

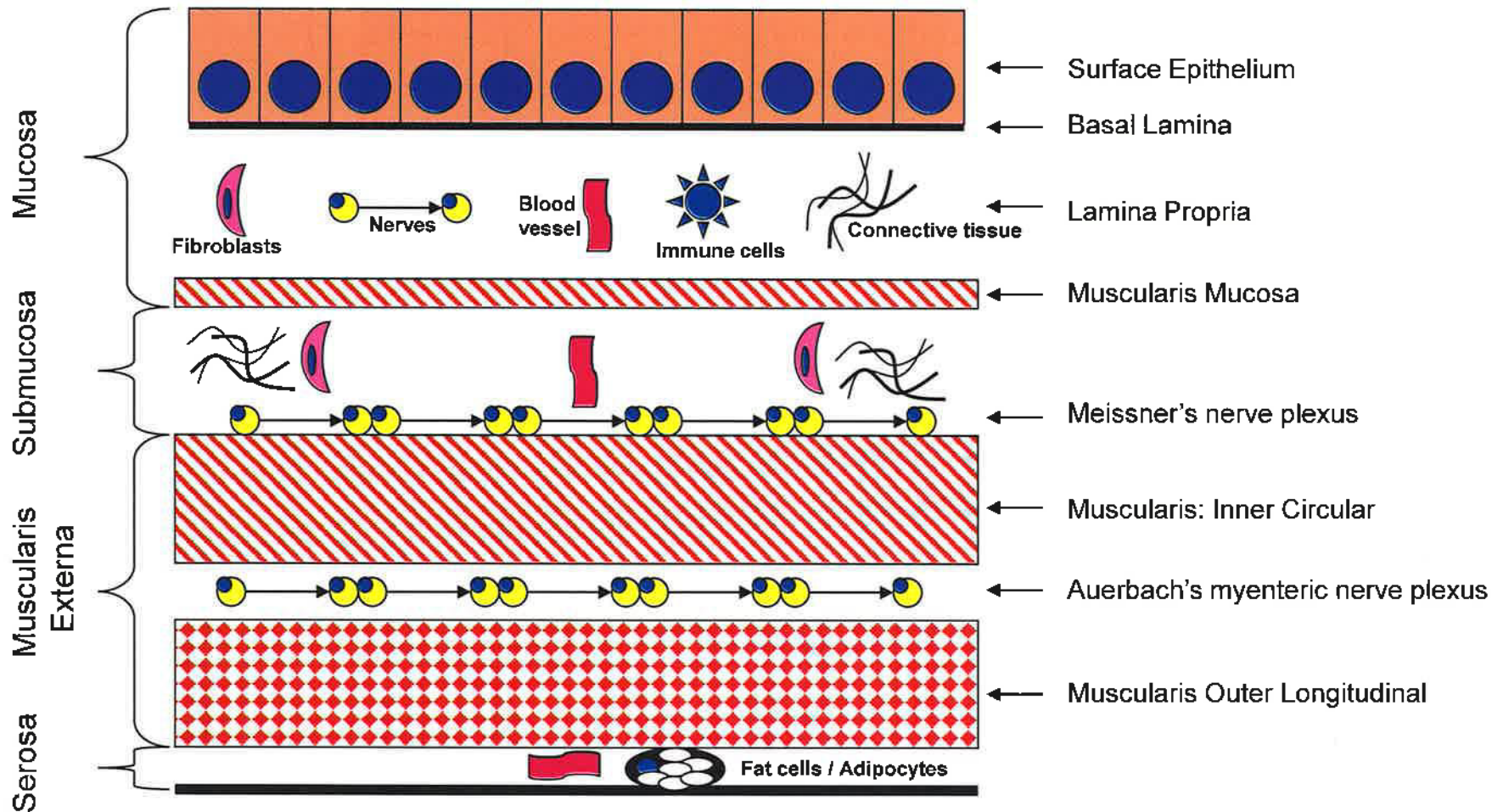
# Goals

- Know the general *layers* of the GI tract
- Know the *function* of the organs of the GI tract

# General Organization of the GI tract

## Layers

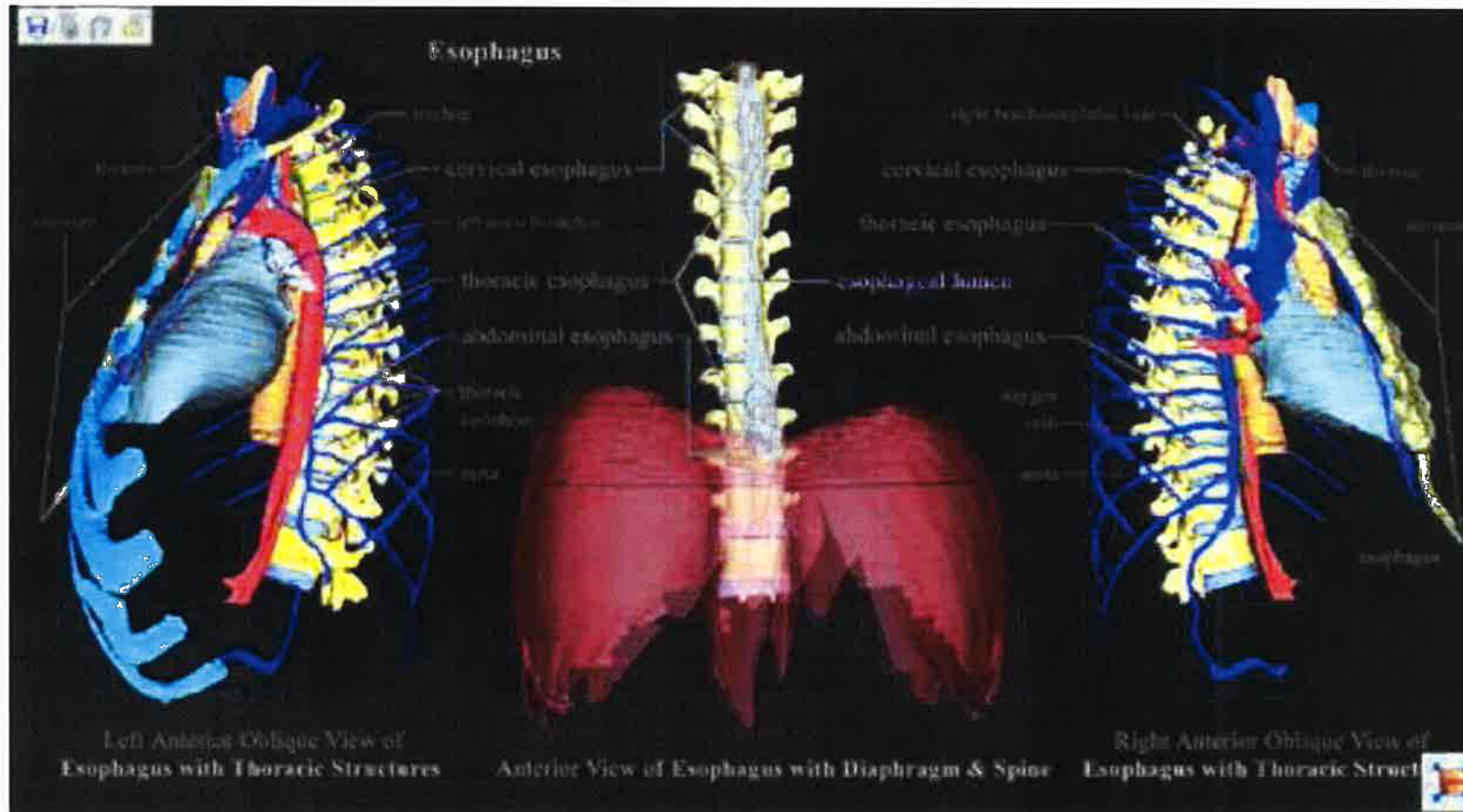
## Structures



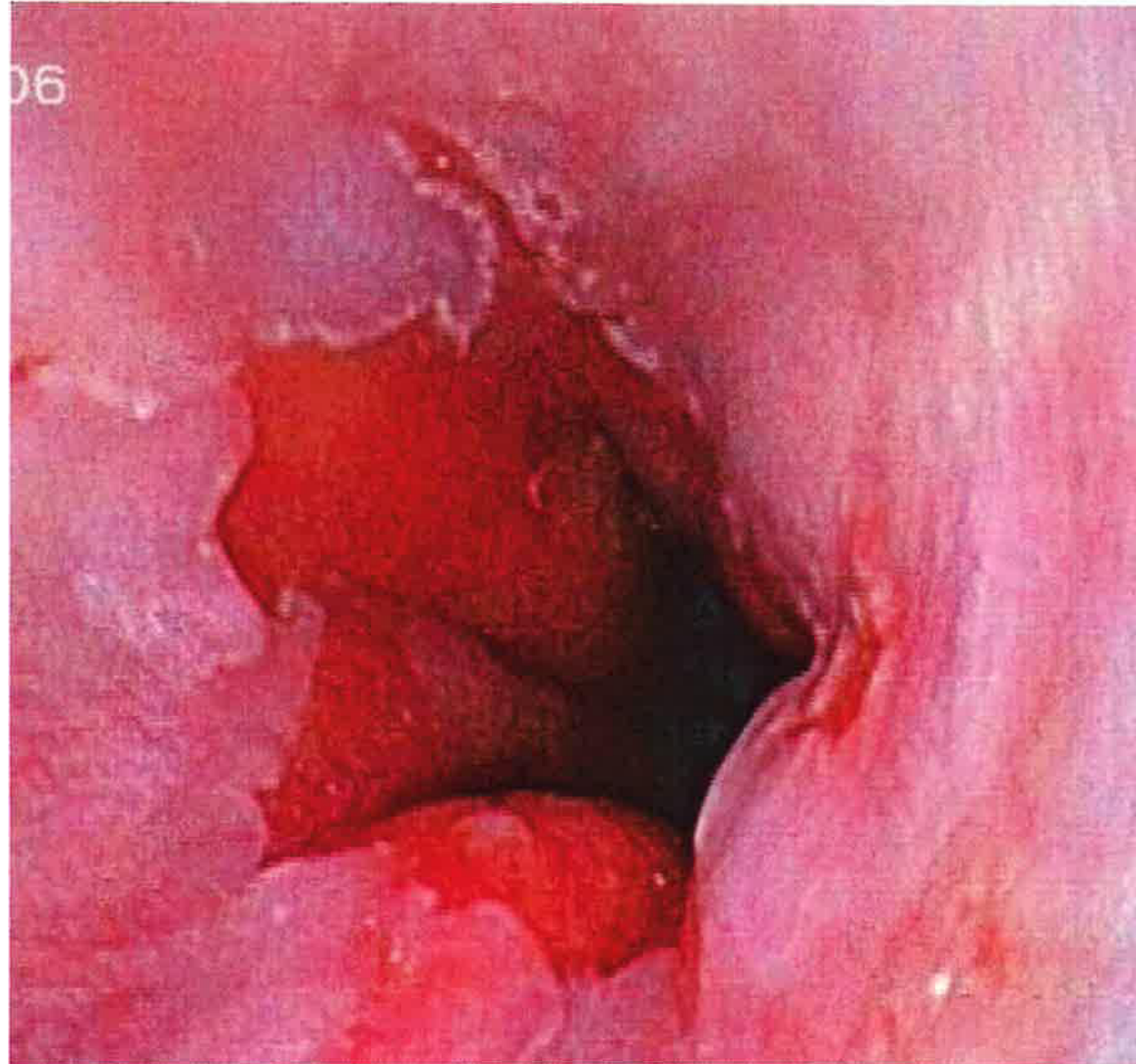
# Esophagus

- **Function:** transit tube
- **Histology:** keratinized stratified squamous epithelium, submucosal mucus glands
- **Disease burden:**
  - Non-neoplastic – gastric reflux
  - Neoplastic – adenocarcinoma & squamous cell carcinoma

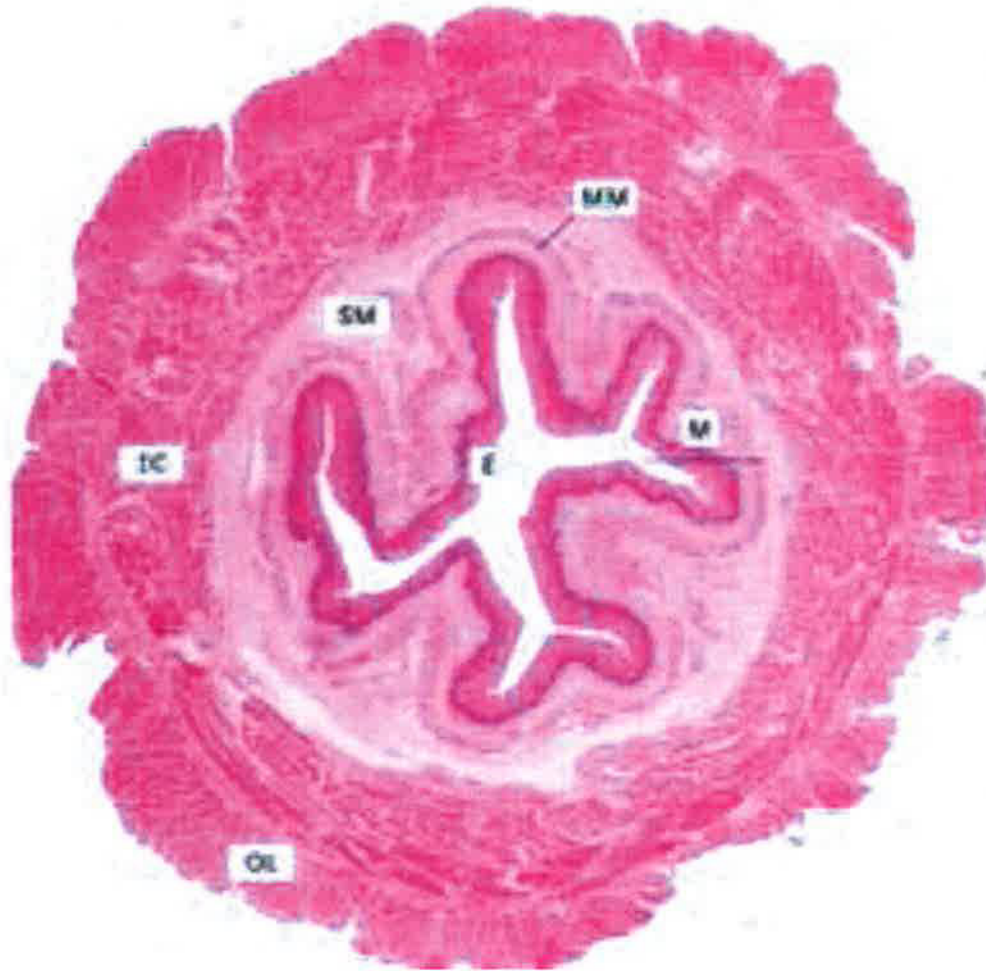
# Gross Anatomy



# Endoscopic view of GE junction

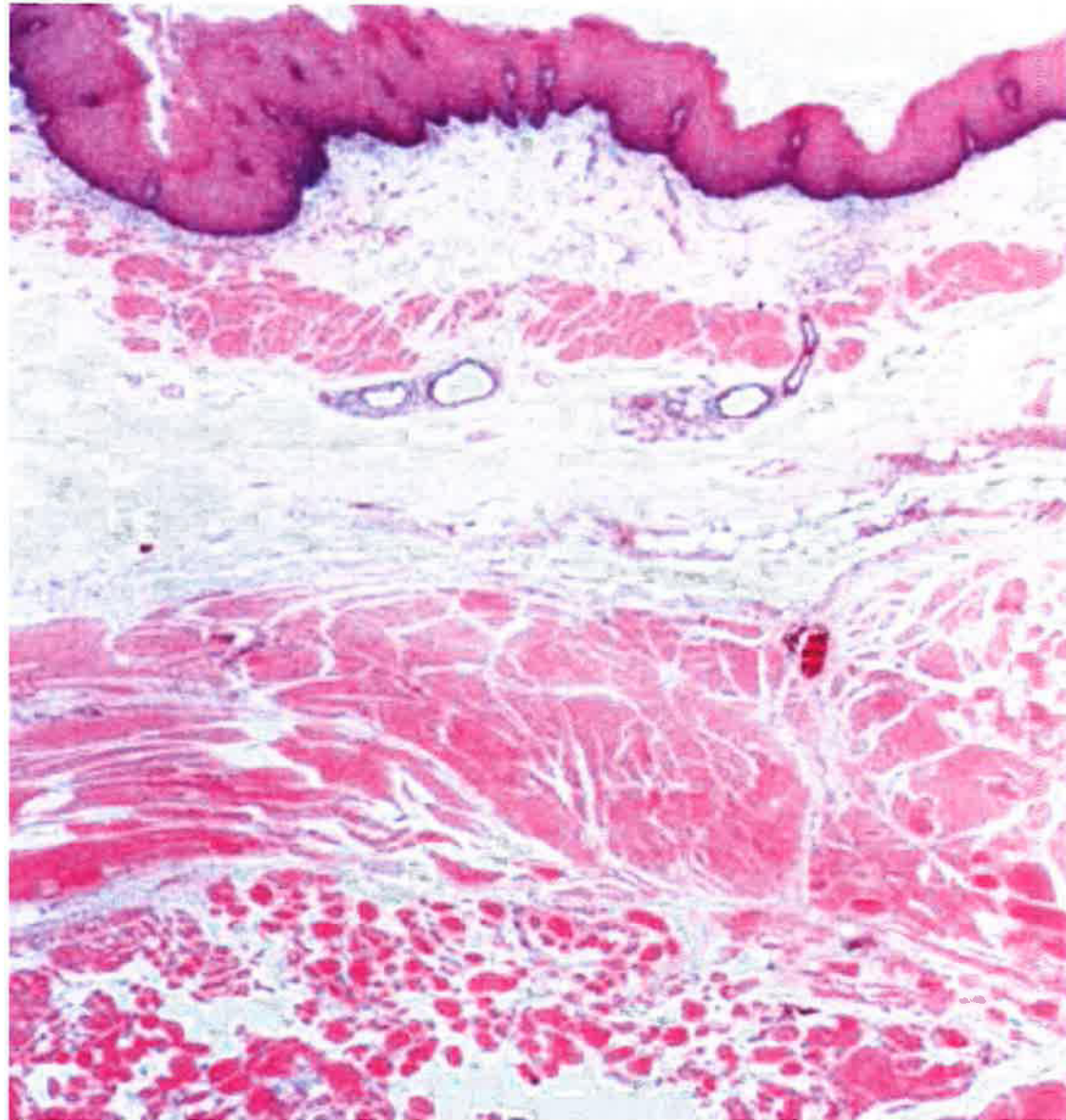


# Histology

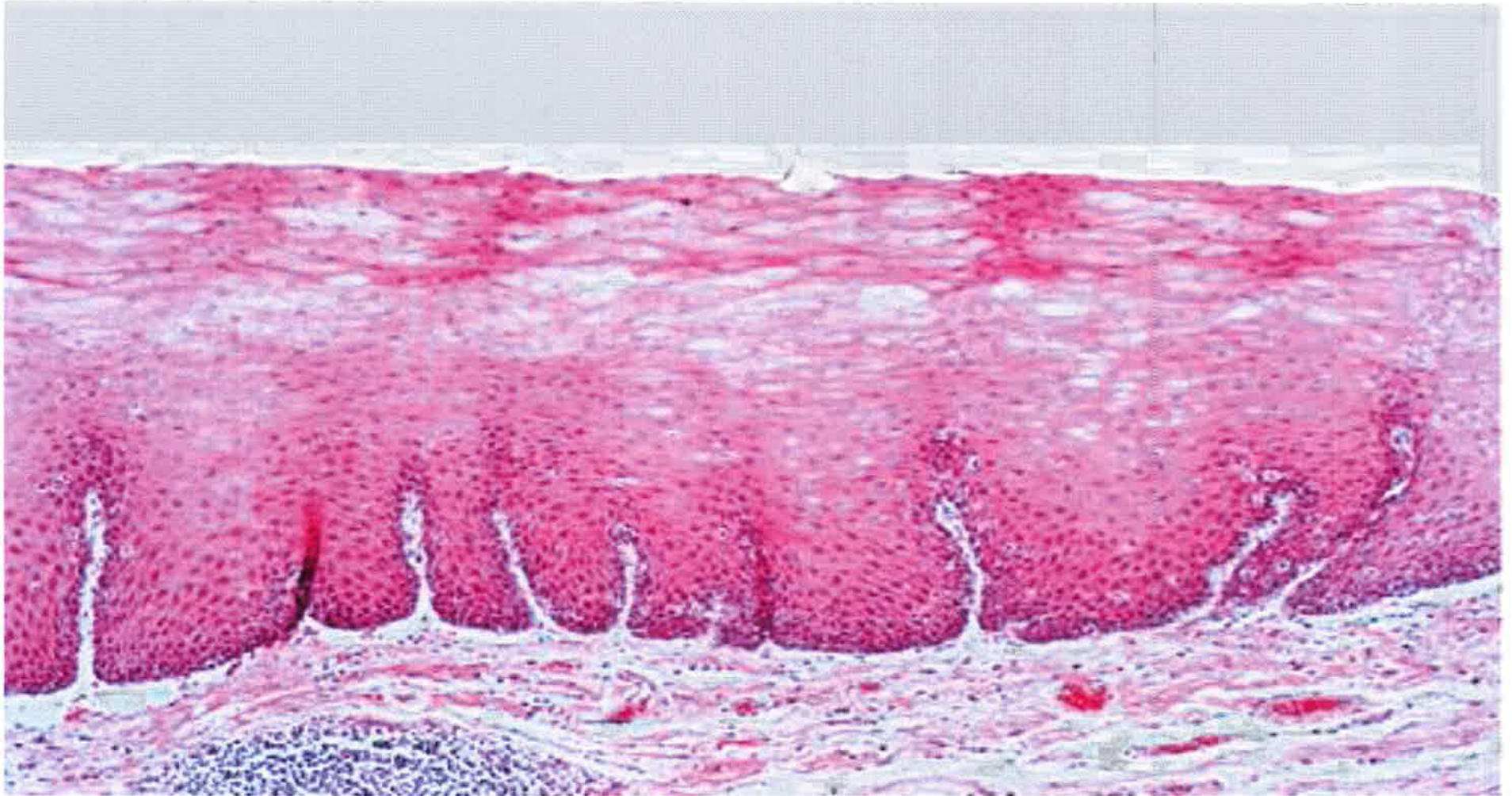


← Fig. 13.1 Regional variations of the gastrointestinal tract. a Esophagus in cross-section shows a stellate-type lumen resulting from folding of the mucosa (M) typical of the relaxed state. The muscularis mucosae (MM) of smooth muscle is noted; surrounding the submucosa (SM) the muscularis externa of smooth muscle shows the inner circular (IC) and outer longitudinal (OL) layers. With the introduction of a food bolus, a peristaltic wave of contraction of the muscle is initiated, lasting 6–7 seconds. The upper and lower ends of the esophagus have sphincters (the lower one is not histologically distinct), which relax in association with the transport of a bolus along the esophagus. The stratified squamous epithelium (E) protects against wear and tear.

