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BIOL 244L HUMAN ANATOMY AND PHYSIOLOGY II LABORATORY
DIGESTION II

DIGESTIVE HISTOLOGY

The digestive tract tube is composed of layers of tissues, and these same layers are generally present at all levels of the tract. As the different actions of the digestive process (secretion, mixing-motility, and absorbtion) have differing emphasis along the tract, the tissue layers performing these functions will have different emphases and elaborations along the tract. As you work through the slides moving down the digestive tract, look for features that distinguish the different segments of the digestive tract tube and allow you to identify the particular segments.

1. **Salivary glands**: Use slide labeled "Submandibular gland, Monkey", and refer to the illustration in the textbook. **Acini** (from Latin acinus = "grape") are small spherical groups of cells that form a functional unit in a gland, in this case the acini secrete the saliva. All the purple cells are **serous cells**, and they secrete salivary amylase. This is the enzyme that breaks down polysaccharide chains of carbohydrates into smaller segments. The pale pink cells (or very pale, almost clear) are **mucous cells** and they secrete mucus which keeps the mouth moist and lubricates the food as it is chewed. What is the difference between mucus and mucous? It is the same stuff really: a mixture of protein and polysaccharide that functions as a lubricant, particle trapper (in the respiratory airways) and chemical buffer in the mucous membranes. The difference, then? Mucus is the noun and mucous is the adjective. Individual salivary gland acini may be made of only one of the 2 types of cells, or they may contain both cell types. The photomicrograph in the text does not show **salivary ducts**, but you can find them on our slides. They consist of a single layer of pinker cuboidal or columnar cells. You can recognize them most easily where they clearly form a hollow tube.

2. **Esophagus**: Use the slide labeled "Esophagus, Human". Look first with the naked eye. Turn the slide so the label is on the right and the printed with upside down lettering faces you. Hold the slide up to the light. The top, wavy, purple layer is the **epithelium**. The pale purple or pink (depending on the staining) thin layer just beneath the epithelium is the **Lamina propria**. Together, this epithelium and underlying connective tissue (lamina propria) and a thin layer of smooth muscle, the **muscularis mucosae** (visible when you use the microscope below), make up the **mucosa**. The middle and most pale layer is the **submucosa**. The thick, bright purple bottom layer is the **muscularis**. Note that the muscularis can be seen to be composed of two layers even with the naked eye. Look also at the text illustration of the esophagus. The general illustration of the layers of the digestive tract in the text figure on the structure of the digestive tract is useful for studying the relative dimensions of the different layers as we proceed down the digestive tract.

Turn the slide around, so the label is right-side-up and examine it with the microscope beginning with the 4X objective. Using the 4X and then the 10X objective find the layers described above. At these higher powers the appearance of the **stratified squamous epithelium** and pale fibrous texture of the submucosa will help you. Switch to the 40X objective to see the details. Just outside the lamina propria is the **muscularis mucosae** which is darker pink in appearance and makes a clear boundary with the submucosa connective tissue further out. The individual fibers of the **muscularis** are too close together for us to see them; we see only the two layers, but the inner layer is composed of a circular arrangement of muscle fibers and the outer layer is longitudinal. The stratified squamous epithelium of the esophagus resists the frictional forces as the food is swallowed; that is the older cells at the lumen of the esophagus slough off under frictional stress during swallowing. The **bolus**, or unit mass of food moving in the digestive tract, may still have a lot of rough edges in the esophagus. There is mucous secretion in the esophagus, but it primarily

comes from subepithelial glands rather than the epithelium itself. The submucosa contains lots of blood vessels to supply the tissues of the esophagus.

3. **Stomach**: Use the slides labeled "Stomach, fundus, Monkey" and "Stomach, fundus, human" as well as the illustrations in the text on the stomach lining. As we did for the esophagus, first look at the slide without the microscope. Turn the slide so the label is on the right with the printed side facing you. Note that all the layers are comparatively thin. the **mucosa** is purple, the **submucosa** is pale and thin, and the **muscularis** is red or pink.

Turn the slide around so the label is right side up for reading. With the microscope's 4X, then 10X, objective lenses, find a "level" region (not too convoluted) to examine. The epithelium is now **simple columnar**, and shows in section the channels of the **gastric pits**. In the lower portions of the gastric pits are the **gastric glands** showing as a slightly more dense purple stain. The secretion includes hydrochloric acid and the proteolytic enzyme pepsin (secreted as the inactive precursor pepsinogen). All these structures are in the **mucosa**. The **submucosa** appears somewhat shredded because the collagen fiber bundles split during histological preparation, but the **muscularis** layer is thick and solid. We cannot see the individual fibers in the muscularis, but the nuclei show us where the fibers are. Switch to the 40X objective to see the details. Once the stomach contents are processed with HCl and pepsin, the proteins holding food materials together are fragmented and the stomach contents has a soupy consistency with suspended solids. This is now called chyme, and anyone who has ever been nauseous and vomited knows what chyme looks like. Chyme is passed on to the small intestine.

