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Fetal Pig Dissection Manual (BIOL 105)

Nathalia G. Holtzman
CUNY Queens College, nholtzman@qc.cuny.edu

Daniel J. Yakubov
CUNY Queens College, Daniel.Yakubov63@qmail.cuny.edu

CUNY QUEENS COLLEGE

General Biology I

Fetal Pig Dissection Manual

Daniel J. Yakubov

Edited by Dr. Nathalia G. Holtzman

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DAY 1

Introduction to Dissections and Laboratory Procedure

Ethics

It is imperative to understand that the pig fetuses you will be using in the next few laboratory sessions are real specimens – please treat the specimens with the utmost respect. The fetuses were salvaged from pregnant sows being processed for food. They are not raised specifically for dissection purposes. The fetuses are removed from the sow and embalmed with a preservative, which is injected through the umbilicus (belly button). Following this, the vascular systems are injected under pressure with latex, a rubber-like compound. Arteries (red) are injected through the umbilicus; veins (blue) are injected through one of the jugular veins at the base of the throat.

With the possible exception of the abdominal cavity, organs rarely appear as they are presented in a diagram. If the purpose of this exercise were simply to have you memorize diagrams (or computer screens), we would do only that and bypass the expense, time, and controversy of dissecting. Dissection is a powerful teaching method, especially for concrete thinkers and visual learners. **Only by dissecting can you really appreciate the structural and functional role of the many membranes, mesenteries, and connective tissues that will impede your progress every step of the way. Only by dissecting can you really appreciate the relationship between an organ's texture, location, and function. You are expected to take your dissection seriously and utilize your pig to the fullest extent.**

Laboratory Procedure

Before Class: Make sure to read through the labs and the appropriate sections of this dissection manual (keep in mind, everything is found on one document). Also, it is suggested that you watch supplementary videos that will be listed at the beginning of each chapter. Finally, you should look through the procedure and/or checklist to identify and (possibly) define any words that are in **bold.**

Take into account that the following website as it is a great resource for pre-class review, as well as for post-class studying: https://www.whitman.edu/academics/departments-and-programs/biology/virtual-pig/anatomical-references

Additionally, you may have to review (if you forgot) how to use a microscope properly. This link will direct you to the video that you watched during your first lab this semester: https://www.youtube.com/watch?v=3dkwYC-QsSA

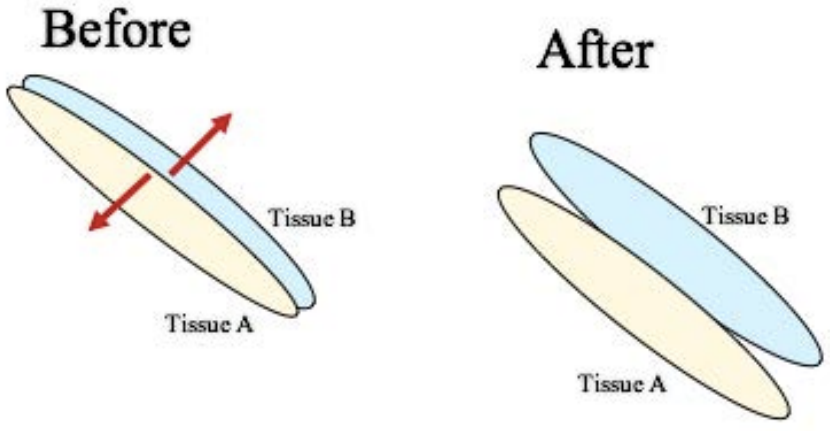
Lastly, make sure to check the **Basic Vocabulary** and **Pre-Laboratory** sections before class.

During Class: For the dissection labs, you will work in pairs. Additionally, you will have to examine others' specimens to see fetal pigs of a sex other than that of yours.

Remember to ALWAYS (and we mean ALWAYS) wear protective gloves.

Also, when dissecting, **LESS is MORE** – this cannot be stressed enough. Avoid cutting deeply; scissors are often better than scalpels. Blunt dissection is often all that is needed. **Blunt dissection** is effectively using a probe or finger to separate and delineate structures by running either a blunt probe or your finger along the orientation of a structure like a blood vessel. For example, once you've made an incision into the abdomen, you'll notice that there is a tissue, called the peritoneum, that covers the abdominal organs. You may want to separate the peritoneum from the abdominal wall – the best way is with blunt dissection, as illustrated by Figure 1.1 below.

Figure 1.1



Anatomical Planes

The fetal pig that you will dissecting is a mammal. Thus, many aspects of its structural and functional organization are identical with those of other mammals, including humans. Therefore, a study of the fetal pig is in a very sense, a study of humans. To properly orient yourself throughout the dissection, it is ideal that you learn the different anatomical planes and their respective directional terminologies.

Typically, there are three (3) anatomical planes – the **coronal/frontal plane, sagittal/medial plane,** and the **transverse plane,** as indicated in Figure 1.2A-B. The sagittal plane divides the body into left and right sides. A sagittal plane that runs exactly down the middle of the organism is referred to as the **mid-sagittal plane**. In relation to the anatomical planes, there are terms that are used to describe the locations of structures or the directions of movements as shown in Figure 1.3 (human directionality) and Figure 1.4 (pig directionality) below. Respectively, structures of the body that are further away from the sagittal plane are coined **lateral**, and structures that are closer to the sagittal plane are labeled as **medial.** The coronal or frontal plane divides the body into two additional segments – an **anterior/ventral** segment and a **posterior/dorsal** segment**.** Typically, when referring to animals, we use ventral and dorsal. However, when we refer to humans, we use anterior and posterior. Finally, the transverse plane divides the body into a **cranial/superior** segment and a **caudal/inferior** segment**.** Additionally, along the transverse plane run two more directional terms. These terms are **proximal** and **distal**, referring to the extremities (arms and legs).

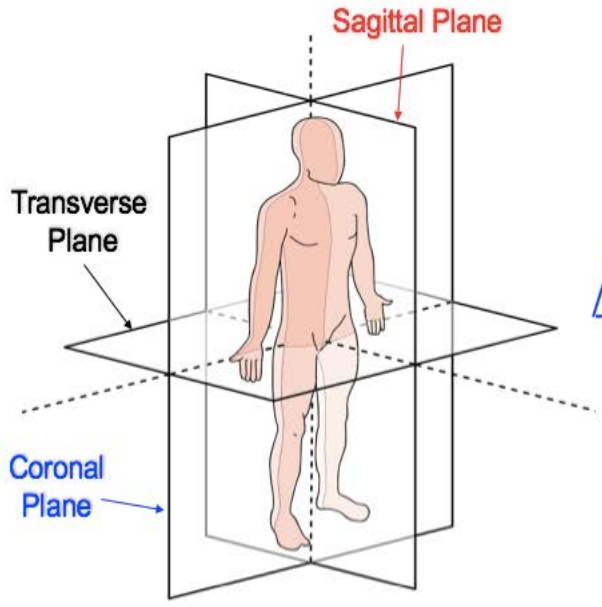


Figure 1.2A

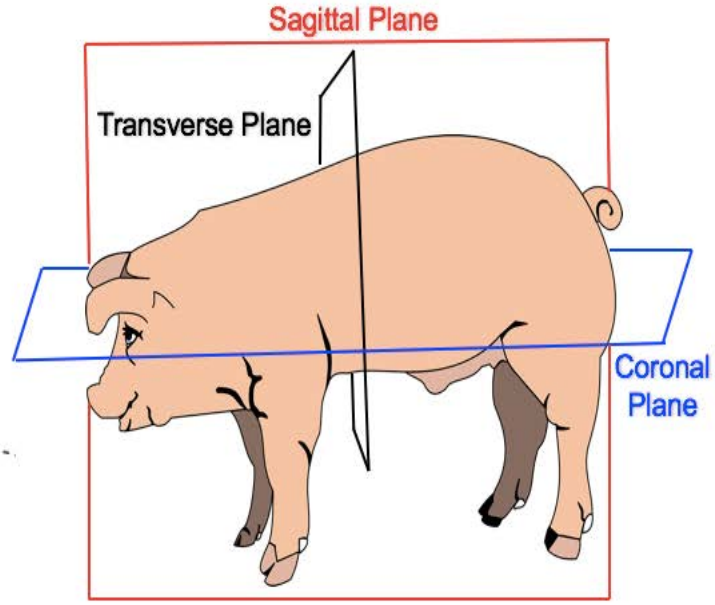


Figure 1.2B

Directionality of Humans

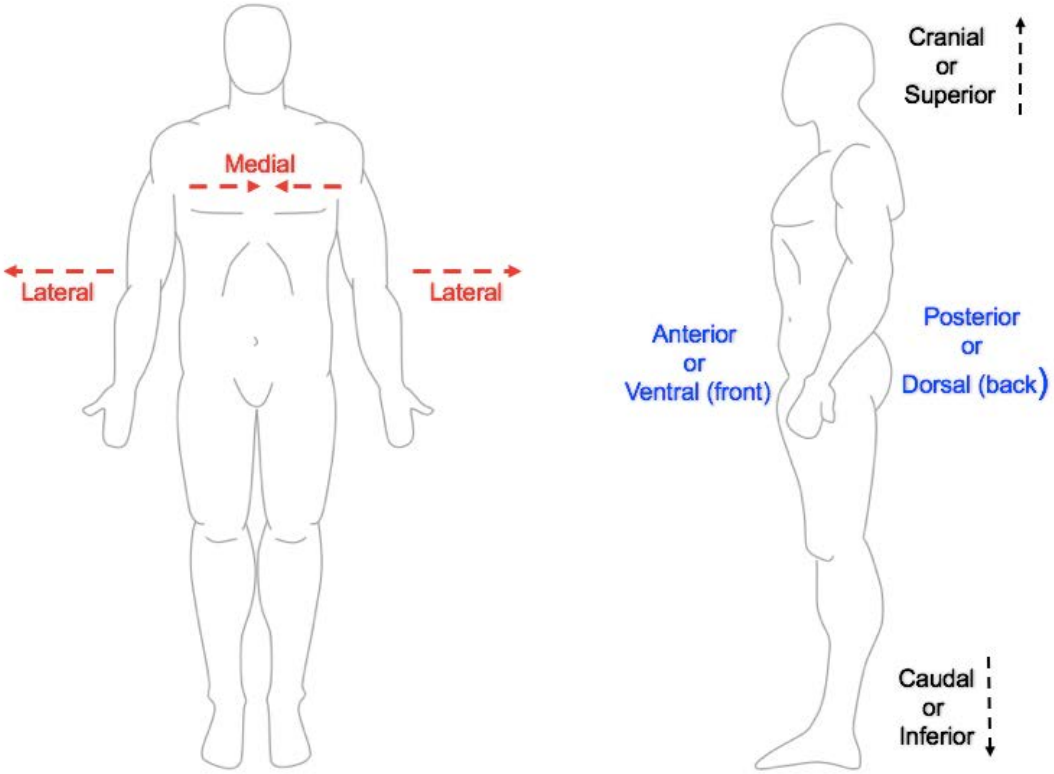


Figure 1.3

Directionality of the Fetal Pig

Since we are dissecting the fetal pig, it is important to better orient ourselves with the directionality of the pig. Note: many of these terms will be used in the subsequent chapters.

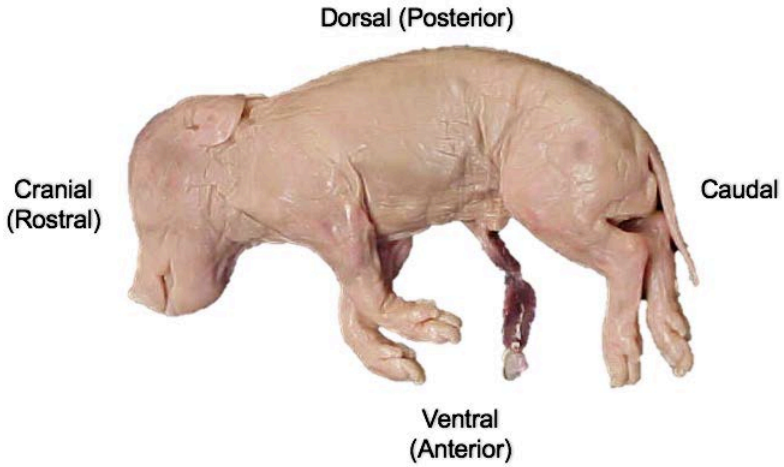
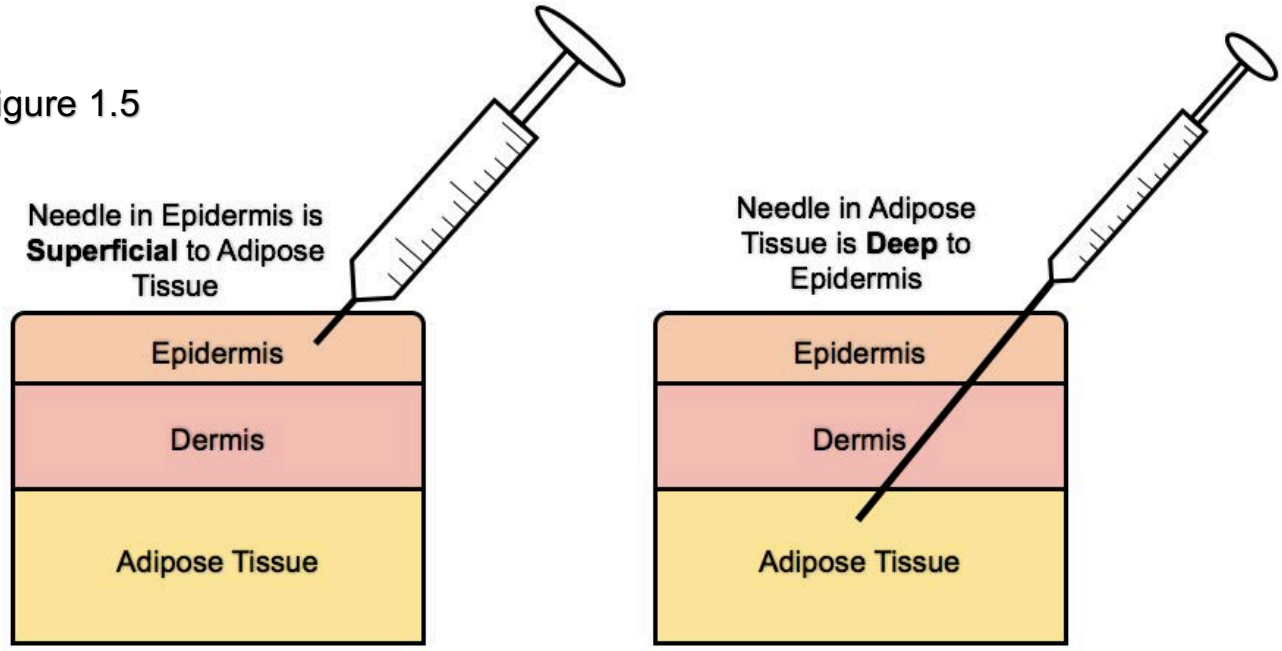


Figure 1.4

Superficial VS. Deep

When dissecting, you may make superficial and deep incisions. Simply put, **superficial** refers to structures nearest to the skin and **deep** refers to structures further away from the skin. These are relative terms – meaning, these terms can be should be used instead of directional vernacular "on top of" (**superficial** to) or "underneath" (**deep** to). For example, as illustrated in Figure 1.5, the epidermis is superficial to adipose tissue.

Figure 1.5



DAY 1

Fetal Pig Anatomy I: External Features, Oral Cavity, Pharynx, and Digestive System

Student Learning Objectives

A. Students should have respect for the fetal pig they are working on.
B. Students should be able to identify the names of the external morphology of the pig.
C. Students should be able to identify the names, structures, and function of both the oral cavity/pharynx and the digestive system organs based on the lab and lecture material.

Supplemental Videos

http://www.youtube.com/watch?v=lWikhoXMxkI

What is the purpose of this lab?

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Recitation & Procedure

BACKGROUND INFORMATION

Before we begin the dissection, it is important to understand the taxonomy and morphology of the fetal pig. All animals, including the pig, belong to the **Kingdom, Animalia.** The next rank in taxonomic hierarchy is phylum. Pigs belong to the **Phylum, Chordata** and the **Subphylum**, **Vertebrata** – just as humans. Please note: ALL vertebrates exhibit **bilateral symmetry**, in which the animal can be divided into an equal mirror image along the **sagittal plane** (as we discussed in Chapter 1). Furthermore, ALL vertebrates exhibit **cephalization**, presence of a **true coelom** (having a body cavity with complete lining called peritoneum that is derived from mesoderm), **an endoskeleton** that is attached to a network of **striated muscles**, **paired limbs**, **deuterostome development** (anus develops first from blastopore), **a closed circulatory system** (we will discuss this in Chapter 3), and **a complete digestive system**.

Among vertebrates, pigs and humans both belong to the same **class**, the **Mammalia.** Mammals are "warm-blooded", or **endothermic** animals. They use heat generated by a high level of metabolism and can control and maintain their internal body temperature, despite ambient temperature fluctuations, by regulating the amount of heat that is expelled at the body surface, making them **homoeothermic.** Mammals, apart from the platypus, are also **viviparous** – giving birth to live young. Being well socially-bonded animals, new born mammal offspring are nursed by their mother post-birth; the mother's milk is secreted by the **mammary glands**, another common feature shared among mammals.

The gestation period for pigs is about 16 weeks; at birth, the newborn is about 30-35 cm in length. The sow carries 7-12 fetuses, rarely reaching up to 16. Now, it's time for you to measure your fetal pig, and determine the it's approximate age, in weeks.

PROCEDURE:

Note: Remember to work in groups!

1. Obtain a fetal pig, dissection tray, gloves, ruler, string, scissors, a probe, and a scalpel.
2. Always wear gloves when handling the specimen. Remove the fetal pig from the specimen wrapping. When you obtain your fetal pig, you may notice a wrinkled appearance of the skin – don't worry, it's due to preservation of the specimen and the storage process.
3. Place the fetal pig on your dissecting tray. Refer to Figure 2.1.
4. Complete Activity 1.

Figure 2.1

ACTIVITY 1: Take the string and run it from the tip of the snout to the tail along the dorsal side. Mark the length of the string. Using a ruler, measure the length. Then, determine its approximate age, in weeks.

Age of Fetus (in weeks)	Length of Fetus
14	**22 – 23 cm**
15	**24 – 27 cm**
16-17 (full term)	**28 – 30+ cm**

Length of your pig: _____cm Approximate age of your pig: _____weeks

PROCEDURE:

5. Now, follow along with your laboratory professor as they review the external features of the pig

EXTERNAL ANATOMY

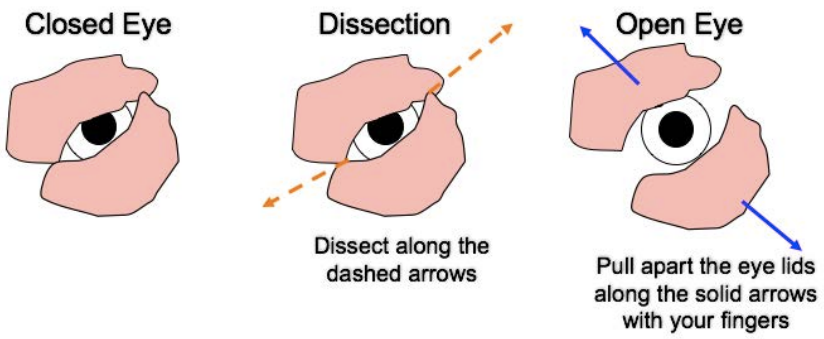
***** As the laboratory professor goes through the external anatomy, you may want to complete Activity 4 on pg. 12-13. *****

Notice that the body of the fetal pig, like that of many terrestrial vertebrates consists of four segments – the **head,** the **neck**, the **trunk** (where two pairs of **appendages** arise)**,** and the **tail.** The head of the pig is marked by the **rostral plate** (porcine snout disk), which has two orifices, the external nostrils (or **nares**). Pigs use the rostral disk for "**rooting**" – another words, it is used to sift-through leaf matter and soil to find edible roots. The **mouth** consists of fleshy lips, which are partly incorporated to the rostral plate. The external part of the ear consists of a fleshy flap called the **auricle** (also known as the **pinna**). Additionally, the ear consists of a tunnel, the **external acoustic meatus** (labeled in Figure 2.4 as letter "A"), which leads to the **tympanic membrane** (the eardrum). The **eyes** are contained underneath the upper and lower **eyelids.**

PROCEDURE:

6. Make a small incision, laterally, at the corners connecting the two eyelids. Pull apart the eyelids.

Figure 2.2



As you pull apart the eyelids, look out for the **nictitating membrane.** The nictitating membrane is in the rostral part of the eye, and is responsible for distributing tears. Note: the membrane is found in both eyes. In humans, there is something like the nictitating membrane – the **semilunar fold**, which is in the median corner of the eyes.

The **trunk** of the fetal pig consists of a **cranial part** and a **caudal part.** The cranial part is also referred to as the **thorax** and consists of the rib cage, housing the heart and the lungs. The caudal part consists of a ventral region, the **abdomen**, and a dorsal region, the **lumbar region.** In the fetal pig, the **umbilical cord** (Figure 2.3A-B) is attached to the ventral surface of the abdomen. The umbilical cord is responsible for connecting the mother and the fetus during embryonic development.

PROCEDURE:

7. Locate the umbilical cord. Using a scissor, cut across the umbilical cord about 1cm (indicated by orange dashed line) from its attachment to abdomen.

