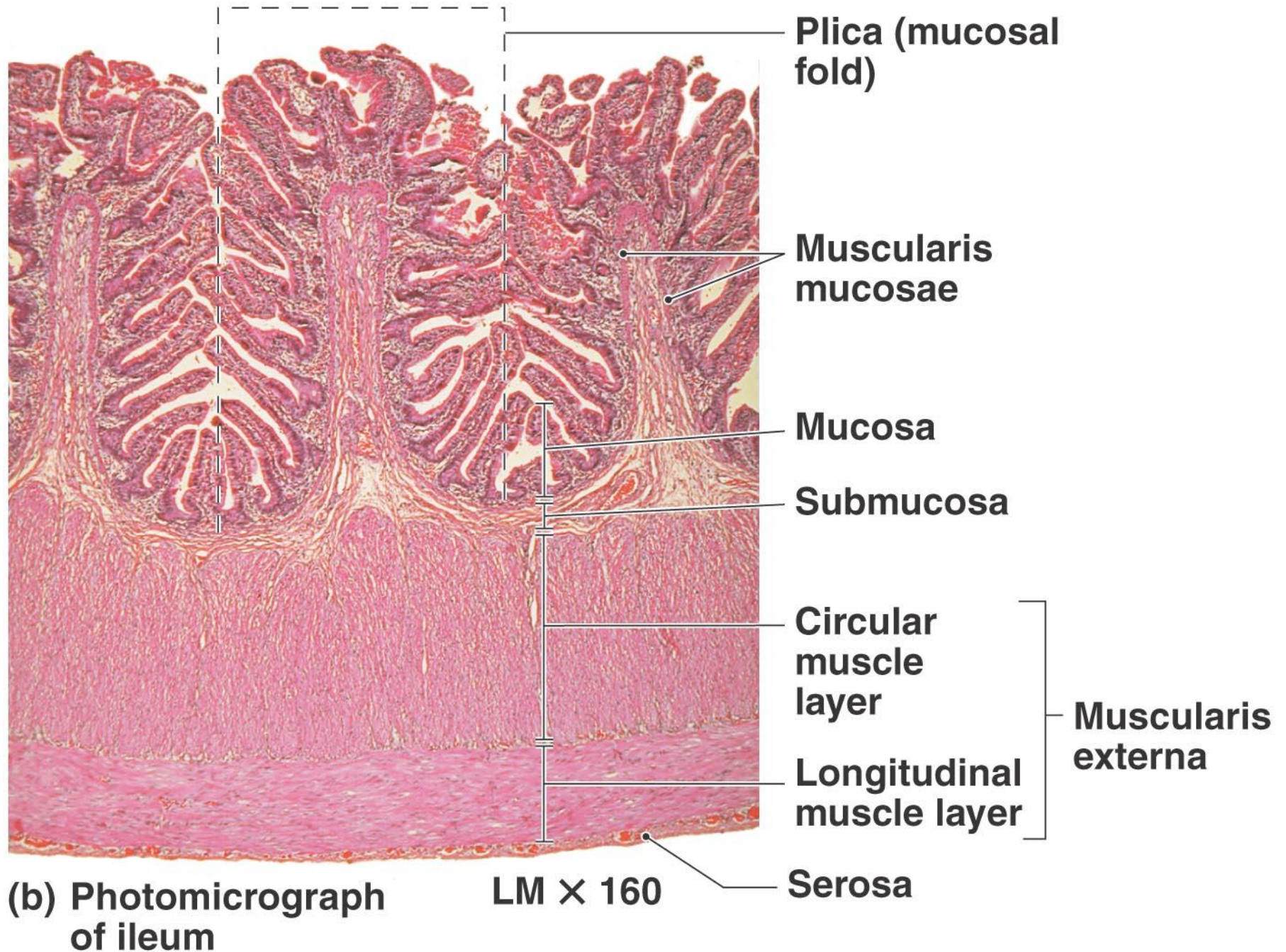


Small Intestine



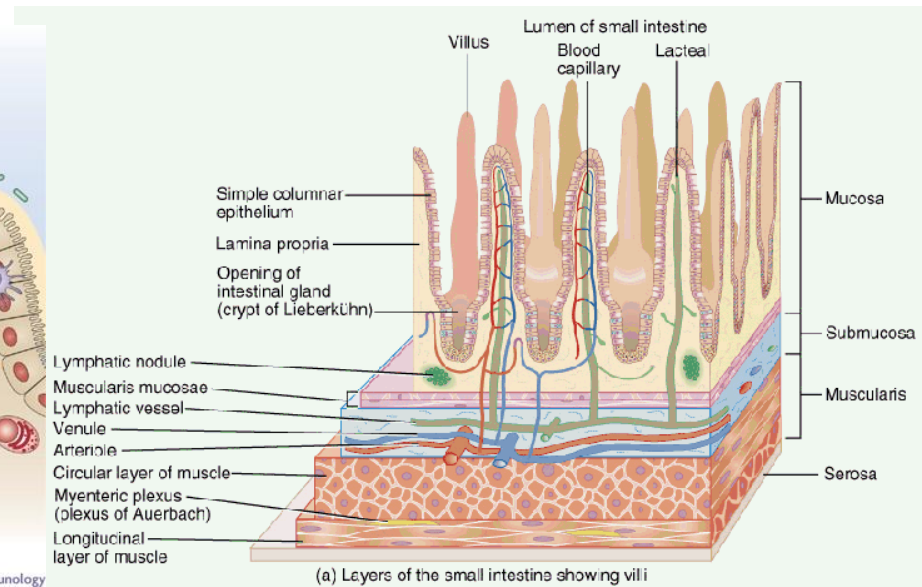
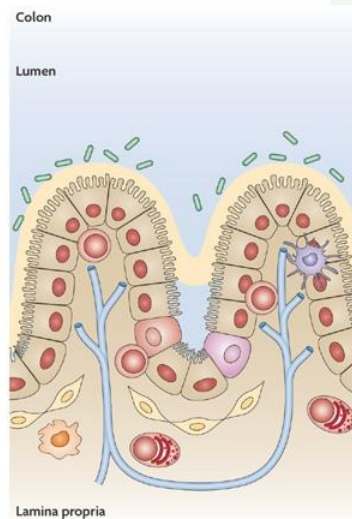
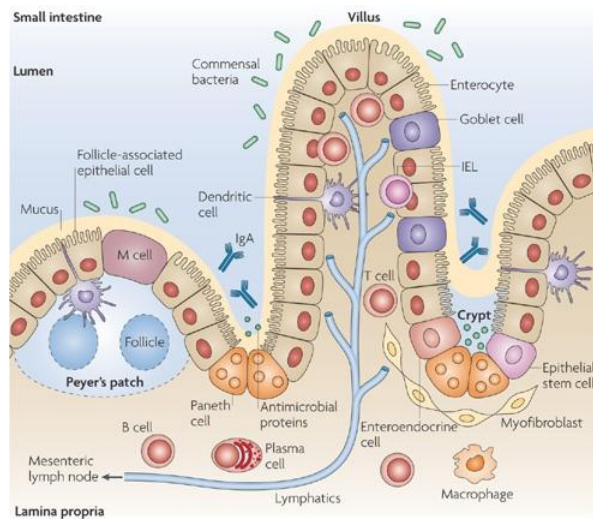
Microvilli: PM projections forming "brush border"; Hold enzymes that complete protein & carbohydrate digestion

