Digestive System Small and Large Intestines
Lec. 21

Histology

Second year

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Small Intestine

- The small intestine is a long, convoluted tube about 5 to 7 m long; it is the longest section of the digestive tract. The small intestine extends from the junction with the stomach to join with the large intestine or colon. For descriptive purposes, the small intestine is divided into three parts: the duodenum, jejunum, and ileum. Although the microscopic differences among these three segments are minor, they allow for identification of the segments. The main function of the small intestine is the digestion of gastric contents and absorption of nutrients into blood capillaries and lymphatic lacteals.

Surface Modifications of Small Intestine for Absorption

- The mucosa of the small intestine exhibits specialized structural modifications that increase the cellular surface areas for absorption of nutrients and fluids. These modifications include the plicae circulares, villi, and microvilli. In contrast to the rugae of stomach, the plicae circulares are permanent spiral folds or elevations of the mucosa (with a submucosal core) that extend into the intestinal lumen. The plicae circulares are most prominent in the proximal portion of the small intestine, where most absorption takes place; they decrease in prominence toward the ileum. Villi are permanent fingerlike projections of lamina propria of the mucosa that extend into the intestinal lumen. They are covered by simple columnar epithelium and are also more prominent in the proximal portion of the small intestine. The height of the villi decreases toward the ileum of the small intestine. The connective tissue core of each villus contains a lymphatic capillary called a lacteal, blood capillaries, and individual strands of smooth muscles

- Each villus has a core of lamina propria that is normally filled with blood vessels, lymphatic capillaries, nerves, smooth muscle, and loose irregular connective tissue. In addition, the lamina propria is a storehouse for immune cells such as lymphocytes, plasma cells, tissue eosinophils, macrophages, and mast cells. Smooth muscle fibers from the muscularis mucosae extend into the core of individual villi and are responsible for their movements. This action increases the contacts of the villi with the digested food products in the intestine. Microvilli are cytoplasmic extensions that cover the apices of the intestinal absorptive cells. They are visible under a light microscope as a striated (brush) border. The microvilli are coated by a glycoprotein coat glycocalyx, which contains such brush border enzymes as lactase, peptidases, sucrase, lipase, and others that are important for digestion.