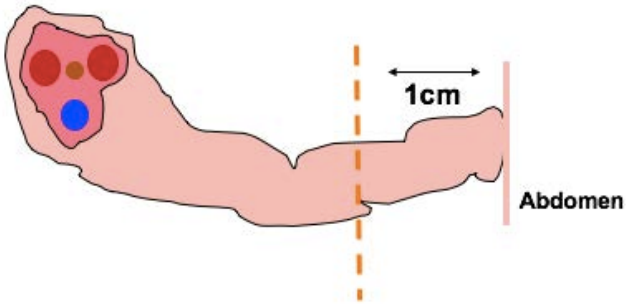


Figure 2.3A

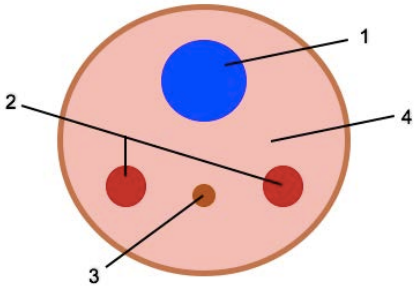


Figure 2.3B

Notice that the umbilical cord contains two thick-walled vessels, the **umbilical arteries**, which carry **deoxygenated** blood and waste products from the fetus to the placenta in the mother. There is also a large, irregularly-shaped thin walled blood vessel, the **umbilical vein**, which carries **oxygenated** blood from the placenta to the fetus. Additionally, either between or beneath the umbilical arteries, there is a hard cord of tissue called the **allantoic stalk**, which is remnant of the **allantois** (a hollow organ that contributes to the formation of the placenta). All the structures found in the umbilical cord are suspended in a connective tissue called **Wharton's Jelly.**

ACTIVITY 2: Why is the **umbilical artery** carrying **deoxygenated** blood? Why is the **umbilical vein** carrying **oxygenated** blood? (Hint: *You may want to refer to Pg. 33 for assistance)*

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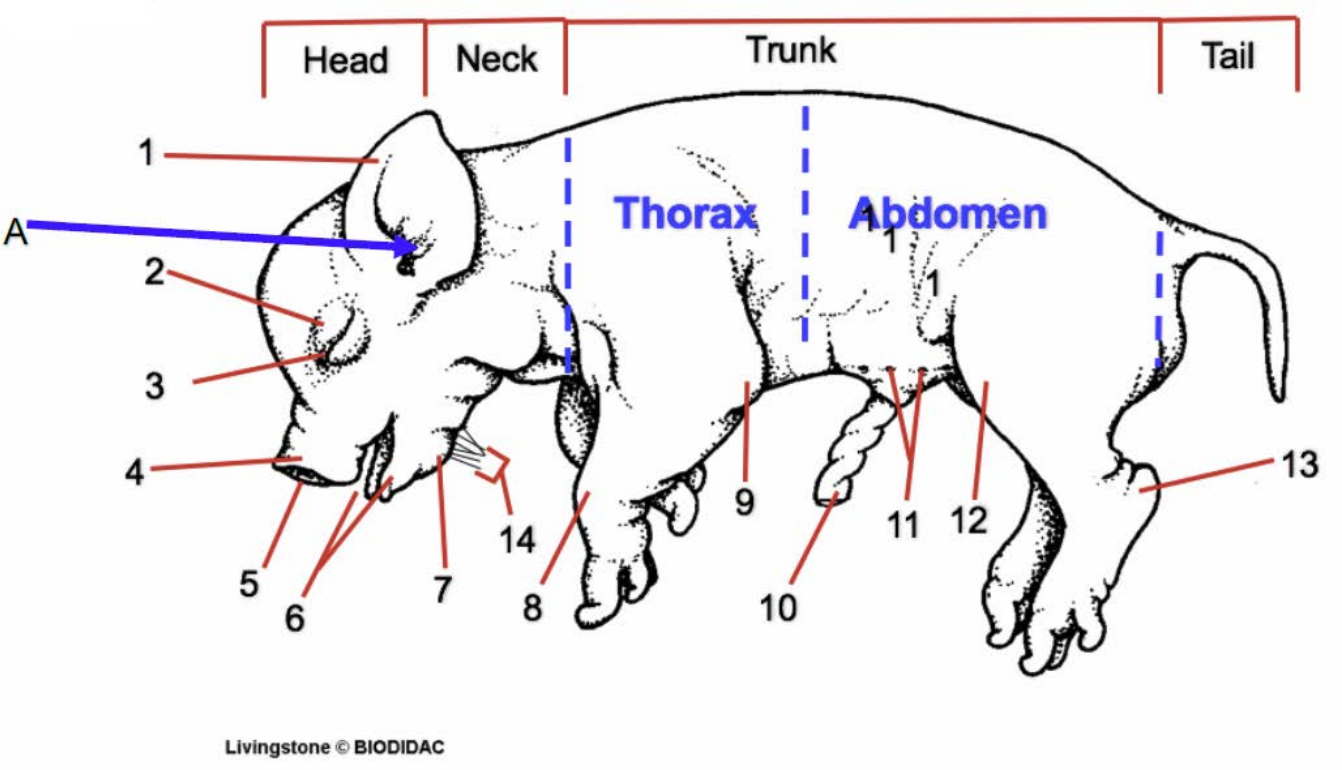
Unlike humans, who walk plantigrade (walking with entire foot and heel place on the ground), pigs are **ungulates**. Pigs walk and run **unguligrade** by pressing on the tips of their toes. Note: because pigs are ungulates, their toes are protected by keratinized structures called hooves. Additionally, because the pig walks on its toes tips, and because the foot is elongated, the **wrist** and **ankle** are always carried off the ground. Make sure not to confuse these joints with the **elbow** and **knee.** A pig's appendages also correspond to those of humans. Both pigs and humans have a **brachium** (upper arm), **antebrachium** (forearm), and the **hand** in the pectoral appendage (appendage branching from the shoulder); **thigh**, **crus** (shin), and **foot** in the pelvic appendage (appendage branching from the acetabulum of the innominate bones that make up the pelvis). Refer to Figure 2.4.

Now, you may be wondering about why we haven't discussed hair yet, as a pig is mammal. Well, unless your fetal pig is unusually mature, body hair will not be apparent. However, it is important to notice that are hairs on the snout and under the chin called **vibrissae.** These hairs are surrounded by touch receptors and serve as sensory organs. Finally, there is a gland that is located at the base of the chin – it is called the **mental gland.** This gland is responsible for secreting pheromones (a chemical signal that affects the behavior or physiology of other individuals of its species).

ACTIVITY 3: Following along with your laboratory professor, and using diagrams from throughout the chapter, fill in the corresponding numbers in the table below.

***** Note that all the external anatomy covered in the previous section is summarized in Figure 2.4. *****

Figure 2.4



Rostral Plate	
Mouth, Lips	
Nares (External Nostrils)	
Eyes, Eyelids	
Vibrissae	
Auricle of the Ear	
Nictating Membrane	
Elbow	

Mental Gland	
Knee	
Wrist	
Umbilical Cord	
Ankle	
Mammary Papillae	

HEAD & NECK: PAROTID GLAND & MASSETER

Located bilaterally on the fetal pig, there is the parotid gland and the masseter. The **parotid gland** is large, triangular gland that is located in between the base of the ear and shoulder. The gland is responsible for secreting saliva through the parotid duct into the mouth, which aids in swallowing of food and the beginning of the digestion of starches (you should remember this from lecture). Note: humans also have two parotid glands (one on each side) that are located slightly inferior to the ears. Next to the parotid gland, lies the **masseter** (refer to Figure 2.5) – the large jaw muscle that covers the angle of the mandible (lower jaw). Check out this video: https://www.youtube.com/watch?v=Cp50fyln16Y .

PROCEDURE:

8. Using Figure 2.5 as a guide, dissect through the superficially (please be very careful with this dissection, as the facial muscles tend to attach to the skin).
9. You can either keep the dissected skin as a flap or you can dissect it completely off the specimen.
10. As soon as you dissect through the skin, you should see glandular tissue and muscular tissue.
    - **a.** You can recognize muscle underneath the dissected segmented by recognizing the small, parallel bundles of muscle fibers that can be seen, when the connective tissue around it is carefully picked-off.
    - **b.** The glandular tissue is identified using different features. This tissue consists of little lobes of tissue that are arranged in clusters.
11. Identify the **masseter** and the **parotid gland.**

ACTIVITY 4: What do you think is the function of the masseter? Hint: think about where it's located – connected to the mandible (bottom jaw bone). Refer to Figure 2.5.

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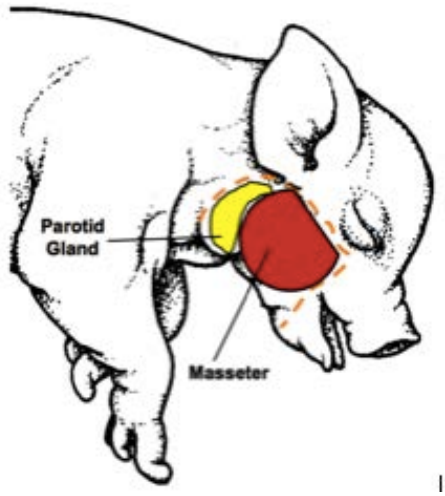
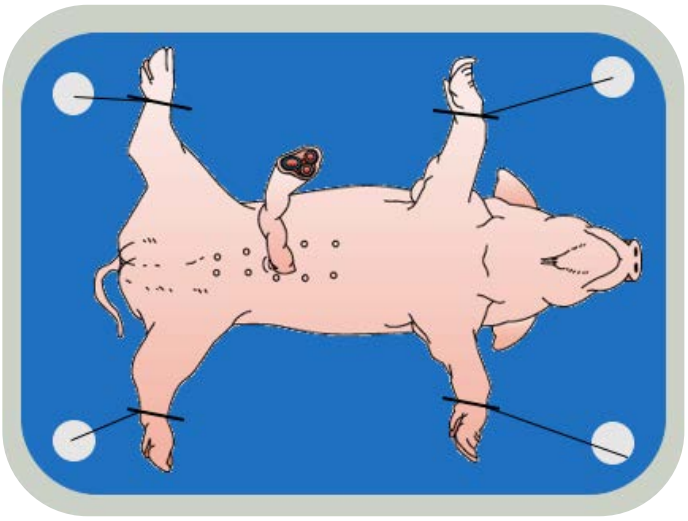


Figure 2.5

PROCEDURE:

12. Tie the string around either the wrist/ankle of each appendage (limb).
13. Make sure to rest the pig on its dorsal side (back).
14. Tie the other ends of the string to the bulbs on the dissecting tray. If you are missing the bulbs, tie the string around objects on your table (like an outlet) to hold open the pig. Refer to Figure 2.6.

Figure 2.6



GENDER IDENTIFICATION

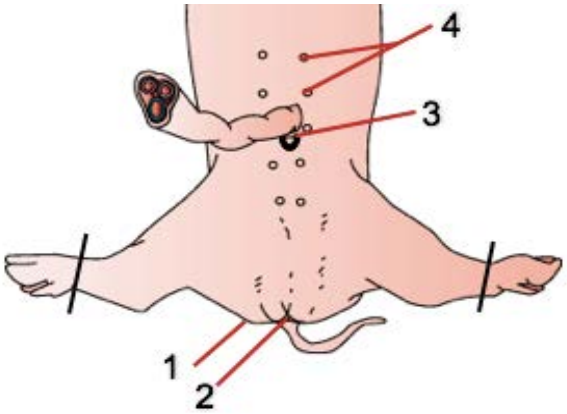
Males: If your pig is male, the **preputial orifice** of the **prepuce**, is found directly caudal to the attachment of the umbilical cord to the abdomen. Caudal to the hind legs and ventral to the tail, you will find a skin pouch, the **scrotum**, which would have enclosed the **testes** in a mature male pig. Refer to Figure 2.7A.

Females: In females, the common orifice of the urinary tract and the vagina is called the **urogenital orifice** – located ventral to the anus. The orifice is confined by two laterally positioned skin folds, the **labia.** These labia will converge ventrally to form spike-like **genital papilla.** The region housing the urogenital orifice and the labia is known as the **vulva.** Refer to Figure 2.7B.

Both Sexes: Immediately ventral to the tail, there is an **anus** – an orifice leading out of the digestive tract. Both sexes also have **mammary papillae** – however, the papillae become part of the mammary glands in mature females. The papillae are arranged in rows of five or six, adept for nursing six to twelve offspring.

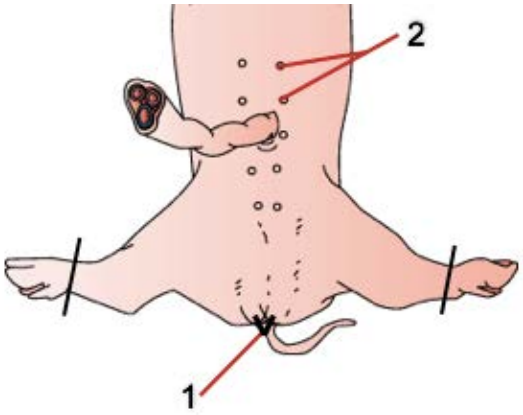
ACTIVITY 5: Using Figures 2.7A-B, identify the Gender of your fetal pig. _____

Figure 2.7A **MALE**



1-Scrotum; 2-Anus; 3-Preputial Orifice; 4-Mammary Papillae

FEMALE Figure 2.7B



1-Genital Papillae; 2-Mammary Papillae

MOUTH & PHARYNX

The **oral cavity** is primarily composed of teeth, the tongue, and the palate. When you observe the **teeth** in the fetal pig, you'll see some of the teeth have emerged from the gum and some are still submerged within the gum. While looking at the upper and lower jaws, you are likely to see the third incisor and the canine. If you are interested, you can palpate the gums to see if any teeth have yet to break through. The tongue in mammals is completely muscular and does not include any bony or cartilaginous elements. The **tongue** is responsible for manipulating food in the mouth, mixing it with saliva, shaping it into a bolus, and then pushing it into the esophagus. On the tongue, there are four types of papillae – marginal, fungiform, filiform, and vallate. The lateral margins (sides) of the tongue are covered in **marginal papillae**, which become engorged with blood and will stiffen during suckling, creating a firm connection between the tongue of the fetal pig and the nipple of the sow. The front part of the tongue consists of tiny, button-like **fungiform papillae**. Towards the back portion of the tongue, there are **filiform papillae.** Directly in-front of the filiform papillae, are the **vallate papillae.** The **taste buds** are associated with the fungiform and the vallate papillae, however the filiform papillae only serve to provide a better grip on the bolus as it is being pushed down into the esophagus. Refer to Figures 2.10A-B.

The roof of the mouth is called the **palate**. The palate is composed of two parts – the **hard palate** and the **smooth palate.** The most important feature of the rough palate is horizontal (transverse) ridges called **rugae**. The rugae facilitate the movement of the bolus backwards towards the esophagus.

Figure 2.8A

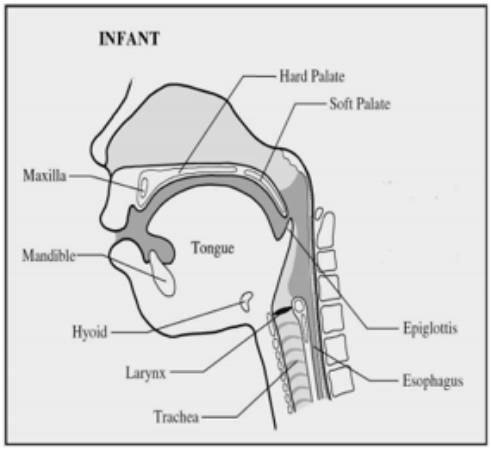
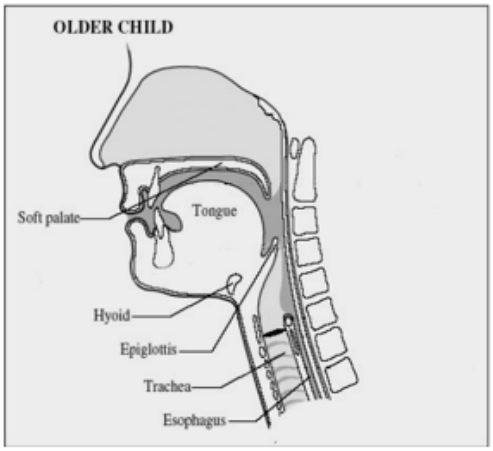


Figure 2.8B



Both the nasal and oral cavities lead into the **pharynx**, which is subdivided into three (3) parts. Near the palate, the **nasal pharynx**, a single chamber, is formed by paired (2) nasal cavities. The internal nares are openings between the nasal cavities and nasal pharynx. It is important to note that the **laryngeal pharynx** leads to both **esophagus** and to the **trachea**. It is in the laryngeal pharynx that the food and air passages overlap. Air enters through the nares and into the nasal cavities, which leads to the trachea.

Note how the **epiglottis** (a structure that protects the airway) and the slit-like opening of the **glottis** (the part of the larynx consisting of the vocal cords and the slit-like opening between them) fit into the entrance to the nasal pharynx. This allows air to pass from the nasal cavity into the larynx and **trachea**.

This arrangement makes it easier for the pig to drink and breathe (nasally) efficiently without getting fluid in the airway. During swallowing, the tongue pushes down on the epiglottis, and the slits of the glottis and larynx are closed, allowing food to be pushed into the **esophagus** without entering the airway. The arrangement of the epiglottis in the fetal pig is largely retained in most adult mammals, but in humans, to facilitate speaking, the epiglottis and glottis descend. This is critical for speaking, but makes it harder to eat and breathe (or talk) at the same time. There are undesirable consequences if you try (please do not try, but if you do – we told you so). You may refer to Figures 2.8A-B to orient yourself.

PROCEDURE:

15. Expose the organs of the mouth and pharynx by inserting your scissors in the angle of the mouth bilaterally (on both sides) dissecting caudally (in the direction of the tail). Note: if your specimen is large, you may need you may have to dissect through the masseter. Refer to Figure 2.9.
16. You can continue your incisions/dissections until you see the epiglottis. Remember, the epiglottis is located dorsally to the soft palate.
17. Carefully pull the epiglottis, and continue to cut dorsal to it. Continue to cut until you see the larynx with its opening, the glottis.
18. Once you have made your bilateral dissections, you will have to pry open the oral cavity using your hands. The mouth should be easily swung open.

