Lab 41
Digestive System Anatomy

For Lab Practical 2
• Be able to identify the following tissues microscopically: esophagus, stomach, small intestine (identify section), liver (identify central vein and triads), pancreas, salivary glands. Instead, identify large intestine
• Be able to identify the following structures on a model: esophagus, stomach, small intestine, large intestine, pancreas, liver, gall bladder, salivary glands.

Digestive System
• Mouth (oral cavity)
  – Salivary glands
  – Teeth
  – tongue
• Throat (pharynx)
• Esophagus
• Stomach
• Small Intestine
• Large Intestine

Histology of the Digestive Tract
• Major layers of the digestive tract:
  – mucosa
  – submucosa
  – muscularis externa
  – serosa

Salivary glands
• This is a composite slide, with three different tissues. Look at all three, but sketch one (pick your favorite). Do your best to label any cells or ducts. Hint: serous cells tend to stain darker than mucous cells. The parotid gland contains predominantly serous cells, while the sublingual and submandibular glands have a mixed population of cells. Take an educated guess as to which salivary gland you are looking at, and label it as such.

Salivary Glands
• Parotid Salivary Glands
  – Inferior to zygomatic arch
  – Produce serous secretion:
    • enzyme salivary amylase (breaks down starches)
• Sublingual Salivary Glands
  – Covered by mucous membrane of floor of mouth
  – Produce mucous secretion:
    • buffer and lubricant
• Submandibular Salivary Glands
  – In floor of mouth
  – Secrete buffers, glycoproteins (mucins), and salivary amylase
• Each have their own ducts to reach the mouth
Salivary Glands

Parotid – serous secretions

Sublingual and submandibular

Parotid – serous secretions

Esophagus

- **Esophagus**
- Draw and clearly label the esophagus. Remember to include the total magnification used for your sketch. Label: the **mucosa** (yes, bracket the entire mucosa), and then within the mucosa, label: the **epithelia** (label the TYPE of epithelia), **lamina propria** (note the TYPE of connective tissue), and **muscularis mucosae**. Label the **submucosa** (note glands if seen), and **muscularis externa** (label the two different muscle layers here).

The Esophagus

- Wall of esophagus has 3 layers:
  - mucosal
  - submucosal
  - muscularis

Histology of the Esophagus

- Characteristics of the Esophageal Wall
  - Mucosa contains nonkeratinized, stratified squamous epithelium
  - Mucosa and submucosa:
    - both form large folds that extend the length of the esophagus and allow for expansion
  - **Muscularis mucosae** consists of irregular layer of smooth muscle
  - Submucosa contains **esophageal glands**;
    - produce mucous secretion which reduces friction between bolus and esophageal lining
  - **Muscularis externa**:
    - has usual inner circular and outer longitudinal layers
    - **Superior portion** has some skeletal muscle fibers
  - No serosa (adventitia instead)

Stomach

- The box of ‘stomach’ slides contains a variety of slides. If you choose the composite slide, it contains three stomach regions. The first sample (left most) is from the **fundus**, the third sample (right most) is from the **pyloric region**. Sketch and clearly label these two regions of the stomach.
- For the fundus, label: **epithelia** (what type), **gastric pits**, **gastric glands**, the **thin muscularis mucosae**, **submucosa**, and **external muscularis layers**. Indicate the area in the tissue where you expect to find parietal and chief cells.
- For the pyloric region of the stomach, label similarly as above. Indicate where you would expect to find G cells.
The Stomach

Regions of the Stomach

- **Cardia:**
  - smallest part; superior, medial portion within 3cm of esophagus
  - abundant mucus glands
- **Fundus**
  - portion superior to esophageal junction
- **Body**
  - Area between fundus and esophageal junction
  - Many gastric glands
- **Pylorus**
  - The curve portion of the “J”, ends at pyloric sphincter
  - Glands here secrete gastrin

Histology of the Stomach

- **Rugae** = folds of empty stomach
- **Muscularis mucosa and externa** contain extra oblique layers of smooth muscle
- Simple columnar epithelium lines all portions of stomach, is a secretory sheet; produces mucus that covers interior surface of stomach
- **Gastric Pits**
  - shallow depressions that open onto the gastric surface
  - Mucous cells found at base, or neck, of each gastric pit actively divide, replacing superficial cells

Gastric Glands

- Found in fundus and body of stomach, extend deep into underlying lamina propria
- Each gastric pit communicates with several gastric glands
- Two types of secretory cells in gastric glands secrete gastric juice:
  - parietal cells
  - chief cells
Gastric Gland cells

• Parietal Cells
  – Mostly in proximal portions of glands
  – Secrete intrinsic factor and hydrochloric acid (HCl)

• Chief Cells
  – Most abundant near base of gastric gland:
  – Secrete pepsinogen (inactive proenzyme)
  – Pepsinogen is converted by HCl in the gastric lumen to pepsin (active proteolytic enzyme)

Pyloric Glands

• Pyloric Glands in the pylorus produce mucus secretions

• Enteroendocrine Cells are scattered among mucus-secreting cells:
  – G cells
  – Abundant in gastric pits of pyloric antrum
  – Produce gastrin: stimulates both parietal and chief cells and promotes gastric muscle contractions
  – D cells
  – In pyloric glands
  – Release somatostatin, a hormone that inhibits release of gastrin

Small Intestine

• This is another composite slide. The three regions of the small intestine are presented on the slide in order of appearance in the body. Please sketch the first and third.