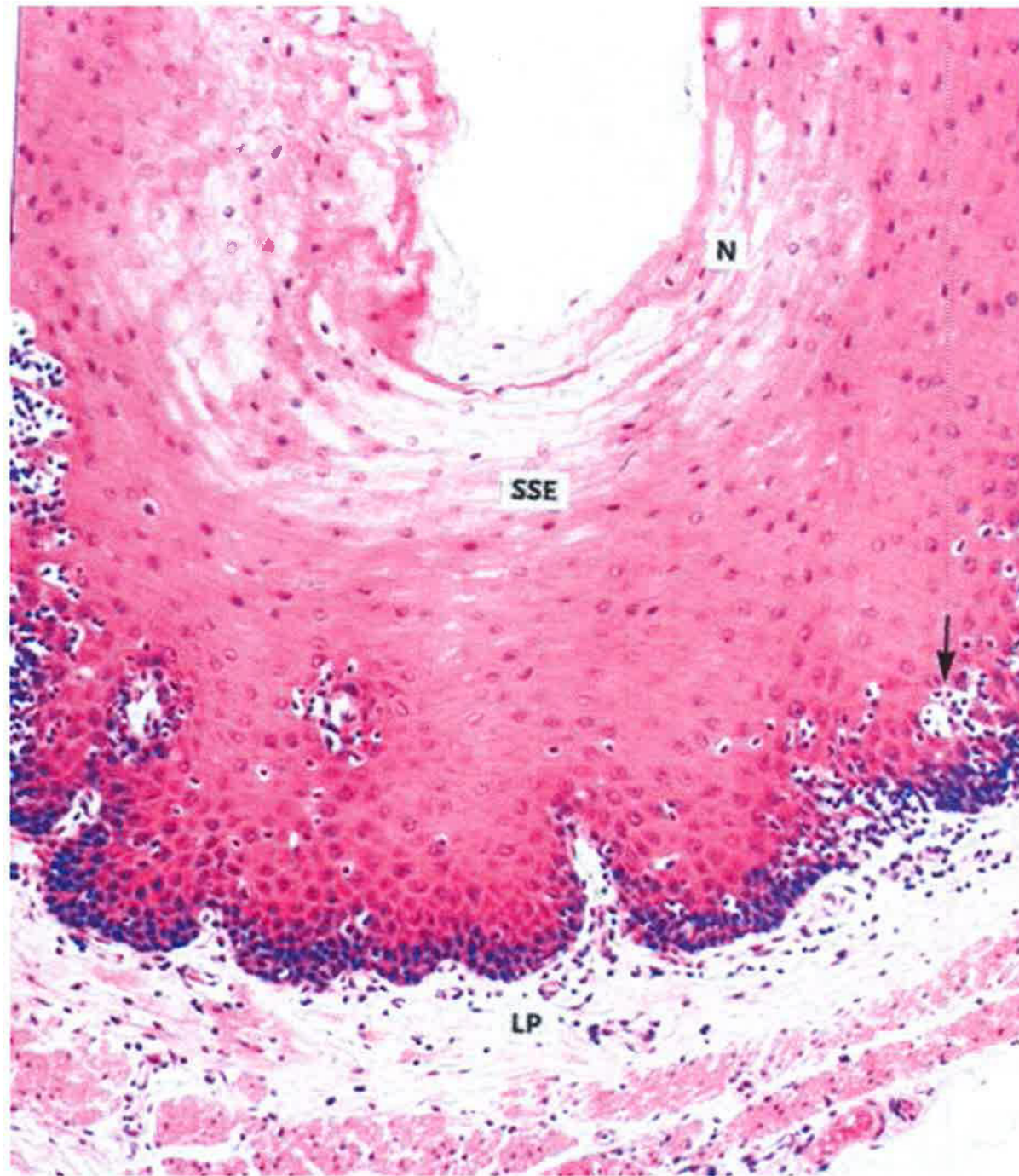
# Histology

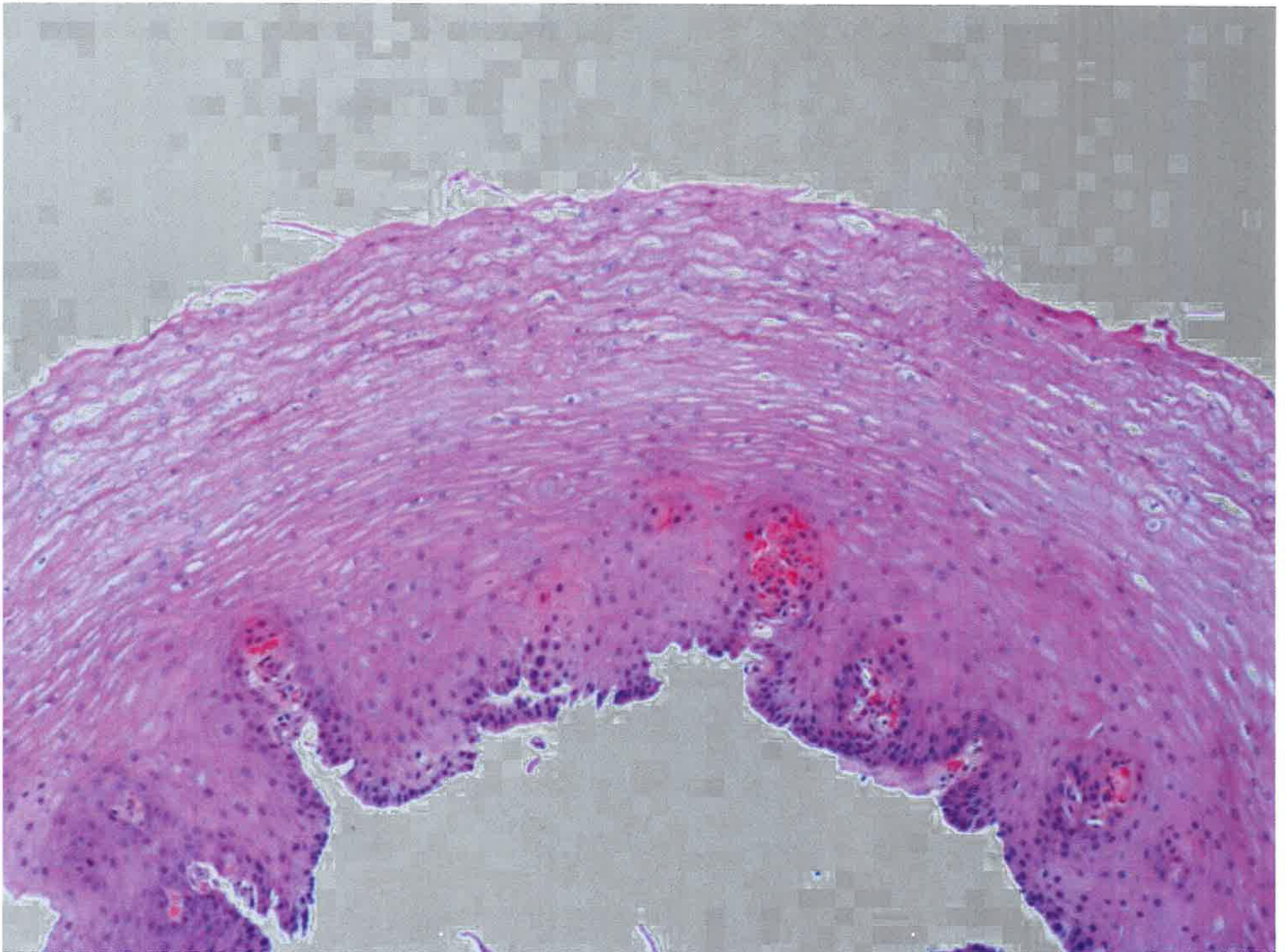


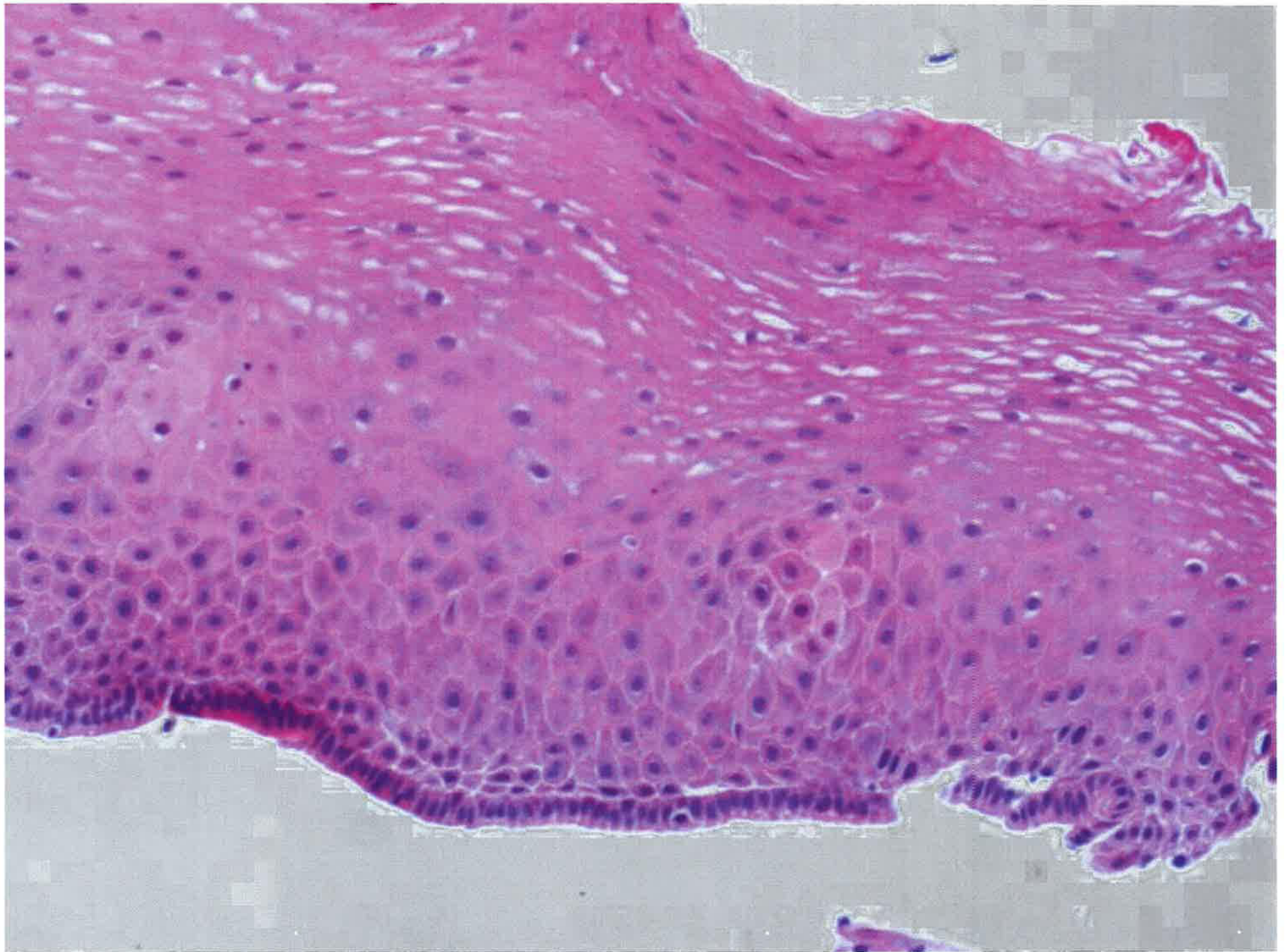
# Histology

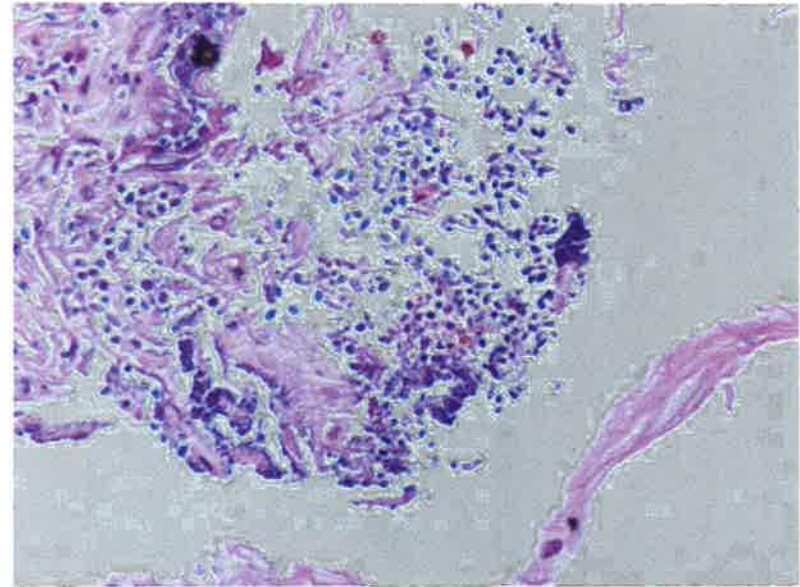
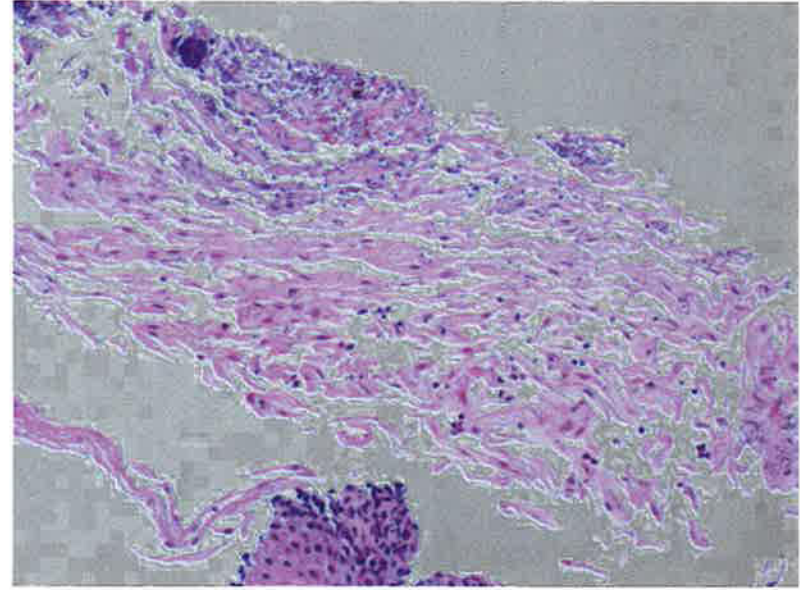
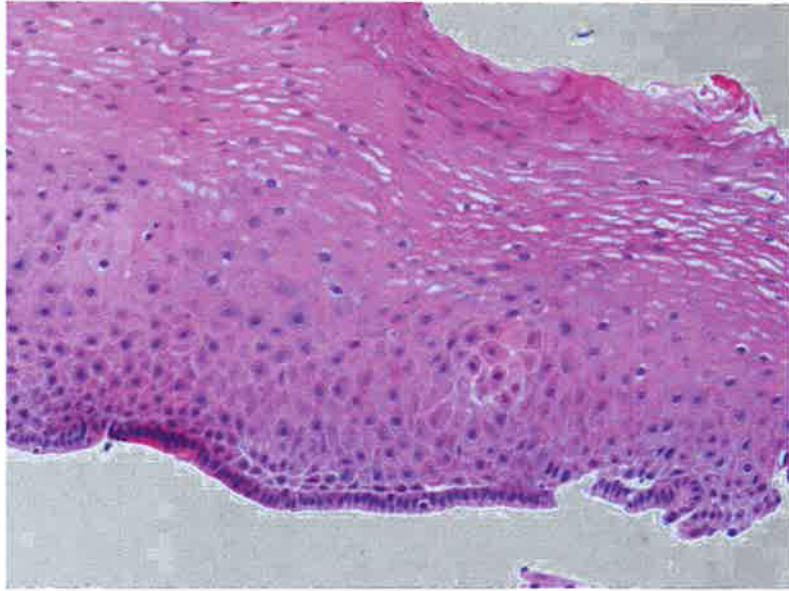






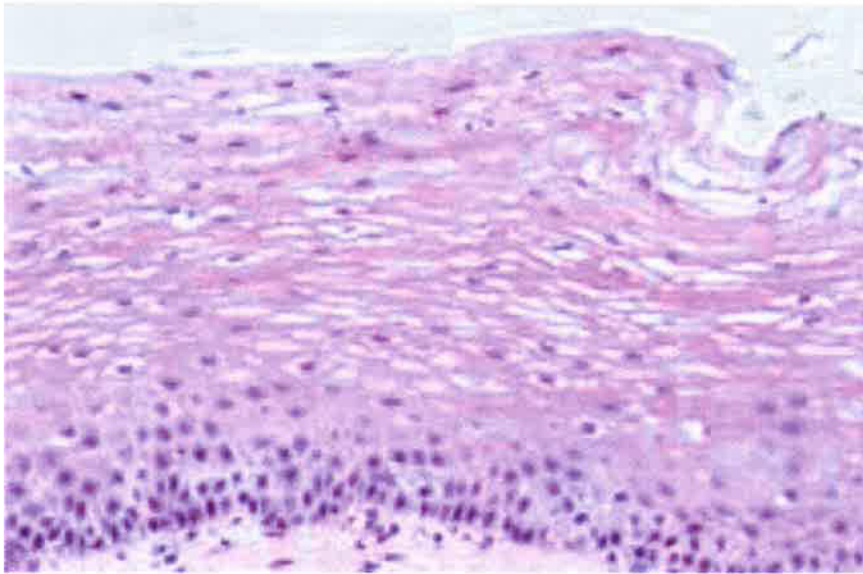




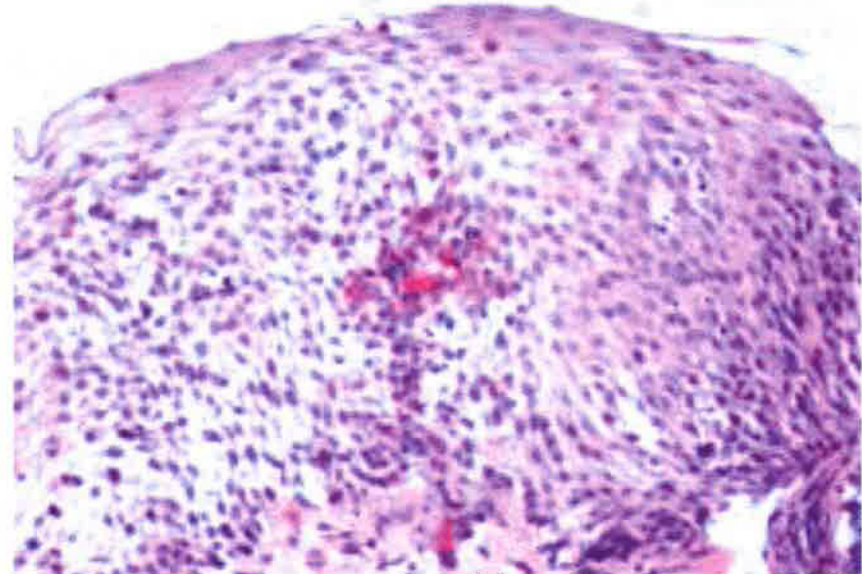


# Gastric Reflux

Normal



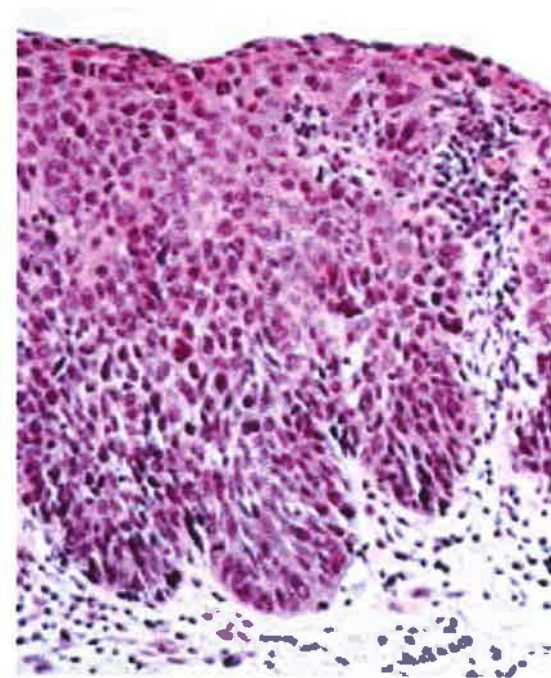
Reflux



# Carcinoma



Adenocarcinoma



Squamous cell carcinoma

# Stomach

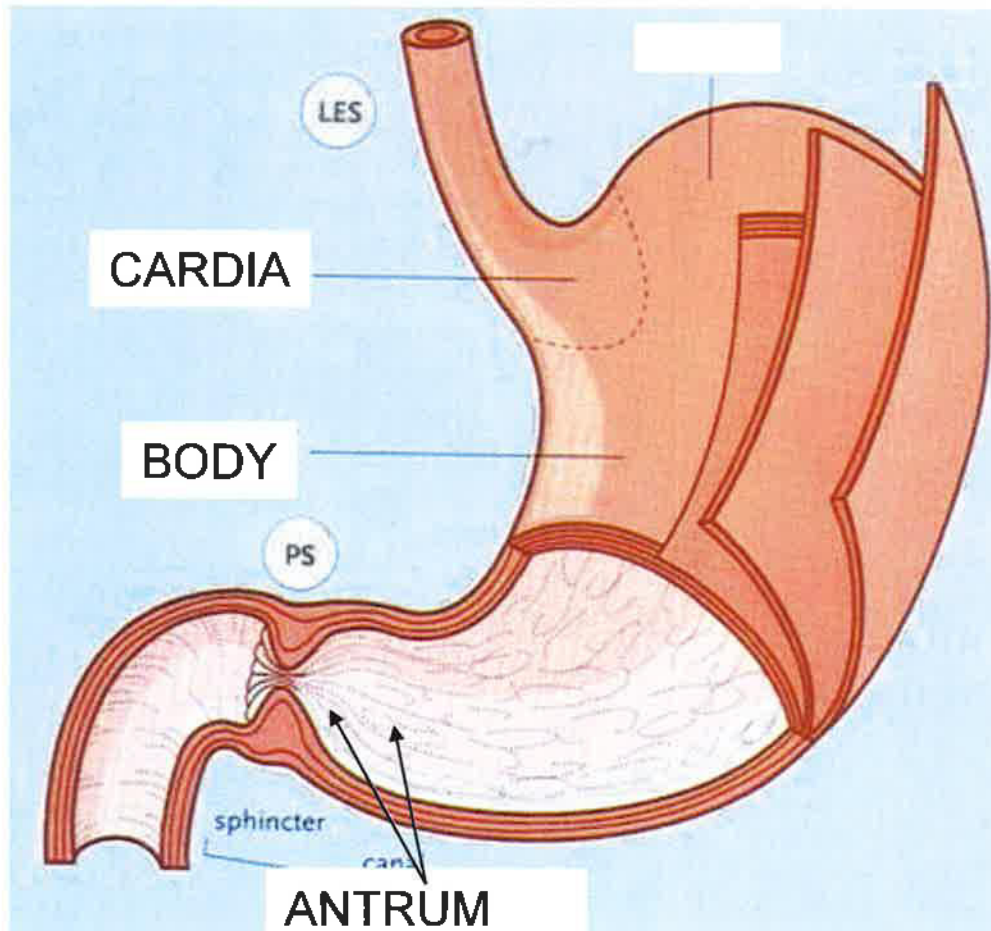
- **Function:** Endocrine controlled digestive bag of acid and enzymes
- **Histology:**
  - Body
    - Surface epithelium of columnar mucous cells
    - Deeper glands of parietal (oxyntic) and endocrine cells
  - Antrum
    - Surface cuboidal epithelium of mucous cells
    - Deeper loosely coiled glands of cuboidal epithelium of mucous and endocrine cells

# Stomach cont.

- **Disease burden:**
  - Non-neoplastic – gastritis, gastric ulcer
  - Neoplastic – adenocarcinoma carcinoma

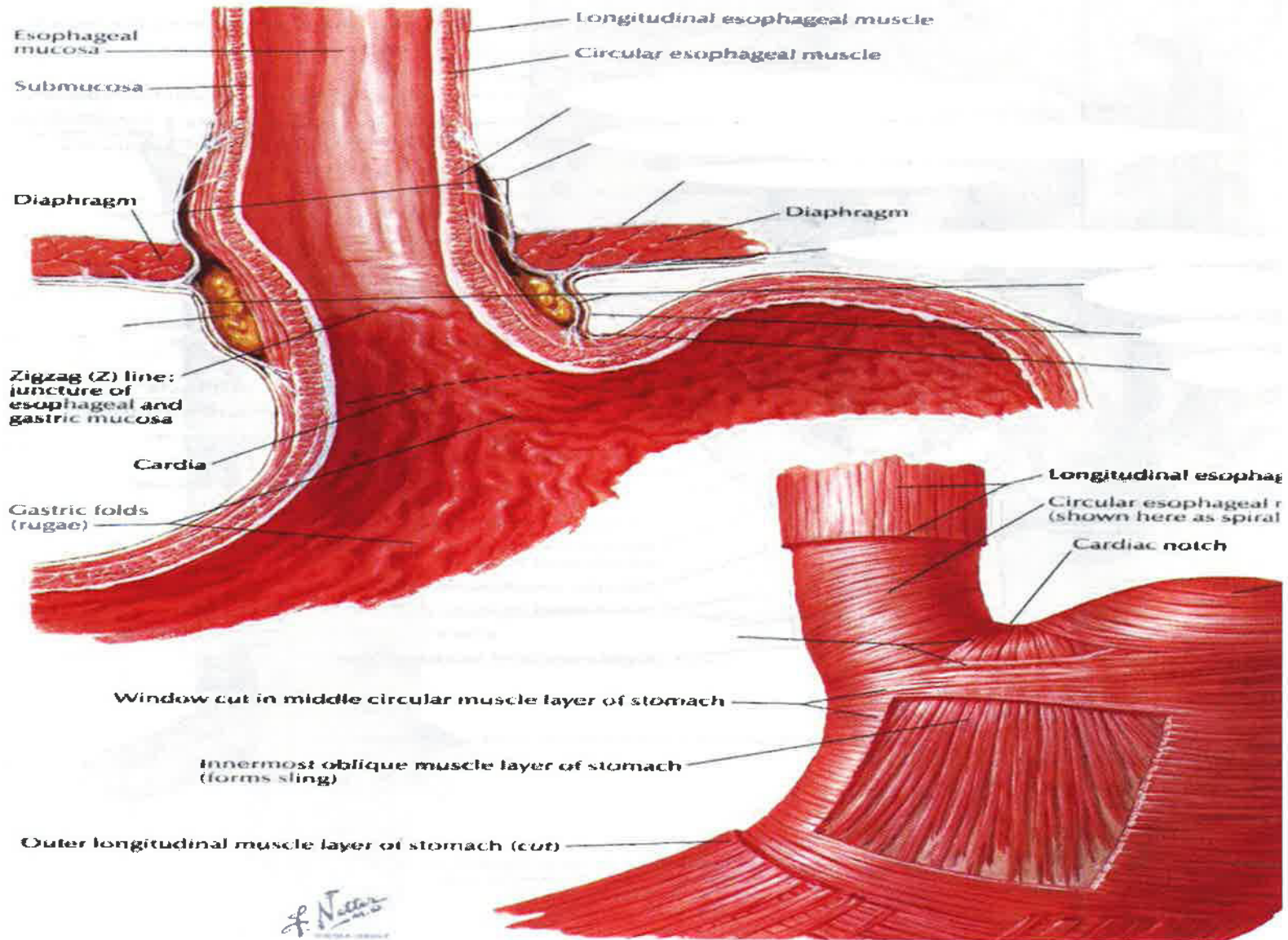


# Gross Anatomy



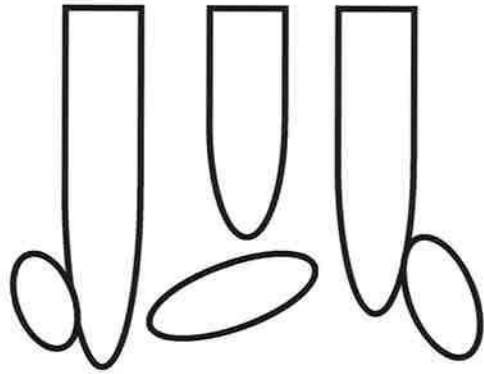
← Fig. 13.7 Regional variations of the gastric mucosa. **a** Principal regions of the stomach. The histologically distinct regions are in **bold**. The lower esophageal sphincter (LES) **is a** physiological sphincter with **no** structural specialization, whereas the pyloric sphincter (PS) is a thickening of the circular muscle in the muscularis externa. The muscularis externa may show three layers: the inner oblique (distal half of stomach), the middle circular (whole stomach), and the outer longitudinal layer (upper two-thirds of stomach).

# Gross Anatomy

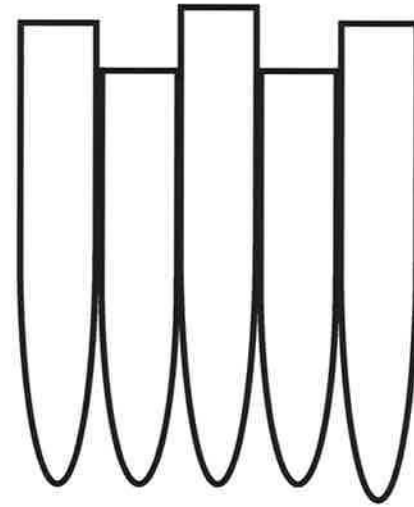


# Histology

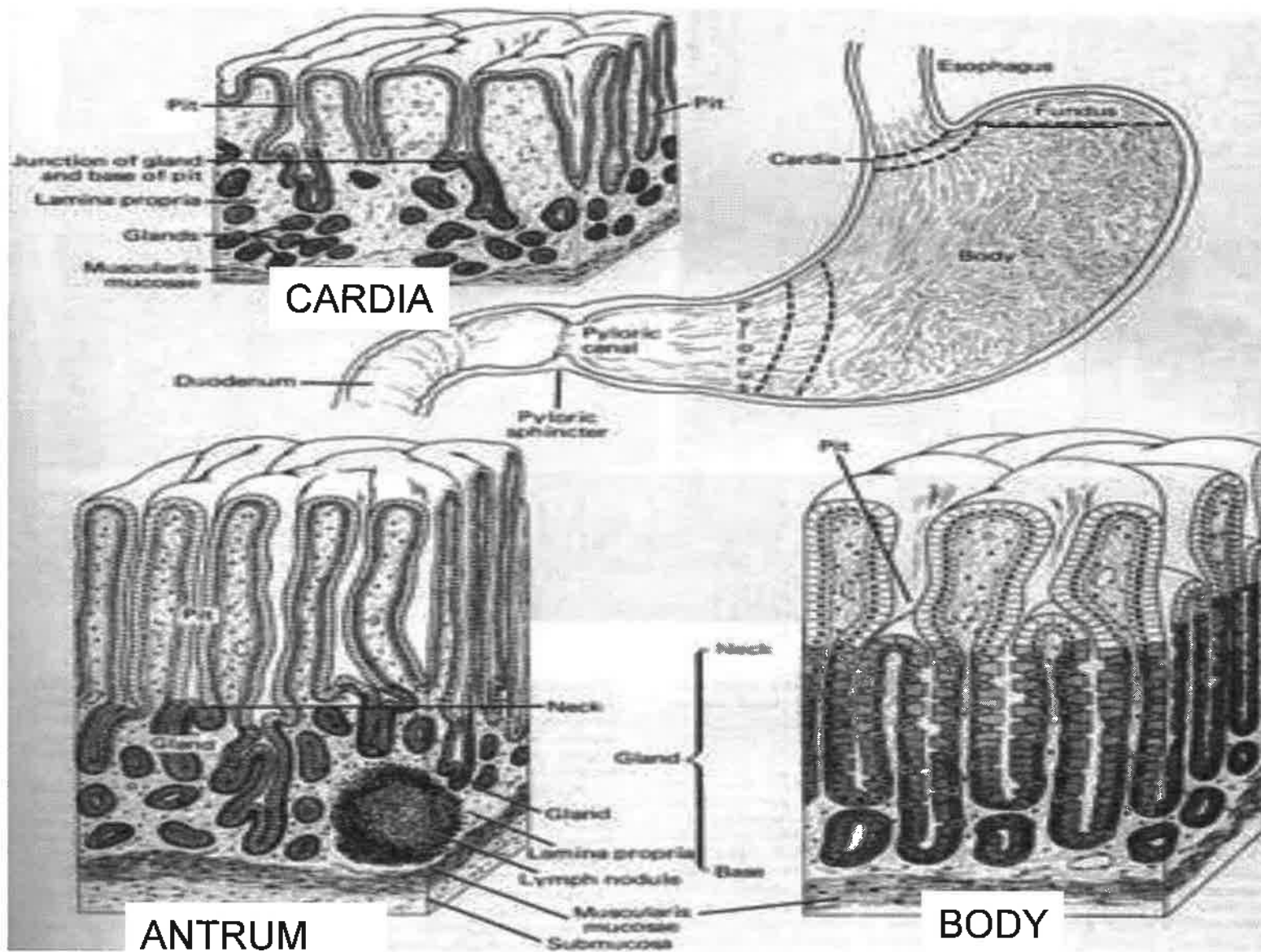
*-glandular profile-*



ANTRUM

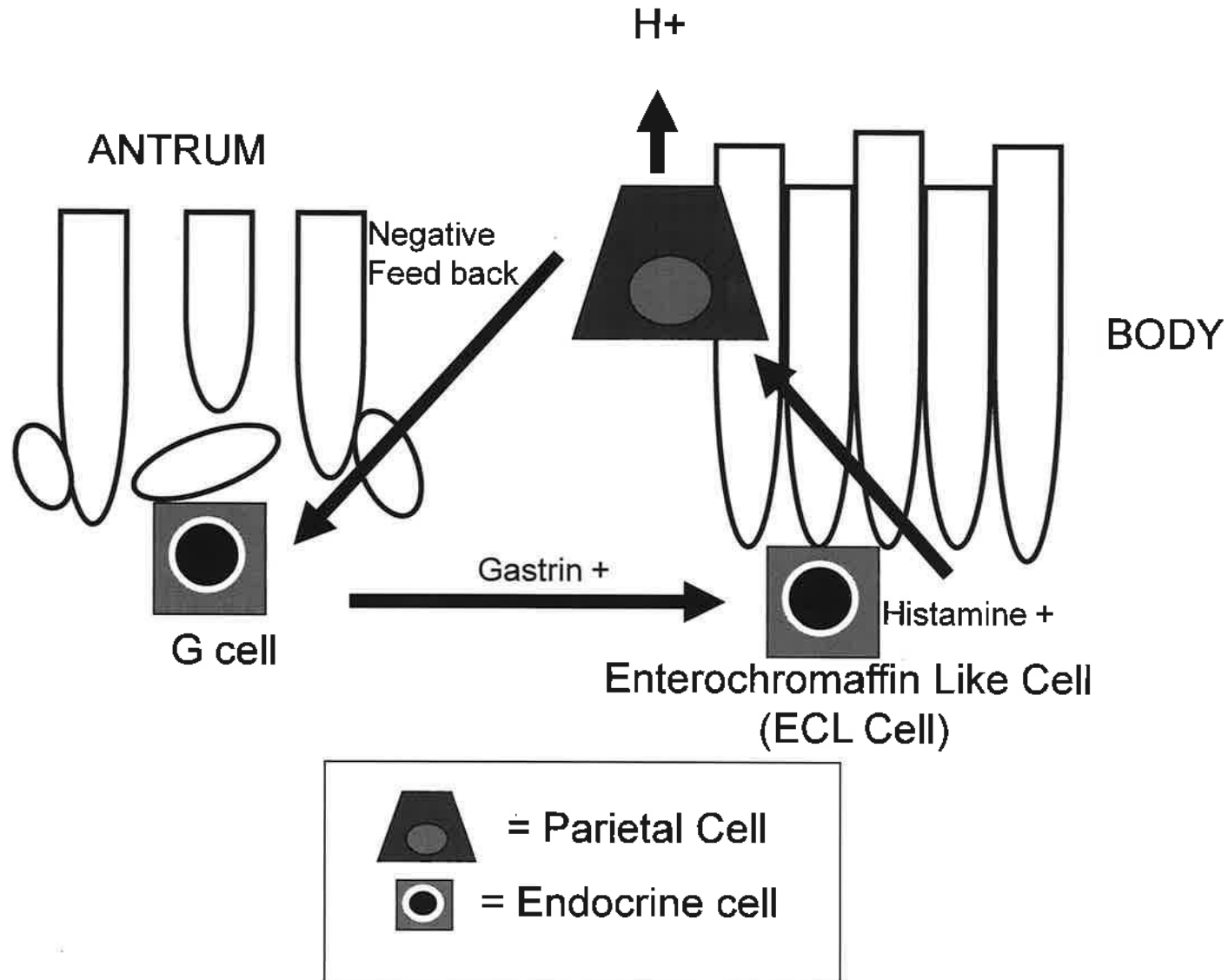


BODY

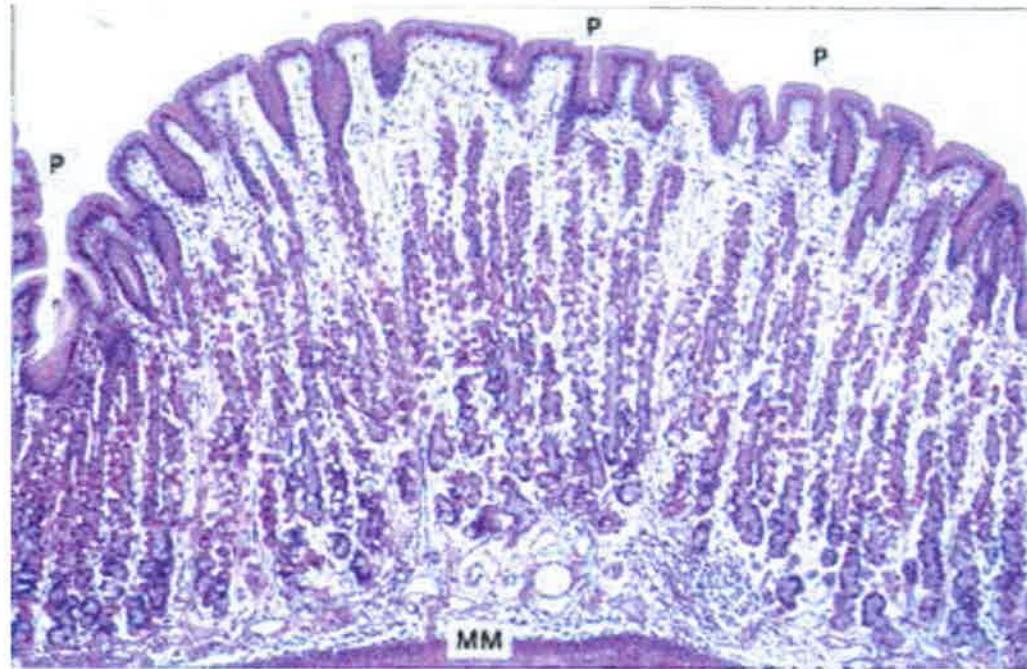


# Endocrine System

*-negative feedback loop-*

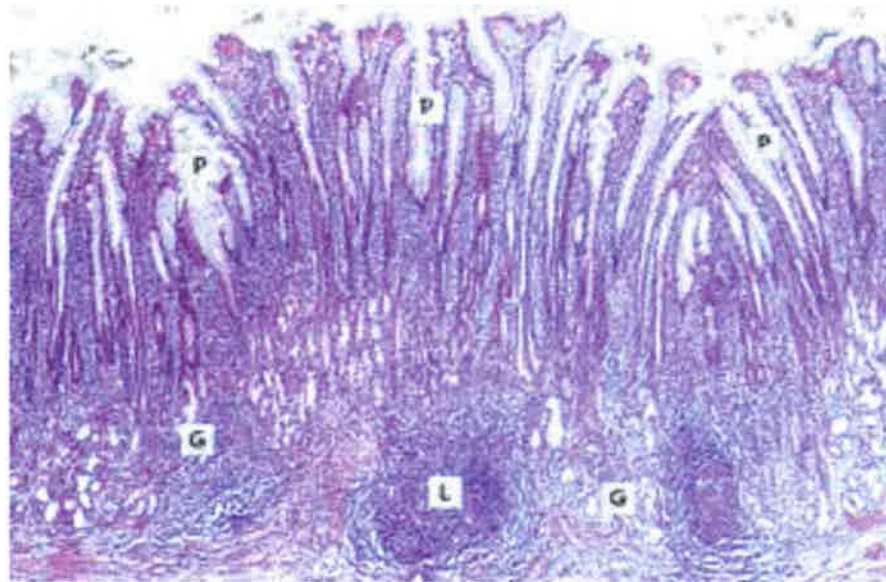


# Histology



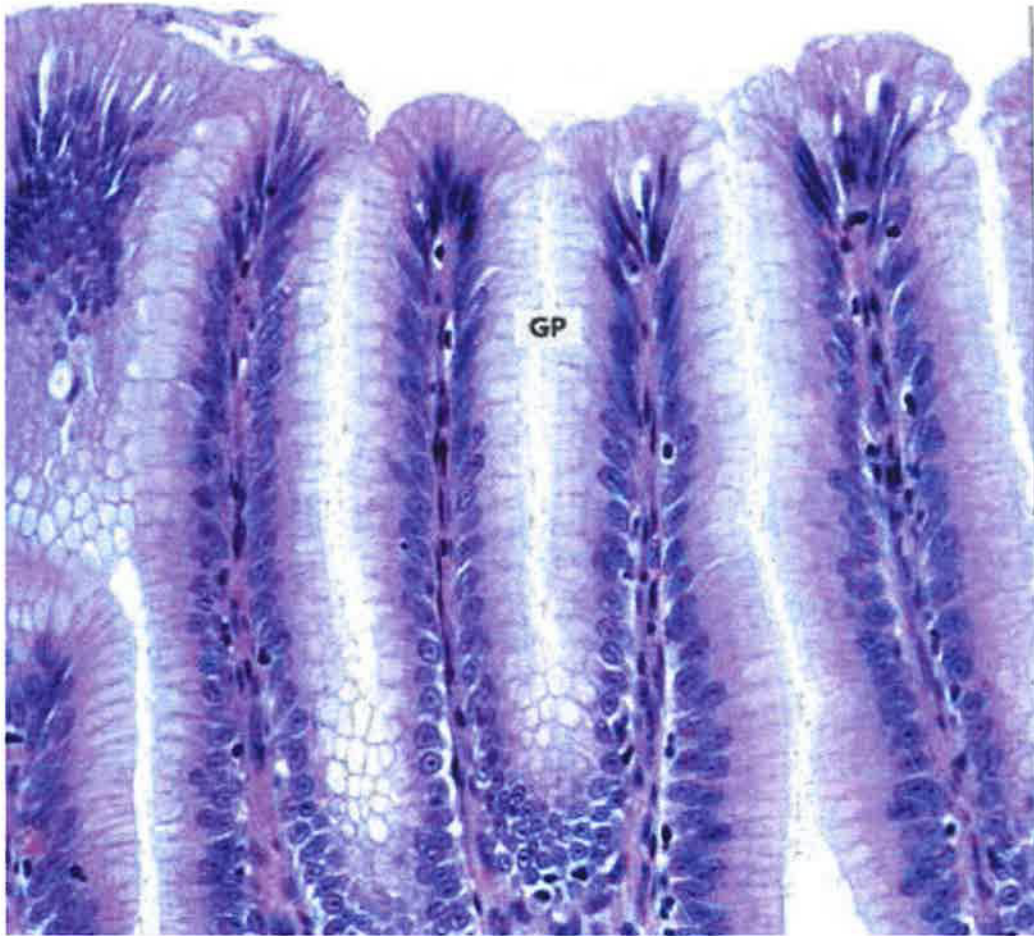
← **Fig. 13.7c Body (or corpus) mucosa.** This occupies about 80% of the lining of the stomach and is identified by shallow gastric pits (P), which are lined by surface mucous cells. Long, straight tubular glands extend downward from these cells toward the muscularis mucosae (MM). These gastric glands contain mucous, stem, acid-secreting, enzyme-secreting, and endocrine cells. The volume of fluid secreted by the stomach mucosa is about 1.5–2 L per day, most of which is secreted by the gastric glands of the body of the stomach.