Villi: velvety mucosa of absorptive epithelium containing capillaries & lymph lacteals



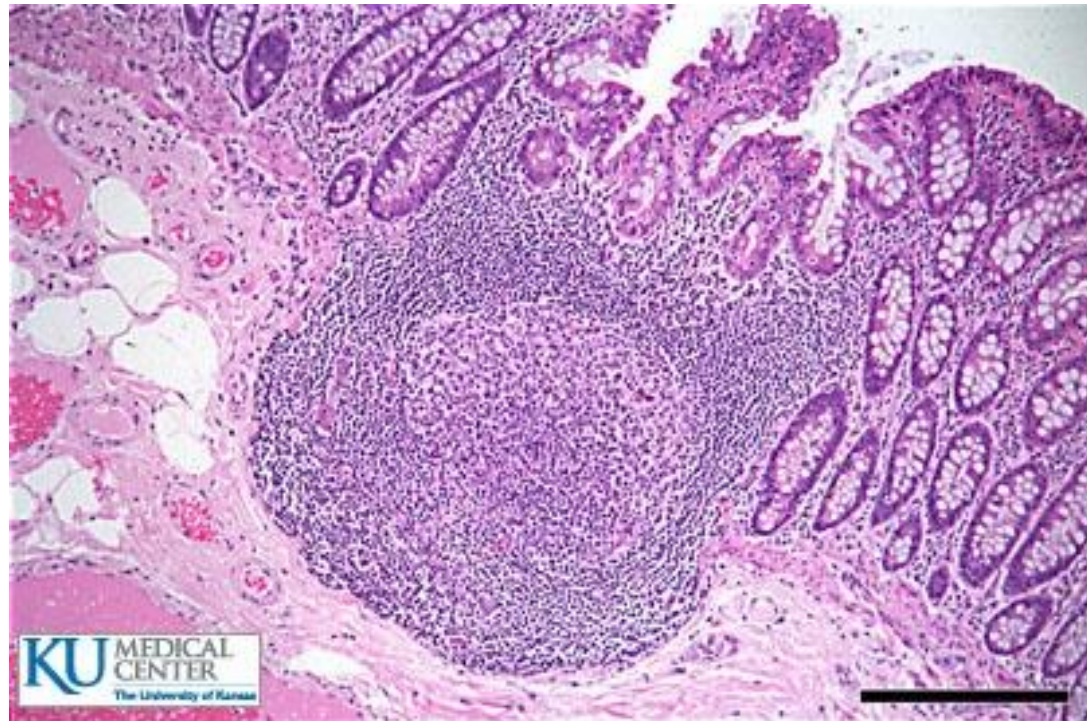
Small intestine Wall

- Cell types:
 - Mostly absorptive cells
 - Goblet (mucous) cells increase in number as the small intestine progresses
 - Enteroendocrine cells
 - T-Lymphocytes



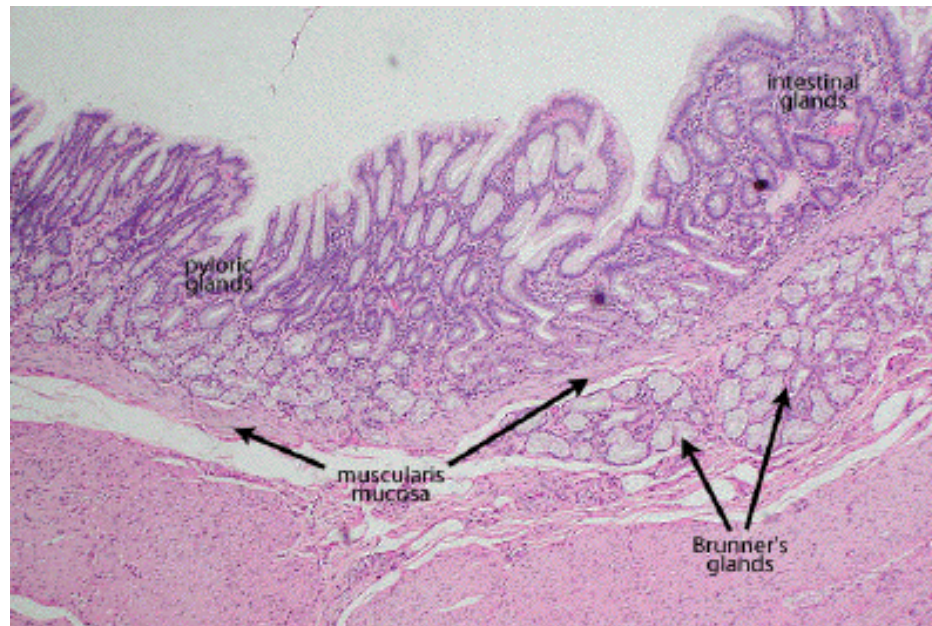
Small intestine Wall

- Intestinal crypts with cells that secrete intestinal juice & contain Paneth cells that secrete protective lysozyme (antibacterial)
- Peyer's Patches: lymphoid follicle in submucosa