4. **Small Intestine:** There are some structural differences between the three parts of the small intestine (duodenum, jejunum, and ileum) even though they appeared similar from the outside when you dissected the cat. We will use sections of the duodenum and ilium to study the features of the small intestine as a whole, and to contrast a few of the differences between the regions. There is a text illustration of a section of the small intestine and villi (which means "shaggy hair" in latin) at the level of the jejunum. Look at the slides first without the microscope, turning them as we did above. Note that all the layers are thin. The **villi** are just barely visible with your naked eye (but do not confuse them with the larger **folds** of the entire mucosa).

Duodenum: Use two slides, one labeled "Duodenum Human", and the second labeled "Duodenum, upper, Monkey". With the label right side up, and with the microscope's 4X, then 10X, objective lenses, find a region similar to the text illustration of the intestinal wall. Observe the **villi**, their **simple columnar epithelium**, the **crypts** (intestinal glands) between the villi, the **lamina propria** inside the villi and between the crypts, the pale **submucosal (Brunner's) glands** in the **submucosa**, and the **muscularis** below the submucosa. The crypt cells secrete digestive enzymes and hormones controlling the digestive process. The submucosal (Brunner's) glands secrete an alkaline mucus that assists in neutralizing stomach acid in the chyme. They are dense in the duodenum, but disappear in passage to the jejunum and ilium. As usual, we cannot see the individual fibers in the muscularis, but the nuclei show us where the fibers are, and in some preparations, you can get a sense that the fibers run in different directions. Switch to the 40X objective to see the details.

In some areas, the ends of the epithelial cells next to the lumen can be seen to be more than a single line (use 40X objective). The layer between the two lines of this "double line" is the **brush border** because on good preparations it is seen to be made of many, many short, parallel lines like the bristles of a brush. The brush border actually represents the layer of **microvilli** on the outer ends of the epithelial cells. The villi increase the surface area of the intestine for secretion and absorption and the microvilli increase this area even further. See the illustration in Chapter 24 of villi. You can also see an electron microscope photo and diagram of microvilli on a single epithelial cell in Chapter 3 and Chapter 4 to appreciate this idea of microvilli upon villi.

Ilium: Use the slide labeled "Ilium, Human". First, hold the slide up to the light for viewing with the

naked eye. There are folds of mucosa too large to be villi. These are **plicae circularis**, and we saw these in the section of small intestine in the cat last time. The **villi** appear to the eye as a fringe of projections along the plicae circularis. Now, under the microscope at low power, the **muscularis mucosae** tracks along with the folded plicae circularis just beneath the mucosa. The submucosa is much thinner compared to that in the duodenum. This layer is mostly connective tissue and does not contain the submucosal Brunner's glands. At higher power, looks again at the villi for the double line appearance of the brush border.

5. **Large intestine**: Use the slide labeled "Colon, Human" and the illustrations in your textbook in Chapter 24. With the microscope's 4X, then 10X, objective lenses, find a "level" region to examine. Observe the **Simple columnar epithelium**, the **intestinal glands**, the **goblet cells** in the intestinal glands, the **lamina propria** between the intestinal glands, the pale, fibrous **submucosa**, and the thick and more red 2-layered **muscularis**. Goblet cells in the intestinal glands secrete mucus for lubrication of the passage of colonic contents, while most of the other cells in the glands have the business of absorbing rather than secreting. Here they are absorbing water and ions to recover almost all of the remaining fluids secreted earlier and not already absorbed by the small intestine. Switch to the 40X objective to see the details.

Between the bottoms of the intestinal glands and the submucosa is a darker pink area with some of the oblong nuclei of smooth muscle fibers. This is the **muscularis mucosae** layer of the mucosa. Although it is present in other regions of the digestive tract, it is most apparent on the tissue preparations of the colon. Find one of the areas where the mucosa is interrupted by a cluster of thousands of very closely spaced, dark purple staining nuclei with nothing else present. This is a **lymphatic nodule**. You may have seen these in other sections of the digestive tract, but they are particularly numerous in the large intestine. These lymphatic nodules are a line of immunological defense lying just below the epithelium to intercept foreign microorganisms that may pass into the body from the digestive tract.

6. **Appendix**: Use the slide labeled "Appendix, Human". Looking first at the slide with the naked eye, note the circular shape that resulted from sectioning a human appendix like slicing a sausage. This metaphor is not such a stretch; processed meats are traditionally packaged in "casings," which are submucosal connective tissues from intestines and thoroughly biodegradable packaging. As usual, the **mucosa** is purple, the **submucosa** is pale, and the **muscularis** is pink. With the microscope's 4X, then 10X, objective lenses, find the **lumen**, with its lining of **simple columnar epithelium**, the **intestinal glands**, the **goblet cells** (these appear similar to the rest of the large intestine), the **lamina propria** between the intestinal glands (may be a bit tricky to distinguish), the **submucosa**, and finally the more red **muscularis** with its oblong nuclei of smooth muscle fibers. Switch to the 40X objective to see the details.

The unique feature of the appendix is the almost continuous layer of **lymphatic nodules** that lie mostly just below the intestinal glands. Each nodule is a cluster of thousands of very closely spaced, dark purple nuclei and little else present. The **lamina propria** here in the appendix is also dense with lymphoid cells.