Typical Layers of the Alimentary Canal

- **Mucosa**
  - Epithelial lining
    - **Simple Columnar Epithelium** and Non-Keratinized Stratified Squamous Epithelium
  - Function
    - Selectively permeable layer, transport/absorption, digestions of food, and hormone and mucus production
  - Lamina propria
    - Loose connective tissue with glands, blood and lymph vessels, lymph nodules, nerve fibers
  - Muscularis mucosae
    - Smooth muscle (inner circular and outer longitudinal)
    - Function
      - Localized contractions

- **Submucosa**
  - Dense Irregular Connective Tissue
    - With blood and lymph vessels
  - May contain glands and lymphoid tissue
  - Meissner’s Submucosal Plexus (ANS)
    - Postganglionic parasympathetic cell bodies
      - Control motility and secretory activity

- **Muscularis**
  - Two layers of smooth muscle that cause peristalsis
    - Inner circular
    - Outer longitudinal
  - Auerbach’s Myenteric Plexus (ANS)
    - Between two muscular layers
    - Postganglionic parasympathetic cell bodies
    - Control peristalsis

- **Serosa/Adventitia**
  - Thin layer of loose connective tissue
  - Blood vessels, lymphatics, adipose tissue
  - Mesothelium covering
    - Continuous with mesentery (where applicable)
  - Location
    - Serosa – within abdominal cavity
    - Adventitia – outside abdominal cavity

- **Video recording**
  - Layers of the alimentary canal

- **Microscope Images**
  - 4x
**Tongue**

- **Function**
  - Propel digestive products to the esophagus
  - Formation of speech
  - Sensation of taste through various taste buds

- **Location**
  - Oral cavity

- **Structure**
  - Epithelium
    - Ventral surface
      - Nonkeratinized stratified squamous epithelium
    - Dorsal surface
      - Keratinized stratified squamous epithelium
  - Papillae
    - Filiform papillae
      - Numerous, keratinized
      - Elongated conical shape
      - Lack taste buds
      - Facilitate food movement
    - Fungiform papillae
      - Less numerous, lightly keratinized
      - Mushroom-shaped
      - Contain taste buds
    - Foliate papillae
      - Posterolateral aspect of tongue
      - Vertical furrows
      - Degenerate by adulthood
      - Contain taste buds
      - 4x, 10x, 40x
    - Vallate papillae
      - Least numerous and largest in size
      - Anterior to the sulcus terminalis
      - Contain taste buds
  - **Subepithelial layer**
    - Dense connective tissue
  - **Muscularis layer**
    - Skeletal muscle organized into strands perpendicular to each other
    - Superior longitudinal
    - Vertical
    - Inferior longitudinal

- **Video recording**
  - Tongue
• Microscope images
  o 4x
  o 10x
  o 40x
Esophagus

- **Function**
  - Muscular tube (~25cm) that conveys a bolus of food from the oral pharynx to the stomach

- **Location**
  - From the oral cavity through the thoracic cavity piercing the diaphragm at the esophageal hiatus to join the cardiac portion of the stomach
  - Contains an upper and lower esophageal sphincter

- **Structure**
  - **Mucosa**
    - Non-keratinized stratified squamous epithelium
    - Lamina propria
      - Esophageal cardiac glands
    - Muscularis mucosae
  - **Submucosa**
    - Dense irregular connective tissue
    - Esophageal (submucosal) glands
    - Meissner’s Plexus (ANS)
  - **Muscularis**
    - Proximal 1/3 – skeletal muscle
    - Middle 1/3 – skeletal and smooth muscle
    - Distal 1/3 – smooth muscle
    - Auerbach’s Myenteric Plexus (ANS)
  - **Adventitia/Serosa**
    - Adventitia – majority
    - Serosa – distal portion

- **Video recording**
  - Esophagus

- **Microscope Images**
  - 4x
  - 10x
  - 40x
**Stomach**

- **Function**
  - Churn food into chyme
  - Produce HCL, intrinsic factor and digestive enzymes