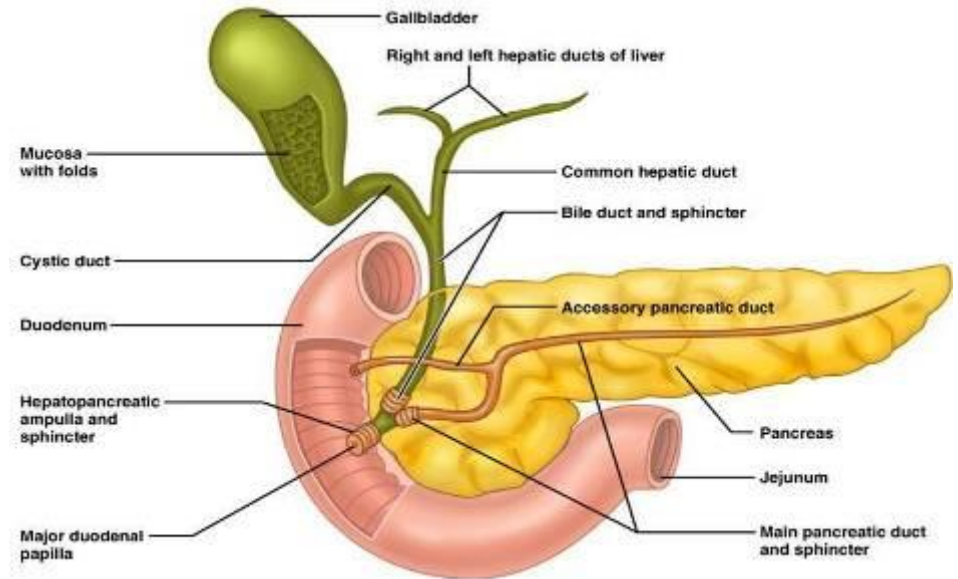


Small intestine Wall

- Brunners glands (duodenum) secrete HCO_3^- rich mucous to increase the pH of chyme
- Villus epithelium is replaced every 3-6 days
- Intestinal Juice : isotonic with blood plasma, slightly alkaline, low enzyme content



Small Intestine



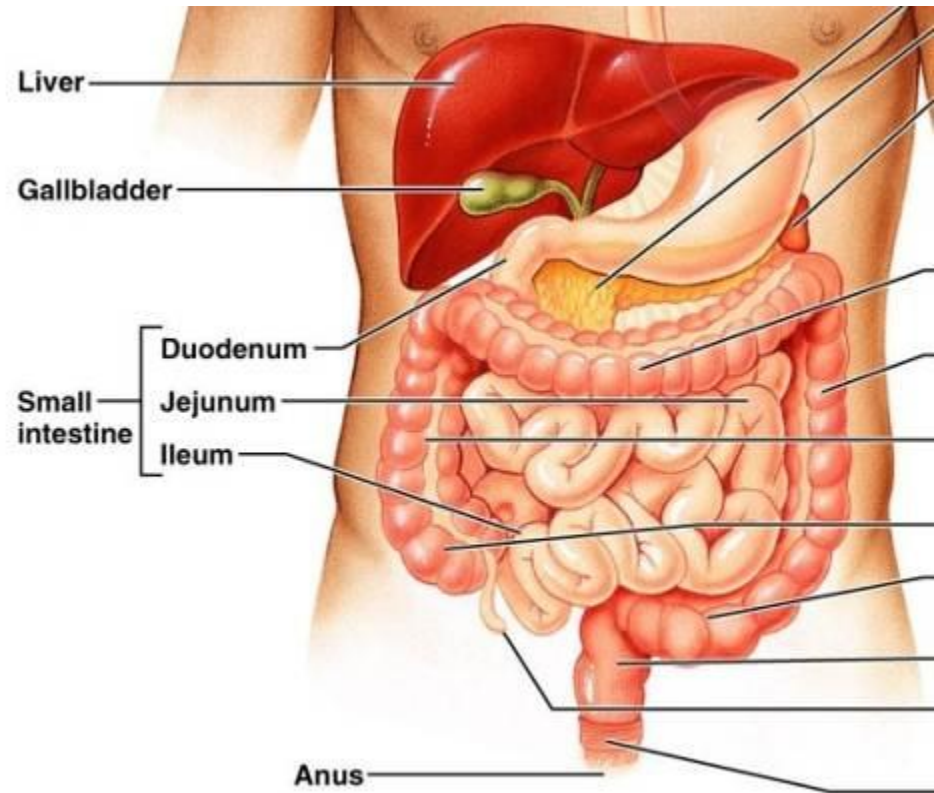
- Duodenum :
 - Curves around the pancreatic head (~25cm long)
 - Contains the hepatopancreatic ampulla : formed by the merger of the bile duct & the pancreatic duct.
 - Hepatopancreatic sphincter controls admission of bile & pancreatic enzymes to the duodenum
 - Duodenum is retroperitoneal

Small Intestine

- The Duodenum
 - The segment of small intestine closest to stomach
 - 25 cm (10 in.) long
 - “Mixing bowl” that receives **chyme** from stomach and digestive secretions from pancreas and liver
 - Functions of the duodenum
 - To receive chyme from stomach
 - To neutralize acids before they can damage the absorptive surfaces of the small intestine

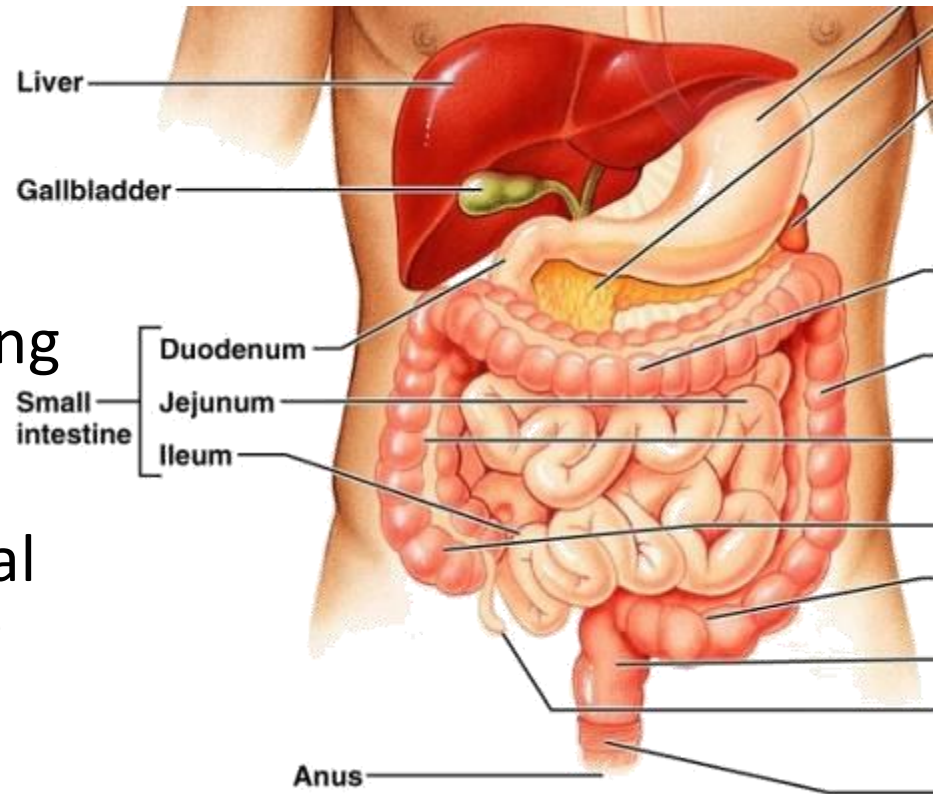
Small Intestine

- The Jejunum
 - Is the middle segment of small intestine: extends from duodenum to ileum (~2.5m long)
 - 2.5 meters (8.2 ft) long
 - Is the location of most
 - Chemical digestion
 - Nutrient absorption
 - Has few plicae circulares
 - Small villi

