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A. Oral Cavity
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2. Soft palate
3. Tongue
4. Tooth
B. Gastrointestinal Tract
1. Esophagus
2. Stomach
3. Small Intestine
   a. Duodenum
   b. Jejunum
   c. Ileum
4. Colon and Appendix
5. Rectum and Anal Canal
C. Accessory Organs
1. Salivary Glands
   a. Sublingual
   b. Submandibular
   c. Parotid
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IV. Summary
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Keywords
Adventitia
Ameloblasts
Autonomic ganglia
Bile duct
Cementum
Central vein
Chief (peptic) cells
Circumvallate papillae
Colonic glands
Dental pulp
Dentine
Duodenal glands
Duodenum
Enamel
Enterocytes
Excretory ducts
Filiform papillae
Fungiform papillae
G (gastrin) cells
Gallbladder
Gastric glands
Gastric pit
Gastroesophageal junction
Gingiva
Goblet cell
Hepatic artery
Hepatic plate
Hepatic portal vein
Hepatic sinusoids
Hepatocytes
Ileum
Interlobular duct
Intestinal crypt
Intralobular duct
Ito cells
Jejunum
Kupffer (macrophage) cells
Lacteal
Large intestine (colon)
Liver
Lobules
Mucosa
Mucous glands
Mucous neck cells
Muscularis
Muscularis mucosae
Myenteric plexus
Odontoblasts
Oral cavity
Oral mucosa
Pancreas
Pancreatic islets
Parietal cells
Paneth cells
Parotid cells
Periodontal ligament
Plicae circulares
Portal tract
Portal triad
Predentine
Pyloric glands
Secretory acini
Serosa
Small intestine
Stomach
Striated border
Striated ducts
Sublingual gland
Submandibular gland
Submucosa
Submucosal plexus
Surface mucous cells
Taeniae coli
Taste bud
Tongue
Tooth
Villi
von Ebner’s glands
the lips are mucocutaneous junctions, transitioning from the skin lining the external surface of the lip to the oral mucosa lining the internal surface; the vermilion border (Lt. "little worm"), on the anterior aspect of the lip, is the dry, hair-free area between the outer cutaneous and inner mucosal surfaces; the core of the lip is composed of skeletal muscle and a connective tissue submucosa containing clusters of minor salivary glands (labial glands)
the palate separates the oral cavity from the nasal cavity; the anterior aspect of the palate contains bony processes of the maxillae and palatine bones providing a rigid core to the tissue and is aptly named the hard palate; the soft palate is located posterior to the hard palate and lacks the bony core; it consists of a superior nasal mucosa, lined by respiratory epithelium, overlying a core of skeletal muscle; the inferior surface of the palate is lined by oral mucosa with extensive mucous glands (minor salivary glands) within the submucosa
the tongue consists of an extensive core of skeletal muscle covered by a surface mucosa of stratified squamous epithelium; the complex embryology of the tongue results in the posterior 1/3 of the tongue being separated from the anterior 2/3 of the tongue by the sulcus terminalis; the two parts of the tongue differ in epithelial origins and innervation; the anterior 2/3 of the dorsal (superior) surface of the tongue is covered by a variety of projections (papillae): filiform papillae are the most numerous and contain keratinized tips; fungiform papillae are scattered amongst the filiform but are localized mainly at the tip of the tongue; the large 8-12 circumvallate papillae are located in a row along the anterior border of the sulcus terminalis
the above slide is from the back of the tongue, just anterior to the *sulcus terminalis*; one large *circumvallate papilla* (Lt. "surrounded with walls") is seen surrounded by a marginal sulcus (deep furrow) and underlying *von Ebner’s glands* within the lamina propria and submucosa; the serous glands drain into the “moats” (sulci) surrounding the 8-12 circumvallate papillae and wash out debris ensuring the *taste buds* lining the sides of the papilla are accessible and able to respond to new stimuli
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Slide 63 (NW): Rabbit Tongue, H&E

