

GASTROINTESTINAL TRACT HISTOLOGY

Lectures 1 & 2 · Comprehensive Study Notes

Oral Cavity · Salivary Glands · Esophagus · Stomach

General Histology of the Gastrointestinal Tract

Overview

- The GIT is a continuous muscular tube ~5–7 m long, extending from the mouth to the anus.
- Two functional divisions: the GI tract proper (mouth → large intestine) and accessory digestive organs (teeth, tongue, salivary glands, liver, gallbladder, pancreas).
- Primary functions: ingestion, mechanical and chemical digestion, absorption of nutrients, and elimination of waste.

Additional Notes: Why Is GIT Histology Clinically Important?

- The layer-by-layer organization of the GIT is the basis for staging cancer (e.g., TNM staging references mucosal, submucosal, muscular and serosal invasion).
- Biopsy interpretation depends on recognizing normal histology vs. pathological change at each layer.
- Knowing the nerve plexuses helps explain motility disorders (e.g., Hirschsprung disease = absent myenteric plexus in the rectum).

The Four Layers of the GIT Wall

From lumen outward: Mucosa → Submucosa → Muscularis → Serosa/Adventitia.

1. Mucosa

Mucosal Components (Three Sub-layers)

- Epithelium – innermost, directly contacts lumen contents.
 - Lamina propria – loose connective tissue; contains capillaries, lymphatics, glands, MALT.
 - Muscularis mucosae – thin inner circular and outer longitudinal smooth muscle layer; creates mucosal folding.
-
- Epithelial type varies by region:
 - Mouth, pharynx, esophagus, anal canal → Nonkeratinized stratified squamous (protective function).
 - Stomach & intestines → Simple columnar (secretion and absorption).
 - Epithelial renewal every 5–7 days — one of the fastest renewal rates in the body.
 - Enteroendocrine cells (APUD cells) are scattered throughout the epithelium; they release hormones into blood (endocrine) or adjacent cells (paracrine).

2. Submucosa

- Dense irregular connective tissue binding mucosa to muscularis.
- Contains large blood/lymphatic vessels, Meissner (submucosal) nerve plexus, and MALT (mucosa-associated lymphoid tissue).
- Glands present in the submucosa: esophageal mucous glands (throughout); Brunner glands in the duodenum.

Additional Notes: Submucosal vs. Mucosal Glands

- Submucosal glands are a key landmark when identifying organ sections — their presence narrows the differential.
- Esophageal glands (submucosa) produce neutral mucus for lubrication.
- Brunner glands (duodenal submucosa) produce alkaline mucus to neutralize acidic chyme from the stomach.
- The lamina propria contains mucosal glands in the stomach and intestines (crypts of Lieberkühn).

3. Muscularis (Muscularis Externa)

- Two smooth muscle sub-layers throughout most of the tract: inner circular and outer longitudinal.
- Exception: esophagus (upper third skeletal; middle third mixed; lower third smooth), mouth, pharynx, external stomach (adds an inner oblique layer → 3 total).
- Myenteric (Auerbach) nerve plexus is located between the two smooth muscle layers — regulates peristalsis.

4. Serosa / Adventitia

- Intra-abdominal GIT organs are covered by serosa: simple squamous epithelium (mesothelium) + loose areolar CT.
- Retroperitoneal organs and the esophagus are covered by adventitia: only CT (no mesothelial lining), anchors the organ to surrounding structures.

Serosa	Adventitia
Intra-abdominal organs (stomach, jejunum, ileum, etc.)	Esophagus (most), duodenum, rectum
Simple squamous (mesothelium) + areolar CT	Connective tissue only — no epithelial lining
Reduces friction in peritoneal cavity	Anchors organ to surrounding structures

Oral Cavity

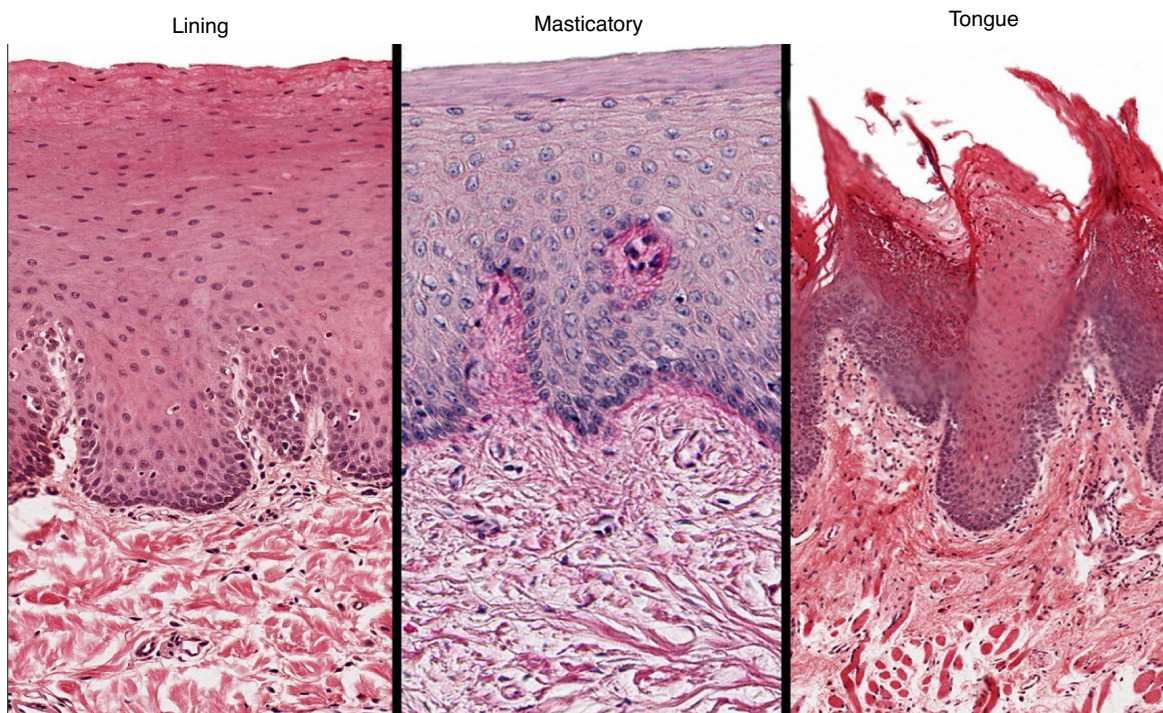
Epithelial Types of the Oral Mucosa

Three types of mucosa are found in the oral cavity, each matching the local mechanical demand:

Type	Location	Key Features
Masticatory mucosa (Keratinized SS)	Gums (gingiva) & hard palate	Lamina propria rests directly on periosteum (no submucosa); withstands chewing forces
Lining mucosa (Non-keratinized SS)	Cheeks, soft palate, floor of mouth, pharynx, lips (inner)	Thick submucosa with minor salivary glands & lymphoid tissue; antigen-presenting cells; rich sensory innervation
Specialized mucosa (Partially keratinized SS)	Tongue dorsum	Bears lingual papillae; varies from lightly (fungiform) to heavily (filiform) keratinized

Additional Notes: Clinical Relevance of Oral Mucosa Types

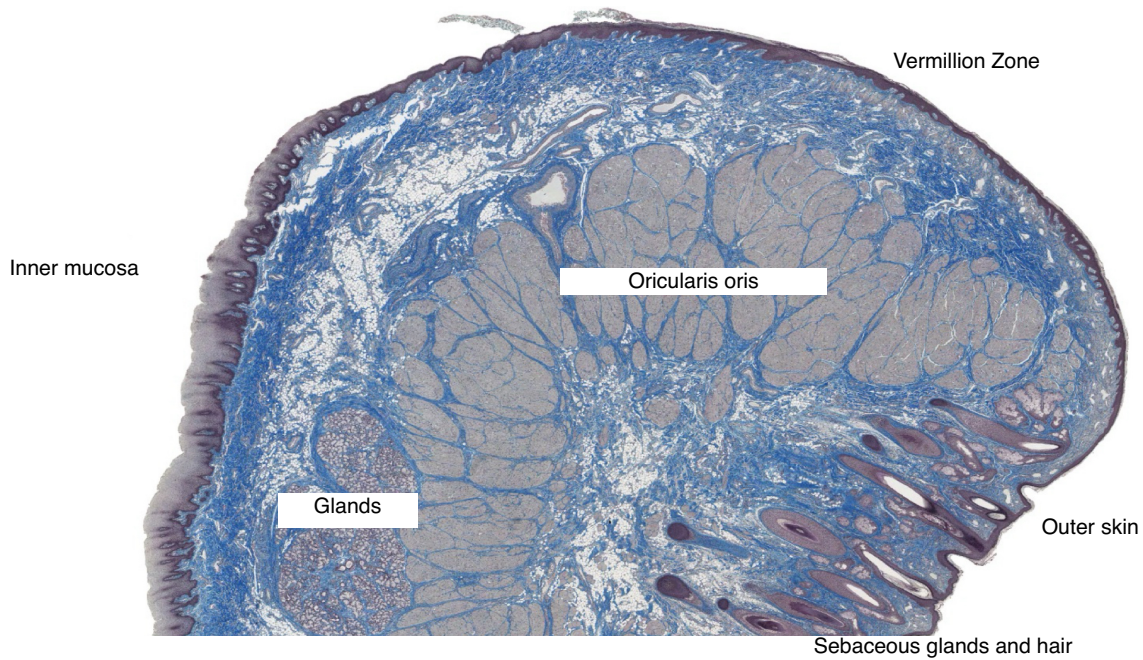
- Non-keratinized lining mucosa is the most common site for aphthous ulcers (canker sores) and viral lesions (herpes simplex type 1).
- Herpes simplex 1 infects epithelial cells when host immunity is compromised → vesicular/ulcerating lesions.
- Keratinized masticatory mucosa lacks a submucosa — biopsies here sample directly to the periosteum.