• For the first (duodenum), label: epithelia (what type), goblet cells (if you see any), crypts (intestinal glands), Brunner’s glands (these are large glands of the submucosa), a lacteal, and a villus.

• For the third (ileum), label the same things as above (if present), and the Peyer’s patches.

Segments of the S.I.

• The Duodenum is the 25 cm (10 in.) long segment of small intestine closest to stomach
  – “Mixing bowl” that receives chyme from stomach, digestive secretions from pancreas and liver

• The Jejunum is the 2.5 meter (8.2 ft) long middle segment
  – the location of most chemical digestion and nutrient absorption

• The Ileum is the final 3.5 meter (11.48 ft) long segment

Intestinal Folds and Projections

• Largest = Plicae: transverse folds in intestinal lining
  – permanent features (they do not disappear when small intestine fills)

• Intestinal Villi: a series of fingerlike projections in mucosa of small intestine

• Villi are covered with simple columnar epithelium which themselves are covered with microvilli

• All serve to increase surface area for absorption (altogether by 600x)
Intestinal Glands

- **Goblet cells** between columnar epithelial cells eject mucins onto intestinal surfaces
- Enteroendocrine cells in intestinal glands produce intestinal hormones:
  - gastrin
  - cholecystokinin
  - Secretin
- **Brunner's Glands**
  - Submucosal glands of duodenum ONLY
  - Produce copious mucus when chyme arrives from stomach

Lacteals

- Each villus lamina propria has ample capillary supply (to absorb nutrients) and nerve supply
- In addition, each villus has a central lymph capillary called a lacteal. These are larger than the blood capillaries and thus can absorb larger particles into the body, such as lipid droplets.
- Muscle contractions move villi back and forth to facilitate absorption and to squeeze the lacteals to assist lymph movement

Crypts

- Openings from intestinal glands to the intestinal lumen at the bases of villi
- Entrances for *brush border enzymes*:
  - Integral membrane proteins on surfaces of intestinal microvilli
  - Break down materials in contact with the brush border
- **Enterokinase**: a brush border enzyme that activates pancreatic proenzyme *trypsinogen*

The Duodenum

- Has few plicae, small villi
- Duodenal glands (submucosal) produce lots of mucus and buffers (to protect against acidic chyme)
  - Activated by Para NS during cephalic phase to prepare for chyme arrival
- Functions
  - To receive chyme from stomach
  - To neutralize acids before they can damage the absorptive surfaces of the small intestine

Duodenum

Ileum
Large Intestine

- **Large intestine** - Sketch the large intestine. Label the numerous goblet cells, crypts (intestinal glands), and mucous glands.
- **Rectum** - Look at the rectum (you do not need to sketch). NOTE the epithelium (what type), muscularis mucosae, submucosa, muscularis externa, and any blood vessels.

Liver

- Sketch and clearly label the liver. Identify and label (approximately) two lobules. For each lobule, label the central vein, portal area (hepatic triad), and hepatocytes.
- YOU MAY NEED TO UTILIZE ON-LINE SOURCES to get a good look at this tissue. Two sites to check out are: http://www.bu.edu/histology/m/t_liverg.htm and <http://meded.ucsd.edu/hist-img-bank/chapter_7/index.htm>

Liver Histology

- Liver lobules are the basic functional units of the liver
- Each lobe is divided by connective tissue into about 100,000 liver lobules about 1 mm diameter each
- Hepatocytes are the main liver cells
  - Adjust circulating levels of nutrients through selective absorption and secretion
  - In a liver lobule they form a series of irregular plates arranged like wheel spokes around a central vein
  - Between them run sinusoids of the hepatic portal system
- Many Kupffer Cells are located in sinusoidal lining
Hexagonal Liver lobule

- Has 6 portal areas (one per corner)
- Each Portal Area Contains:
  - branch of hepatic portal vein (venous blood from digestive system)
  - branch of hepatic artery proper (arterial blood)
  - small branch of bile duct
- The arteries and the veins deliver blood to the sinusoids
  - Capillaries with large endothelial spaces so that even plasma proteins can diffuse out into the space surrounding hepatocytes

Hepatic Blood Flow

- Blood enters liver sinusoids:
  - from small branches of hepatic portal vein
  - from hepatic artery proper
- As blood flows through sinusoids:
  - hepatocytes absorb solutes from plasma
  - secrete materials such as plasma proteins
- Blood leaves through the central vein, returns to systemic circulation
- Pressure in portal system is low

Pancreas

- Sketch and clearly label a small portion of the pancreas. Label: an individual acinar cell, a pancreatic acinus (a collection of acinar cells, all facing a shared lumen, or duct) and label the lumen. Can you find a duct? Also, look for a pancreatic islet.

The Pancreas

- Pancreatic Duct: large duct that delivers digestive enzymes and buffers to duodenum
- Common Bile Duct from the liver and gallbladder
  - Meets pancreatic duct near duodenum
- Pancreas is divided into lobules:
  - ducts branch repeatedly
  - end in pancreatic acini
  - Blind pockets lined with simple cuboidal epithelium
  - Contain scattered pancreatic islets (1%)
Assignment

• Drawings
  – Salivary gland
  – Esophagus
  – Two stomach (fundus, pylorus)
  – Two S.I. (duodenum, ileum)
  – Large intestine
  – Liver
  – Pancreas
• Numbers 1-8 on Review Sheet 38
• Due next Thursday