Cells, Glands, and Lymphatic Nodules in the Small Intestine

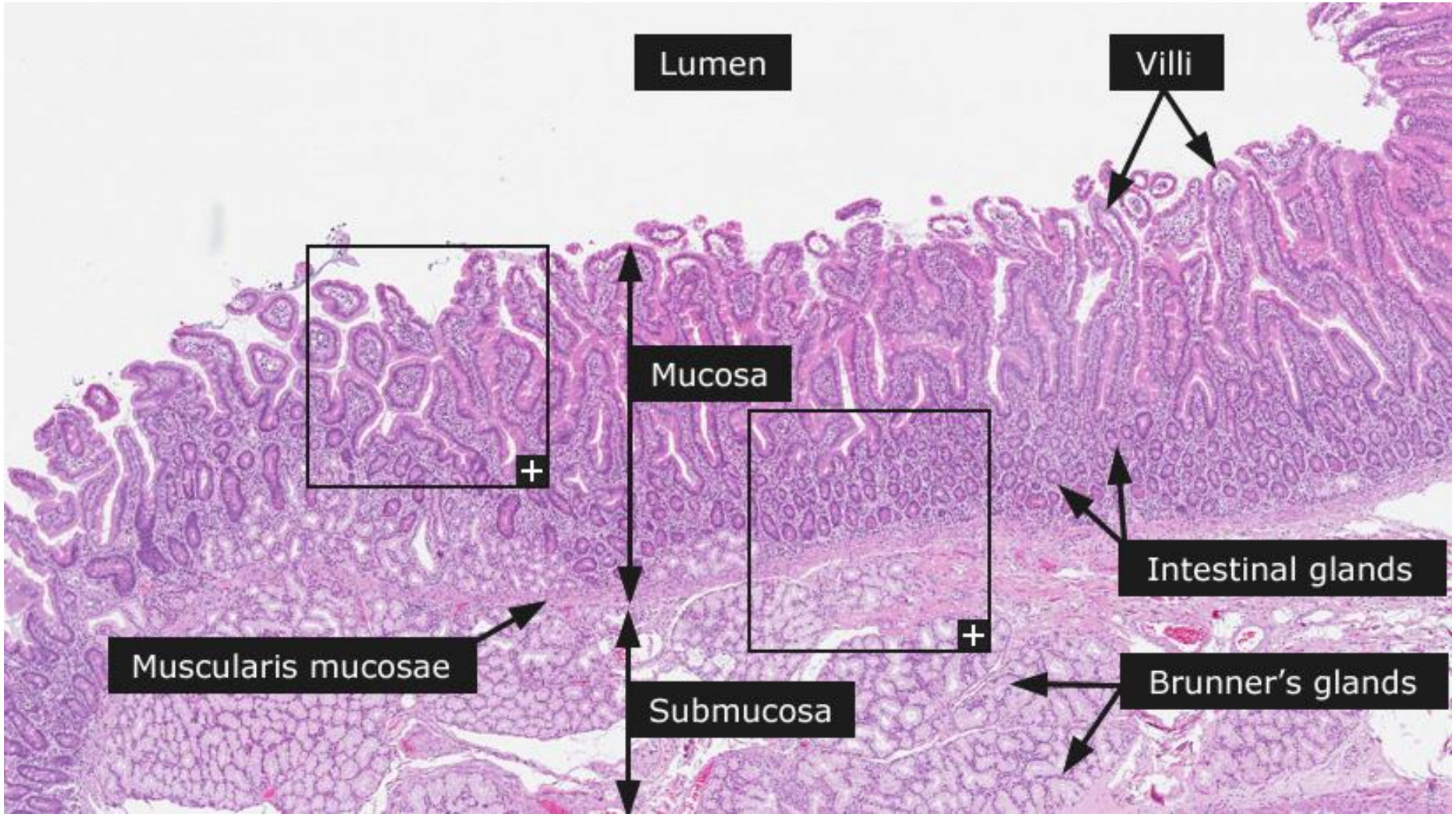
- Intestinal glands (crypts of Lieberkiihn) are located between the villi throughout the small intestine. These glands open into the intestinal lumen at the base of the villi. The simple columnar epithelium that lines the villi is continuous with that of the intestinal glands. In the glands are found stem cells, absorptive cells, goblet cells, Paneth cells, and some enteroendocrine cells.
- **Absorptive cells** are the most common cell types in the intestinal epithelium. These cells are tall columnar with a prominent striated (brush) border of microvilli. A thick glycocalyx coat covers and protects the microvilli from the corrosive chemicals.
- **Goblet cells** are interspersed among the columnar absorptive cells of the intestinal epithelium. They increase in number toward the distal region of the small intestine (ileum).
- **Enteroendocrine or APUD** (amine precursor uptake and decarboxylation) cells are scattered throughout the epithelium of the villi and intestinal glands.