The Lips

Three Surface Zones

Zone	Histological Features
Outer skin (cutaneous)	Thin keratinized epidermis + dermis; hair follicles, sebaceous glands, sweat glands
Red vermilion zone	Very thin keratinized SS; NO salivary/sweat glands; kept moist by saliva; richly vascularized & innervated → pink color
Inner mucous surface	Thick non-keratinized SS; minor labial salivary glands in submucosa; core of orbicularis oris skeletal muscle

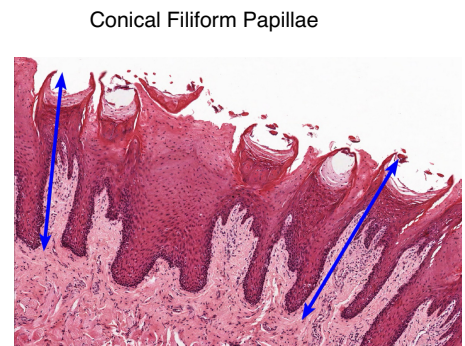
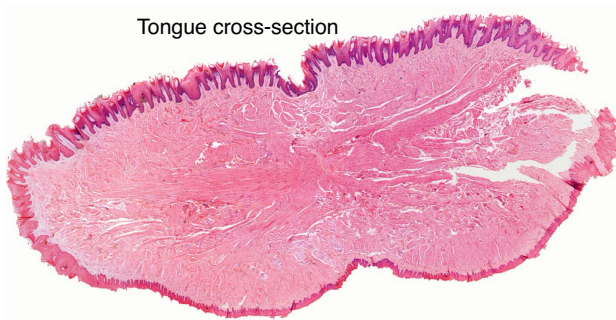


The Tongue

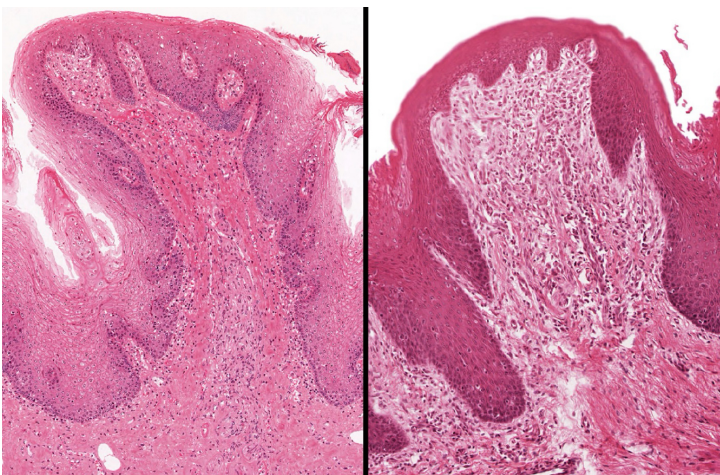
- Composed of interlacing bundles of skeletal muscle in three planes (longitudinal, transverse, vertical) — allows complex 3D movement.
- Dorsal and lateral surfaces bear lingual papillae — projections of lamina propria covered by stratified squamous epithelium.

Types of Lingual Papillae

Type	Shape / Keratinization	Taste Buds	Other Features
Filiform	Elongated conical; HEAVILY keratinized (gray-white)	NONE	Most numerous; provide rough texture for food manipulation
Fungiform	Mushroom-shaped; LIGHTLY keratinized	Yes (~5 per papilla)	Less numerous; richly vascularized core → appear red among filiform
Foliate	Parallel ridges on lateral tongue; partially keratinized	Yes (rudimentary in adults)	More prominent in children; found anterior to sulcus terminalis
Vallate (Circumvallate)	Large dome, surrounded by deep circular groove (sulcus)	YES (~250 per papilla)	8–12 in a V-row; Von Ebner serous glands drain into sulcus



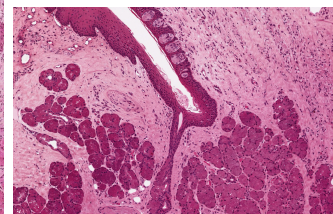
Fungiform Papillae



Circumvallate Papilla



Sulcus and Von Ebner Gland



Taste Buds

- Ovoid structures embedded in stratified squamous epithelium of fungiform, foliate, and vallate papillae (NOT filiform).
- Each taste bud: ~50–100 cells; ~50% are gustatory (taste) cells.
- Gustatory cells — modified epithelial cells that became chemoreceptors; apical microvilli project through the taste pore (2 μm wide).
- Afferent sensory axons enter from below and synapse on gustatory cells.
- Supporting (sustentacular) cells surround gustatory cells.
- Basal cells — stem cells that replenish gustatory and supporting cells.

Additional Notes: Taste Transduction

- Tastants dissolve in saliva and bind receptors on gustatory microvilli \rightarrow depolarization \rightarrow neurotransmitter release \rightarrow afferent signal.
- Five basic tastes: sweet, sour, salty, bitter, umami. Each can be sensed anywhere on the tongue (map myth is incorrect).
- Von Ebner glands (serous) flush the sulcus of vallate papillae to allow new tastants to access taste buds rapidly.
- Gustatory cells are renewed approximately every 10–14 days.



Salivary Glands

Salivary glands are classified as minor (scattered in oral submucosa) and major (three bilateral pairs). All produce saliva containing water, electrolytes, mucins, enzymes, and antimicrobial proteins.

Secretory Cell Types

Serous Cells	Mucous Cells
Pyramidal shape	Columnar shape
Round, centrally-placed nucleus	Compressed, basally-placed nucleus
Abundant RER, Golgi, apical granules (zymogen)	Apical granules with hydrophilic mucins (pale staining)
Form spherical acini with tiny central lumen	Form cylindrical tubules
Secrete enzymes (α -amylase, lysozyme)	Secrete viscous mucus

- Myoepithelial cells: Flat, stellate contractile cells that wrap around acini and intercalated ducts; squeeze secretions forward.
- Mixed glands: serous demilune — serous cells cap the end of a mucous tubule in a crescent shape.

Duct System (from secretory unit → oral cavity)

- Intercalated ducts — smallest, cuboidal; drain acini.
- Striated ducts (intralobular) — cuboidal to columnar with basal plasma membrane infoldings and mitochondria; modify ionic composition of saliva (Na^+ reabsorption, K^+ secretion).
- Excretory ducts (interlobular → main duct) — pseudostratified/stratified columnar.

