Chapter 12

The Fetal Pig Dissection

Objectives

1. Compare and contrast the anatomy of human and pig organ systems.
2. Identify the muscles of the pig back, shoulder, neck, chest, abdomen, forelimb and hindlimb.
3. Identify the major nerves of the brachial and sacral plexuses.
4. Dissect and examine the spinal cord.
5. Locate and identify the major glands of the endocrine system, and associate function with the hormone produced within each gland.
6. Identify the major arteries and veins of the pig circulatory system.
7. Identify and locate the major organs of the lymphatic, respiratory, digestive and reproductive systems.

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Each section of this lab will describe the steps required to view structures found in each of the major organ systems. It is important to keep in mind that the terminology used to describe the position and location of body parts in four-legged animals, like the pig, is slightly different than what is used for humans. First, the *anatomical position* of a four-legged animal occurs when all legs are on the ground. *Superior* refers to the back (or *dorsal*) surface and *inferior* indicates the belly (or *ventral*) surface. *Cephalic* or *anterior* refers to the front (towards the head), and *caudal* or *posterior* refers to the rear structures.

Before beginning this lab exercise, consult with your laboratory instructor as to which of the below activities you will complete as it is not always necessary or desired to complete them all.

12.1 Muscular System of the Pig

As an introduction into the pig muscular system, please note that some muscles found in four-legged animals are lacking in humans, and some muscles are fused in humans but are actually separate muscles in the four-legged animals. Despite these small differences, the muscular system of the pig is a great way to view and study the muscular system as a comparison to humans.

12.1a Safety Reminders

Read these prior to starting any dissection

1. Always wear gloves, safety glasses and lab coat as a way to protect you from the fixatives used to preserve the animal.
2. Do not throw away the fixative or specimen in the normal trash receptacle. Remaining fixative may be used to store the specimen for later use. Any part of the liquid or animal must be disposed of in the hazardous waste.
3. Be very careful with any tool used to cut open the specimen, especially the scalpel. Always point the blade and direct it away to prevent cutting yourself.

12-1 Fetal Pig Muscular System

For the examination of the muscular system, it is important to use care when removing the skin so that you do not damage the muscles. The amount that the skin is attached to the muscle for each body area varies, so the same force cannot be used for each region. For example, the skin in the abdominopelvic region is more loosely attached than in the thigh region. This is due to a layer of adipose tissue that is found between the skin and muscle in the belly area.

When removing the skin, try to remove it as a single intact piece. These pieces can be saved and used to replace on top of the muscles as a way to store and reuse the specimen. This will help to keep the body moist and muscles from drying out. You can also use damp paper towels, moistened in fixative for the same purpose. However, do not use water on the paper towel or rinse the animal as this may lead to the growth of mold.

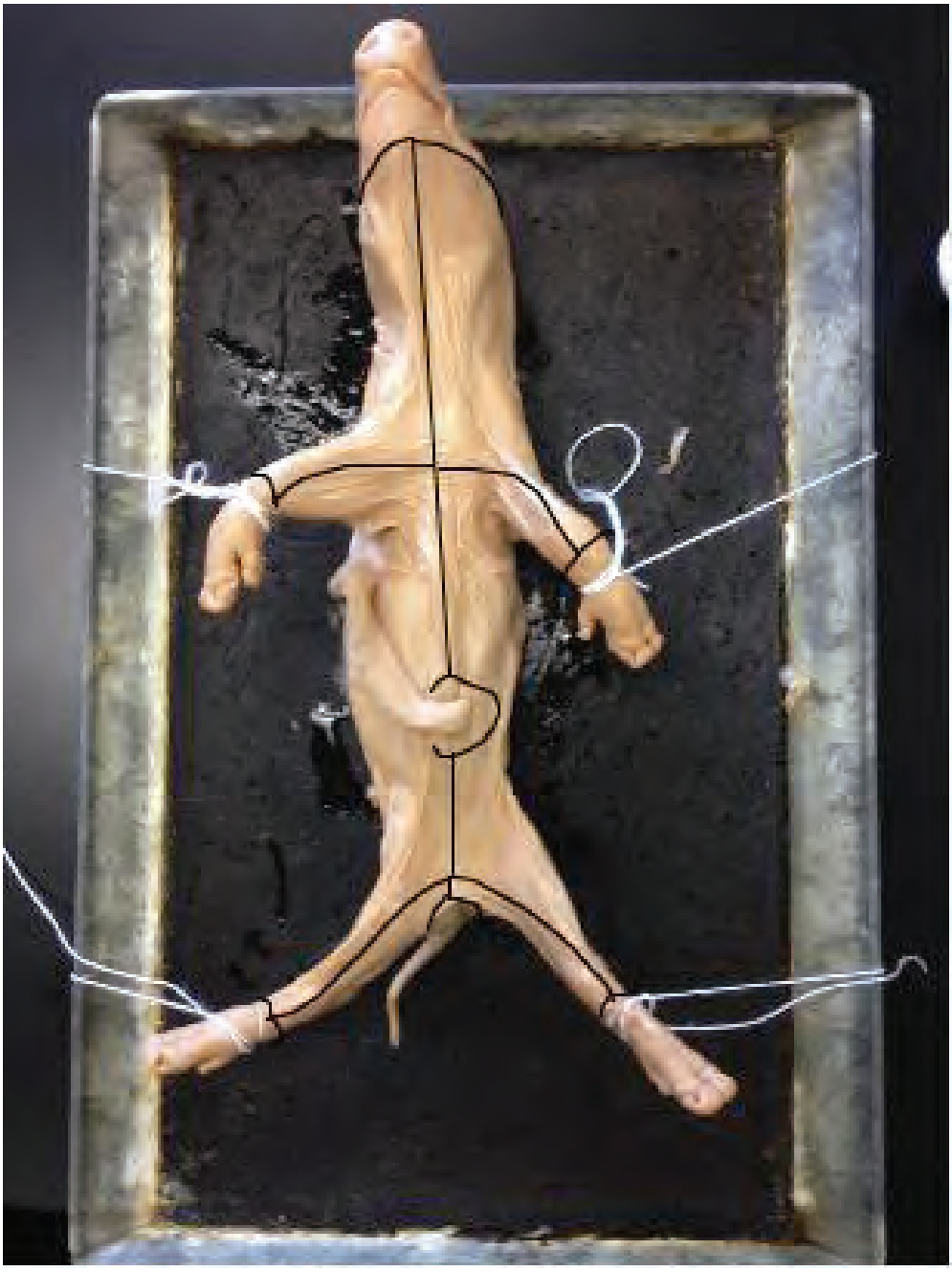
Materials: Gloves, safety glasses, lab coat, dissecting tray, dissecting tools, preserved fetal pig.

Activity 12-1a Prepping the Dissection

1. Use **Figure 12-1** as a reference for this activity. First you must determine whether your specimen is a male or female (also use **Figure 12-9** for help). In males, there is a small hole for the emergence of the penis directly posterior to the umbilical cord, whereas in females the opening for the vagina is directly anterior to the anus.

FIGURE 12-1 Preparation for the Muscular System Dissection

Specimen is positioned on the dissection tray with string. Lines indicate placement of the shallow incisions.