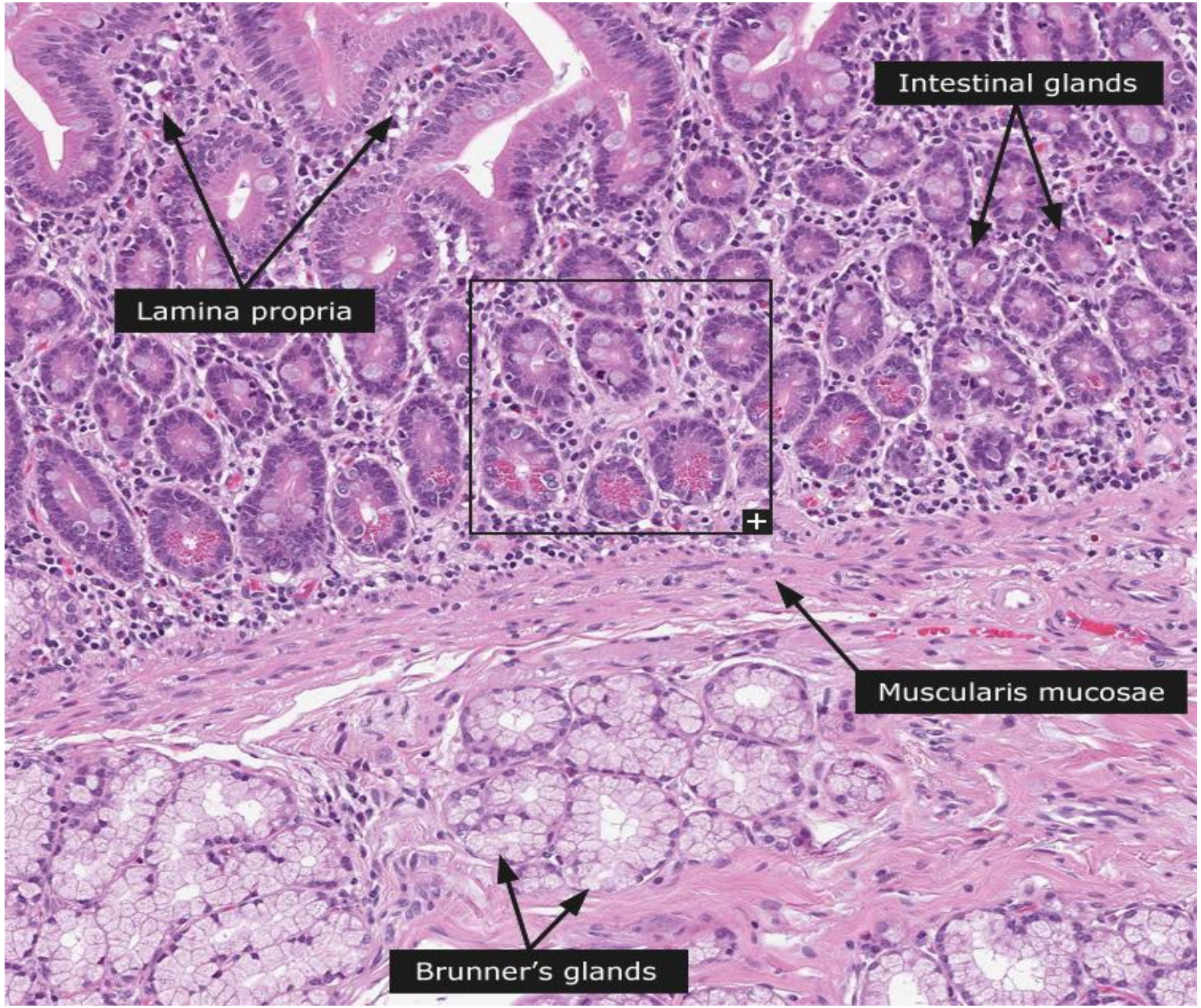
- **Duodenal (Brunner's) glands** are primarily found in the submucosa of the initial portion of the duodenum and are highly characteristic of this region of the small intestine. These are branched, tubuloacinar glands with light-staining mucous cells. The ducts of duodenal glands penetrate the muscularis mucosae to discharge their secretory product at the base of intestinal glands.
- **Undifferentiated cells** exhibit mitotic activity and are located in the base of intestinal glands. They function as stem cells and replace worn-out columnar absorptive cells, goblet cells, and intestinal gland cells.
- **Paneth cells** are located at the base of intestinal glands. They are characterized by the presence of deep-staining eosinophilic granules in their cytoplasm.
- **Peyer's patches** are numerous aggregations of closely packed, permanent lymphatic nodules. They are found primarily in the wall of the terminal portion of small intestine, the ileum. These nodules occupy a large portion of the lamina propria and submucosa of the ileum. M cells are highly specialized epithelial cells that cover the Peyer's patches and large lymphatic nodules; they are not found anywhere else in the intestine.
- **M cells phagocytose** luminal antigens and present them to the lymphocytes and macrophages in the lamina propria, which are then stimulated to produce specific antibodies against the antigens.