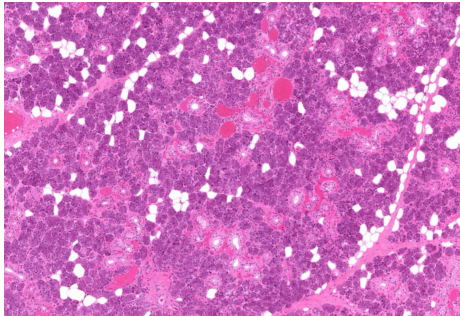
The Three Major Salivary Glands

Gland	Secretory Type	Dominant Cell	Primary Secretion	Key Feature
Parotid	Purely serous acinar	Serous only	Watery; rich α -amylase	Largest; histologically uniform red acini; fat infiltration common in aging
Submandibular	Mixed (primarily serous)	Mostly serous + some mucous with serous demilunes	Both serous enzymes and mucus	Serous demilunes clearly visible; striated ducts prominent
Sublingual	Mixed (primarily mucous)	Mucous tubules predominate; few serous cells	Thick mucus; little enzyme	Smallest; no single main duct; pale (mucous) predominance

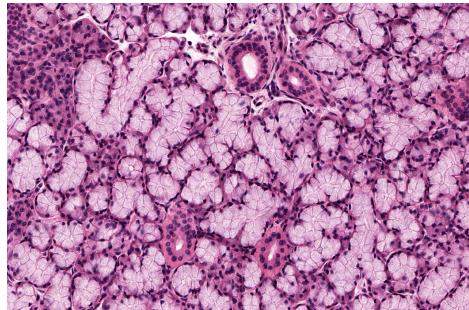
Additional Notes: Salivary Functions Beyond Lubrication

- Amylase begins starch hydrolysis in the mouth (important before gastric denaturation).
- Lysozyme cleaves bacterial cell wall peptidoglycan → antimicrobial defense.
- IgA is transported into saliva → first immunological defense against oral pathogens.
- Bicarbonate in saliva buffers acids → dental caries protection.
- Striated duct basal infoldings = a histological clue to active ion transport (mitochondria power the pumps).

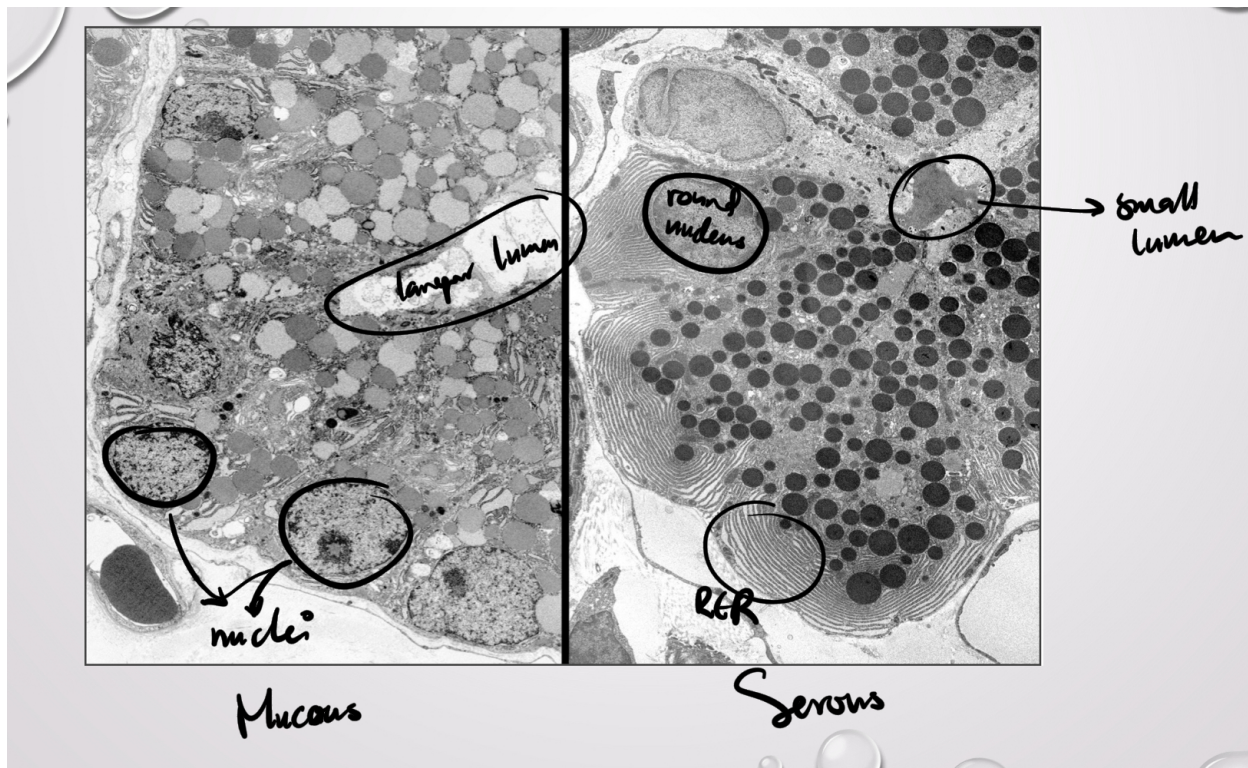
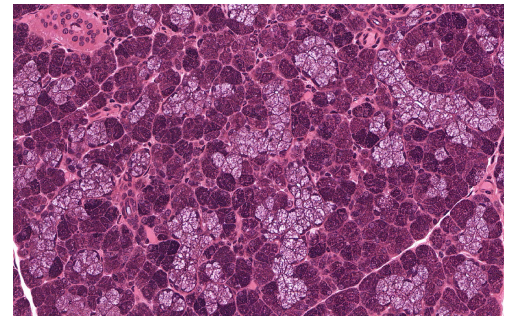
Parotid



Sublingual



Submandibular



Histology of the Esophagus

Gross Anatomy Recap (Read Only)

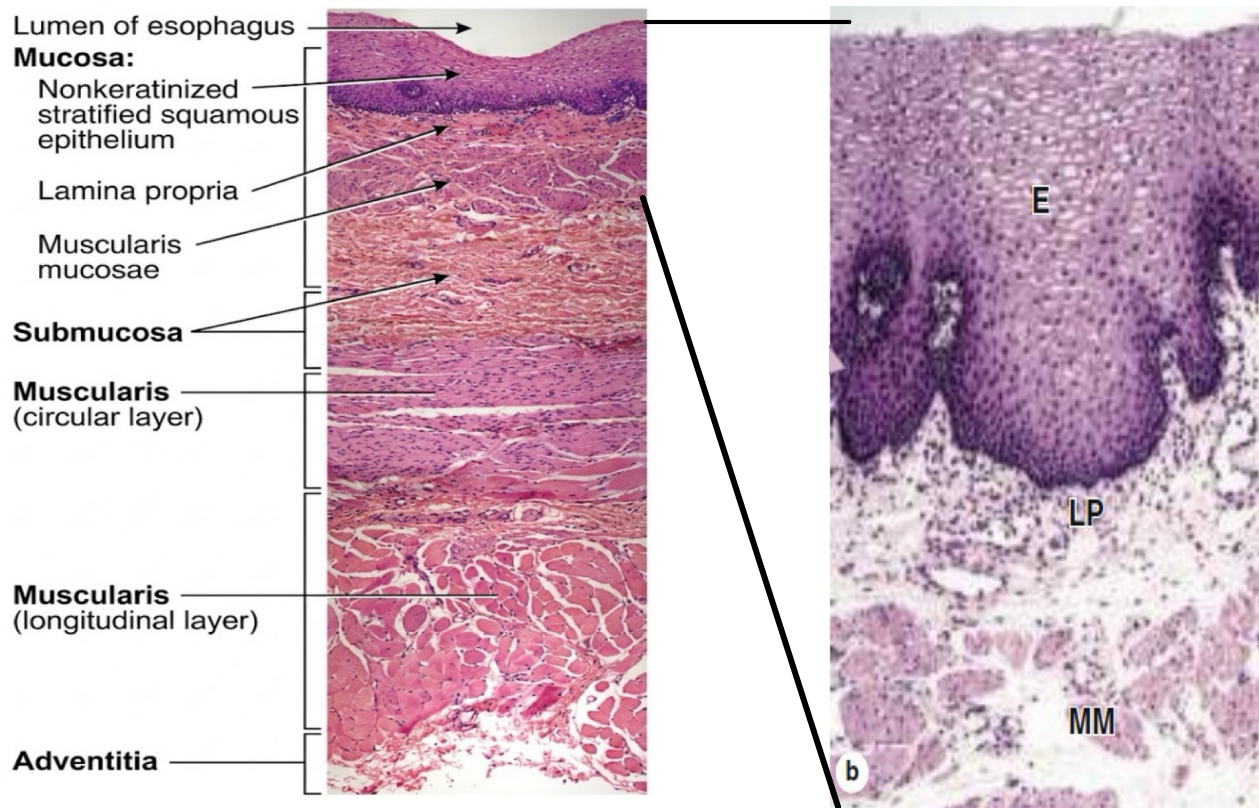
- Collapsible muscular tube ~25 cm long; posterior to trachea.
- Begins at inferior laryngopharynx; pierces diaphragm via the esophageal hiatus.