# Histology



← **Fig. 13.7d Pyloric antral mucosa.** The pyloric region extends proximally up to 5 cm from the pylorus or commencement of the duodenum. The gastric mucosa within this area is characterized by deep gastric pits (P), again lined by mucous cells that occupy more than half of the depth of the mucosa. Arising from the gastric pits, the pyloric glands (G) are coiled and branched and contain mostly mucous cells but some acid-secreting and endocrine cells, notably gastrin cells. Aggregations of lymphoid cells (L) are indicated in the lamina propria.

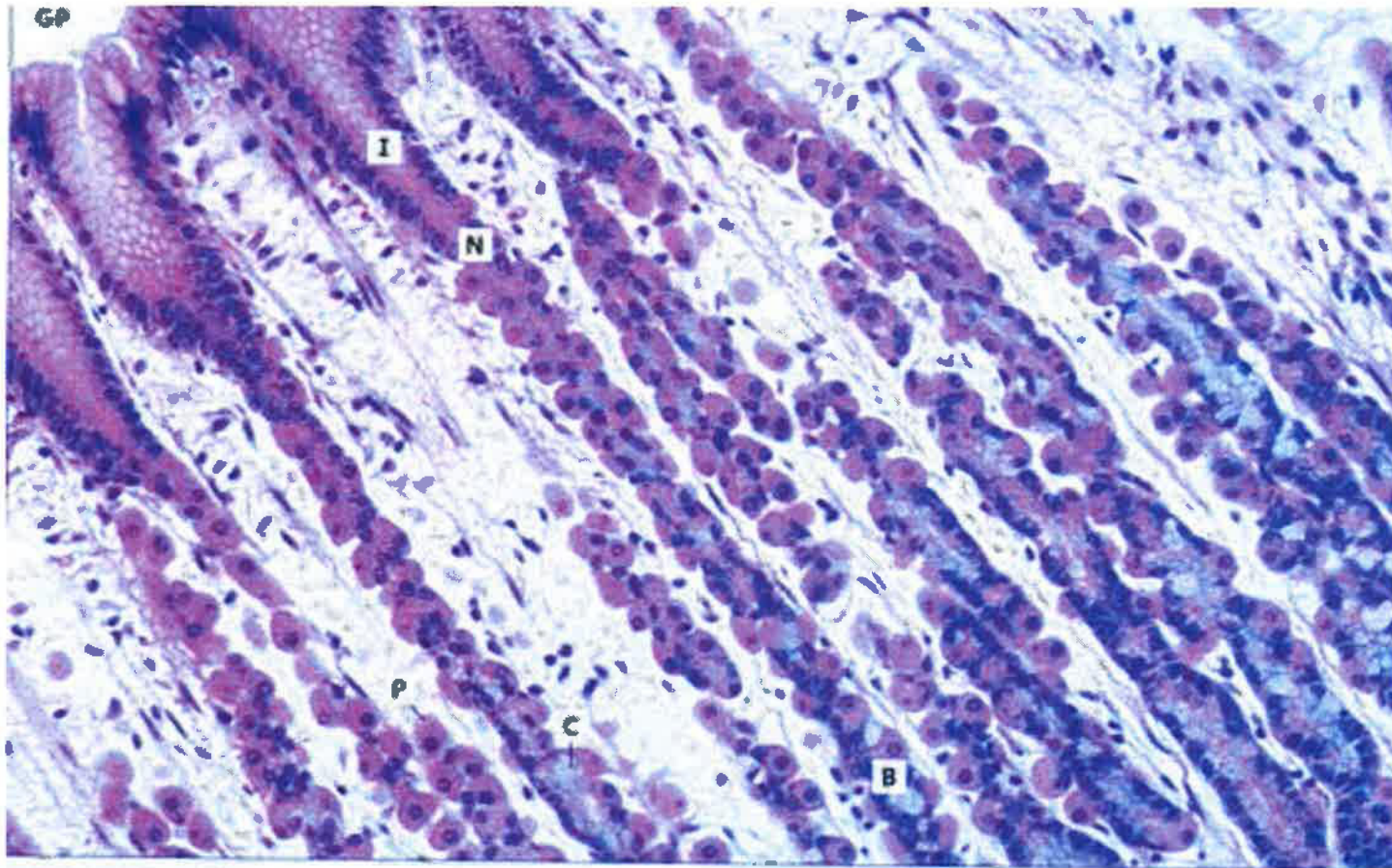
# Histology



← Fig. 13.8 Surface mucous cells.  
a The entire surface of the gastric mucosa is lined by simple columnar epithelial cells that extend into the gastric pits (GP) but are infrequent in the gastric glands in the body of the stomach. Surface mucous cells resemble goblet cells of the intestine in that the apical cytoplasm is eosinophilic with H&E stains resulting from the high content of mucous granules. These give a lightly stained cytoplasm. The secreted mucus contains mucins, that is, glycoproteins that form a viscous gel layer which is resistant to pepsin (enzymatic) degradation. Mucus is produced via mechanical irritation and in response to stimulation of the vagus nerve. Mucin also coats luminal contents, assisting slippage through the stomach.



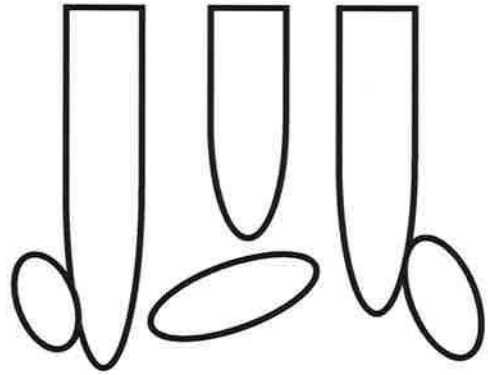
# Histology



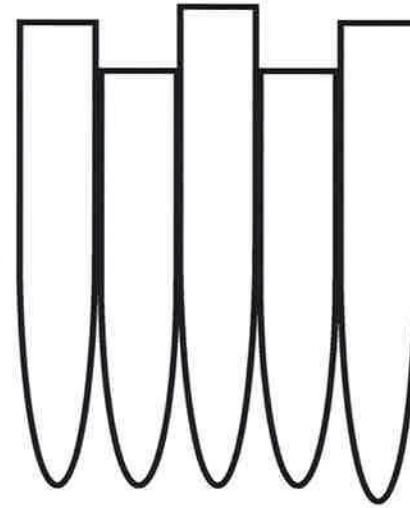
↑ Fig. 13.9b Body of gastric mucosa shows gastric pits (GP) and gastric glands consisting of the isthmus (I), neck (N) and base (B). Parietal cells (P) are pink stained, and chief cells (C) are blue-purple stained with a foam-type cytoplasm. The supporting tissue of the lamina propria contains a loose network of collagen and reticular fibers, wandering cells of the immune system, capillaries and strands of smooth muscle extending vertically from the deeper muscularis mucosae.

# Histology

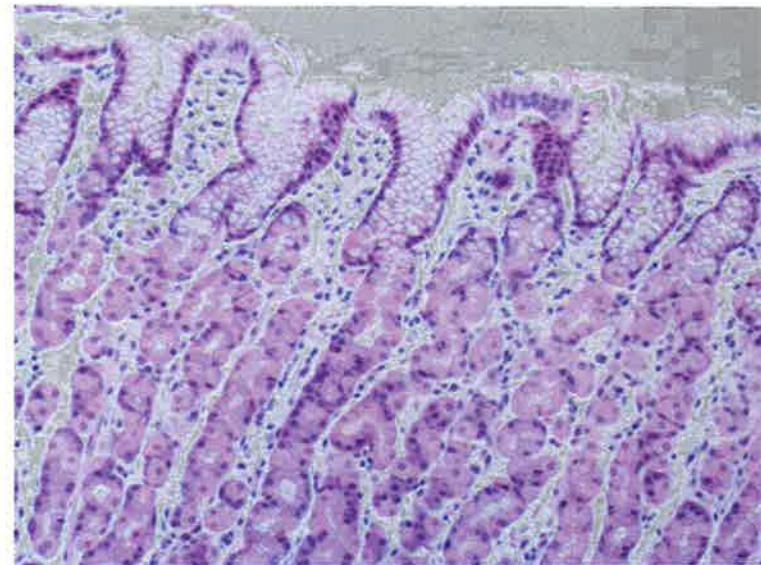
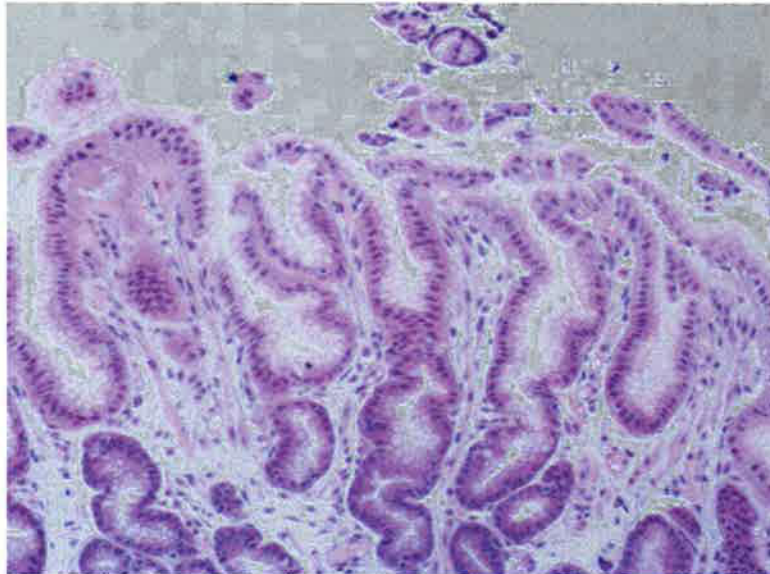
*-glandular profile-*

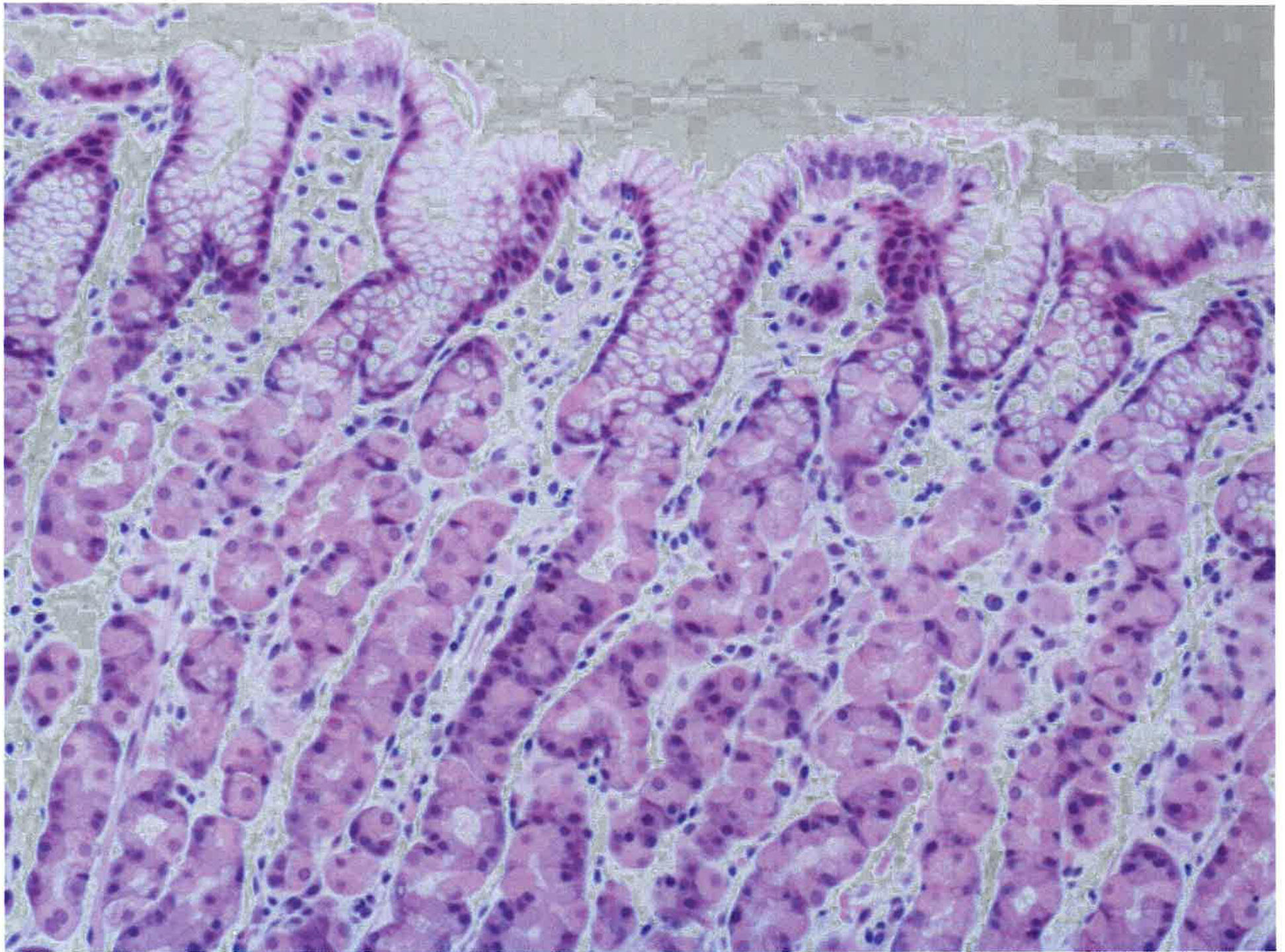


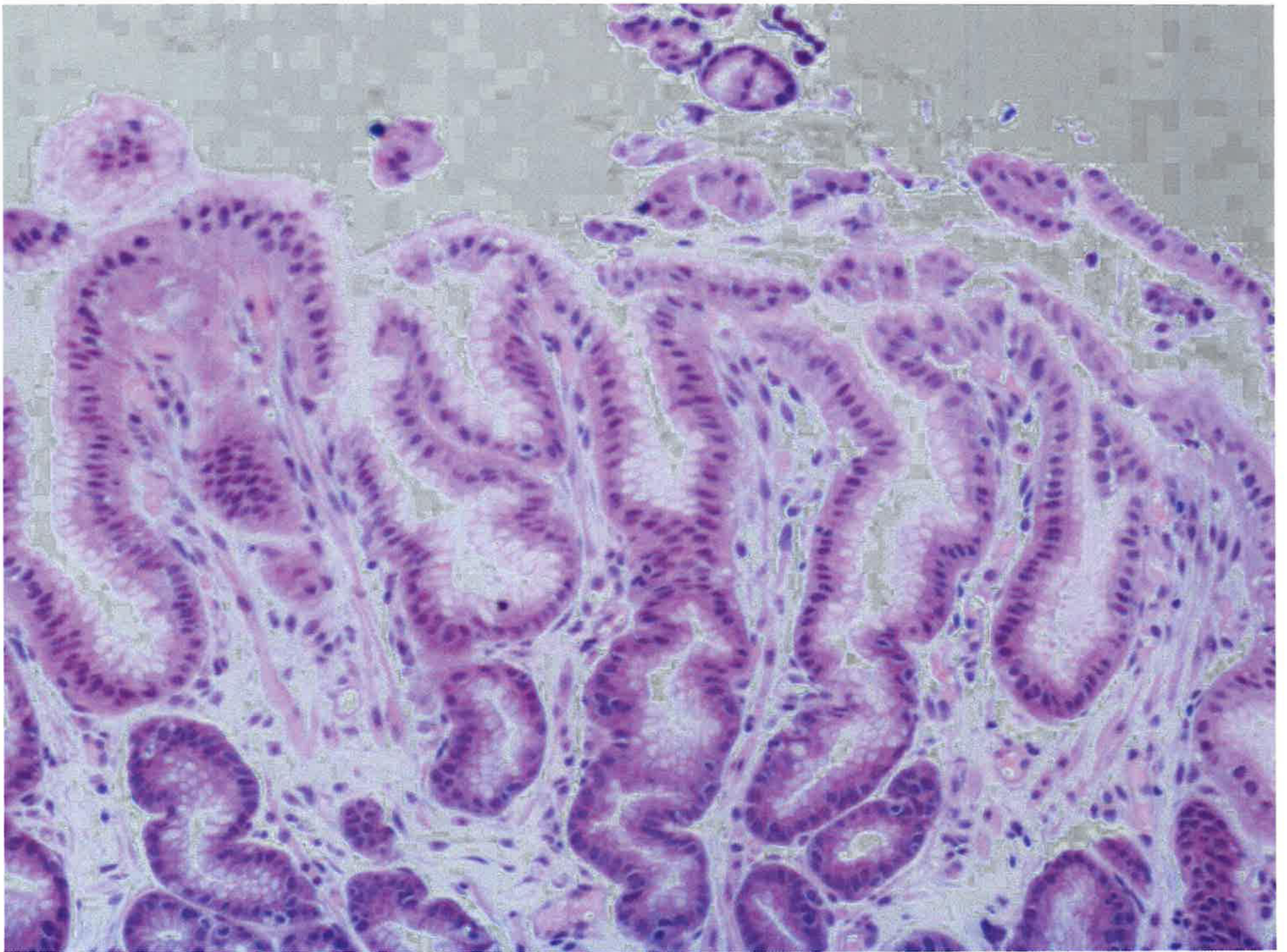
ANTRUM



BODY





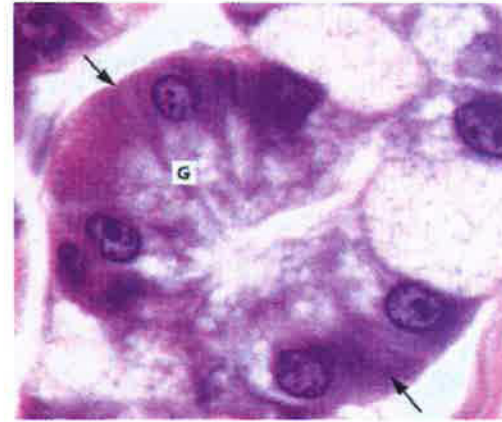


# Histology

Parietal Cell



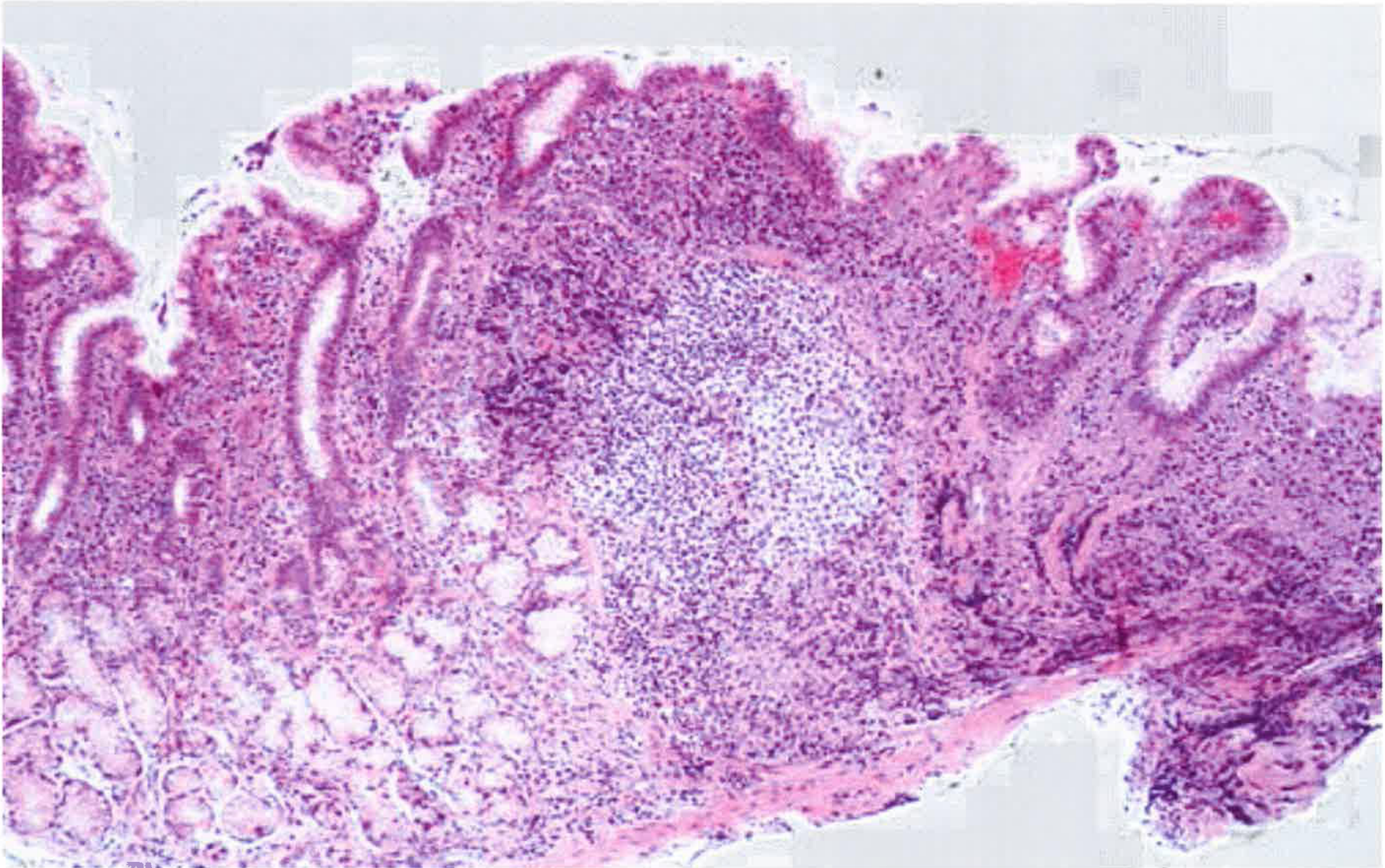
Endocrine Cell



# Stomach

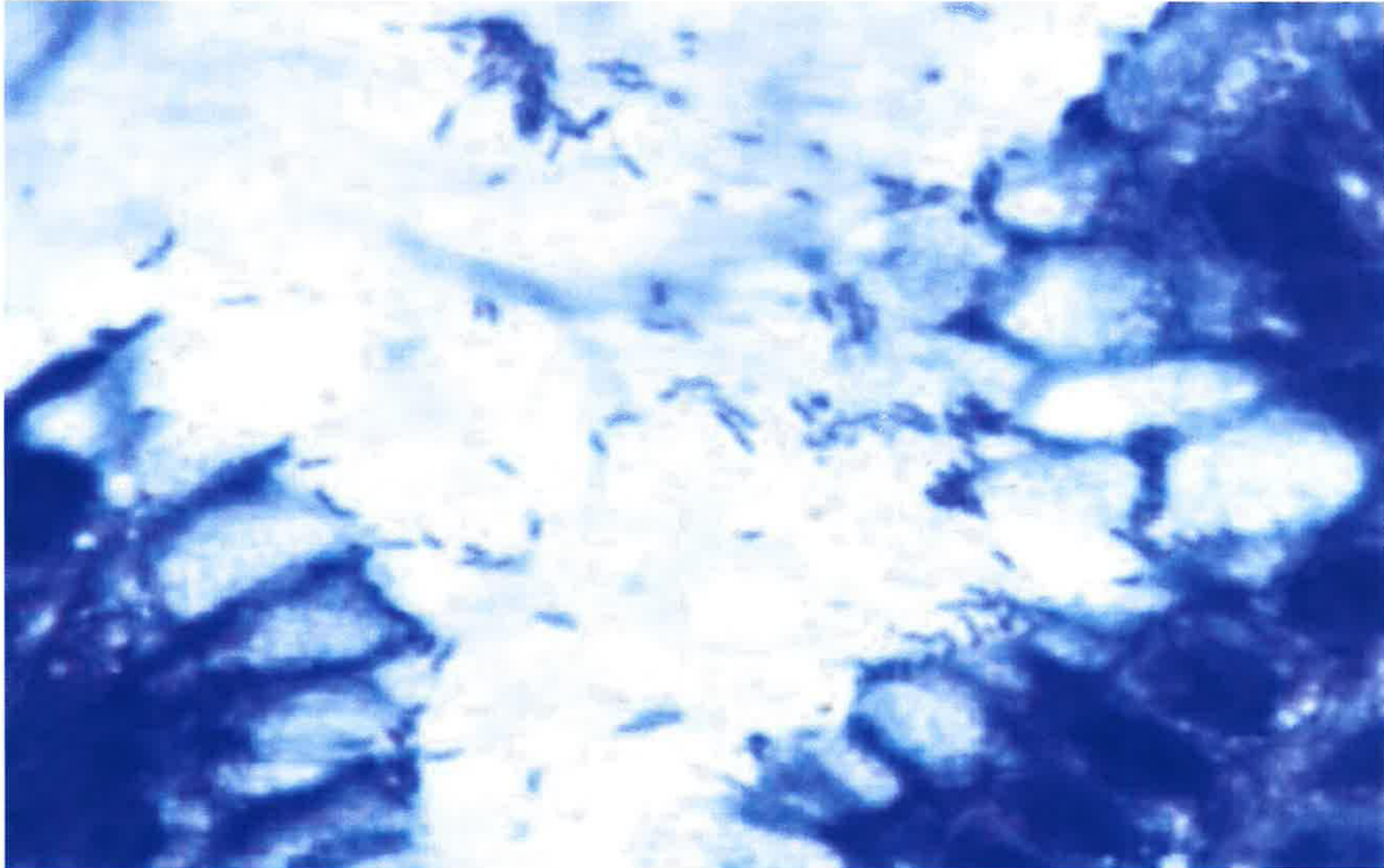
- **Disease burden:**
  - Non-neoplastic - gastritis, gastric ulcer
  - Neoplastic - gastric adenocarcinoma
    - Diffuse infiltrating single cells, non mass forming
    - Discrete mass forming

# Gastric ulcer

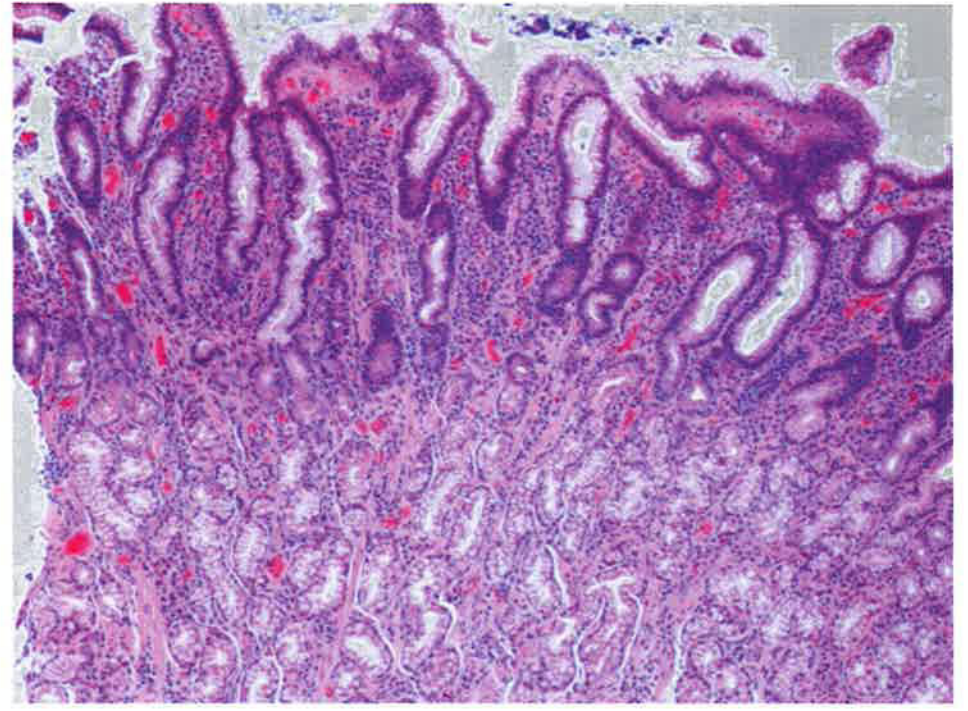
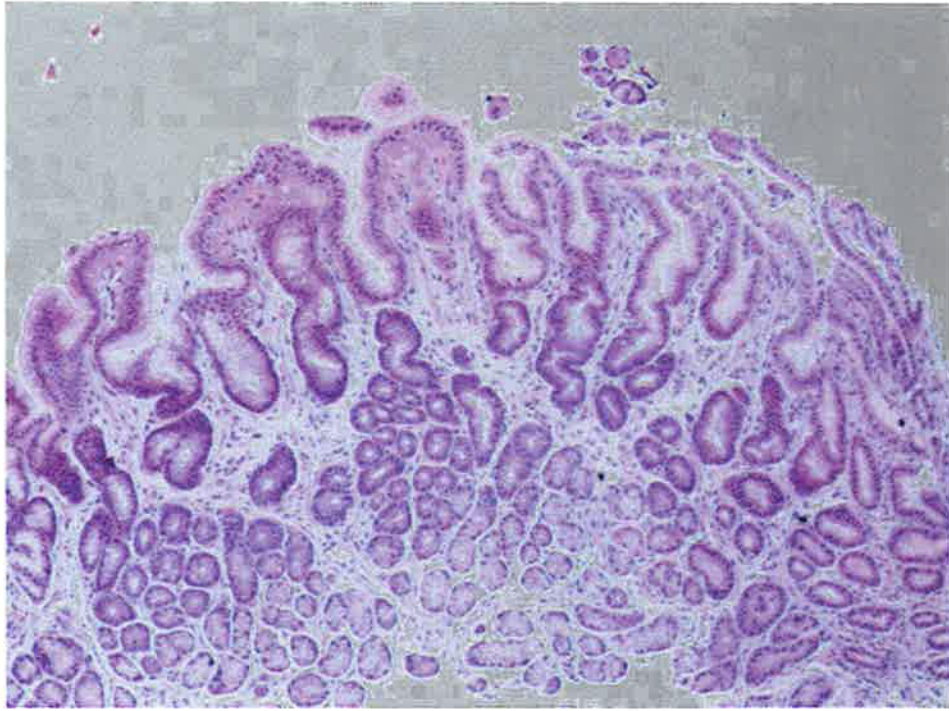


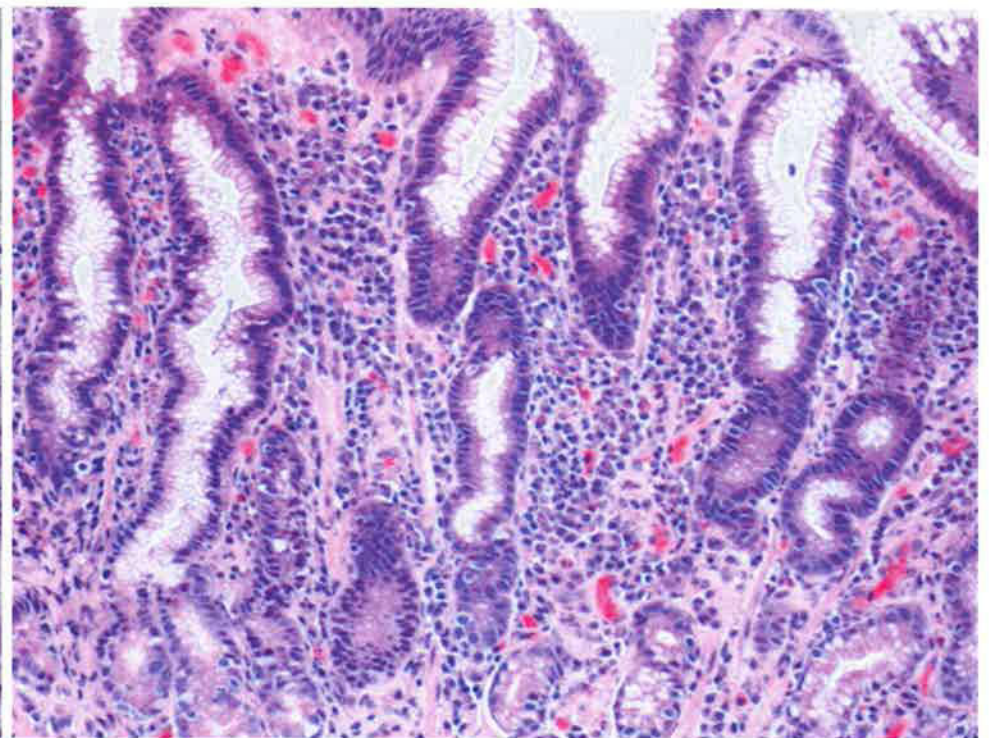
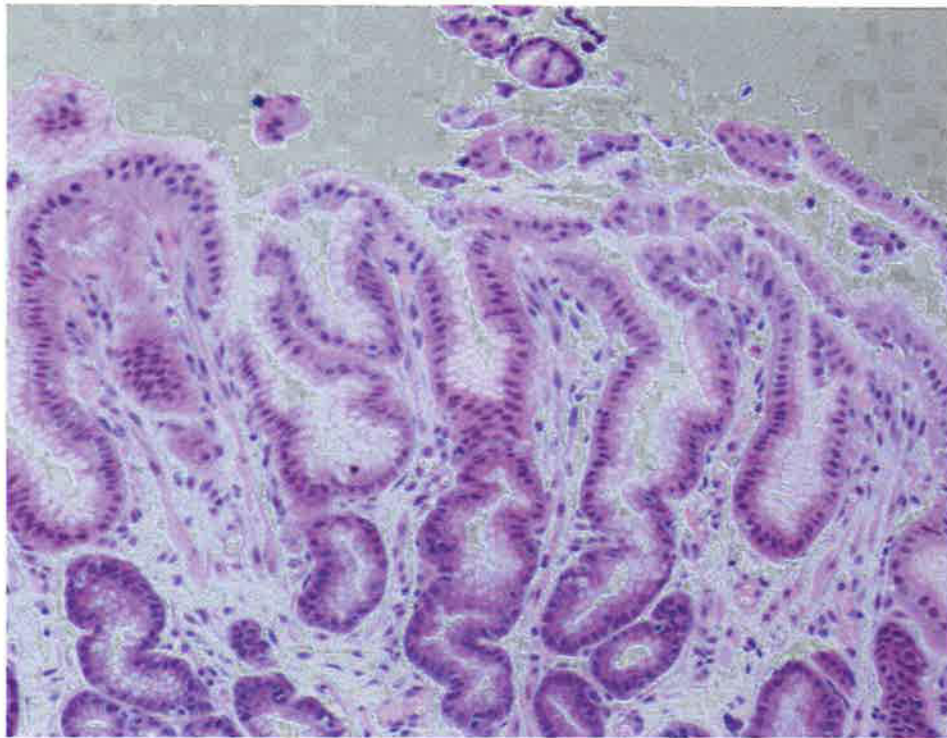
# Gastric Ulcer Etiology

