The Digestive System

The organs of the digestive system fall into two categories: the gastrointestinal tract organs and accessory organs. The gastrointestinal tract is a continuous tube that extends from the oral cavity to the anus, and includes the mouth, pharynx, esophagus, stomach, small intestine and large intestine. The accessory organs include the teeth, tongue, salivary glands, liver, gall bladder, and pancreas. The digestive system has many functions including ingestion (intake of food), digestion (mechanically or chemically with enzymes), absorption of nutrients, and defecation (waste elimination).

Ingestion, mechanical and chemical digestion, and deglutition (swallowing) are all accomplished in the **oral cavity**. These processes are assisted by several accessory organs, including the tongue, teeth, and salivary glands. Swallowing is also accomplished in the **pharynx** and the **esophagus**. Once inside the **stomach**, the food is mixed with acidic gastric juice, and chemical digestion continues. The stomach empties its contents into the **small intestine**. The small intestine, assisted by secretions from the liver, gall bladder and pancreas, is the site of most chemical digestion, and is also where most absorption occurs. The **liver** is the largest gland in the body, and assists lipid digestion through the secretion of bile, an emulsifier. The **gall bladder** is the liver's accessory, storing and concentrating bile. The **pancreas**, also a gland, secretes pancreatic juice, which has enzymes to chemically digest food in the small intestine, and bicarbonate to buffer the acids from the stomach. The small intestine empties into the **large intestine**, which is mainly responsible for the absorption of water from feces and the elimination of waste.

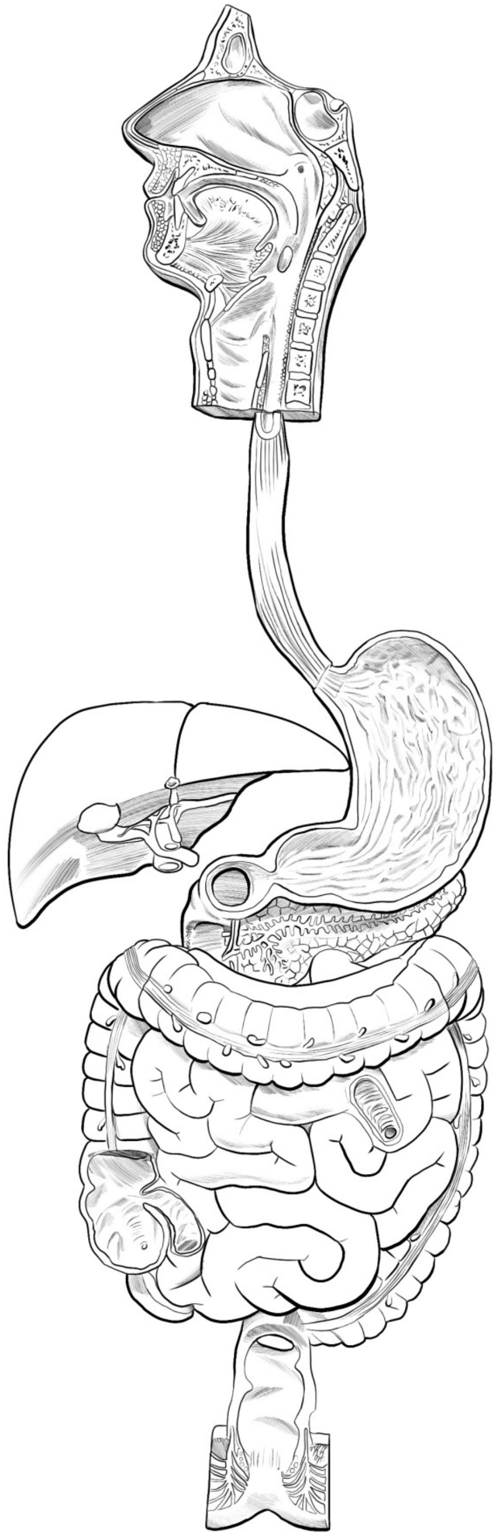
Activity:

1. Identify the following structures:

☐ Esophagus	☐ Liver	☐ Pharynx
☐ Gall bladder	☐ Oral cavity	☐ Small intestine
☐ Large intestine	☐ Pancreas	☐ Stomach

2. Which of the structures above are part of the gastrointestinal tract?
3. Which of the structures above are accessory organs?
4. What are the three regions of the small intestine?

The Digestive System



The Oral Cavity and Pharynx

The digestive process begins in the **oral cavity** (the mouth), when we ingest food. The food gets dissolved by saliva from the salivary glands, and is chewed by the **teeth**. This process leads to the formation of a ball of food, called a bolus. The oral cavity is separated from the nasal cavity by the palate, which forms the roof of the mouth. Recall that the anterior portion, the **hard palate**, is formed by four different bones (two palatine processes of the maxillae and two palatine bones). Posterior to the hard palate is the **soft palate**, which is composed of muscle. A portion of the soft palate, the **uvula**, rises during swallowing to prevent food from entering the **nasopharynx**, the region of the pharynx behind the nose. The **tongue** assists with chewing, and is also involved in swallowing, pushing the bolus of food into the **oropharynx**, the region of the pharynx behind the mouth. Next, the food enters the **laryngopharynx**, the region of the pharynx just posterior to the larynx. Food moves posterior from the laryngopharynx, into the **esophagus**. The **epiglottis** of the larynx closes the glottis, thereby preventing the food from entering the larynx and trachea.

The oral cavity and pharynx have the same layers of tissue as all mucous membranes of the gastrointestinal tract do (from superficial to deep: mucosa, submucosa, muscularis mucosa and serosa/adventitia). Because the oral cavity and pharynx are subject to hard food that could damage the mucosa, they are both lined by protective, wear-and-tear, stratified squamous epithelium. These regions of the GI tract also contain skeletal muscle in their muscularis externa.

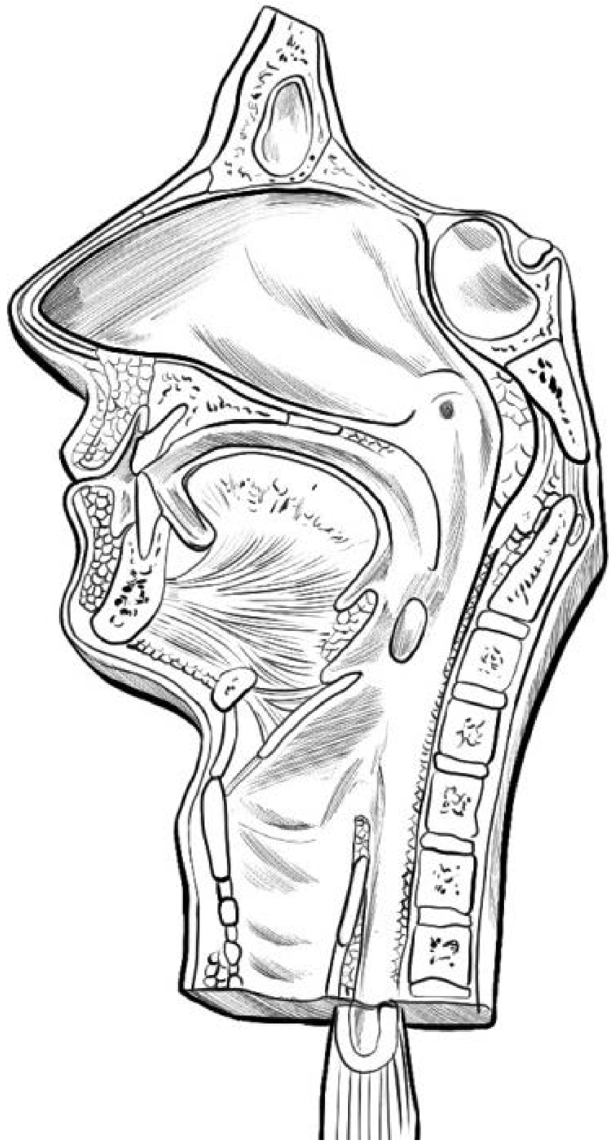
<u>Activity:</u>

1. Identify the following structures:

☐	Epiglottis	☐	Oropharynx
☐	Esophagus	☐	Soft palate
☐	Hard palate	☐	Teeth
☐	Laryngopharynx	☐	Tongue
☐	Nasopharynx	☐	Uvula
☐	Oral cavity		

2. What type of epithelial tissue lines the oral cavity and pharynx?
3. What type of muscle tissue is found in the muscularis externa of these organs?

The Oral Cavity and Pharynx



The Salivary Glands

The salivary glands are responsible for secreting saliva into the oral cavity. Saliva, which contains water, mucus and enzymes, dissolves the food we eat so we can taste and swallow it better, and also contains an enzyme that initiates the digestion of starch. We have intrinsic salivary glands throughout the mucosa of the oral cavity which constantly produce saliva. We also have three pairs of extrinsic salivary glands, which are much larger and are located outside of the mouth. Saliva is produced in large quantities by these glands during a meal. The saliva is secreted into the oral cavity by way of their associated ducts.

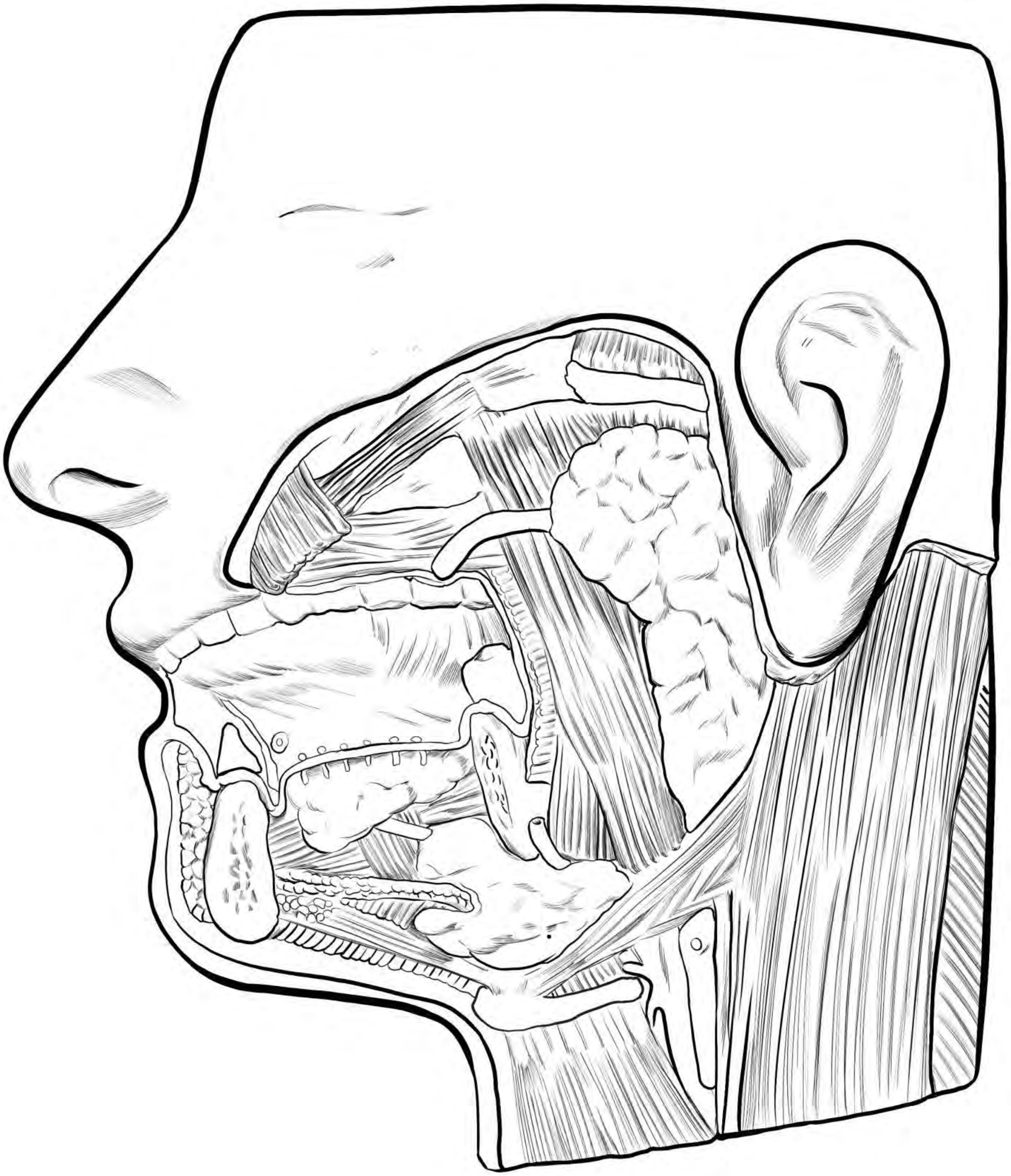
The **parotid glands** are the largest of the three extrinsic salivary glands. They are located superficial to the masseter muscles, and secrete saliva via the **parotid ducts**, which open near the upper molars on both sides of the mouth. The **submandibular glands** are the second largest of the three extrinsic glands. As their name implies, they are located near the mandible. The **submandibular ducts** secrete saliva onto the floor of the mouth, lateral to the tongue. The smallest of the extrinsic glands are the **sublingual glands**. As their name implies, they are located just underneath the tongue. Unlike the other two glands, each of the sublingual glands have about a dozen small **sublingual ducts**, which secrete saliva up into the mouth, just under the tongue.

Activity:

1. Identify the following structures:

☐	Parotid duct	☐	Sublingual gland
☐	Parotid gland	☐	Submandibular duct
☐	Sublingual ducts	☐	Submandibular gland

The Salivary Glands



Microscopic Anatomy of the Esophagus

Similar to the rest of the gastrointestinal tract, the esophagus has four layers of tissue. The **mucosa** has a superficial **epithelium**, which is composed of stratified squamous epithelium, except at the junction with stomach where the epithelium become simple columnar. The **lamina propria** (areolar connective tissue) is deep to the epithelium and the **muscularis mucosa** (smooth muscle) is the deepest layer of the mucosa. The **submucosa** is composed of a special type of connective tissue which has a combination of properties from areolar and dense irregular connective tissues. **Mucous glands** are found in the submucosa; the mucus secreted by these glands helps to move the bolus of food through the esophagus during swallowing. The type of muscle tissue found in the **muscularis externa** varies; the top third is skeletal muscle, the middle third is skeletal and smooth muscle and the bottom third is entirely smooth muscle. The last third has two layers of smooth muscle, an inner circular and an outer longitudinal, which work together to cause peristalsis. Because the esophagus is found in the thoracic cavity, it is extraperitoneal and is surrounded by the **adventitia** (rather than the serosa, found around most other GI organs). The adventitia is composed of loose connective tissue with collagen and elastin fibers.

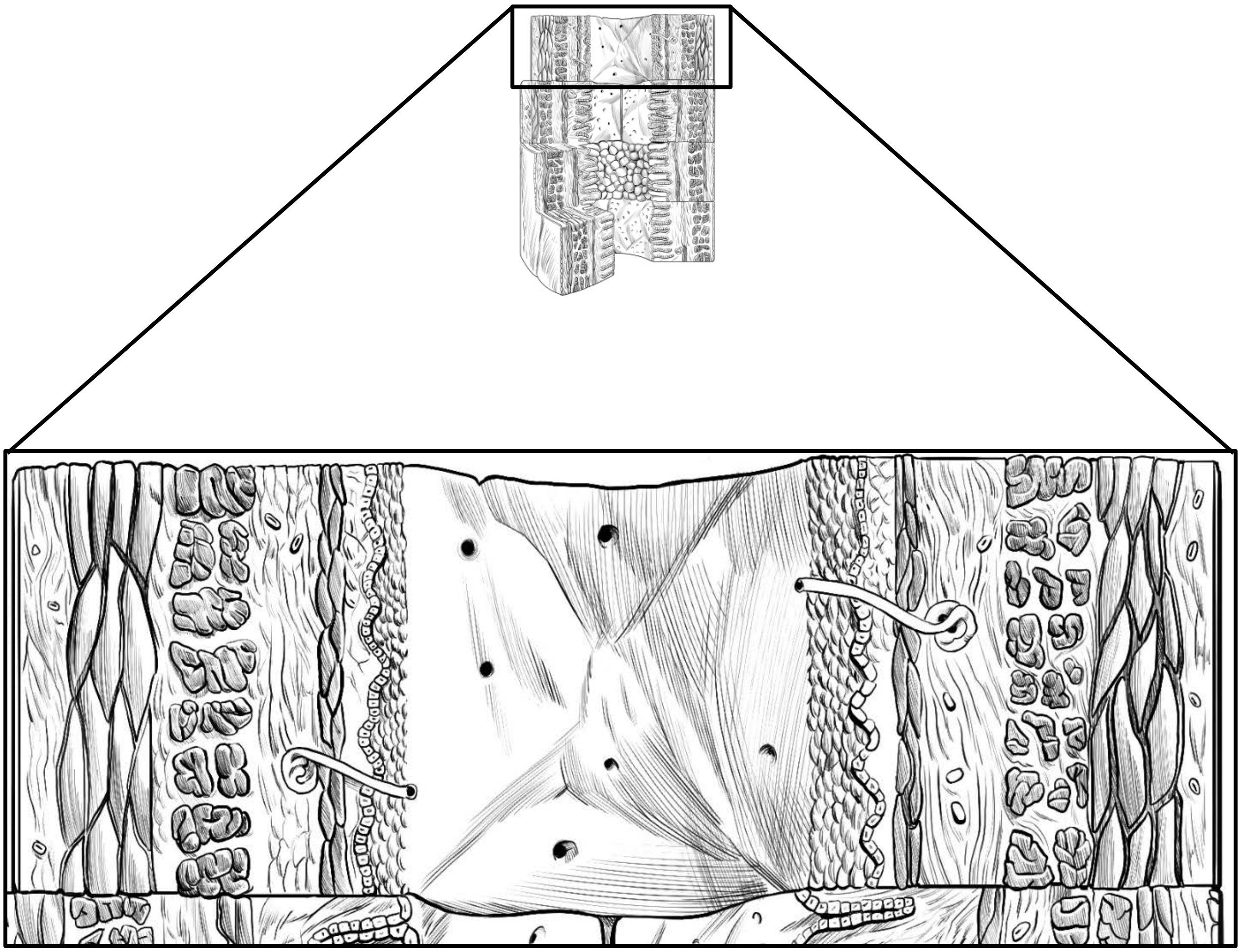
Activity:

1. Identify the following structures/layers:

☐	Adventitia	☐	Mucous gland
☐	Epithelium	☐	Muscularis externa
☐	Lamina propria	☐	Muscularis mucosa
☐	Mucosa	☐	Submucosa

2. What type of tissue is found in the lamina propria of all GI organs?
3. What type of tissue is found in the muscularis mucosa of all GI organs?
4. What type of tissue is found in the submucosa of all GI organs?
5. What type of epithelial tissue is found in the mucosa of the esophagus?
6. What type of muscle tissue is found in the muscularis externa of the esophagus?
7. What is the name of the layer of tissue that surrounds the esophagus? What type of tissue is the layer composed of?