the above slide shows a rabbit tongue with numerous foliate papillae (Lt. “leafed”); foliate papillae are not well developed in humans and are primarily restricted to the sides of the tongue; papillae (all types except filiform) are associated with taste buds consisting of a cluster of 60-80 pale-staining, spindle-shaped cells with an apical taste pore allowing molecules to contact receptors on the microvilli of the neuroepithelial taste cells
the root of the tongue (posterior to the *sulcus terminalis*) lacks the papillae found on the dorsum of the anterior 2/3 of the tongue; it generally has a smooth appearance except for the "bumps" from the *lingual tonsils* and other, smaller lymphoid nodules.
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**Slide 129: Tooth, H&E**

crown
(clinical portion)
portion of tooth above the gingiva
dentine, which in the crown is normally covered by enamel – the hardest substance in the body, consisting of 96% hydroxyapatite – which has been dissolved away in this slide so is not seen
gingiva (or gums)
oral mucosa that overlays the alveolar processes mandible and maxillae bones
dental pulp in pulp cavity (space)
loose CT, fibroblasts, mesenchymal stem cells, nerves, and odontoblasts which line the periphery
alveolar bone
thickened portions of bone of the mandible and maxillae bones that contains the dental alveoli (Lt. “basins”) that hold the teeth
the root of the tooth consists primarily of calcified, acellular dentine surrounding the pulp cavity; covering the dentine is cementum – the third type of specialized mineralized tissue (also enamel and dentine) found in teeth; cementum is similar to bone and is produced by cementoblasts located adjacent to the periodontal ligament – like bone, the cementoblasts become cementocytes once encased within the mineralized ECM; the periodontal ligament contains a mixture of loose and dense CT with fibroblasts and attaches the tooth to the alveolar bone
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Slide 130 (low): Fetal Skull

enamel is produced by ameloblasts (specialized epithelial cells) of the enamel organ from the oral epithelium (thus enamel is derived from oral ectoderm while dentine and cementum are derived from mesenchyme); dentine is produced first, by the tall columnar odontoblasts lining the periphery of the dental pulp; after the dentine is formed, the tall columnar ameloblasts deposit enamel upon the dentine on the part of the tooth that will be the crown and cementoblasts deposit cementum on the part that will be the root; ameloblasts and the enamel organ degenerate upon tooth eruption, while odontoblasts and cementoblasts persist throughout life.
Introduction to the GI Tract

1. The gastrointestinal tract (GI tract), also known as the alimentary canal, is a continuous, epithelial-lined tube running from the oral cavity to the anus.

2. As it is a single tube, it is more appropriate to speak of segments of the GI tract (e.g., esophagus, stomach, small intestine, large intestine) instead of individual organs.

3. Surrounding the central lumen, the wall of the tube is composed of four distinct layers:
   - Mucosa
   - Submucosa
   - Muscularis (also known as the muscularis externa or muscularis propria)
   - Adventitia or serosa

4. While all of the GI tract segments have the same four layers, the individual segments (e.g., small intestine) and even specific segments such as the duodenum and ileum of the small intestine, can be identified based upon the unique characteristics of the layers for a given segment; these unique characteristics reflect the functions of the segment.
### Layers of the Gastrointestinal (GI) Tract

<table>
<thead>
<tr>
<th>General Layer</th>
<th>Specific Layer</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mucosa</strong></td>
<td>Epithelium</td>
<td><strong>Stratified squamous epithelium</strong> (for protection) in the oral cavity, pharynx, esophagus, and anal canal</td>
</tr>
<tr>
<td></td>
<td>Lamina propria</td>
<td>Thin layer of loose CT beneath the epithelium; it supports the epithelium and contains a diffuse population of resident and wandering cells (e.g., fibroblasts and lymphocytes)</td>
</tr>
<tr>
<td></td>
<td>Muscularis mucosae</td>
<td>Thin layer of smooth muscle of the mucosa; separates the mucosa from the underlying submucosa; functions to allow localized agitation/movement of the mucosa</td>
</tr>
</tbody>
</table>