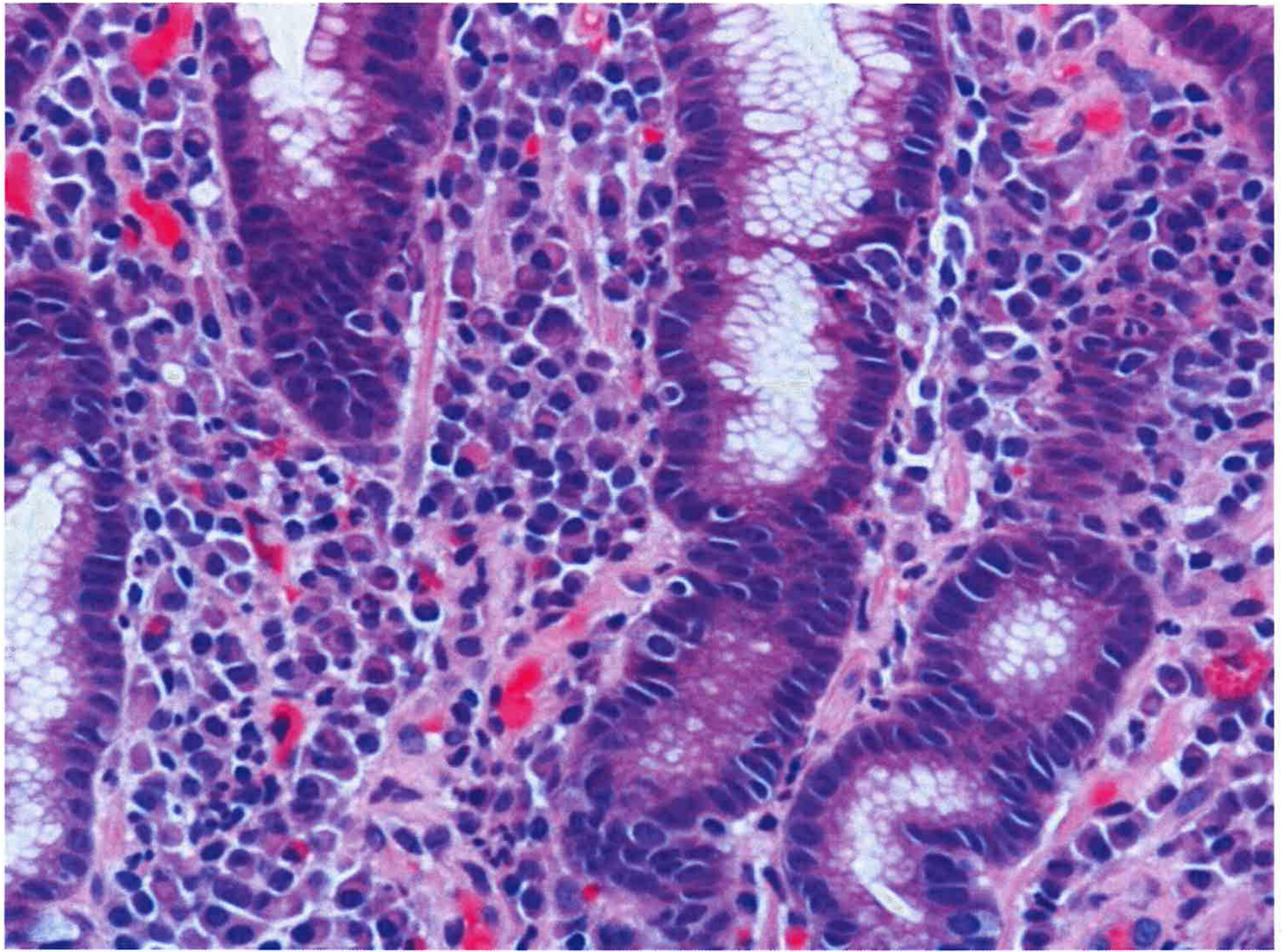
*-Helicobacter pylori-*

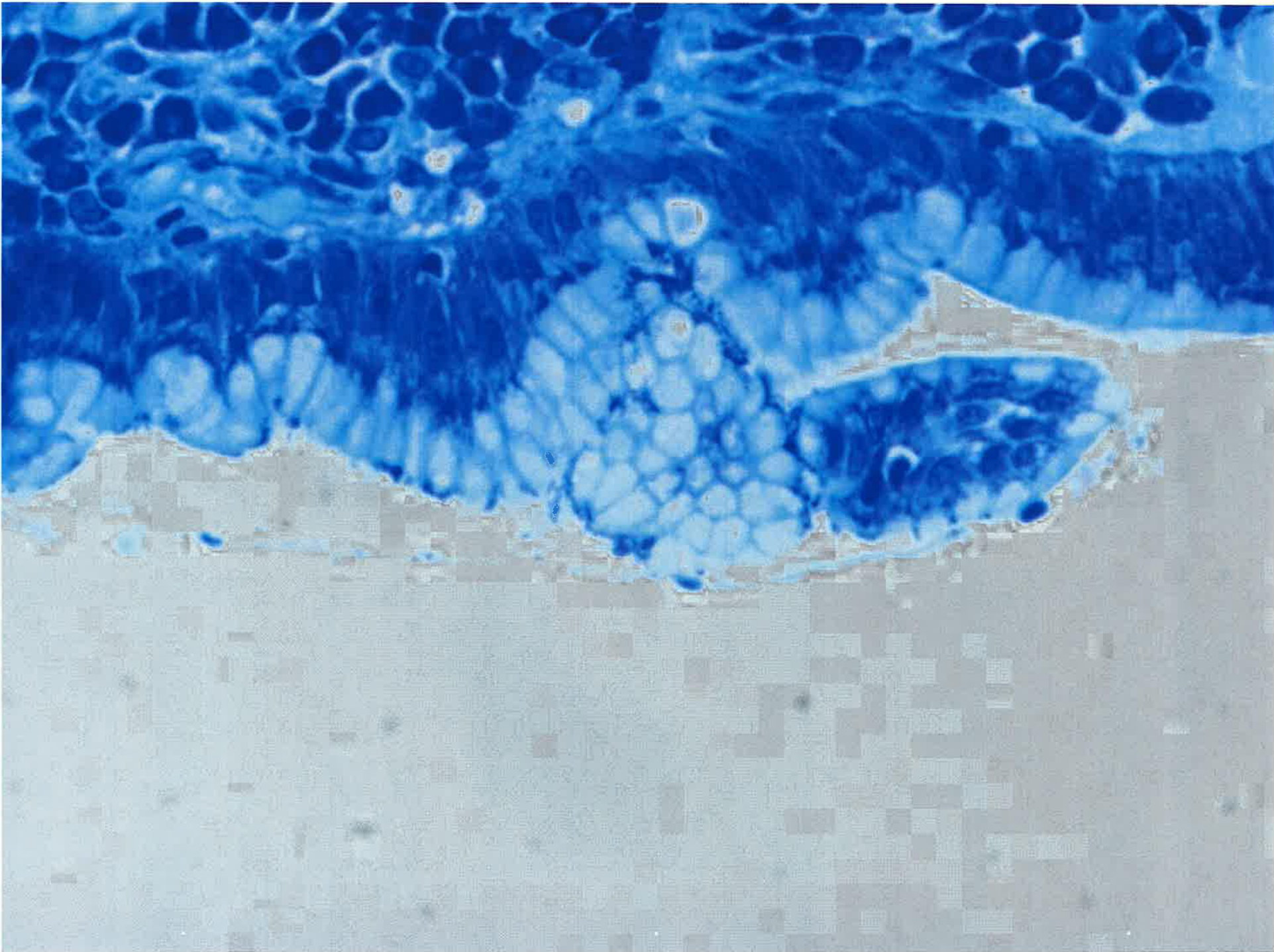






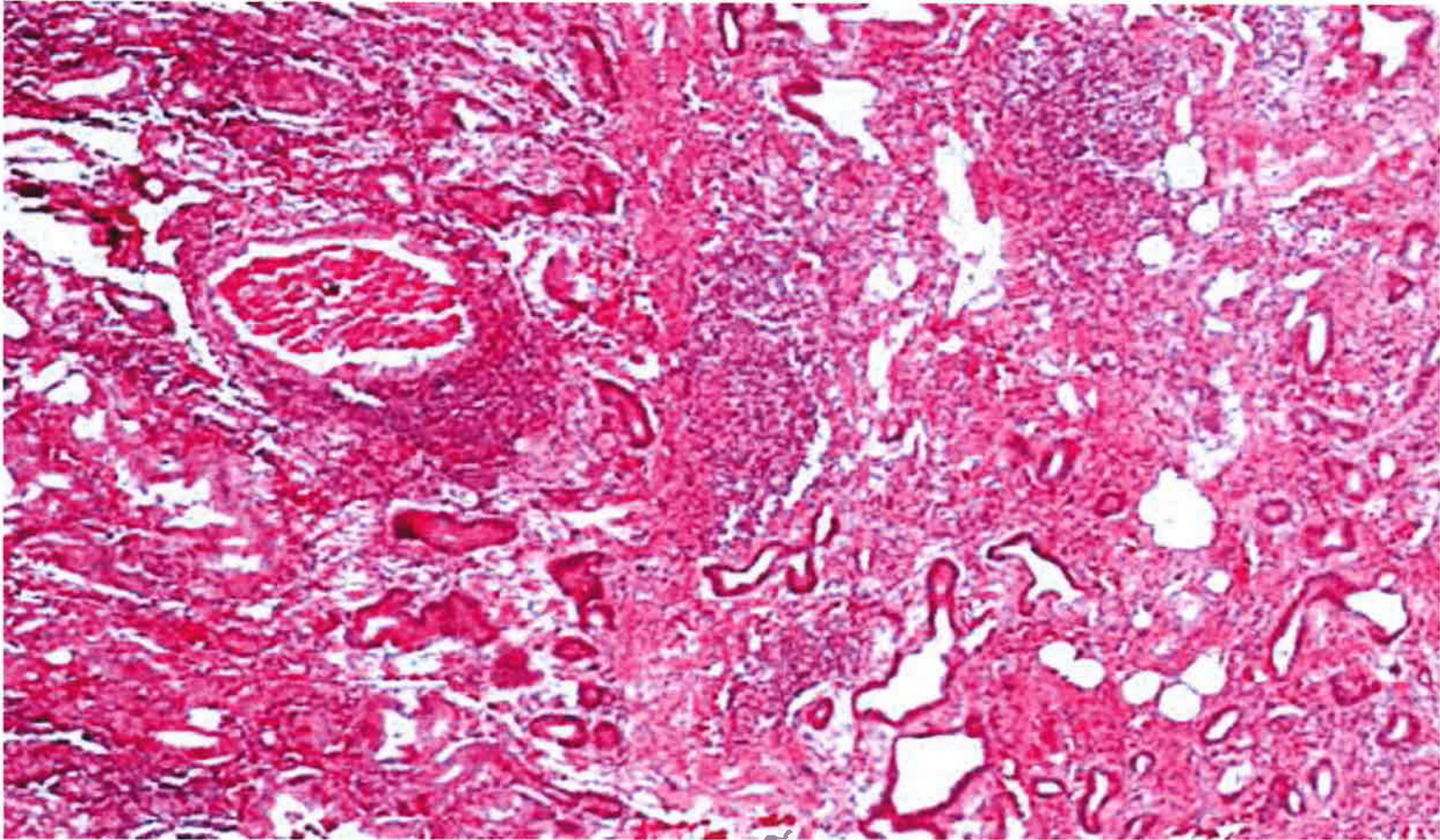






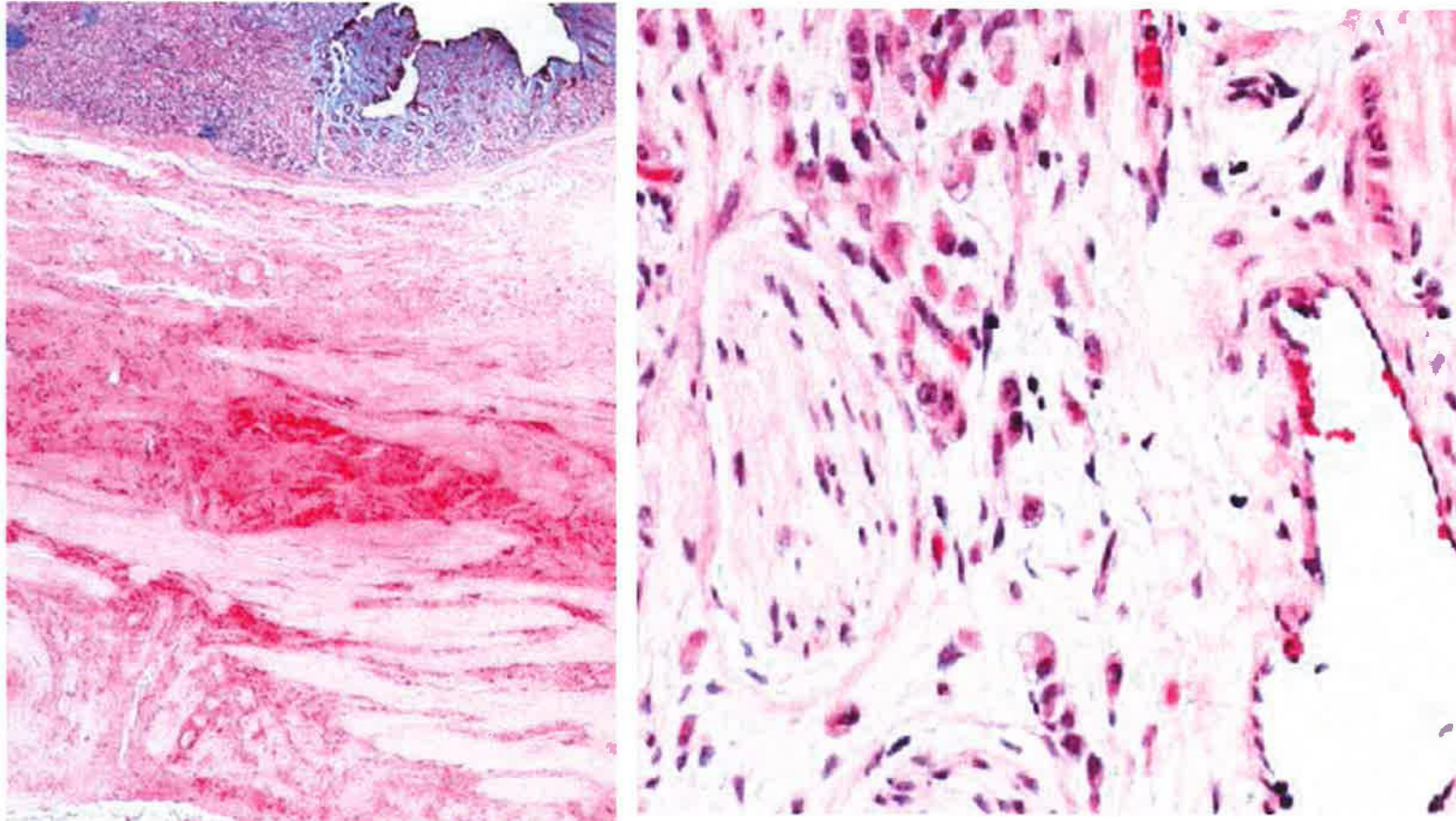
# Gastric Adenocarcinoma

*-mass forming-*



# Gastric Adenocarcinoma

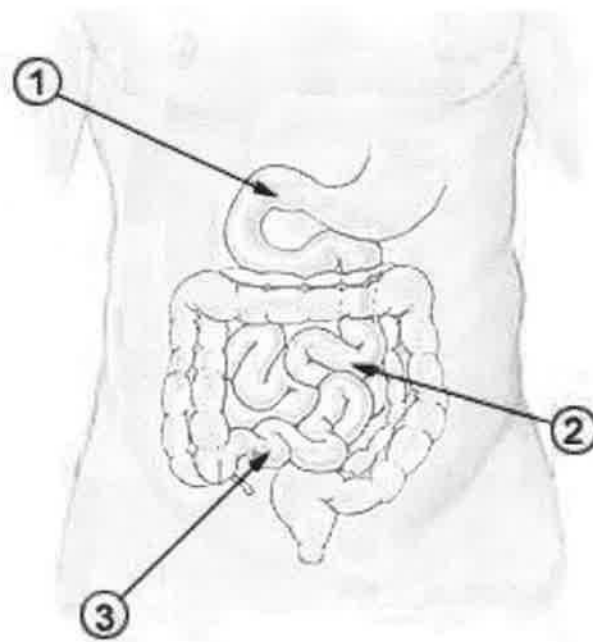
*-non mass forming-*



# Small Intestine

- **Function:** Absorption!
- **Histology:**
  - Villous forms covered with columnar cells with a brush border.
  - Submucosal Brunner's gland in duodenum
  - Lymphoid follicles throughout, most prominent in ileum
  - Surface area amplification
    - Plica circularis – grossly evident folds
    - Villous – microscopic finger like projections
    - Microvilli – form the brush border
- **Disease burden:**
  - Malabsorption
  - Adenocarcinoma, rare

# Gross Anatomy





# Histology

*-villi-*

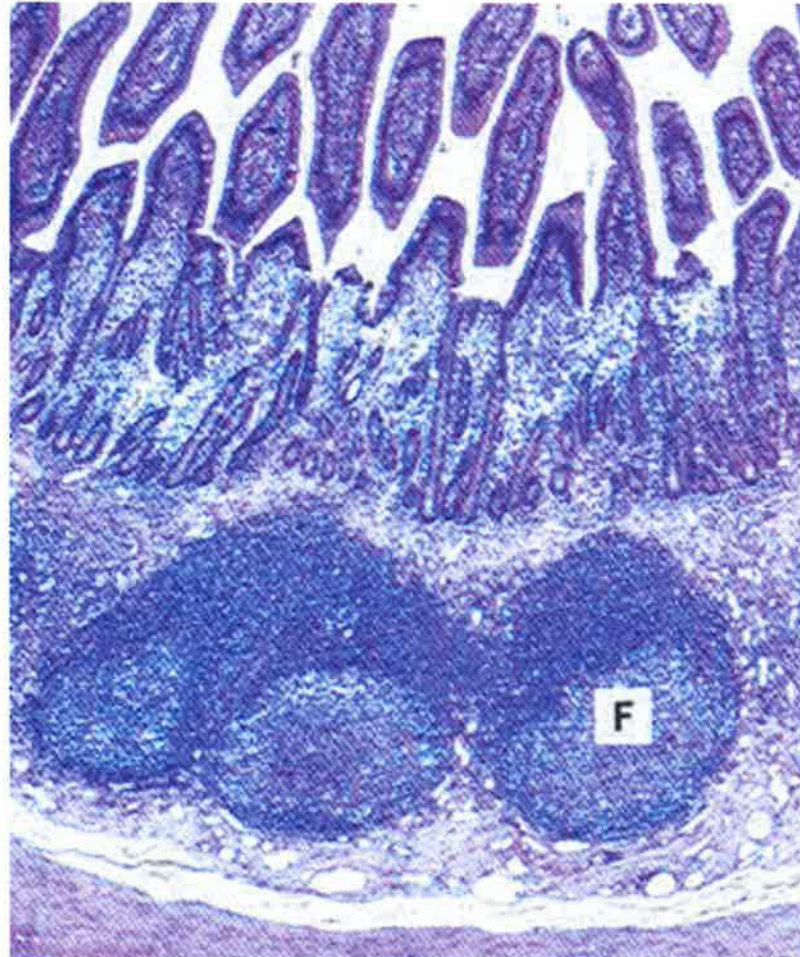


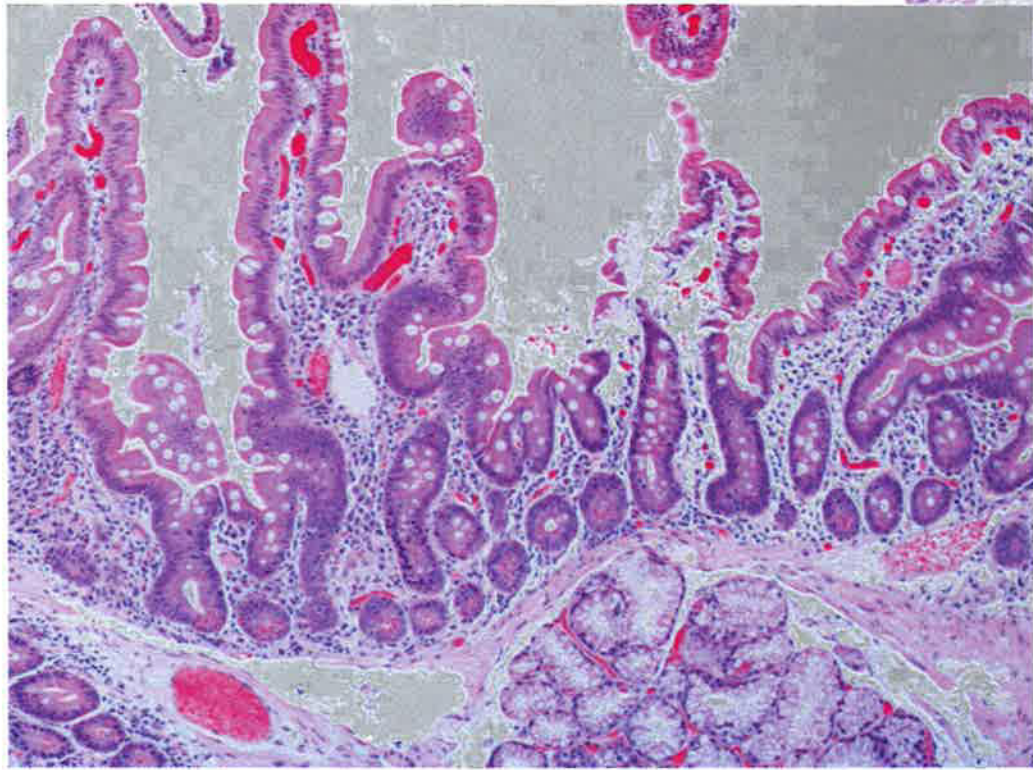
# Histology

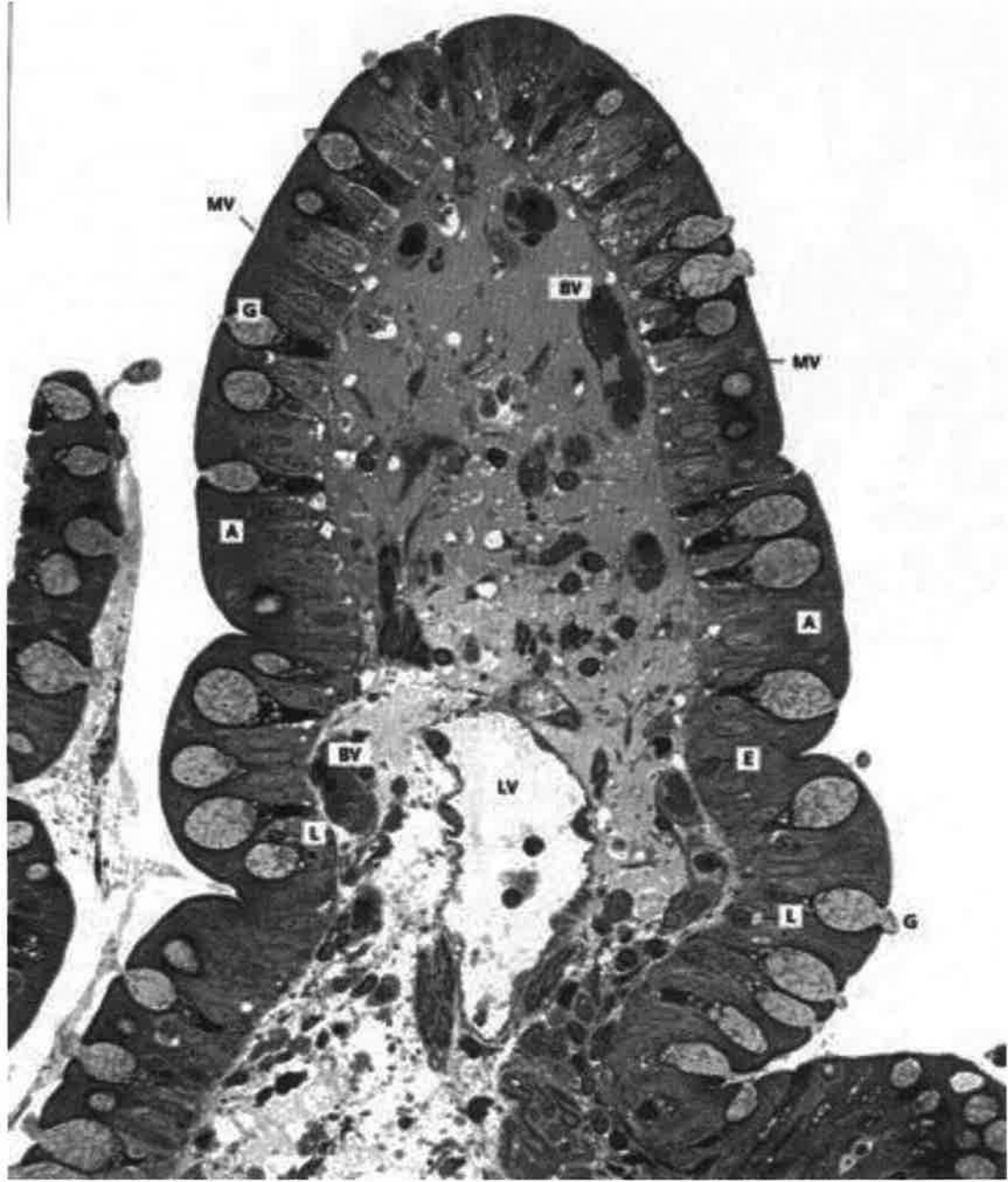


← **Fig. 13.16b** Downward extensions of the surface epithelium of the villi, often branched, are termed intestinal glands or crypts of Lieberkühn. These open upward into the lumen between the bases of the villi. Each crypt is surrounded by the loose connective tissue of the lamina propria (LP), which is richly supplied with lymphoid cells, notably lymphocytes. Crypts terminate at the muscularis mucosae (MM). Some major functions of the crypts are (1) to provide new epithelial cells that migrate to the villi to replace cells lost there, (2) to secrete mucus via scattered goblet cells (G), and (3) to produce ions and isotonic alkaline fluid (approximately 2 L per day) that assist in keeping the epithelium wet and diluting chyme. This fluid is reabsorbed by the villi thus assisting their absorption of nutritive

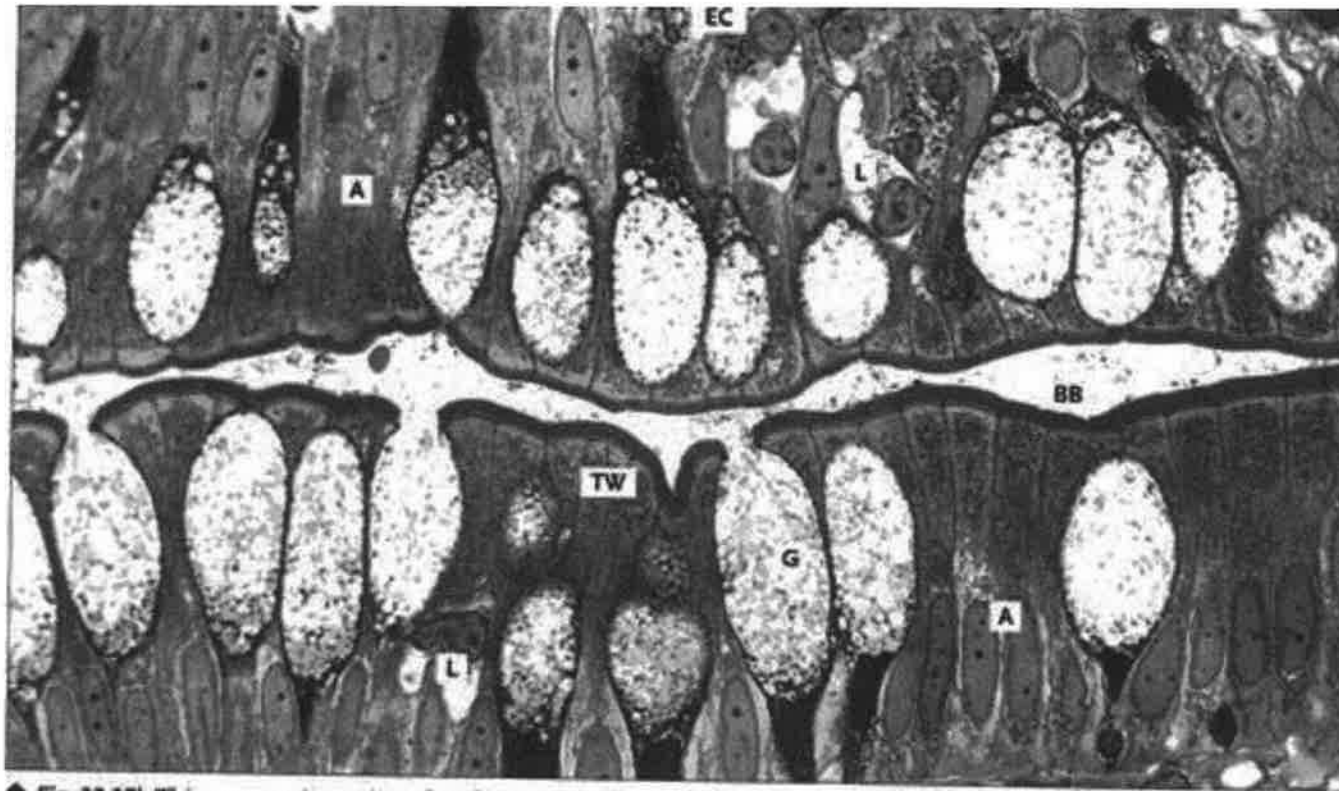
# Histology





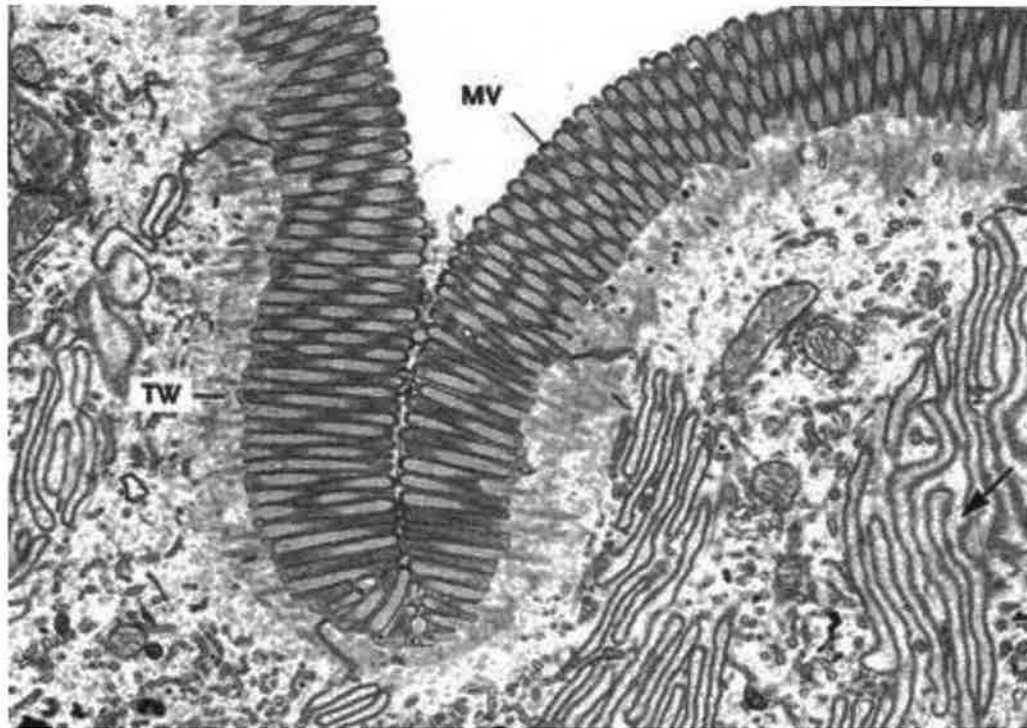


# Histology



↑ Fig. 13.17b Thin epon resin section of surface epithelium of two villi shows goblet cells (G) with mucous granules, some released onto the surface of the brush border (BB). The precise role of mucus in the small bowel is unknown, but, it may provide barrier protection for the epithelium against harmful agents (microorganisms or toxins), envelop exfoliated cells and clear them by distal transport, or stabilize immunoglobulins directed against bacteria or viruses. Tall columnar absorptive cells (A) display a clear zone or terminal web (TW) subjacent to the brush border, representing an anchoring site for the core of microvilli. Lymphocytes (L) are usually T-suppressor/cytotoxic cells serving as an immunological defense. Basal epithelial cells with granules represent enteroendocrine cells (EC). There are at least 16 types of ECs that secrete a variety of peptides or amines that perform local stimulatory or inhibitory functions regulating secretory or absorptive activities of the mucosa. Numerous ECs are classified as amine precursor uptake and decarboxylation (APUD) cells, which provide protein or biogenic amine hormones acting locally. [Biopsy specimen courtesy of Dr P. Gibson, Department of Medicine, University of Melbourne., Australia]

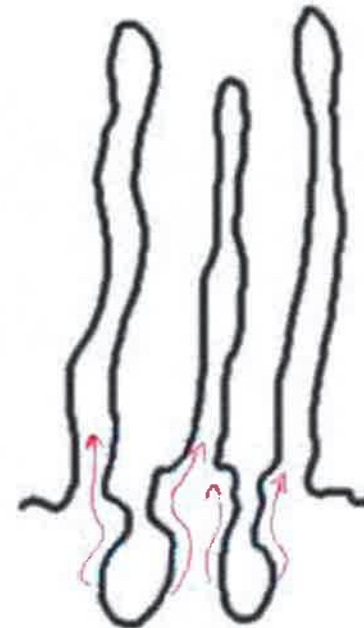
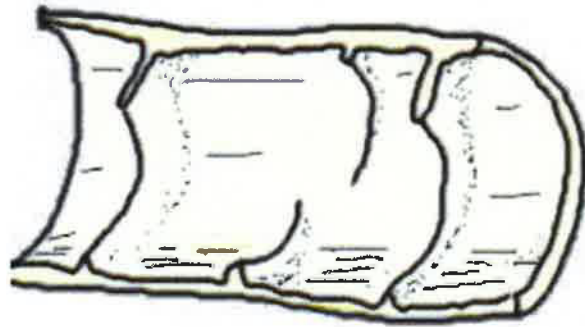
# Microvilli



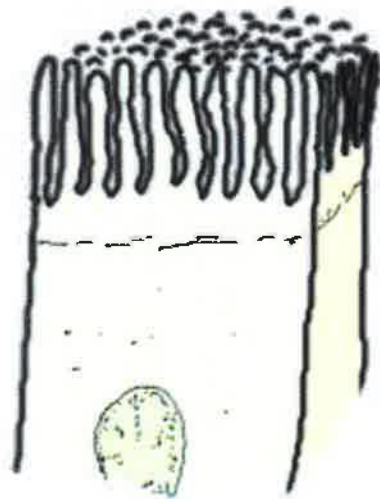
← Fig. 13.18 Surface of the villous epithelium. Brush border of microvilli (MV) lines the surface of the intestinal absorptive cells. Note the flocculent appearance of the terminal web (TW) containing filaments of actin. The lateral plasma membranes of adjacent cells interdigitate extensively (arrows) and contain ion pumps, which facilitate transport of fluids and absorbed nutrients into the intracellular space that opens up during periods of intestinal absorption. The contents flow into capillaries in the lamina propria and then into the portal system en route to the liver.