Microscopic Anatomy of the Esophagus



Esophagus Histology

Once you are familiar with the microscopic structure of the esophagus, you should be able to identify many of the features on prepared and stained sections of the esophagus.

This slide is of a cross section of the esophagus, in which you will be able to identify the different layers of tissue.

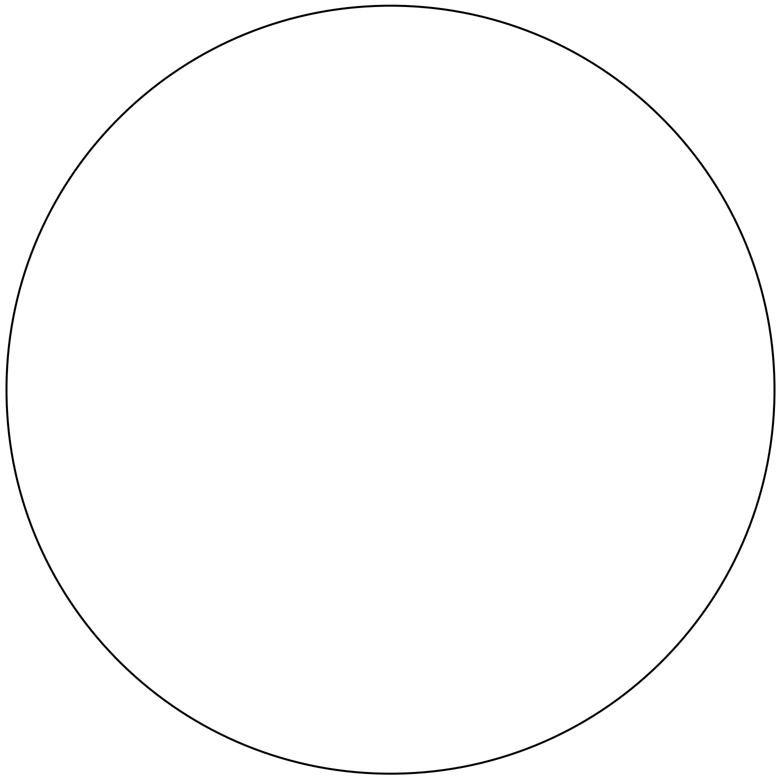
Activity:

1. Obtain slide number 68 from your slide box.
2. Using the 10X objective lens, locate the following:

    Mucosa
    Submucosa
    Muscularis externa
    Adventitia

3. Draw what you see on the following page, labelling the structures listed above.

Esophagus Histology



The Stomach

Once food enters the stomach, it is stored for a short time and then mixed with gastric juice to form chyme. Protein digestion begins in the stomach, and any carbohydrate digestion that began in the mouth is now inhibited by the acids of the stomach.

The esophagus and stomach are separated by a circular muscle called the **lower esophageal sphincter** (LES). This muscle remains contracted at all times, except during swallowing, thereby preventing the acidic gastric juice from rising into the esophagus and damaging its lining. During swallowing, the LES relaxes and food enters the **cardiac region** of the stomach. Next, the food enters the **fundus**, a small pouch on the left side of the stomach, where it is stored. After about an hour of storage, the food enters the **body** of the stomach, which is the largest region. Here, the muscles of the stomach mix and churn the food with gastric juice. Finally, the chyme enters the **pylorus** of the stomach. This narrower region of the stomach connects to the duodenum of the small intestine. Controlling the movement of chyme from the pylorus to the duodenum is another sphincter muscle called the **pyloric sphincter**.

The stomach has a characteristic J shape. The smaller, concave surface of the stomach is called the **lesser curvature**, while the larger, convex surface is called the **greater curvature**.

This figure shows you a coronal section of the stomach so that you can see the different regions, as well as inside of the stomach. Notice that the inside of the stomach is not flat; instead it has ridges called **rugae**, which increase the storage capacity of the stomach. When the stomach is empty the folds are larger and when the stomach is full, the folds flatten. The stomach has a tremendous capacity for stretch; it can hold up to 4 liters in extreme cases!

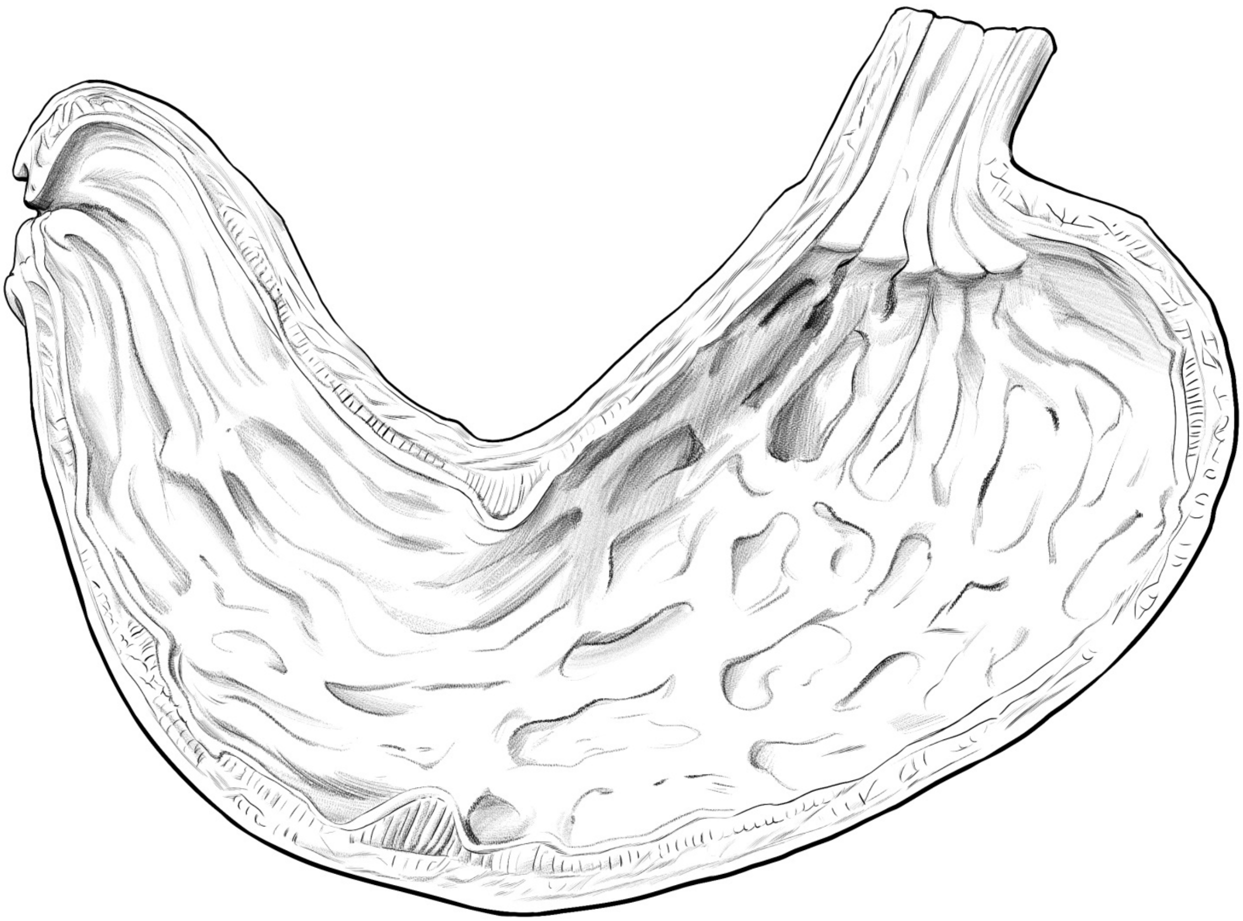
Activity:

1. Identify the following structures:

☐	Body	☐	Lesser curvature
☐	Cardiac region	☐	Pylorus
☐	Fundus	☐	Pyloric sphincter
☐	Greater curvature	☐	Rugae

2. What is the name of the sphincter that separates the esophagus and stomach?
3. What is the name of the sphincter that separates the stomach and small intestine?
4. What is the purpose of rugae?

The Stomach



Microscopic Anatomy of the Stomach

The stomach has the same layers of tissue as the rest of the gastrointestinal tract. The **mucosa** has a superficial **epithelium**, composed of simple columnar epithelium, with the **lamina propria** (areolar connective tissue) deep to that and the **muscularis mucosa** (smooth muscle) as the deepest layer. The mucosa is not flat; rather, it has **gastric pits** which lead to **gastric glands**. The cells lining the pits secrete a thick layer of mucus that protects the lining of the stomach. The cells lining the glands secrete the different components of gastric juice, such as pepsinogen and hydrochloric acid. The **submucosa** is composed of the same connective tissue as the esophagus. The **muscularis externa** is entirely smooth muscle. What is unique about the stomach is that there are three layers of smooth muscle: circular, longitudinal and oblique. This modification allows for greater mixing and churning of food during digestion. Unlike the esophagus, the stomach is surrounded by a **serosa** since it is an intraperitoneal organ. The serosa is composed of mesothelium (simple squamous epithelium) and areolar connective tissue.

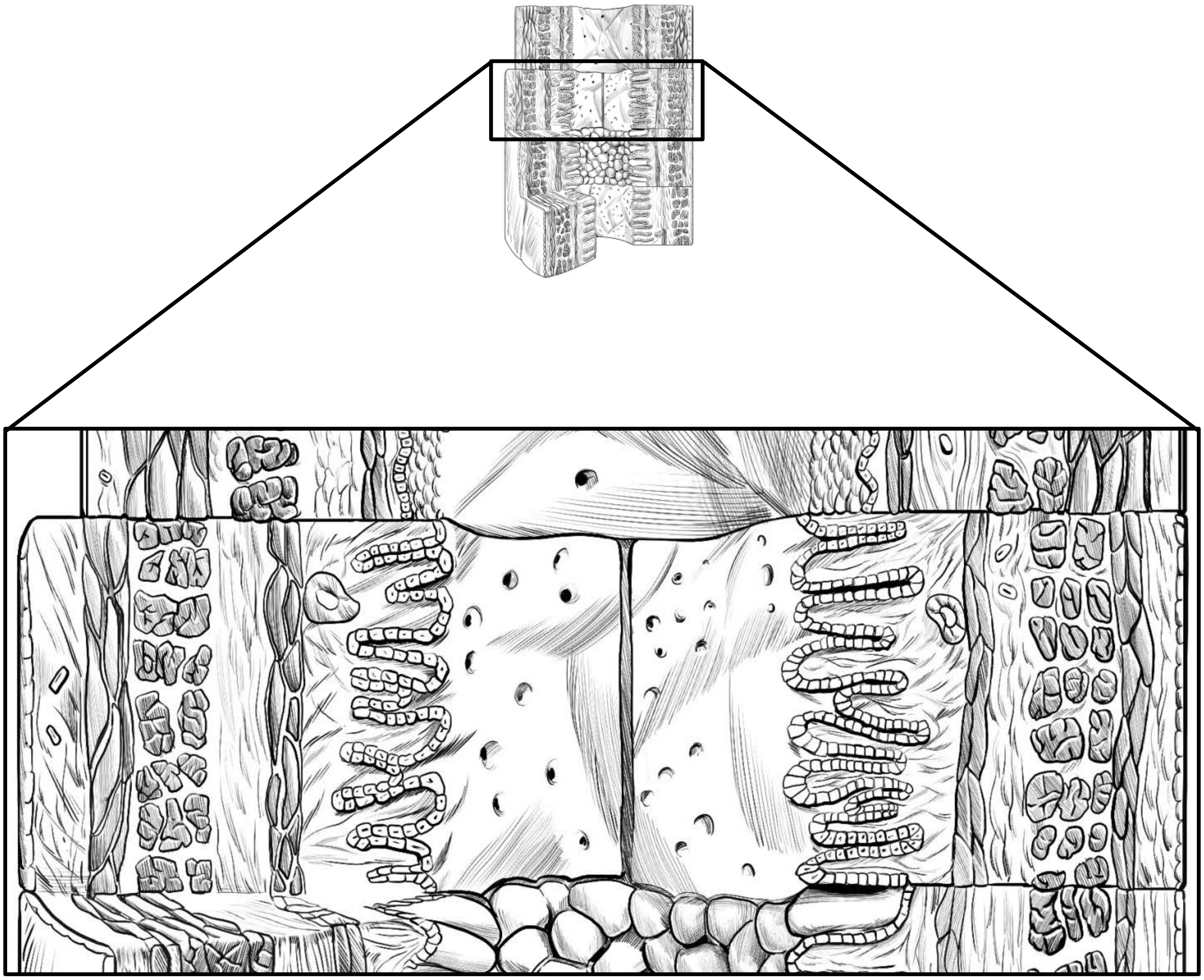
<u>Activity:</u>

1. Identify the following structures/layers:

☐	Epithelium	☐	Muscularis externa
☐	Gastric pit/gland	☐	Muscularis mucosa
☐	Lamina propria	☐	Serosa
☐	Mucosa	☐	Submucosa

2. What type of epithelial tissue lines the mucosa of the stomach?
3. What type of muscle tissue is found in the muscularis externa of the stomach?
4. How many layers of muscle tissue are found in the muscularis externa of the stomach?
5. What type of tissue is found in the serosa?

Microscopic Anatomy of the Stomach



Stomach Histology

Once you are familiar with the microscopic structure of the stomach, you should be able to identify many of the features on prepared and stained sections of the stomach.

This slide is of a cross section of the stomach, in which you will be able to identify the different layers of tissue.

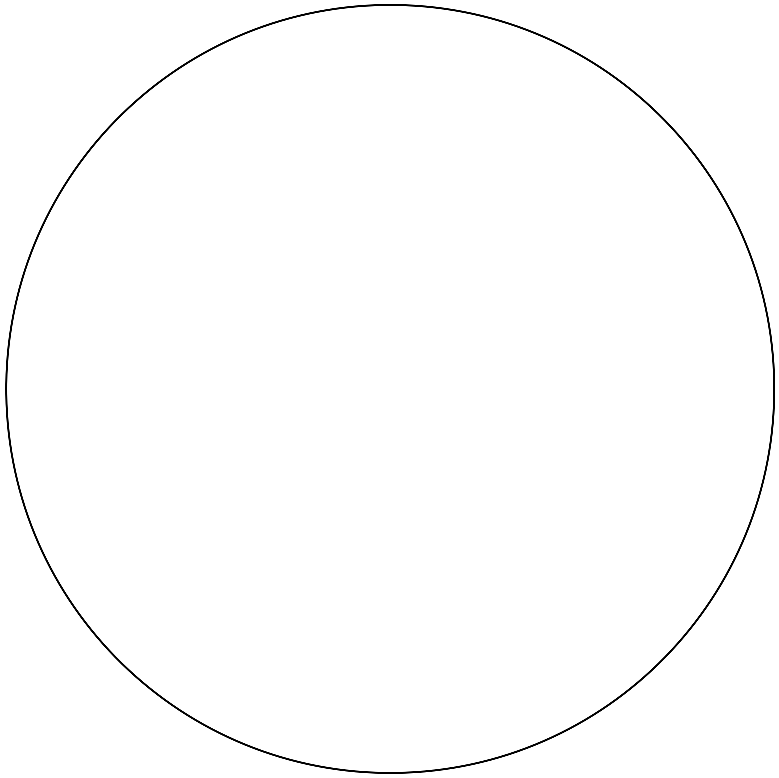
Activity:

1. Obtain slide number 70 from your slide box.
2. Using the 10X objective lens, locate the following:

    - Mucosa
        - Epithelium
        - Lamina propria
        - Muscularis mucosa
    - Submucosa
    - Muscularis externa
    - Serosa

3. Draw what you see on the following page, labelling the structures listed above.

Stomach Histology



The Small Intestine

The small intestine, the site of most chemical digestion and absorption, has three regions. The first region, which attaches to the pylorus of the stomach, is the **duodenum.** Recall that the **pyloric sphincter** of the stomach controls how much chyme is entering the duodenum from the pylorus. This duodenum, which accounts for the first 10 inches of the small intestine, is retroperitoneal. The duodenum begins at the pylorus of the stomach, heads to the left side of the body, past the pancreas, and makes a sharp turn back toward the middle of the abdomen. It receives acidic chyme from the stomach, bile from the liver and gall bladder, and pancreatic juice from the pancreas. The bicarbonate from pancreatic juice buffers the acidic chyme. Pancreatic juice also contains digestive enzymes that the small intestine uses to chemically digest carbs, proteins and fats. To assist in fat digestion, bile from the liver and gall bladder emulsifies fat.

Of the remaining length of the small intestine, roughly the first 40% is the **jejunum** and the remaining 60% is the **ileum**. Both of these regions are within the peritoneum. The ileum attaches to the first segment of the large intestine, called the **cecum**. A sphincter, called the **ileocecal valve**, controls the movement of chyme from the ileum to the cecum.

Note that you can identify the duodenum and ileum based on their attachment points to the stomach and large intestine, respectively, but it is difficult to distinguish where one region ends and another begins when looking at the gross structure of the small intestine. The jejunum is found mostly in the umbilical region of the abdominopelvic cavity; whereas the ileum is found mainly in the pubic region.

Activity:

1. Identify the following structures:

- [ ] Cecum
- [ ] Ileocecal valve
- [ ] Jejunum
- [ ] Duodenum
- [ ] Ileum
- [ ] Pyloric sphincter

The Small Intestine

Microscopic Anatomy of the Small Intestine

The small intestine has the same layers of tissue as the rest of the gastrointestinal tract. The **epithelium** of the **mucosa** is composed of simple columnar epithelium. These absorptive cells have a structural modification on their apical surface, called **microvilli**, which are microscopic projections of the plasma membrane. The **lamina propria** and **muscularis mucosa** are the same as the esophagus and stomach. The mucosa is not flat; rather, it has finger-like extensions called **villi** as well as small invaginations called **intestinal crypts**. Both the villi and microvilli create a tremendous amount of surface area, which is important for the small intestine since most nutrient absorption occurs here. We will take a closer look at villi and intestinal crypts shortly. The **submucosa** is composed of the same connective tissue as the other organs, the **muscularis externa** is composed of two layers of smooth muscle, and the small intestine is surrounded by a **serosa**.