- **Location**
  - Epigastric region of abdominal cavity

- **Structure**
  - Four gross regions
    - Cardiac
    - Fundus
    - Body
    - Pylorus
  - Rugae
    - Longitudinal folds of the mucosa and submucosa
  - Mucosa
    - Fundic and body regions
      - Epithelium
        - Simple columnar epithelium with microvilli
          - “Surface lining cells”
          - Produce protective mucus to maintain neutral pH on surface of stomach wall
      - Gastric pits
        - Invaginations of epithelial layer into lamina propria
      - Gastric glands
        - From base of gastric pits to muscularis mucosae
        - Three Regions
          - Isthmus
            - Surface lining cells
              - Continuation from surface lining cells
            - Enteroendocrine/DNES/APUD cells
              - Secrete hormones (i.e. serotonin)
            - Stem cells
              - Differentiate into many cells of the gastric gland
              - Turnover 4-7 days
          - Neck
            - Mucous neck cells
              - Different from epithelial cells
              - Lubrication for gastric contents
            - Stem cells (see above)
            - **Parietal cells**
              - Eosinophilic cytoplasm
- Round nuclei
- Secrete HCL and intrinsic factor

**Base**
- Parietal cells (occasional)
- **Chief cells**
  - Basal located nuclei
  - Basophilic cytoplasm
  - Cytoplasmic granules
    - Secrete inactive enzyme pepsinogen
    - Activated into pepsin in presence of acidic environment
- Enteroendocrine cells (see above)

**Cardiac and pyloric regions**
- **Mucosa**
  - Shallow and coiled gastric pits
  - **Cardiac**
    - Same cell types as other regions; except no chief cells
  - **Pyloric**
    - Same cell types as other regions; except more mucous neck cells and secrete lysozymes
- Lamina propria – typical
- Muscularis mucosae – typical

- Submucosa – typical

- Muscularis
  - Three layers
    - Inner oblique layer
    - Middle circular layer
      - Forms pyloric sphincter
    - Outer longitudinal layer
  - Auerbach’s Myenteric Plexus (ANS)

- Serosa
  - Loose connective tissue
  - Covered with mesothelium

**Video recording**
- **Stomach**

**Microscope Images**
- 4x
- 10x
- 40x
Small Intestines

- **Function**
  - Site of terminal food digestion, nutrient absorption and endocrine secretion

- **Location**
  - Umbilical and hypogastric region of abdominal cavity

- **Structure**
  - Three regions
    - Duodenum, Jejunum and Ileum
  - Plica Circularis
    - Circular folds of mucosa and submucosa
  - Mucosa
    - Villi
      - Circular folds of mucosa
      - Leaf shaped in duodenum
      - Finger-like in jejunum and ileum
      - Most numerous in jejunum
    - Epithelium
      - Simple columnar epithelium with microvilli and goblet cells
    - Intestinal crypts
      - Short tubular glands between villi
      - Continuous epithelial layer from surface
        - Enterocytes
          - Microvilli create a brush border and secrete activating enzymes “brush border enzymes”
        - Goblet cells
          - Between enterocytes
          - Abundant in the ileum
          - Protect lining of small intestines
        - Paneth cells
          - Basal portion of crypt
          - Cytoplasm contains eosinophilic granules
            - Release lysozymes, phospholipase A2 and defensins
            - Immune function
        - Enteroendocrine cells
        - M (microfold) cells
  - Lamina propria – typical
    - Lymph vessels contain lacteals
      - Absorb large lipid molecules
  - Muscularis mucosae – typical
- Submucosa – typical
  - Duodenum
    - Brunner’s (duodenal) glands
      - Alkaline secretion
  - Ileum
    - Peyer’s Patches (MALT)
      - Lymphatic nodules occurring in large groups
      - 4x, 10x

- Muscularis – typical

- Serosa – typical
  - Some parts of duodenum retroperitoneal so contain adventitia
  - Mostly serosa

- Video recording
  - Duodenum
  - Jejunum
  - Ileum

- Microscope Images
  - Duodenum
    - 4x
    - 10x
    - 40x
  - Jejunum
    - 4x
    - 10x
    - 40x
  - Ileum
    - 4x
    - 10x
    - 40x
**Large Intestines**

- **Function**
  - Absorption of digestive end products
  - Formation of feces from chyme

- **Location**
  - Throughout all quadrants of abdominal cavity

- **Structure**
  - **Subdivisions**
    - Cecum, colon, rectum, anus
  - **Mucosa**
    - **Epithelium**
      - Simple columnar epithelium
        - Microvilli
        - Abundant goblet cells
    - **Intestinal crypts**
      - Similar to small intestines; except no Paneth cells
      - **Lymphoid nodules**
    - **Muscularis mucosae** – typical
  - Submucosa – typical
  - **Muscularis**
    - Inner circular
    - Outer longitudinal
    - Three bands of tissue – taeniae coli
    - Auerbach’s Myenteric Plexus (ANS)
  - Serosa and Adventitia – typical