2. Lay the pig with its ventral side up in the dissecting tray. With a scalpel, cut a short, shallow incision on the midline of the ventral surface at the base of the neck. It is important that this cut is shallow for the skin is thin and you do not want to cut *into* the muscles, just deep to the skin.
3. Continue the incision down the abdomen. For a female pig, encircle the umbilical cord and continue onto the anus. For a male pig, partially encircle the umbilical cord and continue in two cuts towards the anus. This protects the penis.
4. On both sides of the mid-ventral incision, use your fingers or a blunt probe to gently separate as much skin as possible from the underlying muscle and connective tissue fibers.
5. With a scalpel, make a lateral incision to each wrist of the forelimbs from the ventral incision. Encircle the wrists to free the skin.
6. Similarly, make lateral incisions from midway between the umbilical cord and anus to the ankle of each hindlimb. Encircle the ankle to free the skin above the hoof.
7. Extend the midventral incision to the anterior edge of the lower jaw. Cut around the ear, cheek and mandible.
8. Use your fingers to gently free the entire skin from the underlying connective tissue. Work from the ventral surface toward the dorsal surface at the posterior of the body, and then work toward the neck. Continue working from the ventral to the dorsal surface, freeing the skin from underlying tissue and other structures. The only skin that should remain at the end of this is the skin on the head, tail and hoofs below the wrist and ankle.
9. Remove all the remaining skin from the side of the neck and up to the ear. Be careful not to sever the external jugular vein, which is the large bluish vein lying on the ventral surface of the neck. Free this vein from the underlying muscles, and clean the connective tissue from the back of the shoulder and the ventral lateral surfaces of the neck. Do not remove the connective tissue from the midline of the back; this is the origin of the trapezius muscle group.
10. Depending on the specimen, you may observe some or all of the following: thin red or blue latex-injected blood vessels, mammary glands between the skin and underlying muscle in female pigs and cutaneous nerves, which are small, white, cordlike structures extending from the muscles to the skin. Leave the skin near the external genitalia untouched as you will assess this later in the section on the reproductive system.
11. Before you begin dissection of muscles, remove the **platysma muscle** and as much hair, extraneous fat, and loose fascia as possible.

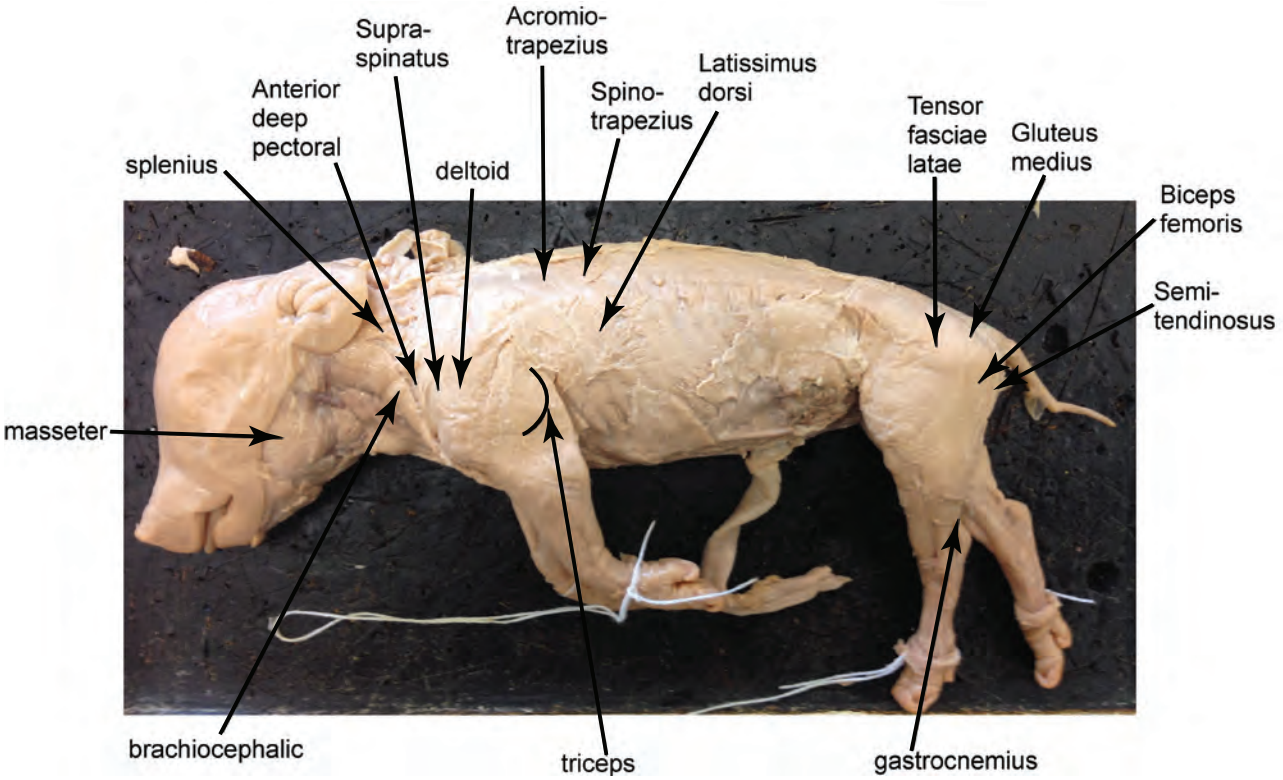
Activity 12-1b Superficial Muscles of the Back and Shoulder

Your job: Use **Figure 12-2** as a reference for each of the superficial muscles of the back and shoulder. Take a picture of your specimen. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture.

1. Locate the **trapezius muscle group**. This is found on the dorsal surface of the neck and scapula region. This is an example of a muscle group that is fused in humans and separate muscles in the pig. The posterior of these muscles is the **spinotrapezius**, originating on the spinous processes of the posterior thoracic vertebrae with an insertion on the scapular spine. Its action is to pull the scapula dorsal and caudal. Anterior to this muscle is the larger **acromiotrapezius**, a square-shaped muscle with an origin on the spinous process of the cervical and anterior thoracic vertebrae and insertion on the scapular spine. Its action is to stabilize the scapula. Finally, the **clavotrapezius** is a broad muscle found anterior to the acromiotrapezius and inserts onto the humerus.

2. Just posterior to the trapezius group is a large flat **latissimus dorsi**. This muscle's origin is on the spines of the thoracic and lumbar vertebrae and its insertion is found on the medial side of the humerus. Its action is to pull the forelimb posteriorly and dorsally. Just lateral to the trapezius group is the **deltoid**, a thin muscle that works to raise the humerus. (**Figure 12-2**)