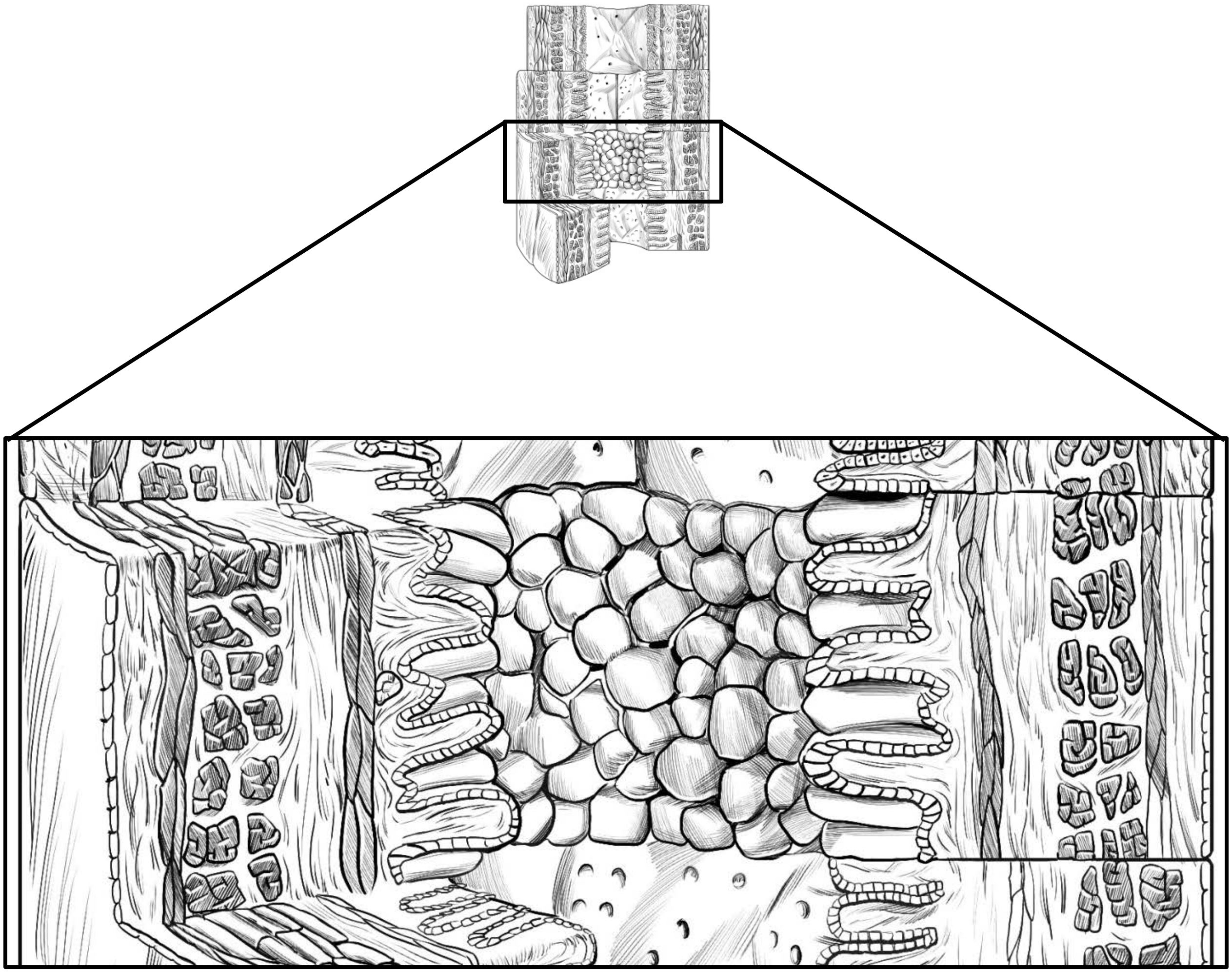
Activity:

1. Identify the following structures/layers:

☐ Epithelium	☐ Muscularis mucosa
☐ Lamina propria	☐ Serosa
☐ Mucosa	☐ Submucosa
☐ Muscularis externa	☐ Villi

2. What type of epithelial tissue lines the mucosa of the small intestine?
3. What type of muscle tissue is found in the muscularis externa of the small intestine?
4. How many layers of muscle tissue are found in the muscularis externa of the small intestine?

Microscopic Anatomy of the Small Intestine



Small Intestine Villi

As you have learned previously, the mucosa of the small intestine is not flat. Instead, it has finger-like projections called **villi** which increase its surface area. This figure shows you a closer perspective of villi. Simple columnar epithelial cells line the mucosa of the villus. Some of the cells are **absorptive cells**, with microvilli on their apical surface. These cells create digestive enzymes called brush border enzymes and are also responsible for the absorption of nutrients. The rest of the cells are **goblet cells**, which secrete mucus to lubricate the chyme and also protect the lining of the small intestine. Inside the **lamina propria** of each villus is a lymphatic capillary, called a **lacteal**, which aids in the absorption of fat. A thin layer of smooth muscle – the **muscularis mucosa** – lies underneath the lamina propria. Between the villi, there are small invaginations of the mucosa called intestinal crypts. The cells lining the crypts secrete intestinal juice, which aids in digestion. In the duodenum, the submucosa contains **duodenal glands**, which secrete buffers to neutralize the acidic chyme coming from the stomach.

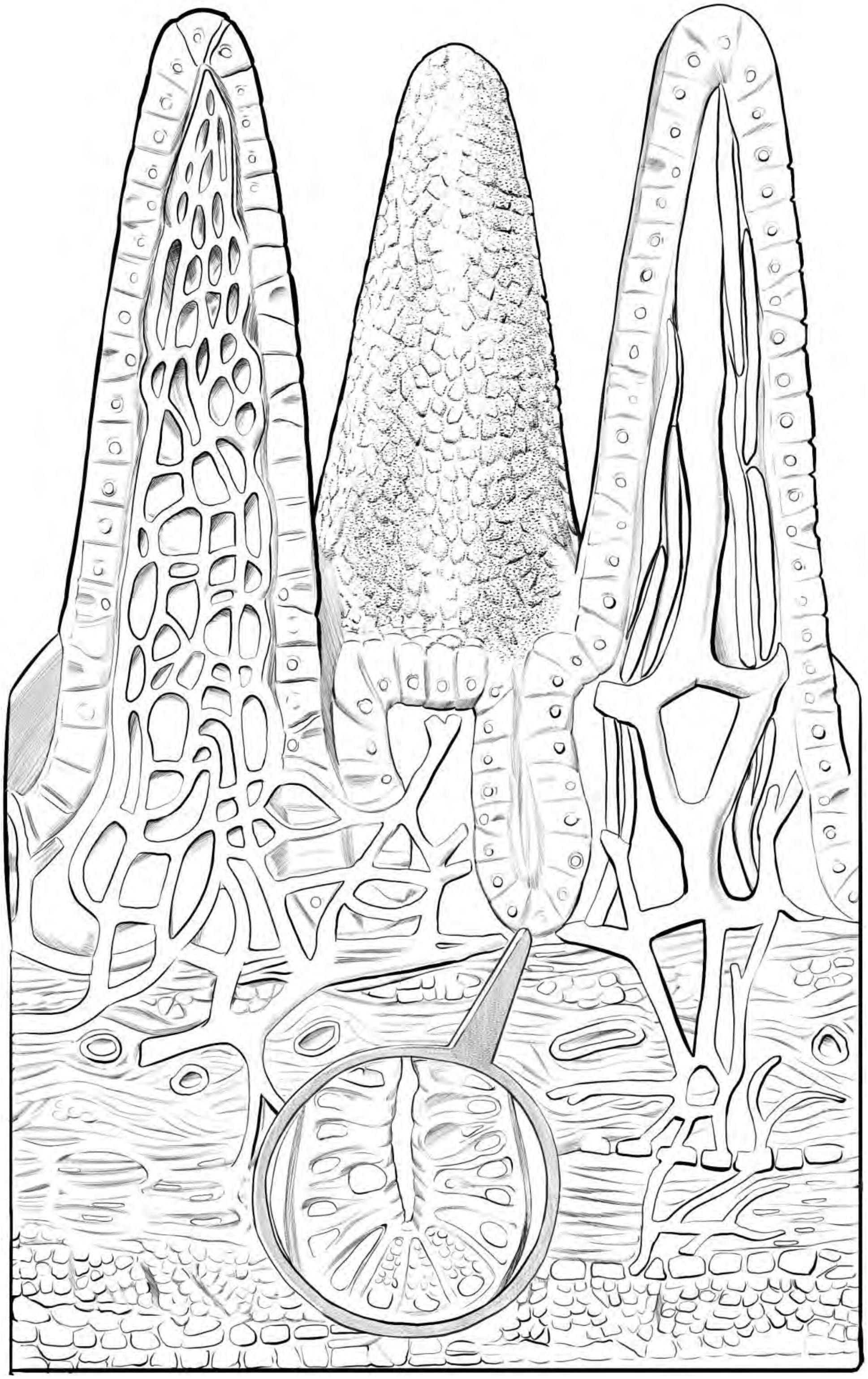
Activity:

1. Identify the following structures/layers:

☐	Absorptive cell	☐	Lamina propria
☐	Duodenal gland	☐	Muscularis mucosa
☐	Goblet cell	☐	Submucosa
☐	Intestinal crypt	☐	Villus
☐	Lacteal		

2. What is the purpose of the villi?
3. What is the purpose of the intestinal crypts?

Small Intestine Villi



Small Intestine Histology

Once you are familiar with the microscopic structure of the small intestine, you should be able to identify many of the features on prepared and stained sections of the small intestine.

This slide is of a cross section of the duodenum, in which you will be able to identify the different layers of tissue.

Activity:

1. Obtain slide number 72 from your slide box.
2. Using the 10X objective lens, locate the following:

   - Mucosa
     - Epithelium
     - Lamina propria
     - Muscularis mucosa
   - Muscularis
   - Serosa
   - Submucosa
   - Villi

3. Draw what you see on the following page, labelling the structures listed above.
4. What type of epithelial tissue is found in the mucosa?
5. What type of muscle tissue is found in the muscularis?
6. What is the purpose of villi?

Small Intestine Histology

The Large Intestine

The large intestine is so named because its diameter is larger than the small intestine; however, it is significantly shorter than the small intestine. The **cecum** of the large intestine is connected to the **ileum** of the small intestine. Recall that the **ileocecal valve** controls the movement of chyme from the small intestine to the large intestine. Attached to the cecum is the **vermiform appendix**, a small pouch that contains lymphatic tissue. The cecum then leads to the colon, which has several segments. The **ascending colon**, which directly attaches to the cecum, ascends up the abdominopelvic cavity toward the liver. It then makes a turn at the **hepatic flexure** to become the **transverse colon**. The transverse colon transcends across the abdominal cavity toward the spleen, until it makes another turn at the **splenic flexure**. This leads to the **descending colon**, which descends down the abdominopelvic cavity toward the left pelvis. As the colon enters the pelvis, it becomes an S-shaped **sigmoid colon**. Note that the ascending and descending colon are both retroperitoneal. Also, note that the hepatic flexure is lower in the abdomen than the splenic flexure because the position of the liver is lower in the abdominopelvic cavity than the spleen. The colon leads to the retroperitoneal **rectum**, which descends down the middle of the pelvis. As the rectum passes through the pelvic floor, it becomes the final region of the large intestine, the **anal canal**.

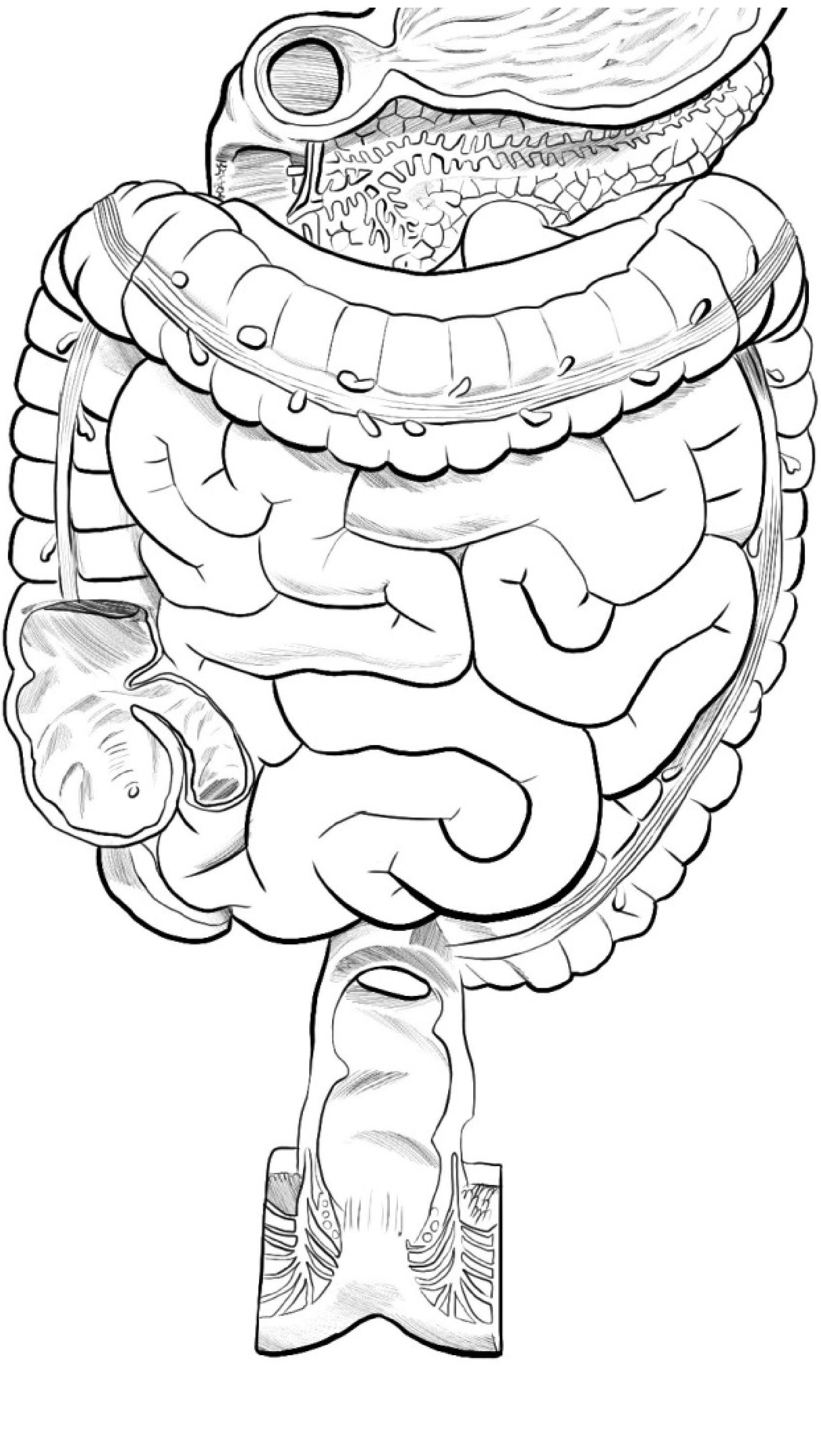
There are three structural modifications associated with the cecum and colon of the large intestine. Longitudinal bands of thickened smooth muscle, called **teniae coli**, are found on the outside of the cecum and colon. They create tone in the large intestine and, as a result, the cecum and colon bulge into structures called **haustra**. These pouches allow small amounts of chyme to move through the colon in segments through a type of movement called haustral contractions. Finally, there are fat filled sacs of visceral peritoneum, called **epiploic appendages**, which are hanging from the outside of the large intestine. Their purpose is not known, but they can be problematic if they become inflamed.

Activity:

1. Identify the following structures:

☐ Anal canal	☐ Hepatic flexure	☐ Splenic flexure
☐ Ascending colon	☐ Ileocecal valve	☐ Teniae coli
☐ Cecum	☐ Ileum	☐ Transverse colon
☐ Descending colon	☐ Rectum	☐ Vermiform appendix
☐ Epiploic appendages	☐ Sigmoid colon	

The Large Intestine



Microscopic Anatomy of the Large Intestine

The large intestine has the same layers of tissue as the rest of the gastrointestinal tract. The **epithelium** of the **mucosa** is composed of simple columnar epithelium along the majority of the large intestine, except in the anal canal where the epithelium changes into stratified squamous. The **lamina propria** and **muscularis mucosa** are the same as the three other organs. The mucosa is not flat; rather, it has invaginations called **intestinal crypts**. There are many mucus secreting goblet cells lining the crypts. The **submucosa** is composed of the same connective tissue as the other organs, except that it has more lymphatic tissue associated with it. The **muscularis externa** is composed of two layers of smooth muscle, and there is a **serosa**.

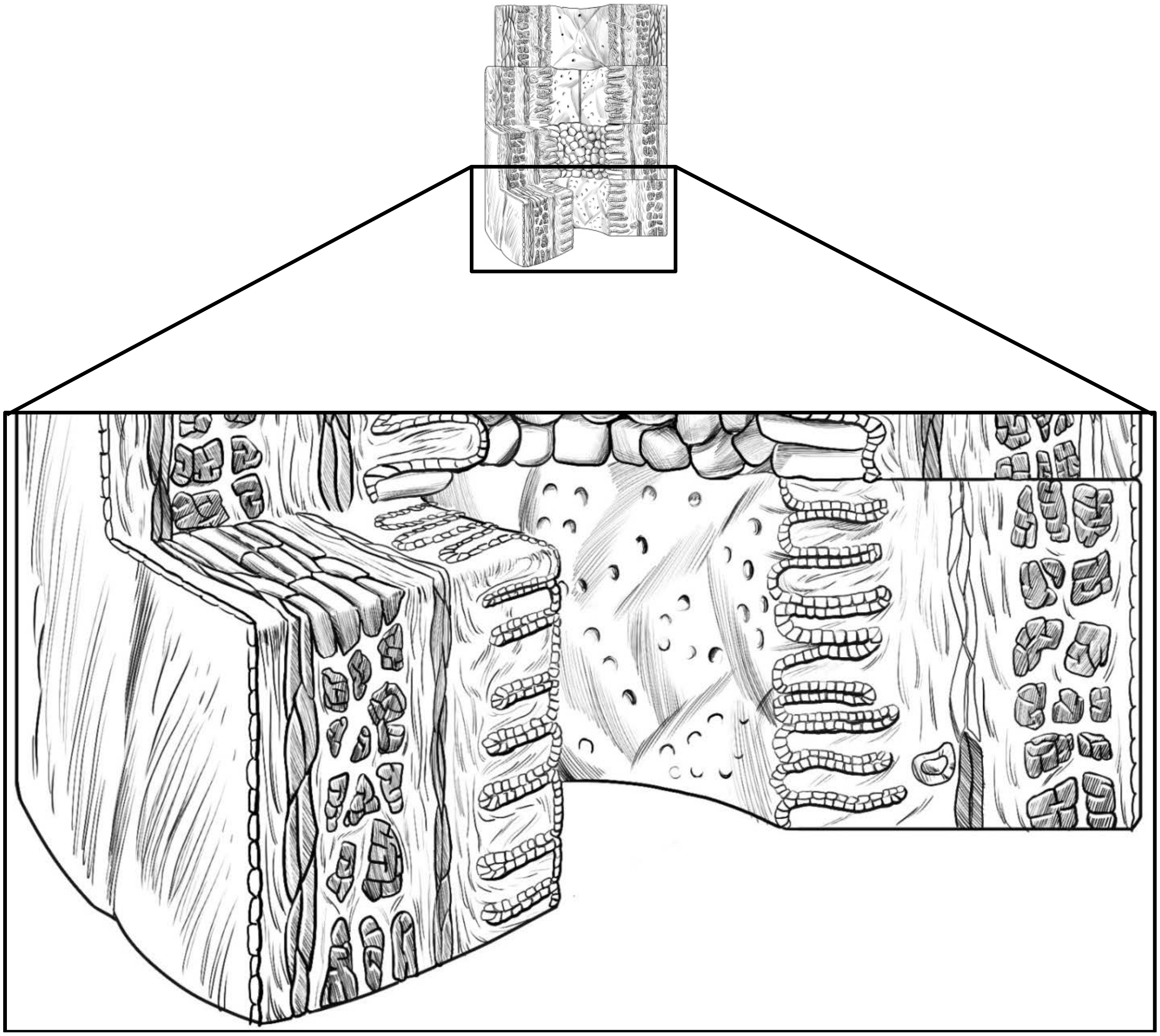
Activity:

1. Identify the following structures/layers:

☐	Epithelium	☐	Muscularis externa
☐	Intestinal crypt	☐	Muscularis mucosa
☐	Lamina propria	☐	Serosa
☐	Mucosa	☐	Submucosa

2. What type of epithelial tissue lines the mucosa of the large intestine?
3. What type of muscle tissue is found in the muscularis externa of the small intestine?
4. How many layers of muscle tissue are found in the muscularis externa of the large intestine?