Histological Layers of the Esophagus

Mucosa

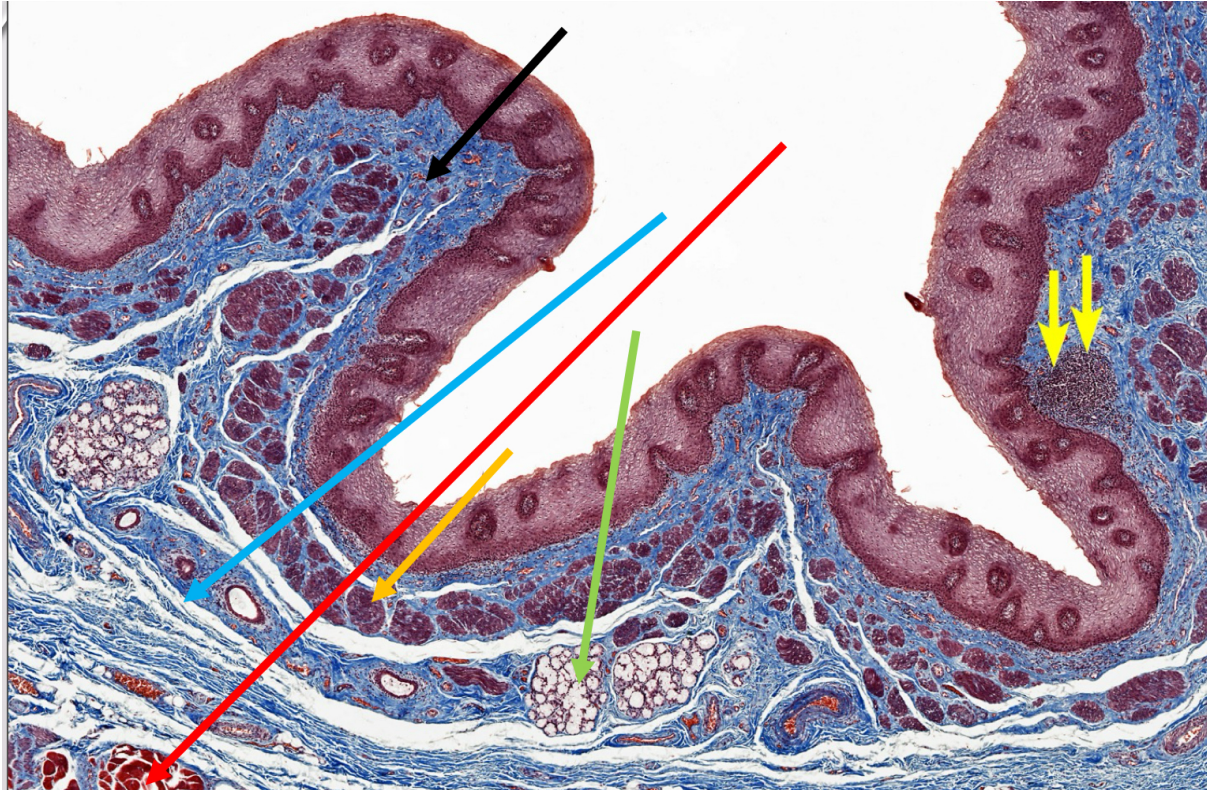
Esophageal Mucosa

- Epithelium: Nonkeratinized stratified squamous epithelium — reflects protective function against abrasive food.
- Lamina propria: Loose CT with small lymphoid nodules (MALT) and esophageal cardiac glands near the GEJ (compound mucous).
- Muscularis mucosae: Smooth muscle; appears as a single longitudinal layer despite consisting of two layers(thinner than in stomach/intestine, and less developed).



Submucosa

- Dense CT with blood/lymph vessels and Meissner plexus.
- Contains esophageal mucous glands proper (throughout esophagus) — mucus-secreting, reduce friction.
- Near the stomach: esophageal cardiac glands appear — similar to cardiac-type gastric glands.



★ mucous glands (submucosal)

★ muscularis mucosae

★ submucosa

★ muscularis

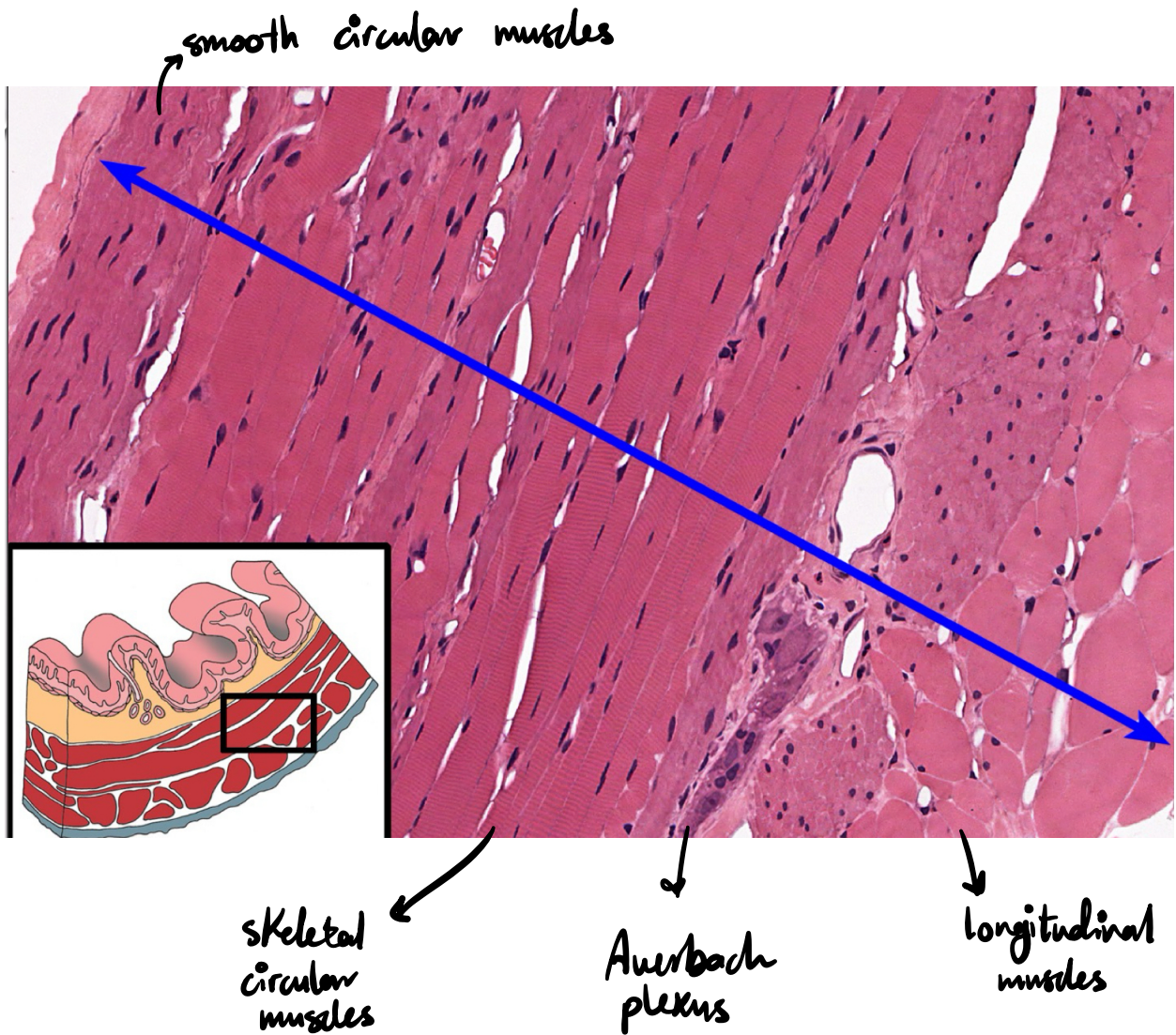
★ GALT → lymph nodule

★ lamina propria

Muscularis

Muscle Type by Region (Esophagus)

- Superior 1/3: Skeletal muscle only (voluntary swallowing).
- Middle 1/3: Mixed — both skeletal and smooth muscle.
- Inferior 1/3: Smooth muscle only.
- Auerbach (myenteric) plexus lies between the circular and longitudinal layers.