FIGURE 12-2 Superficial Muscles of the Back and Shoulder, Lateral View

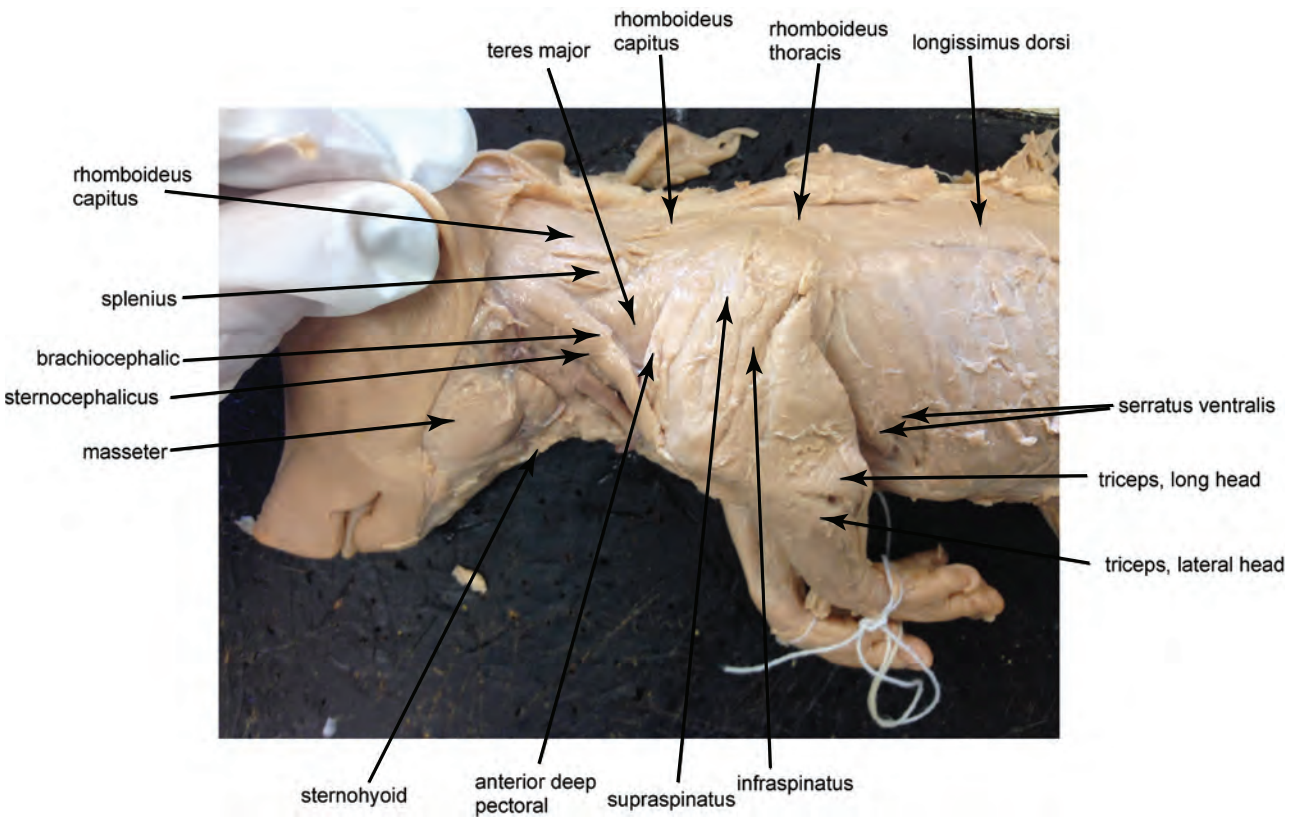


Activity 12-1c Deep Muscles of the Back and Shoulder

Your job: Use **Figure 12-3** as a reference for each of the deep muscles of the back and shoulder. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen after exposing the deeper muscles.

1. On the left side of the pig, carefully cut the three muscles of the trapezius group and latissimus dorsi to start exposing the deeper muscles of the shoulder and back. Pull back these cut muscles and reveal the underlying muscles.
2. Deep to the acromiotrapezius is the **supraspinatus**, which is found on the lateral side of the scapula in the supraspinous fossa. Its origin is on the scapula and insertion is the humerus, which works to extend the humerus. Also on the lateral surface of the scapula is the **infraspinatus**, found within the infraspinous fossa. This muscle originates on the scapula and inserts on the humerus. Contraction of this muscle rotates the humerus laterally. Finally, the **teres major** is found on the axillary border of the scapula, with the origin on this border and insertion on the proximal end of the humerus. Contraction causes rotation and posterior movement of the humerus.

FIGURE 12-3 Deep Muscles of the Back and Shoulder, Lateral View



3. A group of muscles called the **rhomboideus group**, connects the spinous processes of the cervical and thoracic vertebrae with the vertebral border of the scapula. As a group, these muscles stabilize the dorsal part of the scapula to the body. The posterior muscle of this group is the **rhomboideus thoracis**, a fan-shaped muscle originating on the spinous processes of the posterior cervical and anterior thoracic vertebrae and inserting on the dorsal posterior angle of the scapula. This muscle draws the scapula dorsally and anteriorly. Anteriorly to this, the **rhomboideus cervicus** originates on the spines of the posterior cervical and anterior thoracic vertebrae and inserts along the vertebral border of the scapula. This works to bring the scapula forward and dorsal. Finally, the **rhomboideus capitus** is the most anterior and lateral muscle of the group. It originates on the spinous nuchal line and inserts on the vertebral border of the scapula, working to elevate and rotate the scapula. (This last muscle is not found in humans.)
4. Next, find the **splenius**, a broad, flat, and thin muscle that covers a large portion of the lateral surface of the cervical and thoracic vertebrae, and deep to the rhomboideus capitus. The origin of this muscle is on the spine of the thoracic vertebrae and the insertion is on the superior nuchal line of the skull, acting to both turn and raise the head.
5. Fold back the *latissiumus dorsi* and *trapezius muscles* that were cut previously. On the lateral surface of the thoracic wall, ventral to the scapula is the large fan-shaped **serratus ventralis**, with its many origins on the ribs. The muscle passes ventrally to the scapula and inserts on the vertebral border of the scapula. This pulls the scapula forward and ventral, homologous to the human serratus anterior.

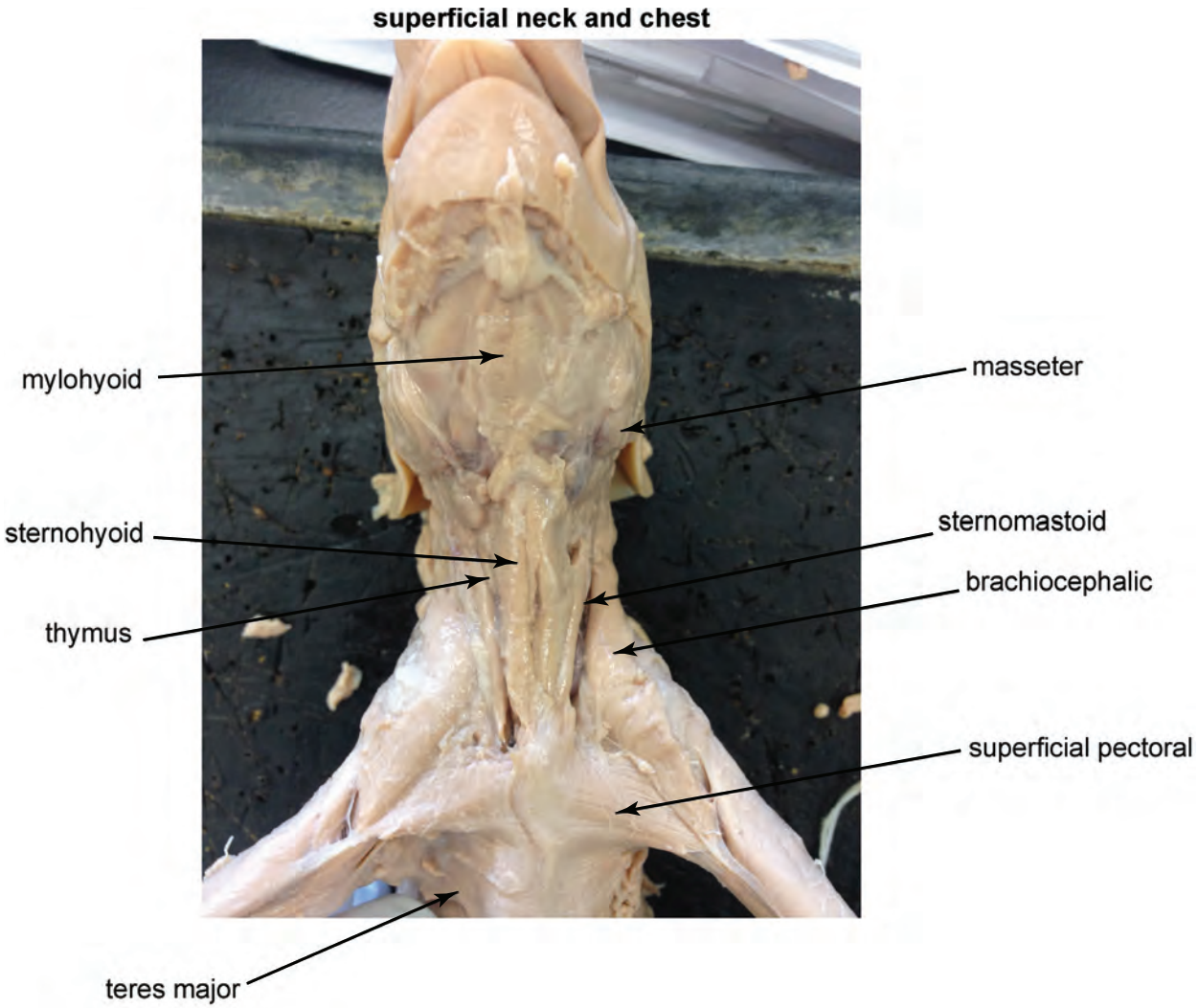
6. Medial to the above is the **serratus dorsalis**, with its origin along the dorsal cervical, thoracic and lumbar regions and insertion on the ribs. This muscle pulls the ribs outward.
7. Finally, locate the **intercostals**, both external and internal. The **external intercostals** are deep to the external oblique, and its fibers run obliquely from their origin on the caudal border of one rib to insert in the cranial anterior boarder of the next rib, lifting the ribs during inspiration. The **internal intercostals** are deep to the external intercostals. To access these, you must cut through one external intercostal. The fibers of the intercostals run at oblique angles to each other, with the internal running medial to lateral. The origin of the internals is on the superior border of a rib and insert on the inferior border of the rib above it. These pull the ribs together during forceful or active breathing.