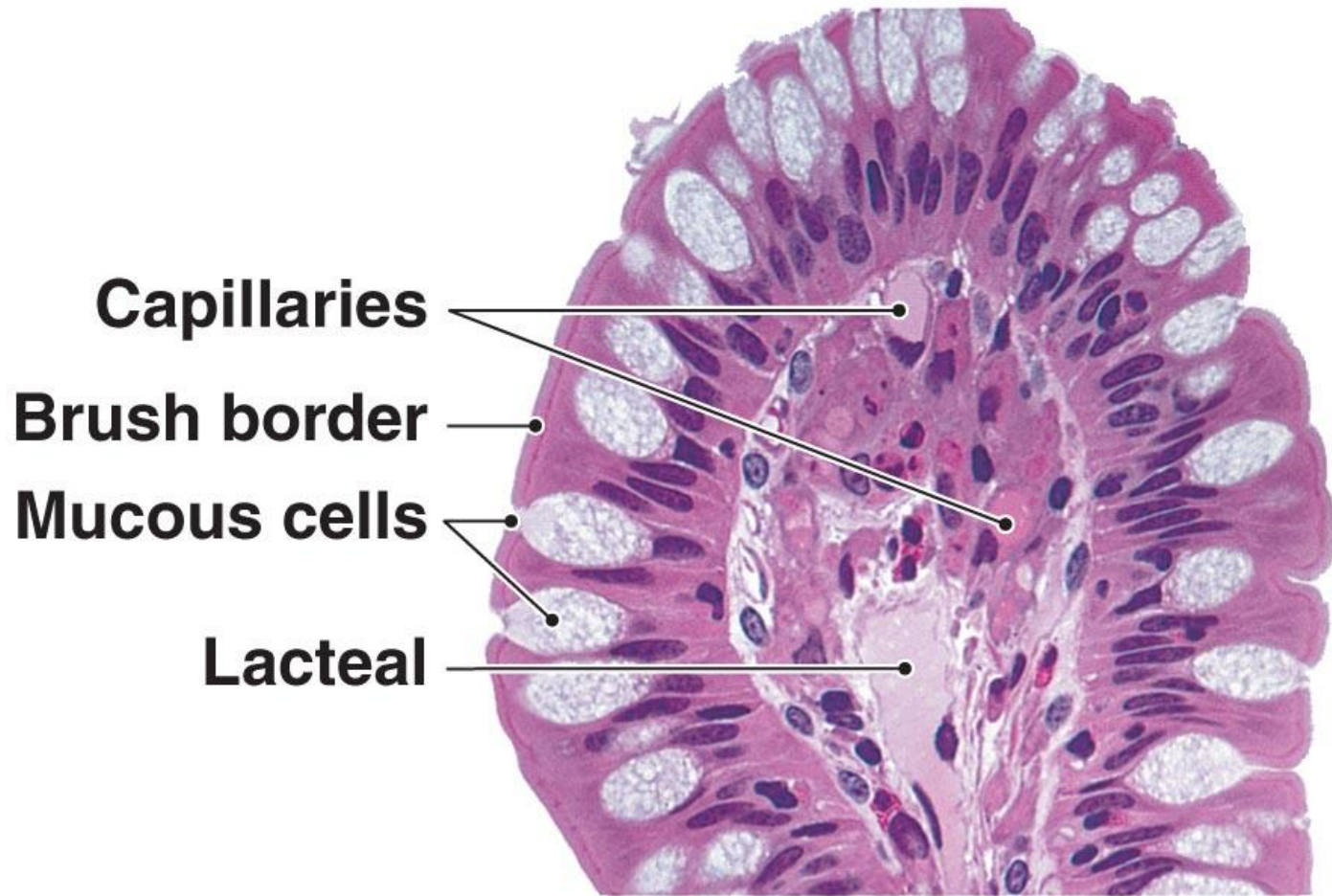


Small Intestine

- The Ileum
 - The final segment of small intestine: from jejunum to ileocecal valve (~3.6m long)
 - 3.5 meters (11.48 ft) long
 - Ends at the **ileocecal valve**, a sphincter that controls flow of material from the ileum into the large intestine



Small Intestine



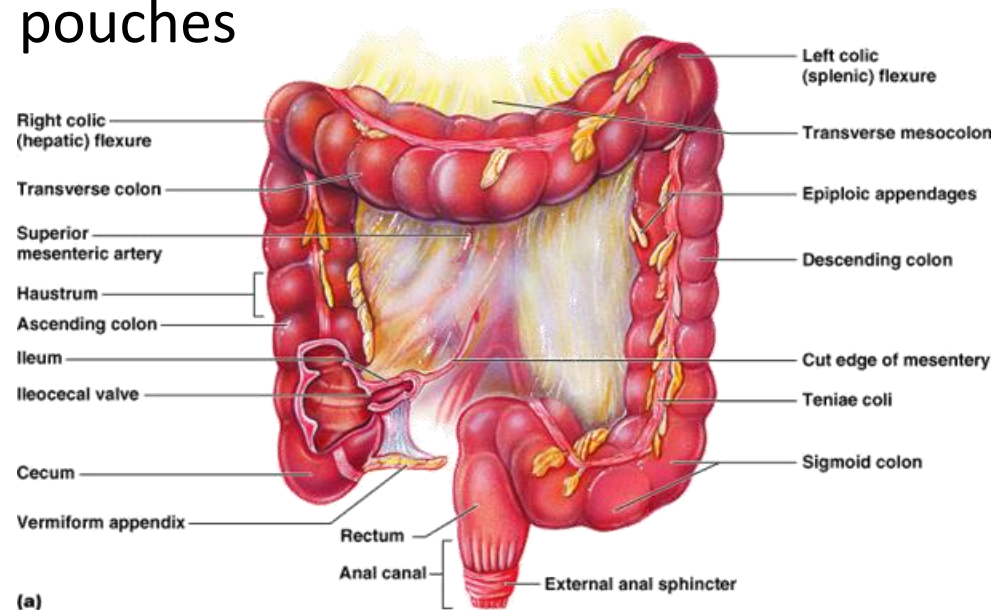
(d) LM × 252

Small Intestine

- Jejunum & Ileum function in absorption;
 - Intraperitoneal
 - Suspended from mesentery whose veins & lymph vessels carry nutrients away from small intestine