**Submucosa** (w/ Meissner’s plexus)  
Dense CT with larger blood vessels and lymphatics; glands and lymphoid tissue may also be present; Meissner’s plexus provides autonomic innervation of mucosal glands and the muscularis mucosae

**Muscularis** (w/ Auerbach’s plexus)  
**Innermost oblique**  
Innermost layer of smooth muscle found only within the stomach  
**Inner circular**  
Thick layer of muscle with two specific layers separated by thin layer of CT; most muscle is smooth but skeletal muscle may also be present (e.g., upper 1/3 of esophagus); contraction mixes and propels luminal contents forward; Auerbach’s plexus is found between muscle layers and provides autonomic innervation  
**Outer longitudinal**  

**Serosa/Adventitia**  
Outermost covering of the GI tract; adventitia is a thick layer of CT, lacking mesothelium, that merges into surrounding tissues – it covers structures outside of the abdominal cavity, e.g., most of the esophagus, rectum, and anal canal; serosa is a thin layer of CT covered by mesothelium (simple squamous epithelium) – it covers most of the GI tract within the abdominal cavity
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#### B. Gastrointestinal Tract

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3. Small Intestine
   - a. Duodenum
   - b. Jejunum
   - c. Ileum
4. Colon and Appendix
5. Rectum and Anal Canal

#### C. Accessory Organs

1. Salivary Glands
   - a. Sublingual
   - b. Submandibular
   - c. Parotid
2. Pancreas
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### IV. Summary

**Characteristics of the Esophagus**

<table>
<thead>
<tr>
<th>General Layer</th>
<th>Specific Layer</th>
<th>Esophagus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mucosa</strong></td>
<td>Epithelium</td>
<td>nonkeratinized stratified squamous epithelium</td>
</tr>
<tr>
<td></td>
<td>Lamina propria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muscularis mucosae</td>
<td>prominent (depending on location)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Submucosa (w/ Meissner’s plexus)</th>
<th>esophageal (submucosal) glands</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Muscularis (w/ Auerbach’s plexus)</th>
<th>Inner circular</th>
<th>thick; skeletal in upper 1/3 of esophagus, smooth in lower 2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer longitudinal</td>
<td>thick; skeletal in upper 1/3 of esophagus, smooth in lower 2/3</td>
<td></td>
</tr>
</tbody>
</table>

| Serosa/Adventitia | adventitia (serosa at lower end) |
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Slide 66: Esophagus, H&E

the four layers of the GI tract wall (mucosa, submucosa, muscularis, and adventitia) are readily identifiable on the above slide; the muscularis mucosae (arrows) is more prominent in the esophagus than elsewhere in the GI tract; nervous tissue (•) of the Auerbach’s myenteric plexus, within the layers of the muscularis, is easily seen
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Slide 66: Esophagus, H&E

- non-keratinized stratified squamous epithelium
- lamina propria consisting of loose CT with small vessels and generally an abundance of lymphoid cells
- muscularis mucosae smooth muscles fibers are oriented longitudinally in the esophagus
- submucosa consisting of CT with larger vessels and relatively fewer cells than in the lamina propria