Activity 12-1d The Muscles of the Neck

Your job: Use **Figure 12-4** as a reference for each muscle of the neck. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen.

FIGURE 12-4 Muscles of the Neck and Chest

Superficial a) and deep b) muscles of the neck and chest



a)

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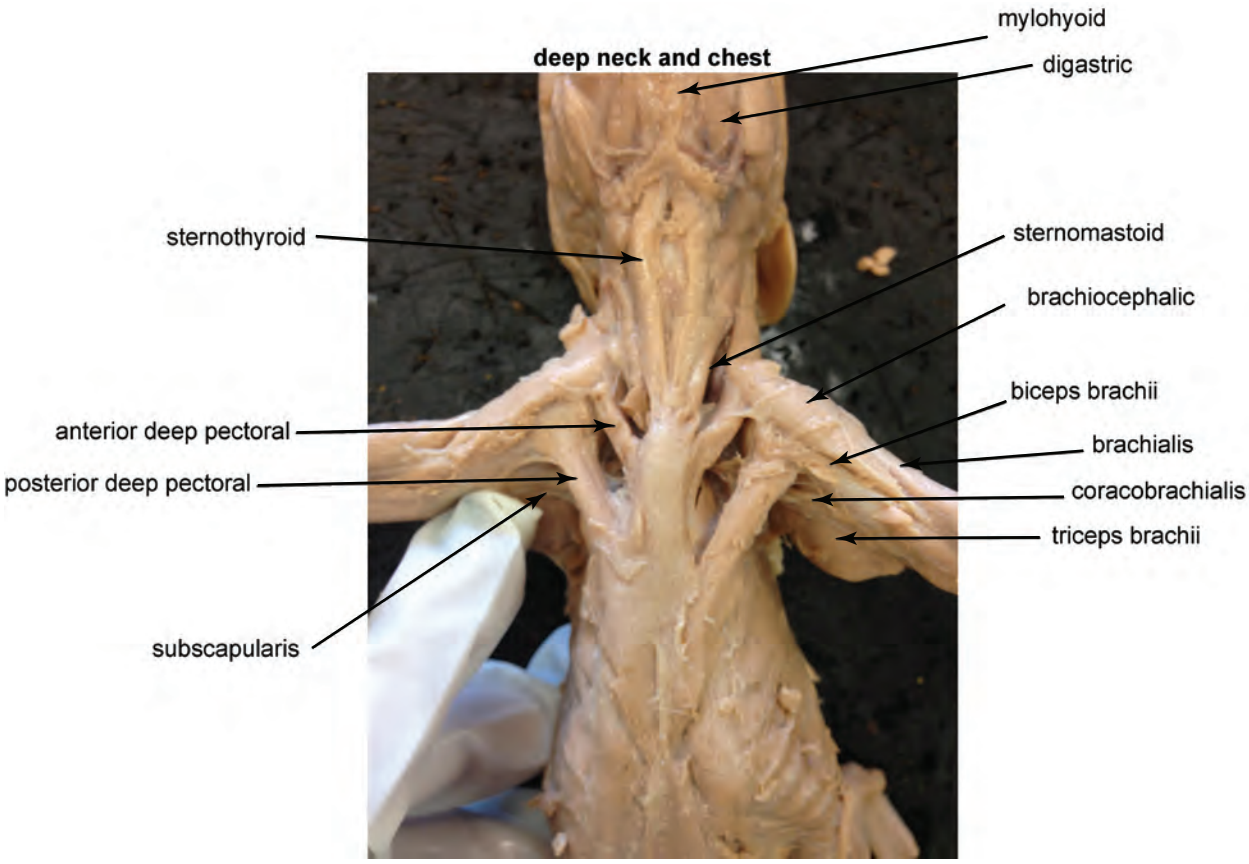
FIGURE 12-4 Muscles of the Neck and Chest *(continued)*



b)

Work carefully on this section, as the muscles of the neck in the fetal pig are delicate and easy to tear or damage. Use the blunt probe from your dissection kit to separate the skin from the underlying muscles.

1. First, the **sternomastoid**, (homologous to the sternocleidomastoid in humans) is a large V-shaped muscle between the sternum and head. Its origin is on the manubrium of the sternum and insertion on the superior nuchal line as well as on the mastoid process of the cranial bones. Its action is to turn and depress the head.
2. The **sternohyoid** is a narrow muscle lying over the larynx and along the mid-ventral line of the neck. Originating on the costal cartilage of the first rib and inserting on the hyoid bone, this muscle depresses the hyoid bone.
3. The **sternothyroid** is the most medial of the throat muscles. It is not as smooth as the other two, with slight ridges. This originates from the manubrium and inserts on the thyroid cartilage (or Adam's apple) of the pig. This muscle depresses the larynx.

4. The **digastric** is a superficial muscle, extending along the inner surface of the mandible. Its origin is on the occipital bone and mastoid process, and works to depress the mandible.
5. Next, the **mylohyoid** is another superficial muscle that passes transversely in the midline and deep to the digastrics. Its origin is on the mandible and insertion on the hyoid bone, working to raise the floor of the mouth.
6. Finally, the **masseter** is a large muscle found anteroventral to the parotid gland at the angle of the jaw. This is a cheek muscle that originates on the zygomatic bone and inserts on the posterolateral surface of the mandible, elevating it.

Activity 12-1e The Muscles of the Chest

The chest muscles in the fetal pig are similar to those found in humans. If you are planning to use your specimen to observe other organ systems, use care when folding back and cutting these muscles, so as to not damage the deeper blood vessels or organs.

Your job: Use **Figure 12-4** as a reference for each muscles of the chest. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen.