Histology of the Stomach

Overview

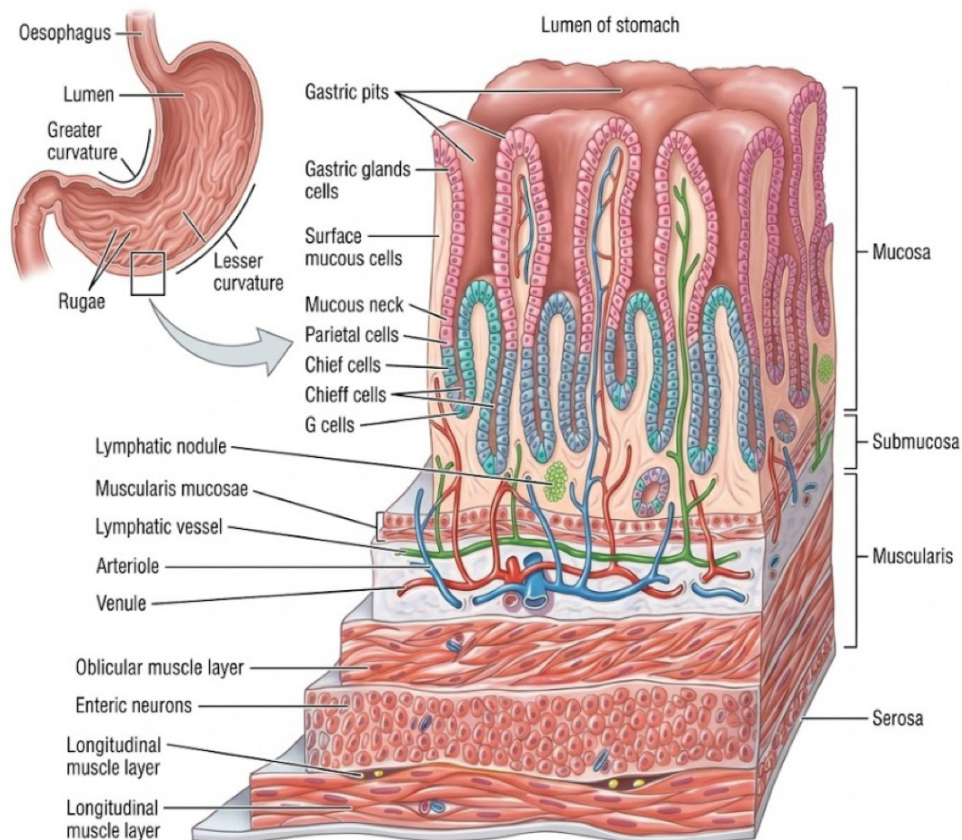
- The stomach has three gross regions: cardia, body/fundus, and pylorus (antrum) — each with distinct glandular histology.
- The mucosal surface is thrown into large folds called rugae — these flatten when the stomach is distended.
- The mucosa is studded with millions of gastric pits (foveolae), into which gastric glands open.

Mucosal Organization

Gastric Mucosa Layers

- Epithelium: Simple columnar — surface mucous cells (SMC) line the lumen AND the gastric pit.
- Lamina propria: Packed with gastric glands extending from pit base to muscularis mucosae.
- Muscularis mucosae: Inner circular + outer longitudinal smooth muscle.

Surface mucous cells (SMC) secrete a thick, bicarbonate-rich, alkaline mucus layer that coats the entire gastric surface — protecting against autodigestion by HCl and pepsin.



Gastric Glands & Their Cells

Surface Mucous Cells

- Line the lumen and gastric pits (NOT part of the gland proper).
- Tall columnar cells with apical mucin granules and basally displaced nucleus.
- Secrete alkaline mucus — first line of defense against acid.

Mucous Neck Cells

- Located in the neck (upper) region of gastric glands.
- Shorter than surface mucous cells; irregular nuclei.
- Secrete acidic mucus (different from the alkaline mucus of SMC).
- Also act as progenitor/stem cells — differentiate into all gland cell types.

Parietal (Oxyntic) Cells

Parietal Cell — Key Features

- Location: Predominantly in the neck and upper body of fundic glands (among mucous neck cells).
- Morphology: Large, rounded or pyramidal; INTENSELY eosinophilic (abundant mitochondria power the H⁺/K⁺-ATPase pump).
- Products: (1) Hydrochloric acid (HCl) — activates pepsinogen, kills microbes, aids iron/calcium absorption; (2) Intrinsic factor — glycoprotein required for vitamin B12 absorption in the ileum.
- Stimulation: Parasympathetic (vagal) innervation, gastrin (from G cells), and histamine (from ECL cells) all stimulate HCl secretion.

HCl Production Mechanism (Read Only):

- Water → H⁺ + OH⁻. H⁺ pumped into gastric lumen via H⁺/K⁺-ATPase.
- OH⁻ + CO₂ → HCO₃⁻ (catalyzed by carbonic anhydrase). HCO₃⁻ exchanged for Cl⁻ into blood ("alkaline tide").
- Cl⁻ enters lumen; combines with H⁺ → HCl.

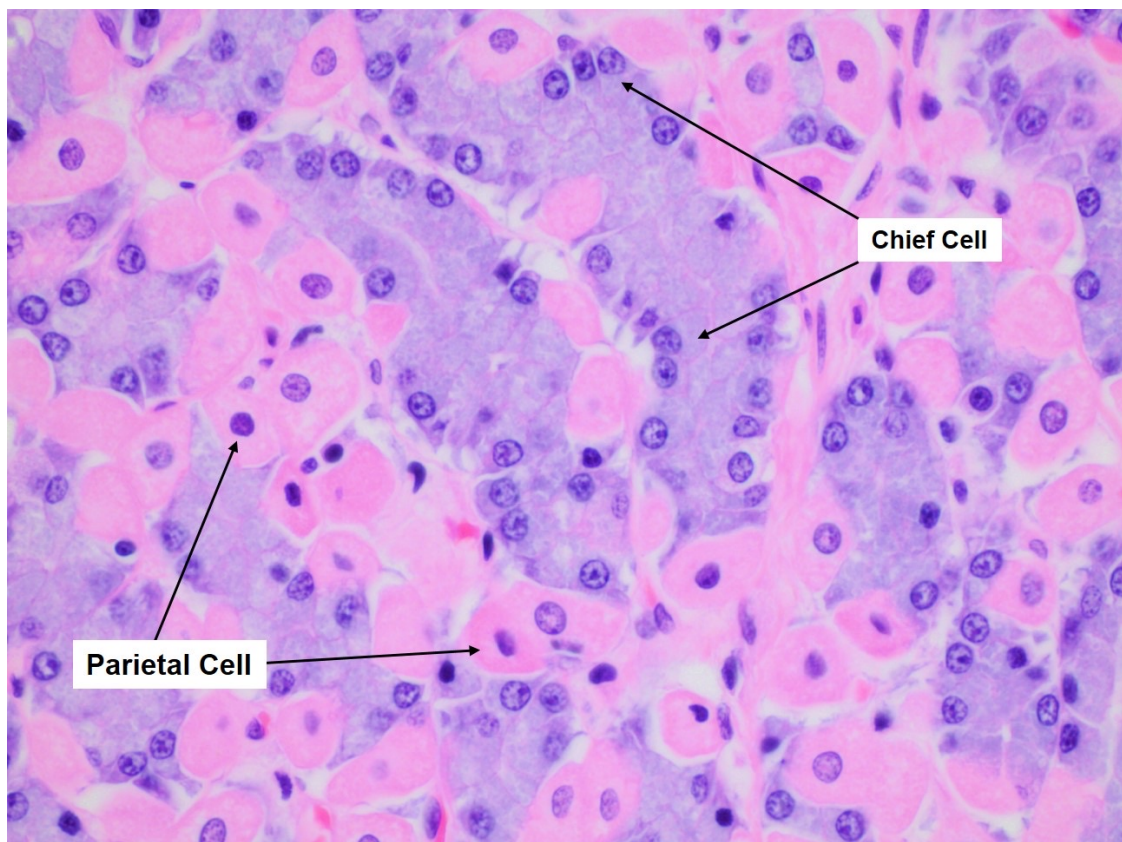
MEDICAL APPLICATION: Parietal Cell Damage and Pernicious Anemia

- Autoimmune destruction of parietal cells (Type A gastritis) → insufficient intrinsic factor → vitamin B12 malabsorption.
- B12 is essential for DNA synthesis; deficiency reduces erythropoiesis → megaloblastic (pernicious) anemia.
- Proton pump inhibitors (PPIs, e.g., omeprazole) block the H⁺/K⁺-ATPase — the main pharmacological target for GERD/ulcer therapy.

Chief (Zymogenic) Cells

Chief Cell — Key Features

- Location: Predominantly in the BASE of fundic glands.
- Morphology: Basophilic (abundant RER — protein synthesis); apical zymogen granules containing inactive pepsinogen.
- Products: (1) Pepsinogen — activated to pepsin by HCl; pepsin begins protein digestion; (2) Gastric lipase — begins lipid digestion.
- Histological appearance: Darker, more basophilic than parietal cells; found in lower gland → 'dark lower cells'.