Large Intestine

- Ileocecal valve to anus (~1.5m)
- Teniae coli: 3 ribbons of longitudinal smooth muscle
- Haustra: pocket-like segments of large intestine
- Epiploic appendages: fat filled pouches of visceral peritoneum



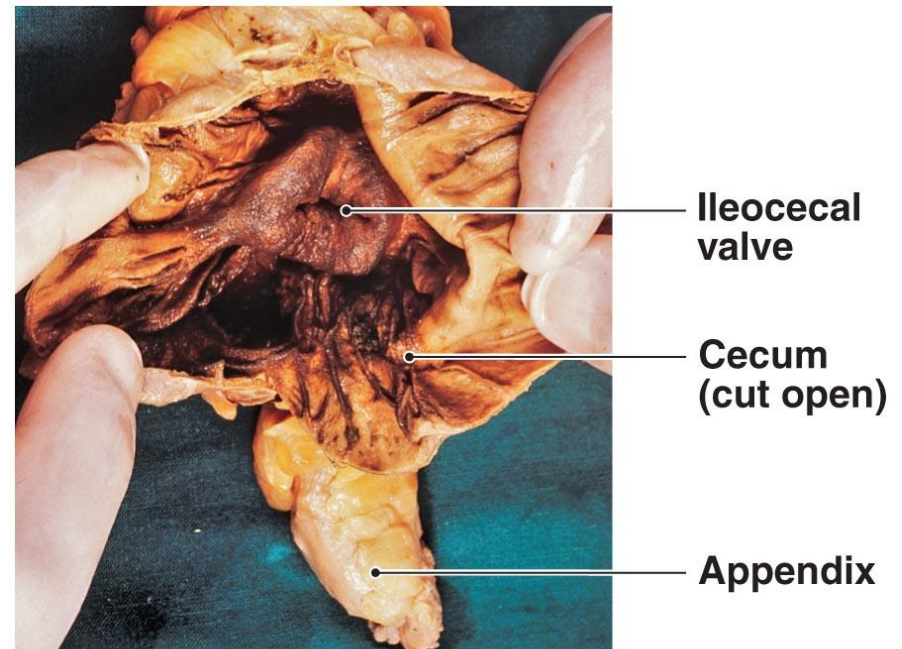
Parts of Large Intestine

- **The Cecum**

- Is an expanded pouch
- Receives material arriving from the ileum
- Stores materials and begins compaction

- **Appendix**

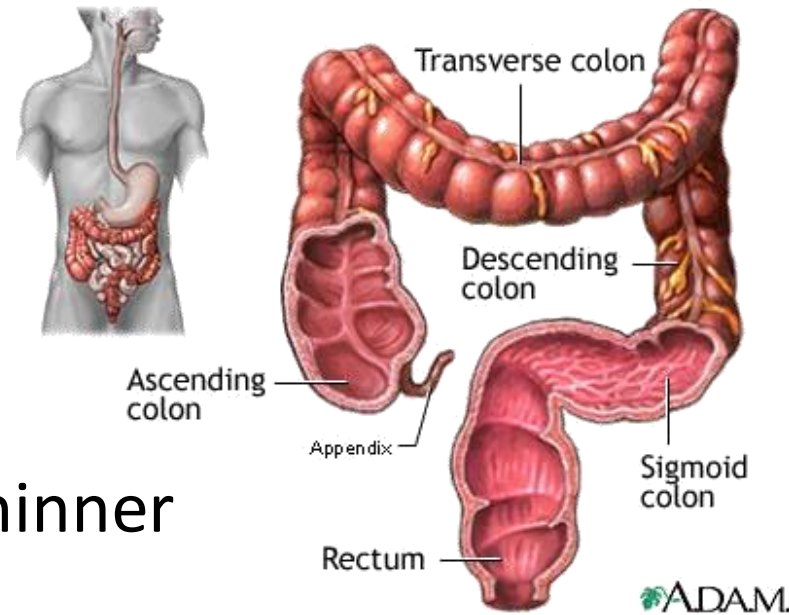
- Also called vermiform appendix
- Is a slender, hollow appendage about 9 cm (3.6 in.) long
- Is dominated by lymphoid nodules (a lymphoid organ)



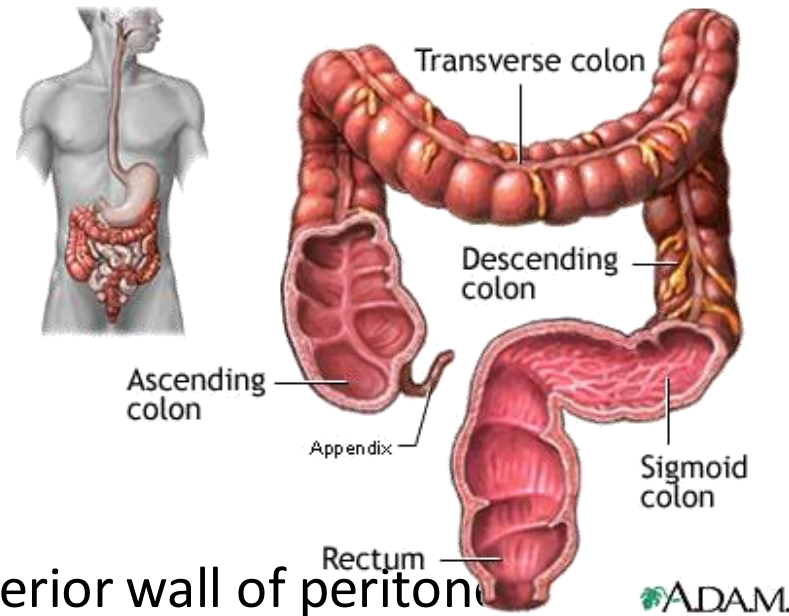
(b) Cecum and appendix

Parts of Large Intestine

- The Colon
 - Has a larger diameter and thinner wall than small intestine
 - The wall of the colon
 - Forms a series of pouches (**haustra**)
 - Haustra permit expansion and elongation of colon



Parts of Colon



- **Ascending Colon**

- Begins at superior border of cecum
- Ascends along right lateral and posterior wall of peritoneal cavity to inferior surface of the liver and bends at **right colic flexure** (hepatic flexure)

- **Transverse Colon**

- Crosses abdomen from right to left; turns at **left colic flexure** (splenic flexure)
- Is supported by transverse mesocolon
- Is separated from anterior abdominal wall by greater omentum