1. First, the **pectoralis group** of muscles covers the ventral surface of the chest. These arise primarily from the sternum and attach to the humerus. In the pig, there are 3 muscles in this group, while in humans only 2. In the pig, these muscles are harder to dissect or pull apart easily. The **superficial pectoral** (not found in humans) is a thin band of muscle crossing the base of the neck to the humerus. Its origin is on the upper sternum and inserts on fascia of the forelimb. It works to adduct the forelimb.
2. Second, the broad triangular **posterior deep pectoralis major** is inferior to the superficial pectoral. Its origin is also on the sternum and insertion on the posterior humerus, working to adduct the forelimb.
3. Finally, the **anterior deep pectoralis minor** is deep to the superficial pectoral, and is a thin strap of muscle. It extends posteriorly to the pectoralis major, originating on the sternum and inserting near the proximal end of the humerus, also adducting the forelimb.

Activity 12-1f The Muscles of the Abdomen

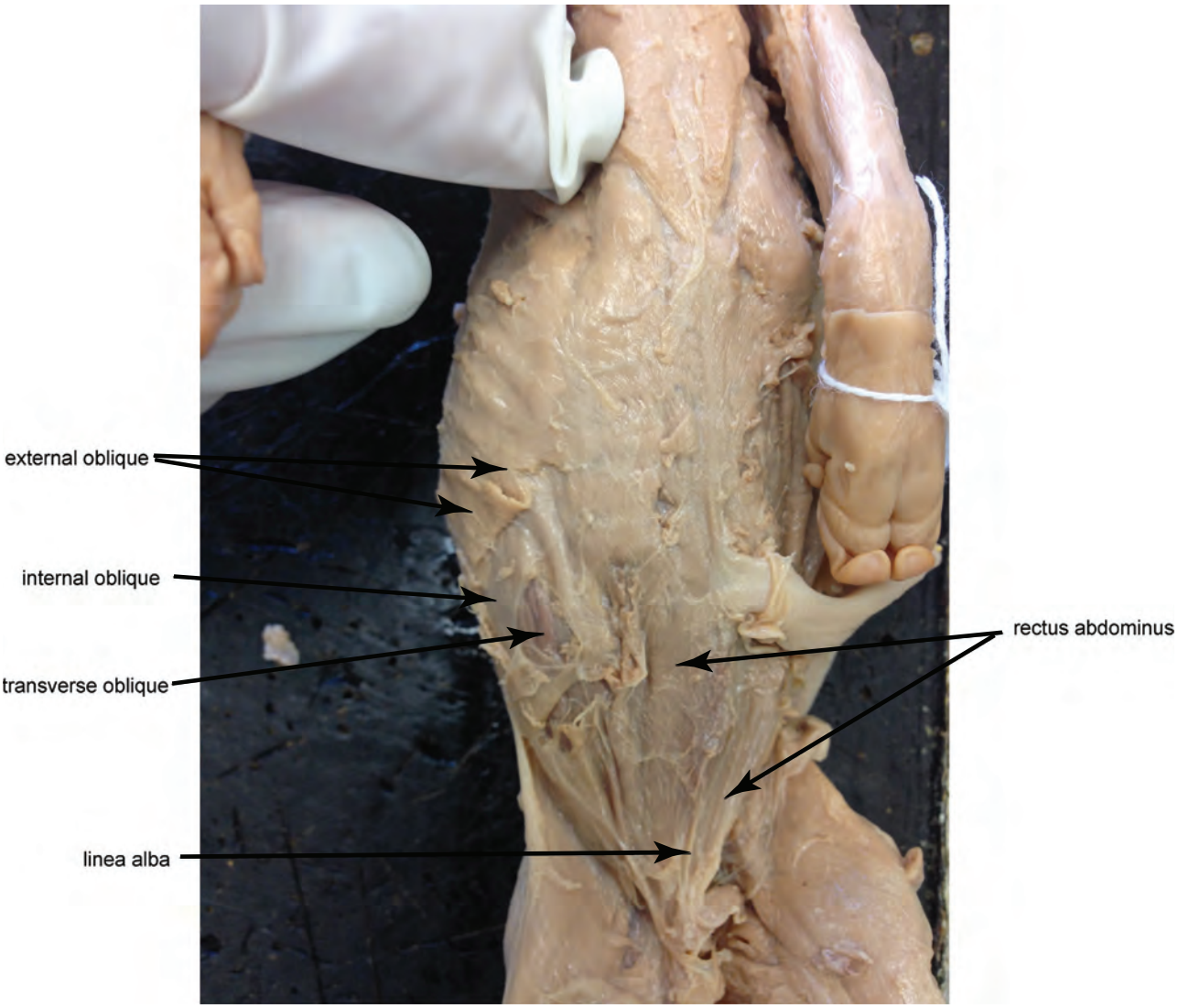
There are three layers of muscle that forms the lateral wall of the abdomen, and a fourth muscle forms the ventral surface of the wall. The three layers on the lateral wall are very thin, so work carefully as you separate them. These muscles together work to compress the abdomen.

Your Job: Use **Figure 12-5** as a reference for each muscles of the abdomen. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen.

1. Starting on the lateral muscles, the **external oblique** is the most superficial of the three. Its origin is on the posterior ribs and lumbodorsal fascia, and its insertion is on the linea alba from the sternum to pubis. Its fibers run anterodorsal to posteroventral.
2. Second, the **internal oblique**, just deep to the external oblique, contains fibers that run perpendicular to those of the external, posterodorsal to anteroventral. This muscle originates on the pelvis and lumbodorsal fascia and inserts on the linea alba.
3. The deepest of the three muscles on the lateral surface is the **transverse abdominis**, and its fibers run transversely across the abdomen. Its origin is on the posterior ribs and inserts on the linea alba, acting to compress the abdomen.

4. Finally, the **rectus abdominis** is the muscle in which all the lateral muscles insert. It is a long, ribbon-like muscle in the midline of the ventral surface of the abdomen, originating on the pubic symphysis and inserting on the costal cartilage, compressing the internal organs of the abdomen.