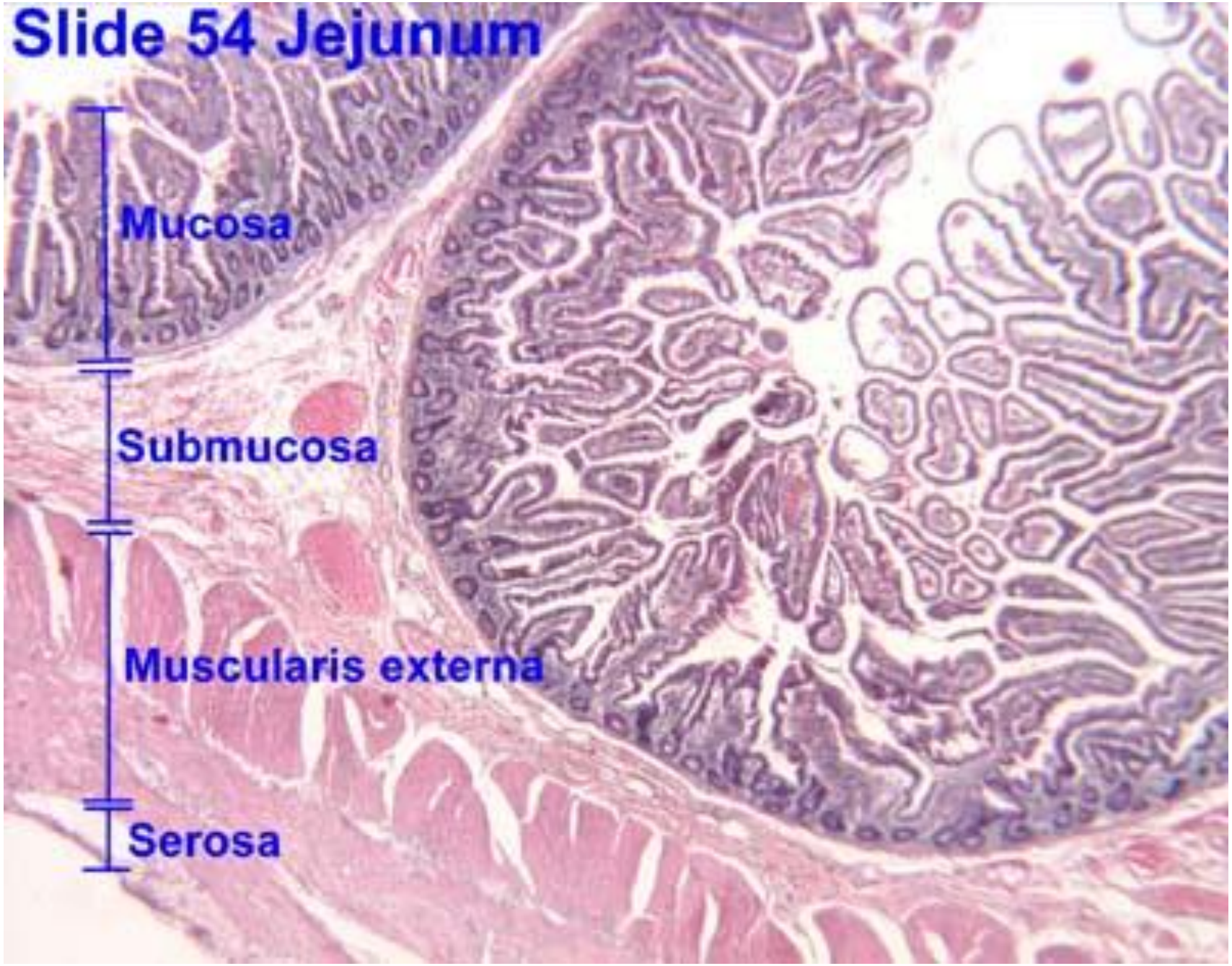
Regional Differences in the Small Intestine

- **The duodenum** is the shortest segment of the small intestine. The villi in this region are broad, tall, and numerous, with fewer goblet cells in the epithelium. Branched **duodenal (Brunner's) glands** with mucus-secreting cells in the submucosa characterize this region.
- **The jejunum** exhibits shorter, narrower, and fewer villi than the duodenum. There are also **more goblet cells** in the epithelium.
- **The ileum** contains few villi that are narrow and short. In addition, the epithelium contains more goblet cells than in the duodenum or jejunum. The lymphatic nodules are particularly large and numerous in the ileum, where they aggregate in the lamina propria and submucosa to form the prominent **Peyer's patches**.