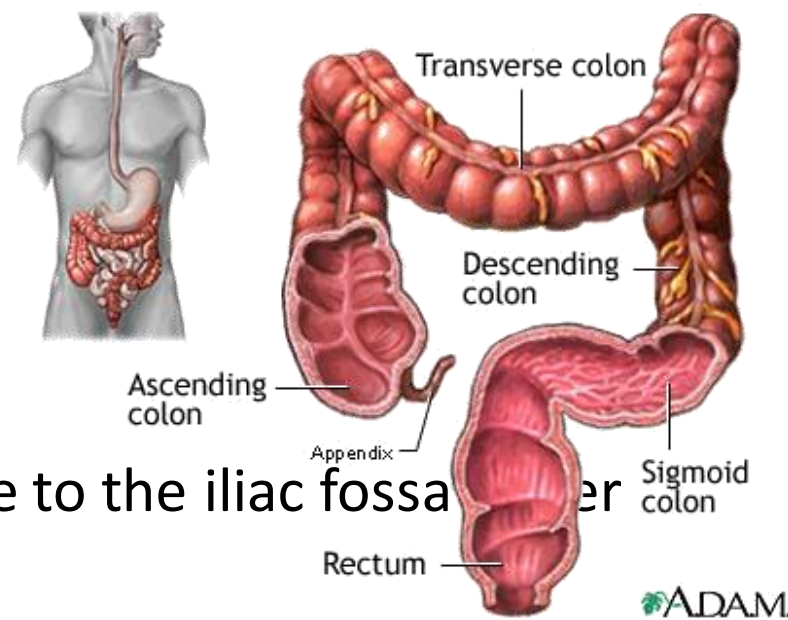
Parts of Colon

- **The Descending Colon**

- Proceeds inferiorly along left side to the iliac fossa (right surface of left ilium)
- Is retroperitoneal, firmly attached to abdominal wall

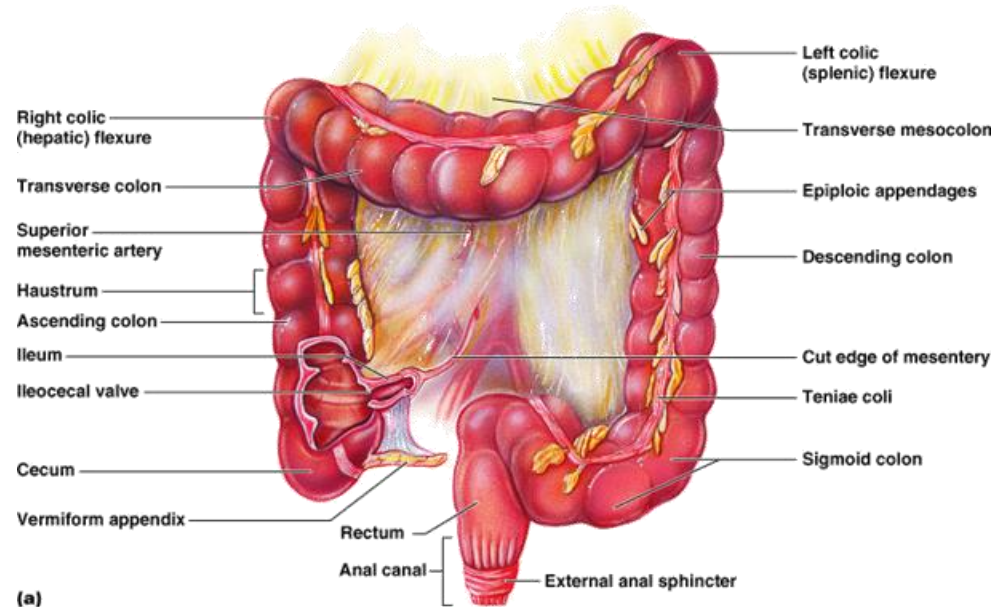
- **The Sigmoid Colon**

- Is an S-shaped segment, about 15 cm (6 in.) long
- Starts at **sigmoid flexure**
- Lies posterior to urinary bladder
- Is suspended from sigmoid mesocolon
- Empties into rectum

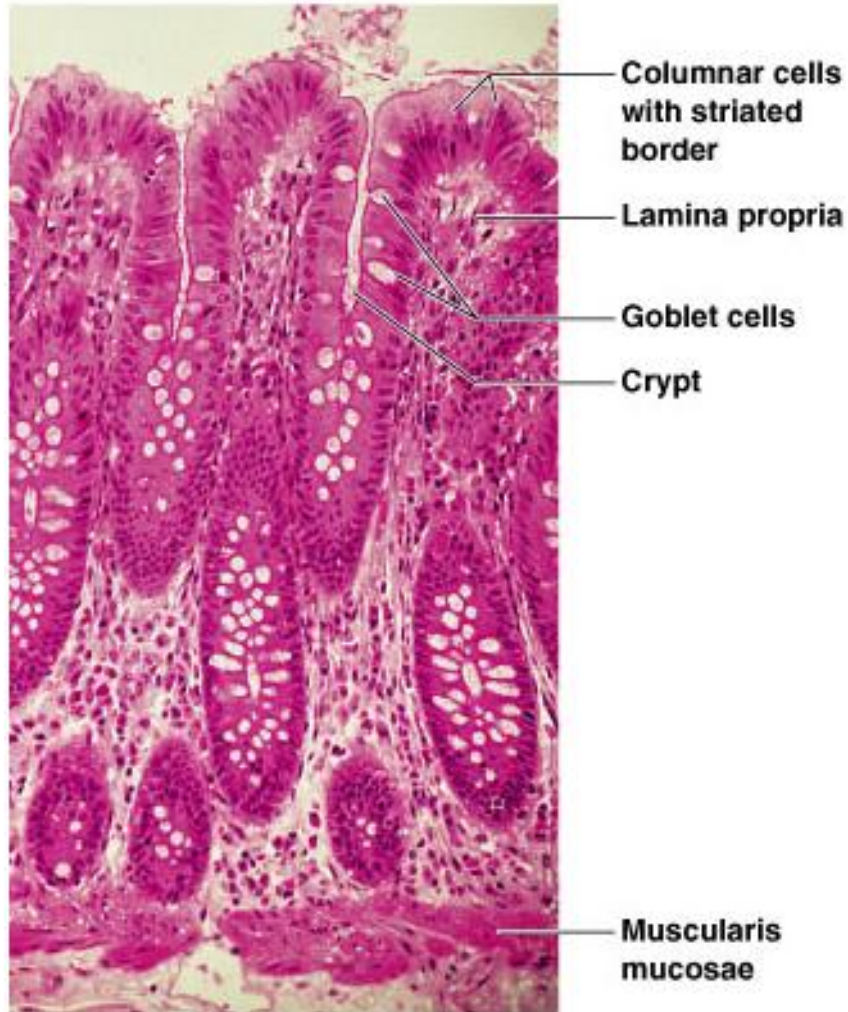


Large Intestine

- All 4 layers present
- Mucosa: simple columnar epithelium until anal canal (stratified squamous)
 - No folds or villi. No significant enzyme secretions
 - Crypts: invaginations of mucosa contain large numbers of goblet cells that secrete mucous for protection & lubrication