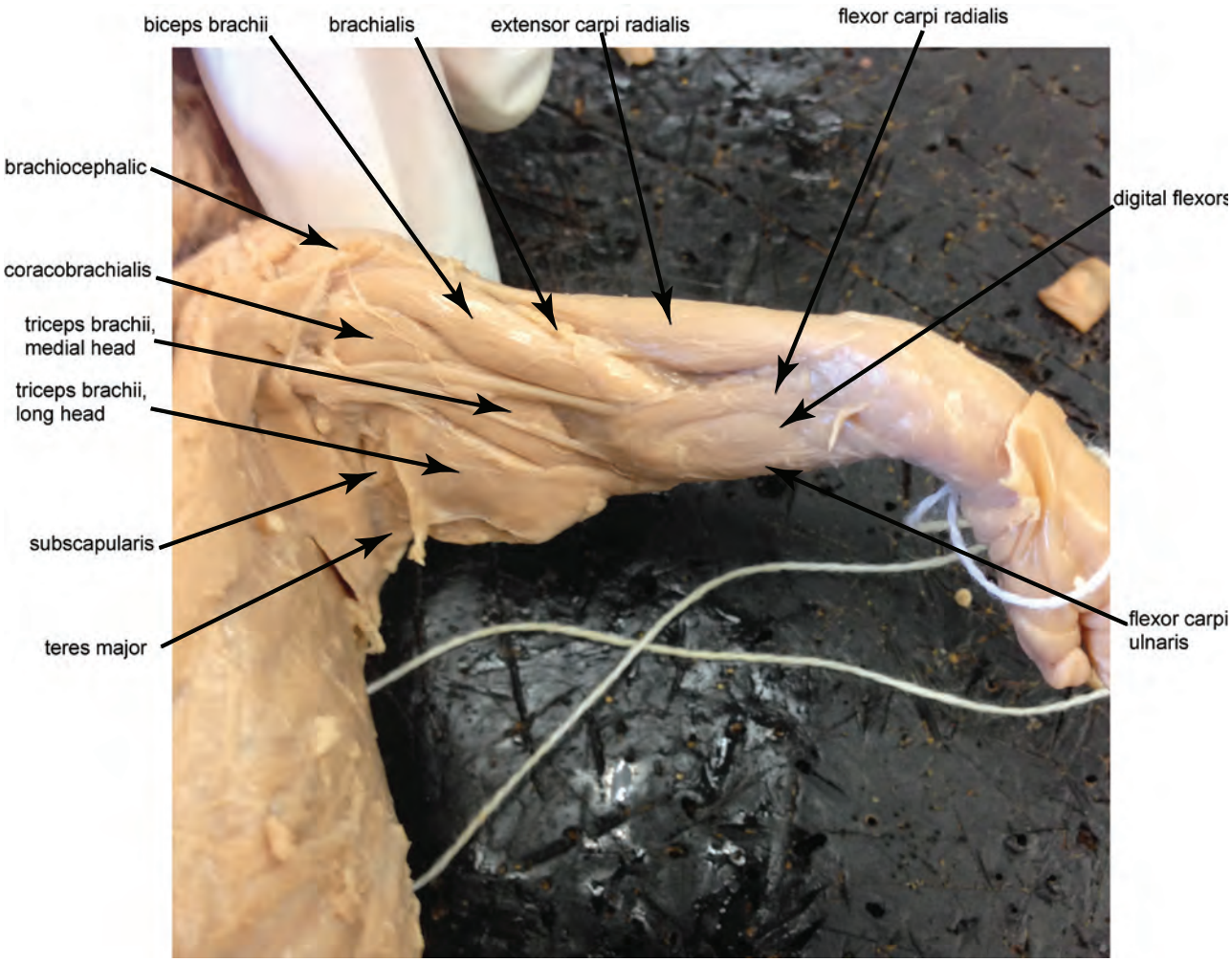
FIGURE 12-5 Abdominal Muscles



Activity 12-19 The Muscles of the Forelimb

Your Job: The muscles found on the forelimb of the fetal pig are also similar to what is found in humans' upper limb. Use **Figure 12-4** and **Figure 12-6** as references for these muscles. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen.

FIGURE 12-6 Muscles of the Forelimb



1. First, the **triceps brachii** is the largest of the superficial muscles found in the forelimb. It has three places of origin, leading to three heads. Removing the fascia reveals these three origins. The long head is a large muscle mass on the posterior surface and originates on the lateral border of the scapula. Next to this on the lateral surface, the lateral head originates on the deltoid ridge of the humerus. Finally, the small head lies deep to the lateral head, originating on the shaft of the humerus. All three heads insert at the same location, on the olecranon of the ulna, acting to extend the forelimb.
2. Next, the **brachialis**, found on the ventrolateral surface of the humerus, originates on the lateral side of the humerus and inserts on the proximal end of the ulna. This muscle acts to flex the forelimb.
3. The **biceps brachii**, a convex muscle, is found on the interior surface to the pectoralis major and minor, on the ventromedial surface of the humerus. It originates on the scapula and inserts on the radial tuberosity near the proximal end of the radius, flexing the forelimb.

4. A ribbon-like **brachioradialis** muscle is found on the lateral surface of the humerus. Its origin is on the mid-dorsal border of the humerus and inserts on the distal end of the radius, working to flex the forelimb.
5. On the lateral surface of the forelimb are bands of extensor muscles of the foot and digits (or hoof). Focusing on the lower forelimb (and use **Figure 12-6** for help) locate the **extensor carpi radialis**, **extensor carpi ulnaris** and the **extensor digitorum lateralis** (if possible). These originate on the distal humerus and proximal ulna, and insert on the metacarpals.
6. The **flexor carpi radialis**, is located next to the pronator teres, originating on the distal end of the humerus and inserting on the second and third metacarpal, acting to flex the wrist.
7. The **palmaris longus** is a large flat muscle in the center of the medial surface of the forelimb. Its origin is on the medial epicondyle of the humerus and inserts on the digits, flexing the digits.
8. Finally, the **flexor carpi ulnaris**, is a flat muscle on the posterior edge of the forelimb, arising from two origins, on the medial epicondyle of the humerus and on the olecranon process, and inserting on the ulnar side of the carpals, flexing the wrist.

Activity 12-1h The Muscles of the Hindlimb: Thigh

In four legged animals, the leg, or hindlimb, appears different from the human leg. For example, the metatarsals in the arch of the foot of the pig are longer than in humans, making the ankle very high, appearing as the knee joint instead of the ankle. Prior to beginning this section, run your hand on the pig's pelvis and slide your hand onto the thigh, locating the distal knee joint, then the ankle.

Your Job: Use **Figure 12-7** as a reference for each muscle of the hindlimb. Locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen.

1. First, the **sartorius**, is a wide, superficial muscle covering the anterior half of the medial aspect of the thigh, originating on the ilium and inserting on the tibia. This muscle functions to adduct and rotate the femur as well as extending the tibia.
2. The **gracialis** is a broad muscle, covering the posterior portion of the medial aspect of the thigh. This muscle originates on the ischium and pubic symphysis and inserts on the medial surface of the tibia, adducting the thigh and drawing it posteriorly.
3. The **tensor fasciae latae** is a triangular muscle found posteriorly to the sartorius. This originates on the crest of the ilium and inserts into a broad tendon that extends the thigh.
4. Posterior to this is the **gluteus medius**, the largest of the gluteal muscles. This originates on both the ilium and transverse processes of the last sacral and first caudal vertebrae. The muscle inserts into the femur and abducts the thigh. Just posterior to this is the **gluteus maximus**, a smaller triangular hip muscle, originating on the transverse processes of the last sacral and first caudal vertebrae and inserting on the proximal femur. This also abducts the thigh.
5. The **adductor magnus** is a large triangular muscle, originating on the ischium and pubis, and inserting on the femur, adducting the thigh. (This muscle is split in humans into the adductor femoris and adductor longus.) The **pectineus** is anterior to the adductor magnus. This is a deep, small muscle posterior to the femoral artery and vein. It originates on the anterior border of the pubis and inserts on the proximal end of the femur, working to adduct the thigh.

6. There are several muscles in the **hamstring** group, all working to flex the hindlimb. First, the **biceps femoris**, is a large broad muscle covering most of the lateral region of the thigh. It originates on the ischial tuberosity and inserts on the tibia. In addition to flexing the hindlimb, it also abducts the thigh. Second, the **semitendinosus** is visible under the posterior portion of the biceps femoris. Its belly is a uniform strap from its origin on the ischial tuberosity to the insertion on the medial side of the tibia. The **semimembranosus** is a large muscle found medial to the semitendinosus. In order to view this on the anteromedial view, cut the semitendinosus. This originates on the ischium and inserts on the medial epicondyle of the femur as well as on the medial surface of the tibia, extending the thigh.
7. There are four large muscles of the **quadriceps femoris group**, covering about a half of the surface of the thigh, extending the leg. Cut through the sartorius and free the borders of the tensor fasciae latae. Fold this back and observe the muscles of the quadriceps that converge onto the patella. The large fleshy muscle on the anterolateral surface is the **vastus lateralis**. Its origin is along the length of the lateral surface of the femur. The **vastus medialis** is found on the medial surface of the femur, under the sartorius. Its origin is on the shaft of the femur and inserts on the patellar ligament. The **rectus femoris** is the small cylindrical muscle between the above medialis and lateral muscles. In pigs, this originates on the femur. Finally, the **vastus intermedius** is found deep to the femoris. Cut through the rectus femoris to expose this, originating on the shaft of the femur.