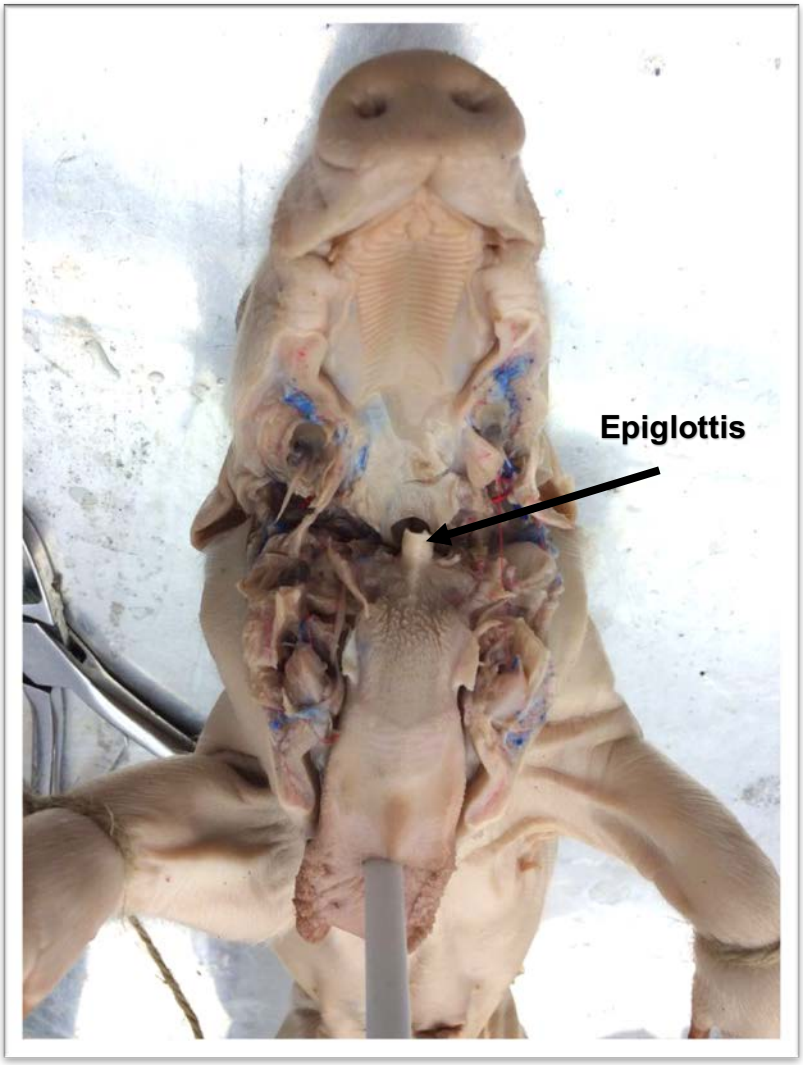


Figure 2.9

*** Figures 2.10A and 2.10B visually summarize the material that was covered in the previous few sections. ***

Figure 2.10A

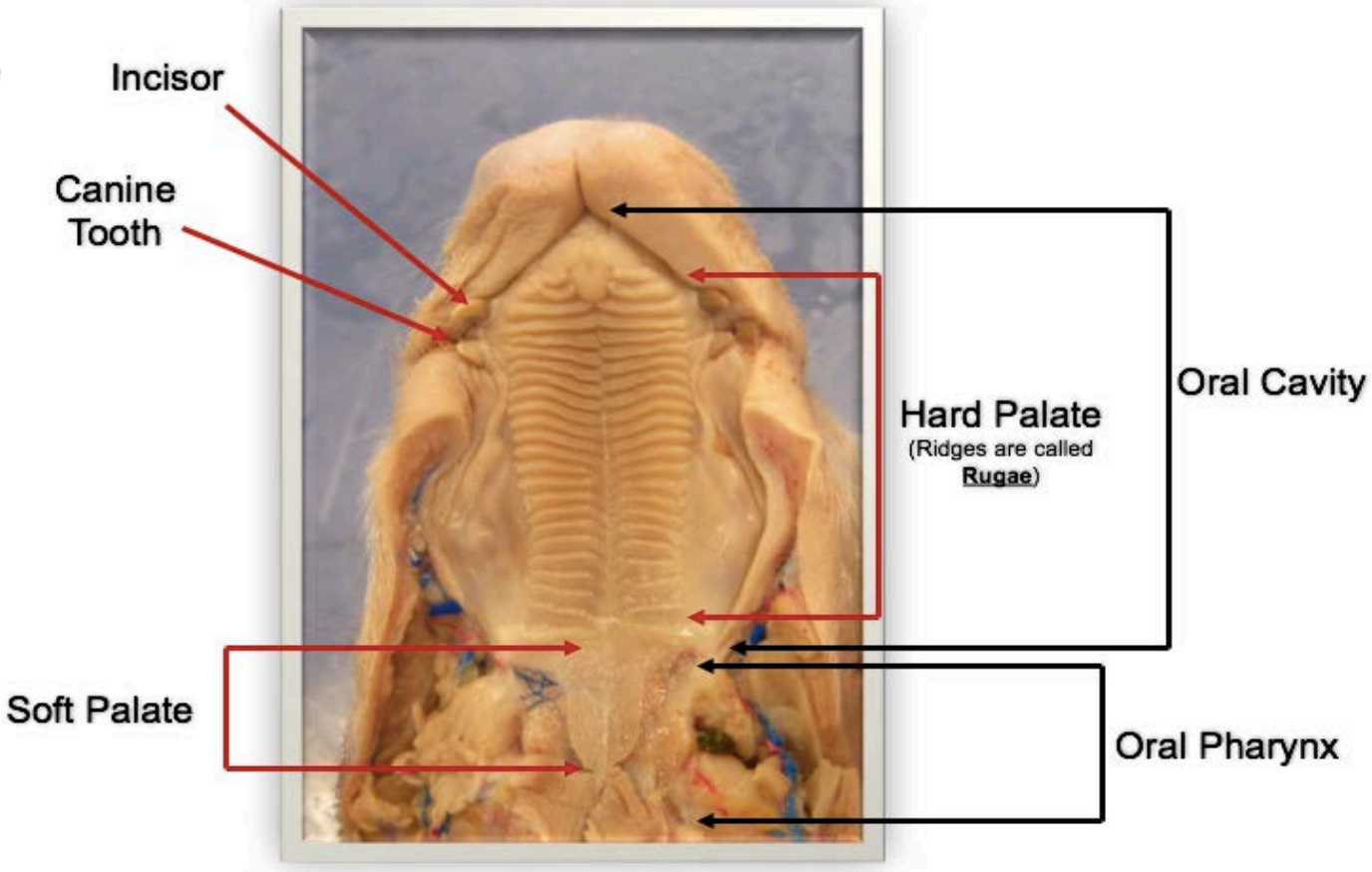
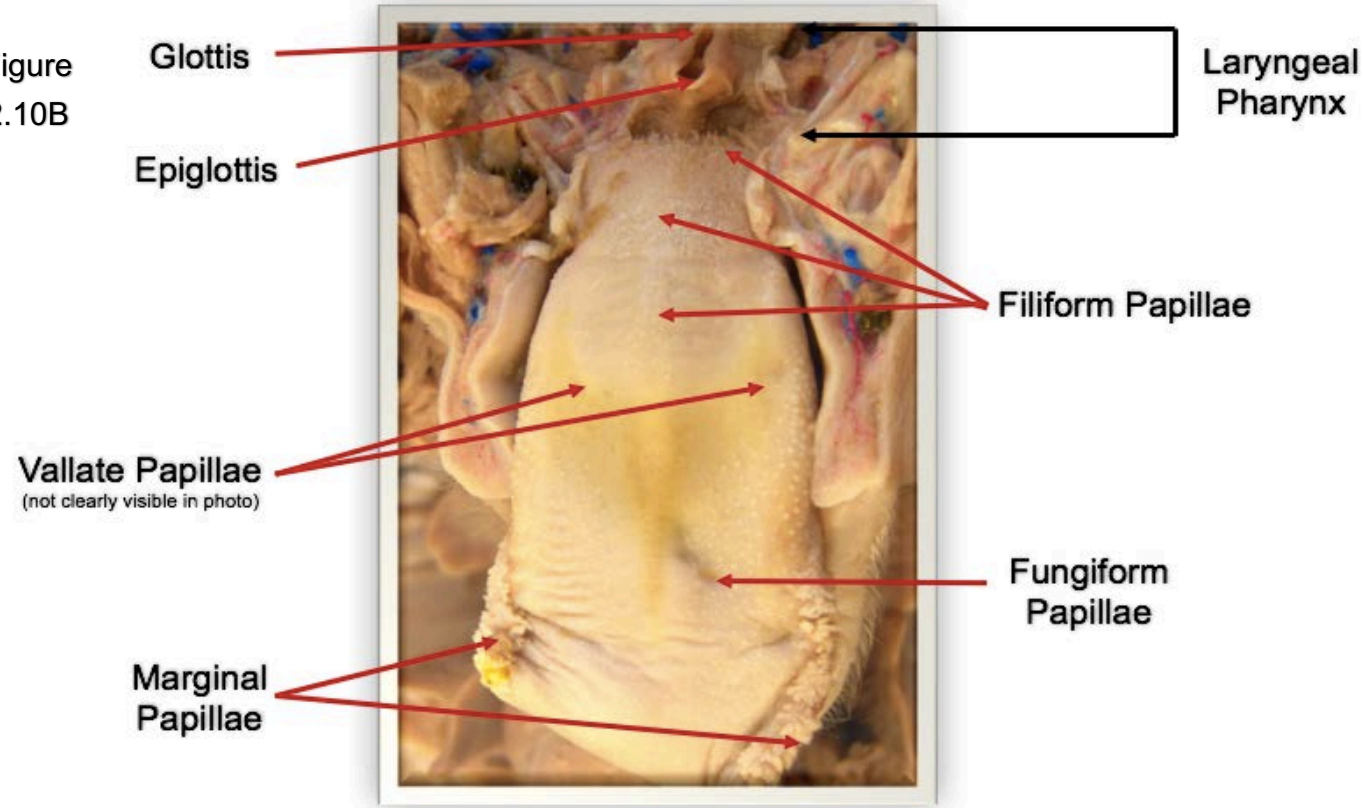


Figure 2.10B



THE ABDOMINAL CAVITY

After your dissection through the abdominal cavity, you will come across a transverse muscle, the **diaphragm.** This muscle serves to aid in respiration (we will cover this next week), and separates the thoracic cavity from the abdominal cavity. Speaking of cavities, both the human body and the pig's body have many. These many body cavities, or **coelomic cavities**, are collectively known as the **coelom**. Inside these coelomic cavities lie the internal organs (or **viscera).** When you look inside the body cavities, you will notice that they are completely covered with this shiny epithelial tissue known as the **serosa**. The serosa secretes lubricating fluid, which allows the viscera in all cavities to glide smoothly past each other and the cavity wall. The serosa is crucial to life as many body organs will change their morphology and volume through the course of life.

The main cavity of focus in this chapter is the **peritoneal cavity**, which has a serosa called the **peritoneum**. There are two types of peritoneum – **visceral peritoneum**, which covers the abdominal organs, and the **parietal peritoneum**, which lines the abdominal wall. Both peritoneum tissues are continuous with each other and form the **mesenteries** (Figure 2.11)**.** The mesenteries are these thin membranes connecting viscera to the body wall and to one another.

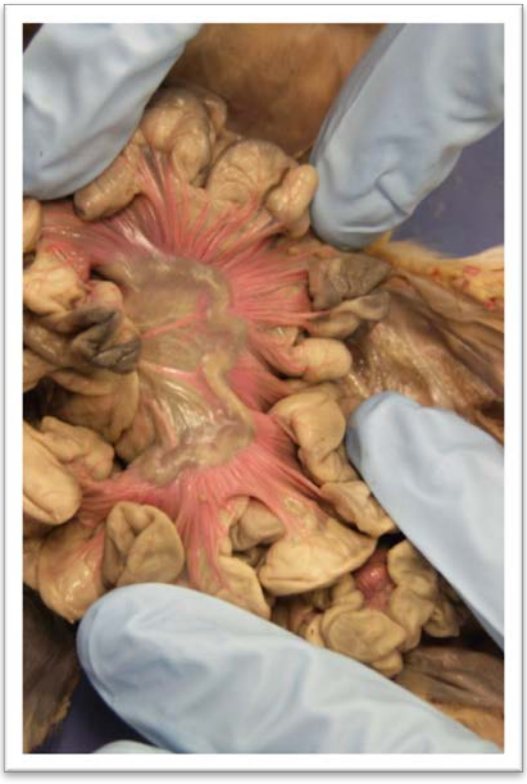


Figure 2.11

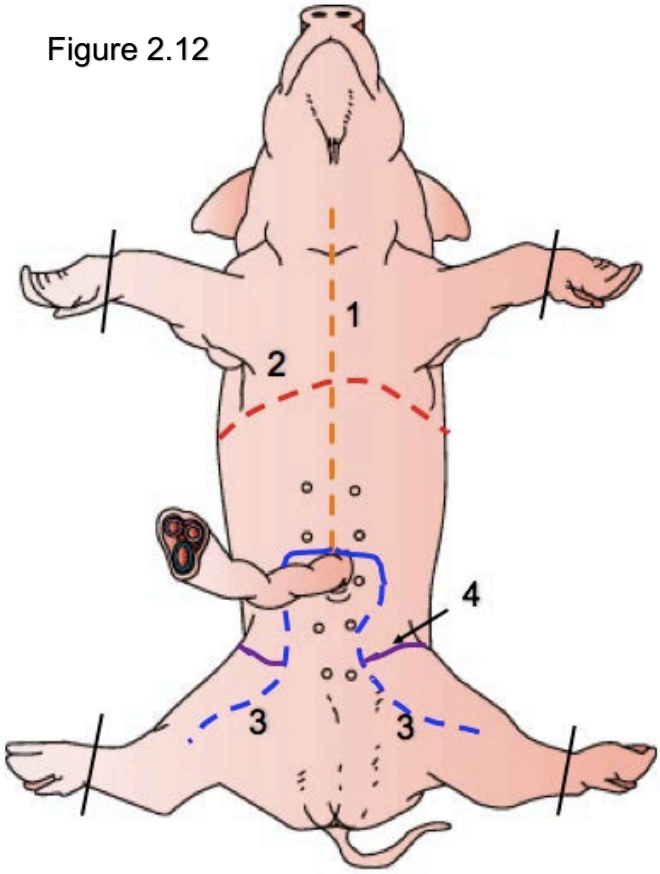
PROCEDURE:

The lines numbered 1-4 on Figure 2.12 show the first set of incisions that you will make. How do you know that you are dissecting correctly? Well, if you get three (3) flaps, then you are on the right track. Remember, because we are using these pigs for the next few weeks, you do need to preserve the organs inside – you do this by creating flaps.

19. With scalpels, make the incisions, beginning with #1. Especially to those who are aspiring surgeons (and generally to all students), please remember to **CUT AWAY FROM YOURSELF.** So, if you are holding the pig down near the chest, you should be cutting down, away from your hand.
20. Note that sometimes it's difficult to work with scalpels, so you may want to use scissors. If you do use scissors, remember to keep the tips of the scissors pointed upward, because you do not want to cut deeply, which will destroy the organs in the cavity.

21. To find the exact location for the incision marked 3, press along the thorax with your fingers to find the lower edge of the ribs. This is where you will make incision 3.
22. After you have made your incisions through the body wall, spread the flaps of the body wall apart. You will see the **Peritoneum** (as described in the recitation section above). Cut through it, carefully. Now, you will be able to see the organs in the abdominal cavity.
23. Now it is time for you to explore the internal organs of the abdominal cavity. You may want to use the material below as a guide.

Figure 2.12

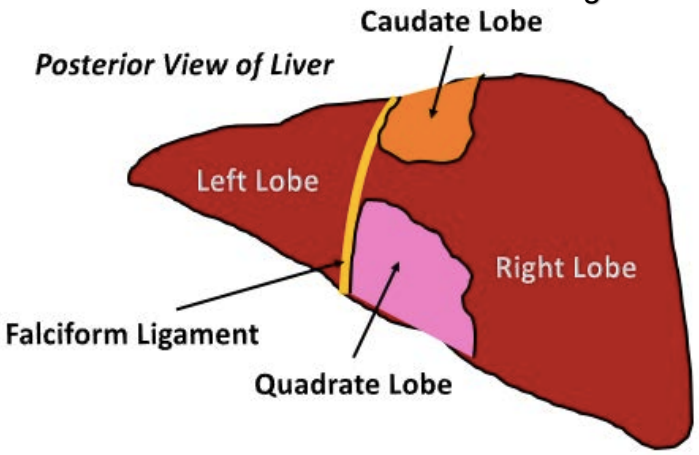


DIGESTIVE ORGANS OF THE ABDOMINAL CAVITY

Directly beneath the dome of the diaphragm, lies the most discernable abdominal organ – the **liver.** In addition to producing bile (we will cover this later), the liver has the crucial role in the storage and metabolism of nutrients, as well as in the conversion of highly toxic by-products (from protein metabolism) to less toxic substances like urea. The umbilical vein, which runs from the umbilical cord to the liver, divides the liver in the fetal pig into the left and right sides. As you lift the **left** and **right medial lobes** of the liver, you will uncover the **left** and **right lateral lobes** of the liver. Underneath the right lateral lobe, you will find the **caudate lobe** of the liver, which should be partially hidden underneath coils of intestine. It is important to note that humans have a **right lobe**, **left lobe, quadrate lobe,** and a **caudate lobe** of the liver. Refer to Figure 2.13 for visual, posterior representation of the human liver.

ACTIVITY 6: Referring to the previous paragraph, compared to humans, how many lobes of the liver do pigs have? _____

Figure 2.13



PROCEDURE:

24. Locate the diaphragm. Look at the most obvious structure in the abdominal cavity, the brownish-colored **liver**. Count the number of lobes. Work on Activity 6.

Initially when food is swallowed, it travels through a muscular tube called the **esophagus,** which joins the mouth with the **stomach**. The bolus, at this point, is pushed down through the esophagus until it reaches the stomach. To find the stomach, you can lift the left lobes of the liver - the stomach is located underneath. One important aspect of the stomach, is that it contains rugae. Now, you may recognize that word from earlier.

PROCEDURE:

25. Find the tube-like esophagus**,** which joins the mouth and the stomach. Food moves down the esophagus by muscular contractions after being softened by saliva (**salivary amylase** breaks down carbohydrates) in the mouth. Follow the esophagus and locate the soft, sac-like stomach beneath the liver.
26. Work on Activity 6 and 7.

ACTIVITY 7: What do you think the rugae of the stomach are for?

_____

_____

Refer to Figures 2.14A and 2.14B to better acquaint yourself with the anatomy of the stomach.

Figure 2.14A

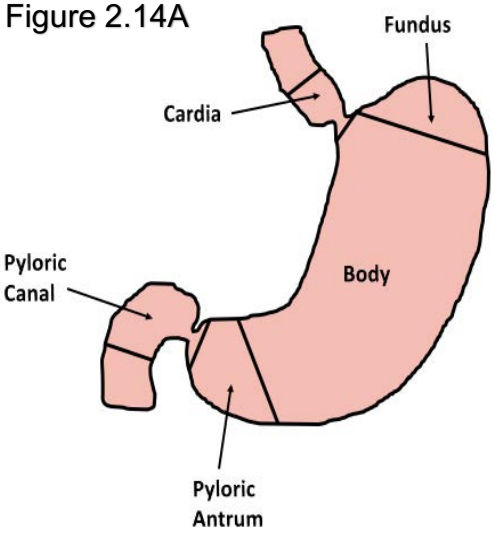
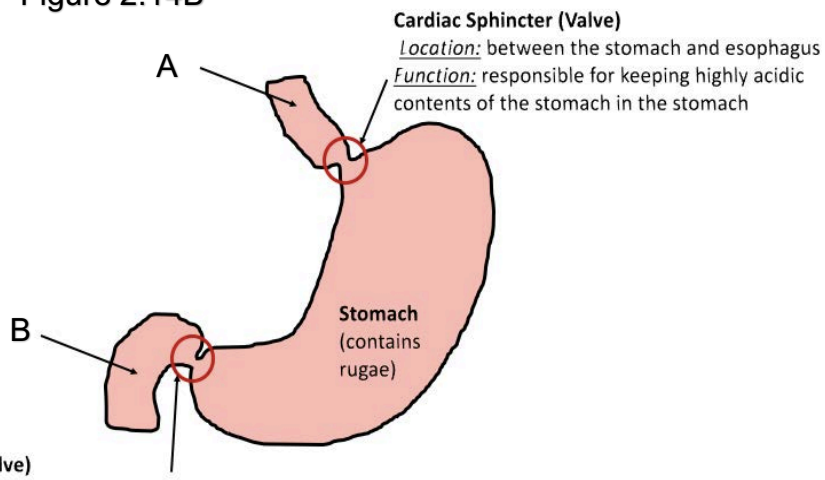


Figure 2.14B



ACTIVITY 8: Based on the information provided above, and using Figure 2.14B, what are "A" and "B" are referring to?

A: _____ **B:** _____

To the left of the stomach, a dark elongated **spleen** is present. In a fetus, the spleen is part of the blood forming **(hematopoietic)** tissues that produce red blood cells. In adults, the spleen is part of the immune system producing lymphocytes. Additionally, the spleen acts a filter organ – it filters (captures and breaks down) senescent (gradual deterioration in function) red blood cells and white blood cells. The end products of this filtration are sent to the liver, where they are eliminated with the bile.

Once the bolus has been further digested by the stomach, it is now known as **chyme.** The chyme enters the first part of the small intestine, the **duodenum**. The chyme then enters the **jejunum** followed by the **ileum.** If we were to cut open the small intestine, we would see these minute projects – they are called **villi**. The absorptive surface area of the small intestine is greatly increased by the villi.

Figure 2.15 represents a schematic of small intestine – the schematic also provides a relatively easy acronym, so that you can memorize the order of segmentation of the small intestine.

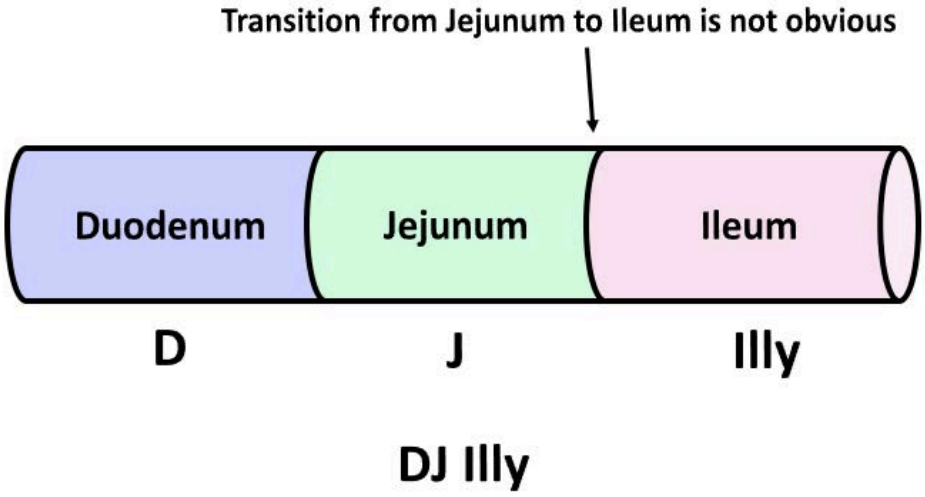


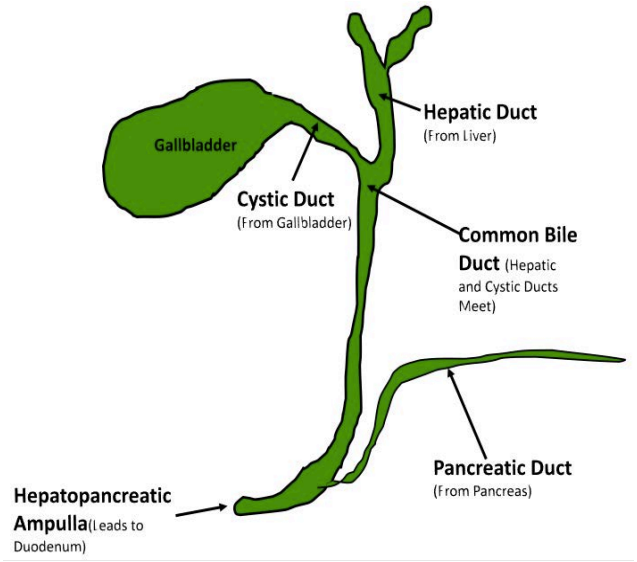
Figure 2.15

DJ Illy

At the U-shaped duodenum, pancreatic juice, made by the **pancreas**, and bile, made by the liver and stored in the **gall bladder** (found posterior side of the liver), are added to food to continue digestion. Refer to figure 2.16A for anatomical reference. Bile, aiding in the digestion of lipids, is produced in the liver. The **emulsification** process is extremely important as it provides **lipases** (digest lipids) a greater surface area in which they can properly digest fats. Excess bile, that is not used during digestion, is stored in the gallbladder. When needed, bile from the gallbladder is released into the **cystic duct**, while the bile produced by the liver is released into the **hepatic duct.** The junction where both the cystic and hepatic ducts meet form the **common bile duct**. An additional duct, which carries digestive juices, originates in the pancreas – and is termed the **pancreatic duct**. The common bile duct and the pancreatic duct meet at the **hepatopancreatic ampulla,** which allows these digestive juices to seep into the duodenum. These ducts are outlined in figure 2.16B.