Microscopic Anatomy of the Large Intestine



Large Intestine Histology

Once you are familiar with the microscopic structure of the large intestine, you should be able to identify many of the features on prepared and stained sections of the large intestine.

This slide is of a cross section of the large intestine, in which you will be able to identify the different layers of tissue as well as intestinal glands.

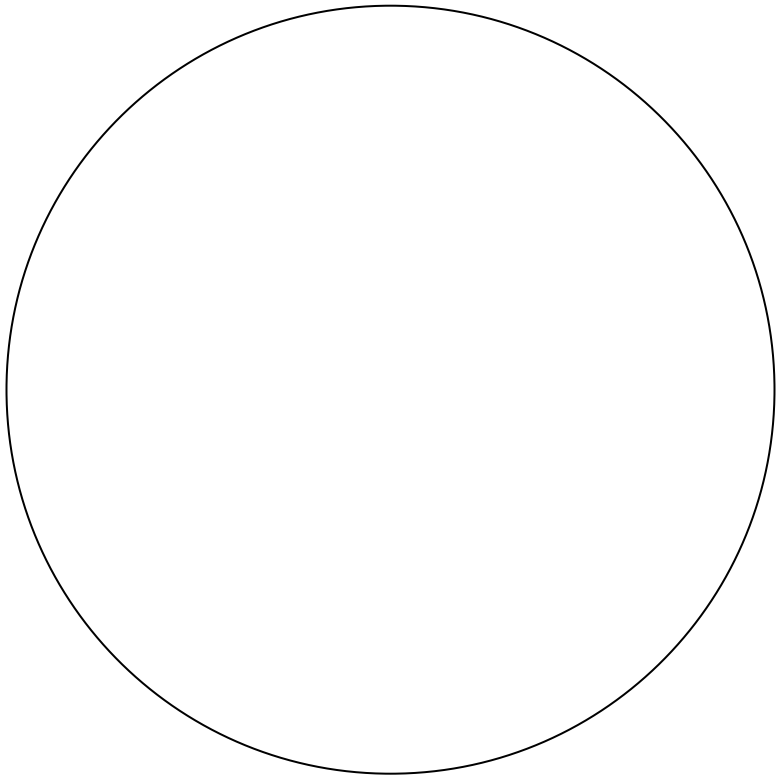
Activity:

1. Obtain slide number 74 from your slide box.
2. Using the 10X objective lens, locate the following:

    Intestinal glands
    Mucosa
    Muscularis
    Serosa
    Submucosa

3. Draw what you see on the following page, labelling the structures listed above.
4. What type of epithelial tissue is found in the mucosa?
5. What type of muscle tissue is found in the muscularis?

Large Intestine Histology



The Liver and Gallbladder
(Visceral surface)

The liver, the largest gland in the body, is located on the right side of the abdominal cavity. It is an accessory organ to the digestive system; it aids in the digestion of fat by producing bile, an emulsifier, which is secreted into the duodenum of the small intestine.

This figure shows the visceral surface of the liver, which faces posterior and inferior, toward the other abdominal viscera. The liver has two lobes. The **right lobe**, the larger of the two, is located (as its name implies) on the right side of the liver. The **left lobe**, the smaller lobe, is on the side facing the stomach. The right and left lobes are divided by a **fissure;** within the fissure is the **ligamentum teres,** which is a developmental remnant of the umbilical vein. The left lobe has two smaller lobes with which it shares blood vessels and nerves; these lobes, called the **caudate lobe** and **quadrate lobe**, are located just to the right of the fissure.

There are three types of blood vessels supplying the liver. All three major vessels enter and leave the liver at an area called the **porta hepatis**. The **hepatic artery** delivers oxygenated blood to the liver, while the **hepatic vein** carries deoxygenated blood away from the liver. A third vessel – called the **hepatic portal vein** – carries blood from the intestines to the liver. After a meal, the hepatic portal vein is rich with nutrients; those nutrients are delivered to the liver so they can be processed.

The **gall bladder**, which is the liver's accessory, is located near the right lobe of the liver. It stores and concentrates the bile produced by the liver.

<u>Activity:</u>

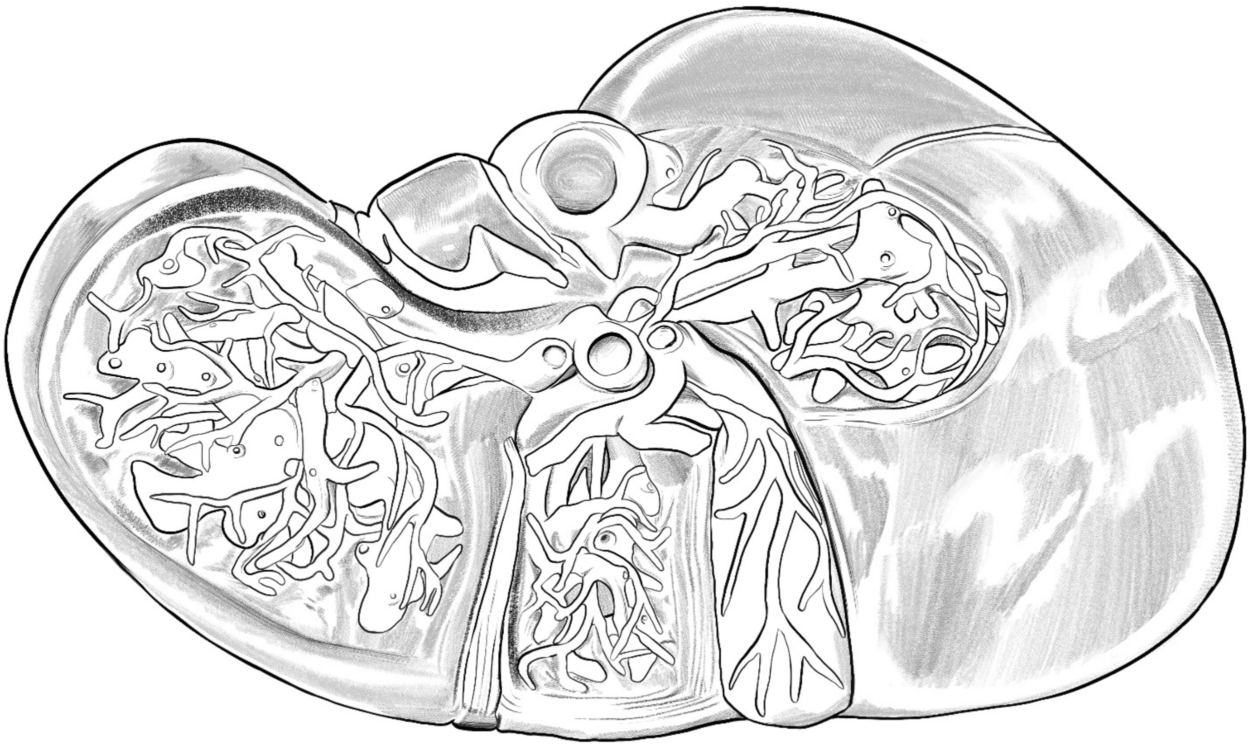
1. Identify the following structures:

☐	Caudate lobe	☐	Hepatic veins
☐	Fissure	☐	Left lobe
☐	Gall bladder	☐	Ligamentum teres
☐	Hepatic artery	☐	Quadrate lobe
☐	Hepatic portal vein	☐	Right lobe

2. Circle the porta hepatis on the figure.

The Liver and Gallbladder

(Visceral surface)



Liver Histology

Once you are familiar with the generalized structure of the liver, you should be able to identify many of the features on prepared and stained sections of the liver.

The functional unit of the liver is called the **lobule**. These microscopic structures are shaped like hexagons. In the center of the lobule is a **central vein**; these veins ultimately drain blood into the hepatic veins. At the corners of the hexagon there are **portal triads**, which consist of an **arteriole** (branch of the hepatic artery), a **portal venule** (branch of hepatic portal vein), and a **bile duct**. The remainder of the lobule is composed of **hepatocytes**, liver cells, and **sinusoids**, leaky capillaries that drain into the central vein.

This slide is of a section of the liver, in which you will be able to identify the lobules and their central veins.

Activity:

1. Obtain slide number 76 from your slide box.
2. Using the 4X objective lens, locate the following:

    Central vein
    Lobule

3. Draw what you see on the following page, labelling the structures listed above.
4. What are liver cells called?

Liver Histology

The Pancreas

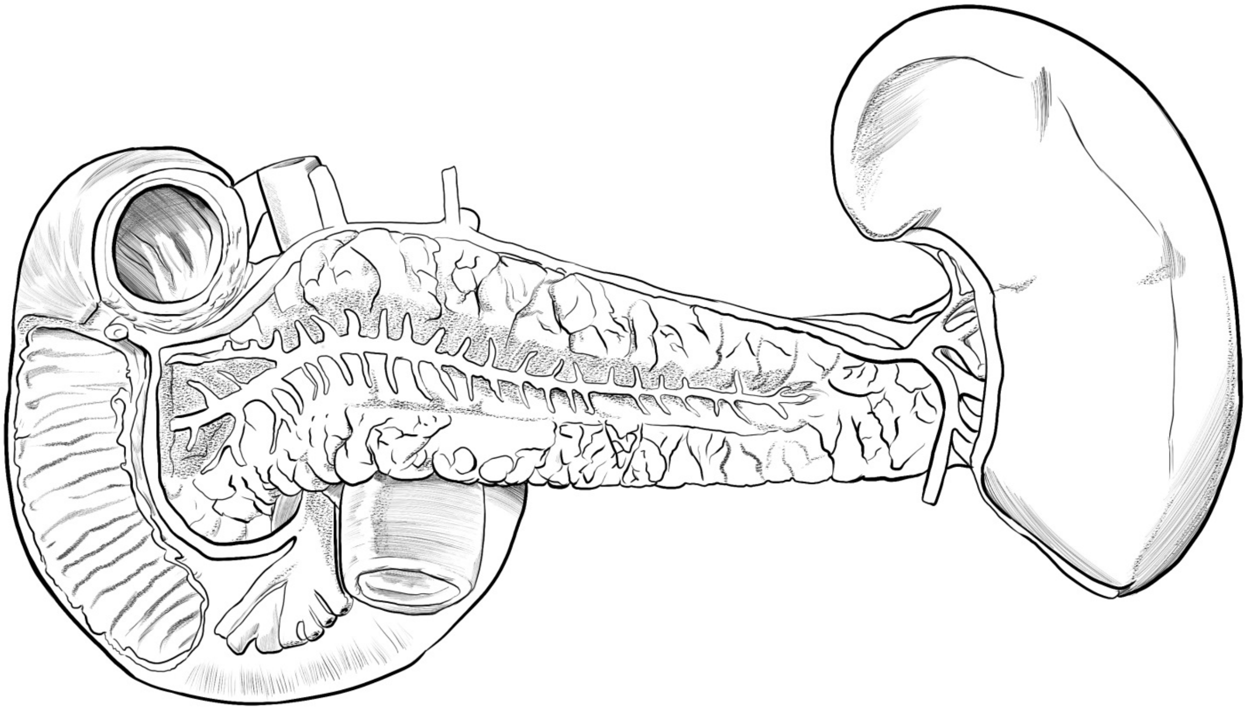
This figure shows you the position of the **pancreas**, relative to the **spleen** and the **duodenum**. The pancreas sits in the upper region of the abdominal cavity, just behind the stomach. It is a retroperitoneal organ, with three regions. The **head** fits in the C-shaped turn of the duodenum, the **tail** points toward the spleen, and the **body** lies between the head and the tail. The pancreas is both an endocrine and exocrine organ; the endocrine function will be discussed later. The exocrine secretions – digestive enzymes and buffers – are released from the exocrine cells into the **main pancreatic duct**. This duct extends the entire length of the pancreas, from head to tail. Within the head there is an additional, smaller duct, called the **accessory pancreatic duct**. The pancreatic ducts ultimately release the exocrine secretions into the duodenum, to assist with digestion. The intricate duct system involving both the liver and the pancreas will be discussed shortly.

Activity:

1. Identify the following structures:

- ☐ Accessory pancreatic duct
- ☐ Body
- ☐ Duodenum
- ☐ Head
- ☐ Main pancreatic duct
- ☐ Spleen
- ☐ Tail

The Pancreas



The Hepatopancreatic Duct System

Recall that the duodenum of the small intestine receives pancreatic juice (enzymes and buffers) from the pancreas and bile from the liver and gall bladder. These exocrine glands deliver their respective secretions to the duodenum by a network of ducts.

The right lobe of the liver secretes bile into the **right hepatic duct**. The left lobe of the liver secretes bile into the **left hepatic duct**. These two ducts then combine to form the **common hepatic duct**. Meanwhile, the gall bladder secretes bile into the **cystic duct**. The common hepatic and cystic ducts combine to form the **common bile duct**.

Most of the pancreatic secretions leave the pancreas via the **main pancreatic duct**. The main pancreatic duct meets with the common bile duct at the wall of the duodenum; these two ducts combine to form an opening to the duodenum, called the **hepatopancreatic ampulla**.

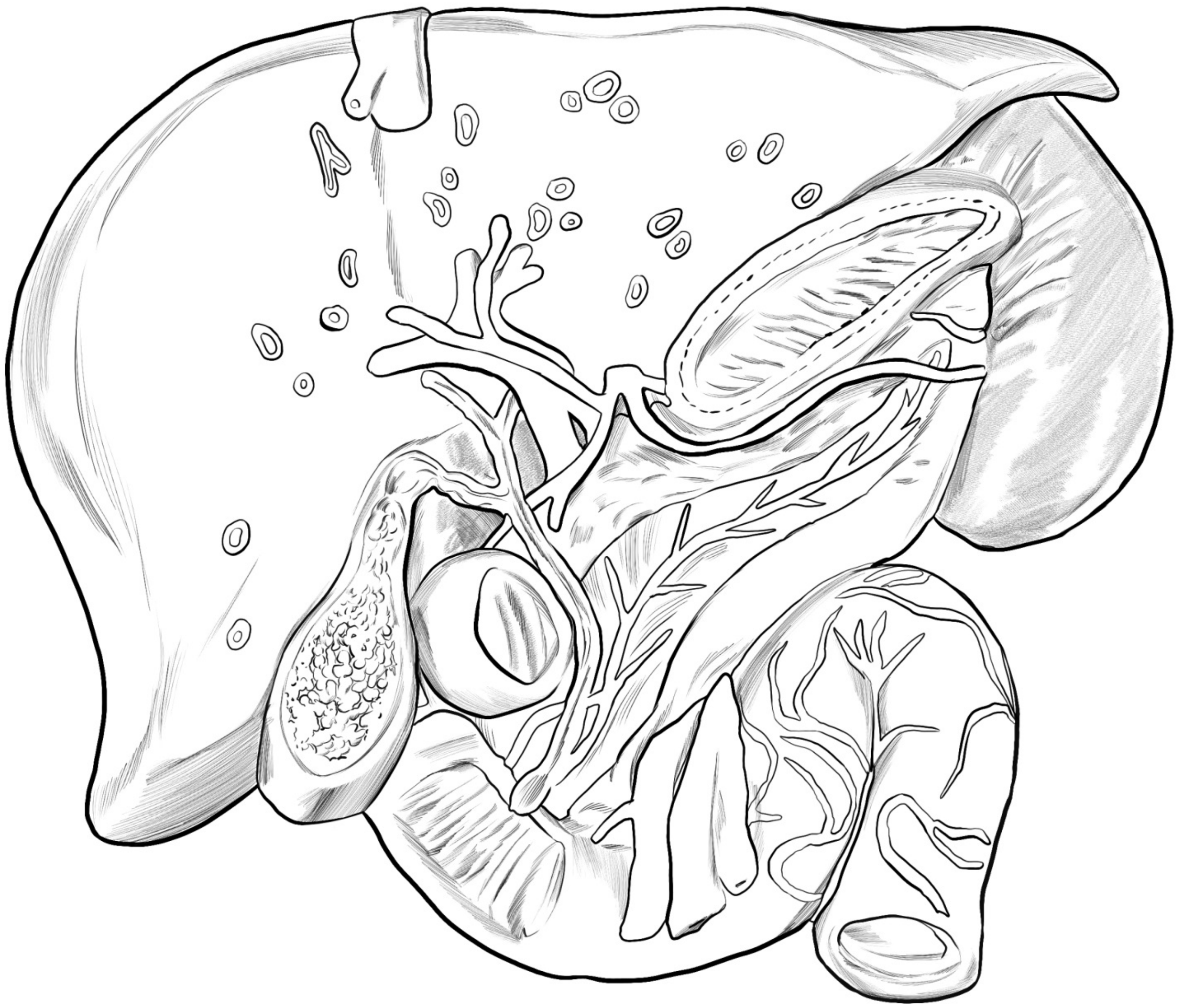
In some people, the head of the pancreas has an additional duct, called the **accessory pancreatic duct**. This duct drains directly into the duodenum, without first combining with the main pancreatic or common bile ducts.

Activity:

1. Identify the following structures:

☐ Accessory pancreatic duct	☐ Gall bladder
☐ Body	☐ Head
☐ Common bile duct	☐ Left hepatic duct
☐ Common hepatic duct	☐ Main pancreatic duct
☐ Cystic duct	☐ Right hepatic duct
☐ Duodenum	☐ Tail

The Hepatopancreatic Duct System



Pancreas Histology

Once you are familiar with the generalized structure of the pancreas, you should be able to identify many of the features on prepared and stained sections of the pancreas.