the mucosa of the esophagus consists of a thick, protective non-keratinized stratified squamous epithelium (after the esophagus stratified squamous epithelium is not seen again until the anal canal); connective tissue papillae of the lamina propria (similar to the dermal papillae of the skin) project upward into the epithelium and are rich in capillaries; the muscularis mucosae (Lt. "muscular layer of the mucosa") is a layer of smooth muscle at the border between the mucosa and the submucosa; it is thickest in the esophagus and has longitudinally oriented fibers (in relation to the GI tract) here but elsewhere the fibers lack a clear orientation
the **muscularis mucosae** on this slide is deceptively prominent; several **esophageal glands** are visible; they are mucous glands that aid in the lubrication of the mucosal surface; the esophagus is one of two places in the GI tract where submucosal glands exist – the other being the Brunner’s glands within the submucosa of the proximal aspect of the duodenum (the first segment of the small intestine)
except for the stomach, all of the GI tract contains a **muscularis** (**externa** or **propria**) composed of two layers of muscle (principally smooth muscle): an **inner circular layer** and an **outer longitudinal layer** which are named according to the direction of their muscle fibers in relation to the long axis of the GI tract; between the layers of muscle there is connective tissue with vasculature and nervous tissue of **Auerbach's myenteric plexus**, containing nerve fibers and ganglia (parasympathetic) for innervation of the muscularis and regulation of peristalsis; small neurons and satellite cells are present at the arrows
the upper 1/3 of the *muscularis* in the esophagus contains skeletal muscle (voluntary control), instead of the smooth muscle (involuntary) found in the majority of the GI tract; the above slide shows the transition between the upper skeletal muscle and the lower smooth muscle fibers of the muscularis, so both types are seen intermixed; after the upper 1/3 of the esophagus, skeletal muscle does not reappear until the external anal sphincter in the anal canal
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the gastroesophageal junction (various names exist) marks the transition between the esophagus and the cardia of the stomach; at the z-line (clinical terminology), the epithelium changes from stratified squamous to simple columnar; the mucosa loses its smoothness and becomes folded into gastric pits into which drain the underlying cardiac glands (mucous glands), which are only found in this region of the stomach.
Characteristics of the Stomach

<table>
<thead>
<tr>
<th>General Layer</th>
<th>Specific Layer</th>
<th>Stomach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mucosa</strong></td>
<td><strong>Epithelium</strong></td>
<td>simple columnar epithelium w/ surface mucous cells; depressions (gastric pits) lead to gastric glands w/ mucous neck cells, parietal cells, and chief cells</td>
</tr>
<tr>
<td><strong>Lamina propria</strong></td>
<td>very thin between glands</td>
<td></td>
</tr>
<tr>
<td><strong>Muscularis mucosae</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Submucosa** (w/ Meissner’s plexus) | folds with the mucosa to form rugae |

| **Muscularis** (w/ Auerbach’s plexus) | Innermost oblique | additional layer of muscularis |
| Inner circular | thickens to form pyloric sphincter at junction with duodenum |
| Outer longitudinal | |

| **Serosa/Adventitia** | serosa |
the stomach is divided into four anatomic regions: cardia, fundus, body, and pylorus; the body and fundus collectively constitute 2/3 of the stomach, have identical histology, and are represented on the above slide – they are distinguished from the cardia and pylorus by the type of glands present within the mucosa; the mucosa of the stomach is generally much thicker than in other regions of the GI tract due to the abundance of glands; in a non-distended stomach, the mucosa and submucosa contract into large longitudinal folds called rugae which flatten and are not visible when the stomach is stretched with food/liquid
the luminal surface of the mucosa consists of simple columnar epithelium (surface mucous cells) invaginated into small openings called gastric pits, which are the duct portions of the underlying glands; deep to the pits are the simple branched tubular gastric glands; several glands converge to drain into a single gastric pit; the loose CT of the lamina propria surrounds the glands and is generally inconspicuous; the muscularis mucosae, usually appearing as two layers, separates the mucosa from the deeper submucosa connective tissue
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**Slide 101: Stomach, H&E**

- **Surface mucous cells** extend into the gastric pits; they are tall cells with oval, euchromatic nuclei displaced basally while the apical portion has a characteristic pale-staining "mucous cup" appearance; **mucous neck cells** have more granules and polyribosomes than surface mucous cells so stain more readily; they are found within the neck of the glands, squeezed between parietal cells; **parietal cells** have a characteristic "fried egg" appearance with a central, round nucleus and intensely eosinophilic cytoplasm due to abundant mitochondria; within the base of the glands, **chief cells** have basally-displaced nuclei with basophilic, granular cytoplasm.
the **pylorus** is the most distal region of the stomach, adjacent to the duodenum; **pyloric glands** replace the gastric glands of the body/fundus; the gastric pits become much thicker than in the body, and the glands are composed almost entirely of mucous secretory cells (i.e., parietal cells and chief cells are no longer present)
the pylorus (Gr. "gatekeeper") is the distal region of the stomach as it prepares to transition into the small intestine (duodenum); the mucous pyloric glands are simple branched tubular glands, with several glands draining into a common gastric pit which empties onto the luminal surface; the gastric pits are much deeper in the pylorus than in the body/fundus and typically extend at least half the depth of the mucosa
The **gastroduodenal junction** occurs at the transition between the pylorus (stomach) and the duodenum and marks the start of the absorptive portion of the GI tract; the inner circular layer of smooth muscle of the muscularis thickens to become the **pyloric sphincter**; as the circular layer thickens, the innermost oblique layer disappears and is not found in the duodenum or the remainder of the GI tract.
### Characteristics of the Specific Segments of the Small Intestine