Figure 2.16A

Figure 2.16B



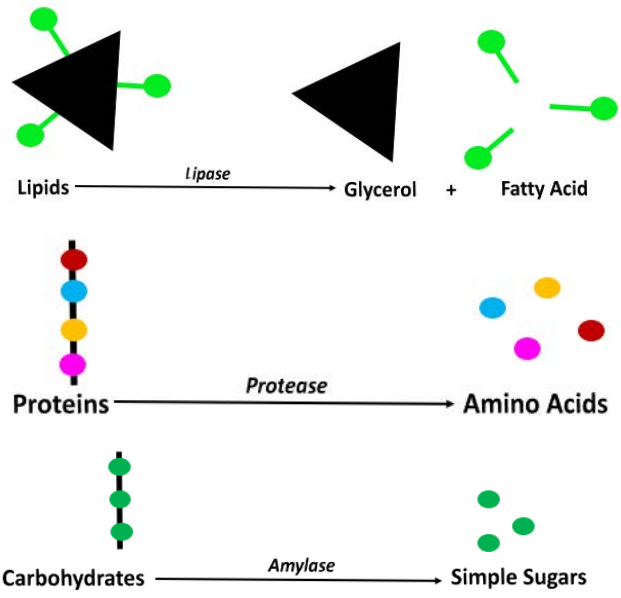
PROCEDURE:

27. Identify the first part of the small intestine, the U-shaped duodenum, which connects to the lower end of the stomach.
28. Study the rest of the small intestine. Notice that it is a coiled, narrow tube, held together by tissue called **mesentery**. You can refer back to figure 2.11.
29. After you've examined the rest of the small intestine, look between the lobes of the liver to find the greenish-brown gallbladder as shown in figure 2.16A.
30. Carefully cut through the mesentery and uncoil the small intestine. The mid-segment is the **jejunum**, and the last segment is called the **ileum**. Refer to figure 2.15.

ACTIVITY 9: Using the information provided above, please complete the table. You can use figure 2.17 as a guide.

Figure 2.17

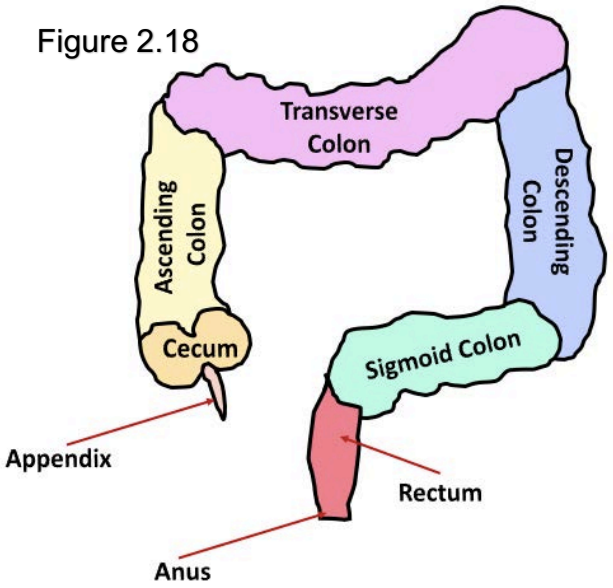
Macromolecule	What is the enzyme that breaks down this macromolecule?	Where is this enzyme found?
Carbohydrates		Saliva (Mouth)
	Proteases (Pepsin, Trypsin, Chymotrypsin)	**Pepsin**: Stomach **Trypsin**: found in duodenum, when trypsinogen made in the pancreas is activated. **Chymotrypsin**: duodenum
Lipids/Fats	Lipases (+ Bile Salts)	



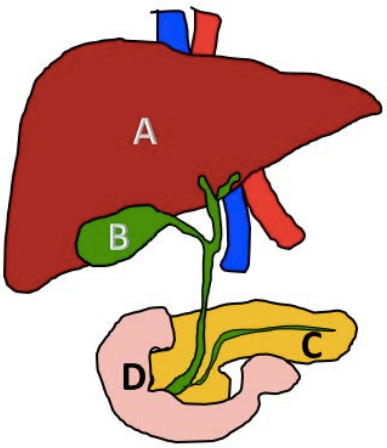
Following the coils of small intestine, chyme will eventually enter the large intestine or **colon**. At the junction of the small intestine and the large intestine lies a "blind sac" – the **caecum**. The caecum of the fetal pig has no known function. However, in humans, the caecum is responsible for absorbing fluids and salts that remain after intestinal digestion. When you look at the pig, you will notice that majority of the colon is a tightly coiled mass. The coiled part of the colon in the pig is analogous to the **ascending colon** in humans. As the colon emerges from the coiled mass, it continues as the **transverse colon**, and then directs caudally as the **descending colon** (figure 2.18). The colon will then continue as the **rectum** as it enters the pelvic cavity (encased in pelvic girdle, which is made of two (2) innominate bones). The colon then opens on the body surface through the **anus**. And then... surprise! As you can tell, once you've stuffed your face with that sandwich, it takes quite a trip through your gastrointestinal system.

ACTIVITY 10: For **Part A**, label structures A, B, C, and D on the image below. For **Part B**, complete the sequencing of the **alimentary canal** (GI tract).

Figure 2.18



PART A



A: _____

B: _____

C: _____

D: _____

PART B

A: _____

Pharynx

Esophagus

B: _____

C. _____

Colon

Rectum

D: _____

MICROSCOPY

PROCEDURE/ ACTIVITY 11:

31. Examine a cross section of the esophagus with a compound microscope. There is a lot of muscle here. What is this muscle for?

_____

_____

_____

_____

_____

_____

_____

Note that the digestive system has four (4) layers of muscle. A thin simple **squamous epithelium** or **serosa** surrounding the outside of the esophagus. Two **external muscle layers** of circular and longitudinal muscle fibers. Since this is a cross section, the longitudinal muscles (superficial) are cut in cross section. The circular muscles (deep) appear to be going around in a circle. A **submucosal** layer that contains connective tissue, as well as vessels and nerves. A mucosal layer includes at its base muscles, connective tissue and a **stratified squamous epithelium** lining the **lumen**. Refer to figure 2.19.

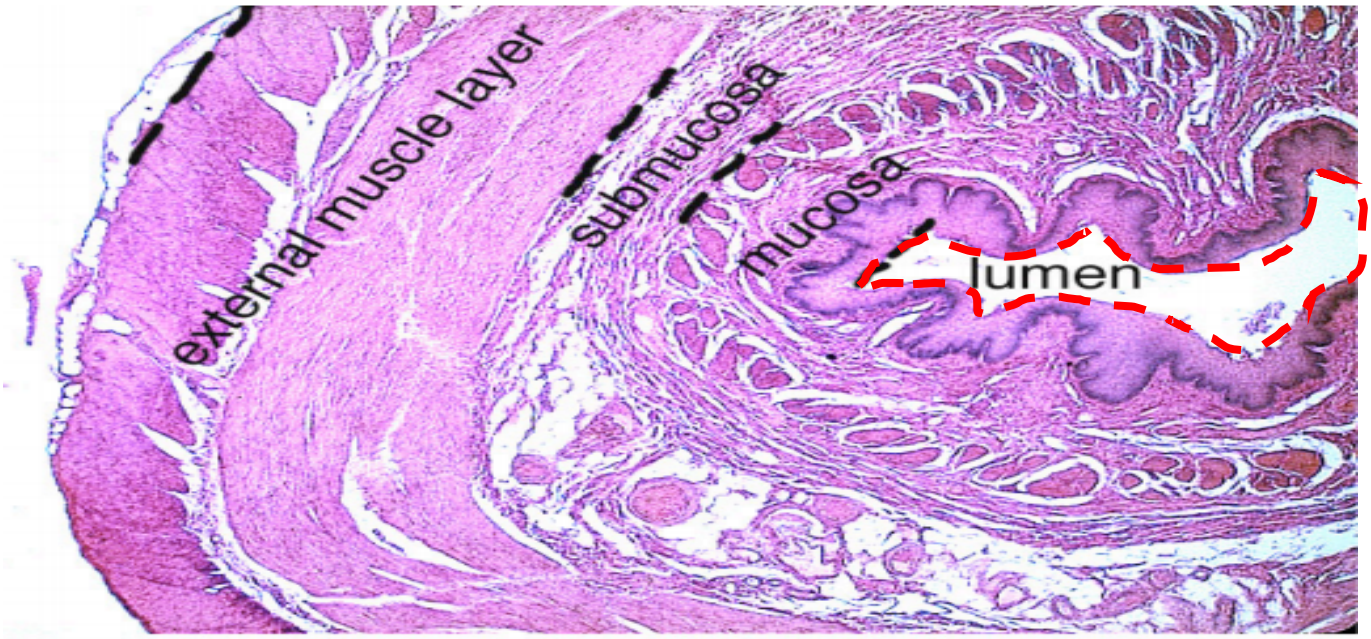


Figure 2.19

ACTIVITY 12

What cells is the red, dashed line tracing over? *Hint:* What type of epithelial cells?

_____

CLEAN-UP PROCEDURE:

Clean up your materials and work area. Wrap the pig in damp paper towels and put the specimen into a plastic bag. Label your bag with your names (or come up with a group name or name for your pig), as directed by your laboratory professor. Wash all your materials thoroughly, and return your lab equipment. Sanitize your lab bench!! Thoroughly wash your hands with soap!!

****** Remember to answer the Post-Lab questions. You are to submit the assignment to your lab professor next week. ******

Post-Laboratory Questions (Day 1)

Name _____

1. **How do the epithelia between the esophagus and small intestine differ?**

2. **What are the functional reasons for the different structures?**

3. **What are the major structures of the digestive tract, in order, starting with the mouth?**

4. **What are the large glands associated with the digestive tract and where do the ducts from these glands enter the tract?**

DAY 2

Fetal Pig Anatomy II: The Respiratory System & Cardiovascular System

Student Learning Objectives

A. Students should have a basic understanding of the structures and functions of the respiratory system.
B. Students should have a basic understanding of the structures and functions of the cardiovascular system.

Supplemental Videos

http://www.youtube.com/watch?v=vbwrOUzndIE
http://www.chw.org/display/PPF/DocID/23045/router.asp
http://www.youtube.com/watch?v=P4XCJJ44CBQ

What is the purpose of this lab?

_____

_____

_____

_____

_____

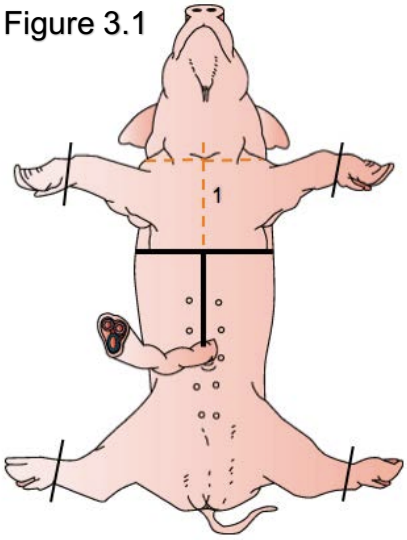
Recitation & Procedure

PROCEDURE:

Today, we will be examining the organ systems of the thoracic cavity. To do this, we first must make yet another incision.

1. Make a medial incision, and two (2) lateral incisions based on the orange, dashed lines on figure 3.1. The black lines signify incisions already made.
2. Please note: you may need to use scissors to cut through the sternum (breastbone located in the center of the chest).
3. When making the incision/cutting with scissors, make sure to be extremely careful. You do not want to puncture the viscera lie within the thoracic cavity.

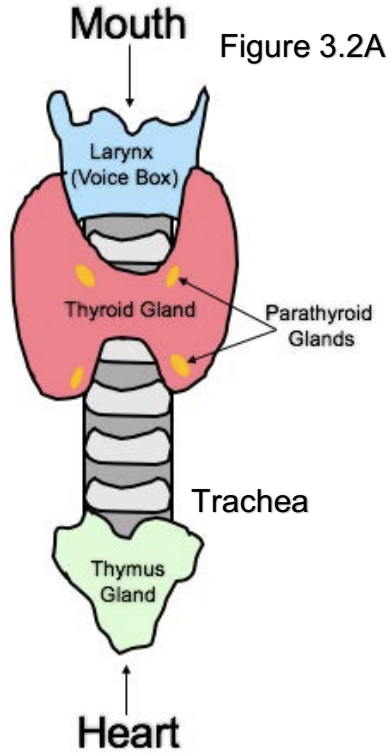
Figure 3.1



HEAD & NECK: LARYNX & NECK

As you complete the dissection illustrated in figure 3.1, you will come across the **larynx** (or voice box). The larynx is supported by many **laryngeal cartilages**. As you may remember from last week, the **epiglottis** is rostral (superior) to the larynx. This organ contains the **vocal cords** that enable to animal to produce sounds. Air enters the larynx easily only when the slight-like opening, the **glottis**, is fully open during **inspiration** (inhalation of air). The air will then travel through the windpipe, or **trachea**, which extends inferiorly from the larynx to the beginning of the lungs. The trachea is held firmly up-right by oval cartilaginous rings, so air can travel easily through **respiration** (action of breathing)**.**

Figure 3.2A



You will also come across a few glands. First, you will see the **thyroid gland,** which is located a short distance below the larynx. It is classified as an **endocrine gland** (you should remember this from lecture), and is responsible for secreting hormones. The thyroid primarily produces a hormone called **thyroxine**, which is needed for the maintenance of a high level of metabolism and heat production. You may not see the microscopic **parathyroid glands,** but they are important for the secretion of a hormone that regulates calcium metabolism. Located directly below the thyroid gland and above the heart, is the **thymus gland.** In fetuses, it is relatively large, and will decrease in size with age. **–** The thymus is a lymphatic organ, and has the important responsibility for producing and maturing T-Lymphocytes, before they are distributed to the lymph nodes and other lymphatic tissues, which aid in the immune system defense against fungal and viral infections. To better orient yourself with the anatomy, refer to figures 3.2A and 3.2B.

PROCEDURE:

4. Find the trachea, a large air tube that lies anterior to the lungs. The trachea is easy to identify because of the cartilaginous rings that help keep it from collapsing as the animal inhales and exhales.
5. At top, anterior end of the trachea, you will find the larynx.
6. Lying ventral, inferior to the larynx is the pinkish-brown, thryoid gland.
7. Inferior to the thyroid and near the heart, you will find the thymus gland.

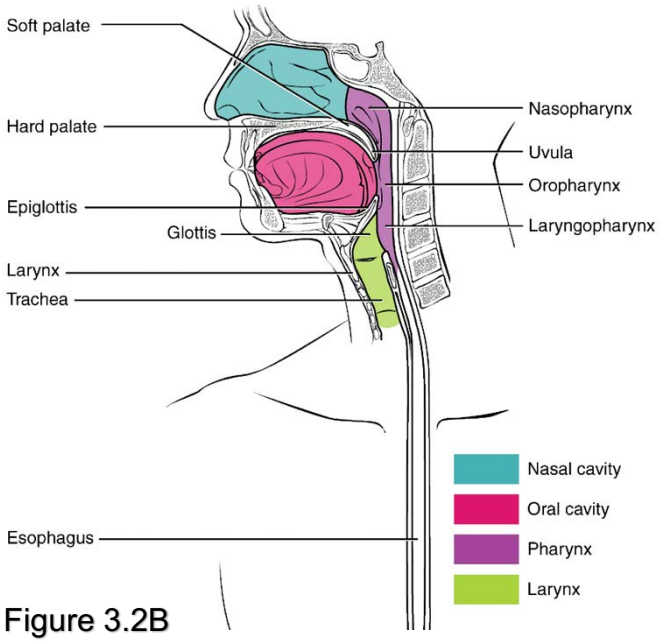


Figure 3.2B

RESPIRATORY ORGANS OF THE THORAX

As soon as you look into the thoracic cavity, you will find two, spongy **lungs** that surround the heart. The cavities in which the **lungs** are located are called the **pleural cavities** (there is a **left** and a **right** pleural cavity). There is a tissue that covers and protects the lungs called the **pleura** (you may or may not see the pleura in your specimen). It is important to note that the lungs in the fetal pig are collapsed, because the fetus was never able to use them – the lungs only fill the pleural cavity post-partum. The **right lung** contains the **superior lobe, middle lobe,** and the **inferior lobe,** opposed to the **left lung** which only contains the superior and inferior lobes.

ACTIVITY 1: Based on your observations of the lungs, how many lobes does the left lung have compared to the 3-lobed, right lung? ____ **Lobes**

Why do you think the left lung has this many lobes? (Hint: refer to figure 3.3).

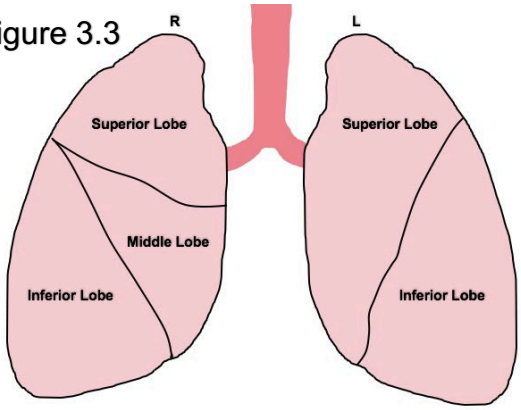
_____

_____

_____

_____

Figure 3.3



Following the trachea, air then flows through the **left** and **right bronchi** (sing. bronchus). Note that the **left bronchus** is slightly smaller in diameter than the **right bronchus**. The bronchi will divide many times into smaller and smaller branches termed the **bronchioles**. The microscopic, terminal bronchioles then lead to **alveolar sacs** which contain a collection of **alveoli,** which are small mucus-lines pouches made of squamous epithelial cells. These alveoli are covered in capillaries that allow the diffusion of gases in our respiratory system (figure 3.5). Figure 3.4 serves to illustrate the anatomy of the lungs.

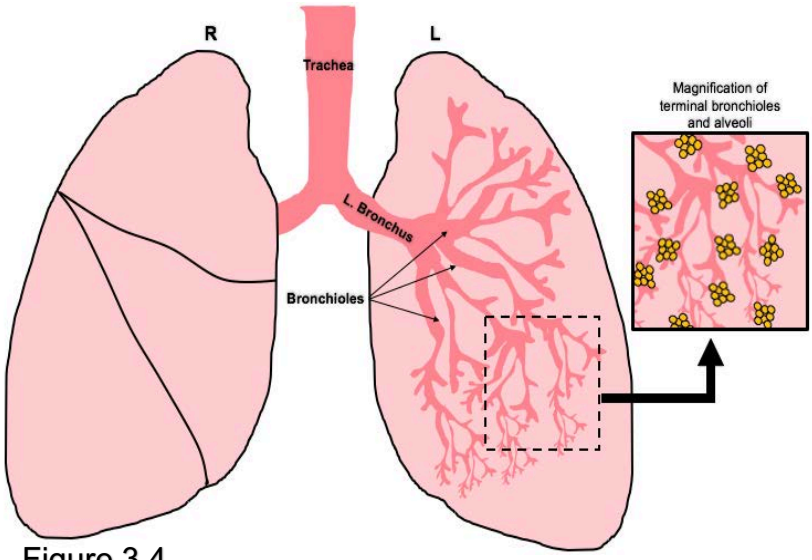


Figure 3.4

ACTIVITY 2: The entire **respiratory system** beginning from the trachea and ending at the alveoli is known as the **Respiratory Tree.** Take some time to test your knowledge air flow by completing the sequencing below.

Mouth/Nasal Nostrils → Larynx → _____ → _____ → Bronchioles → _____

Just as we discussed before, the **diaphragm** divides the thoracic and abdominal cavities. The diaphragm also plays an important role in breathing, since it's contraction increases the volume of the thorax, allowing the inflation of the

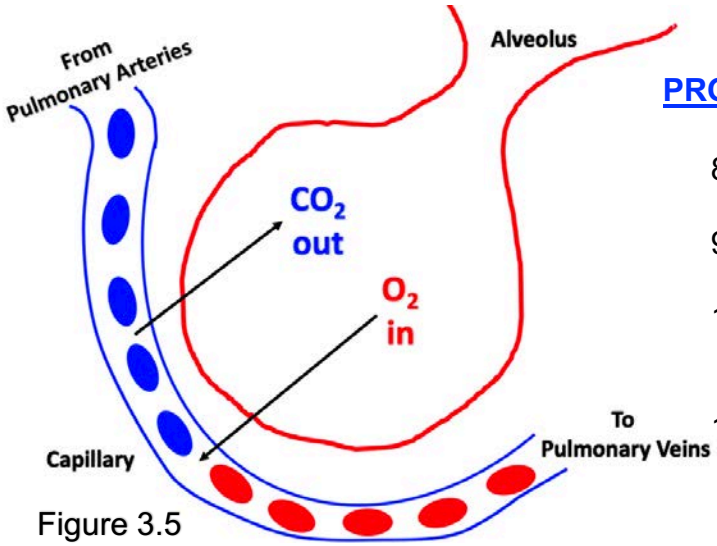


Figure 3.5

PROCEDURE:

8. Find the diaphragm. This is the sheet of muscle below the heart and above the liver (figures 3.6 & 3.7).
9. Divert your attention to the left pleural cavity (where the left lung is housed).
10. Pull the left lung ventrally and towards the middle of the body. You should come across a large, muscular, white tube in the midline of the body – this is the **aorta**.
11. At the level of the heart, the aorta is crossed another blood vessel, the **left azygos vein** (figure 3.8). This vein is responsible for receiving deoxygenated blood from the **intercostal veins** (carry deoxygenated blood from thoracic wall).