Recall that the pancreas is both an endocrine and exocrine organ. The exocrine portion forms the majority of the pancreas, with small clusters of endocrine cells throughout. The exocrine cells are called **acinar** cells. These glandular cells secrete digestive enzymes and buffers to aid the chemical digestion that occurs within the small intestine. The clusters of endocrine cells are called the islets of Langerhans (pancreatic islets); these cells will be discussed during the endocrine system unit.

This slide is of a section of the pancreas, in which you will be able to identify the acinar cells. You will also see the islets of Langerhans, but you don't need to identify them during this activity.

Activity:

1. Obtain slide number 78 from your slide box.
2. Using the 10X objective lens, locate the following:

    Acinar cells

3. Draw what you see on the following page, labelling the structures listed above.
4. What is the purpose of acinar cells?

Pancreas Histology

The Urinary System

The urinary system serves the vital purpose of ridding the blood of waste products and balancing different variables of blood (e.g. volume, pressure, pH, osmolality). The **kidneys** perform these functions of the urinary system. These retroperitoneal organs are located in the posterior abdomen, extending from about T12 to L3. Note that the left kidney is slightly higher than the right kidney, because of the position of the liver on the right side. The kidneys are bean-shaped, with a lateral convex surface and medial concave surface. The medial surface has a large fissure, called the **hilum**, where the **renal artery** enters the kidney and the **renal vein** and **ureter** leave the kidney.

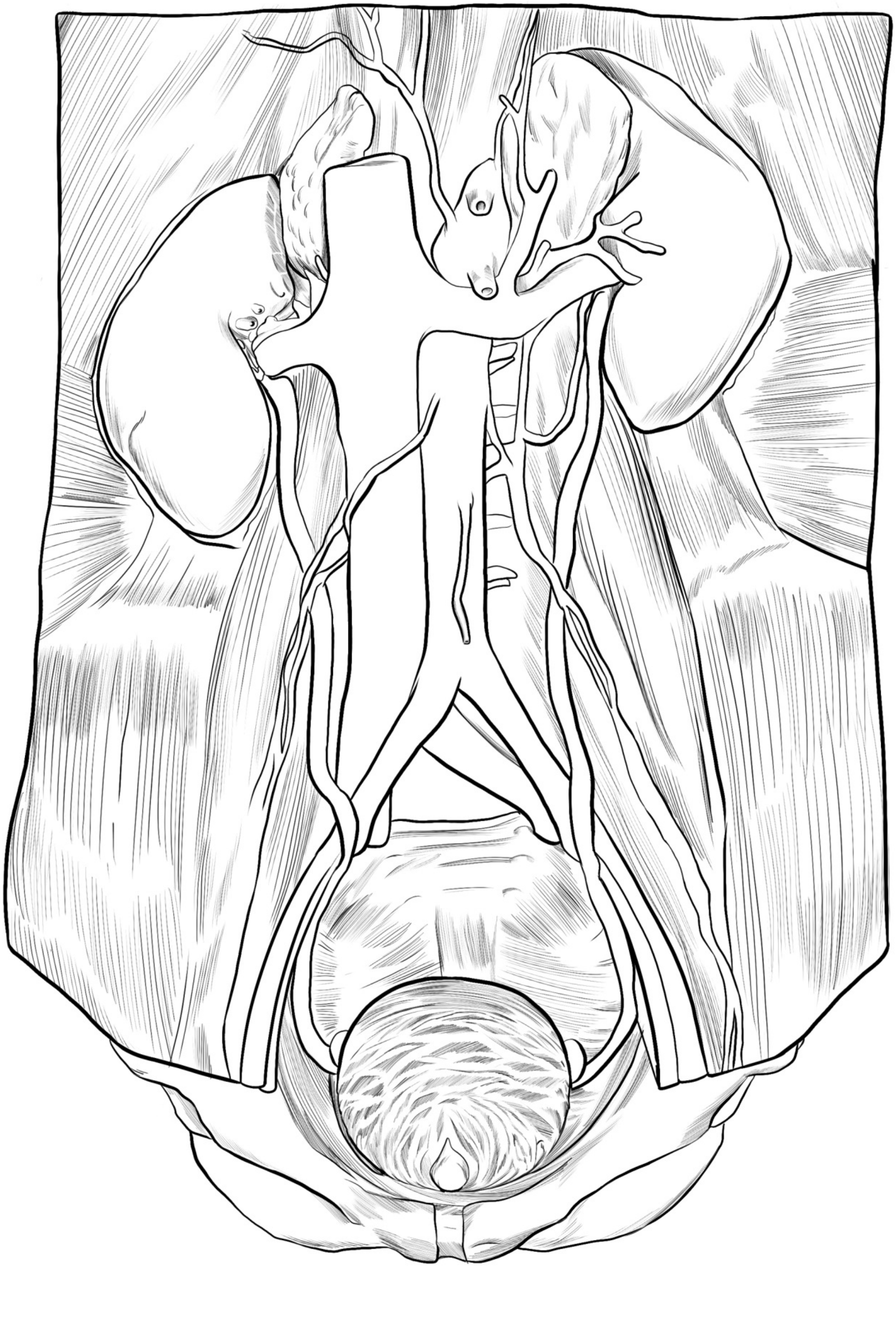
Once urine is produced by the kidneys, it is drained from the kidneys by the ureters. These long tubes extend retroperitoneal down the abdominopelvic cavity, and empty into the **urinary bladder**. The muscular urinary bladder stores urine, and then expels it during micturition. The bladder is shaped like an upside down pyramid. The lateral points are attached to the two ureters. The anterior point is a fibrous structure called the **urachus**; during fetal development this was a tube (the allantois) that drained the fetal bladder into the umbilical cord. The inferior point connects to the **urethra**, the tube that drains urine from the bladder.

Activity:

1. Identify the following structures:

☐	Kidney	☐	Urachus
☐	Renal artery	☐	Ureter
☐	Renal hilum	☐	Urethra
☐	Renal vein	☐	Urinary bladder

Urinary System



Gross Kidney Structure

This figure shows you the gross structure of a kidney, which has been sliced along the coronal section. There is a **fibrous capsule** surrounding the kidney, which is composed of collagen and elastin fibers. This capsule holds the structures of the kidney together and protects it from trauma. Within the kidney, there are two regions: the outer cortex and inner medulla. The **cortex** contains millions of nephrons, the functional units of urine production. The **medulla** contains some nephrons, but is mostly composed of structures that conduct the urine away from the kidney. **Renal pyramids** are found within the renal medulla. These cone-shaped, striped structures contain the ducts that drain urine from the nephrons; the broad portion faces the cortex and the apex, called the **renal papilla**, faces the interior of the kidney. Columns of cortex tissue, called **renal columns**, extend between the renal pyramids.

The urine from each renal papilla drains into a **minor calyx**. Two to three minor calyces combine to form a **major calyx**. Two to three major calyces combine to form the **renal pelvis**. The **ureter** attaches to the renal pelvis, and transports urine from the kidney to the bladder.

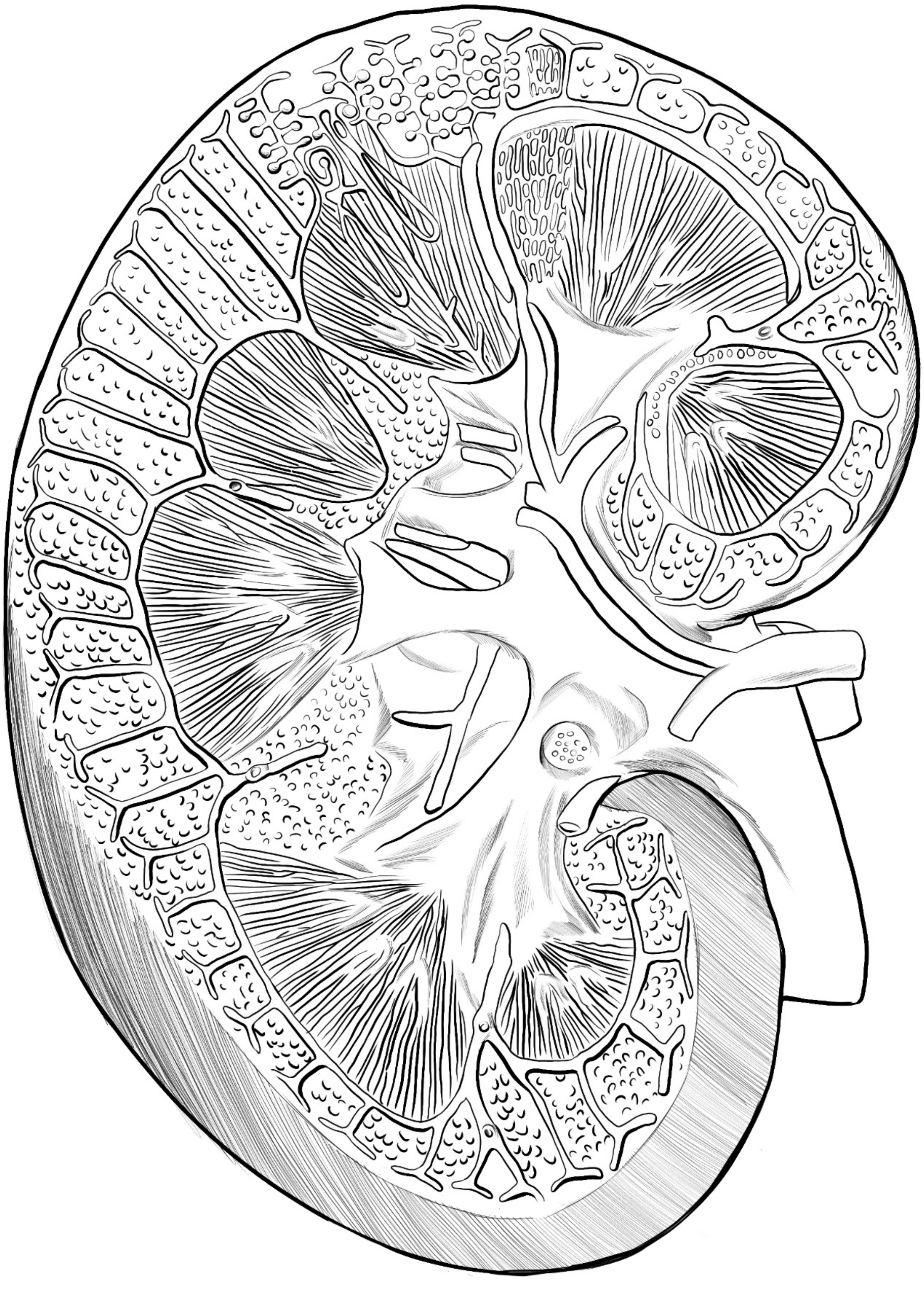
Activity:

1. Identify the following structures:

☐	Fibrous capsule	☐	Renal column
☐	Major calyx	☐	Renal pelvis
☐	Minor calyx	☐	Renal pyramid
☐	Renal papilla	☐	Ureter

2. Label which region is the cortex, and which region is the medulla.

Gross Kidney Structure



Blood Vessels of the Kidney

The kidneys are highly vascular organs, containing large volumes of blood at all times. The **renal artery** delivers blood to the kidney. The renal artery then splits into five segmental arteries, which enter the kidney at the hilum. Once inside the renal medulla, the segmental arteries then split into **interlobar arteries**; these arteries are found within the renal columns. Where the medulla meets the cortex, the interlobar arteries become **arcuate arteries**. These arteries are found arching over the base of the renal pyramids. The arcuate arteries then give rise to the **cortical radiate arteries**. These small arteries, which radiate toward the outer surface of the kidney, feed into the microcirculation of the nephron, the functional unit of the kidney.

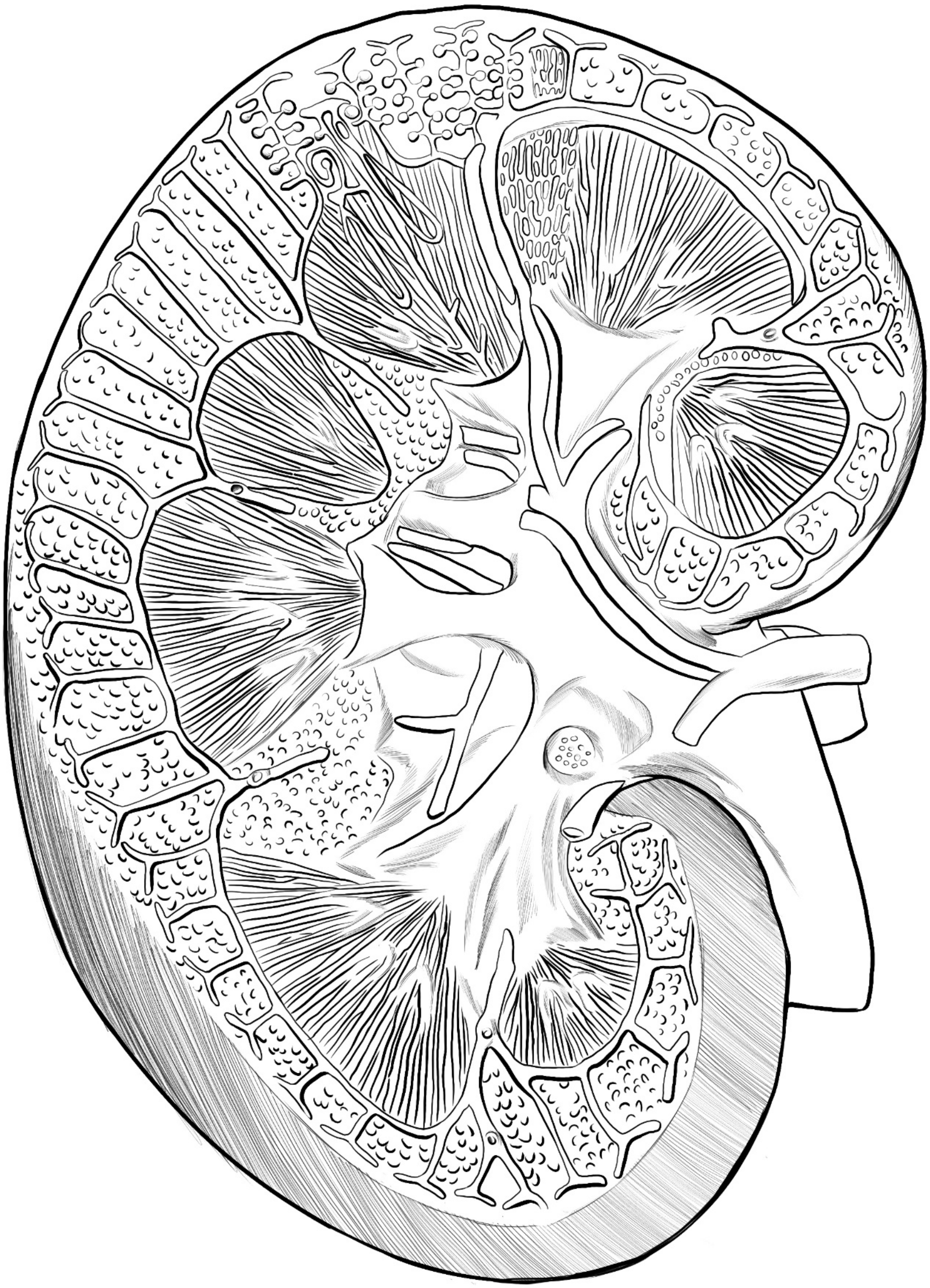
The veins of the kidney are very similar to the arteries, in terms of name and location. The microcirculatory vessels of the nephron feed deoxygenated (but cleaner!) blood into the **cortical radiate veins**. The cortical radiate veins then feed into **arcuate veins**, which become **interlobar veins**. The interlobar veins drain directly into the **renal vein**; note that there are no segmental veins.

Activity:

1. Identify the following vessels:

- [ ] Arcuate artery
- [ ] Arcuate vein
- [ ] Cortical radiate artery
- [ ] Cortical radiate vein
- [ ] Interlobar artery
- [ ] Interlobar vein
- [ ] Renal artery
- [ ] Renal vein
- [ ] Segmental artery

Blood Vessels of the Kidney



The Nephron
(Tubules)

Each of the kidneys contains more than a million nephrons, the function unit of the urinary system. The nephron is composed of tubules and blood vessels, which are closely associated. The tubules remove wastes from the blood, and also selectively retain nutrients and other chemicals in the blood.

Urine formation begins at the **renal corpuscle** of the nephron. **Bowman's capsule** surrounds a cluster of capillaries called the **glomerulus**. A filtration membrane lies between them, allowing certain blood constituents (selected based on size) to leave the blood, thereby forming a fluid called filtrate. The filtrate moves into the remaining tubules of the nephron, and is modified along the way through the processes of reabsorption and secretion until urine is formed. The regions of the tubule, in order, are: the **proximal convoluted tubule**, the **descending limb of the loop of Henle**, the **ascending limb of the loop of Henle**, and the **distal convoluted tubule**. The distal convoluted tubule then empties into the **collecting duct**, which collects urine from several different nephrons and sends it through the renal pyramids of the medulla to ultimately be excreted by the kidney.

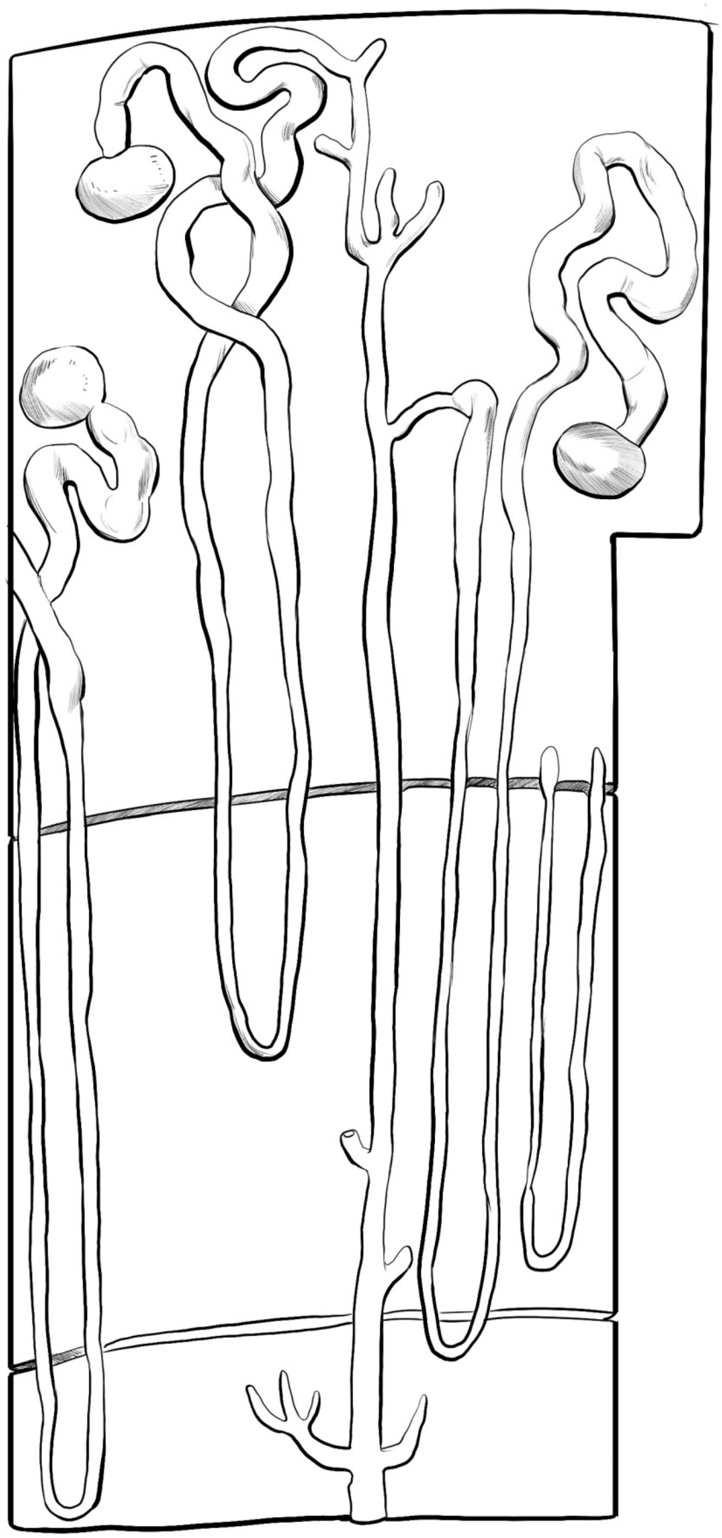
This image is focusing on the tubules of the nephron; we will look at the microscopic blood vessels shortly.