FIGURE 12-7 Muscles

Medial a) superficial lateral b) and deep lateral hindlimb c) muscles

a)

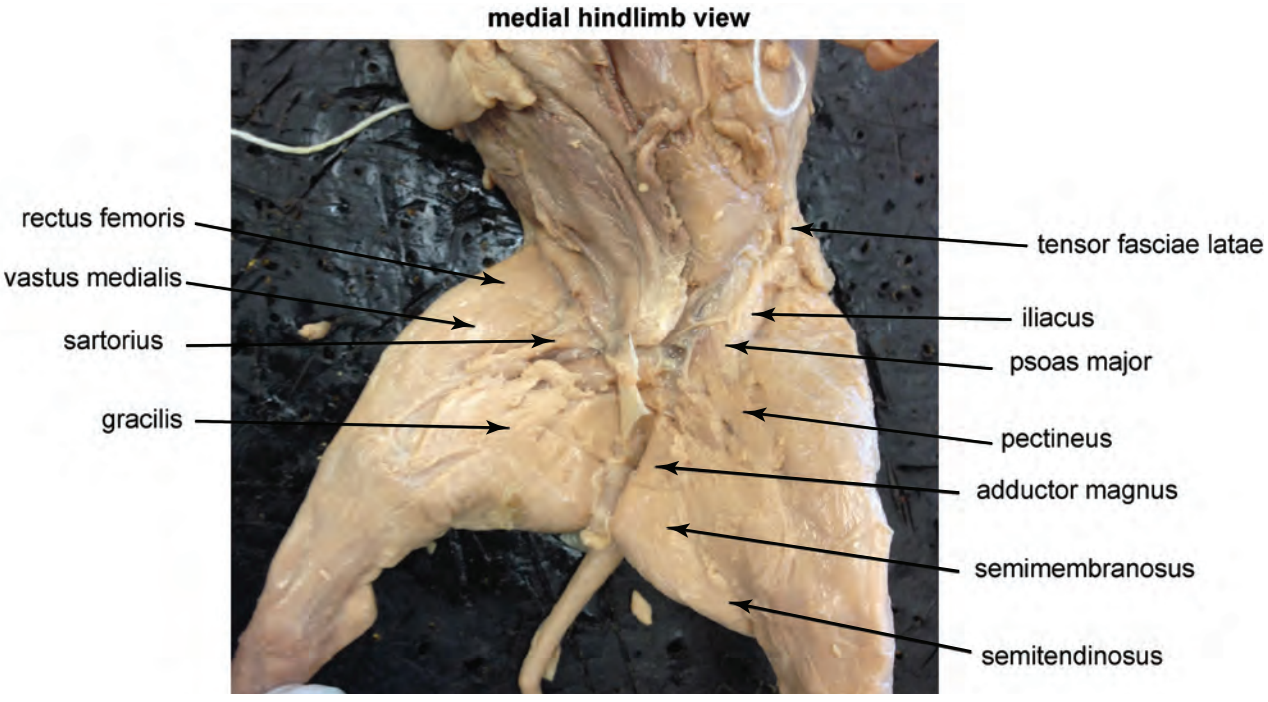


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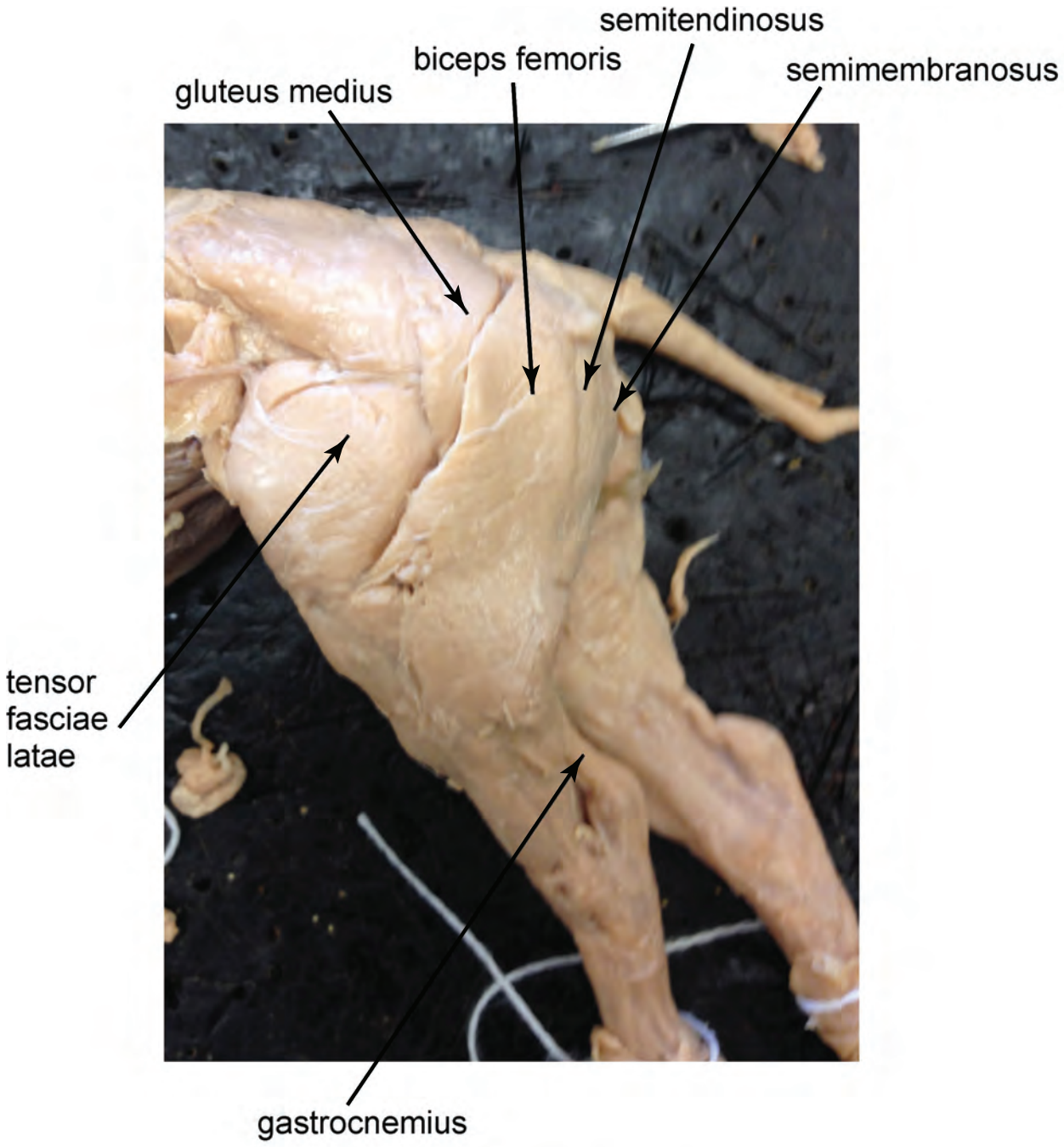
FIGURE 12-7 Muscles *(continued)*