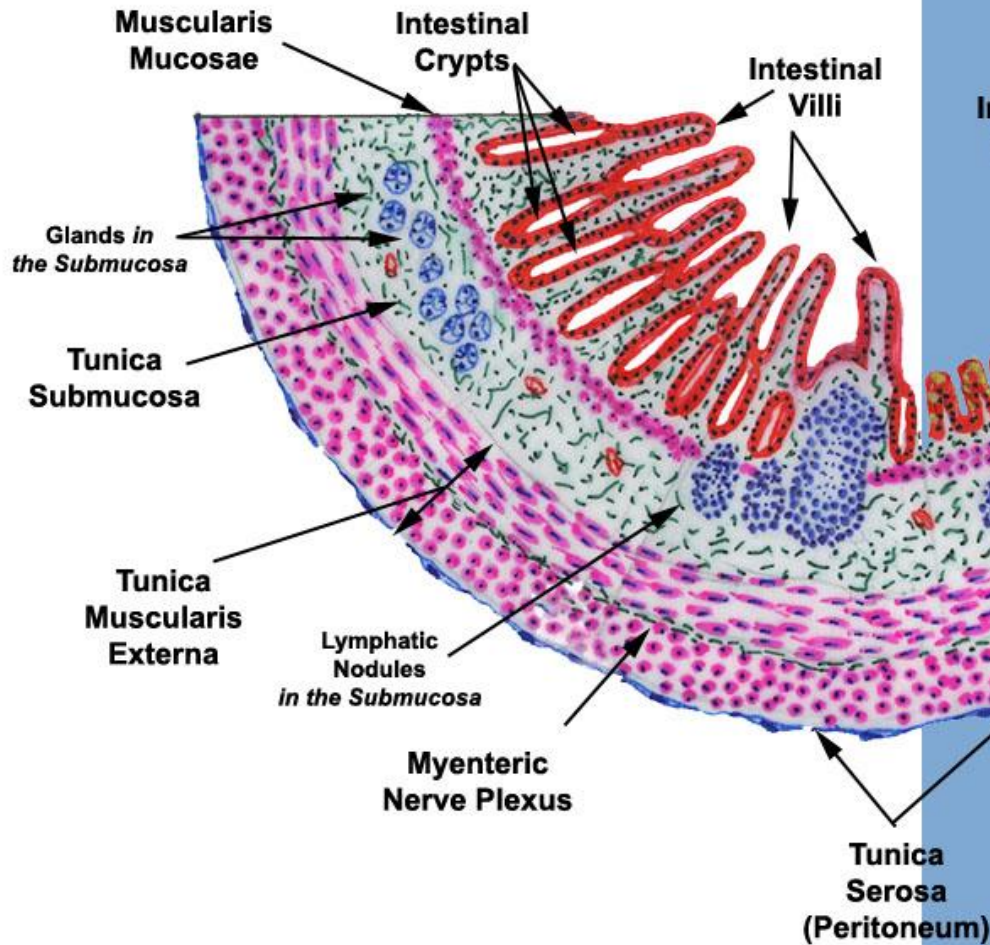


Histology – large intestine

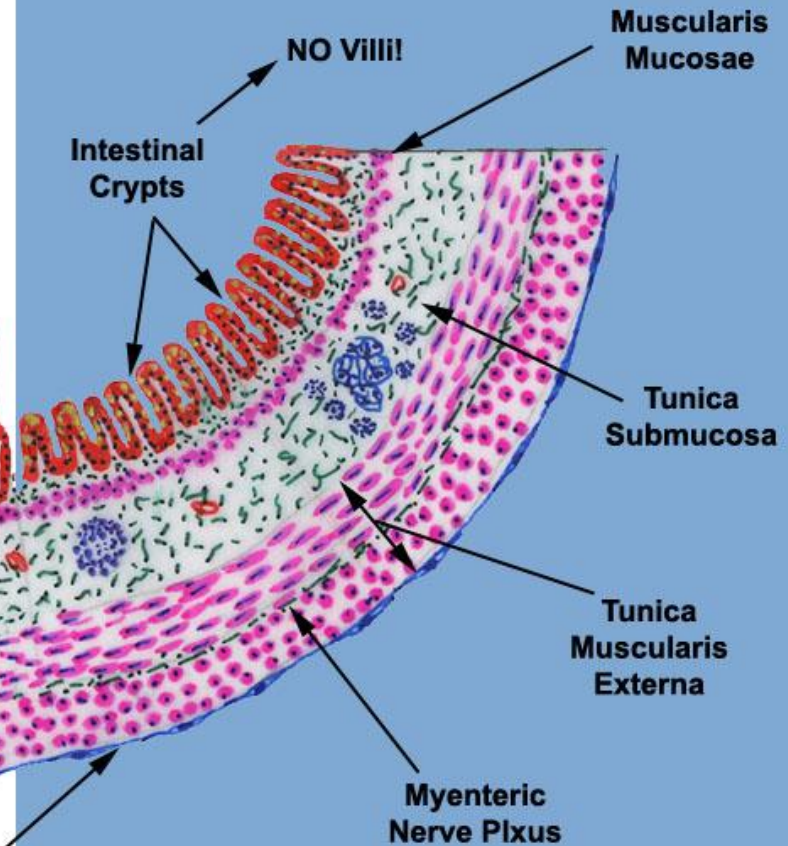


- No villi
 - Fewer nutrients absorbed
- “Columnar cells” in pic = absorptive cells
 - Take in water and electrolytes
- A lot of goblet cells for mucus
 - Lubricates stool
- More lymphoid tissue
 - A lot of bacteria in stool