<u>Activity:</u>

1. Identify the following regions of the tubule:

☐ Ascending limb of loop of Henle	☐ Descending limb of loop of Henle
☐ Bowman's capsule	☐ Distal convoluted tubule
☐ Collecting duct	☐ Proximal convoluted tubule

The Nephron
(Tubules)



The Nephron
(Blood Vessels)

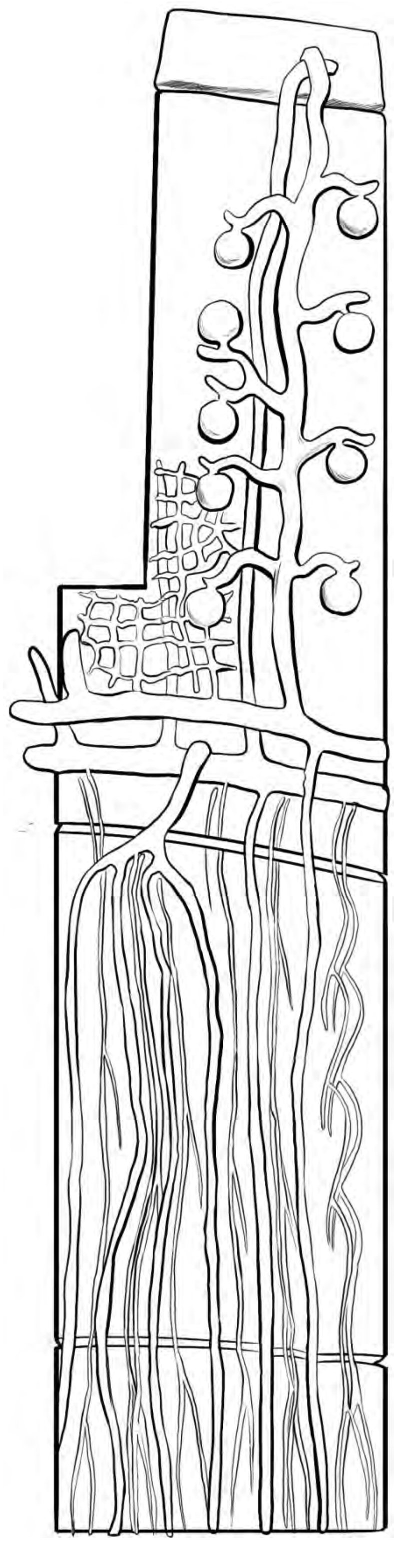
This image provides greater detail of the blood vessels that supply the nephron. Recall that the **arcuate arteries** feed into the **cortical radiate arteries**. A small arteriole, called the **afferent arteriole**, branches off the cortical radiate artery. The afferent arteriole feeds into the **glomerulus**, the cluster of capillaries found within the renal corpuscle, where filtration occurs. Blood then leaves the glomerulus through the **efferent arteriole**, which then gives rise to **peritubular capillaries**. This capillary bed intertwines amongst the tubules of the nephron, allowing for the reabsorption of substances from filtrate to blood, and the secretion of wastes from blood to filtrate. Here, the blood transitions from oxygenated to deoxygenated. The peritubular capillaries empty into the **cortical radiate veins**, which then empty into the **arcuate veins**. The deoxygenated, but cleaner, blood continues on through the venous system.

Activity:

1. Identify the following blood vessels:

☐	Afferent arteriole	☐	Cortical radiate vein
☐	Arcuate artery	☐	Efferent arteriole
☐	Arcuate vein	☐	Glomerulus
☐	Cortical radiate artery	☐	Peritubular capillaries

The Nephron
(Blood Vessels)



The Renal Corpuscle

This figure shows you a close up perspective of the **renal corpuscle**. Recall that the renal corpuscle includes an outer **Bowman's capsule** surrounded by a cluster of capillaries called the **glomerulus**. The first step of urine formation – filtration – occurs here. The glomerulus is lined by a single layer of endothelial cells which have fenestrations, or pores. Blood comes to the glomerulus via the **afferent arteriole**, and leaves via the **efferent arteriole**. The radius of the afferent arteriole is larger than the efferent; this keeps the blood pressure in the glomerulus relatively high to promote filtration.

Bowman's capsule has two layers. The outer, **parietal layer** is composed of simple squamous epithelium and serves no purpose other than to hold the renal corpuscle together. The inner, **visceral layer** is composed of a special type of epithelial cell called a podocyte, so named because they have foot-like processes, called pedicels. The podocytes wrap themselves around the capillary tubes, creating a filtration membrane. The space in between the parietal and visceral layers of Bowman's is the **capsular space**; filtrate is found here. Filtrate then enters the first region of the nephron tubules: the **proximal convoluted tubule**.

Closely associated with the afferent arteriole is a specialized region of the ascending loop of Henle called the **macula densa**. Whereas most of the loop of Henle is lined by simple cuboidal epithelium, the macula densa contains simple columnar epithelium. These cells sit near specialized cells of the afferent arteriole, called **granular cells**. The granular cells and macula densa cells are collectively referred to as the **juxtaglomerular apparatus**, which is a region that is important in blood pressure regulation.

Activity:

1. Identify the following structures:

☐ Afferent arteriole	☐ Macula densa
☐ Capsular space	☐ Parietal layer of capsule
☐ Efferent arteriole	☐ Podocytes
☐ Glomerulus	☐ Proximal convoluted tubule

2. Circle the general location of the juxtaglomerular apparatus.

The Renal Corpuscle

Kidney Histology

Once you are familiar with the structure of the nephron, you should be able to identify many of the features on prepared and stained sections of the kidney.

This slide is of a cross section of the kidney, in which you will be able to identify the different regions of the kidney, as well as some structures of the nephron.

Activity:

1. Obtain slide number 82 from your slide box.
2. Using the 4X objective lens, locate the following:

    Cortex
    Medulla

3. Draw what you see on the following page, labelling the structures listed above.
4. Using the 10X objective lens, locate the following:

    Bowman's capsule
    Capsular space
    Glomerulus
    Tubules

5. Draw what you see on the following page, labelling the structures listed above.

Kidney Histology

Male Reproductive System

This image is of a sagittal section through the male pelvis. It allows you to identify the internal reproductive organs, as well as the external genitalia. The male gonads are the **testes**, which are located outside of the body within the **scrotum**. The sperm created by the testes then travel through several ducts. The first duct is the **epididymis**, which is located on the posterior side of the testes. The epididymis then drains into the **ductus deferens**, a long tube that begins at the base of the testis, up through the spermatic cord, then through the inguinal canal and the abdominal wall, and then over and behind the **urinary bladder**. The ductus deferens leads to the short **ejaculatory duct** that is found within a gland called the prostate gland. The ejaculatory duct empties into the urethra, which transports both urine and semen. The urethra has three regions: the **prostatic urethra** through the prostate, the **membranous urethra** through the urogenital diaphragm, and the **spongy urethra** through the penis.

The ducts are closely associated with three different glands, all of which contribute to the fluid portion of semen. Behind the bladder are the paired **seminal vesicles**; these glands secrete their product into the ejaculatory duct at the same point as the ductus deferens. Under the bladder is the **prostate gland**; this gland empties its secretions into the prostatic urethra. Finally the paired **bulbourethral glands** are located in the urogenital diaphragm and empty their secretions into the spongy urethra.

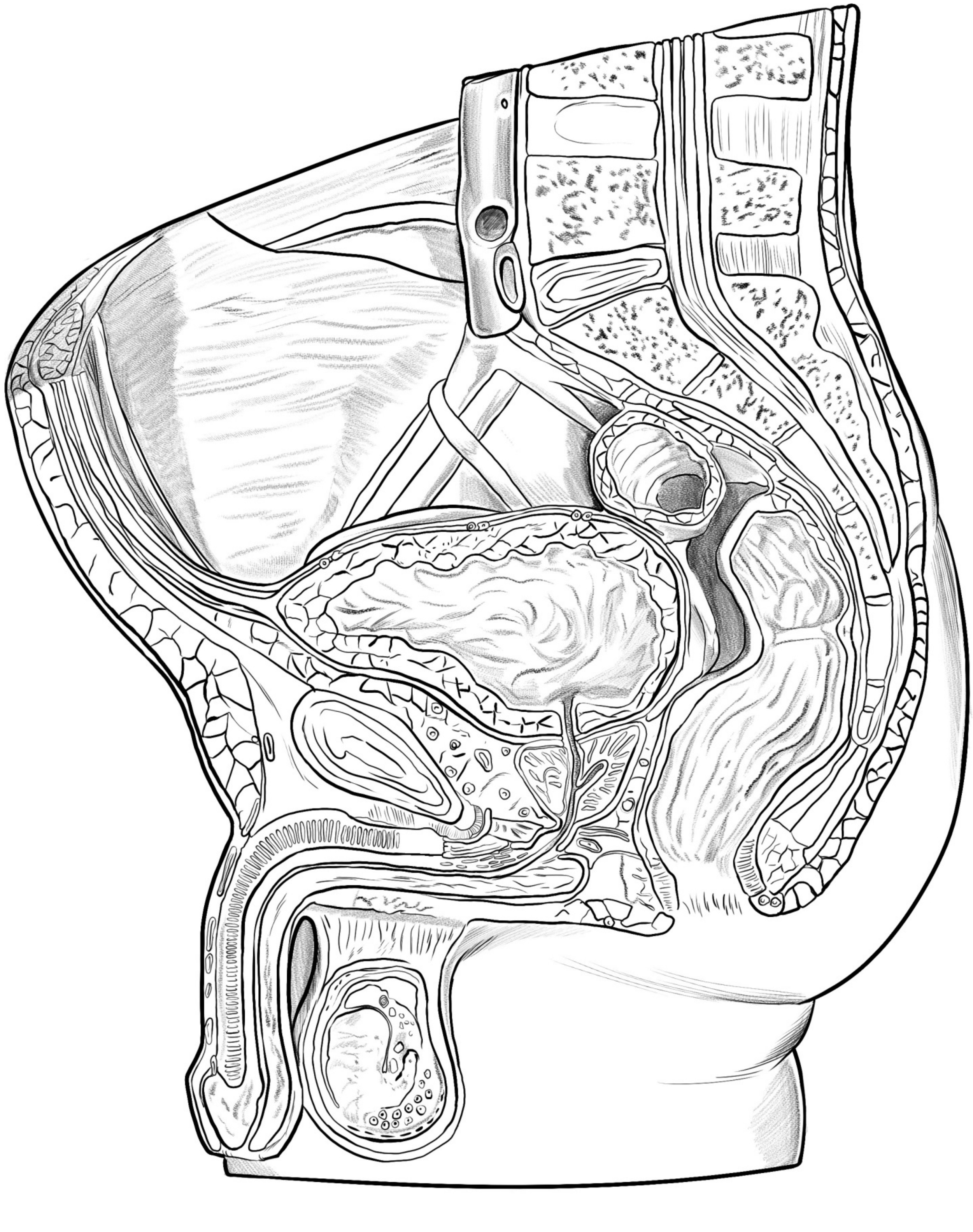
The male external genitalia include the scrotum and penis. The penis is a dual purpose organ; it allows for the expulsion of urine during micturition, and also delivers semen to the female tract during intercourse. It attaches to the pelvis at the **root**; the shaft is referred to as the **body**, which ends at the **glans penis**. There are three columns of tissue that run through the penis. There are two **corpora cavernosa** and a single **corpus spongiosum**, through which the spongy urethra runs.

<u>Activity:</u>

1. Identify the following structures:

☐ Body of penis	☐ Epididymis	☐ Scrotum
☐ Bulbourethral gland	☐ Glans penis	☐ Seminal vesicle
☐ Corpus cavernosum	☐ Membranous urethra	☐ Spongy urethra
☐ Corpus spongiosum	☐ Prostate	☐ Testis
☐ Ductus deferens	☐ Prostatic urethra	☐ Urinary bladder
☐ Ejaculatory duct	☐ Root of penis	

Male Reproductive System



Male Reproductive Histology

Once you are familiar with the structure of the male reproductive organs, you should be able to identify many of the features on prepared and stained slides.

The first slide is of the testis, which contains tubes called **seminiferous tubules**. You will be able to see cross sections of the seminiferous tubules, which are lined by cells in various stages of spermatogenesis called **spermatogenic cells**. In between the seminiferous tubules are **interstitial cells**, which are the endocrine cells that secrete testosterone.

The second slide is of the epididymis. Here you can see the pseudostratified columnar epithlium that lines the mucosa of the epididymis, as well as the surrounding smooth muscle that causes peristaltic contractions to propel the sperm through the male duct system.

The final slide is a cross section of the penis. The different corpora, as well as the spongy urethra, can be observed.

Activity:

1. Obtain slide number 86 from your slide box.
2. Using the 10X objective lens, locate the following:

    Interstitial cells
    Seminiferous tubules
    Spermatogenic cells

3. Draw what you see on the following page, labelling the structures listed above.
4. Obtain slide number 88 from your slide box.
5. Using the 40X objective lens, locate the following:

    Pseudostratified columnar epithelium
    Smooth muscle

6. Draw what you see on the following page, labelling the structures listed above.
7. Obtain slide number 84 from your slide box.
8. Using the 4X objective lens, locate the following:

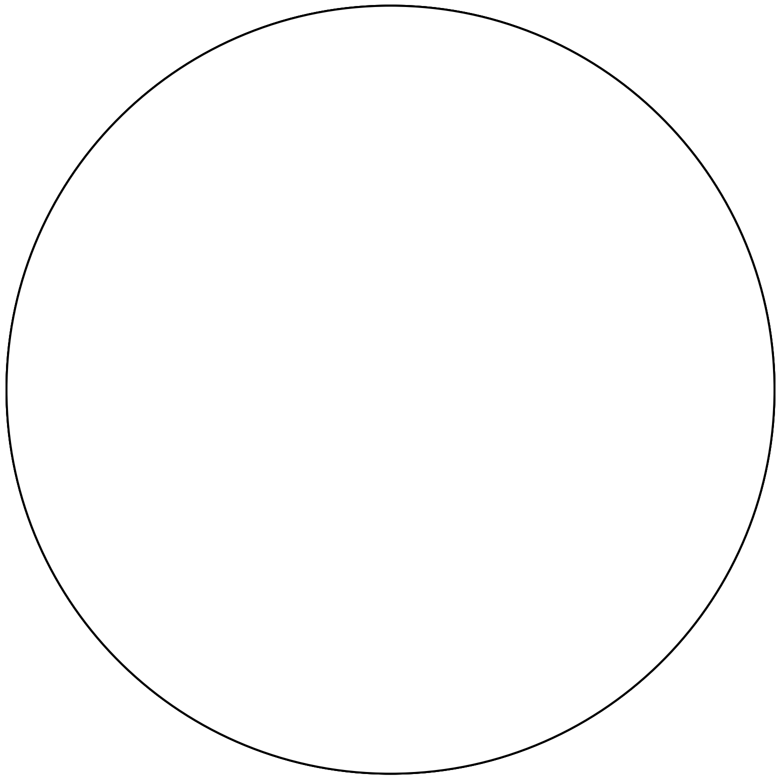
    Corpora cavernosa
    Corpus spongiosum
    Urethra

9. Draw what you see on the following page, labelling the structures listed above.

Male Reproductive Histology

Male Reproductive Histology

Male Reproductive Histology



Female Reproductive System

This image is of a sagittal section through the female pelvis. It allows you to identify the internal reproductive organs, as well as the external genitalia.

The female reproductive organs are found within the pelvic cavity, posterior to the urinary organs and anterior to the digestive organs. The female gonad is the **ovary**. In close association with the ovary is the **uterine tube** (also called oviduct and fallopian tube), which partially connects the ovary to the **uterus** (the womb). The uterus is tilted forward, resting on the urinary bladder. The bottom, neck region of the uterus, called the **cervix**, extends into the **vagina** (birth canal). In the superior-most regions of the vagina, where the cervix extends into it, there are two arch-like areas: the smaller **anterior fornix** and larger and deeper **posterior fornix**.

The female reproductive organs are held in place by several different ligaments, a few of which can be seen on this image. The **round ligament** connects the anterior side of the uterus to the anterior pelvic wall. The remaining ligaments will be discussed shortly.