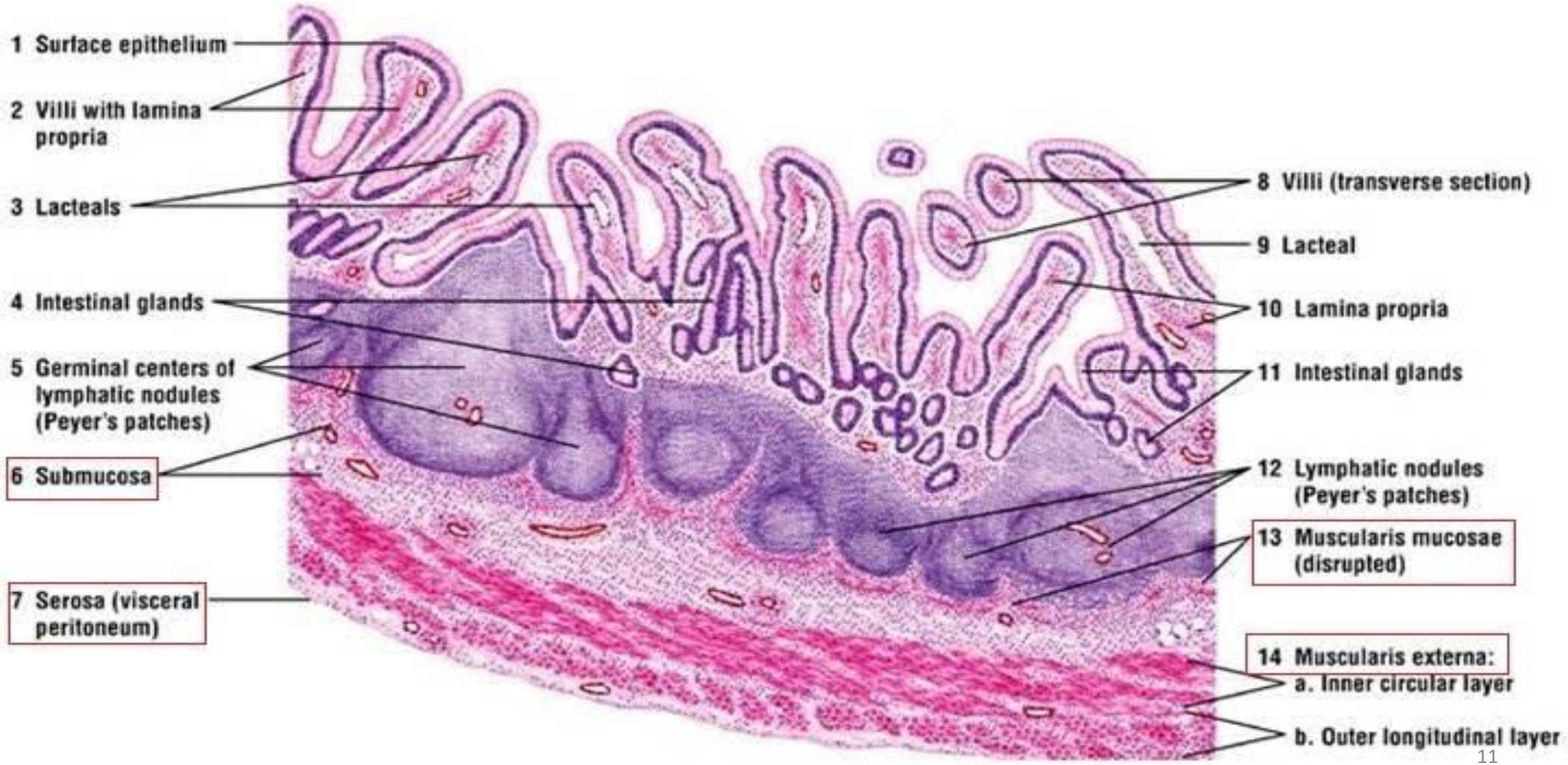
The duodenum




Intestinal glands
Lamina propria
Muscularis mucosae
Brunner's glands

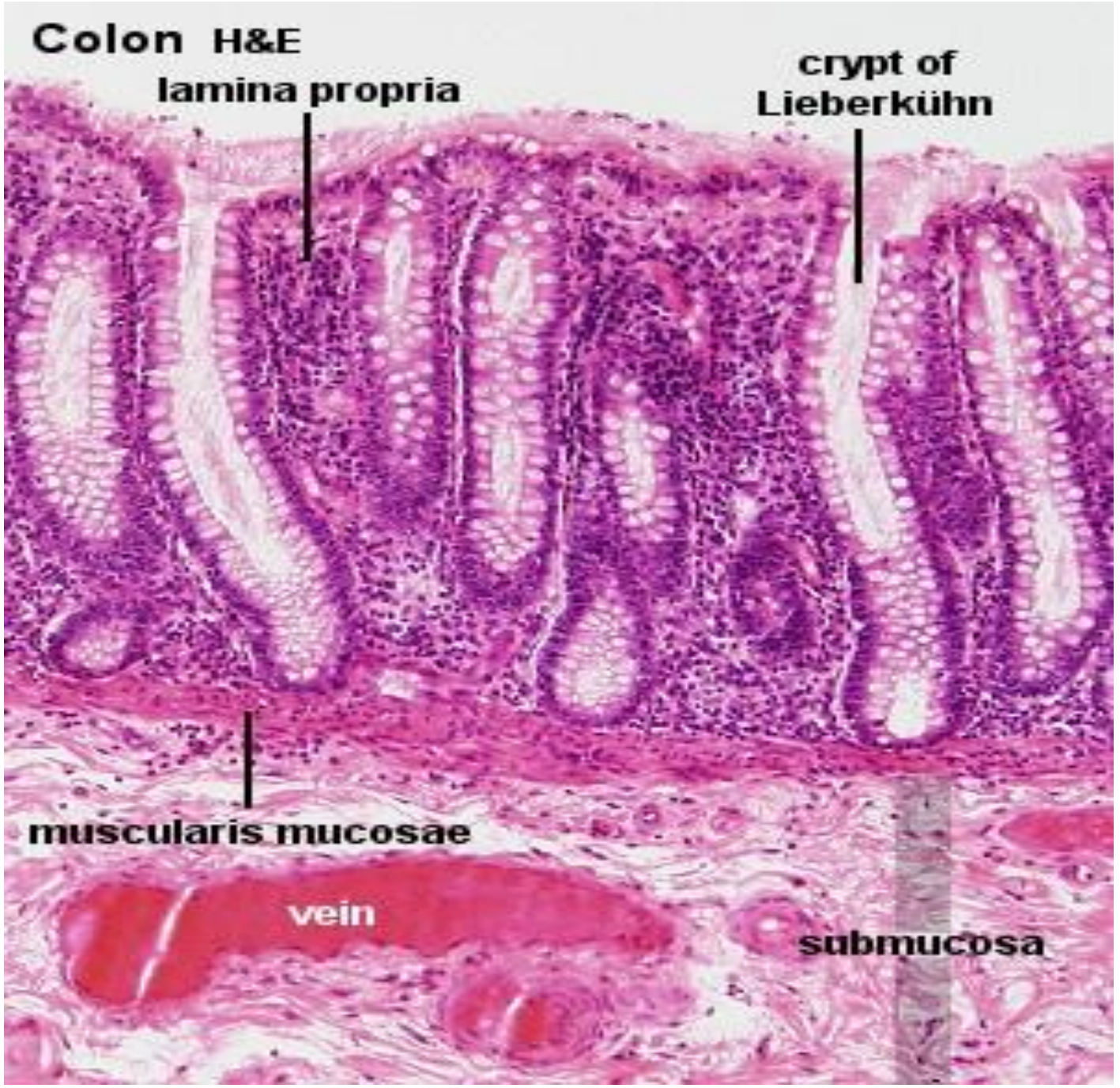

Slide 54 Jejunum
Mucosa
Submucosa
Muscularis externa
Serosa

The ileum

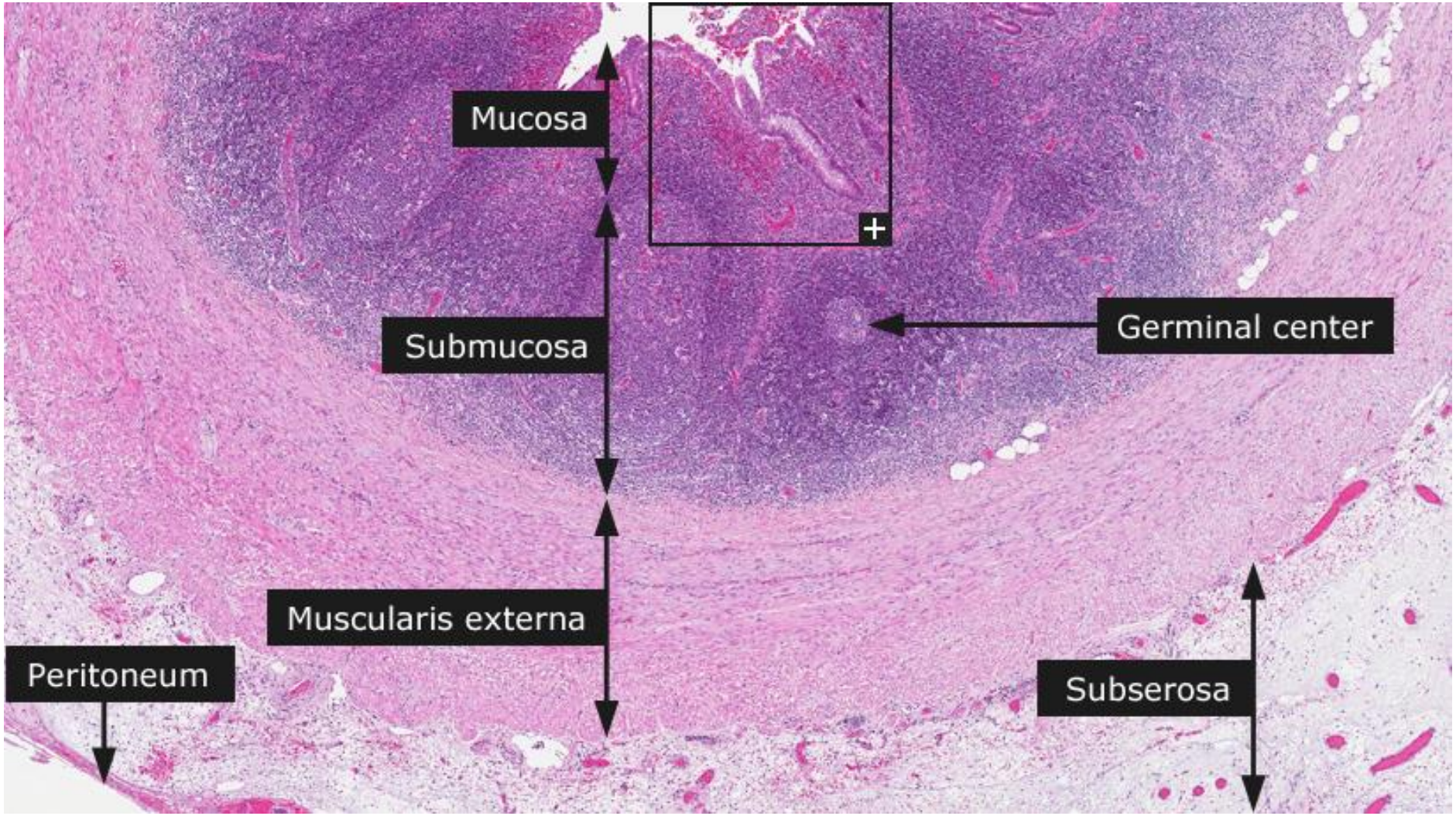

1 Surface epithelium
2 Villi with lamina propria
3 Lacteals
4 Intestinal glands
5 Germinal centers of lymphatic nodules (Peyer's patches)
6 Submucosa
7 Serosa (visceral peritoneum)
8 Villi (transverse section)
9 Lacteal
10 Lamina propria
11 Intestinal glands
12 Lymphatic nodules (Peyer's patches)
13 Muscularis mucosae (disrupted)
14 Muscularis externa:
a. Inner circular layer
b. Outer longitudinal layer

Large Intestine (Colon)

- The large intestine is situated between the anus and the terminal end of the ileum. It is shorter and less convoluted than the small intestine. It consists of an initial segment called the **cecum**, and the ascending, transverse, descending, and sigmoid colon, as well as the rectum and anus. **Chyme** enters the large intestine from the ileum through the ileocecal valve. Unabsorbed and undigested food residues from the small intestine are forced into the large intestine by strong peristaltic actions of smooth muscles in the muscularis externa. The residues that enter the large intestine are in a semifluid state; however, by the time they reach the terminal portion of the large intestine, these residues become semisolid feces.


Colon H&E
lamina propria
crypt of
Lieberkühn
muscularis mucosae
vein
submucosa

Appendix


Mucosa
Submucosa
Muscularis externa
Peritoneum
Germinal center
Subserosa

Rectum