# Surface Area Amplification

**plicae circulares**



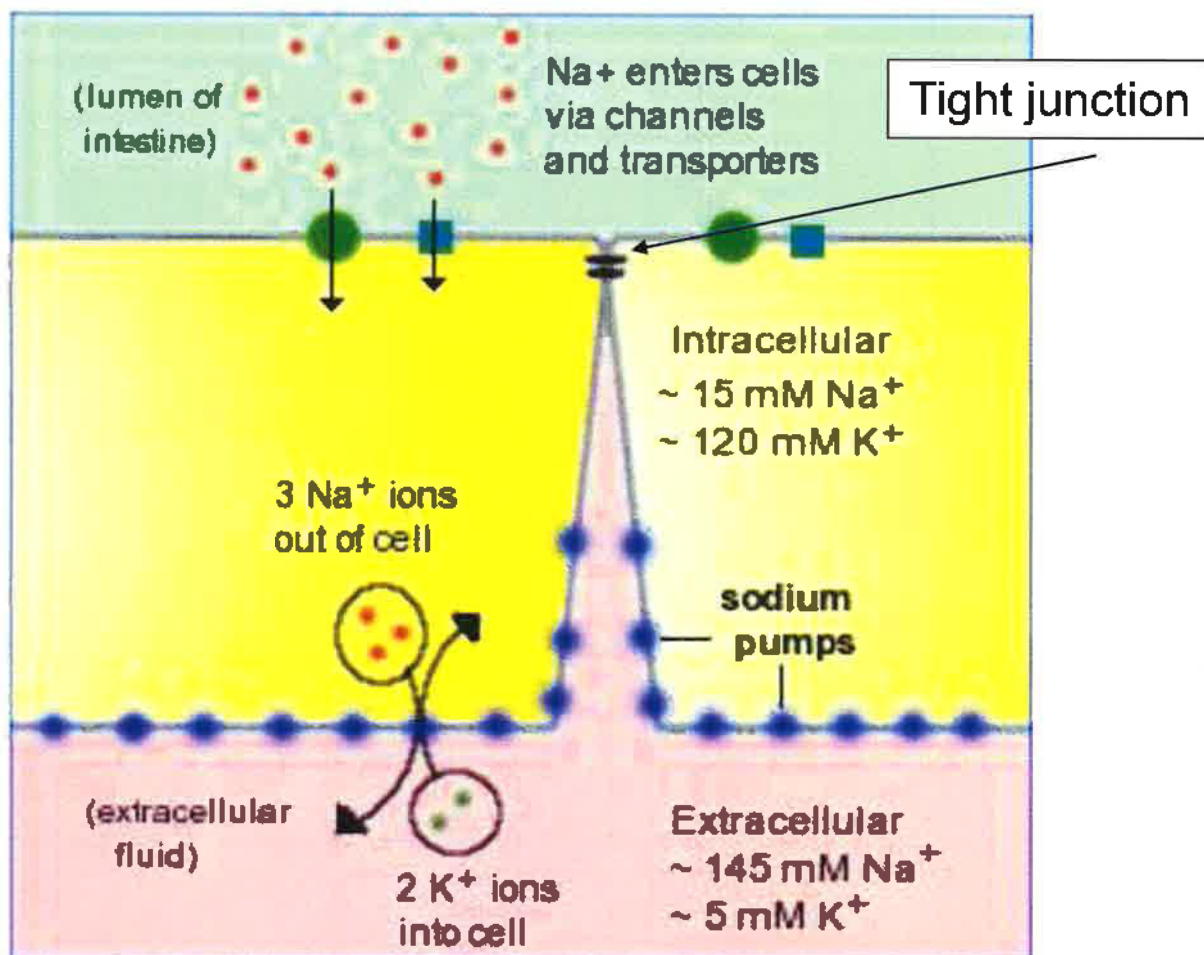
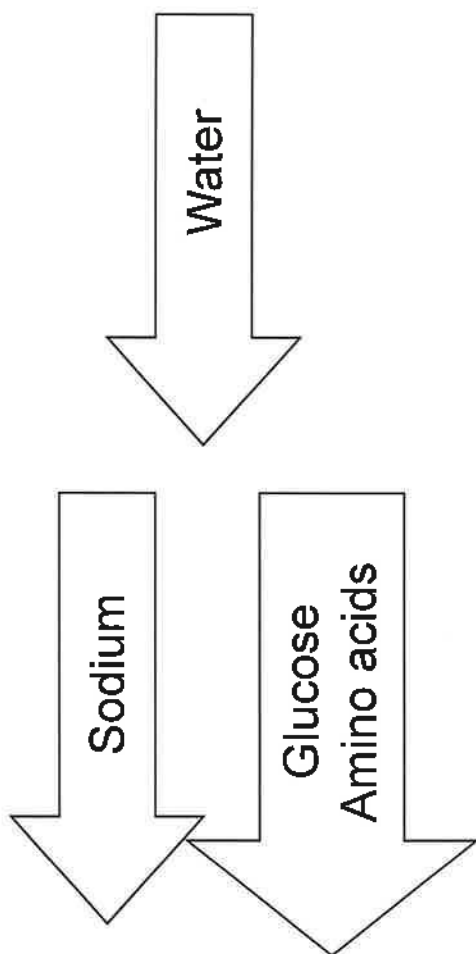
**villi**



**microvilli**



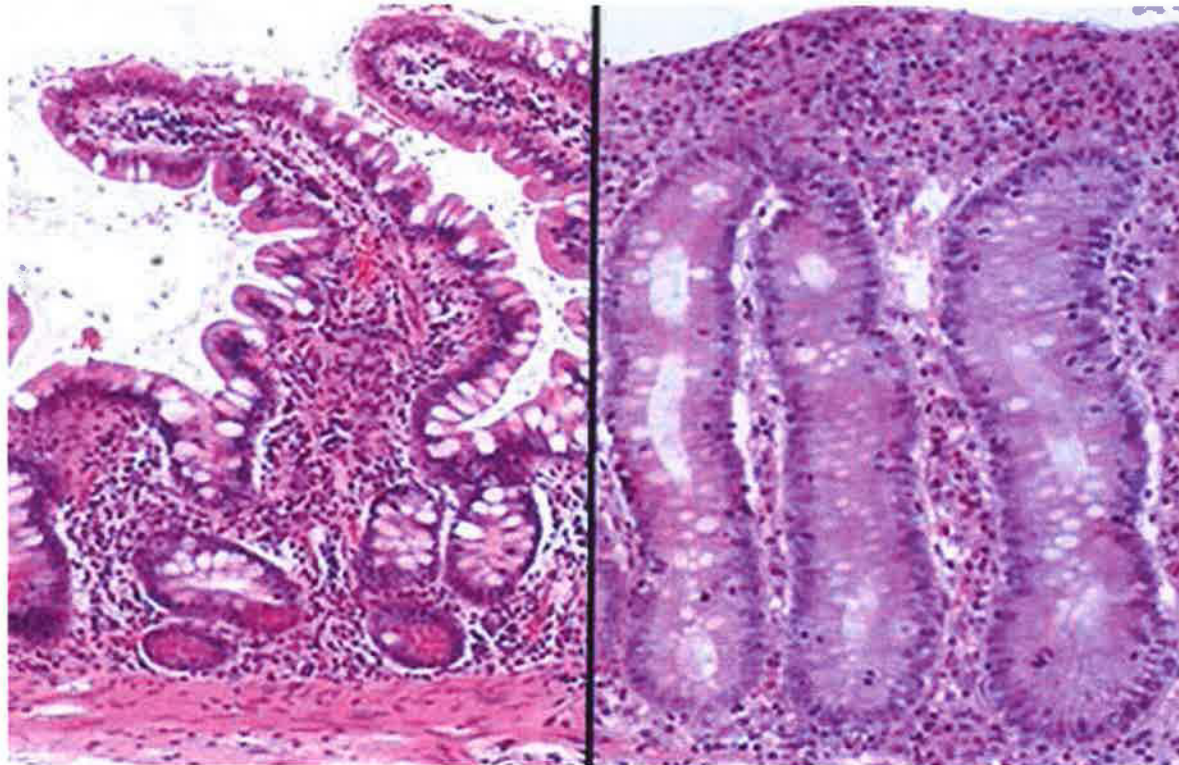
# Absorption

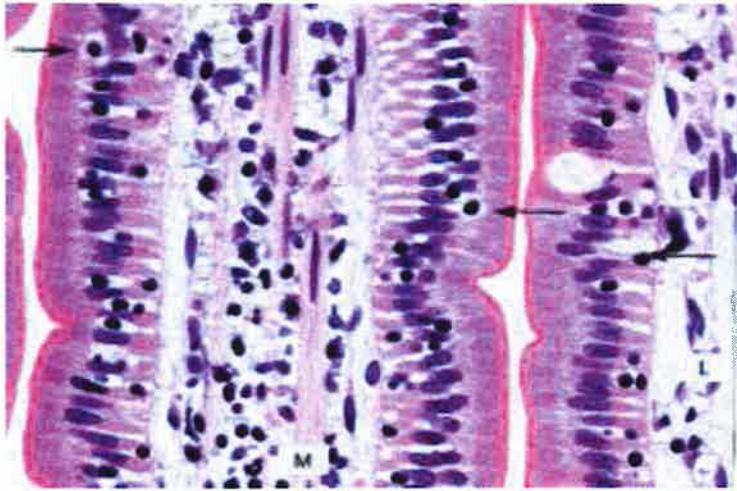


# Malabsorption

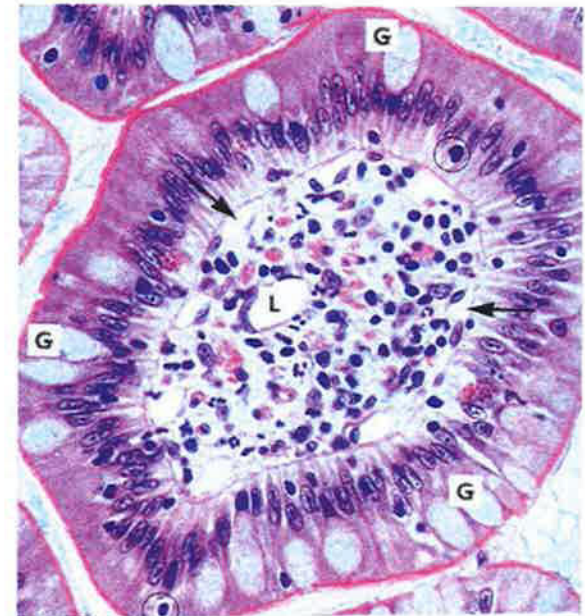
Normal

Celiac disease

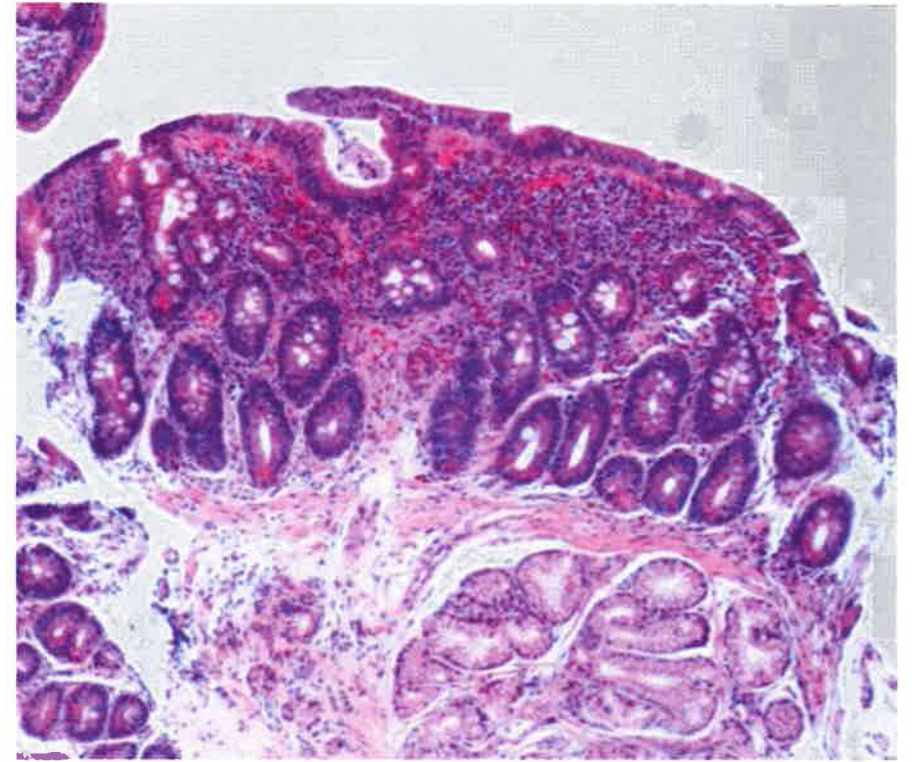
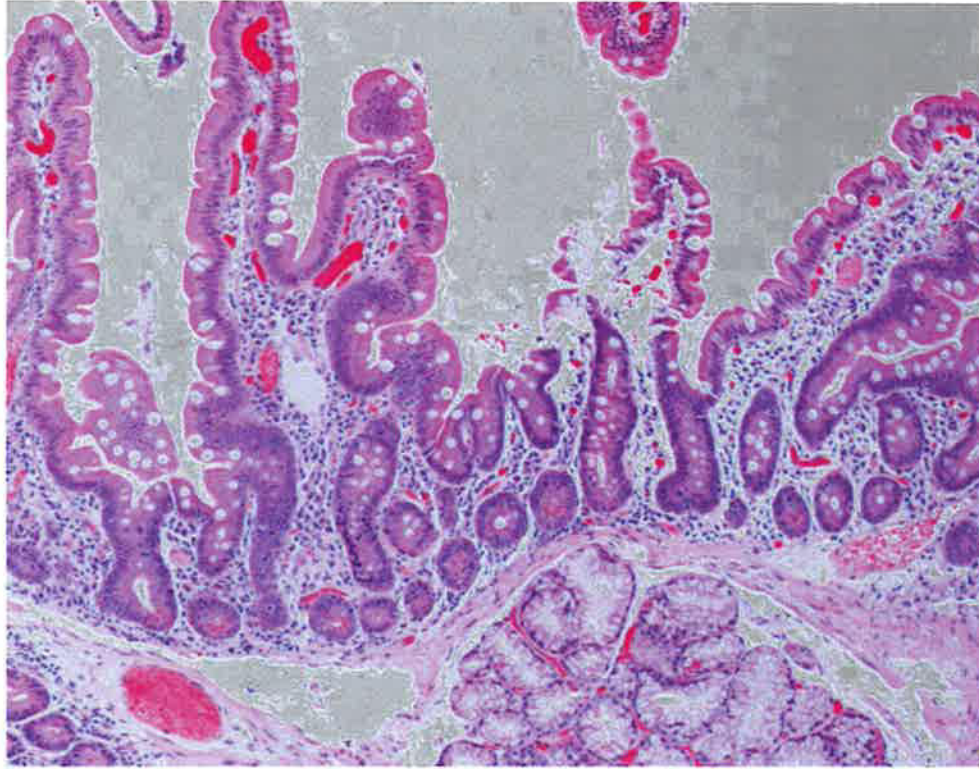


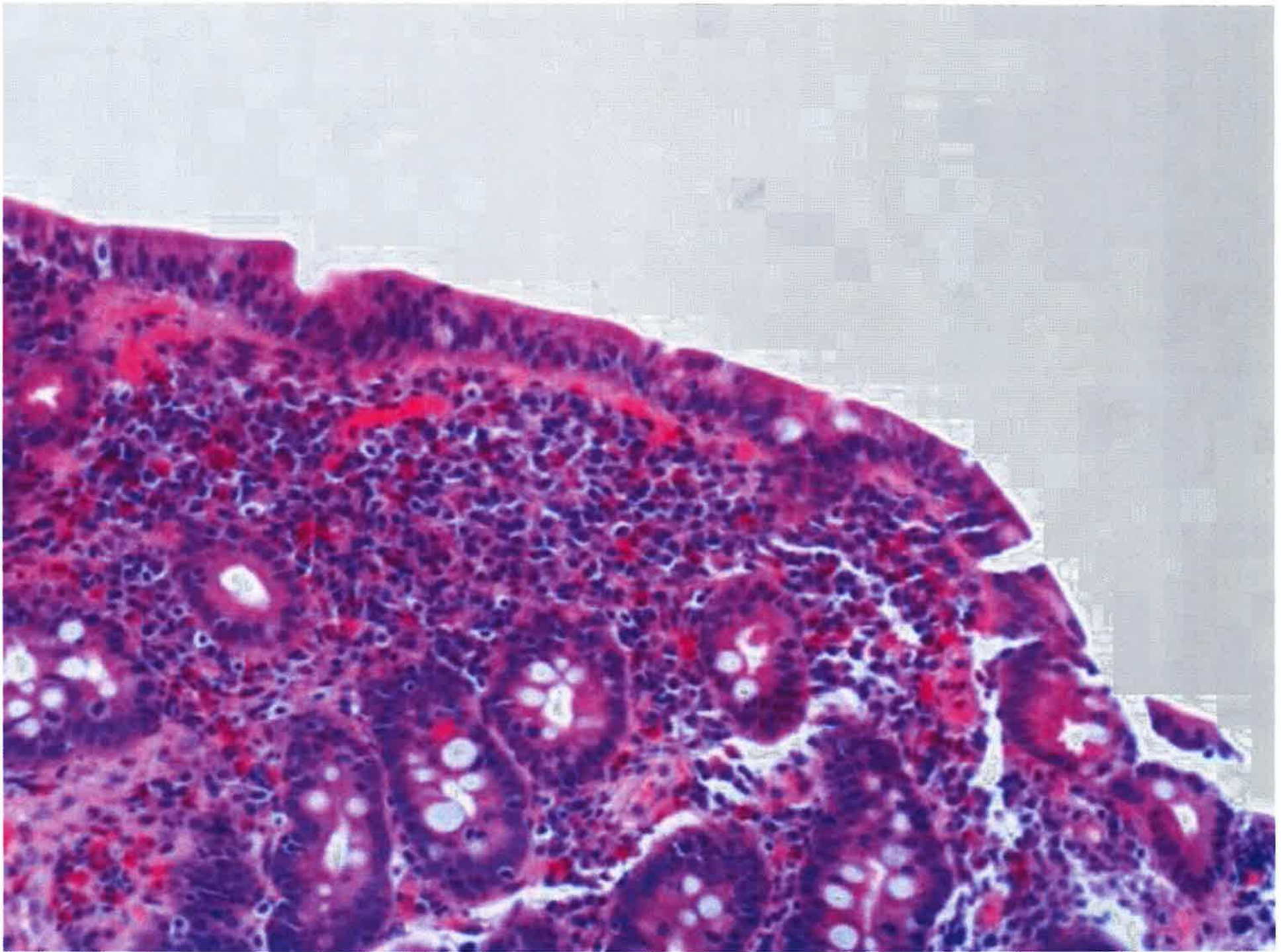


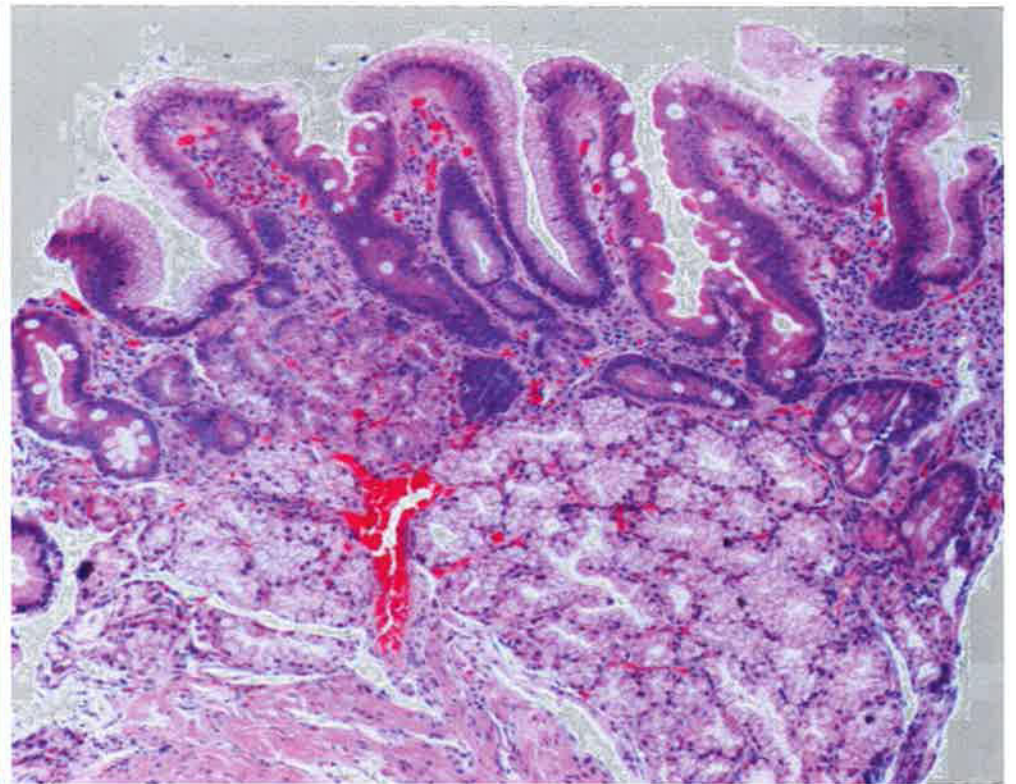
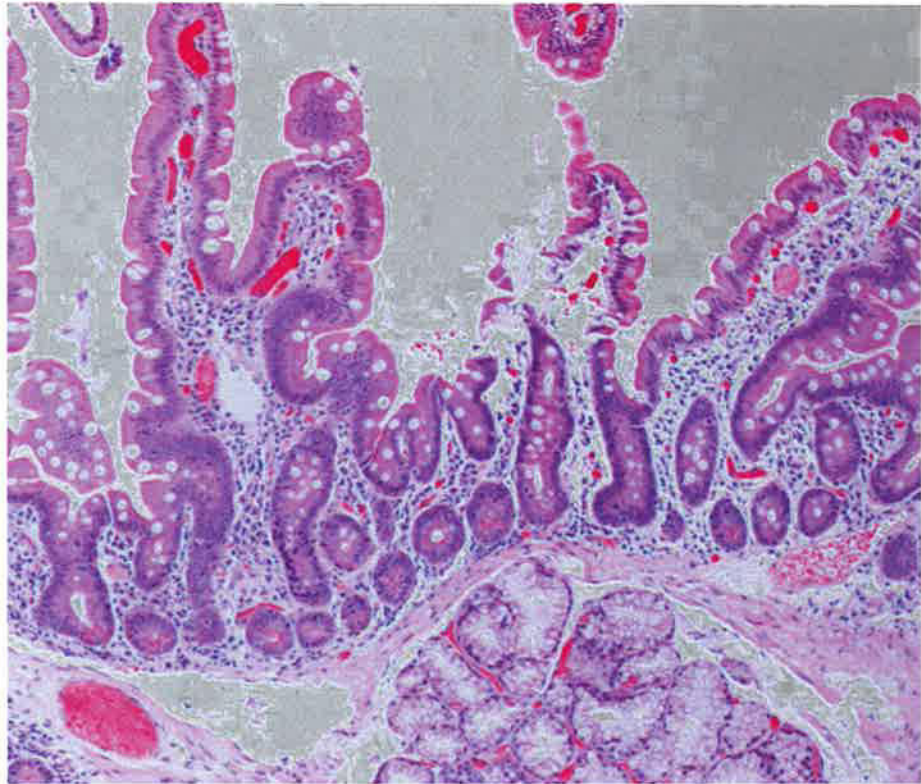
← Fig. 13.19 Villous core. a The villous core is filled with loose connective tissue of the lamina propria containing many free cells of the immune system, particularly plasma cells and lymphocytes with a rich vascular and muscular framework. A central blind ending lacteal (L) is seen, and strips of smooth muscle (M) run the length of the villous core and provide motility for each villus. Numerous lymphocytes appear in the mucosal epithelium (arrows), having migrated across the basement membrane from the lamina propria.

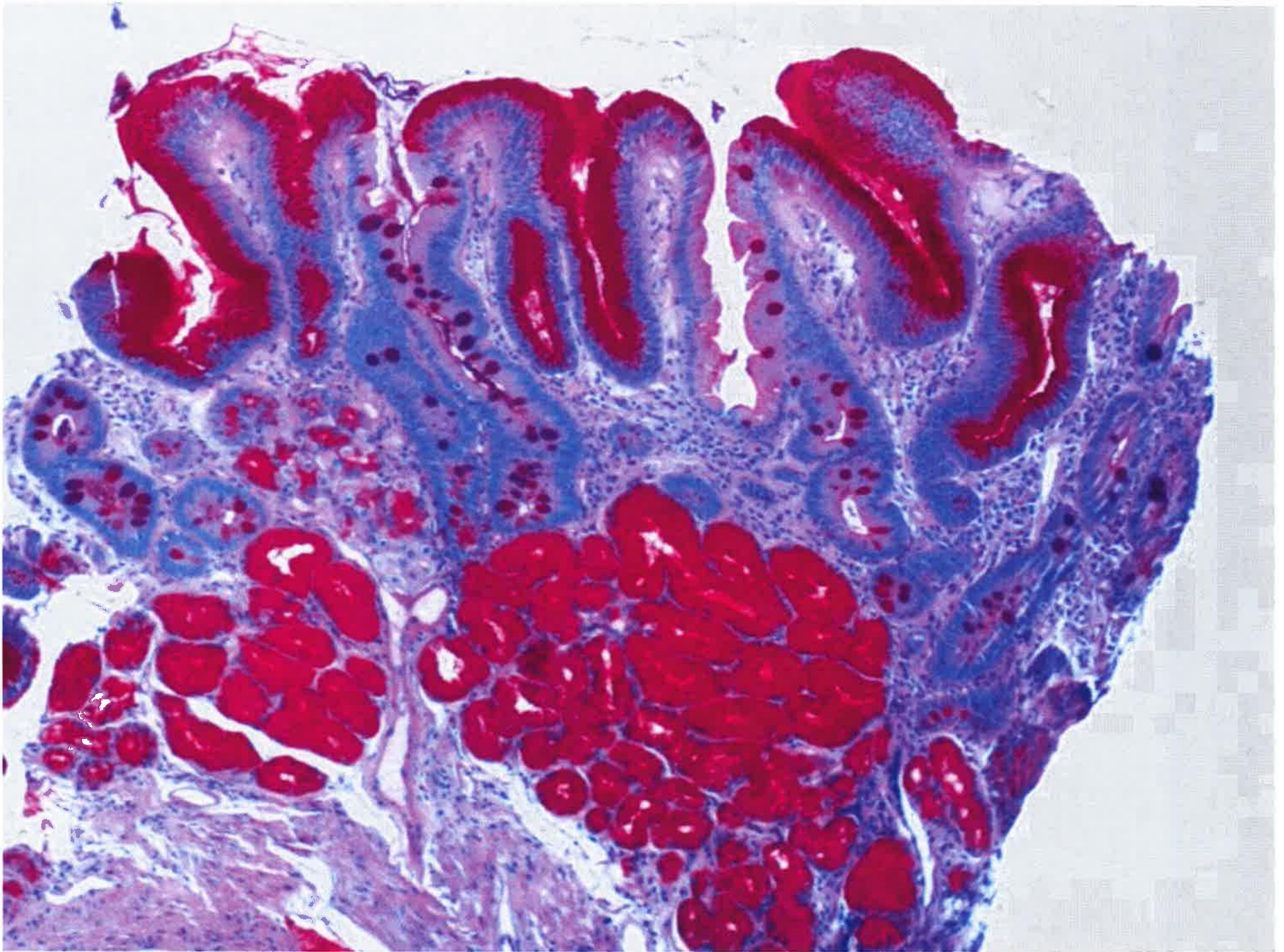


← Fig. 13.19b When viewed in transverse section the villous core displays a central lymphatic capillary (L) surrounded by cells of connective tissue and a variety of leukocytes. The blood vessels (arrows) are located just deep to the epithelium and represent either capillaries or postcapillary vessels that form from the branching of one or more arterioles supplying the villus. Goblet cells (G) and intraepithelial lymphocytes (circles) are indicated in the mucosal epithelium.