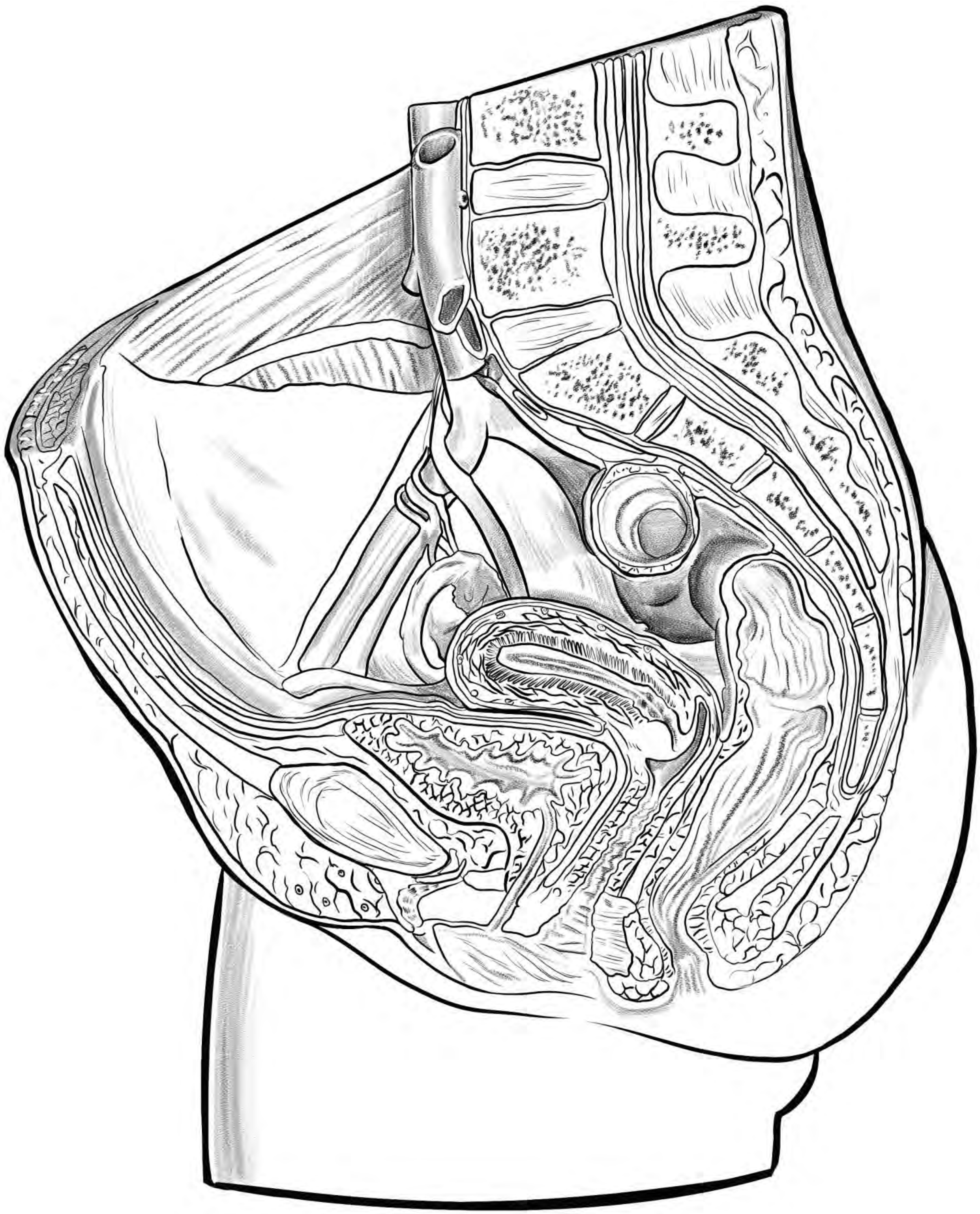
The vagina opens to the exterior at the **vaginal orifice**. The external genitalia are collectively referred to as the **vulva**. This includes the **labia majora** and **labia minora** on the lateral sides, the **clitoris**, which is just anterior to the urethra opening, and the **mons pubis**, a fatty pad that sits in front of the pubic symphysis.

Activity:

1. Identify the following structures:

☐ Anterior fornix	☐ Posterior fornix
☐ Cervix	☐ Round ligament
☐ Clitoris	☐ Uterine tube
☐ Labium majora	☐ Uterus
☐ Labium minor	☐ Vagina
☐ Mons pubis	☐ Vaginal orifice
☐ Ovary	

Female Reproductive System



The Internal Female Reproductive Organs

These figures show the internal organs of the female reproductive system. A large sheet of peritoneum, called the **broad ligament**, which is shown in the first figure, covers all internal reproductive organs and holds them in place. In the second figure, the broad ligament has been removed so you can identify features of the uterus and uterine tube.

The rounded top of the **uterus** is called the **fundus**. The **body** forms the majority of the uterus; it narrows inferiorly to become the **isthmus**. The neck of the uterus is the **cervix**, which projects into the **vagina**. The opening of the cervix superiorly to the uterine body is called the **internal os**, while the opening to the vagina is called the **external os**. The uterus has three layers of tissue. The outermost layer is the **perimetrium**, which is pertineum. The middle layer, the **myometrium**, is composed of smooth muscle. The innermost layer is called the **endometrium**; this highly vascular layer composed of epithelial tissue changes throughout the menstrual cycle and supports the developing fetus.

The **uterine tubes** (also called oviducts and fallopian tubes) extend laterally from the uterus, and partially connect the ovary to the uterus. There are three regions to the uterine tube. The **isthmus** connects the uterine tube to the uterus. Laterally, to the isthmus is the **ampulla**, which is the most common site for fertilization. The lateral-most region is the **infundibulum** which opens to the pelvic cavity. At the very end of the infundibulum are finger-like extensions called **fimbriae**, which help to draw an oocyte into the uterine tube after ovulation.

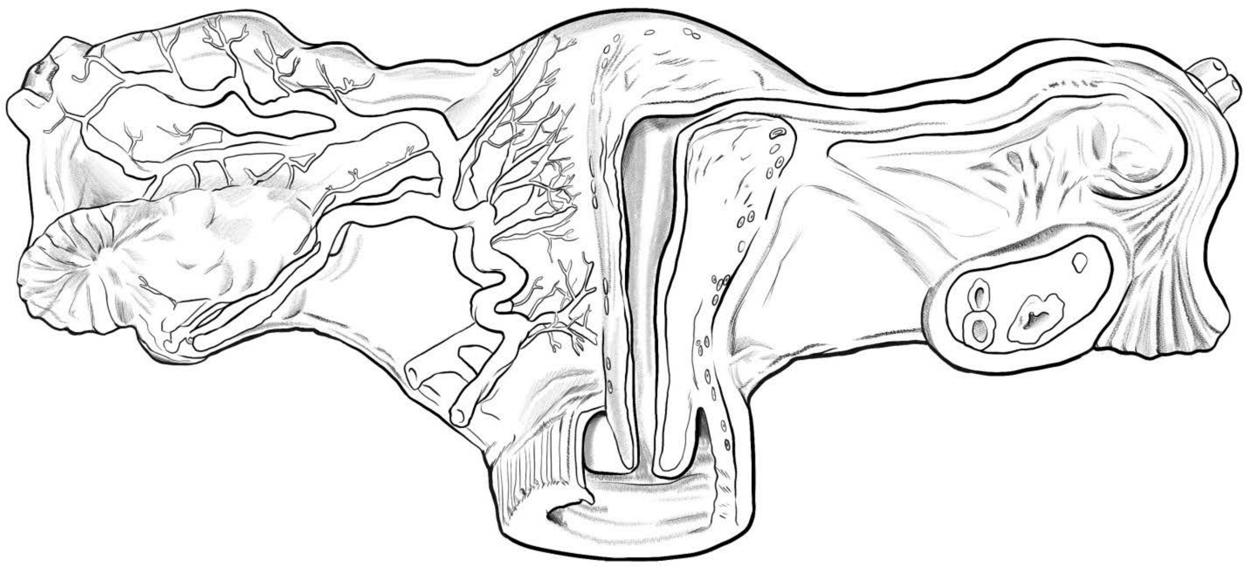
Supporting the uterus, uterine tubes and ovaries are several ligaments. The **ovarian ligament** connects the medial side of the ovary to the uterus. The **suspensory ligament** connects the lateral side of the ovary to the lateral pelvic wall. The round ligament attaches the uterus to the anterior pelvic cavity; this ligament is not shown in these figures.

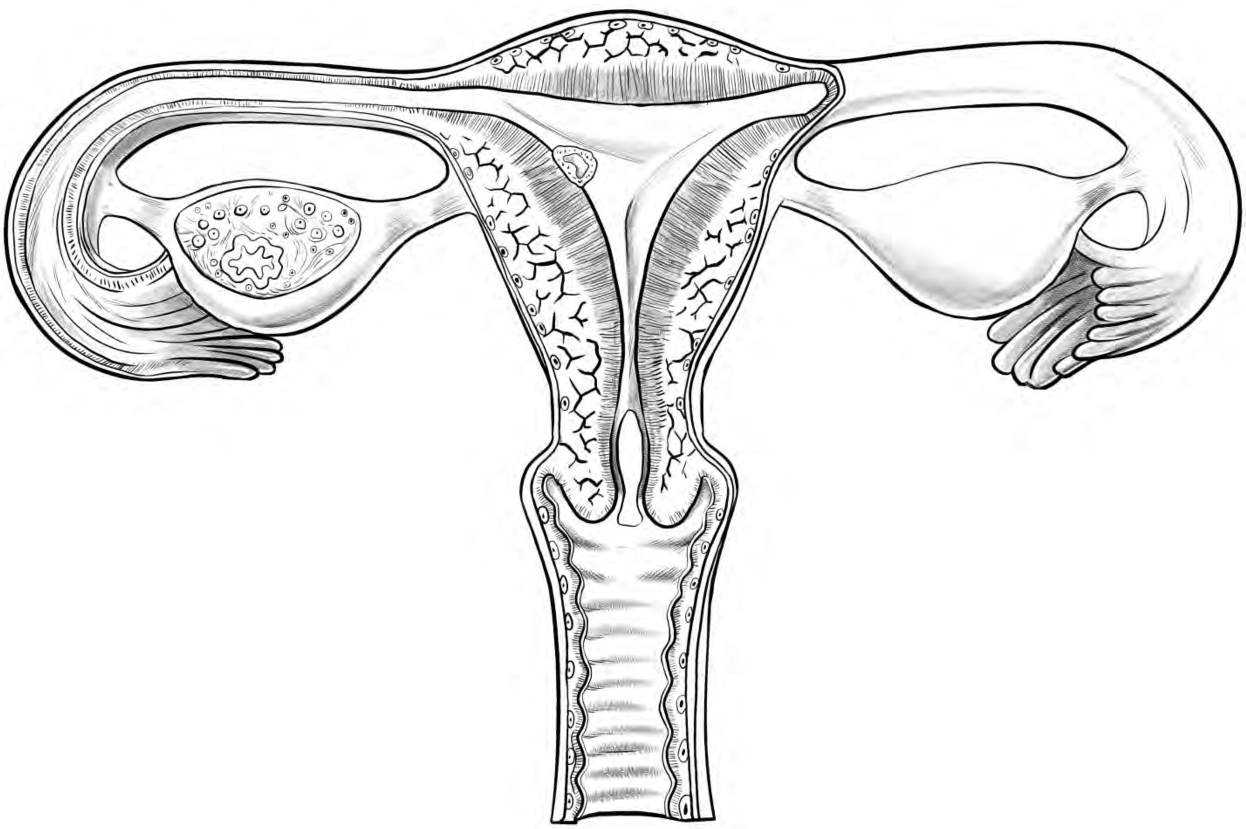
Activity:

1. Identify the following structures:

☐ Ampulla	☐ Fundus	☐ Ovary
☐ Body	☐ Infundibulum	☐ Perimetrium
☐ Broad ligament	☐ Internal os	☐ Suspensory ligament
☐ Cervix	☐ Isthmus, uterine tube	☐ Uterine tube
☐ Endometrium	☐ Isthmus, uterus	☐ Uterus
☐ External os	☐ Myometrium	☐ Vagina
☐ Fimbriae	☐ Ovarian ligament	

The Internal Female Reproductive Organs





The Ovary

This figure is of a coronal section of the ovary, which shows the internal structures of the ovary. The ovary has an outer **cortex**, where the follicles and developing oocytes are located, and an inner **medulla**, which contains highly vascular connective tissue. The ovary is surrounded by the **tunica albuginea**, a layer of fibrous connective tissue that holds the ovary together. Oocytes develop within structures called follicles. The smallest follicles, **primordial follicles**, contain an **oocyte** surrounded by one layer of follicular cells. At the beginning of the ovarian cycle each month, several primordial follicles grow larger to become **primary follicles** as the oocyte and its surrounded follicular cells get larger. Next, the follicular cells begin to multiple until the oocyte is surrounded by several layers of follicular cells; the follicle at this stage is called a **secondary follicle**. The follicle then begins to accumulate fluid on the inside, and begins to grow even larger. The largest of these follicles is the **Graafian follicle**. It is the Graafian follicle that ruptures during **ovulation** to release the oocyte into the pelvic cavity. The empty follicle now becomes an endocrine structure called the **corpus luteum**, which is responsible for secreting the hormones that will support a pregnancy for several months. If a pregnancy does not occur, the corpus luteum will begin to degenerate a little less than two weeks after ovulation to become a scar, called the **corpus albicans**.

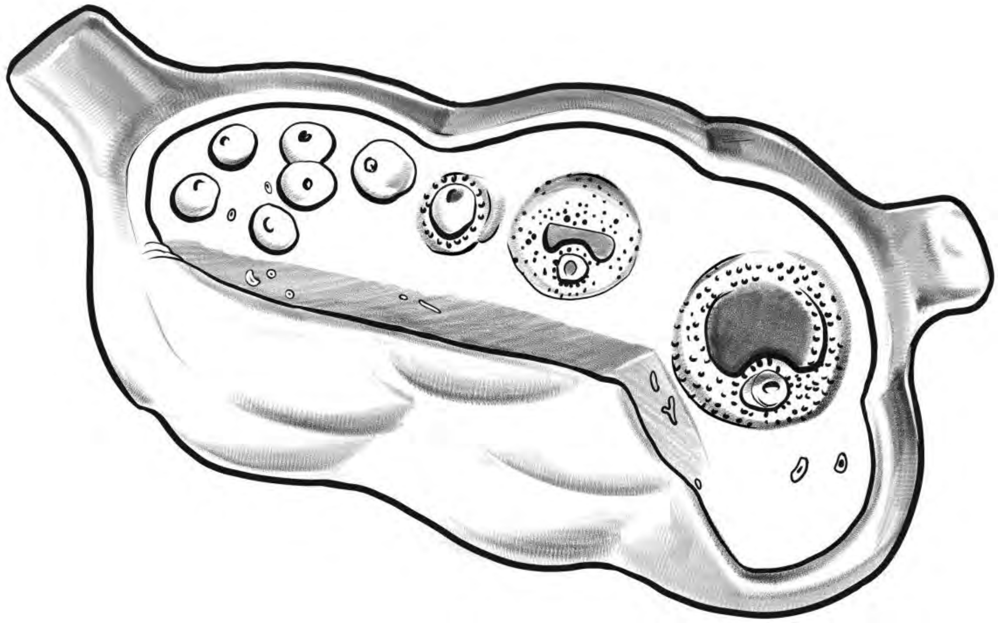
Activity:

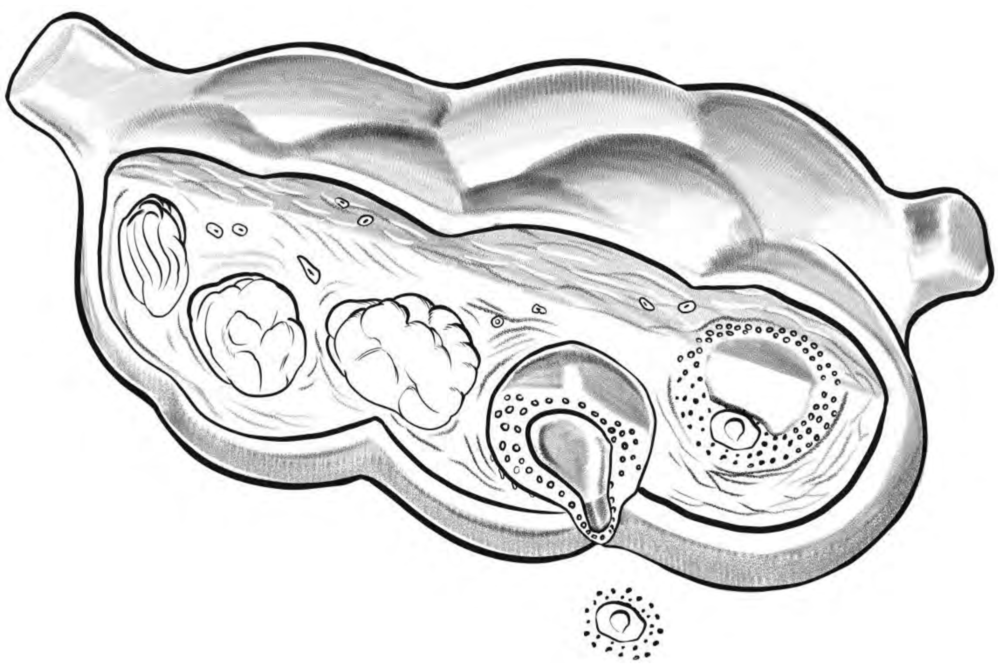
1. Identify the following structures:

☐	Corpus albicans	☐	Primary follicle
☐	Corpus luteum	☐	Primordial follicle
☐	Graafian follicle	☐	Secondary follicle
☐	Oocyte	☐	Tunica albuginea

2. Label the cortex and medulla.
3. Circle the region of the image representing ovulation.

The Ovary





Female Reproductive Histology

Once you are familiar with the structure of the female reproductive organs, you should be able to identify many of the features on prepared and stained slides.

The uterine wall has three layers of tissue. The outer layer, called the **perimetrium**, is composed of peritoneum. The middle layer, called the **myometrium**, is composed of smooth muscle. The inner layer, called the **endometrium**, is the mucosal layer of the uterus which contains simple columnar epithelium and an underlying lamina propria. There are two layers within the endometrium, the innermost **stratum functionalis** and the underlying **stratum basalis**. The stratum functionalis is subject to hormonal influences and changes in thickness throughout the month; this layer is shed during menstruation. The stratum basalis contains cells that re-form the stratum functionalis after menstruation. The first slide that you will be viewing is of the uterus, in which you can see the different layers of endometrial tissue.

The second slide is of the ovary. You should be able to identify the two regions – cortex and medulla – as well as the follicles and oocytes.

Activity:

1. Obtain slide number 92 from your slide box.
2. Using the 4X objective lens, locate the following:

   Stratum basalis
   Stratum functionalis

3. Draw what you see on the following page, labelling the structures listed above.
4. Obtain slide number 90 from your slide box.
5. Using the 4X objective lens, locate the following:

   Cortex
   Graafian follicle
   Medulla
   Oocyte
   Primary/secondary follicle
   Primordial follicle

6. Draw what you see on the following page, labelling the structures listed above.

Female Reproductive Histology

The Pituitary

The **pituitary gland**, also called the **hypophysis**, is the master gland of the endocrine system. This gland rests in the sella turcica of the sphenoid bone, just inferior to the **hypothalamus**. It is connected to the hypothalamus via a stalk of tissue called the **infundibulum**. There are two regions within the pituitary gland; the anterior pituitary is called the adenohypophysis and the posterior pituitary is called the neurohypophysis.