<table>
<thead>
<tr>
<th>General Layer</th>
<th>Specific Layer</th>
<th>Small Intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mucosa</strong></td>
<td>Epithelium</td>
<td>Duodenum</td>
</tr>
<tr>
<td></td>
<td>villi w/ enterocytes and goblet cells (villi are broad and leaf-shaped) crypts/glands w/ Paneth cells</td>
<td>Jejunum</td>
</tr>
<tr>
<td></td>
<td>Lamina propria</td>
<td>lymphoid tissue inconspicuous</td>
</tr>
<tr>
<td></td>
<td>Muscularis mucosae</td>
<td></td>
</tr>
<tr>
<td><strong>Submucosa</strong></td>
<td></td>
<td>Duodenum</td>
</tr>
<tr>
<td>(w/ Meissner’s plexus)</td>
<td>plicae circulares (permanent folds with mucosa) are absent in initial portion; very large in lower portion</td>
<td>Jejunum</td>
</tr>
<tr>
<td></td>
<td>Brunner (duodenal) glands</td>
<td></td>
</tr>
<tr>
<td><strong>Muscularis</strong></td>
<td></td>
<td>Duodenum</td>
</tr>
<tr>
<td>(w/ Auerbach’s plexus)</td>
<td>Inner circular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outer longitudinal</td>
<td></td>
</tr>
<tr>
<td><strong>Serosa/Adventitia</strong></td>
<td></td>
<td>Duodenum</td>
</tr>
</tbody>
</table>

General trends: (1) villi become shorter distally, (2) lymphoid tissue increases distally, (3) proportion of goblet cells increases distally.
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Slide 132 (NW): Small Intestine Composite

- Look for:
  - Brunner’s glands in submucosa
  - Long, thin villi
  - Prominent plicae circulares
  - Peyer’s patches
  - Numerous Paneth cells
Slide 4: Duodenum, BF, PAS

The small intestine, represented by the duodenum on the above slide, has the same wall layers as seen elsewhere in the GI tract (mucosa, submucosa, muscularis, and adventitia/serosa).
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Slide 158: Jejunum

the small intestine contains three types of surface projections that serve to greatly increase its surface area:
- plicae circulares (Lt. “circular folds”) are large folds of the mucosa and submucosa and increase the surface area 3x;
- villi, folds of the mucosa, increase the surface area 10x;
- microvilli, on the apical surface of the enterocytes, increase the surface area 20x; collectively these three projections lead to a 600x increase of the surface area
the villous mucosa of the small intestine consists of simple columnar epithelium with enterocytes and interspersed mucous goblet cells; the mucosa is folded into projections called villi; large lymphatic vessels, called lacteals, are present within the lamina propria and extend upward into the villi; abundant lymphoid tissue with a diverse array of permanent and wandering cells is found within the lamina propria
Slide 131 (NW): Ileum