- **Video recording**
  - **Large intestines**

- **Microscope Images**
  - 4x
  - 10x
  - 40x
Appendix

- **Function**
  - Vestigial structure – loss of function through evolution
  - Immunity – contains many lymphoid cells

- **Location**
  - Tubular structure connected to the cecum near the ileocecal junction

- **Structure**
  - Mucosa
    - Simple columnar epithelium
      - Microvilli
      - Abundant goblet cells
    - Lamina propria
      - Abundant lymphoid follicles
  - Submucosa – typical
    - Abundant lymphoid follicles
  - Muscularis – typical
  - Serosa – typical

- **Video recording**
  - Appendix

- **Microscope Images**
  - 4x
  - 10x
Appendicitis

- **Etiology**
  - Fecal compaction
  - Rare: tumor, gallstone, worms

- **Pathological features**
  - **Lumen**
    - Inflammatory exudate
    - Epithelial cells from ulcerated mucosa
  - **Mucosa**
    - Lymphatic follicles increased
      - Active germinal centers
    - Columnar epithelium ulcerated
  - **Submucosa**
    - Inflammatory cells present
    - Lymphatic follicles increased
      - Active germinal centers
  - **Muscularis**
    - Inflammatory cells present
  - **Serosa**
    - Inflammatory cells present
    - Blood vessels enlarged
    - Fibrin present

- **Microscope Images**
  - 4x
  - 10x
  - 40x
**Anal Canal**

- **Function**
  - Propel feces from colon to anal orifice

- **Location**
  - Distal portion of colon within pelvic cavity

- **Structure**
  - Mucosa
    - To pectinate line
      - Simple cuboidal epithelium
    - From pectinate line
      - Non-keratinized stratified squamous epithelium
    - Lamina propria – typical
      - Anal glands
    - Muscularis mucosae – typical
      - Ends at pectinate line
  - Submucosa – typical
    - Above pectinate line
      - [Internal hemorrhoidal venous plexus](#)
    - Below pectinate line
      - External hemorrhoidal venous plexus
  - Muscularis
    - Inner circular layer
      - Internal anal sphincter
    - Outer longitudinal layer
    - External anal sphincter
      - Skeletal muscle from floor of pelvis
  - Adventitia – typical

- **Video recording**
  - [Recto-anal junction](#)

- **Microscope Images**
  - 4x
  - 10x
Salivary Glands

- **Function**
  - Produce saliva which aids in digestion, lubrication, protection and pH buffer

- **Location**
  - Oral cavity

- **Structure**
  - Capsule
    - Dense connective tissue
  - Cells
    - Secretory cells
      - Acinus – group of similar cells
      - Serous cells
        - Pyramidal shape, narrow apical surface, secretory granules
        - Secrete proteins and digestive enzymes
        - Watery secretion
        - Serous demilune
          - Cap mucous cells
      - Mucous cells
        - Cuboidal to columnar in shape
        - Flat nuclei at base
        - Mucinogen granules
          - Secrete mucus
    - Myoepithelial cells
      - Prevent distention
      - Cause secretion of saliva from ducts
  - Ductal System (in order from cells to exterior)
    1. Intercalated ducts
      - From secretory acini
      - Simple cuboidal epithelium
      - Myoepithelial cells
    2. Striated ducts (differ from pancreas)
      - From intercalated ducts
      - Simple cuboidal to columnar epithelium
    3. Intralobular ducts
      - From striated ducts
      - Simple columnar epithelium
    4. Interlobular ducts
      - Between lobules within connective tissue septa
      - Stratified cuboidal to columnar epithelium
    5. Intralobar ducts
    6. Interlobar ducts
    7. Terminal duct
- **Individual Features of specific salivary glands**
  - Parotid gland
    - Mostly serous glands
    - Produce salivary amylase
  - Sublingual gland
    - Mostly mucous glands
    - Lack a terminal duct
  - Submandibular gland
    - Mostly serous glands
    - Longer striated ducts

- **Video recording**
  - Salivary glands

- **Microscope Images**
  - Parotid gland
    - 4x
    - 10x
    - 40x
  - Sublingual gland
    - 4x
    - 10x
    - 40x
  - Submandibular gland
    - 4x
    - 10x
    - 40x
Pancreas

- **Function**
  - Endocrine
    - Insulin and glucagon secretion
  - Exocrine
    - Pancreatic enzymes (proteases, amylase, lipases, nucleases and bicarbonate ion)