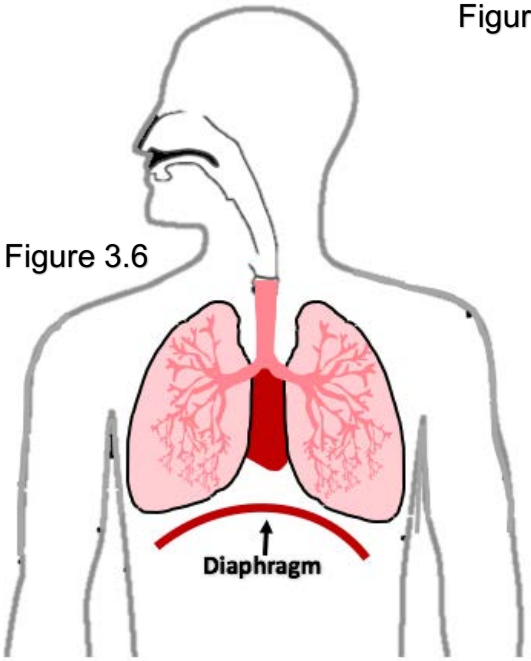
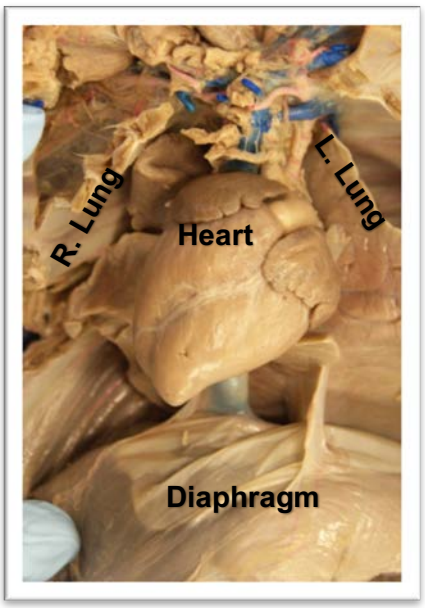


Figure 3.6

Figure 3.7



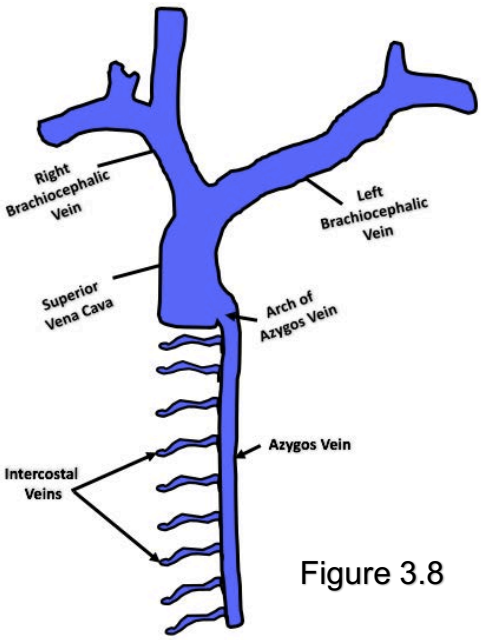


Figure 3.8

MICROSCOPIC SCTRUCTURE OF THE LUNG PROCEDURE

12. Grab a lung tissue slide. Identify the alveoli and blood vessels, as indicated in figure 3.9.

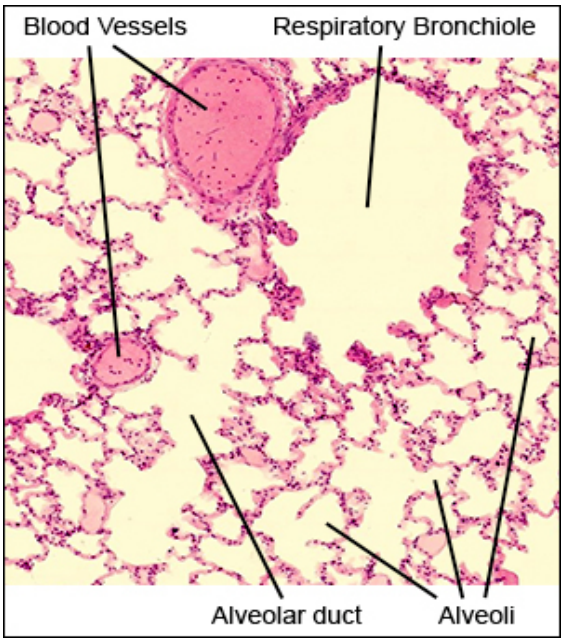


Figure 3.9

ADULT CIRCULATION

The adult circulatory system is a **closed system**. Blood starting from the heart eventually will return to the heart without leaving system.

As you learn about different vessels, think about the direction of blood flow and whether the blood is oxygenated or not, in both the fetus and the adult.

You will surely appreciate the blood vessels you identify by understanding the basic pattern of circulation in an adult mammal (even if you are dissecting a fetus). Blood is transported by muscular blood vessels called **arteries** ***a***way from the heart to thin-walled **capillaries** in tissues where the exchange of water, nutrients, gases and wastes, between the blood and capillary extracellular fluid occur.

The capillary beds are then drained into the **veins** (figure 3.11)**,** which are responsible for returning blood back to the heart. Unlike arteries, veins have **valves** that prevent the back flow of blood. When blood travels to the **capillaries from arteries**, the blood will travel through small branches of the artery, the **arterioles**, before entering the capillary bed. When exiting the capillary bed, blood travels through small branches of the vein, the **venules**, before entering the vein (figure 3.10). In general, veins have thinner walls and a flattened cross section, while arteries have thicker walls and a rounded cross section – we've already seen this during the histology lab.

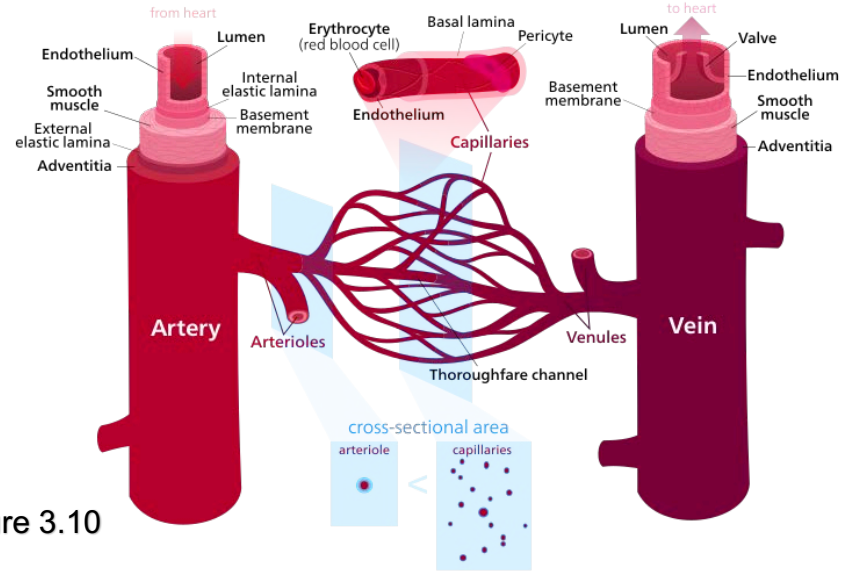


Figure 3.10

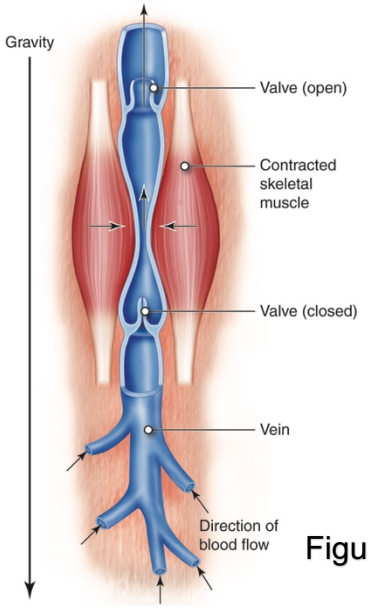
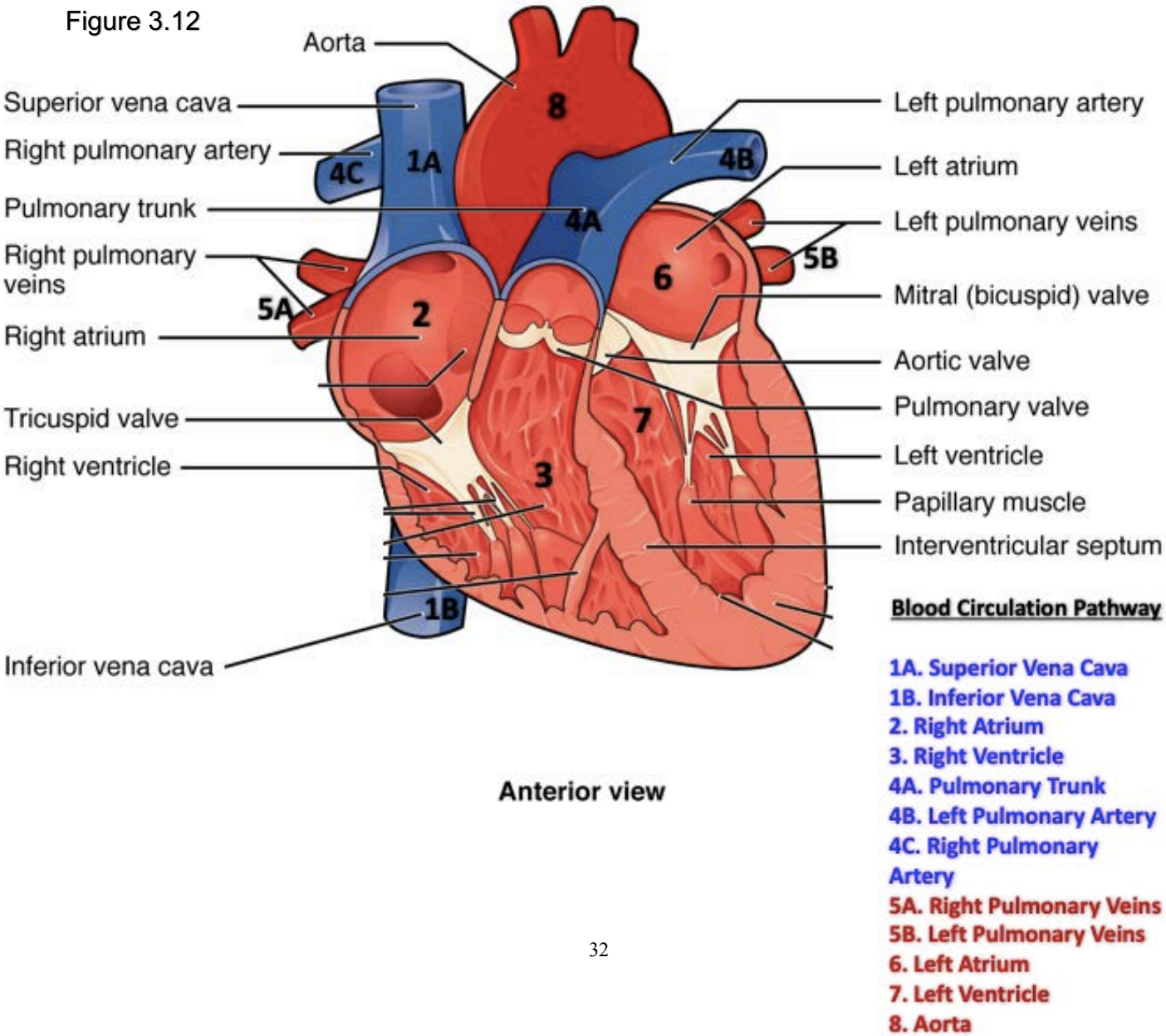


Figure 3.11

In normal adult circulation, oxygen-depleted and carbon dioxide enriched blood is drained into the **right atrium** by two large veins – the **superior** and **inferior vena cava**. The **superior vena cava** drains deoxygenated blood from head, neck, and arms, while the **inferior vena cava** drains deoxygenated blood from the caudal parts and internal organs of the body. After the filling the right atrium, deoxygenated blood is pumped into the **right ventricle.** The blood is then pumped into the **pulmonary arteries** (2). From the pulmonary arteries, the oxygen-poor blood is taken to the lungs to acquire oxygen (as we discussed on pages 30-31). Circulation beginning with the vena cavae and ending in the lungs is termed as **pulmonic circulation.** Once blood has received oxygen by diffusion of gases in the lungs, the blood is pumped into the **pulmonary veins** (4), which drain into the **left atrium**. From the left atrium, blood drains into the **left ventricle**. Following the left ventricle, the oxygen-rich blood is pumped into the **aorta**, the largest artery in the body. The aorta, having many branching points throughout its body, allows for the distribution of oxygenated blood to all body organs. Circulation beginning with the pulmonary veins and ending with the distribution of oxygen-rich blood to all body tissues is termed as **systemic circulation**. Figure 3.12 shows proper circulation of blood.

Figure 3.12



PROCEDURE: EXTERNAL ANATOMY:

12. Locate the heart. The heart in your specimen may be incased in the pericardium/pericardial sac. If so, just remove the membrane to examine the heart.
13. Locate the right and left sides of the heart. The best way: identify the **apex** of the heart, which is facing the left-hand side of the body.
14. Locate the right and left atria and ventricle. The best way: locate the **right auricle** (atrium on the right-hand side of the heart).
15. Notice that the surface of the heart is covered with blood vessels. These blood vessels are a part of the **coronary circulation**, which supply and remove blood from the cardiac tissues.
16. Superior to the heart, locate a large vein that enters the right atrium (it will be stained blue). This is the **superior vena cava.**
17. Now lift the heart to view its dorsal surface. Observe the **inferior vena cava**.
18. Find the **pulmonary artery** which leaves the right ventricle.
19. Locate the **pulmonary veins** that enters the left atrium.
20. Identify the aorta, a large artery that transports blood from the left ventricle. The aorta in your specimen may appear white and will be a thick vessel.

Figure 3.13

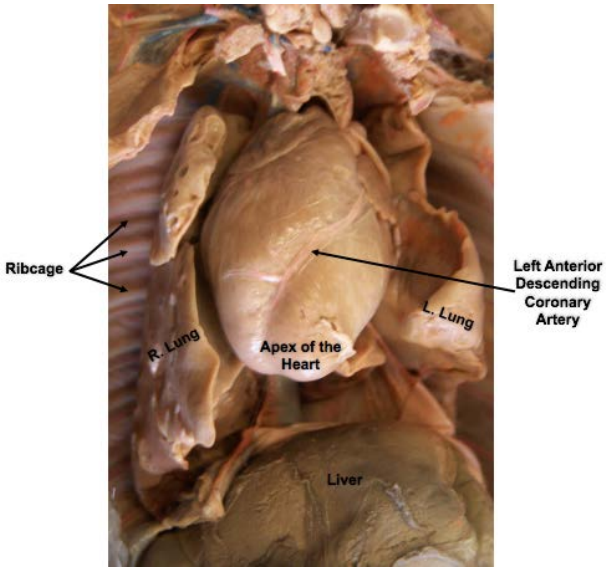


Figure 3.14

ACTIVITY 3: Once you dissect your heart, you will notice that the left ventricle is substantially more muscular than the right ventricle. Why do you think this might be?

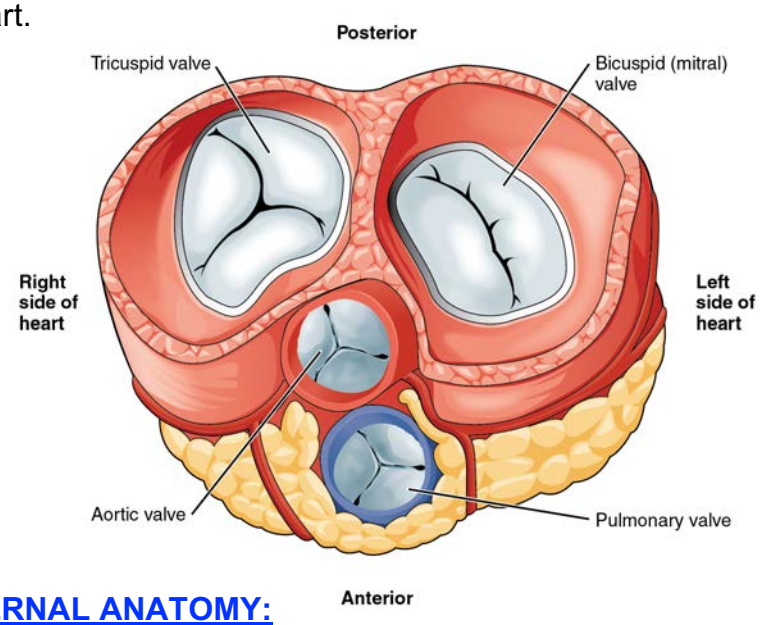
_____
_____
_____
_____

ACTIVITY 4: How many pulmonary arteries does the mammalian heart have? _____

How many pulmonary veins does the mammalian heart have? _____

Besides having just four (4) chambers in the heart, mammals generally have structures that direct and control blood flow within the heart. Valves located between atria and ventricles are called **atrioventricular valves**. The two atrioventricular valves are: the **tricuspid valve** (located between the right atrium and the right ventricle) and the **mitral (bicuspid) valve** (located between the left atrium and the left ventricle). In addition to atrioventricular valves, there are two (2) **semilunar valves** – they are called semilunar, because each leaflet (cusp) that forms the valve looks like a half-moon. The **pulmonary (pulmonic) semilunar valve** guards the entrance to the pulmonary artery, and the **aortic semilunar valve** guards the entrance to the aorta. One last thing: It is important to note that all cardiac valves, apart from the mitral valve, have three (3) cusps (or leaflets). Figure 3.15A shows the arrangement of valves within the heart.

Figure 3.15A



PROCEDURE: INTERNAL ANATOMY:

21. Insert your dissecting scissors into the superior vena cava and make an incision down through the wall of right atrium and ventricle (as shown in **Figure 3.15B;** shown in **pink**). Pull the two sides apart and look for **3 flaps** of tissue. These flaps/cusps of tissue form the **tricuspid valve** (between right atrium and right ventricle). The valve cusps are connected to the **papillary muscles** by tendons called **chordae tendinae**.

22. Insert your blunt probe into the pulmonary artery and see as it comes through the right ventricle. Make an incision down through the pulmonary artery and look out for another three (3) small membranous flaps/cusps (as shown in **Figure 3.15C**; shown in **blue**). This is the **pulmonary semilunar valve**.

23. Insert your dissecting scissors into the left auricle at the base of the aorta and make an incision through the left atrium and left ventricle (as shown in **Figure 3.15B;** shown in **purple**). Locate the two flaps that make up the **mitral** (bicuspid) **valve.** Same as the tricuspid valve, it is connected to papillary muscles by tendons.

24. Insert a probe into the aorta and examine how it connects to the left ventricle. Make an incision up through the aorta and look out for another three (3) small membranous flaps/cusps (as shown in **Figure 3.15C;** shown in **yellow**). This is the **aortic semilunar valve**.