**Intestinal crypts/glands** (crypts of Lieberkühn) are invaginations of the epithelium, between the villi, that extend to the muscularis mucosae; at the base of the crypts are **Paneth cells** (not readily seen in all segments) which are distinguished by their intensely-eosinophilic secretory granules; they serve as part of the innate immune defense and secrete antimicrobial peptides; stem cells, goblet cells, and enteroendocrine cells are also present within the crypts.
the peritoneum (Gr. "stretched around") is a serous membrane, like the pericardium and pleura, covered by mesothelium (simple squamous epithelium); it lines the abdominal cavity with the parietal peritoneum lining the abdominal wall and the visceral peritoneum covering the majority of the GI tract as serosa (instead of adventitia); mesenteries are folds of peritoneum that suspend the GI tract from the abdominal wall; large vessels, lymphatics, and nerves travel through the mesenteries to reach the serosa of the GI tract; the parts of the GI tract that do not have a serosa are attached directly to the cavity wall with adventitia
the **duodenum** (lt. "twelve") is the first, shortest (about 12 finger-widths long), and widest segment of the small intestine; it is principally characterized by the presence of submucosal glands (**Brunner’s glands**), shown at the arrows above, which are mucous glands to buffer gastric acid and protect the mucosa; the glands are found in the highest concentration in the proximal duodenum; **plicae circulares** begin to form distally as the duodenum transitions into the jejunum; unlike other parts of the small intestine, the duodenum is primarily retroperitoneal so overall it has both adventitia and serosa
the **jejenum** (L. "fasting") is the middle portion of the small intestine; it has well-developed **plicae circulares** giving it a large surface area and making it the main absorptive site in the GI tract; however it is generally identified through exclusion of the other possible segments: it does not have Brunner's glands (in duodenum) and it does not have Peyer's patches (in ileum)
the ileum is the terminal segment of the small intestine before joining the cecum of the large intestine; the transition from the jejunum is arbitrary, but overall the ileum has a thinner wall and is generally distinguished by the presence of large collections of lymphoid nodules (Peyer's patches), shown at the arrows above; Peyer's patches become more numerous in the distal ileum and are generally located on the side of the wall opposite to the mesentery attachment; while MALT is usually confined to the lamina propria of the mucosa, the Peyer’s patches are so large that they generally disrupt the muscularis mucosae and invade into the submucosa; Paneth cells are also common within the intestinal crypts.
### Lab 15 – Digestive System

**IUSM – 2016**

I. Introduction

II. Keywords

III. Slides

A. Oral Cavity
   1. Lip
   2. Soft palate
   3. Tongue
   4. Tooth

B. Gastrointestinal Tract
   1. Esophagus
   2. Stomach
   3. Small Intestine
      a. Duodenum
      b. Jejunum
      c. Ileum
   4. Colon and Appendix
   5. Rectum and Anal Canal

C. Accessory Organs
   1. Salivary Glands
      a. Sublingual
      b. Submandibular
      c. Parotid
   2. Pancreas
   3. Liver
   4. Gallbladder

IV. Summary

#### Characteristics of the Large Intestine

<table>
<thead>
<tr>
<th>General Layer</th>
<th>Specific Layer</th>
<th>Large Intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mucosa</strong></td>
<td>Epithelium</td>
<td>“smooth” mucosa lacking villi or plicae circulares</td>
</tr>
<tr>
<td></td>
<td></td>
<td>colonic glands (lack Paneth cells; arranged in orderly pattern)</td>
</tr>
<tr>
<td>Lamina propria</td>
<td>absence of lymphatic vessels; extensive GALT</td>
<td></td>
</tr>
<tr>
<td>Muscularis mucosae</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Submucosa (w/ Meissner’s plexus) | | |

| Muscularis (w/ Auerbach’s plexus) | Inner circular | generally prominent myenteric plexus below |
|                                   | Outer longitudinal | taeniae coli (condensed longitudinal bands of muscle) |