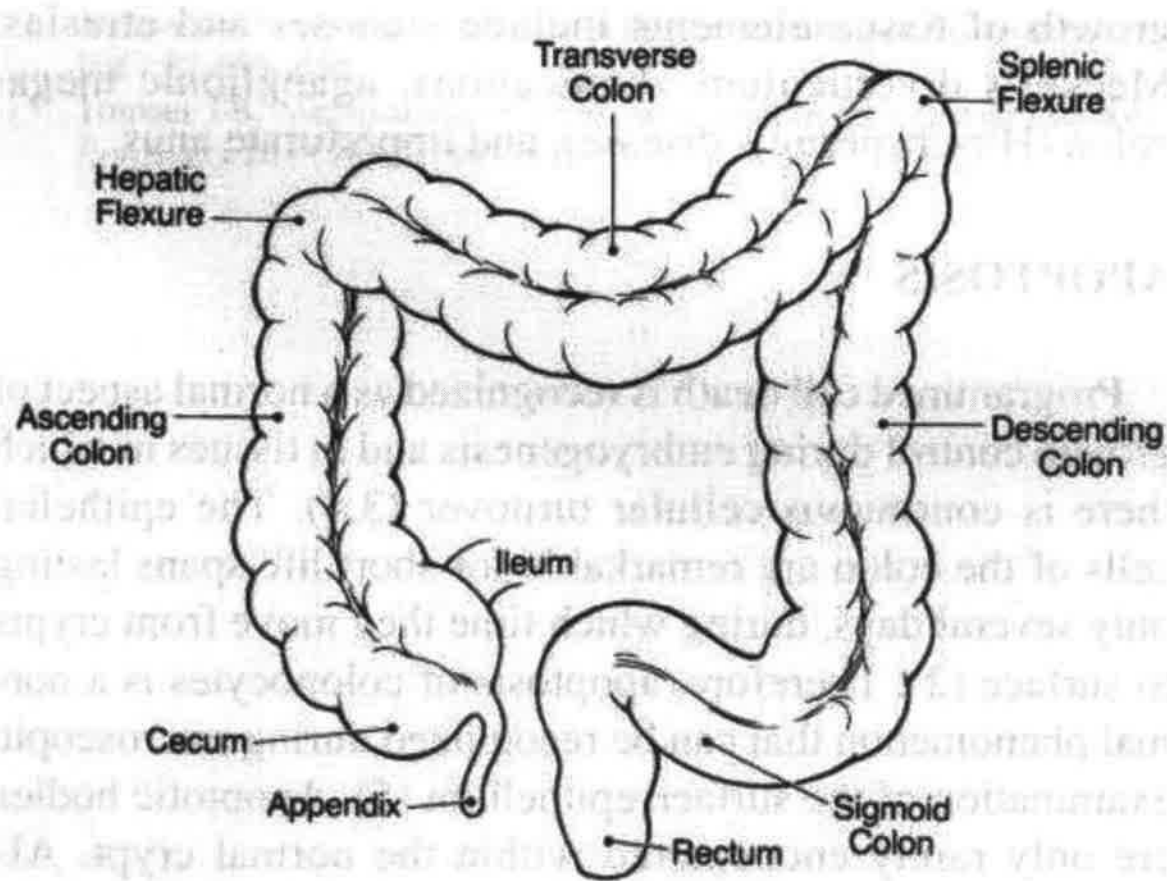


# Colon

- **Function:** Extract water
- **Histology:**
  - Goblet and absorptive columnar cells
- **Disease burden:**
  - Diarrhea
  - Colonic adenocarcinoma



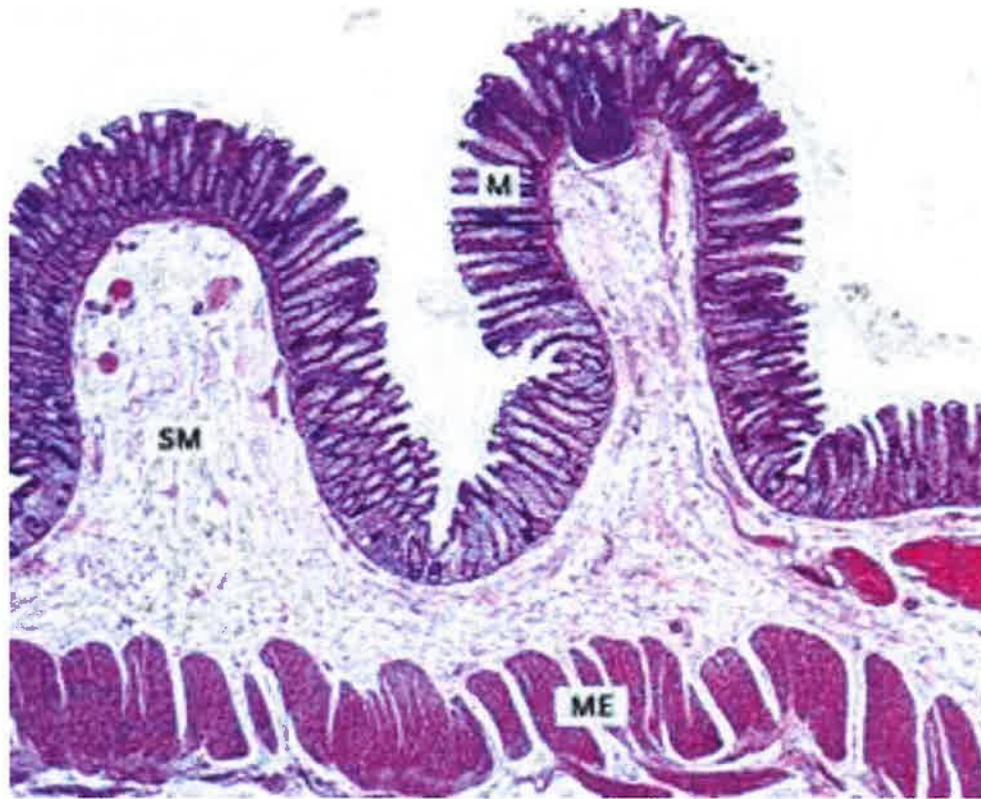
# Gross Anatomy



**FIG. 1.** Diagram of the major regions of the colon.

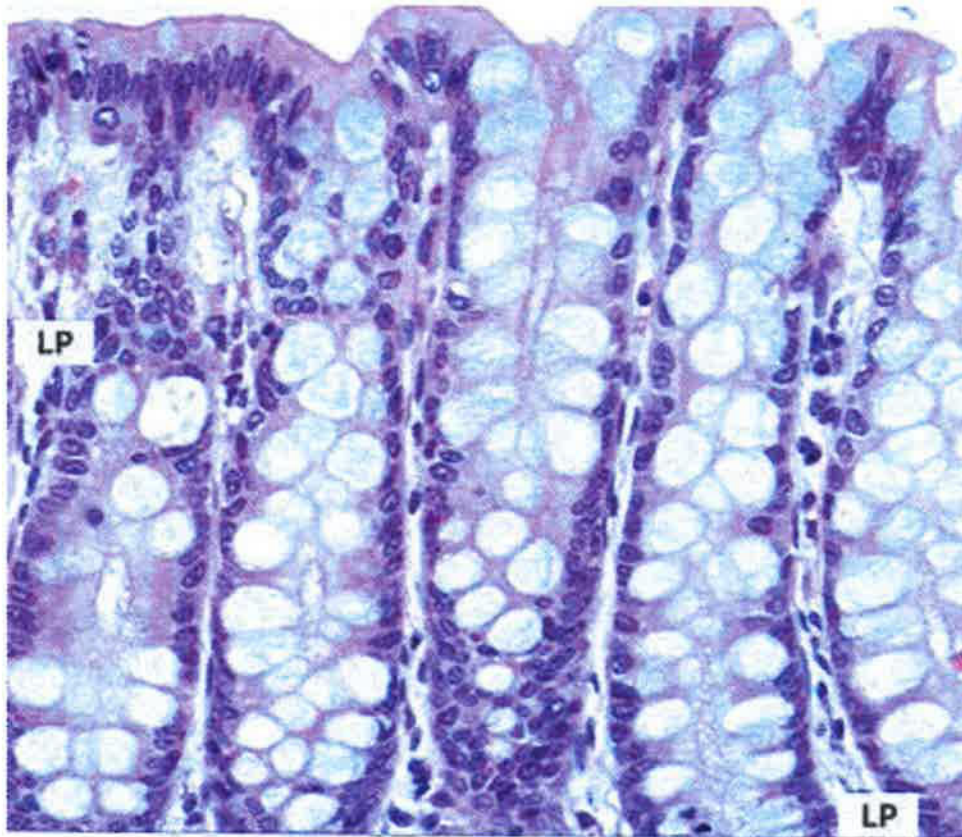


# Histology



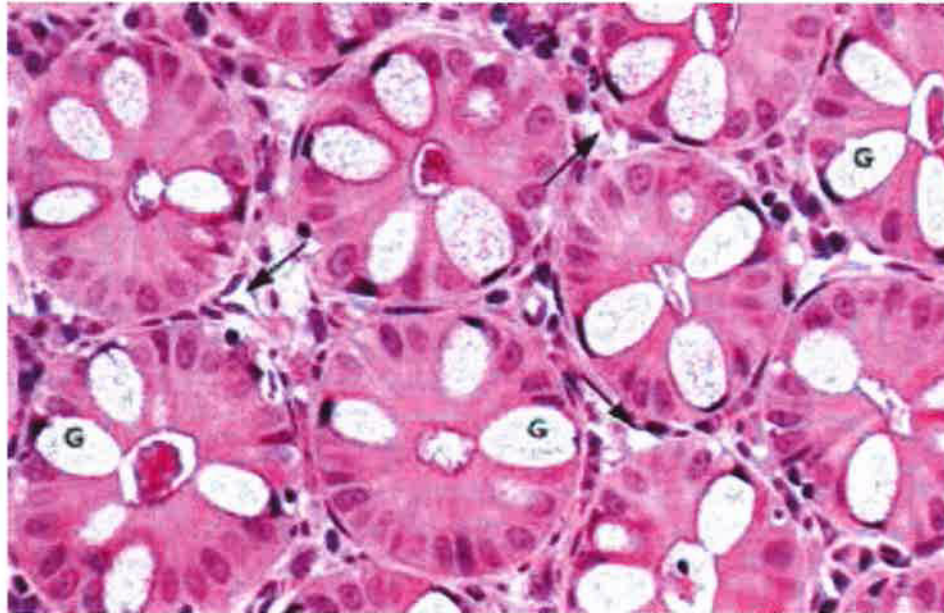
← Fig. 13.22 Colon. a The principal components of the large intestine are the mucosa (M), submucosa (SM), and muscularis externa (ME). Folds in the mucosa are not permanent, being formed by local contractions of either of the above muscle layers. The mucosal epithelium should not be mistaken for villi, since the latter are comparatively large and arise independently with separation between neighbouring villi.

# Histology



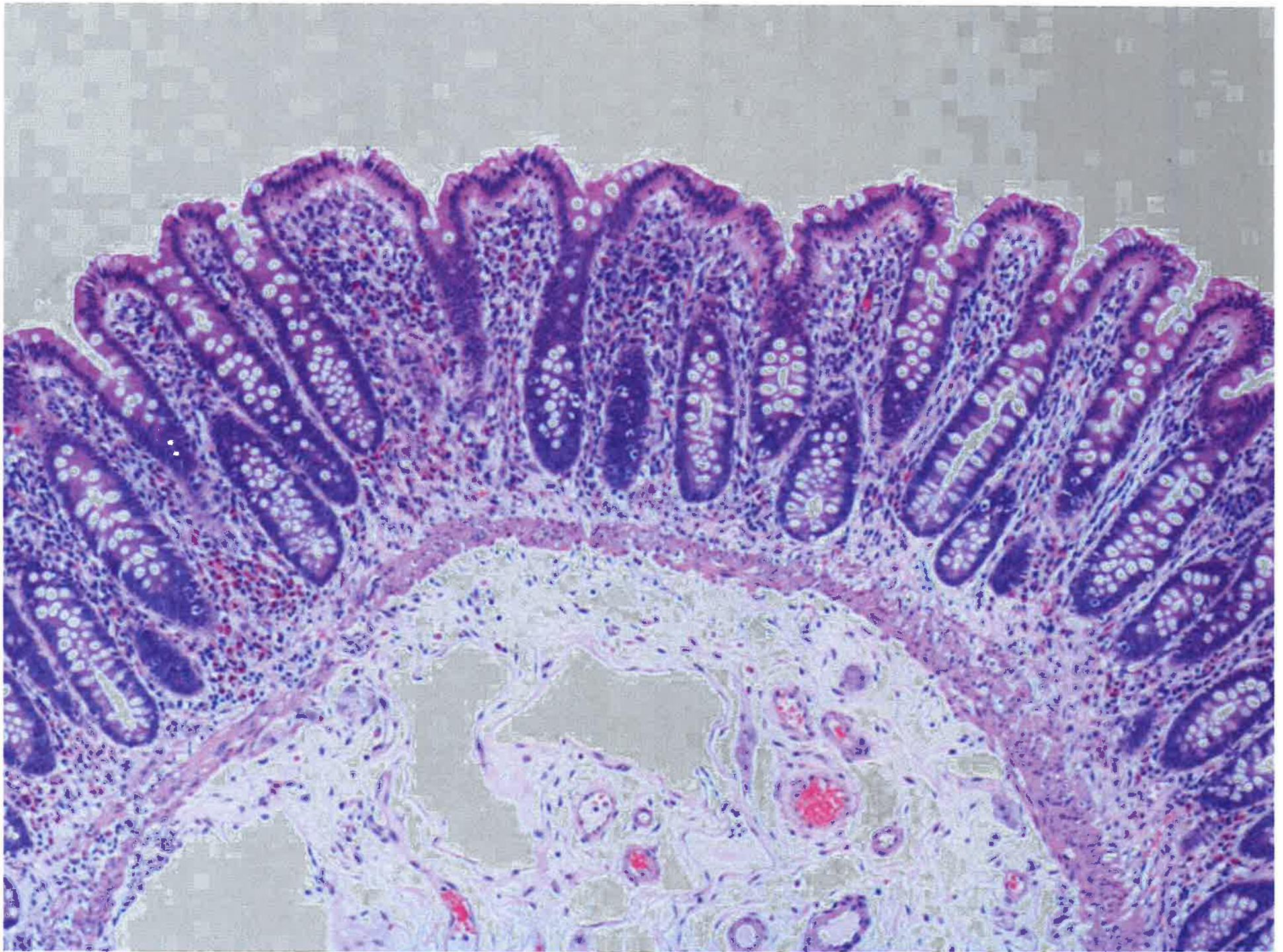
← Fig. 13.22b Colonic crypts or glands with numerous goblet cells have a pale supranuclear region filled with mucous granules. On the surface, columnar absorptive cells are seen, and these cells outnumber the goblet cells in the colon. The characteristic features of colonic crypts are their alignment similar to test tubes in a rack and the abundance of goblet cells together with the columnar enterocytes. In the base of the crypts, new cells arise by mitosis and mature and migrate upward through the crypts until ultimately exfoliated from the surface. Many immunocompetent cells, notably plasma cells, occupy the lamina propria (LP). T lymphocytes also occur there and within the mucosal epithelium.

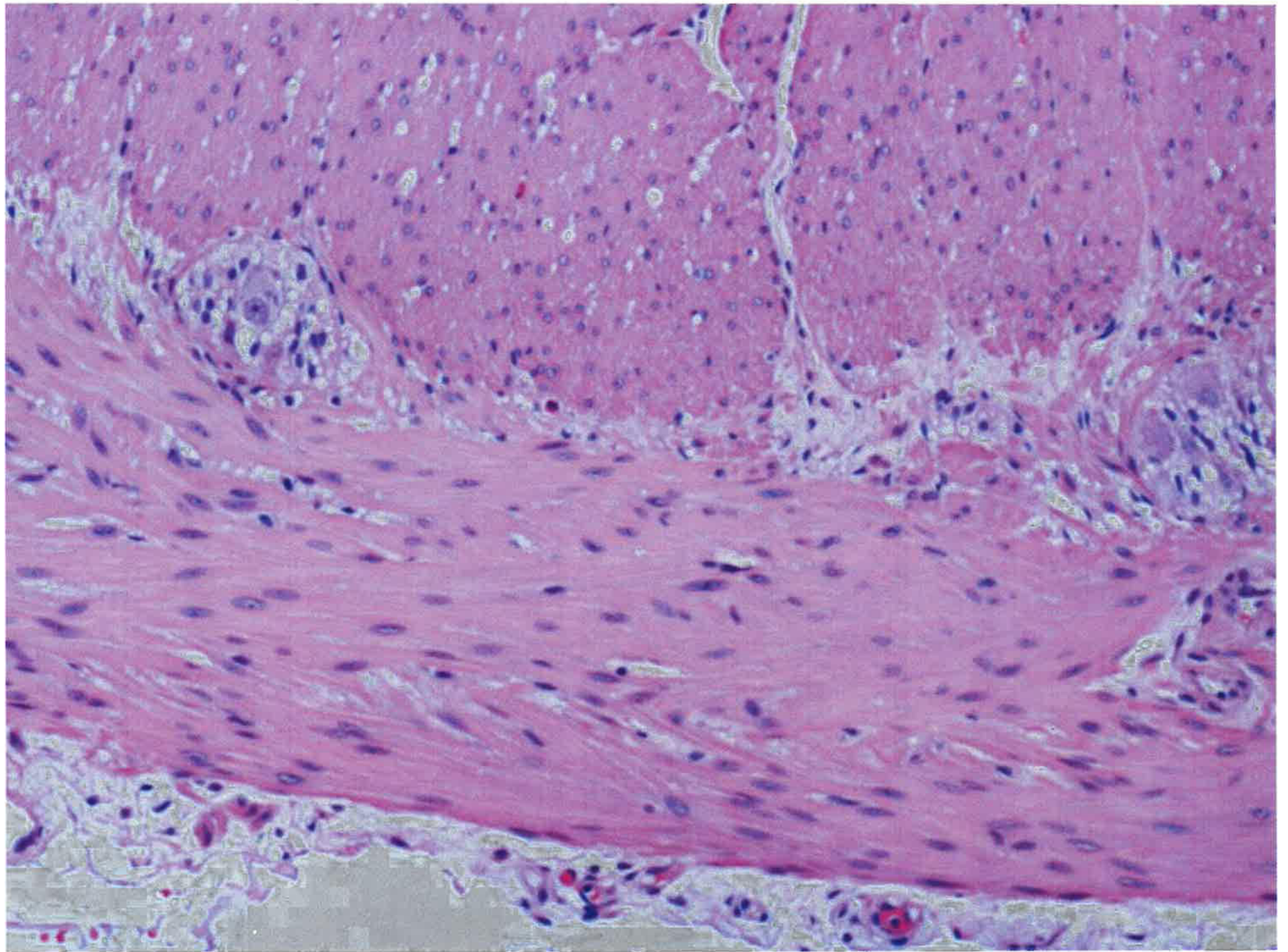
# Histology



← Fig. 13.23b Transverse section through several colonic crypts shows the radial arrangement of goblet cells (G) and the tall intervening columnar absorptive cells. The central lumen of the gland or crypt is quite narrow and is partly filled with mucoid materials. Each gland or crypt is surrounded by the supporting lamina propria, and the fluids/electrolytes taken up by the surface epithelium of the glands are transported from the mucosa via numerous blood vessels (arrows) leading to the portal system. Colonic crypts also secrete an isotonic fluid rich in potassium and bicarbonate ions, acting as a buffering agent in the lumen.



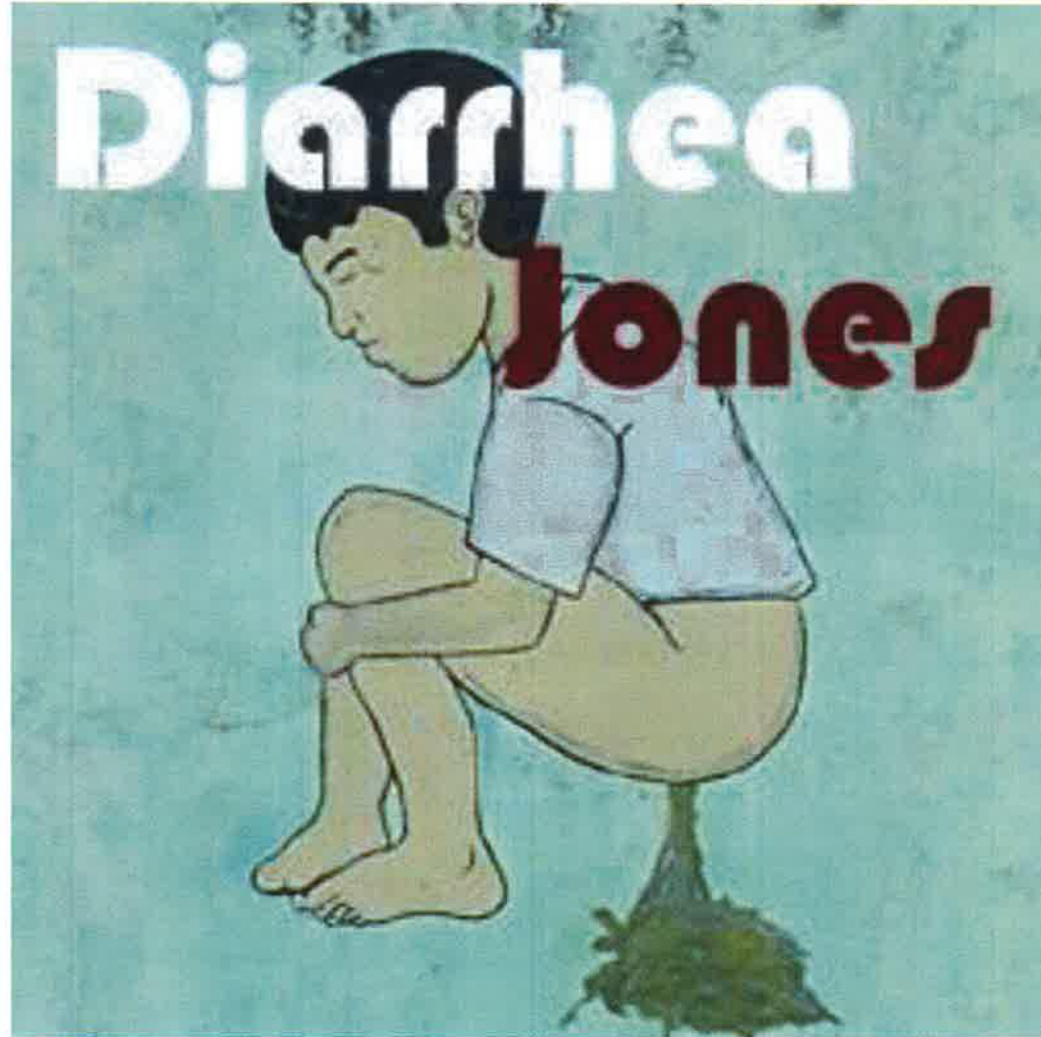




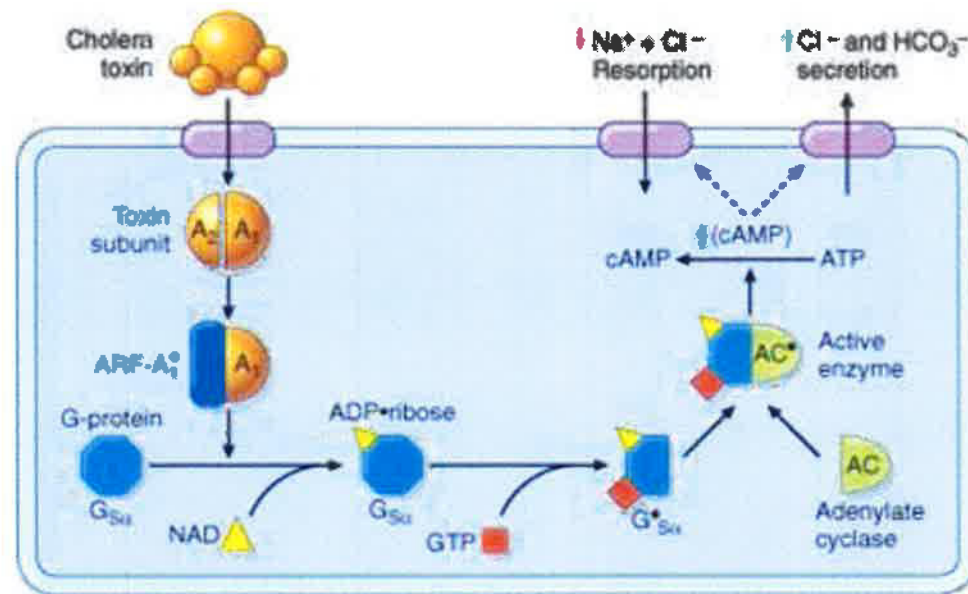


# Diarrhea

# Jones



# Mechanisms of cholera toxin



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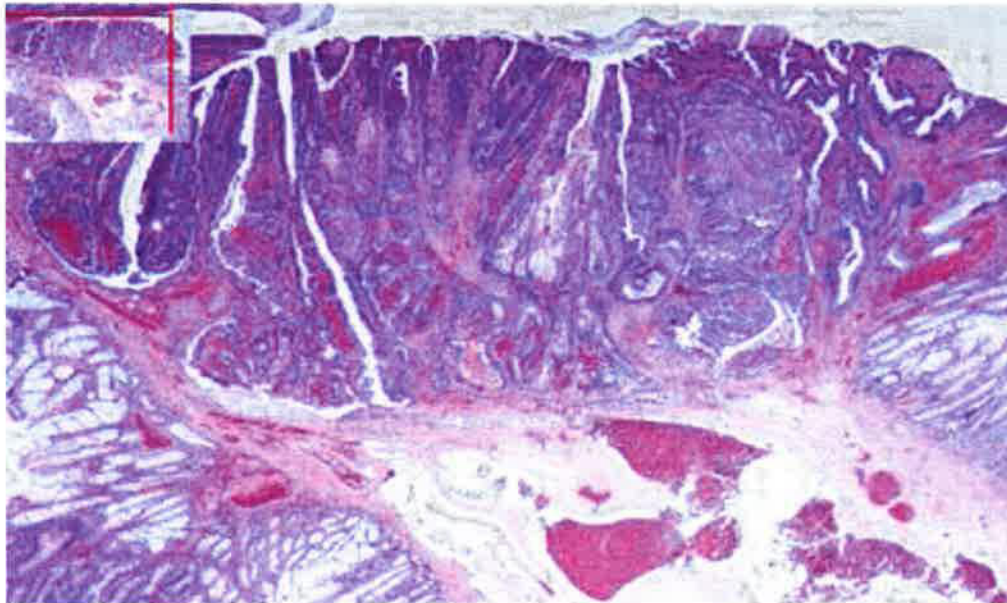
# Diarrhea Histology

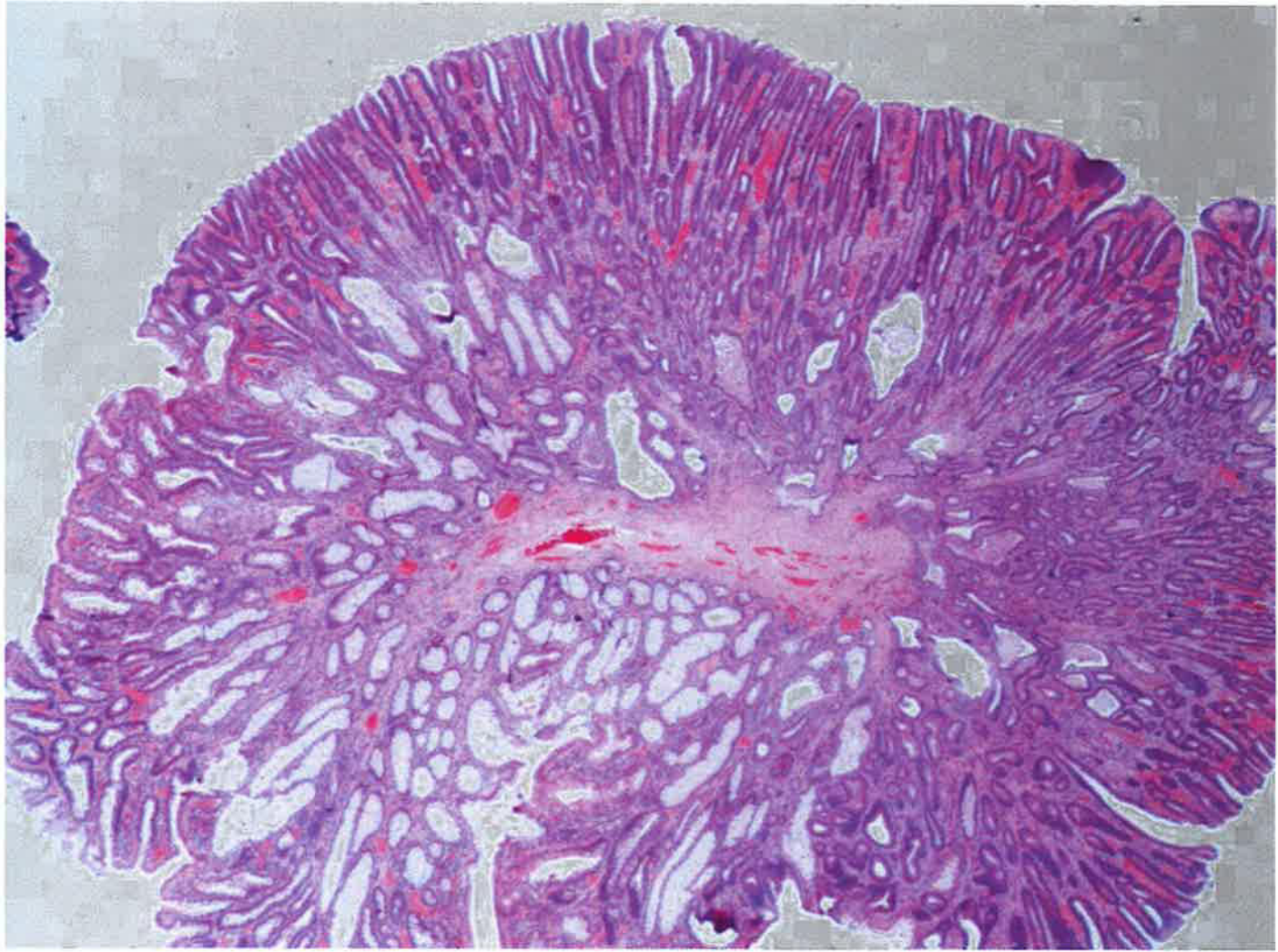
NORMAL

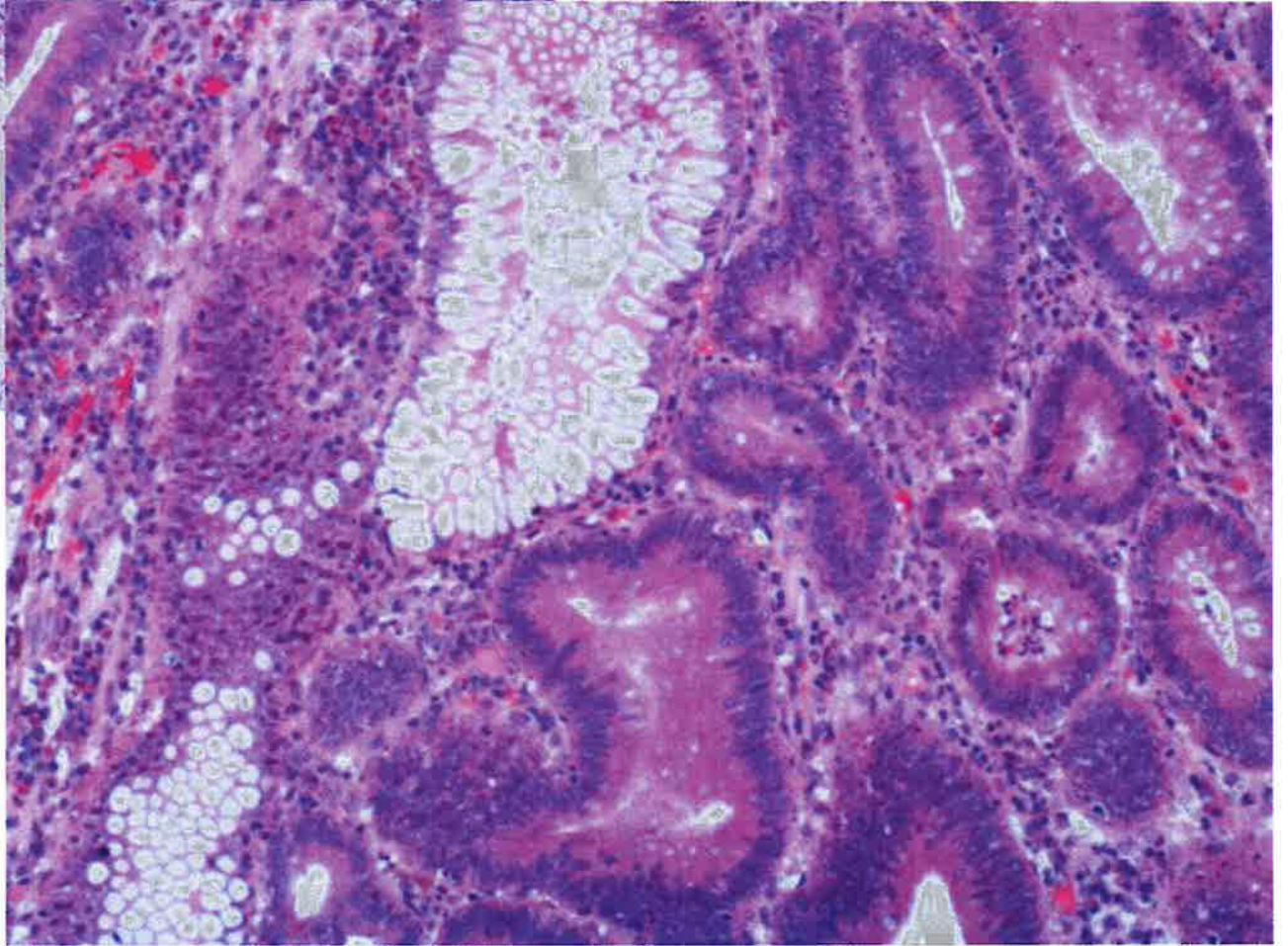
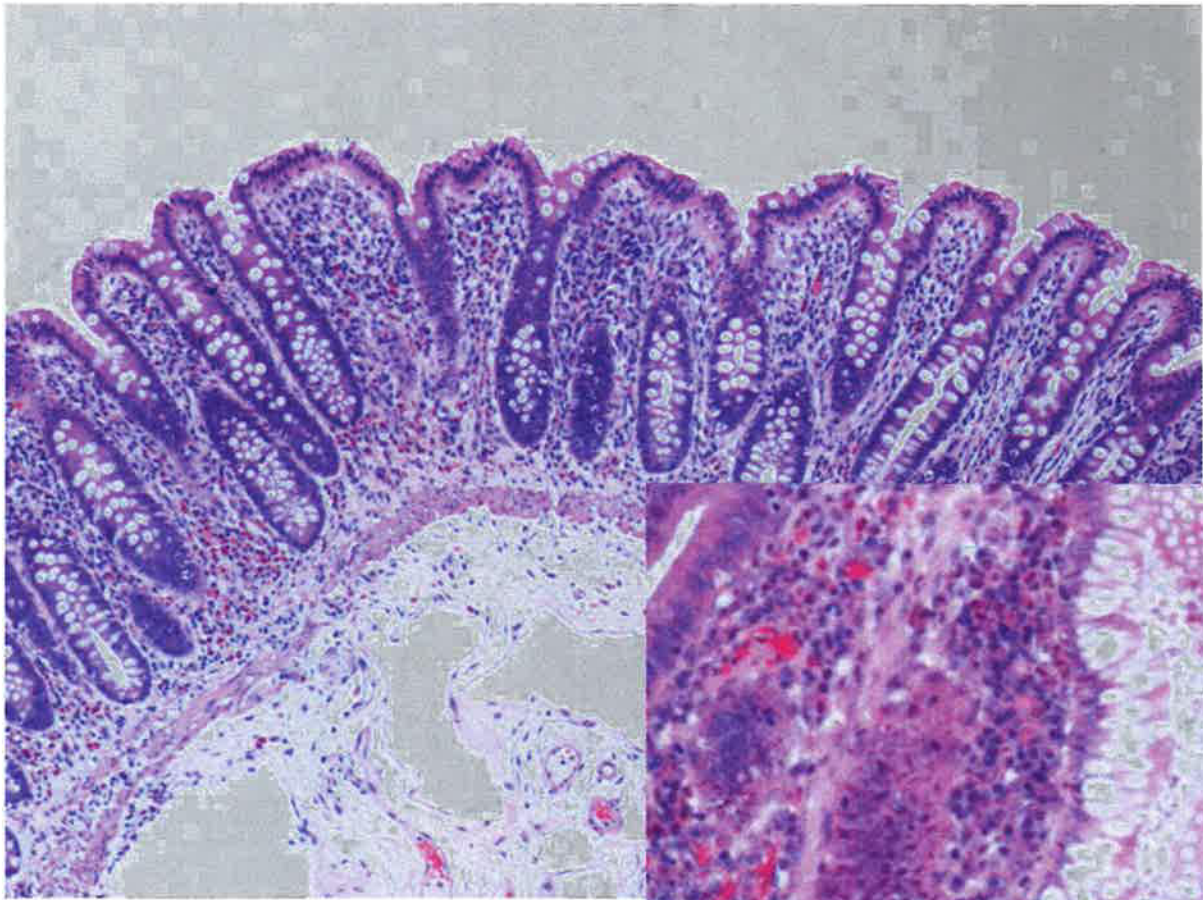


← Fig. 13.22b Colonic crypts or glands with numerous goblet cells have a pale supranuclear region filled with mucous granules. On the surface, columnar absorptive cells are seen, and these cells outnumber the goblet cells in the colon. The characteristic features of colonic crypts are their alignment similar to test tubes in a rack and the abundance of goblet cells together with the columnar enterocytes. In the base of the crypts, new cells arise by mitosis and mature and migrate upward through the crypts until ultimately exfoliated from the surface. Many immunocompetent cells, notably plasma cells, occupy the lamina propria (LP). T lymphocytes also occur there and within the mucosal epithelium.