Enteroendocrine (DNES) Cells

- Scattered singly throughout the gland epithelium; sparse in H&E but identifiable by their basal position and small clear cytoplasm.
- Release hormones basally into the lamina propria capillaries (endocrine) or onto adjacent cells (paracrine).
- G cells (predominate in pyloric antrum) → secrete Gastrin → stimulates parietal cell HCl secretion.
- D cells (pylorus, duodenum, pancreatic islets) → secrete Somatostatin → inhibits secretion from neighboring DNES cells.
- EC cells (throughout GIT) → secrete Serotonin and Substance P → increase gut motility.

Cell	Location	Hormone	Action
G cells	Pyloric antrum	Gastrin	Stimulates HCl secretion; promotes gastric motility
D cells	Pylorus, duodenum, pancreatic islets	Somatostatin	Inhibits neighboring DNES cell secretion (paracrine)
EC cells	Stomach, small & large intestine	Serotonin + Substance P	Increases gut motility
ECL cells	Fundus	Histamine	Stimulates parietal cell HCl secretion
I cells	Small intestine	CCK	Pancreatic enzyme secretion; gallbladder contraction
S cells	Small intestine	Secretin	Pancreatic/biliary bicarbonate secretion; inhibits gastric acid
K cells	Duodenum/jejunum	GIP	Inhibits gastric acid secretion
L cells	Ileum/colon	GLP-1 + Peptide YY	Insulin secretion; inhibits gastric acid; reduces hunger

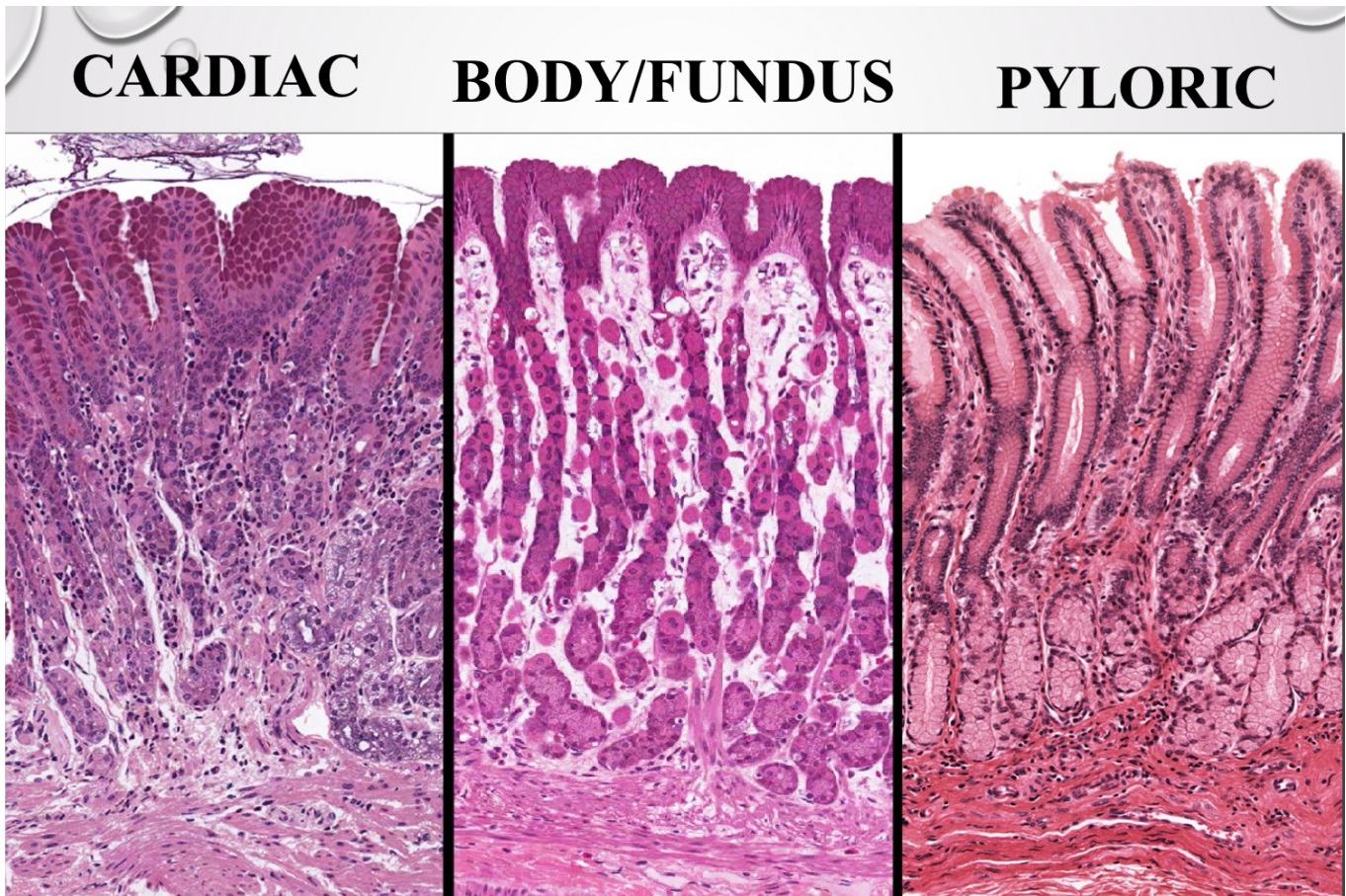
Additional Notes: Enteroendocrine Cells — Histological Identification Tips

- In standard H&E: enteroendocrine cells appear as isolated clear or pale cells at the gland base (basal granules face the capillaries).
- Best visualized with immunohistochemistry (synaptophysin, chromogranin A) or silver stains (argyrophil/argentaffin).
- Neuroendocrine tumors (carcinoids) arise from these cells — important in surgical pathology.

Regional Gastric Glands

The gastric mucosa is divided into three histological zones based on gland composition. This is a high-yield exam topic.

Gland Type	Zone	Pit Depth	Key Cells	Primary Function
Cardiac glands	Cardia (narrow zone at GEJ)	Short pits	Predominantly mucous cells; few/no parietal or chief cells	Alkaline mucus — protects GEJ from acid reflux
Fundic (gastric) glands	Body & Fundus (largest zone)	Short pits; glands fill most of mucosa	Abundant parietal + chief cells; mucous neck cells; ECL cells	Acid production (HCl); protein digestion (pepsinogen); intrinsic factor
Pyloric glands	Pyloric antrum & pylorus	DEEP, branched coiled pits	Predominantly mucous cells; G cells; D cells; rare parietal cells	Hormone secretion (gastrin); heavy mucus at duodenal junction



Additional Notes: How to Distinguish Gastric Zones Histologically

- Cardiac: mucous glands, NO parietal cells, short pits — resembles esophageal cardiac glands.
- Fundic: SHORT pits with LONG glands filling the full mucosa depth. Look for the bright pink (eosinophilic) parietal cells in the neck and basophilic chief cells at the base.
- Pyloric: DEEP pits (pit : gland ratio near 1:1 or deeper). Coiled/branched secretory portions. Parietal cells absent or rare.
- Key rule: If you see lots of eosinophilic cells → you're in the fundus. If you see deep pits with mucous cells → pylorus.

Remaining Gastric Layers

Submucosa

- Dense irregular CT with large vessels, lymphatics, Meissner plexus, lymphoid cells, macrophages, and mast cells.
- NO glands in gastric submucosa (unlike esophagus/duodenum).

Muscularis

Stomach Muscularis — Three Layers (Unique to Stomach)

- Outer longitudinal layer
- Middle circular layer — thickens at the pylorus to form the pyloric sphincter
- Inner oblique layer — unique to stomach; assists in churning and mixing food (chyme formation)
- Auerbach (myenteric) plexus between layers

Serosa

- Simple squamous mesothelium + areolar CT — the stomach is entirely intraperitoneal.

MEDICAL APPLICATION: Peptic Ulcer Disease

- Peptic ulcers are erosive mucosal lesions that can extend into deeper layers.
- Occur anywhere from the lower esophagus to the jejunum.
- Common causes: *Helicobacter pylori* (produces urease → ammonia → mucosal damage); NSAIDs (inhibit prostaglandin synthesis → reduced mucus/bicarbonate); HCl/pepsin overproduction; reduced mucosal defense.
- *H. pylori* infects the mucous layer overlying gastric epithelium; best detected by urease test, biopsy, or serology.

GIT HISTOLOGY — END-OF-UNIT EXAMINATION

Lectures 1 & 2 · 40 Questions · Multiple Choice

Instructions: Choose the single best answer for each question. All options should be considered carefully.