- **Location**
  - Inferior to stomach in epigastric region

- **Structure**
  - Capsule
    - Dense connective tissue
  - Endocrine function
    - Islets of Langerhans (pancreatic islets)
      - Scattered amongst exocrine components
      - ~ 1 million
      - Cells (cannot be differentiated via histological examination)
        - Alpha cells – glucagon
        - Beta cells – insulin
        - Delta cells – somatostatin
        - Gastrin (G) cells – stimulates HCL secretion in stomach
  - Exocrine function
    - Compound tubuloacinar gland
      - Organized into lobules separated by connective tissue septa
      - Cells
        - Acinar cells
          - Pyramid shaped
          - Basal located nucleus
          - Contain zymogen granules
            - Secrete pancreatic enzymes
        - Centroacinar cells
          - Found at lumen of acinus
          - Pale staining
          - Lack granules
          - Indicate beginning of ductal system
  - Ductal system
    1. Intercalated ducts
      - Bordered with centroacinar cells
      - Low cuboidal epithelium
    2. Intralobular ducts
      - From joining of intercalated ducts
      - Low cuboidal epithelium
c. Inside lobule

3. Interlobular ducts
   a. From joining of intralobular ducts
   b. Columnar epithelium
   c. Between lobules in connective tissue

- **Video recording**
  - Pancreas

- **Microscope Images**
  - 4x
  - 10x
  - 40x
Liver

• Function
  o Function in metabolism, detoxification, protein synthesis, digestive biochemical production, erythrocyte degradation, hormone and bile production

• Location
  o Right upper quadrant of abdominal cavity

• Structure
  o Capsule
    ▪ Dense connective tissue
      • Divide gland into lobules by septa
  o Cells
    ▪ Hepatocytes
      • Organized into hepatic lobules (hexagon shape)
      • Surrounded by 3-6 portal triads
      • Centrally located venule
        o 10x, 40x
    ▪ Kupffer cells
      • Specialized stationary macrophages
      • Breakdown erythrocytes
      • Located between sinusoids
    ▪ Ito Cells
      • Fat storage cells
      • Located in the perisinusoidal space (Disse)
  o Portal Triad
    ▪ Hepatic arteriole
    ▪ Hepatic venule
    ▪ Bile duct
  o Liver Sinusoids
    ▪ Specialized leaky capillaries
    ▪ Lined with endothelial cells
  o Perisinusoidal space (Space of Disse)
    ▪ Space that separates endothelial cells from hepatocytes

• Video recording
  o Liver

• Microscope Images
  o 4x, 10x
Cirrhosis of the liver

- **Etiology**
  - Alcohol abuse, chronic hepatitis and biliary disease

- **Features**
  - Fibrosis
    - Bands of scaring within lobules
      - Deposition of type I and III collagen causing disruption of blood flow and impaired diffusion
    - Disruption of parenchyma architecture
  - Irregular nodular architecture of hepatocytes
    - Due to regeneration of hepatocytes
    - Central vein may be obliterated
    - Adipocytes may be present within nodules
  - Inflammatory cells present
    - Present from hepatitis

- **Microscope Images**
  - 4x
  - 10x
  - 40x
**Gall Bladder**

- **Function**
  - Concentrate and store bile

- **Location**
  - Undersurface of liver

- **Structure**
  - Mucosa
    - Simple columnar epithelium with microvilli
    - Lamina propria
      - Loose connective tissue
      - Elastic and collagen fibers
  - Submucosa – None
  - Muscularis
    - Not organized into layers
  - Serosa
    - Mesothelium covering

- **Video recording**
  - Gall Bladder

- **Microscope Images**
  - 4x
  - 10x
  - 40x
NON-CILIATED SIMPLE COLUMNAR EPITHELium 40X
LONGITUDINAL & CIRCULAR MUSCULAR LAYER
LAYERS OF THE ALIMENTARY CANAL 4X
FOLIATE PAPILLAE OF THE TONGUE 10X
FOLIATE PAPILLAE OF THE TONGUE 40X
PARIETAL CELLS OF THE STOMACH 40X
FUNDUS OF THE STOMACH 10X
FUNDUS OF THE STOMACH 40X
PEYER'S PATCHES OF THE ILEUM 10X
LYMPHATIC NODULE OF THE COLON 4X
APPENDICITIS WITH INFLAMMATORY CELLS 10X
CENTRAL VEIN
OF THE
LIVER 10X
CIRRHOSIS OF THE LIVER 4X
CIRRHOSIS OF THE LIVER 40X