The **adenohypophysis** is composed of glandular tissue, which secretes seven different hormones. Four of these hormones are considered tropic hormones, because they stimulate other endocrine glands to produce their hormones. Thyroid hormone (TH) stimulates the thyroid gland; adrenocorticotropic hormone (ACTH) stimulates the adrenal gland; and follicle stimulating (FSH) and luteinizing hormones (LH) stimulate the gonads. The remaining three hormones have non-endocrine gland target tissues. Prolactin (PRL) stimulates milk production in mammary glands. Growth hormone (GH) stimulates body cells to grow. Finally, melanocyte stimulating hormone (MSH) stimulates the production of melanin by melanocytes, and also influences appetite

The **neurohypophysis** is composed of nervous tissue. The neurons arise in the hypothalamus, and the axons extend down through the infundibulum, into the neurohypophysis. This is called the hypothalamic-hypophyseal tract. This portion of the pituitary gland does not produce any hormones; rather, it secretes hormones produced by the hypothalamus. Antidiuretic hormone (ADH) stimulates the kidneys to retain water during dehydration. Oxytocin (OXY) stimulates uterine contractions during childbirth, milk ejection during lactation, and affiliative behaviors.

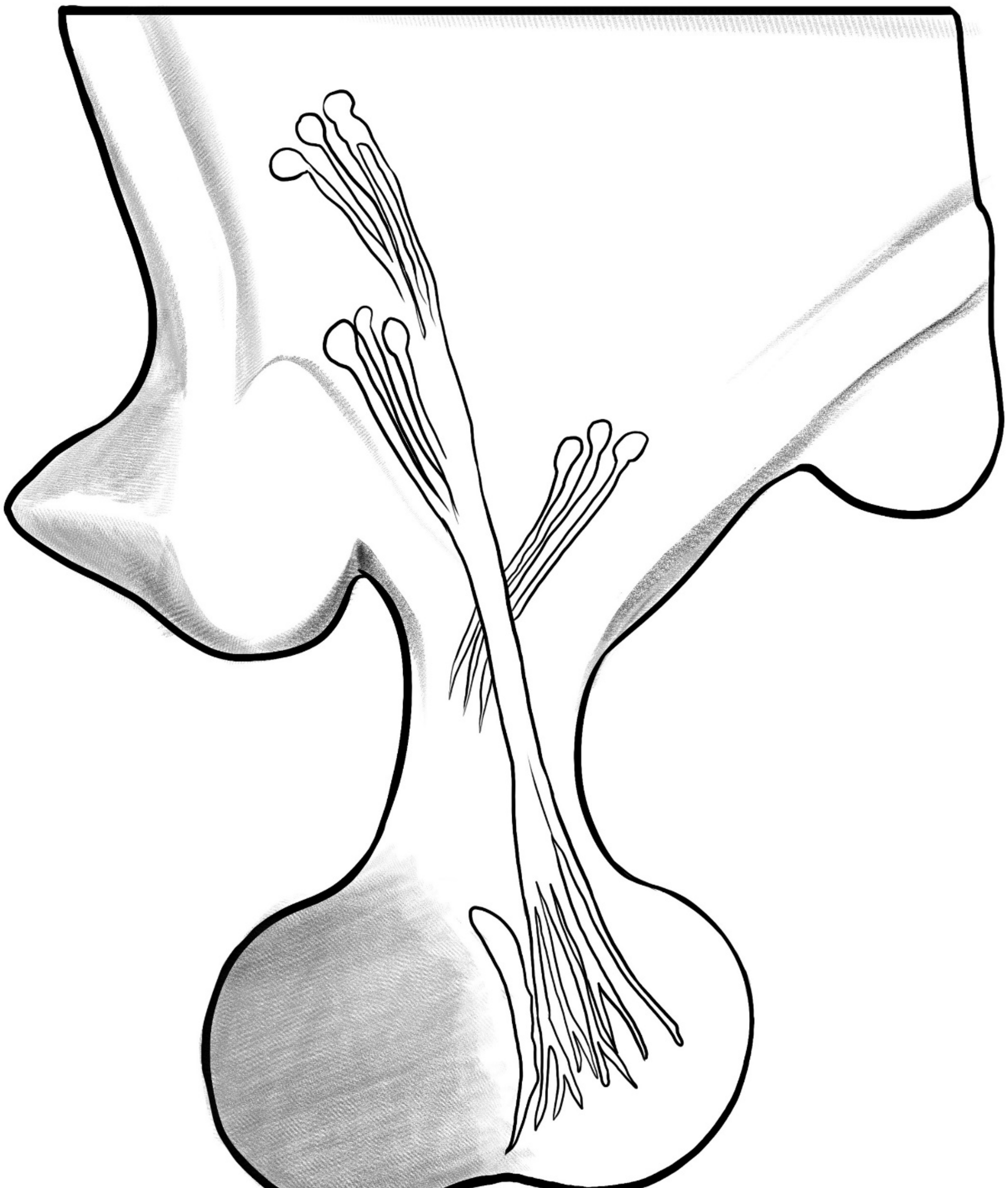
Activity:

1. Identify the following structures:

☐	Adenohypophysis	☐	Infundibulum
☐	Hypothalamus	☐	Neurohypophysis

2. Why is the anterior pituitary called the adenohypophysis?
3. Why is the posterior pituitary called the neurohypophysis?

The Pituitary



The Thyroid Gland
(Anterior View)

The **thyroid gland** is found in the neck, just below the larynx, on the anterior surface of the trachea. It has two lobes, a **left lateral lobe** and a **right lateral lobe**, which are connected by a piece of tissue called the **isthmus**. The thyroid is the largest of all the endocrine glands, and can be felt by palpating the trachea just below the larynx.

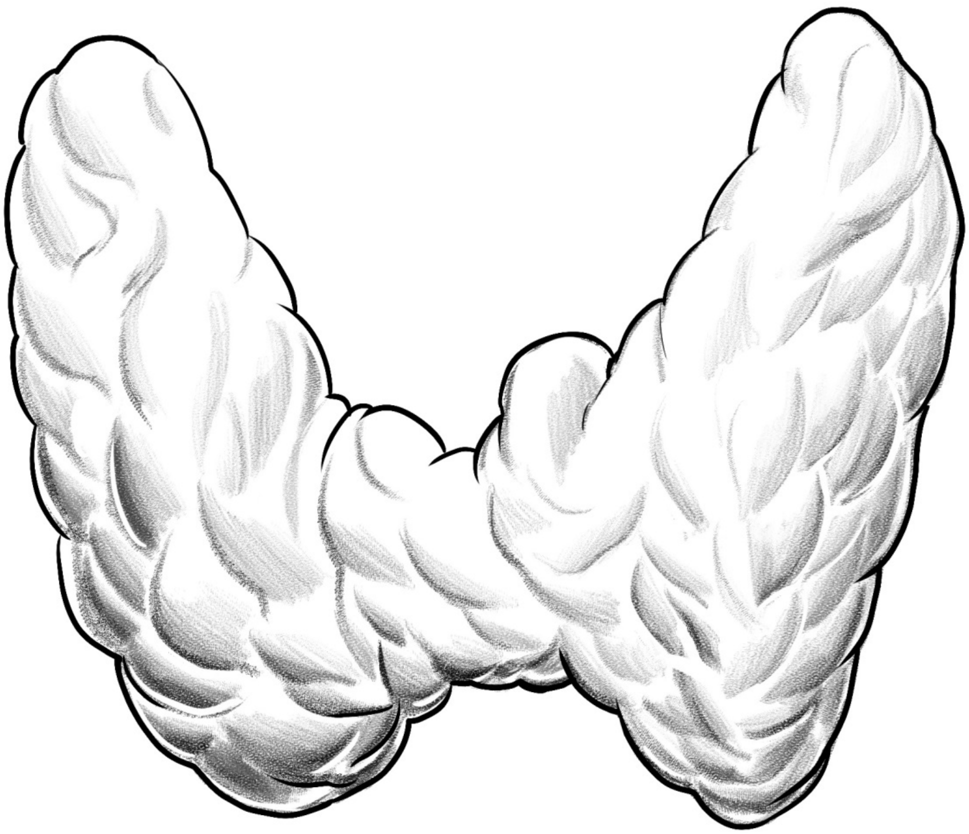
The thyroid gland secretes two hormones: thyroid hormone (also called thyroxine) to increase metabolism and calcitonin to reduce blood calcium concentration.

<u>Activity:</u>

1. Identify the following structures:

☐ Isthmus ☐ Left lateral lobe ☐ Right lateral lobe

The Thyroid Gland
(Anterior View)



The Thyroid and Parathyroid Glands

(Posterior View)

This figure shows you the posterior surface of the **thyroid gland**. The **lobes** and **isthmus** can be observed from this perspective. Note that the **parathyroid glands** are attached to the posterior surface of the thyroid. Even though they are attached to the thyroid gland, they are completely distinct in structure and function. There are normally 4 total glands present, though some individuals can have more or less. These glands secrete a very important hormone called parathyroid hormone, which raises blood calcium level. Recall that calcium is required for nerve impulse generation and muscle contraction. Removal of these glands would result in sudden death due to a lack of neuromuscular function.

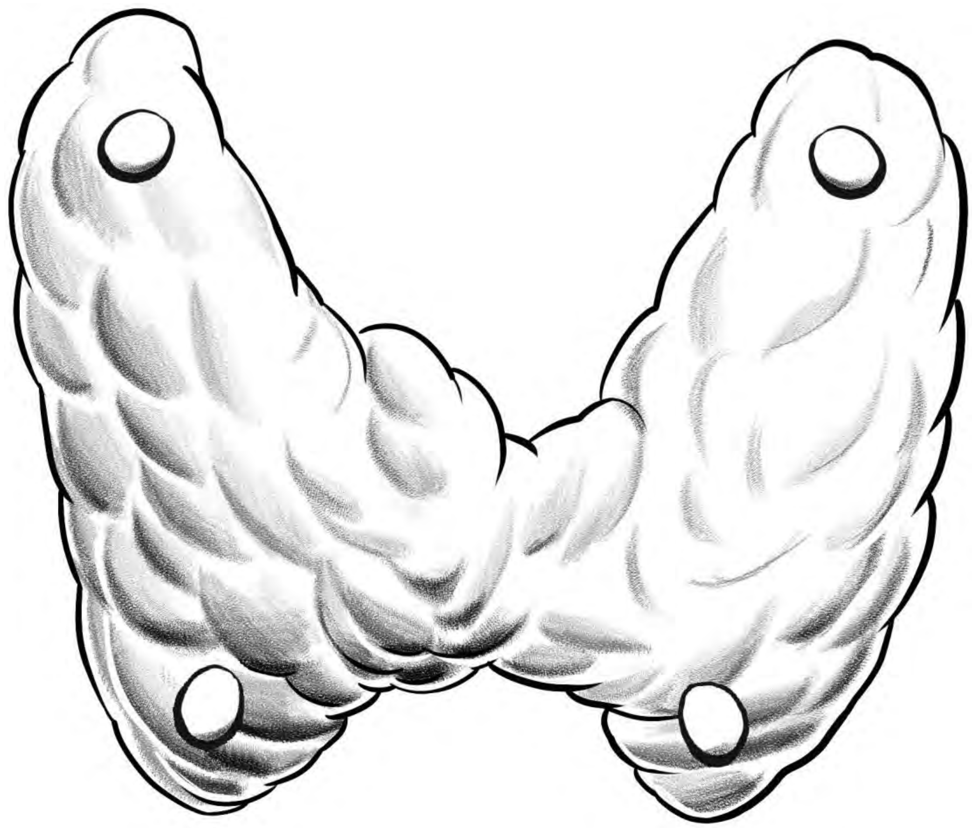
Activity:

1. Identify the following structures:

☐	Isthmus	☐	Parathyroid glands
☐	Left lateral lobe	☐	Right lateral lobe

The Thyroid and Parathyroid Glands

(Posterior View)



The Adrenal Glands and the Pancreas

The **adrenal glands** are also called the suprarenal glands because of their location on the superior surface of the kidney. These pyramid-shaped glands are composed of two types of tissue which almost behave as two distinct glands. The outer cortex is composed of glandular tissue, whereas the inner medulla is composed of nervous-like tissue. The cortex secretes several different hormones, collectively referred to as the corticoids. The mineralocorticoid aldosterone causes the kidneys to retain water in order to increase blood pressure. The glucocorticoid cortisol increases blood glucose level to help the body fight stressors. The medulla secretes the hormones epinephrine and norepinephrine, which are part of the sympathetic response.

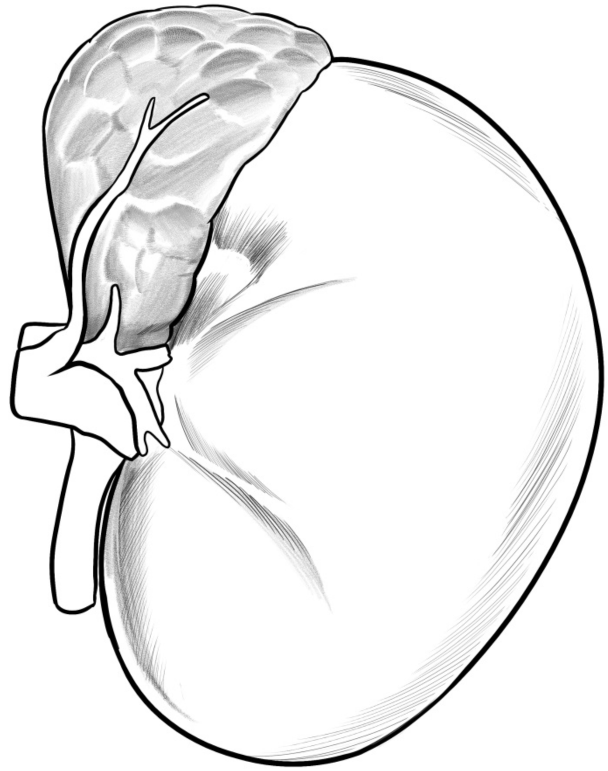
Recall that the **pancreas** is both an exocrine and endocrine gland. The exocrine function was previously discussed with the digestive system. The endocrine portion will be the focus of this section. The endocrine region, which is called the pancreatic islets of Langerhans, contains different cell types that are responsible for secreting various hormones. The two most common are insulin, which lowers blood glucose level, and glucagon, which raises blood glucose level.

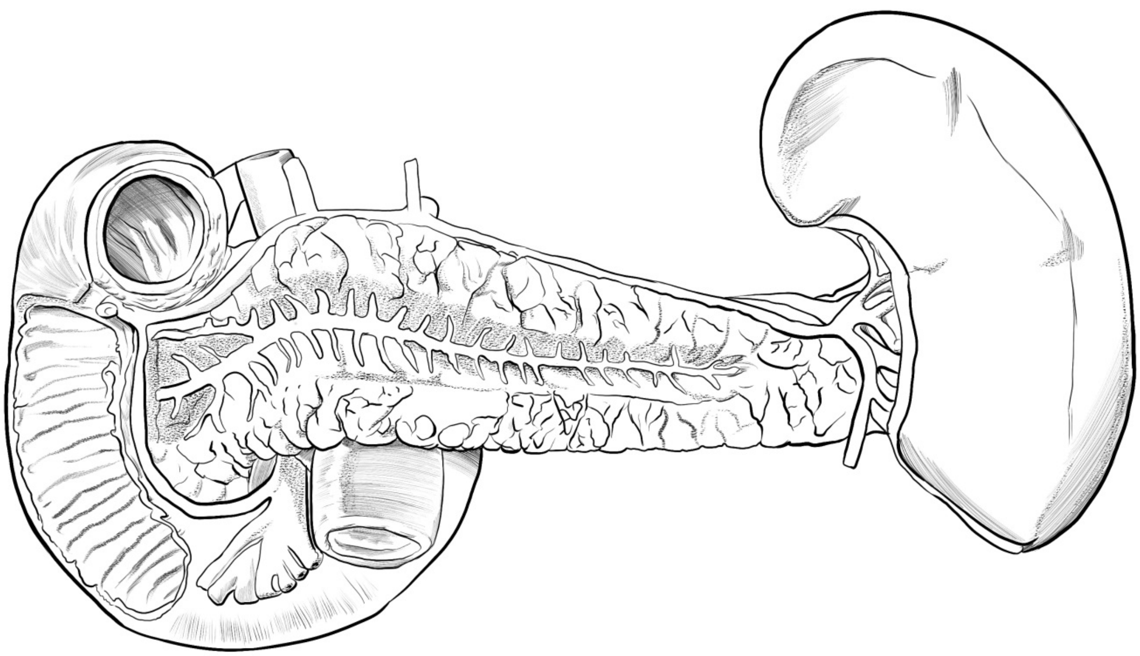
Activity:

1. Identify the following glands:

☐ Adrenal ☐ Pancreas

The Adrenal Glands and the Pancreas





Endocrine Histology

Once you are familiar with the microscopic structure of the endocrine glands, you should be able to identify the different glands by observing prepared and stained sections, and in some cases you should be able to identify different regions or cell types within the glands.

Recall that the **pituitary gland** has two regions: the posterior **neurohypophysis** and the anterior **adenohypophysis**. The neurohypophysis is composed of nervous tissue that secretes ADH and OXY. The adenohypophysis is composed of glandular tissue, which secretes FSH, LH, TH, GH, ACTH, PRL, and MSH. Within the **thyroid gland** are many small bubble-like structures called **follicles**. These fluid filled sacs are surrounded by epithelial cells called **follicular cells,** which secrete thyroid hormone. In between the follicles are **parafollicular cells**, which secrete the hormone calcitonin. The **parathyroid gland** is composed mostly of cells called **chief cells**, which secrete parathyroid hormone. Rarely there are large cells called oxyphil cells, whose function is not known. Recall that the **adrenal gland** has two layers: the outer **cortex** and inner **medulla**. The cortex has three layers of glandular tissue (zona glomerulosa, zona fascuculata and zone reticularis), which secrete the corticoid hormones. The medulla is composed of chromaffin cells, which secrete norepinephrine and epinephrine. Within the **pancreas** there are two cell types: the acinar cells, which are the exocrine cells, and the **pancreatic islets of Langerhans**, which are the endocrine cells. The majority of the tissue falls into the exocrine category, with clusters of islet cells dispersed throughout. Within the islets there are β cells, which secrete insulin, and α cells, which secrete glucagon, D cells, which secrete somatostatin and PP cells, which secrete pancreatic polypeptide. Most of the cells are α and β cells.

Activity:

1. Obtain slide number 94 from your slide box.
2. Using the 4X objective lens, locate the following:

    Adenohypophysis
    Neurohypophysis

3. Draw what you see, labelling the structures listed above.
4. Obtain slide number 96 from your slide box.
5. Using the 40X objective lens, locate the following:

    Follicles
    Follicular cells
    Parafollicular cells

6. Draw what you see, labelling the structures listed above

Endocrine Histology

7. Obtain slide number 98 from your slide box.
8. Using the 40X objective lens, locate the following:

    Chief cells

9. Draw what you see, labelling the structures listed above.
10. Obtain slide number 100 from your slide box.
11. Using the 40X objective lens, locate the following:

    Cortex
    Medulla

12. Draw what you see, labelling the structures listed above.
13. Obtain slide number 78 from your slide box.
14. Using the 10X objective lens, locate the following:

    Islets of Langerhans

15. Draw what you see, labelling the structures listed above.

Endocrine Histology

Endocrine Histology