# Colonic Adenocarcinoma



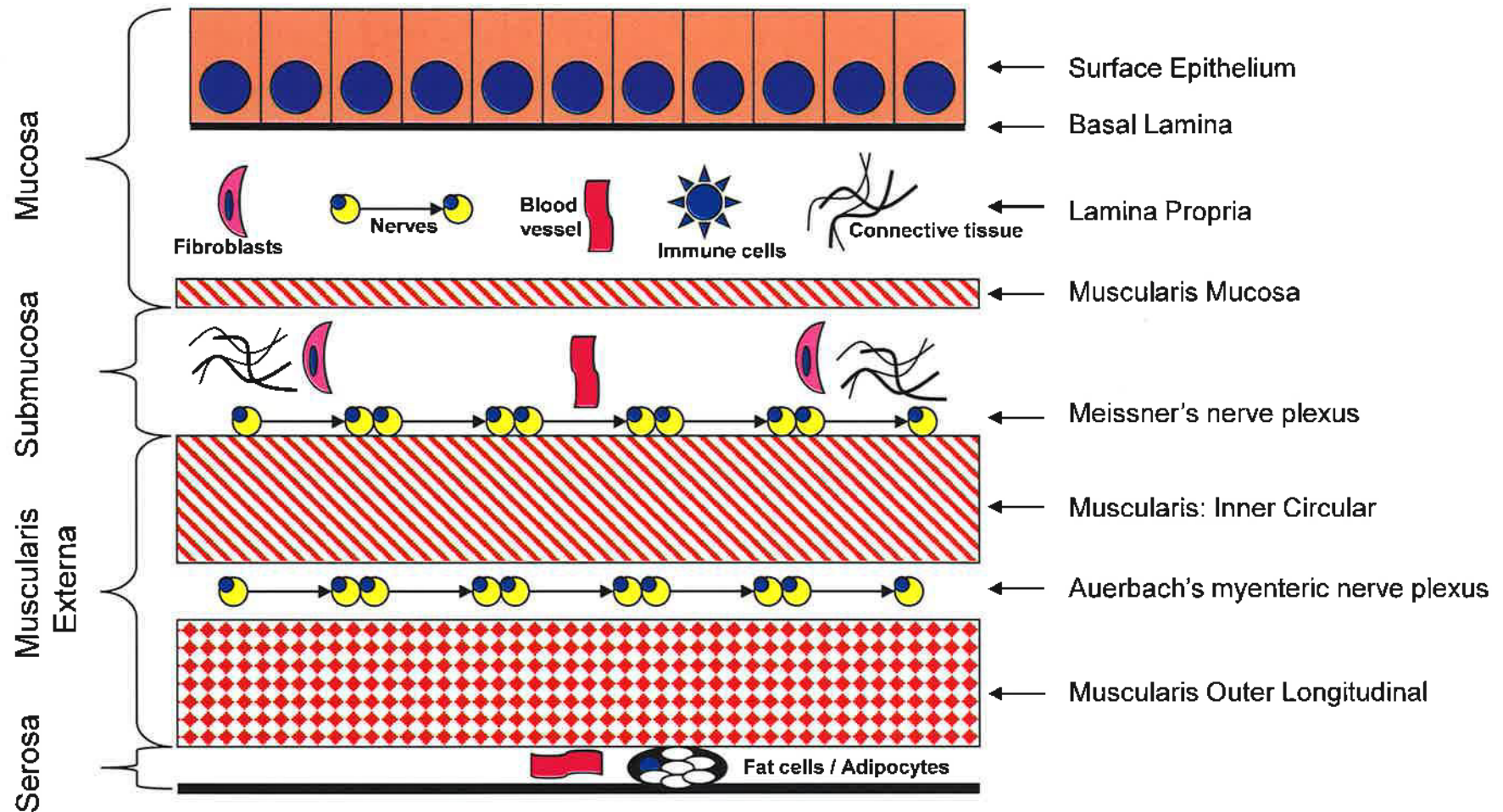




# General Organization of the GI tract

Layers

Structures

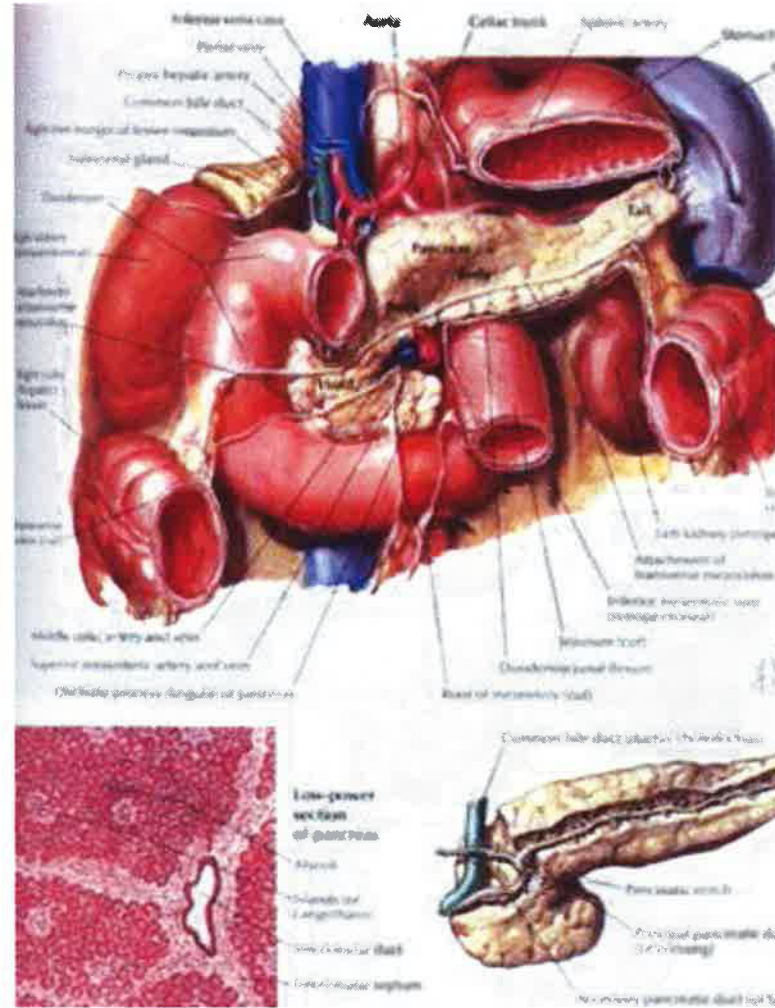


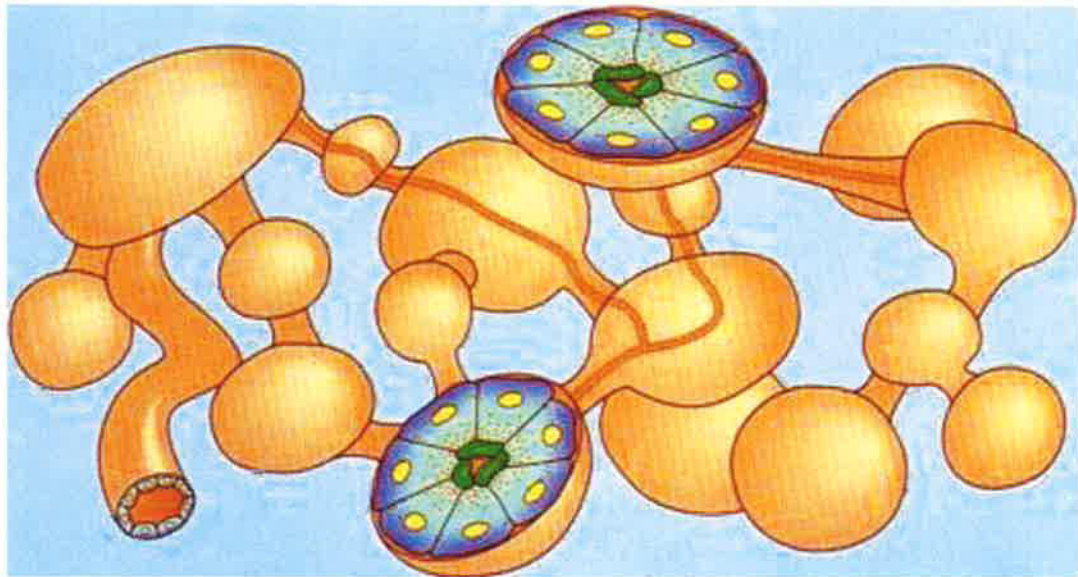
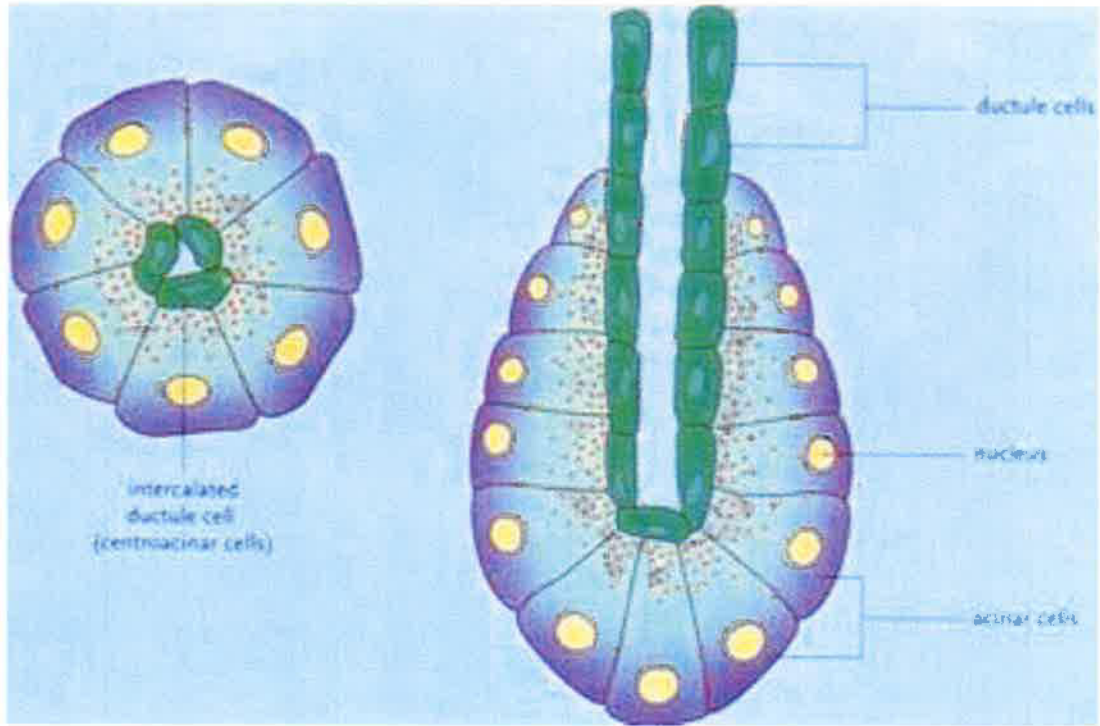
# Pancreas

- **Function:** production of digestive enzymes and hormones
- **Histology:**
  - Acinar cells secrete digestive proteins
  - Ductal cells transport secretions
  - Islets secrete insulin and other hormones
- **Disease burden**
  - Non-neoplastic – diabetes
  - Neoplastic – ductal adenocarcinoma

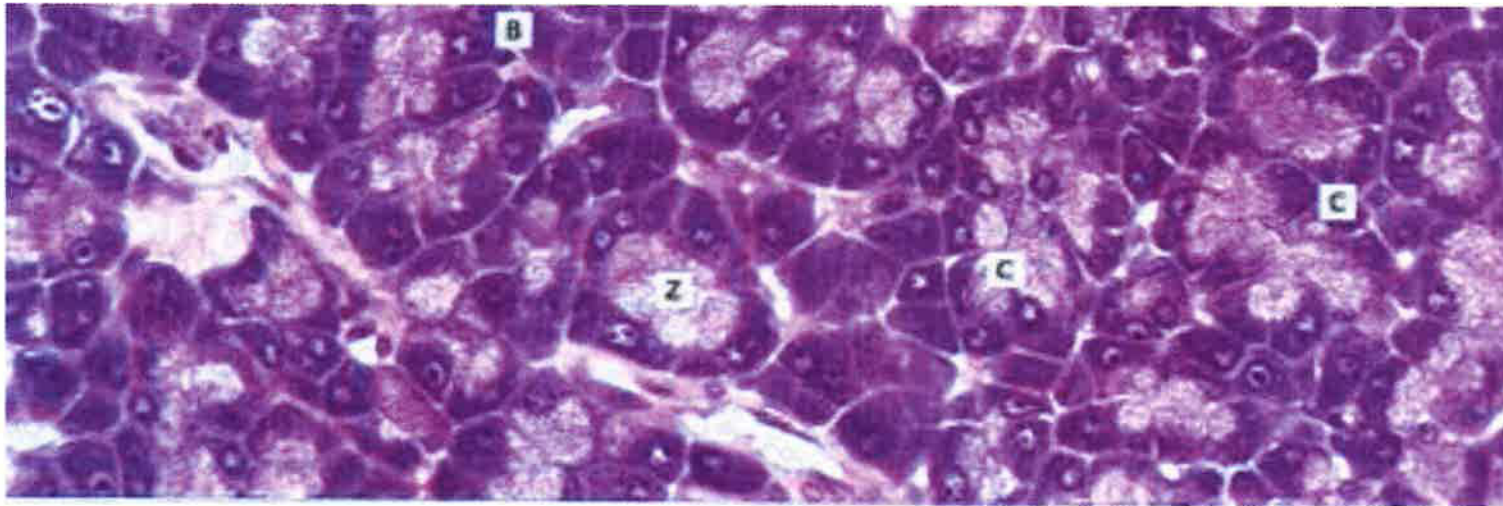


# Gross Anatomy



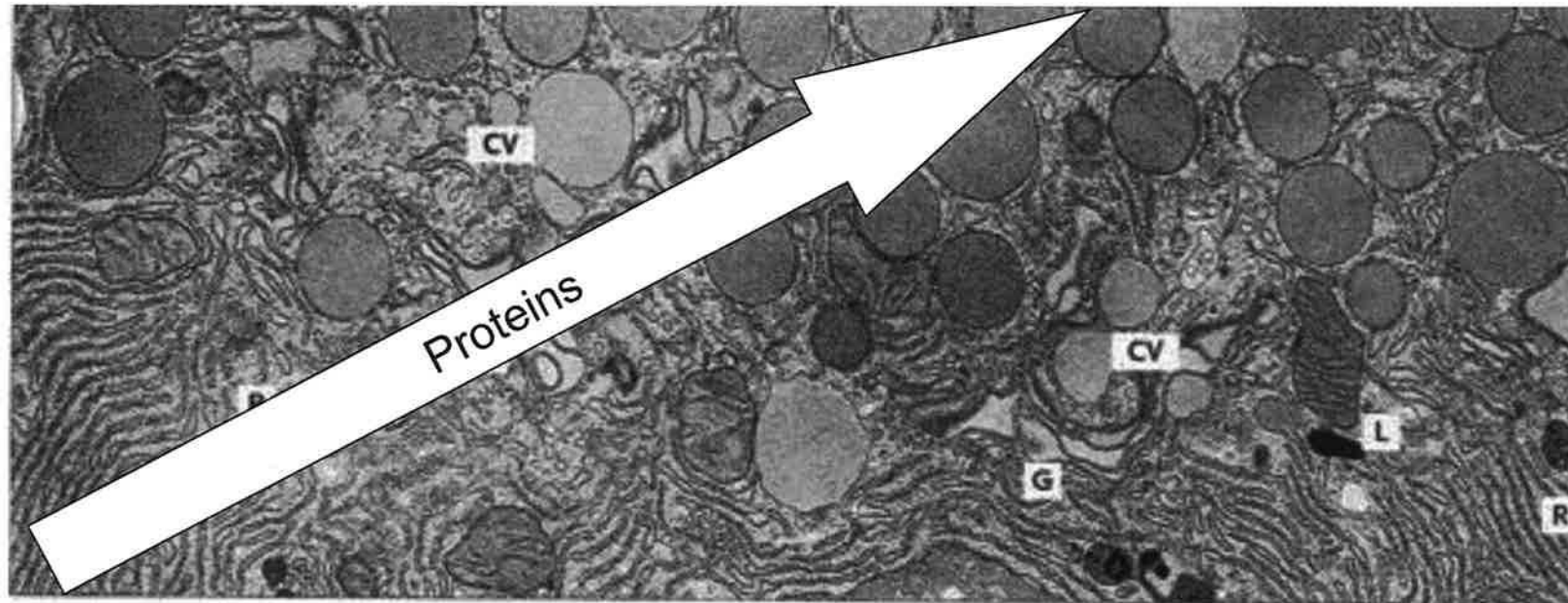


# Histology



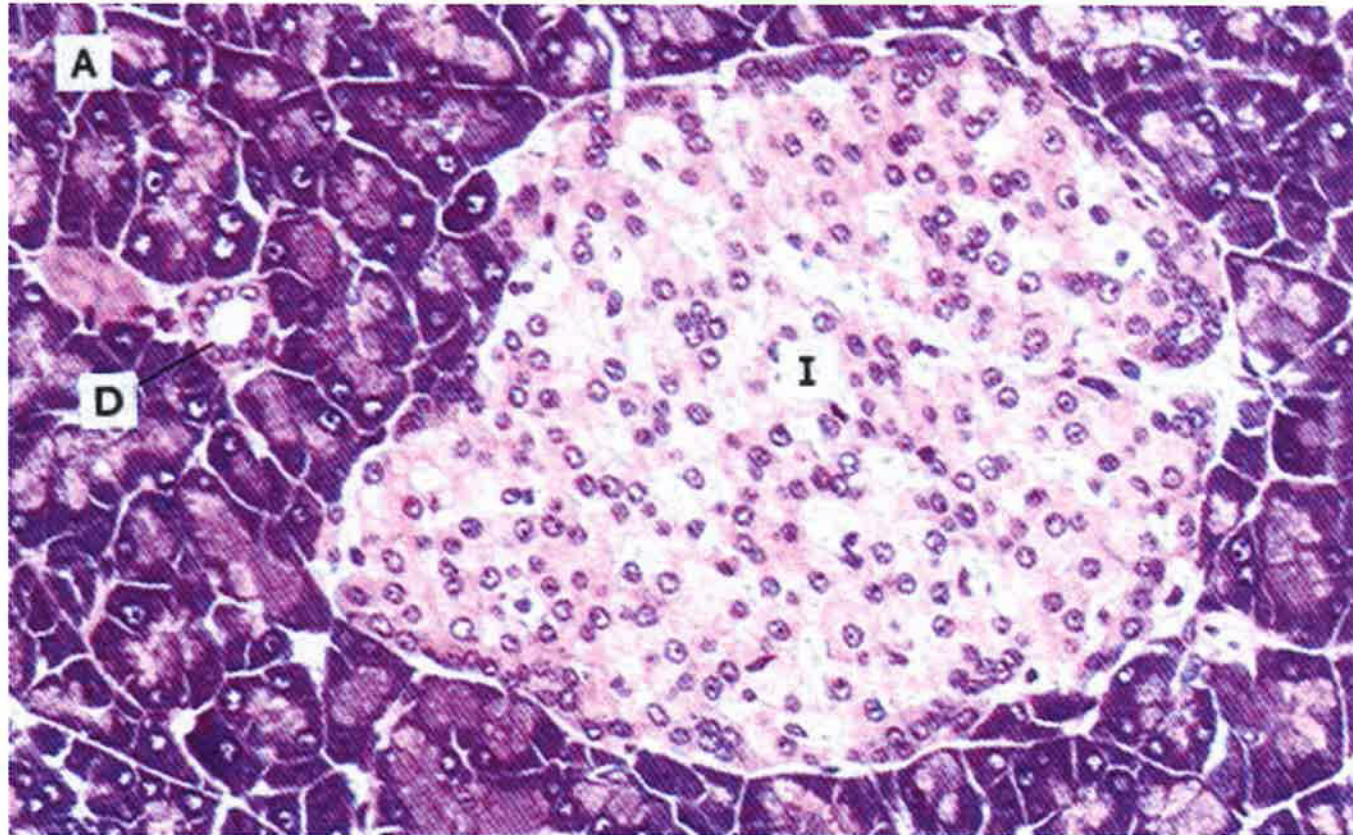
↑ **Fig. 14.9b** Acini, the enzyme-secreting units in the exocrine pancreas, are ovoid-elliptical clusters of acinar cells bordering a common luminal space. In hematoxylin and eosin sections, the basal cytoplasm (**B**) associated with the nuclei is deeply stained and shows a blue or purple color. This basophilia represents cisterns of rough endoplasmic reticulum. In the apical regions, pale-staining zymogen (**Z**) granules (containing packages of inactive enzymes) face the narrow lumen. The supporting tissue is thin, composed of delicate strands of extracellular matrix and collagen. Unique to the acinar complex are the centroacinar cells (**C**) which form the **start** of the pancreatic ducts, intercalated within the acini. Acini are not associated with myoepithelial cells commonly observed in other exocrine glands.

# Histology

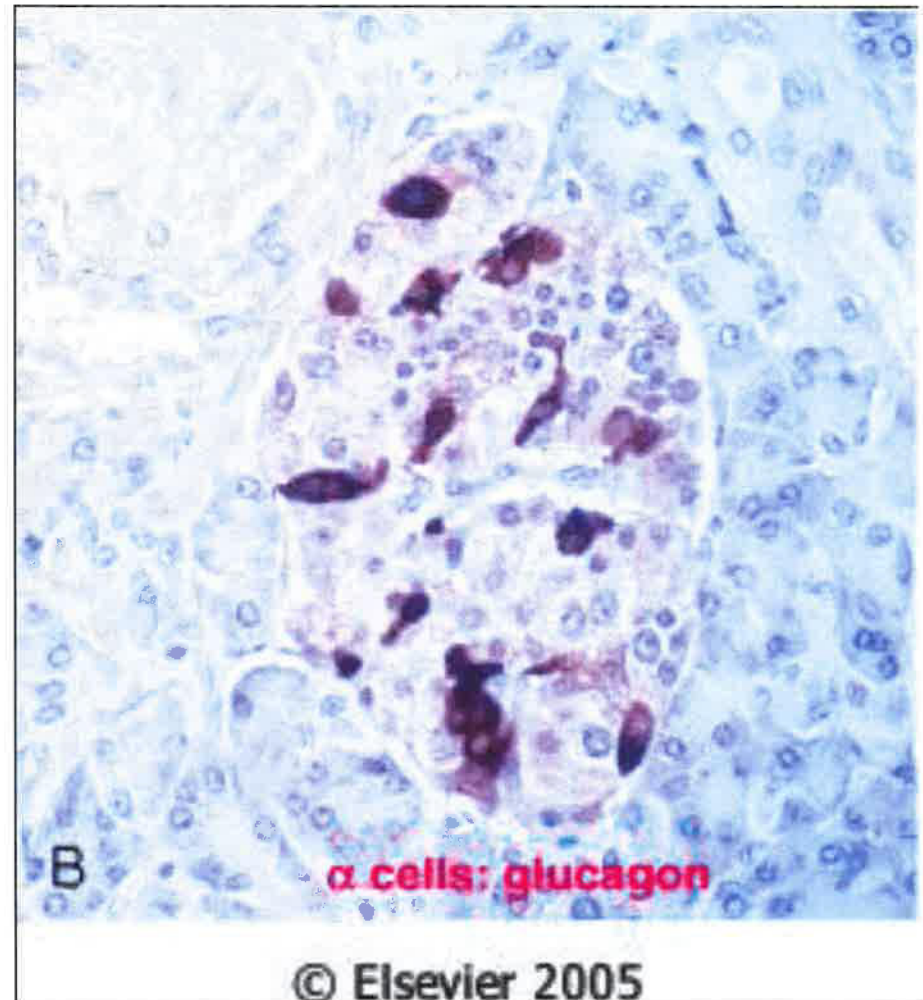
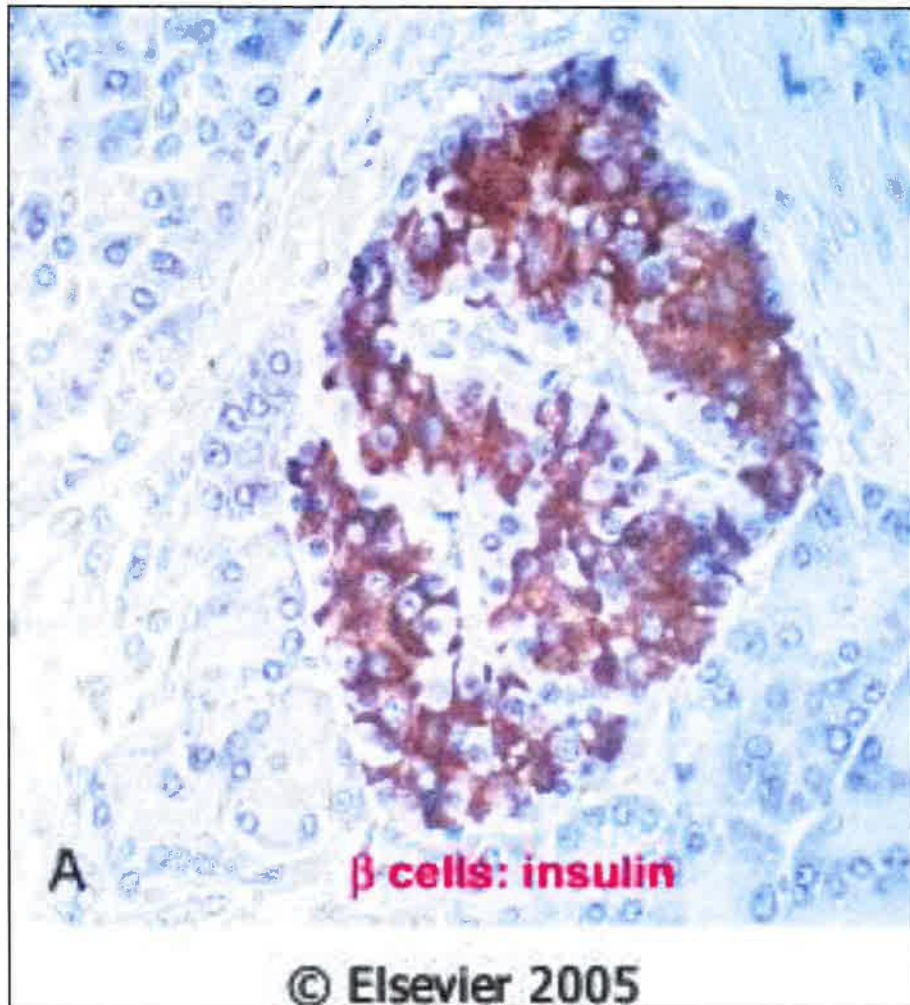


↑ Fig. 14.11b The pathway taken in the synthesis of secretory proteins involves preprotein synthesis in the rough endoplasmic reticulum (R), transport of the Golgi complex (G), processing, sorting, and routing into condensing vacuoles (CV), and concentration into mature zymogen granules (Z), which contain about 20 different zymogens and enzymes. Lysosomes (L) containing a mixture of about 75 acid hydrolases are also formed by the Golgi, but these are mostly sorted into endosomal compartments.