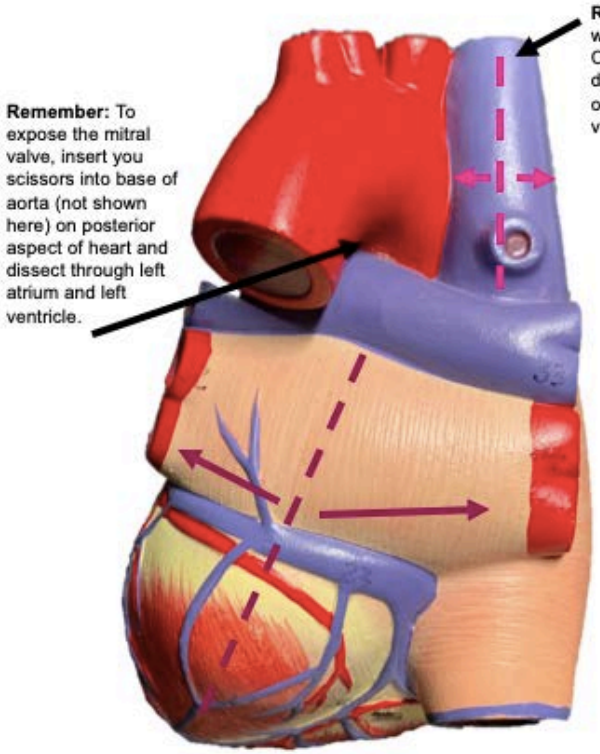


Figure 3.15B

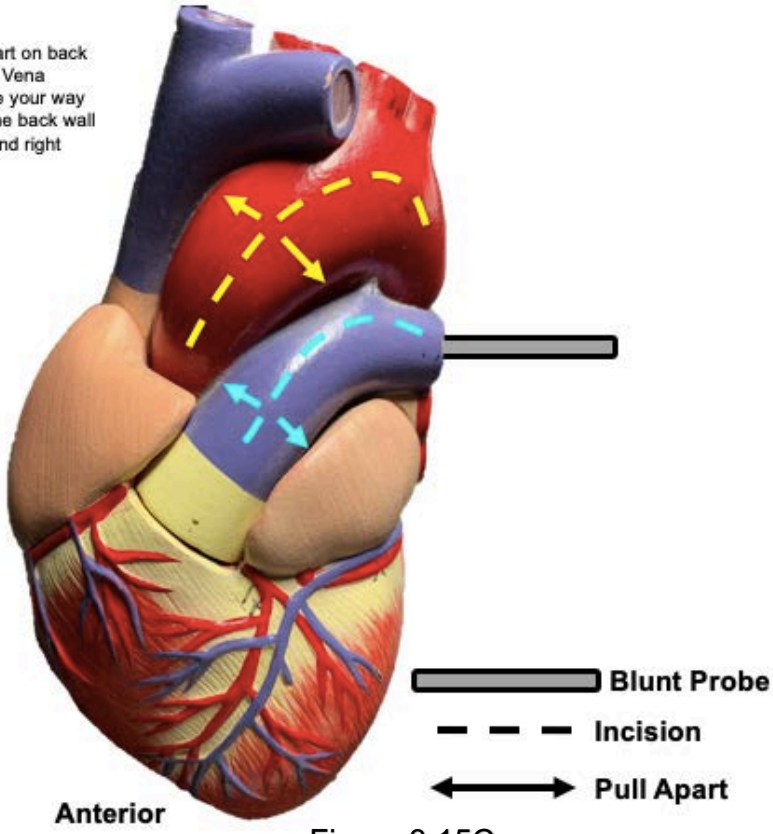


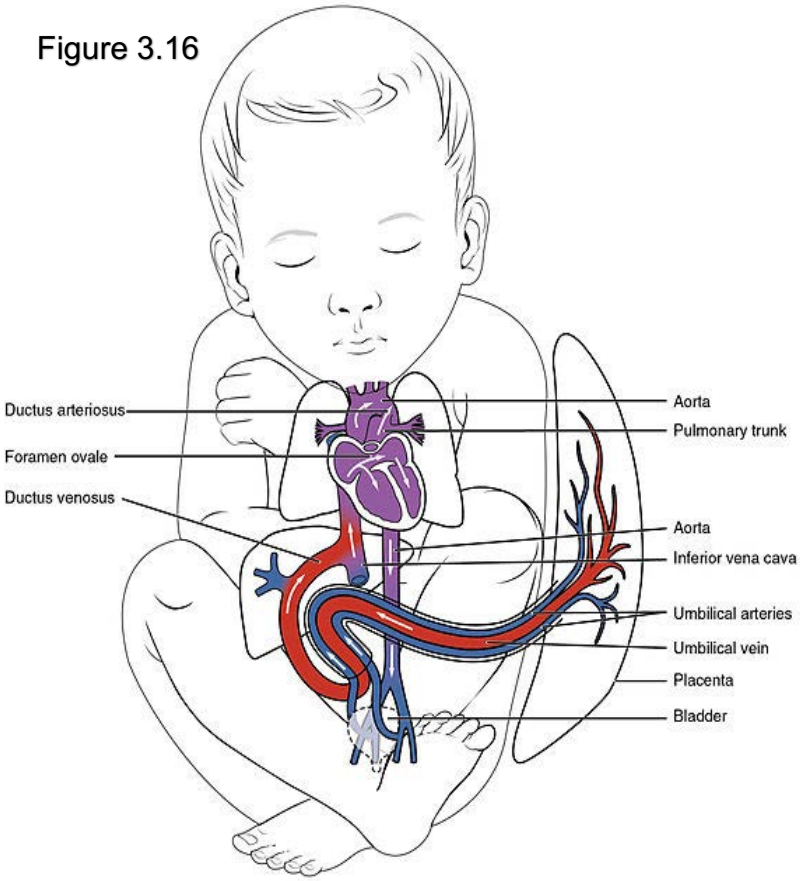
Figure 3.15C

Physiology: As oxygen-poor blood enters the right atrium, blood that is oxygen-rich returns the left atrium. The right and left atria will contract simultaneously and will discharge their blood into the right and left ventricles. The ventricles are expanding by elastic recoil after their previous contractions. When the thick muscular ventricles contract, an increase in pressure closes atrioventricular valves, and the blood is pushed into the two arteries with considerable force. So, what exactly drives the beating of the heart? It is the heart's **electrical conducting system.** The electrical signal travels through a network of conducting pathways, which stimulate the atria and the ventricles to contract. In a nutshell, the heart begins at **sinoatrial (SA) node** that activates the contraction of the atria. The **atrioventricular (AV) node** sends an impulse to the **Bundle of His,** which subsequently sends impulses to the **purkinje fibers** of the ventricles, allowing the ventricles to contract (or pump). A cleaver way to remember the electrical conduction system pathway is by the acronym:

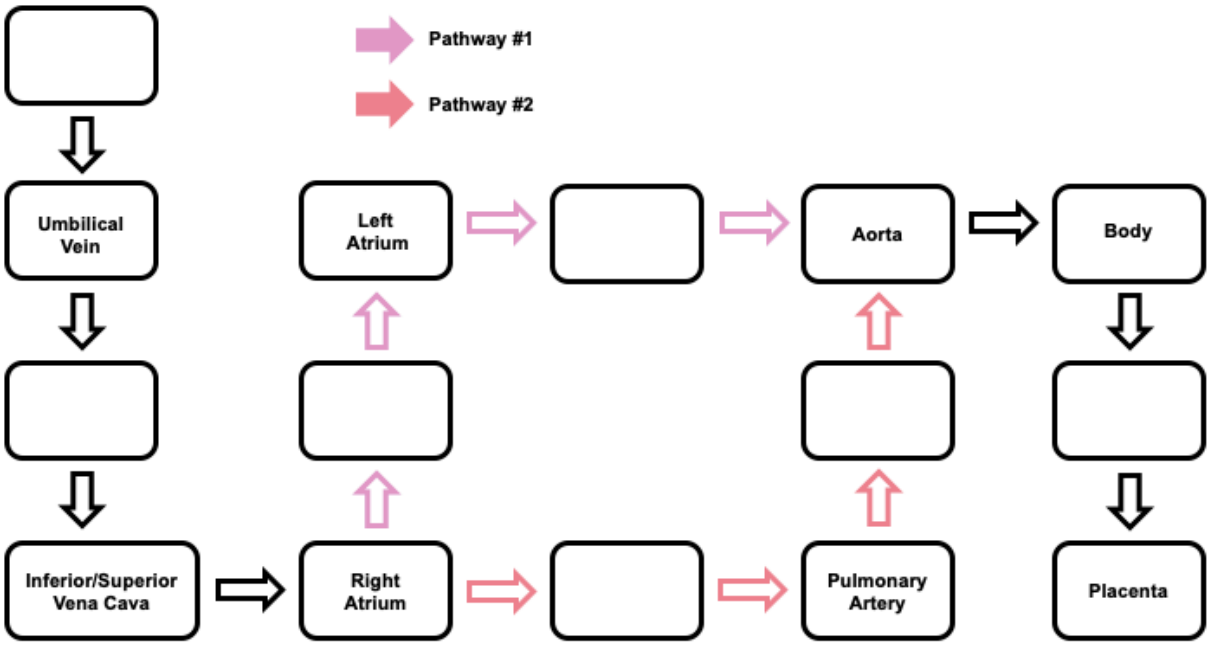
FETAL & NEONATAL CIRCULATION

In addition to what was discussed in the adult circulation section, fetuses and neonates have other structures in the heart that aid in proper blood flow. In the fetus, a large branch of the pulmonary trunk continues dorsally and laterally as the **ductus arteriosus**, which joins the aorta. Because the lungs are not yet functional in the fetus, most of the fetal blood from the right ventricle bypasses the lungs and heads straight into the aorta via ductus arteriosus, as illustrated on figure 3.16. Some fetal blood also bypasses the lungs by flowing directly from the right atrium to the left ventricle by passing through an opening in the atrial septum, **foramen ovale**, in the heart. Additionally, in the fetus there exists a shunt on a portion of the left umbilical vein that allows the flow of blood directly into the inferior vena cava. This shunt is called **ductus venosus** (figure 3.16), and allows for oxygenated blood from the placenta to bypass the liver. Fetal circulation verses adult circulation is one of the most fascinating aspects of mammalian adaption. Due to the similarity between fetal circulation between pigs and humans, we illustrate fetal circulation in a human fetus.

Figure 3.16



ACITIVITY 5:



VEINS & ARTERIES OF THE NECK, HEAD, & THORAX

When examining the cardiovascular system of your specimen, notice that the veins of the neck lie superficially (towards the surface) to the arteries. A pair of **external jugular veins** lie superficially on the lateroventral (on the sides, towards the front) surface of the neck. The **internal jugular veins** are also paired, and lie close to the trachea. The internal jugular veins drain the deoxygenated blood from the inside of the skull. The external and internal jugular veins will then merge with *one* of the **subclavian veins,** which comes from the arm and shoulder. All these veins will then merge into the **brachiocephalic vein**, which then receives blood from the *second* subclavian vein. The brachiocephalic vein then will drain into the **superior vena cava.** Finally, you may notice a pair of **internal thoracic veins** that branch into the **azygos vein** subsequently draining into the superior vena cava ventrally. These veins along with the **internal thoracic arteries** help drain the chest wall.

Now, let's turn our attention to the arteries. The first branches of the **ascending aorta** are the pair of the **coronary arteries** (not shown in figure 3.17B). The more conspicuous **left coronary artery** and the great **cardiac vein**, can be seen on the ventral surface of the heart, running diagonally. You will see the right coronary artery, once the heart is removed. The **aortic arch** gives off the **brachiocephalic trunk**, **left common carotid artery,** and the **left subclavian artery**. The brachiocephalic trunk will then divide into the **right common carotid artery** and the **right subclavian artery**. The common carotid arteries and their associated branches supply oxygenated blood to the head and neck. The pair of subclavian arteries supply oxygenated blood to the upper limbs. When dissecting, the most superficial and easily seen branches of the subclavian arteries are the **internal thoracic arteries**.

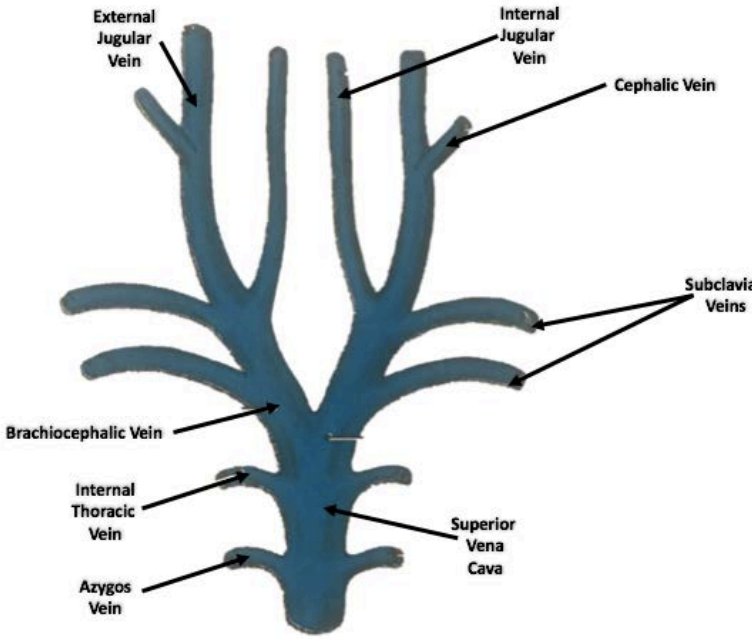


Figure 3.17A

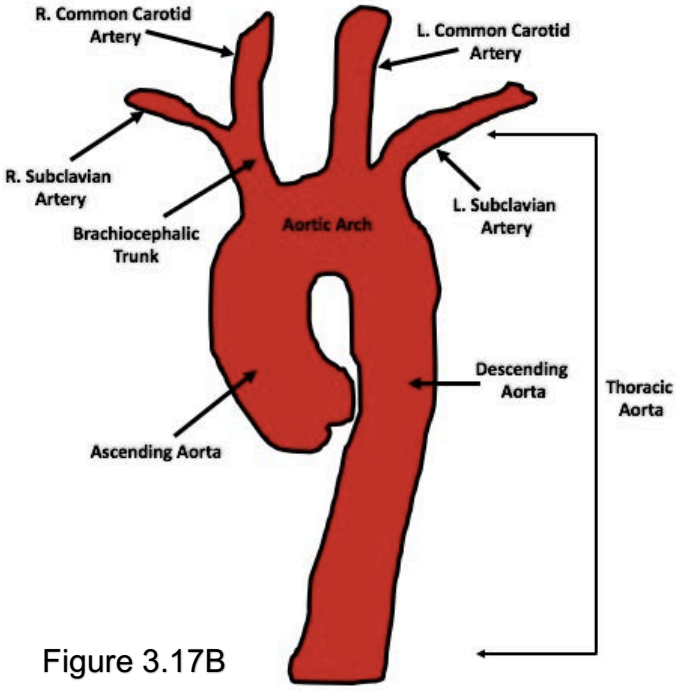


Figure 3.17B

VEINS & ARTERIES CAUDAL TO THE DIAPHRAGM

The abdominal organs, pelvic organs, hind legs, and tail are all supplied oxygenated blood by the **abdominal aorta** and are then drained of deoxygenated blood by the **inferior vena cava**. However, the spleen and **all** digestive organs are drained first by a group of veins that carry blood to the liver. These veins form the **hepatic portal system** (figure 3.18). In essence, a portal system is defined as having veins that lead from capillaries in one organ to capillaries in another organ, rather than draining directly into the heart. The **hepatic portal vein** is the blood vessel that carries blood from the gastrointestinal tract, gallbladder, pancreas, and spleen directly to the liver.

PROCEDURE:

22. Cut through the diaphragm (or what is left of the diaphragm), and push the abdominal viscera to the right.

ACTIVITY 6: Which organs do you think contribute to the formation of the hepatic portal system? Use the information provided in the paragraph above and figure 3.18.

_____

_____

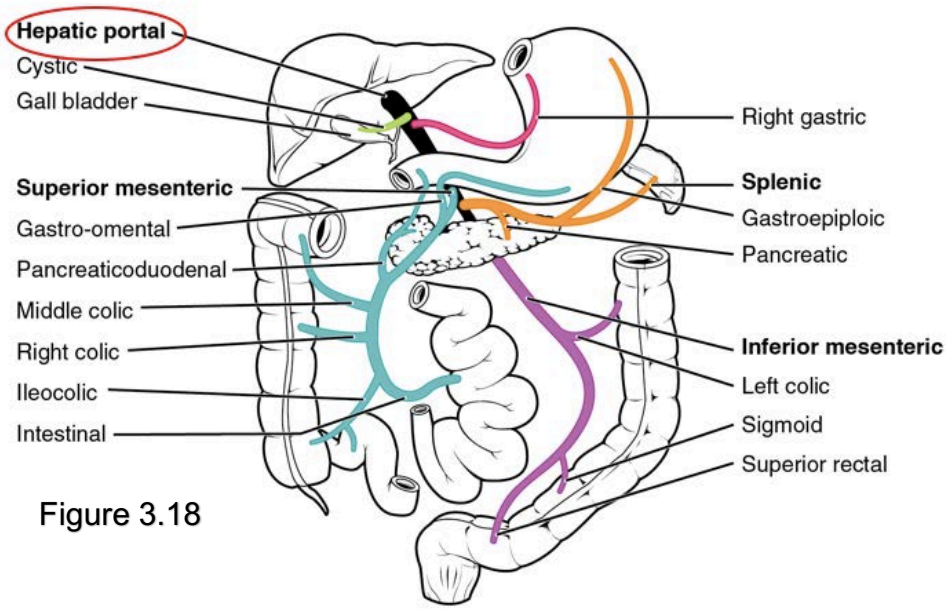


Figure 3.18

Once you push the abdominal organs to the side, you will be able to trace the **abdominal aorta** in the abdominal cavity. The abdominal aorta passes caudally between two **kidneys, adrenal glands** (found on the superior surface of each kidney), and is adjacent to the **inferior vena cava.**

At the segment of the abdominal aorta directly beneath the diaphragm, the median **coeliac artery** exists. The coeliac artery divides into the branches – the left branching bearing the **left gastric artery** (to stomach) and the **splenic artery,** and the right branch being the **hepatic artery** (to liver, duodenum, and pancreas). The next branch of the abdominal aorta following the coeliac artery is the **superior mesenteric artery**, which supplies oxygenated blood to the small and large intestine. Next to aorta, you will find the inferior vena cava. Although the inferior vena cava extends through the liver, it does not carry blood to the liver. In fact, the inferior vena cava receives blood from the liver by several **hepatic veins**.

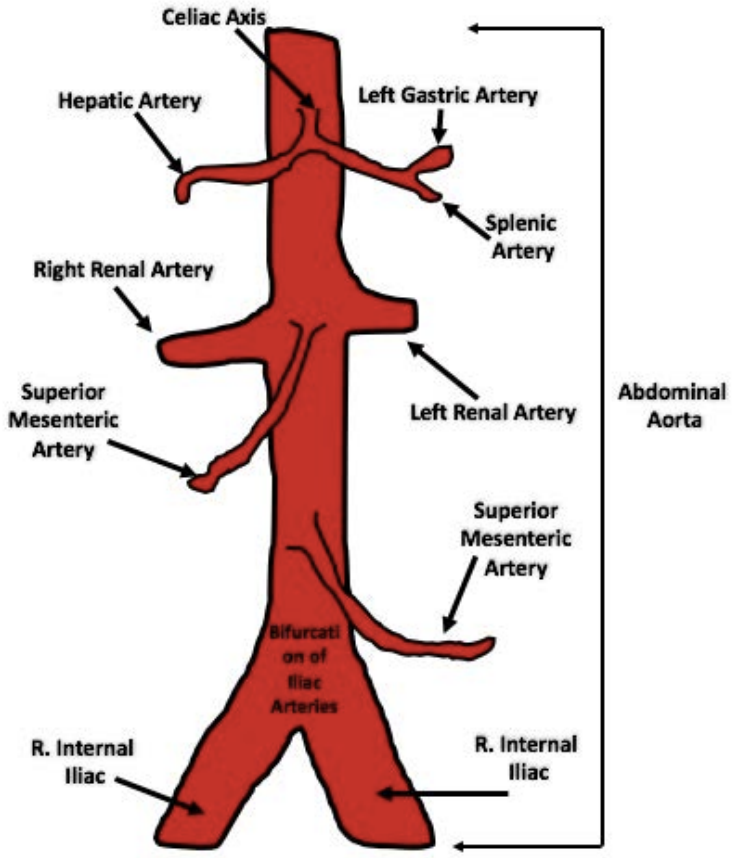


Figure 3.19

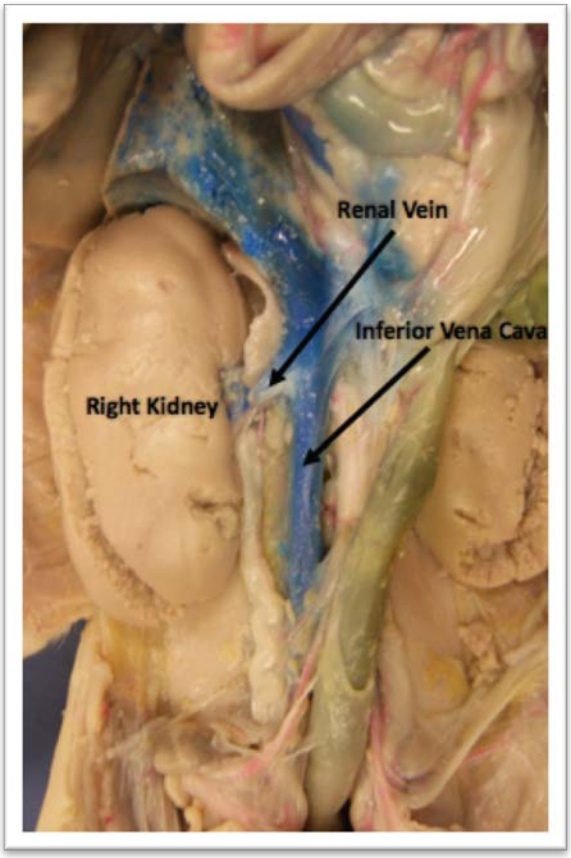


Figure 3.20

BLOOD VESSELS ON THE DORSAL ABDOMINAL AND PELVIC WALLS

Returning to the aorta and the inferior vena cava at the level of the kidneys, you will find the **renal arteries** and the **renal veins**. For your convenience, the renal arteries are stained red and the renal veins are stained blue. Further beneath the renal blood vessels, you will find the **inferior mesenteric artery**, which supplies majority of the colon with blood. Beneath the inferior mesenteric artery, you will find a bifurcation that leads to the right and left **iliac arteries.** The iliac arteries extend onto the ventral body wall along the urinary bladder and continue into the umbilical cord. The distal segments of the iliac arteries that are within the umbilical cord are termed the **umbilical arteries,** and carry deoxygenated blood from the fetus to the placenta.

MICROSCOPIC CARDIOVASCULAR ANATOMY

PROCEDURE:

23. Examine the Slide of cross sections of arteries and veins. In each, locate the endothelium lining the lumen, connective tissue, and the muscle. Note that the artery has many wavy elastic connective tissue fibers

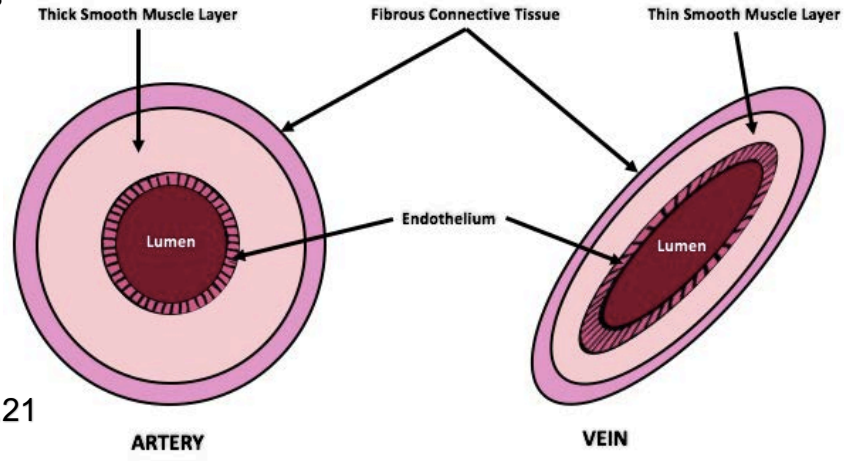


Figure 3.21

ACTIVITY 7: Based on all that you have learned, complete the table below.