| Serosa/Adventitia | both; adipose-filled pouches called epiploic appendices |
the colon (large intestine) is the 1.5m long segment of the GI tract between the small intestine and anal canal; the wall is composed of the same four layers as seen elsewhere in the GI tract; the mucosa is relatively smooth/flat, lacking the villi seen in the small intestine; the outer longitudinal layer of the muscularis condenses into three longitudinal bands called taeniae coli; the serosa may contain adipose-filled pouches called epiploic appendices; several segments of the colon are retroperitoneal so have adventitia
the mucosa of the colon has a relatively flat surface without villi as seen in the small intestine; the mucosa contains a regular distribution of intestinal crypts (colonic glands) which are simple tubular glands seen both in longitudinal and cross section above due to sectioning of the tissue; the lamina propria is relatively inconspicuous and found between the glands
the colonic glands (intestinal crypts) are simple tubular glands composed largely of mucous goblet cells; the mucus plays an important role in protecting the mucosa and in regulating the colonic microbiome; the glands extend from the luminal surface down to the muscularis mucosae and are generally much longer than the glands of the small intestine; Paneth cells are normally absent from the crypts.
the taeniae coli (Lat. “ribbons of the colon”) are three longitudinal bands of smooth muscle formed from the outer longitudinal layer of the muscularis; they are equidistantly arranged around the colon and their tonic contraction causes small pouches of the colon called haustra (giving the “billowy” appearance seen at the gross level)
the **vermiform appendix** (Latin "worm-shaped appendage") projects from the cecum (first segment of the colon); the histology of the appendix is similar to that of the colon, however it contains vast amounts of MALT and large, very conspicuous **lymphoid nodules**; the **muscularis** lacks taeniae coli and is not generally well separated into inner and outer layers.
the **anorectal junction** marks the transition from the rectum (distal colon) to the anal canal; the epithelium abruptly changes from the simple columnar epithelium of the colon to stratified columnar and then non-keratinized stratified squamous; the muscularis mucosae begins to disappear; the inner circular layer of the muscularis thickens to become the *internal anal sphincter* and skeletal muscle forms the *external anal sphincter*
the **anal canal** is the final segment of the GI tract transitioning between the mucosa of the rectum (simple columnar epithelium) and the epidermis of the skin (keratinized stratified squamous epithelium); the muscularis mucosae is no longer present and connective tissue papillae (dermal papillae) become much more pronounced.
Characteristics of the Major Salivary Glands

**Slide 117 (NW): Sublingual**

- **Sublingual gland**
  - Mixed sero-mucus gland, but mostly mucous

**Slide 116 (NW): Submandibular**

- **Submandibular gland**
  - Mixed sero-mucus gland, but mostly serous
  - Serous demilunes

**Slide 115 (NW): Parotid**

- **Parotid gland**
  - Serous gland only

All of the major salivary glands are compound, tubulo-acinar glands; they all have a connective tissue capsule with CT septa that divide the glands into lobules; myoepithelial cells surround the secretory units but are generally difficult to see; while location, size, and shape may be used in distinguishing the glands from each other, they are best identified based upon the predominate nature of their secretory units – either serous, mucous, or both.
the major salivary glands all share a common excretory pathway: saliva made by the secretory cells drain into the small central lumen of the acinus; the acini drain into a network of intralobular ducts, first into small intercalated ducts, of simple squamous or cuboidal epithelium and then into larger eosinophilic striated ducts of simple cuboidal epithelium (basal infoldings and abundant mitochondria produce the striated appearance); the intralobular ducts drain into larger interlobular ducts (generally with stratified epithelium) in the CT septa between the lobules; the ducts ultimately merge to form the main excretory duct of the gland.

**Slide 132: Parotid Gland**

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the sublingual salivary glands are located beneath the tongue in the floor of the mouth; they are a mixed gland of mucous and serous acini, but mucous acini predominate; the sublingual glands drain either directly into the floor of the mouth or into the main excretory duct (Wharton's) of the submandibular gland.
the **submandibular glands** are also mixed glands with serous and mucous acini; however, they are predominantly serous, distinguishing them from the sublingual glands (predominantly mucous); **serous demilunes** (L. “half moons”) may be seen “capping” mucous acini – these demilunes are likely artifacts and are simply normal serous acini displaced by the mucous acini during slide preparation.
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IV. Summary

Slide 132: Parotid Gland

the parotid glands are the largest of the salivary glands and are exclusively serous, easily distinguishing them from the other salivary glands; they have large, readily seen intralobular ducts (striated ducts); unlike the other salivary glands, adipocytes are commonly seen in the parotid gland and can help in identifying the gland; in large sections of the parotid gland, sections of the facial nerve (CN VII) may be seen (not seen on the above slide)