1. A student examines a biopsy from the region immediately internal to the vermilion border of the lip. Which combination of features would be expected in this specimen?

 - A. Thick nonkeratinized stratified squamous epithelium with minor salivary glands in the submucosa
 - B. Thin keratinized stratified squamous epithelium with abundant subepithelial capillaries and no glands
 - C. Simple columnar epithelium with goblet cells and a lamina propria
 - D. Keratinized epithelium with hair follicles and sebaceous glands
2. A section of the gastrointestinal tract shows a wall composed of (from lumen outward) nonkeratinized stratified squamous epithelium, a submucosa containing mucous glands, a muscularis with both skeletal and smooth muscle fibers, and an outermost layer of connective tissue without a mesothelial lining. Which segment is most likely represented?

 - A. Pyloric antrum
 - B. Fundus of the stomach
 - C. Middle third of the esophagus
 - D. Anal canal
3. Which of the following cell types is responsible for secreting the glycoprotein that is indispensable for vitamin B12 absorption, and what is the histological hallmark used to identify these cells?

 - A. Chief cells; basophilic cytoplasm with apical zymogen granules
 - B. Mucous neck cells; pale cytoplasm with basally compressed nucleus
 - C. Parietal cells; intensely eosinophilic cytoplasm due to abundant mitochondria
 - D. G cells; basal granules visible on silver stain
4. A researcher applies a chemical that selectively destroys only the myenteric (Auerbach) nerve plexus throughout a segment of the small intestine. What is the most direct functional consequence?

 - A. Loss of ionic modification of luminal fluid
 - B. Impaired peristalsis and segmentation in that segment
 - C. Failure of water and nutrient absorption across the epithelium
 - D. Reduction in mucus secretion from submucosal glands
5. On histological examination, a gastric biopsy shows very deep, coiled secretory portions, an absence of parietal cells, and numerous mucus-secreting cells. G cells are also identified. From which region was this biopsy most likely taken?

 - A. Body of the stomach
 - B. Fundus
 - C. Cardiac zone
 - D. Pyloric antrum

- 6.** During embryological development, a mutation prevents the formation of myoepithelial cells in the salivary glands. Which process would be most directly disrupted?
- A. Synthesis of α -amylase within serous acinar cells
 - B. Active reabsorption of sodium in the striated duct
 - C. Propulsion of secretory products from acini into duct lumens
 - D. Differentiation of mucous cells into serous cells
- 7.** A patient with long-standing GERD undergoes upper endoscopy, and biopsies from the distal esophagus reveal intestinal-type columnar epithelium with goblet cells replacing the normal squamous lining. This metaplastic change represents which condition, and what is the primary concern?
- A. Reflux esophagitis; the main concern is progressive fibrosis of the muscularis
 - B. Barrett esophagus; it carries a risk of progression to esophageal adenocarcinoma
 - C. Hiatus hernia; the concern is incarceration of the stomach above the diaphragm
 - D. Achalasia; the concern is aperistalsis of the esophageal body
- 8.** A histological section of a major salivary gland shows exclusively serous acini, numerous intercalated and striated ducts, and increasing adipose infiltration between lobules (noted as normal in the context of the patient's age). Which gland is this?
- A. Sublingual gland
 - B. Submandibular gland
 - C. Parotid gland
 - D. Minor labial salivary gland
- 9.** The Meissner (submucosal) plexus and Auerbach (myenteric) plexus are collectively known as the enteric nervous system. Which layer of the GIT wall is immediately deep to the Meissner plexus?
- A. Muscularis mucosae
 - B. Outer longitudinal muscle layer
 - C. Lamina propria
 - D. Inner circular muscle layer
- 10.** Which of the following correctly pairs a lingual papilla type with its keratinization status and the presence or absence of taste buds?
- A. Filiform — lightly keratinized — taste buds present
 - B. Fungiform — heavily keratinized — taste buds absent
 - C. Vallate — surrounded by a sulcus — taste buds present (~250 per papilla)
 - D. Foliate — no keratin layer — present only in infants
- 11.** A pharmacologist develops a drug that selectively inhibits H^+/K^+ -ATPase. At which anatomical site within the gastric mucosa would this drug exert its primary effect?
- A. Surface mucous cells lining the gastric pit
 - B. Chief cells in the base of fundic glands
 - C. G cells in the pyloric antrum
 - D. Parietal cells predominantly in the fundic gland neck and upper body

12. In the submandibular gland, serous cells are sometimes seen arranged in a crescent at the distal end of a mucous tubule. What is the name of this structural arrangement?

- A. Acinar demilune
- B. Serous demilune
- C. Myoepithelial cap
- D. Intercalated crescent

13. A medical student is reviewing a slide of the esophageal wall. She notes the outermost layer is a fibrous connective tissue without any mesothelial covering. However, she finds a small segment at the very end of the specimen that does show mesothelium. What does this finding represent?

- A. A processing artifact caused by tearing of the serosa
- B. The transition from adventitia (most of the esophagus) to serosa in the distal 1–2 cm below the diaphragm
- C. Evidence of Barrett metaplasia extending into the adventitia
- D. The location of esophageal cardiac glands in the submucosal layer

14. Which characteristic best distinguishes the sublingual gland from the parotid gland on H&E staining?

- A. The parotid has exclusively mucous tubules, while sublingual has exclusively serous acini
- B. The sublingual is predominantly mucous with pale poorly-staining cells, while the parotid has deeply staining serous acini
- C. The sublingual contains abundant striated ducts while the parotid lacks them entirely
- D. The parotid is primarily mucous with serous demilunes, while the sublingual is entirely serous

15. Mucous neck cells in the gastric glands differ from surface mucous cells in which of the following ways?

- A. Mucous neck cells secrete alkaline mucus and are taller than surface mucous cells
- B. Mucous neck cells secrete acidic mucus and serve as stem cells for the gastric gland
- C. Mucous neck cells are found exclusively in the pyloric antrum and lack secretory granules
- D. Mucous neck cells produce intrinsic factor and are morphologically identical to parietal cells

16. A 45-year-old patient is found to have autoantibodies targeting parietal cells. Which of the following clinical consequences would be expected from this immune-mediated destruction?

- A. Increased gastric acid secretion leading to peptic ulcers
- B. Vitamin B12 deficiency with megaloblastic anemia due to intrinsic factor loss
- C. Excess gastrin production from G cells leading to Zollinger-Ellison syndrome
- D. Impaired carbohydrate digestion due to salivary amylase deficiency

17. The gingiva (gums) and hard palate are covered by which type of oral mucosa, and what is the structural feature of their lamina propria that is unique among oral regions?

- A. Lining mucosa; lamina propria contains abundant minor salivary glands
- B. Masticatory mucosa; lamina propria attaches directly to the underlying periosteum with no distinct submucosa
- C. Specialized mucosa; lamina propria contains taste buds within papillary projections
- D. Partially keratinized mucosa; lamina propria contains Von Ebner glands

- 18.** During digestion, the hormone gastrin is released. Which cell secretes gastrin, where are those cells predominantly located, and what is the primary physiological effect of gastrin?
- A. ECL cells; fundus; stimulates pepsinogen release from chief cells
 - B. D cells; pyloric antrum; inhibits acid secretion from parietal cells
 - C. G cells; pyloric antrum; stimulates acid secretion from parietal cells
 - D. I cells; small intestine; stimulates gallbladder contraction and pancreatic enzyme release
- 19.** A histology slide shows a tubular organ with a lumen lined by simple columnar epithelium, gastric pits that are notably short relative to the overall mucosal thickness, glands extending to the muscularis mucosae densely packed with large eosinophilic cells in the upper half and basophilic cells in the lower half, and a serosa as the outermost layer. Which region is shown?
- A. Pyloric antrum
 - B. Body/Fundus of the stomach
 - C. Cardiac zone of the stomach
 - D. Duodenum
- 20.** The upper esophageal sphincter (UES) and lower esophageal sphincter (LES) differ in which fundamental histological property?
- A. The UES contains smooth muscle while the LES contains skeletal muscle
 - B. The UES contains skeletal muscle while the LES contains smooth muscle
 - C. Both contain skeletal muscle but the UES is voluntary and the LES is not
 - D. Both contain smooth muscle but they differ in their autonomic innervation
- 21.** Von Ebner glands are serous glands found at the base of a specific type of papilla. Why is it functionally important that these glands are serous rather than mucous?
- A. Serous secretions lubricate the papilla surface to protect against mechanical abrasion
 - B. Serous secretions flush the sulcus with watery enzyme-rich fluid to dissolve tastants, enabling repeated taste sampling
 - C. Serous secretions form a protective film that prevents bacterial colonization of the tongue
 - D. Serous secretions contribute to keratin turnover on the filiform papillae
- 22.** In a striated duct of the parotid gland, the distinctive basal plasma membrane infoldings and abundant mitochondria in the columnar epithelial cells indicate which primary function?
- A. Exocytosis of secretory granules containing digestive enzymes
 - B. Active ion transport to modify saliva electrolyte composition
 - C. Phagocytosis of bacteria present in the ductal lumen
 - D. Synthesis and secretion of salivary immunoglobulin A
- 23.** The cardiac glands of the stomach are functionally analogous to the esophageal cardiac glands found in the esophageal submucosa. What secretory product do both have in common, and what is its significance at this location?
- A. HCl; to acidify the bolus before it enters the stomach
 - B. Pepsinogen; to begin protein digestion at the gastroesophageal junction
 - C. Alkaline mucus; to protect the epithelium at the gastroesophageal junction from acid reflux
 - D. Somatostatin; to inhibit gastrin release from G cells in the adjacent pyloric antrum