Blood Vessel	Deoxygenated or Oxygenated?	Towards the Heart or Away from the Heart?
Aorta		
Superior Vena Cava		
Pulmonary Artery		
Coronary Arteries		
Coronary Veins		
Brachiocephalic Trunk (branching from aorta arch on the right side)		
Left Azygos Vein		
Umbilical Artery		
Umbilical Vein		

CLEAN-UP PROCEDURE:

Clean up your materials and work area. Wrap the pig in damp paper towels and put the specimen into a plastic bag. Label your bag with your names (or come up with a group name or name for your pig), as directed by your laboratory professor. Wash all your materials thoroughly, and return your lab equipment. Sanitize your lab bench!! Thoroughly wash your hands with soap!!

****** Remember to answer the Post-Lab questions. You are to submit the assignment to your lab professor next week. ******

Post-Laboratory Questions (Day 2)

Name _____

1. **Which type of vessels, arteries or veins, has more muscle fibers? What is the functional significance of this?**

2. **In general, we have no conscious control over smooth muscle or cardiac muscle function, whereas we can consciously control to some extent all skeletal muscles. Can you consciously control your breathing? What does this tell you about the muscle type of the diaphragm?**

3. **What is a portal system? What organs does the hepatic portal system connect in adults? What is the purpose of this system?**

4. **Starting with the umbilical vein, list/chart the general flow of blood through the fetus.**

5. **What special features of the lung make it a useful organ for gas exchange?**

6. **The ductus arteriosus and the ductus venosus are two key vessels in the fetal circulation that are absent in the adult circulation. What are their functions in the fetus? Why are they necessary?**

7. **At birth, the fetal circulation is transformed instantaneously into the adult circulation with practically no transition. How is this marvelous process possible?**

DAY

3

Fetal Pig Anatomy III: The Urogenital System

Student Learning Objectives

A. Students should have a basic understanding of the structures and functions urogenital system.

Supplemental Videos

http://www.youtube.com/watch?v=VtTNupjL1Yc
http://www.youtube.com/watch?v=9VI9v8gfuEc
http://www.youtube.com/watch?v=chhNaLi9P3E&feature=PlayList&p=E80DEB28F52B8A16&index=51

What is the purpose of this lab?

_____

_____

_____

_____

Recitation & Procedure

ANATOMY OF THE EXCRETORY SYSTEM

So, what exactly is the **excretory system**? This system primarily consists of the kidneys, which play a vital role in the filtration and expulsion of nitrogenous wastes made by protein metabolism. In doing so, the kidneys, and essentially the whole excretory system help in maintaining homeostasis by regulating the balance of water, salts, ions, sugars in the body fluids.

At this point, you should have the kidneys exposed within the specimen. They lie ventrally on the back muscles and protrude into the peritoneal cavity. The serosa (or parietal peritoneum) only covers the ventral surface of the kidneys; hence, describing the position of the kidneys as **retroperitoneal** (behind the peritoneum). On the superior surface of each kidney there exists the **adrenal** (or suprarenal) **gland.** Each adrenal gland produces hormones that regulate blood sugar content, react to major stressors like an illness or injury, and regulate blood pressure. As you will (or have already learned in lecture), the two most important adrenal hormones are cortisol and aldosterone. Each kidney is drained by a **ureter**, which is chaperoned by the **renal artery** and **renal vein**. As you trace the ureter caudally, you will notice that it turns ventrally at the peak of the pelvis and enters the **urinary bladder**. The caudal end of the urinary bladder leads into the **urethra**. The urethra dips into the pelvic cavity and expels urine through an opening on the body surface. Tracing the urinary bladder into the umbilical cord, you will notice that it continues as the **allantoic stalk**.

Once you dissect the kidney into halves, you will notice that the ureters extend from the kidney at the **renal pelvis.** The renal pelvis is subdivided into many smaller sections, the **renal calyces**, each of which have these clumps of kidney tissue. Each of these clumps is called the **renal pyramid**. Collectively, the renal pyramids form the **renal medulla**. The periphery of the kidney is the called the **renal cortex.**

All the structures described above can be identified by using figures 4.1-4.4.

PROCEDURE

1. Remove the digestive organs to see the organs of the urogenital system.
2. Locate the bean-shaped kidneys lying against the dorsal body wall.
3. Find the ureters. Remember they are tubes that extend from the kidneys to the urinary bladder. The urinary bladder lies between the umbilical arteries (they will be dyed red/pink).
4. Lift the urinary bladder to find the urethra. Follow the urethra to the urogenital orifice on the outside of the pig's body.

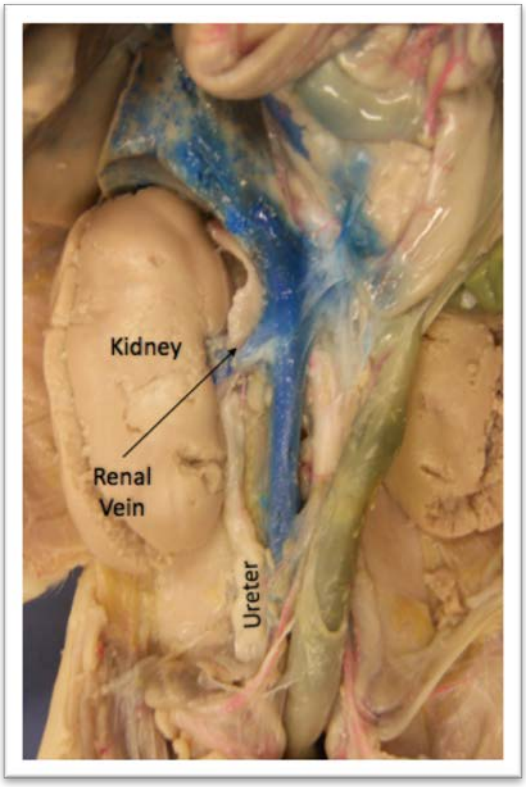


Figure 4.1

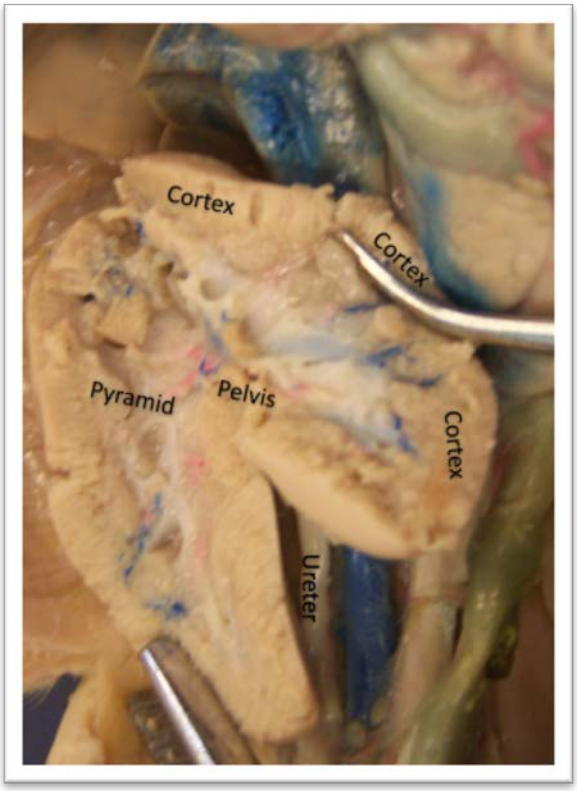


Figure 4.2

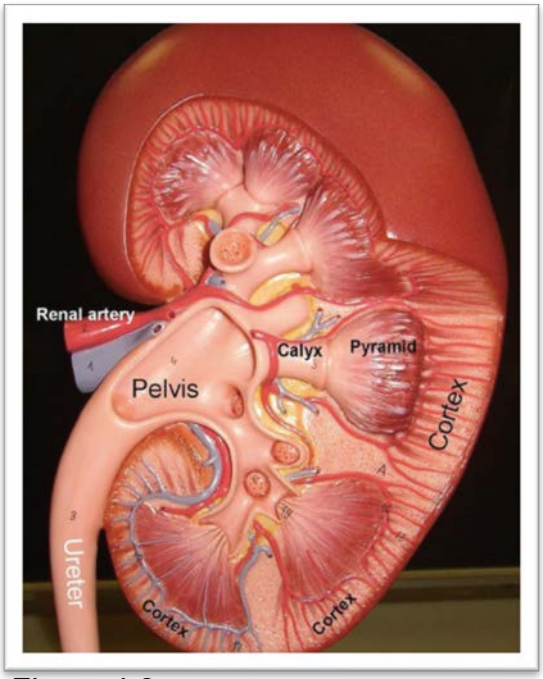


Figure 4.3

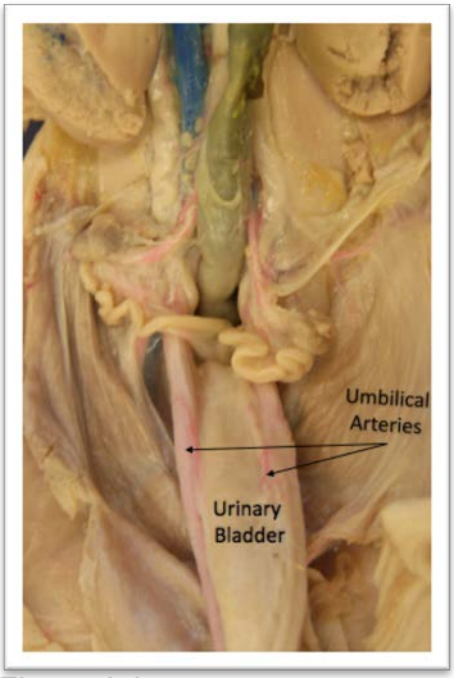
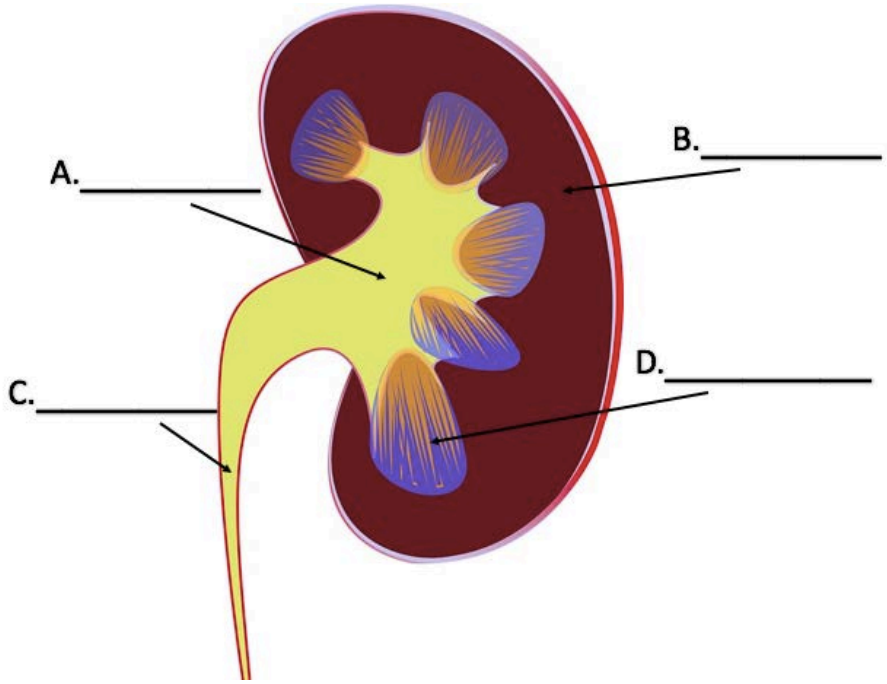


Figure 4.4

ACTIVITY 1: Label the diagram of the kidney.



MICROSCOPIC STRUCTURE AND FUNCTION OF A KIDNEY

The structural and functional unit of a kidney is the **nephron**. It is devised of the **glomerulus**, a clump of capillaries, and the **renal tubule,** which collects fluid from the glomerulus and processes it to form urine. The various partitions of the nephron are placed within the renal cortex and the renal medulla.

Blood coming from the **renal interlobular artery** enters the capillaries of the glomerulus and then filters through **Bowman's Capsule**. The filtrate that enters Bowman's capsule is similar in composition to blood, however, it does not contain any blood cells and protein molecules. The filtrate then continues to the **proximal convoluted tubule** (in the renal cortex), through the **loop of Henle** (in and then out of the renal medulla)**,** and then through the **distal convoluted tubule** (again in the renal cortex). Distal convoluted tubules of many nephrons collect in the **collecting tubule**, which spans the renal cortex and renal medulla, reaching the tip of the renal pyramid. It is important to note that as the filtrate passes through the various parts of the nephron, water, ions, nutrients, and other substances needed by the body are absorbed by the walls of the renal tubules. Once absorbed, the needed substances are diffused back into the blood stream (specifically into the **renal interlobular veins)** via the **peritubular capillaries.** Refer to figure 4.5A and 4.5B for anatomical reference.

PROCEDURE

5. Examine a sagittal section through the kidney at low magnification. You should be able to differentiate the renal cortex, where the Bowman's capsules are located, from the renal medulla, where the renal tubules are mostly straight, and the renal pelvis, where urine collects from all the collecting tubules.
6. Examine the cortex at high magnification (figure 4.6). You should be able to identify Bowman's (glomerular) capsules and the glomerulus of intertwined capillaries within the capsule. (Glomerulus = Gk. a small ball of yarn).
7. Examine the medulla, and identify tubules cut transversely and longitudinally. The tubules are lined by a **cuboidal epithelium**.

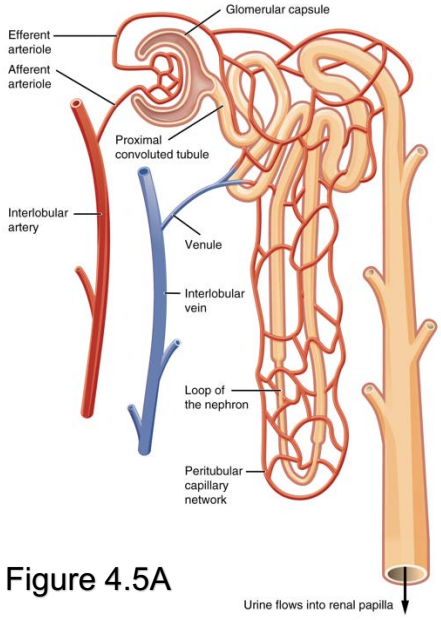


Figure 4.5A

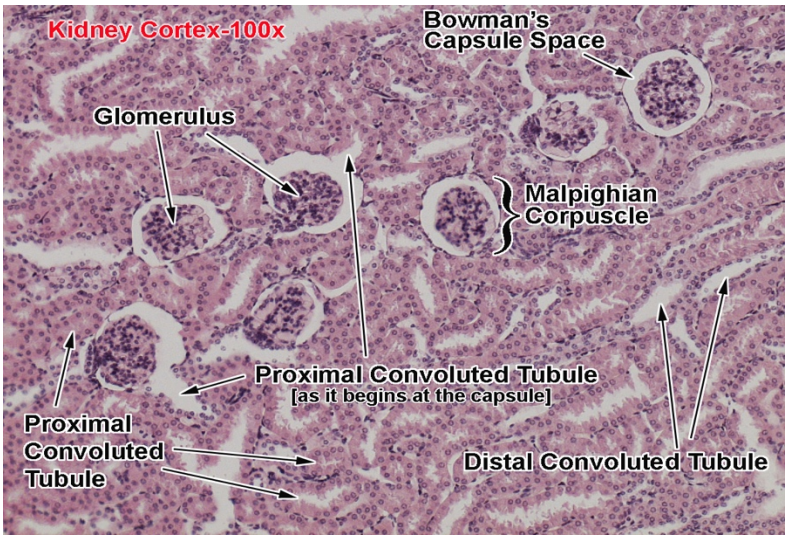


Figure 4.5B

MALE REPRODUCTIVE SYSTEM

On the external surface of the fetal pig, you will come across the **scrotum**, which is ventral to the anus. The scrotum is the sac that houses the testes, once they fully develop. In early embryonic development, the testes are positioned retroperitoneally, caudal to the kidneys. Later during development, the testes will migrate caudally – a process called **descent.** The testes will descend through openings in the abdominal wall – each of these openings are referred to as the **inguinal canal.**

The **testes** (sing. testis) lie in **cremasteric pouches** (pouches that are located at the medio-ventral surface of the thighs). On the cranial end of a testis, you will find the **epididymis.** The epididymis is a band of tissue that extends caudally along one side of the testis, where it continues into the sperm duct, the **ductus deferens** (more commonly known as the **vas deferens**). Sperm cells are generated in the **seminiferous tubules** of the testes and

leave the testes through ducts that enter the cranial end of the epididymis, where the sperm cells mature and await to be ejaculated.

If you examine the caudal surface of the umbilical cord, you will find the **preputial orifice**. The penis extends caudally from that point. One organ that you may not be able to see in the fetus is the **prostate gland.** Just know that the prostate gland is male reproductive organ. Its main function is to secrete prostate fluid, which is also one of the components of semen. At the time of ejaculation, the **bulbourethral glands** secrete a liquid that carries sperm cells – **seminal fluid**. During ejaculation, the sperm cells travel within **seminal fluid** through the **urethra** of the **penis.** It is important to note that the base of the penis is enlarged, because of the presence of the **bulbocavernous muscle**. This muscle assists in the propulsion urine and seminal fluid through the urethra of the penis. Figure 4.6 illustrates the anatomy of the male reproductive system in the fetal pig. However, figure 4.7 illustrates the anatomy of the human male reproductive system.

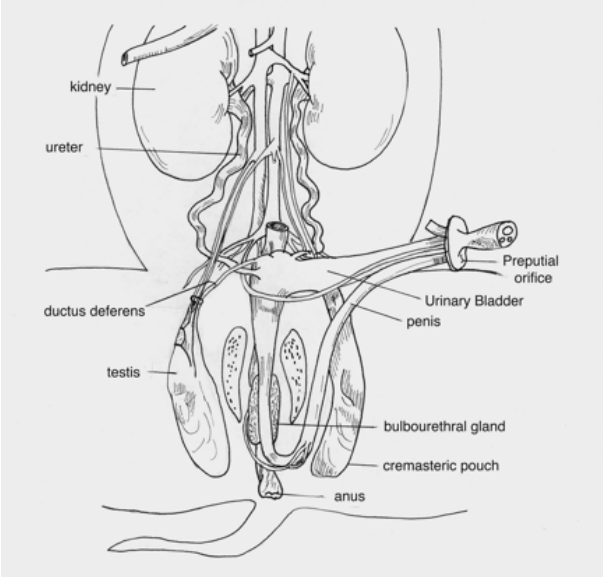


Figure 4.6

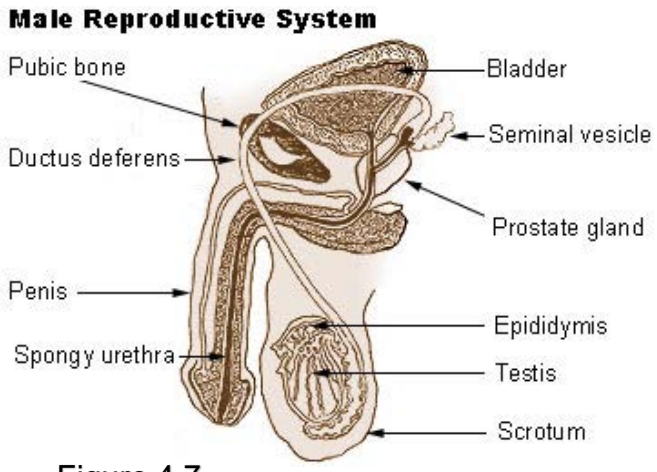


Figure 4.7

MICROSCOPIC ANATOMY OF THE TESTES

The testis is composed primarily of highly coiled **seminiferous tubules.** During the examination of a cross section of a testis, you will see cells at the periphery of the tubule wall; these cells are called **spermatogonia**, which begin to go through mitosis at the onset of puberty. The spermatogonia enlarge and move toward the lumen – these become **primary spermatocytes**. Each primary spermatocyte is diploid and subsequently will undergo the first meiotic division, forming two **secondary spermatocytes**. Each of these secondary spermatocytes divides in the second meiotic division to form two **spermatids** (they are haploid). In end, four haploid spermatids develop from a single diploid primary spermatocyte.

The spermatids will undergo transformation into a mature and motile **sperm cells**. Additionally, it is important to understand that the male hormone is **testosterone**, and is made by the **interstitial cells.** These cells present themselves in clusters in the connective tissue between seminiferous tubules. The structures described can be seen in figures 4.8 and 4.9.