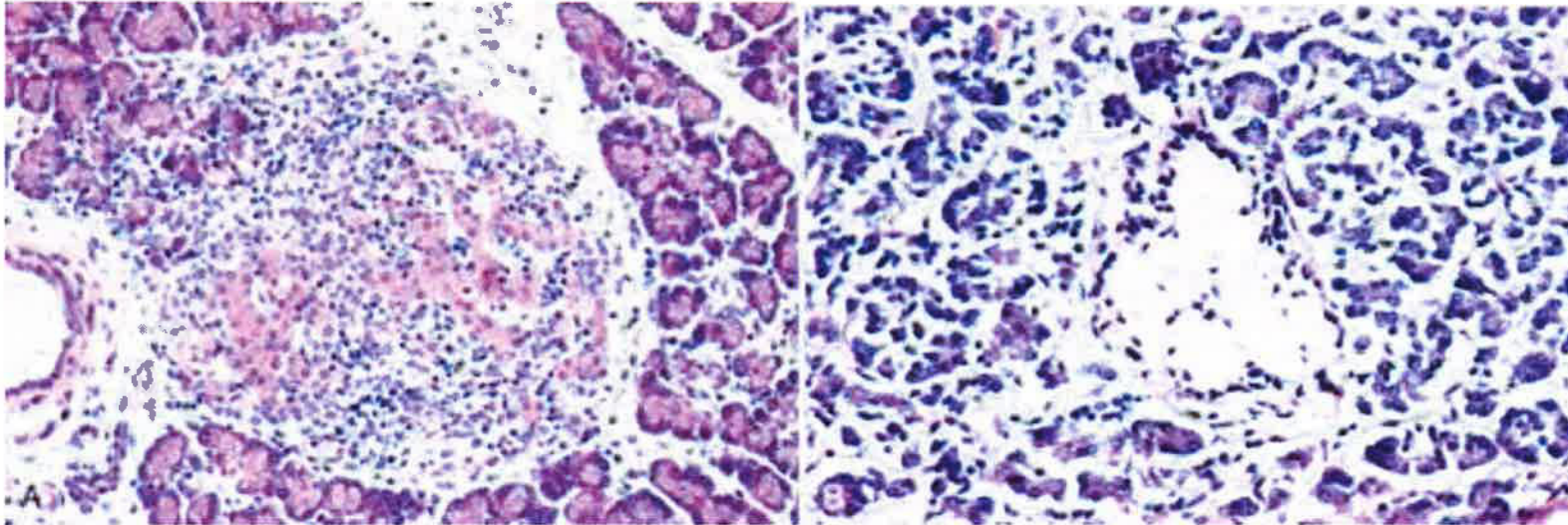
# Islet



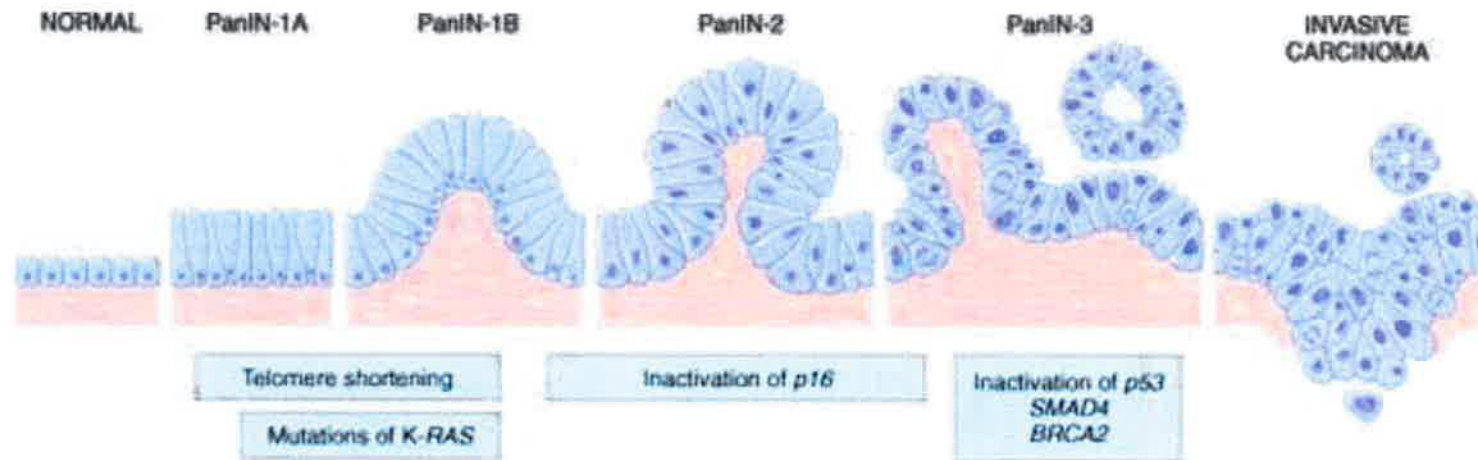
# Stained islet



# Diabetes



# Pancreatic Cancer



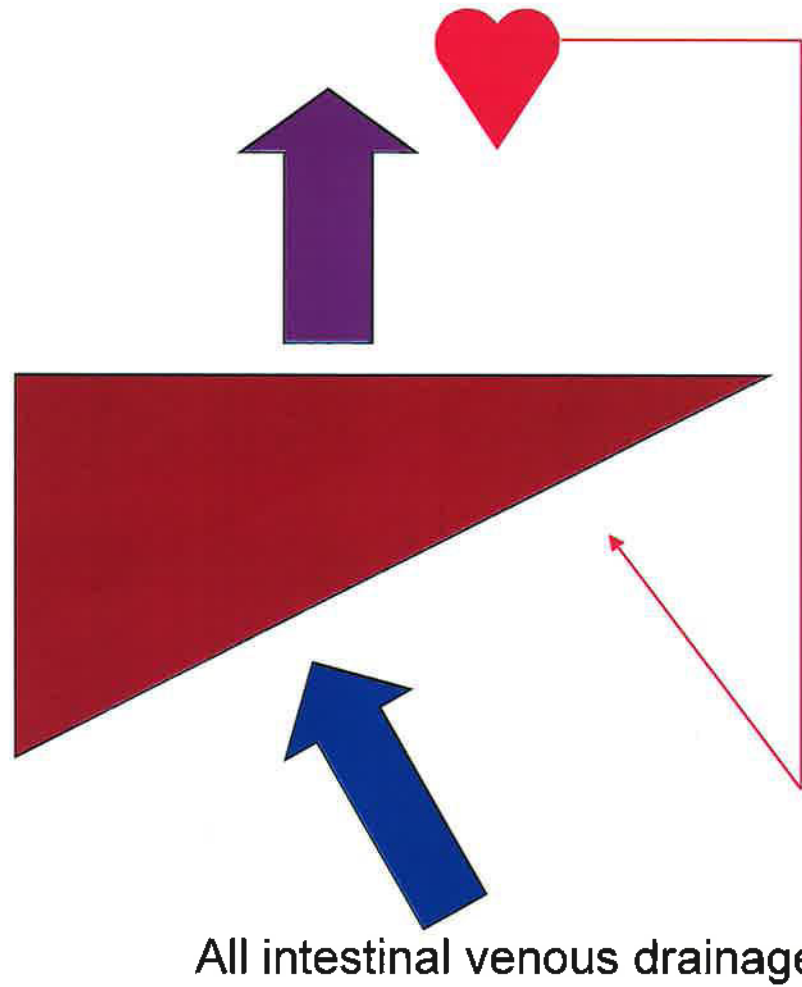
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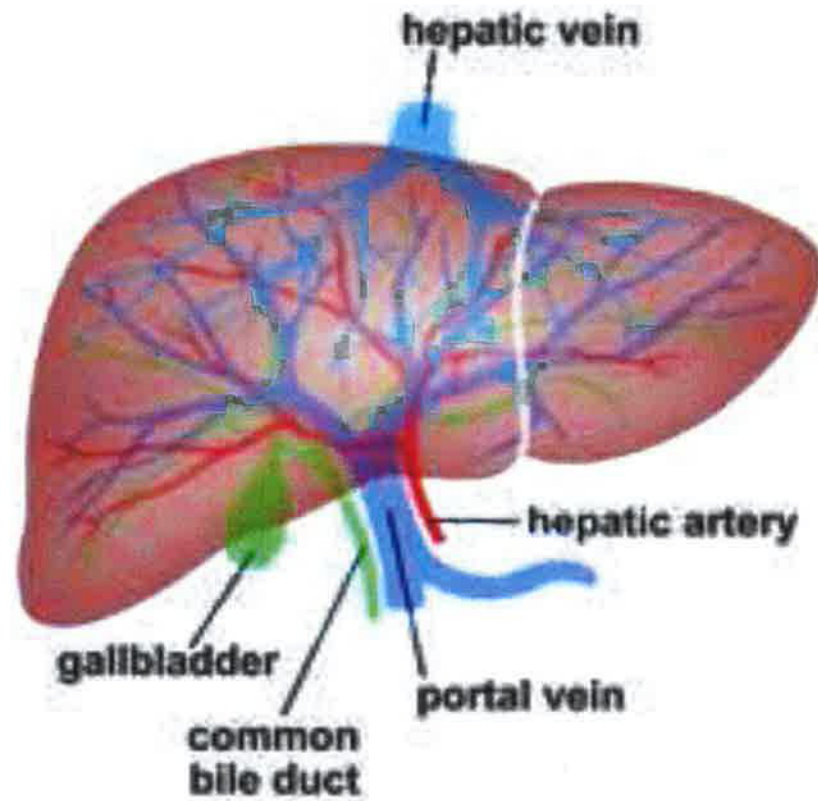
# Liver

- **Function:** Metabolic converter
  - Bile, glucose, lipids, proteins
- **Histology:** Hepatocytes, portal vascular system and bile drainage
- **Disease burden**
  - Non neoplastic – Cirrhosis
  - Neoplastic – Hepatocellular carcinoma

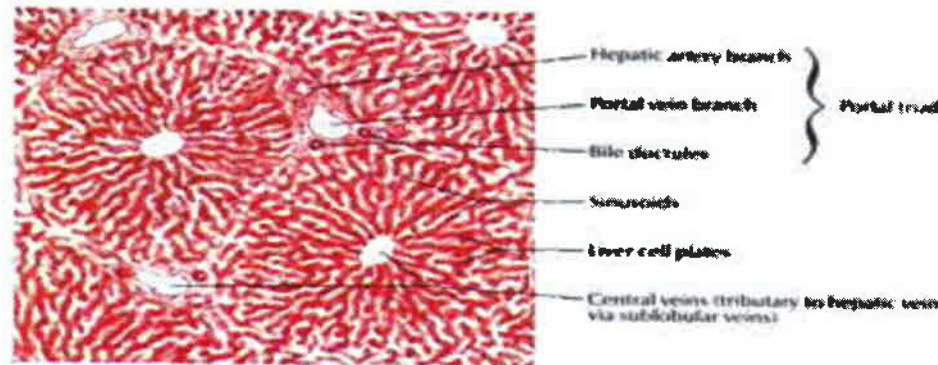
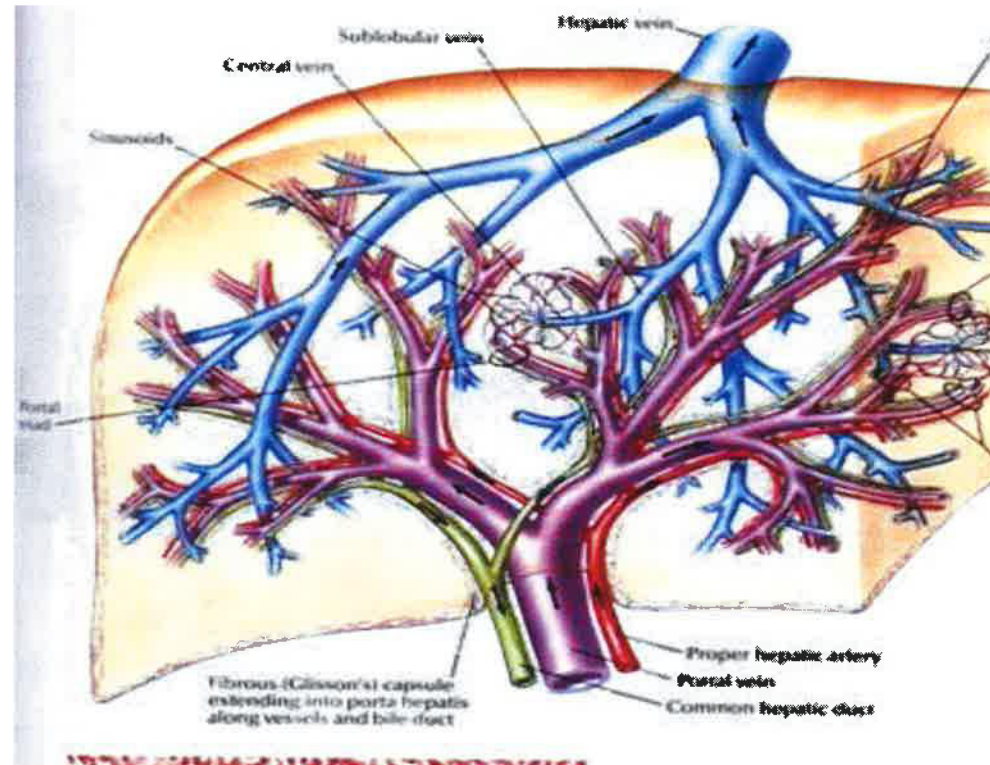
# Portal System



# Liver Anatomy

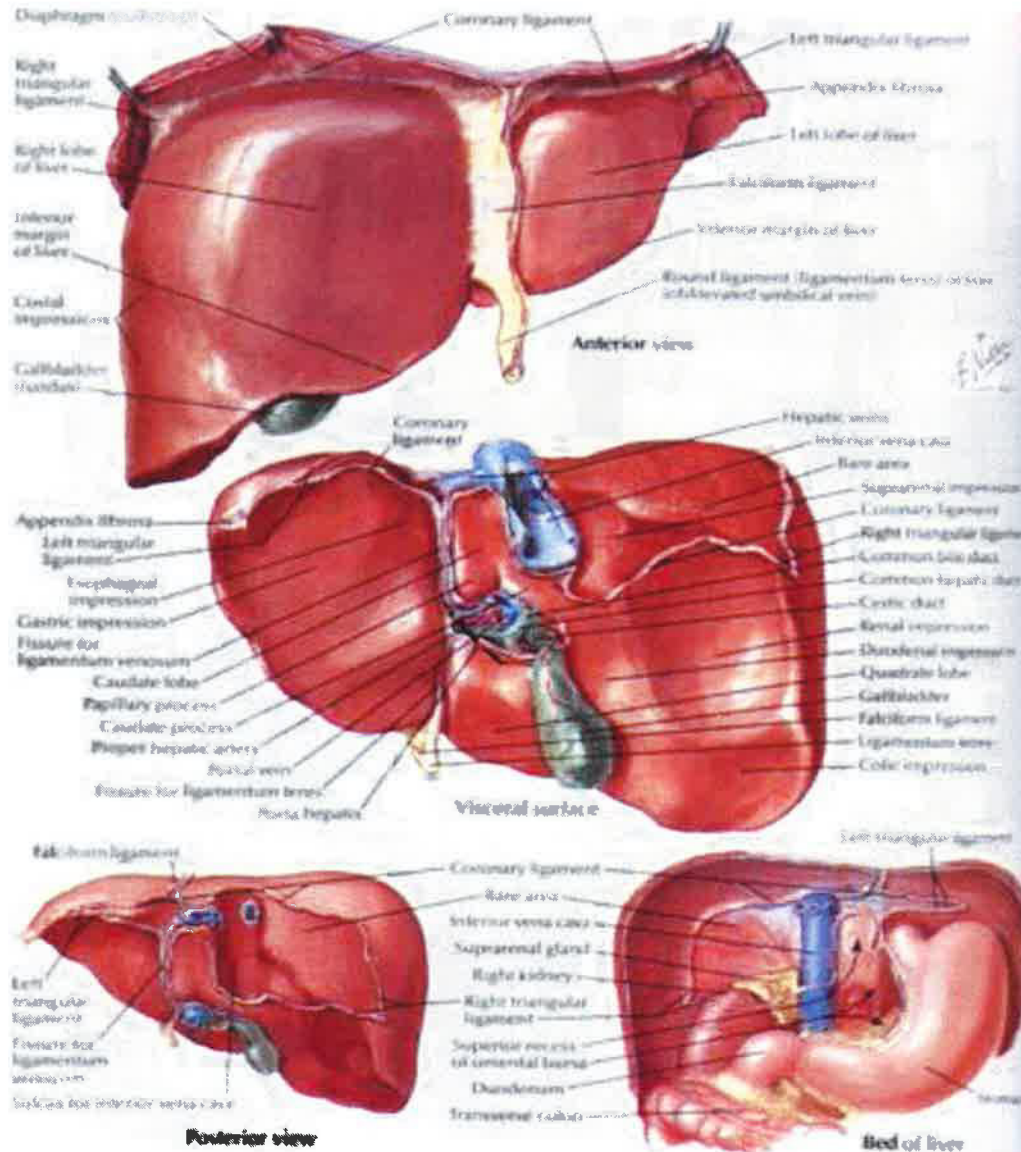


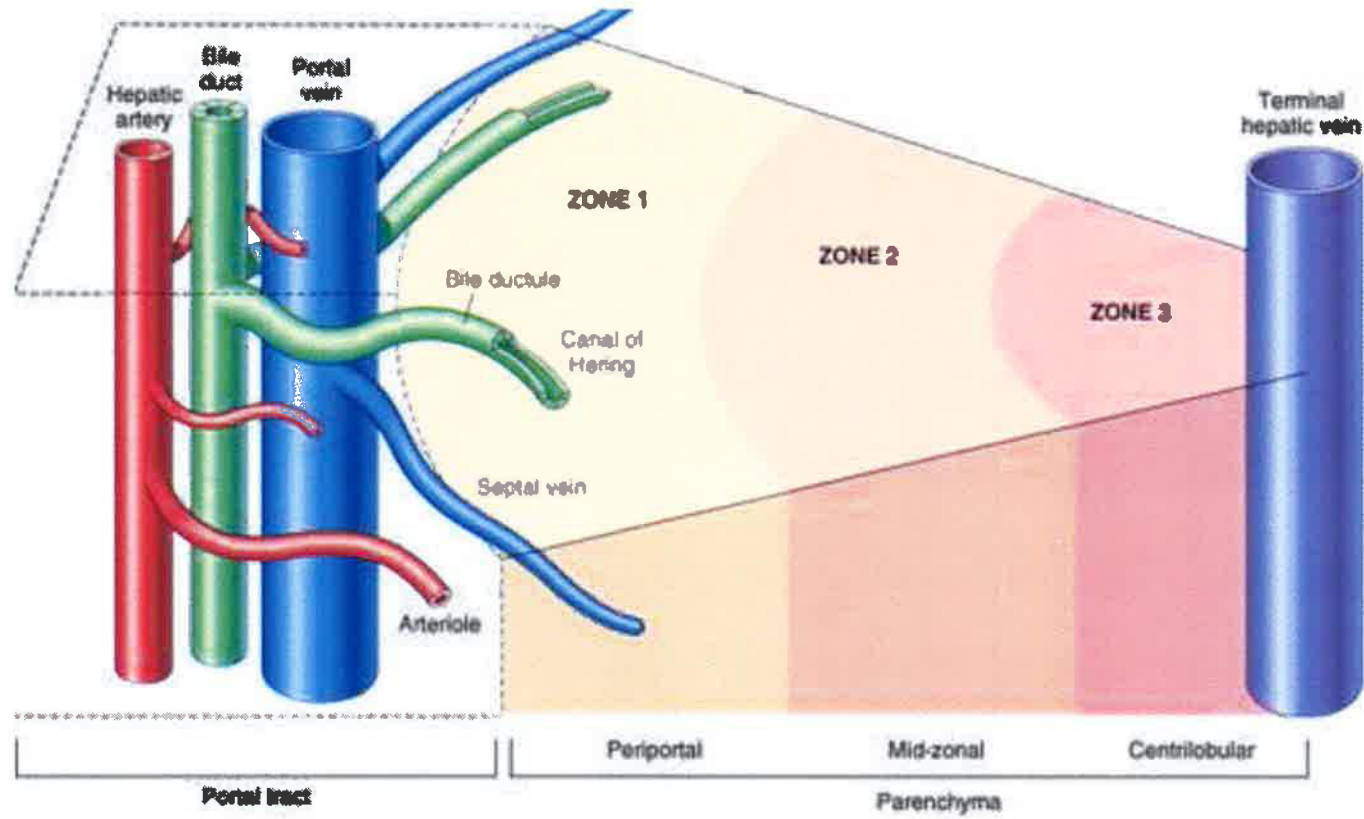
# Gross Anatomy



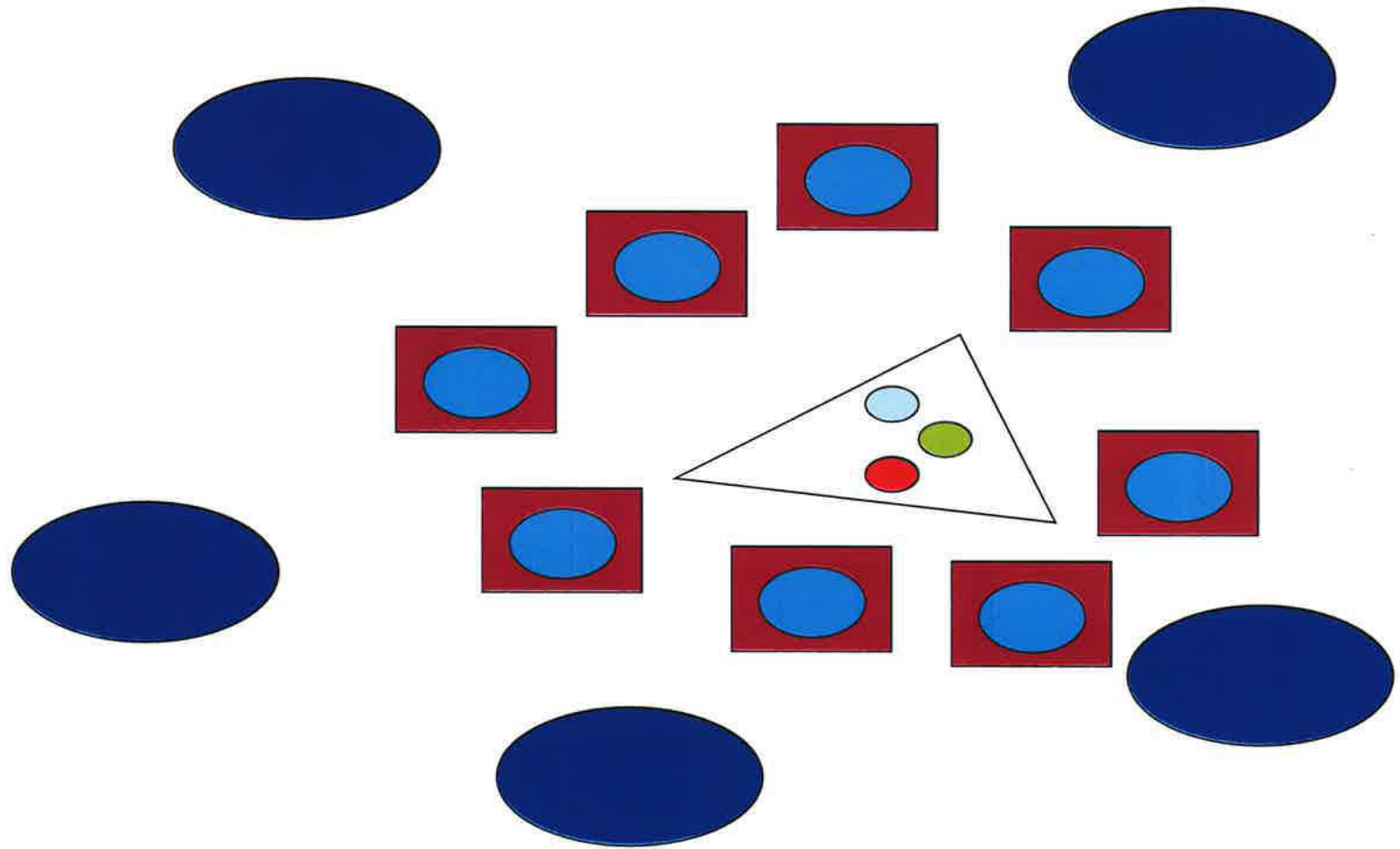
Normal lobular pattern of liver

# Gross Anatomy

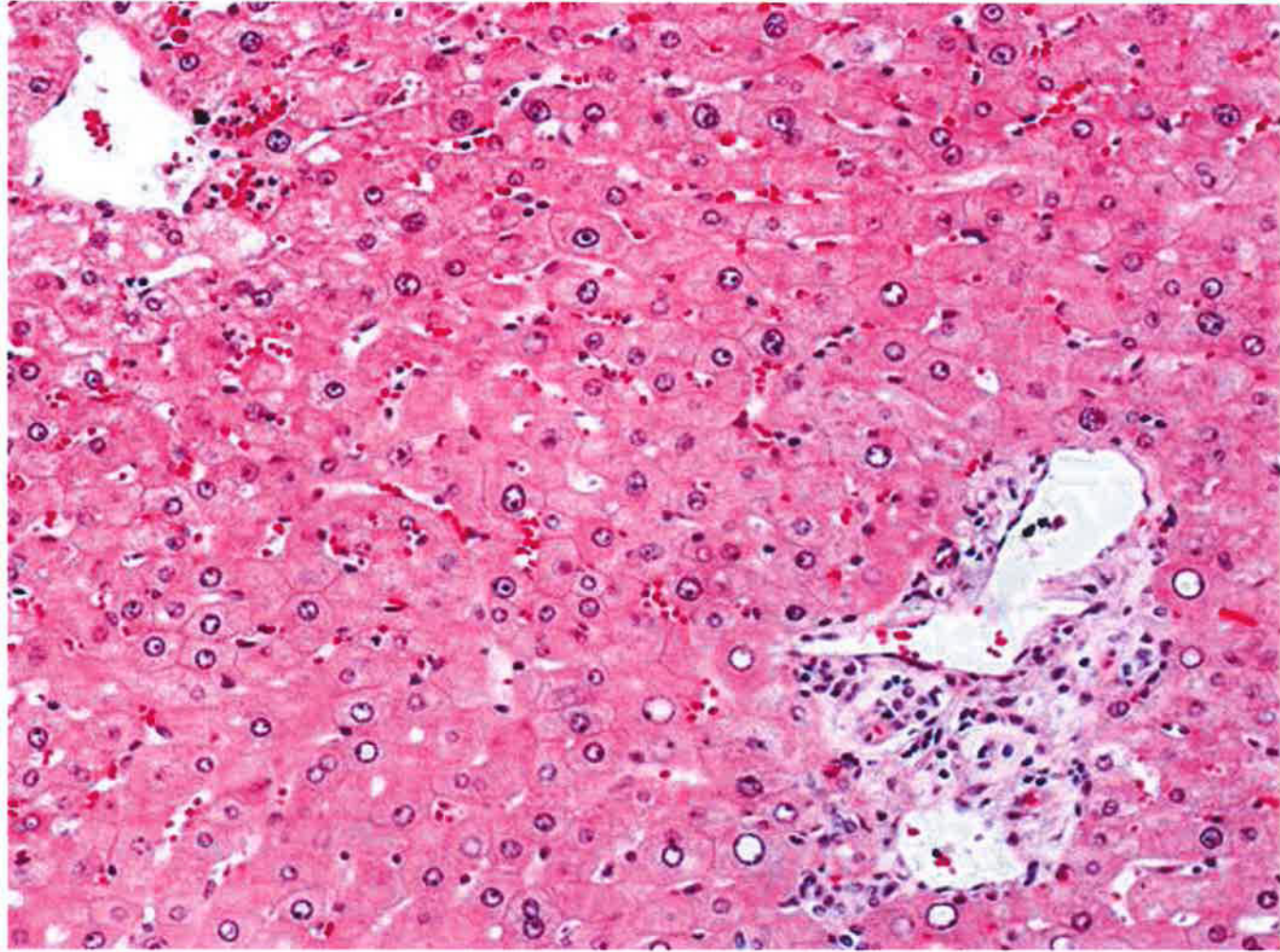




# Hepatic lobule



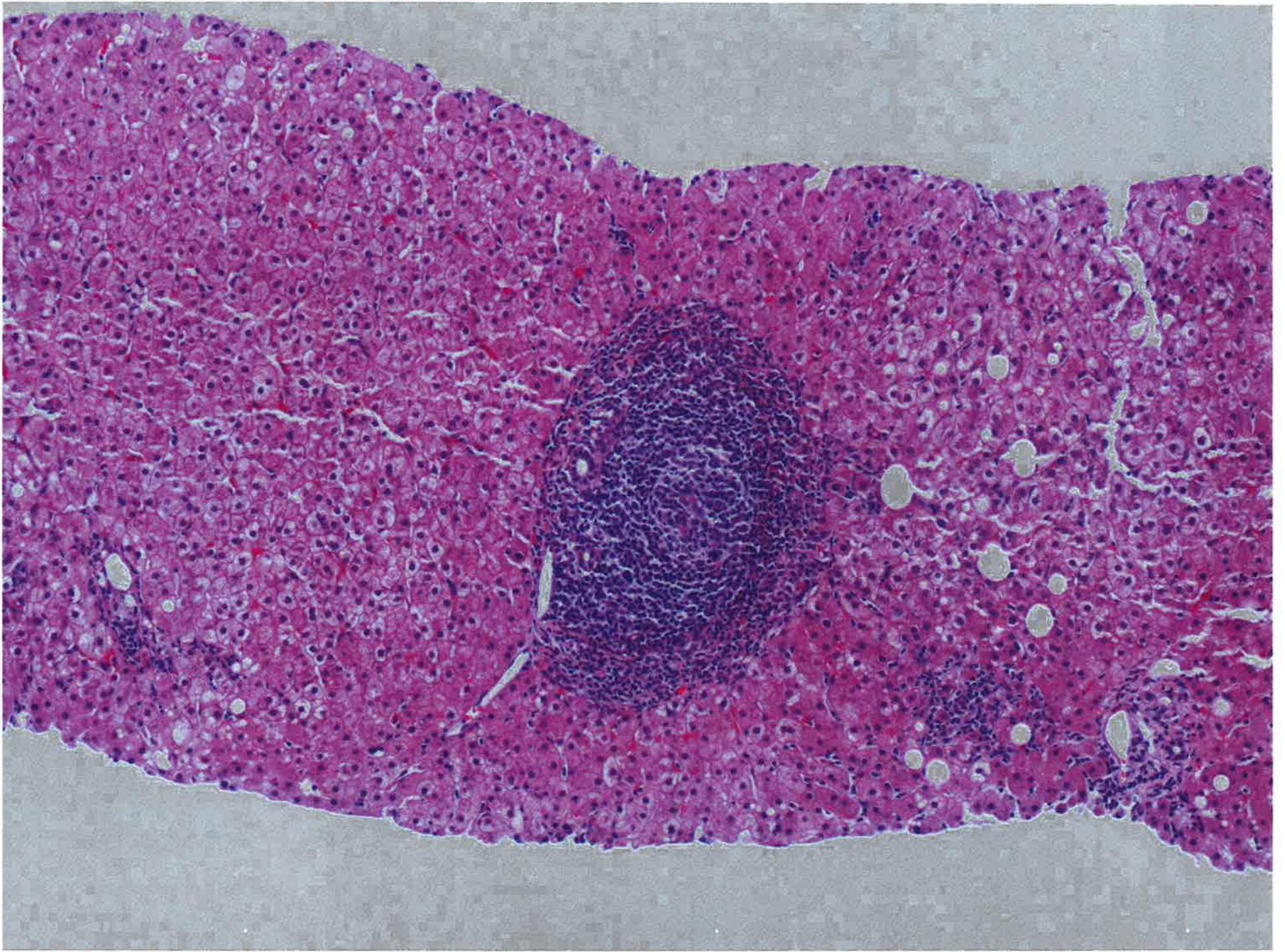
# Histology

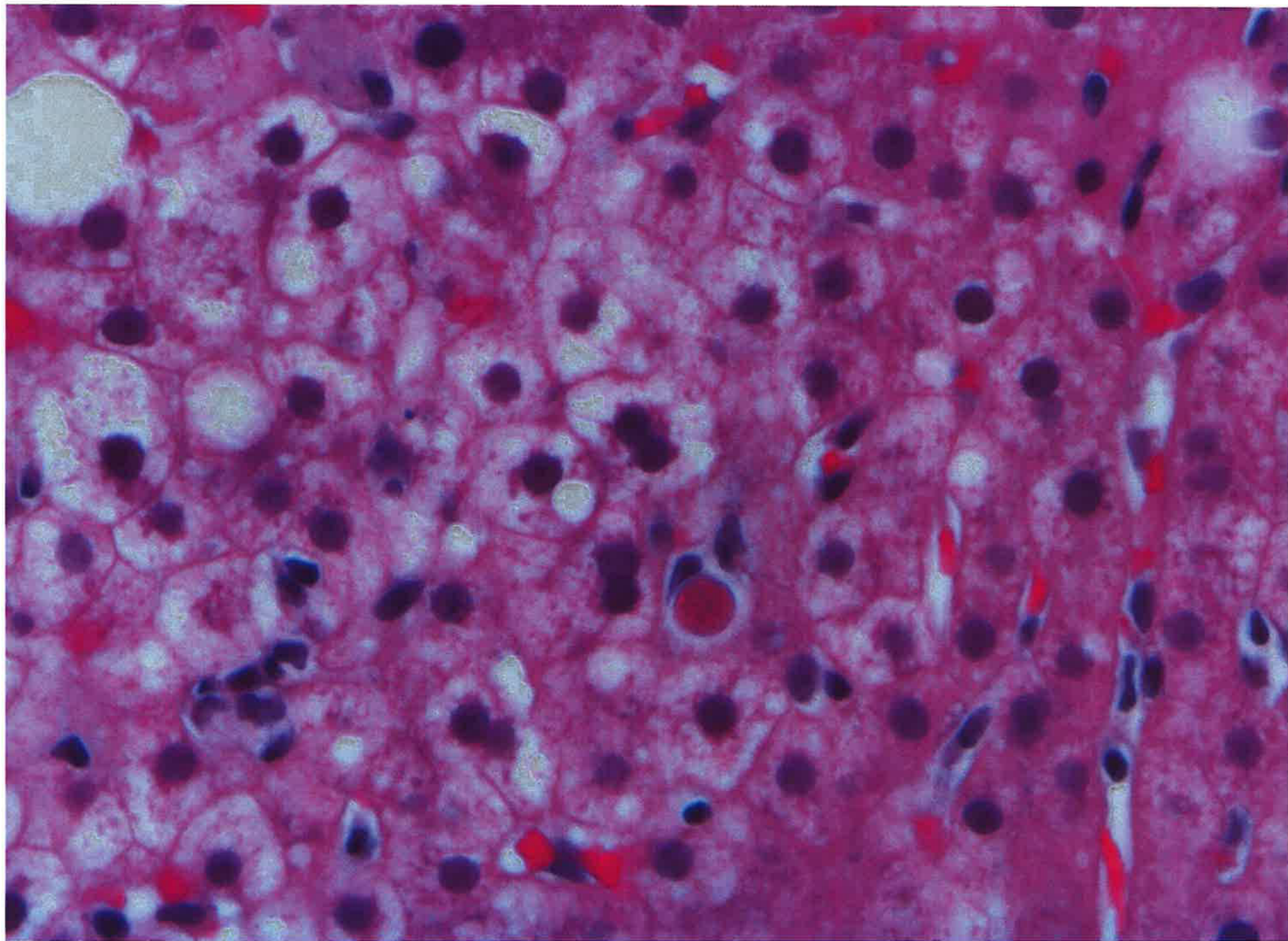




# Cirrhosis







# Hepatocellular Carcinoma