- 24.** A researcher destroys the muscularis mucosae selectively in a section of small intestine. Which of the following functional consequences is the most direct result?
- A. Reduced absorption of fat-soluble vitamins across enterocytes
 - B. Loss of peristaltic contractions that propel luminal contents
 - C. Impaired ability to alter mucosal fold configuration and mixing of luminal contents
 - D. Deficient secretion of digestive enzymes from the lamina propria glands
- 25.** The chief (zymogenic) cells of the stomach are best identified by which combination of features under light microscopy?
- A. Large size, intensely eosinophilic cytoplasm, centrally placed round nucleus, located in gland neck
 - B. Pale cytoplasm with basally displaced flattened nucleus, apical mucin cap, located in gastric pit
 - C. Basophilic cytoplasm with apical zymogen granules, prominent RER, located predominantly in the gland base
 - D. Clear cytoplasm with basal secretory granules, located singly among other cells, identified by silver stain
- 26.** Somatostatin, secreted by D cells, acts primarily as a paracrine inhibitor of neighboring enteroendocrine cells. If D cell function is abolished, which of the following would be the most likely direct consequence?
- A. Decreased pepsinogen secretion from chief cells
 - B. Decreased gastric motility due to loss of serotonin
 - C. Unregulated gastrin secretion from G cells leading to excessive acid production
 - D. Increased bicarbonate secretion from Brunner glands
- 27.** The filiform papillae differ from all other lingual papilla types in one critical way. What is that difference?
- A. They are the least numerous papillae found on the tongue dorsum
 - B. They do not contain taste buds and function primarily in food manipulation via texture and touch receptors
 - C. They are the only papillae associated with Von Ebner glands in their base
 - D. They are the only type arranged in a V-shaped row near the sulcus terminalis
- 28.** A pathologist examining an esophageal biopsy notes a gradual, graded transition of the epithelium from stratified squamous to columnar over several millimeters. What would you expect at a NORMAL gastroesophageal junction?
- A. A gradual transition consistent with normal anatomical variation
 - B. An abrupt, sharply demarcated transition between the two epithelial types
 - C. A transition zone lined by pseudostratified columnar epithelium
 - D. An intermediate zone of keratinized stratified squamous epithelium
- 29.** Which salivary gland secretes primarily mucus with only a minor serous component, is the smallest of the three major glands, and opens via multiple small ducts rather than a single main duct?
- A. Parotid gland
 - B. Submandibular gland
 - C. Sublingual gland
 - D. Minor buccal gland

30. The stomach muscularis differs from that of most other GIT segments. What layer is present in the stomach that is absent elsewhere, and what is its function?

- A. An outer serosal muscle layer; prevents acid from eroding into the peritoneum
- B. A submucosal muscle layer; contributes to rugae formation during fasting
- C. An inner oblique smooth muscle layer; produces the churning motion that creates chyme
- D. A middle longitudinal layer; uniquely allows the stomach to expand during filling

31. A taste bud contains approximately 50–100 cells. Roughly half are gustatory cells; what are the remaining cells and their function?

- A. Endocrine cells that release hormones in response to bitter tastants
- B. Supporting (sustentacular) cells and basal stem cells that maintain taste bud integrity and renewal
- C. Myoepithelial cells that propel saliva toward the taste pore
- D. Keratinocytes that form the structural epithelial capsule of the taste bud

32. On a histological slide, the submucosa of an organ contains densely packed branching tubular mucous glands. Which organ does this finding most likely represent?

- A. Stomach
- B. Jejunum
- C. Esophagus
- D. Ileum

33. The pyloric sphincter is formed by thickening of which specific smooth muscle sub-layer of the gastric muscularis?

- A. Inner oblique layer
- B. Outer longitudinal layer
- C. Middle circular layer
- D. Muscularis mucosae

34. Herpes simplex virus type 1 (HSV-1) preferentially infects the oral epithelium under conditions of immunosuppression. What type of lesion does the viral cytopathic effect produce, and which mucosal type is most susceptible?

- A. Hyperkeratotic plaques on masticatory mucosa (gums and hard palate)
- B. Vesicular or ulcerating lesions primarily on non-keratinized lining mucosa
- C. Painless mucosal nodules on the tongue dorsum near the vallate papillae
- D. Erosive lesions on the red vermilion zone with associated gland destruction

35. Which of the following best describes why parietal cells appear intensely eosinophilic in H&E-stained sections?

- A. High glycogen content that stains deeply with eosin
- B. Abundant rough endoplasmic reticulum required for intrinsic factor synthesis
- C. Exceptionally large numbers of mitochondria needed to power the H⁺/K⁺-ATPase proton pump
- D. Dense zymogen granules in the apical cytoplasm that bind eosin strongly

36. In the GIT, epithelial renewal occurs approximately every 5–7 days. In the context of gastric glands, which cell type is responsible for replenishing the glandular cell population?

- A. Surface mucous cells undergoing dedifferentiation
- B. Parietal cells that divide and migrate toward the base
- C. Mucous neck cells acting as pluripotent progenitors
- D. G cells that proliferate under gastrin stimulation

37. A student is given a slide labeled 'major salivary gland' and observes that the section shows mostly pale-staining, poorly-outlined tubular structures with compressed basal nuclei, a small number of darker serous acini capping some tubules, and prominent striated ducts. Which gland does this represent?

- A. Parotid gland
- B. Submandibular gland
- C. Sublingual gland
- D. Minor labial gland

38. Which of the following enteroendocrine cell types is correctly matched with both its location AND its hormone AND the primary action of that hormone?

- A. I cells — pyloric antrum — secrete secretin — stimulate gastric acid
- B. S cells — small intestine — secrete secretin — stimulate pancreatic bicarbonate secretion
- C. K cells — ileum and colon — secrete GLP-1 — inhibit insulin release
- D. L cells — duodenum/jejunum — secrete GIP — increase gut motility

39. A histology examination question shows a cross-section of the esophageal wall. The muscularis layer contains cells that are clearly striated (cross-striations visible). Which region of the esophagus was this section most likely taken from?

- A. Distal third, just above the gastroesophageal junction
- B. Middle third, showing a mixed skeletal-smooth transition
- C. Superior third, where the muscularis is entirely skeletal muscle
- D. Distal third below the diaphragm, where smooth muscle predominates

40. In designing a drug to selectively prevent all gastric acid secretion without affecting pepsinogen release, a pharmacologist would need to target which combination of stimulants that act specifically on parietal cells?

- A. Cholecystokinin, secretin, and motilin receptors
- B. Vagal muscarinic (M3) receptors, gastrin (CCK-B) receptors, and histamine H2 receptors on parietal cells
- C. Somatostatin receptors, GIP receptors, and peptide YY receptors
- D. Alpha-adrenergic receptors, VIP receptors, and GLP-1 receptors on parietal cells

ANSWER KEY

Question	Question	Question	Question
Q1: B	Q2: C	Q3: C	Q4: B
Q5: D	Q6: C	Q7: B	Q8: C
Q9: D	Q10: C	Q11: D	Q12: B
Q13: B	Q14: B	Q15: B	Q16: B
Q17: B	Q18: C	Q19: B	Q20: B
Q21: B	Q22: B	Q23: C	Q24: C
Q25: C	Q26: C	Q27: B	Q28: B
Q29: C	Q30: C	Q31: B	Q32: C
Q33: C	Q34: B	Q35: C	Q36: C
Q37: B	Q38: B	Q39: C	Q40: B