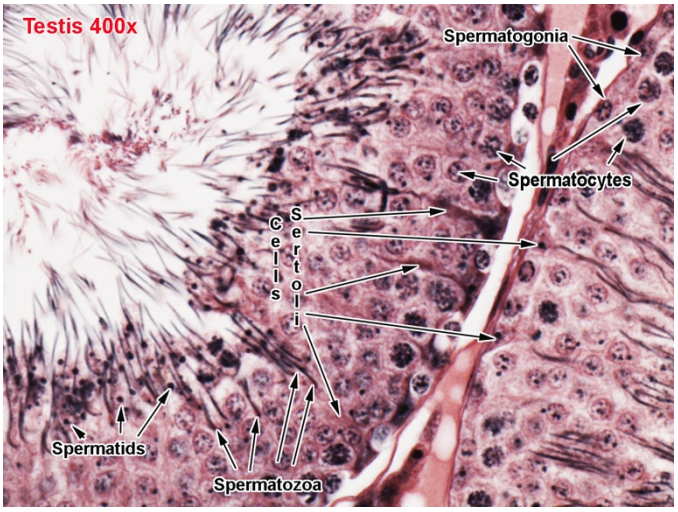


Figure 4.8

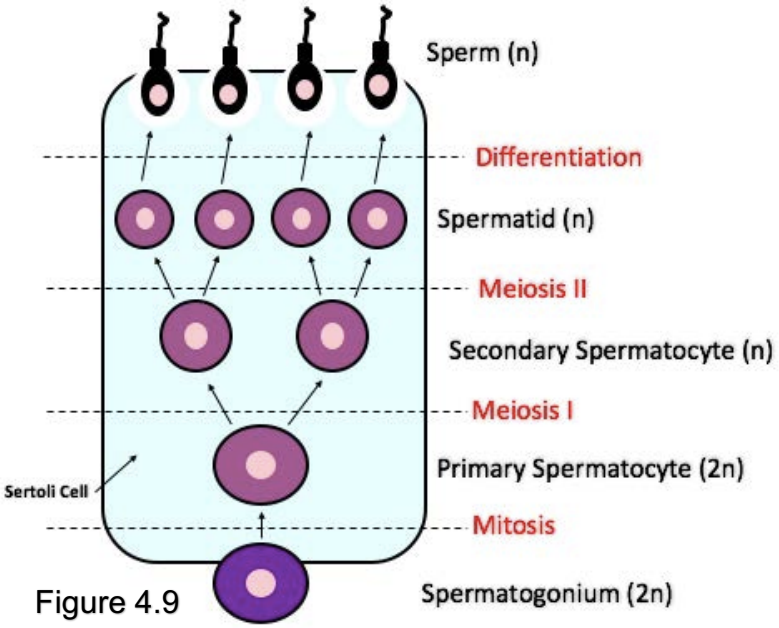


Figure 4.9

PROCEDURE (MALE SPECIMEN)

8. Locate the two scrotal sacs at the posterior end of the pig. If the pig is in the later stages of development, you will find the testes descended in each sac. If not, then the testes can be found in the abdominal cavity, because they have not yet descended into the scrotal sacs.
9. On each testis, you will find the coiled epididymis. Sperm cells that are made in the testis pass through the epididymis and into a tube called the vas deferens. The vas deferens crosses over the ureter and proceeds to enter the urethra.
10. One you are done examining the male reproductive anatomy in the fetal pig, obtain a testis microscope slide, if available. Examine the structures on the slide, and make sure to use figure 4.8 for reference.

FEMALE REPRODUCTIVE SYSTEM

One of the most important structures that compose the female reproductive system are the **ovaries**. The ovaries are paired, nodule-like organs located on the bilaterally caudal to the kidneys. A pretty visible structure, located near the body cavity wall and the ovaries, is the **uterine horn**. The horn of the uterus then narrows to form the highly convoluted **fallopian tubes,** which aid in the propulsion of the egg cell to the uterus. Fertilization takes place in the fallopian tubes. The uterine horns along with the

fallopian tubes then continue to open into the Y-shaped **body of the uterus.** The ending of the body of the uterus leads to the **cervix of the uterus**. The smoother part of the passage that lies between the cervix of the uterus and the **vaginal vestibule** (urogenital canal) is the **vagina**. The vagina will appear as a continuation of the uterus. Sperm from the male are deposited into this organ during mating. The vagina and the urethra open into a common area called the **urogenital sinus**. This cavity opens to the outside at the urogenital opening. Figure 4.10 illustrates the female urogenital anatomy of a fetal pig, while figure 4.11 illustrates the female urogenital anatomy of a human.

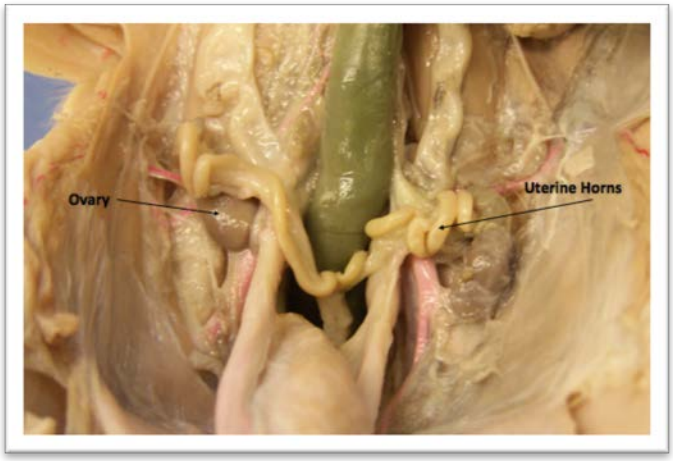


Figure 4.10

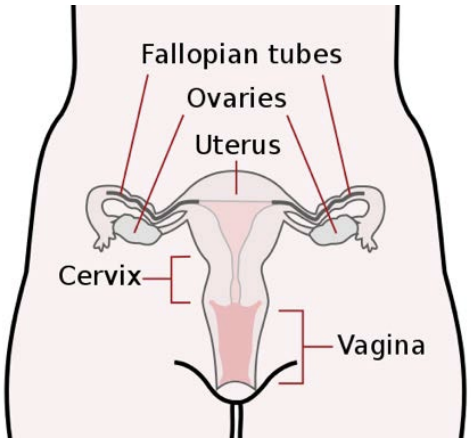


Figure 4.11

MICROSCOPIC ANATOMY OF THE OVARIES

In contrast to the testis, the ovary essentially consists of a solid mass of cells and tissues. Once you examine the ovary cross section slide, you will come across the small **ovarian medulla** in the center of the ovary, which is composed of a highly vascular, thin connective tissue. The thicker tissue, the **ovarian cortex**, consists of connective tissue that contains developing follicles with maturing egg cells. For the purposes of this lab, you need to understand these **stages in follicle formation:**

a. all follicles contain diploid oocyte, and release **estrogen**
b. **primordial follicle**, maturation stimulated by follicle stimulating hormone (FSH) ⇒
c. **primary follicle** (stimulated by FSH) ⇒
d. **secondary follicle** (stimulated by FSH) ⇒
e. **mature follicle** (not likely to be visible), oocyte has undergone first meiotic division.

Another important note: **Ovulation** is stimulated a surge in **luteinizing hormone** (LH). LH also maintains follicle after ovulation as **corpus luteum** (may be visible), which secretes **progesterone**. Progesterone is needed for the final development and the increase in vascularization of the uterine lining as the uterus prepares itself for the implantation of an embryo.

**** More of this physiology is covered in lecture. ****

PROCEDURE (FEMALE SPECIMEN)

11. In the female pig, find the two ovaries at the posterior end of the abdominal cavity. Observe the coiled Fallopian tube attached to each ovary, which carries eggs from the ovary.
12. Follow the Fallopian tube to the uterus. The uterus is dorsal to the urinary bladder and the urethra.
13. Trace the uterus to a muscular tube called the vagina.

CLEAN-UP PROCEDURE:

Clean up your materials and work area. Wrap the pig in damp paper towels and put the specimen into a plastic bag. Label your bag with your names (or come up with a group name or name for your pig), as directed by your laboratory professor. Wash all your materials thoroughly, and return your lab equipment. Sanitize your lab bench!! Thoroughly wash your hands with soap!!

Basic Vocabulary

Key vocabulary for this chapter is **bolded**. However, there are some terms that will not be discussed during the recitation portion of the chapter – these terms are simple, basic words that you should know prior to beginning the lab. You are responsible for defining these terms on your own. Though not mandatory, it is highly encouraged.

Day 1

1. **Orifice:**
2. **Vein:**
3. **Artery:**
4. **Gland:**
5. **Taxonomy:**
6. **Appendage:**
7. **Vestige:**

Day 2

8. **Respiration:**
9. **Circulation (of blood):**
10. **Thorax/Thoracic Cavity:**
11. **Cranial/Caudal (we covered this on Day 1):**
12. **Oxygenated/Deoxygenated:**
13. **Intercostal (spaces):**
14. **Lumen:**
15. **Endothelium:**

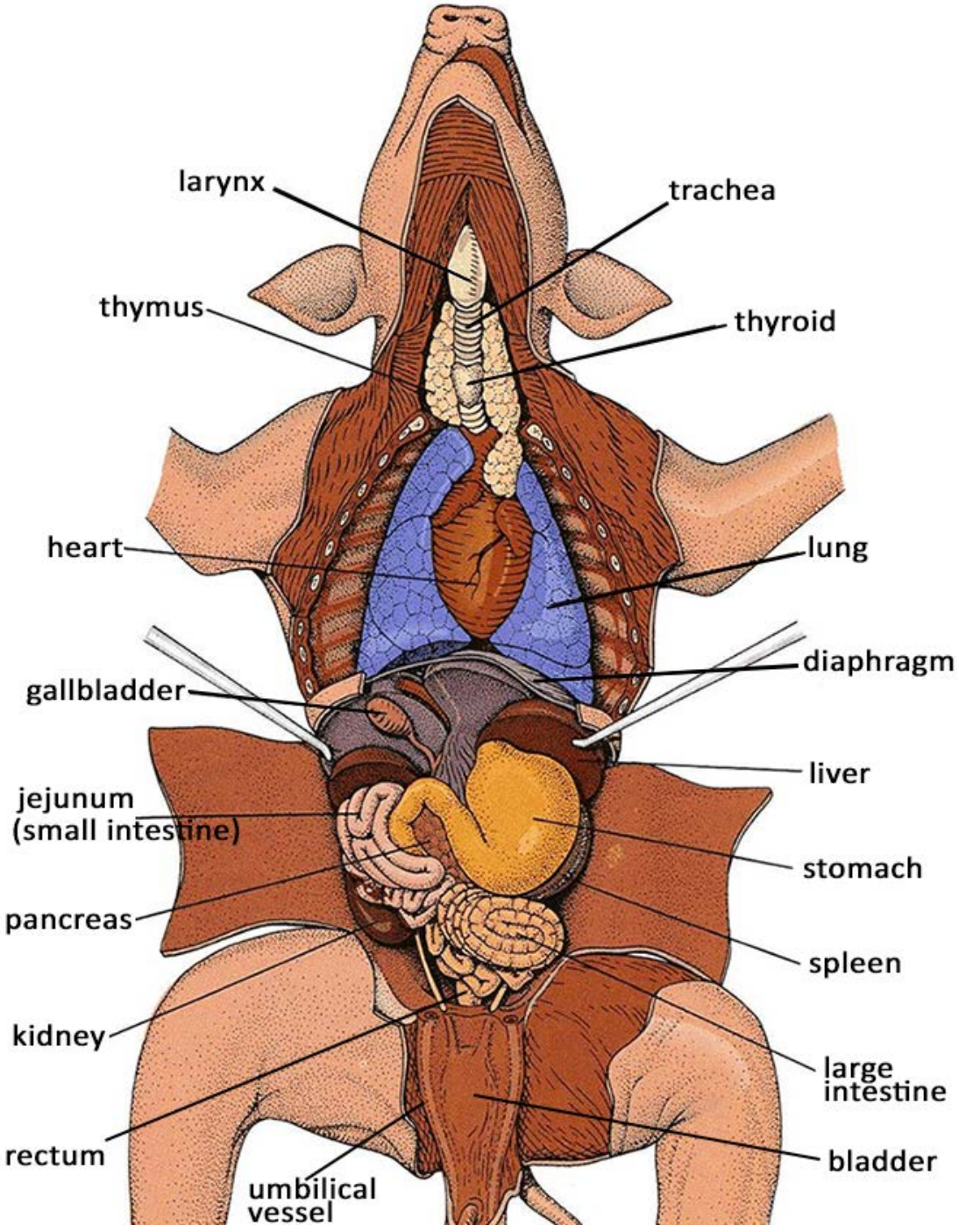
Once you begin to go over the different structures of the respiratory and circulatory systems, it is helpful to identify and define root words as they might help you understand the location, anatomy, and physiology of each structure. Below are a few root words you should familiarize yourself with. Here's a link to help you complete this assignment: https://www.dropbox.com/s/mgqfodn8aepdph7/ANATOMICAL%20WORD%20ROOTS.docx?dl=0

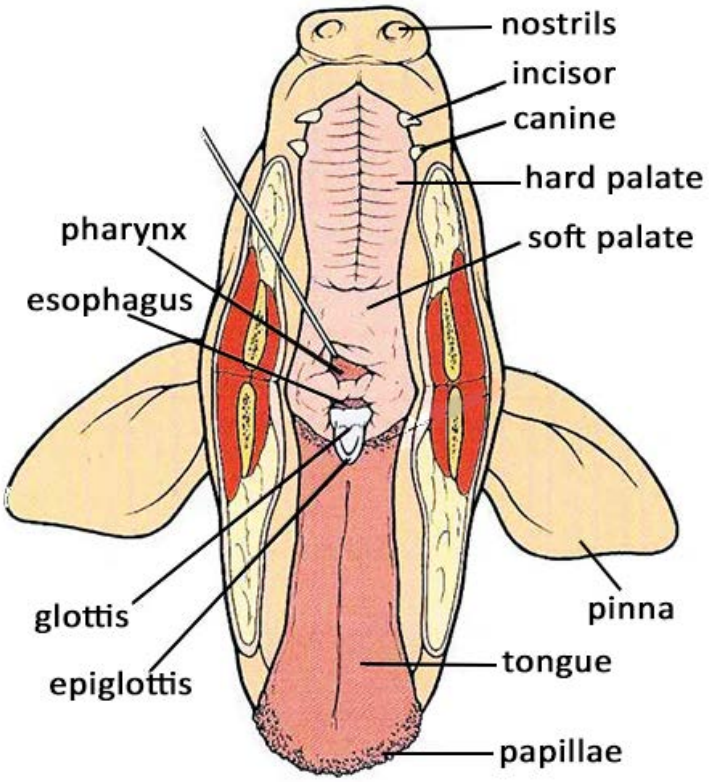
1. ***aorta:***
2. ***bronch- :***
3. ***carotid:***
4. ***ren- :***
5. ***ur - :***
6. ***atri- :***
7. ***ventr- :***
8. ***brachio- :***
9. ***clav- :***
10. ***cav- :***
11. ***duct- :***
12. ***ceph- :***
13. ***thym- :***
14. ***brachio- :***
15. ***cost- :***
16. ***coron- :***
17. ***hepa- :***
18. ***neph- :***
19. ***medull- :***

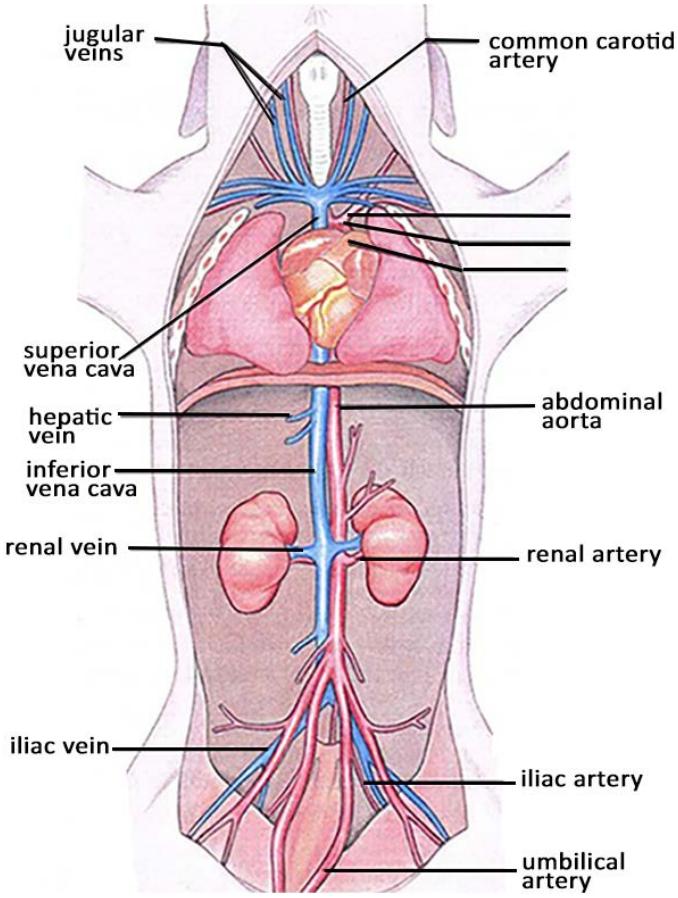
Day 3

1. **Nitrogenous Wastes:**
2. **Homeostasis:**
3. **Filtrate:**
4. **Filtration:**
5. **Sperm:**
6. **Semen:**
7. **Ejaculation:**
8. **Convoluted:**

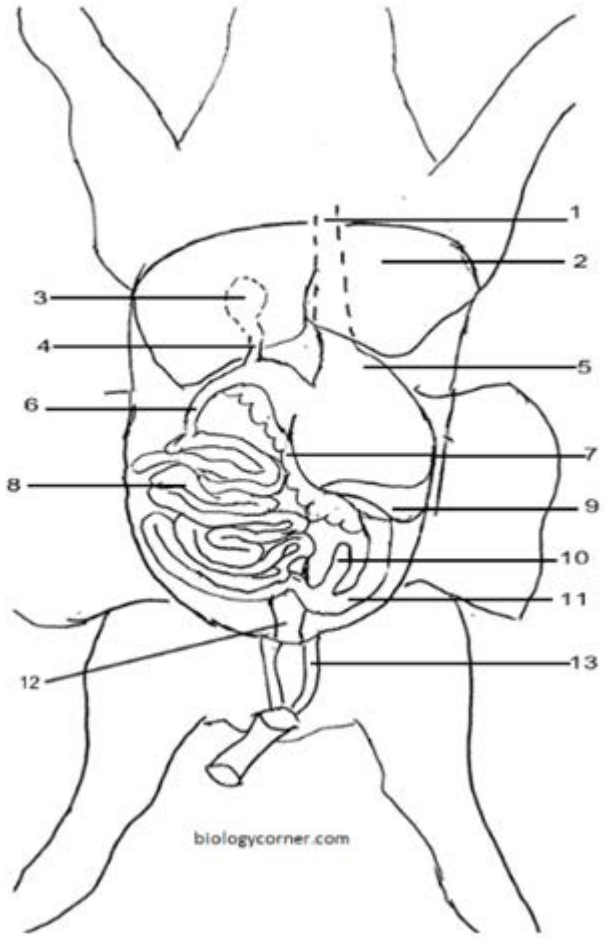
Summary


larynx
trachea
thymus
thyroid
heart
lung
diaphragm
gallbladder
liver
jejunum
(small intestine)
stomach
pancreas
spleen
kidney
large
intestine
rectum
bladder
umbilical
vessel


nostrils
incisor
canine
hard palate
soft palate
pharynx
esophagus
glottis
epiglottis
pinna
tongue
papillae


jugular veins
common carotid artery
superior vena cava
hepatic vein
abdominal aorta
inferior vena cava
renal vein
renal artery
iliac vein
iliac artery
umbilical artery

Practice Questions

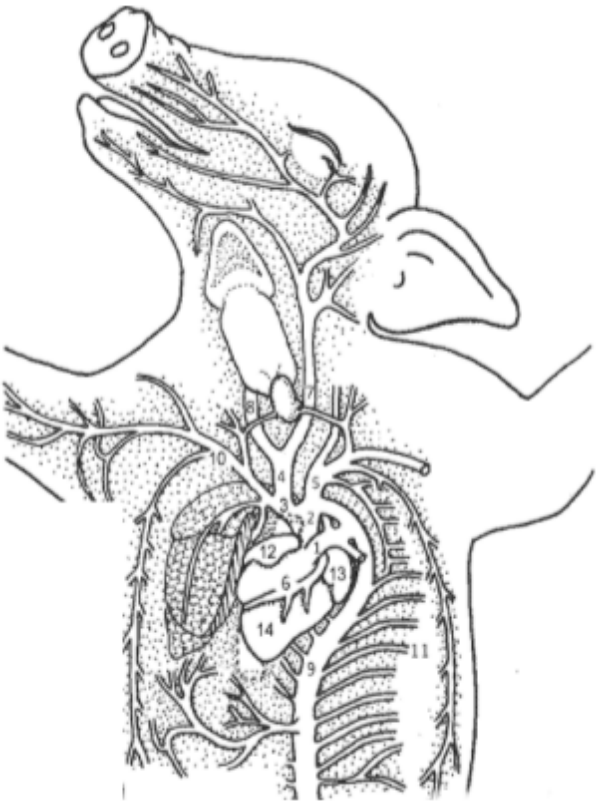


Identify the structures on the diagram.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____

Identify the organ (or structure).

14. _____ Opening (valve) between stomach and small intestine.
15. _____ Stores bile, lies underneath the liver.
16. _____ A branch of the large intestine, a dead end.
17. _____ Separates the thoracic and abdominal cavity; aids breathing.
18. _____ Membrane that holds the coils of the small intestine.
19. _____ The straight part of the small intestine just after the stomach.
20. _____ Empties bile into the duodenum from the gallbladder.
21. _____ The last stretch of the large intestine before it exits at the anus.
22. _____ Bumpy structure under the stomach; makes insulin.
23. _____ Lies between the two umbilical vessels.



Identify by number and Label on the Image

Aorta ___ Dorsal Aorta ___ Pulmonary Trunk ___ Common carotid ___ Left & Right Carotid ___
Coronary vessels ___ Left Subclavian ___ Right Subclavian ___ Right Brachiocephalic ___
Right Atrium ___ Left Atrium ___ Intercostal ___ Ventricle ___

Identify the organ (structure)

1. _____ Membrane over the heart.
2. _____ Airway from mouth to lungs.
3. _____ Blood supply to head.
4. _____ Lower heart chambers.
5. _____ Blood supply to lower body.
6. _____ Muscle to aid breathing.
7. _____ Returns blood to heart.
8. _____ Large vessel at top of heart.
9. _____ Used to make noises.
10. _____ Arteries on heart surface.