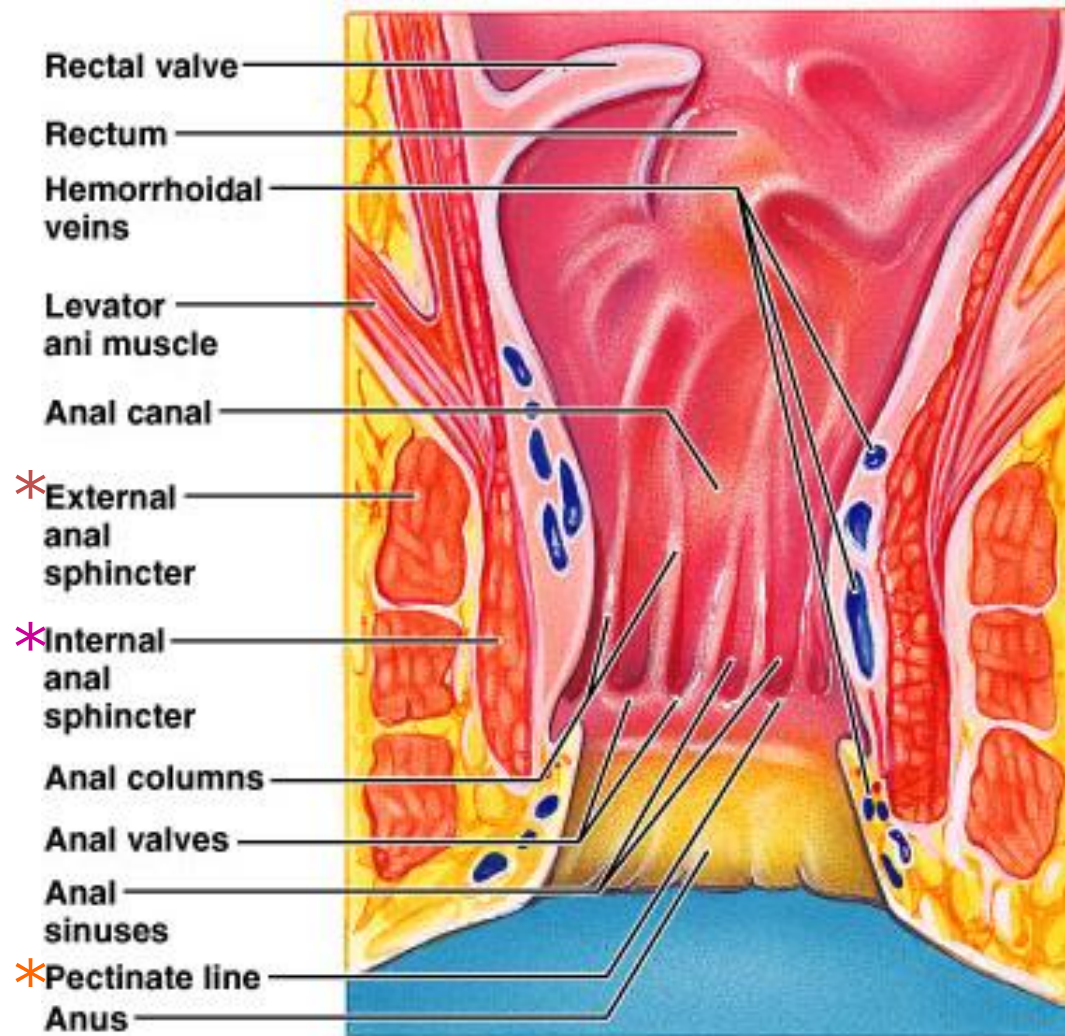
SMALL INTESTINE



LARGE INTESTINE

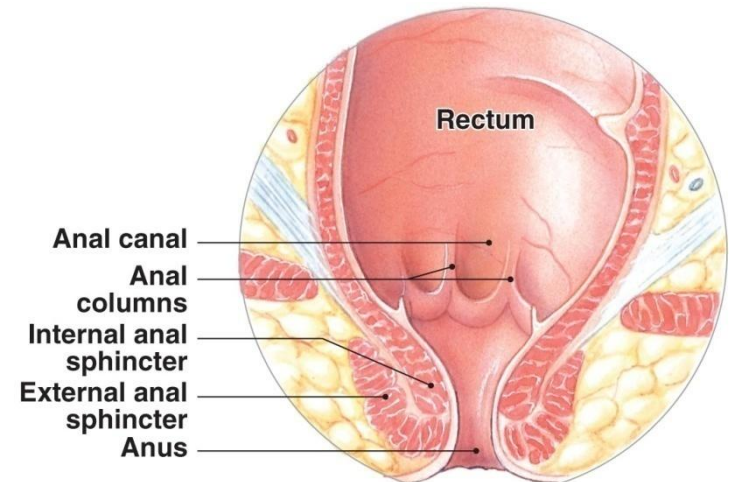


- Rectum
 - In pelvis
 - No teniae
 - Strong longitudinal muscle layer
 - Has valves
- Anal canal
 - Pectinate line*
 - **Inferior to it: sensitive to pain**
 - Hemorrhoids (enlarged veins)
 - **Superior to pectinate line: internal**
 - **Inferior to pectinate line: external**
 - Sphincters (close opening)
 - **Internal***
 - smooth muscle
 - involuntary
 - **External***
 - skeletal muscle
 - voluntary

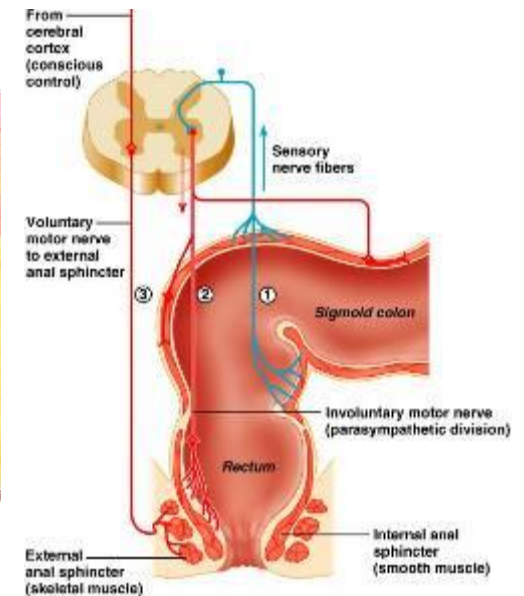
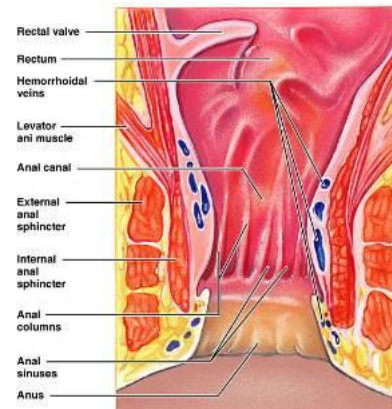


Parts of Large Intestine

- The Rectum
 - Forms last 15 cm (6 in.) of digestive tract
 - Is an expandable organ for temporary storage of feces
 - Movement of fecal material into rectum triggers urge to defecate
- The **anal canal** is the last portion of the rectum
 - Contains small longitudinal folds called **anal columns**
- Anus
 - Also called anal orifice
 - Is exit of the anal canal
 - Has keratinized epidermis like skin



(c) Rectum, sectioned



Large Intestine

- Bacterial flora
 - Ferment indigestible CHO: produces about 500ml of gas per day
 - Synthesize B complex vitamins & most vitamin K