b) **lateral hindlimb, superficial**

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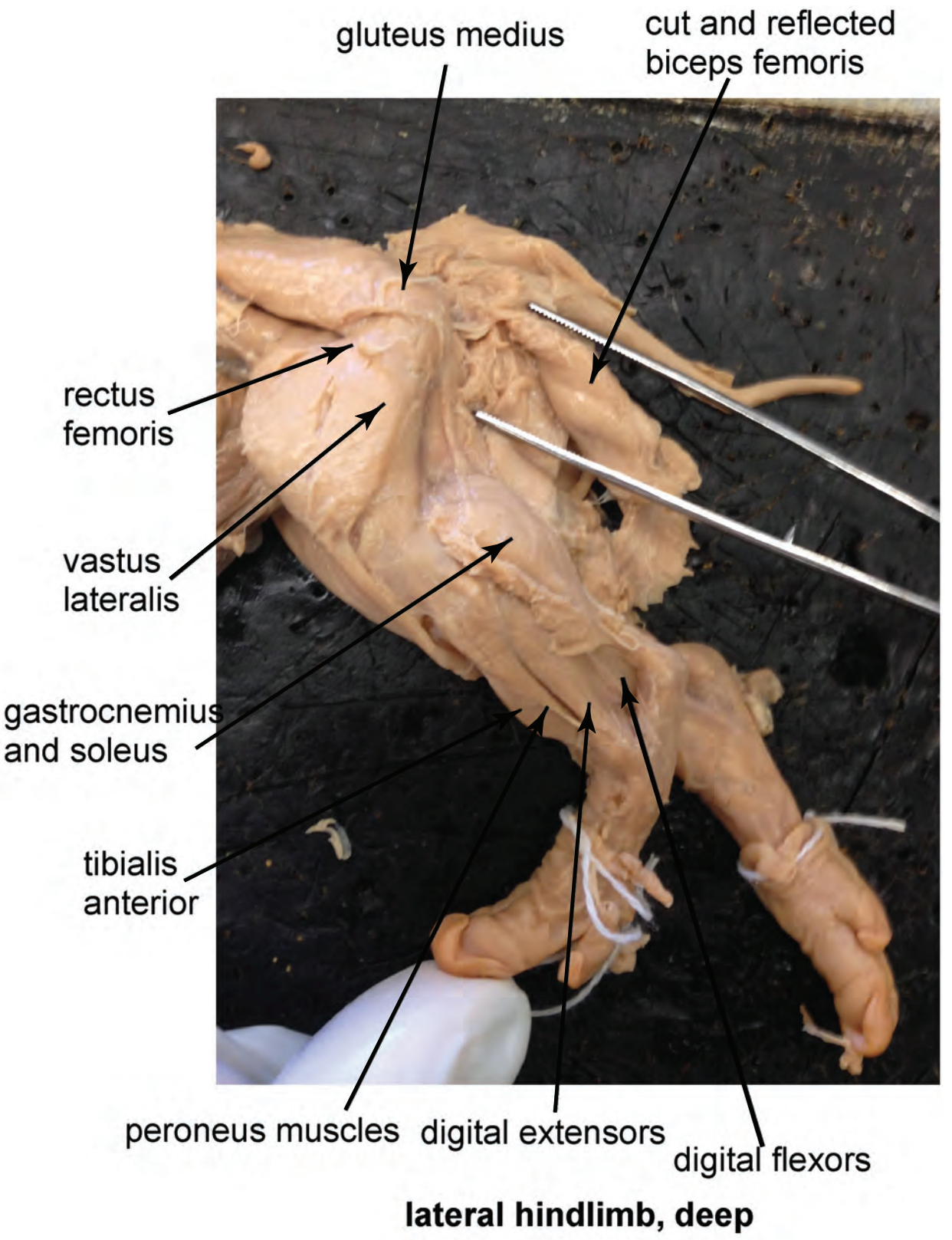
FIGURE 12-7 Muscles *(continued)*



c)

Activity 12-1i The Muscles of the Hindlimb: The Leg

In four legged animals, the inferior hindlimb is similar to the calf of humans. Use **Figure 12-7** again as a reference for each muscle of the inferior hindlimb.

Your job: Using **Figure 12-7**, locate each of the **boldfaced** muscles here in your specimen and label them on the picture you take of your specimen.

1. The **gastrocnemius** is the calf muscle found on the posterior hindlimb. Its two heads of origin are medial on the knee's fascia and lateral on the distal end of the femur. The two bellies then unite at the calcaneal tendon, and insert on the calcaneus, extending or pointing the foot. Deep to this and visible on the lateral surface is the **soleus**, originating on the fibula and inserting on the calcaneus, also extending the foot.
2. The **flexor digitorum longus** is found between the gastrocnemius and tibia. Its two heads originate on the distal end of the tibia and on the head and shaft of the fibula. It inserts at four tendons onto the bases of the terminal phalanges, acting to flex the digits. On the anterolateral border of the tibia, the **extensor digitorum longus** originates on the lateral epicondyle of the femur and inserts by long tendons on the digits, extending the digits.
3. The **tibialis anterior** is found on the anterior surface of the tibia. It originates on the proximal ends of the tibia and fibula, and inserts on the first metacarpal, flexing the foot.
4. The **fibularis group**, or **peroneus muscles**, contains three muscles deep to the soleus on the posterior and lateral surfaces. The **fibularis brevis** lies deep to the tendon of the soleus, originating from the distal portion of the fibula and inserting on the base of the fifth metatarsal, extending the foot. The **fibularis longus**, a long thin muscle, lies of the lateral surface of the hindlimb, originating on the proximal portion of the fibula and inserting at the base of the metatarsals, flexing the foot. Finally, the **fibularis tertius** originates on the fibula and inserts on the fifth metatarsal, extending the fifth digit and flexing the foot.

12.2 Nervous System of the Pig

The nervous system of the pig is similar to that of the human. Thus, they have 38–40 pairs of spinal nerves leaving the segments of the spinal cord (humans have 31), though the pig nerves are often difficult to distinguish individually. Here, you will learn to identify the major nerves of the brachial and sacral plexuses, as well as examine a dissected spinal cord. You can use the same specimen used for the examination of the muscular system if desired or start with an unopened specimen.

12-2 Nervous System of the Pig

Materials: gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string, preserved fetal pig (new or saved from the previous activity)

Activity 12-2a The Brachial Plexus

The brachial plexus can be viewed with a dissection of the chest and forelimb. It is a network of nerves that arise from cervical nerves 6–8 and thoracic nerve 1, and innervates the muscles and structures of the forelimb and some of the thoracic wall. For this dissection, it is important to remember that nerves are extremely delicate and can easily be torn.

Your job: Locate each of the **boldfaced** nerves here in your specimen and label them on the picture you take of your specimen.

1. Lay the pig ventral side up in the dissecting tray, and spread its limbs out. Tie each limb apart by passing a piece of string under the tray and using it to tie both forelimbs and another string to tie both hindlimbs.
2. Fold back the pectoralis muscle that you exposed previously, and look for the blood vessels in the axilla. Some pigs have latex paint injected into their vessels, red for arteries; blue for veins.
3. Carefully remove any fat or other extraneous tissue from around the vessels.
4. Look for the largest nerve of the brachial plexus, the **radial nerve**, which lies dorsal to the axillary artery. This nerve innervates the triceps brachii and other dorsal muscles. Follow the nerve from its medial location towards the triceps muscle.
5. Next, the **musculocutaneous nerve**, found superiorly to the radial nerve, innervates the coracobrachialis and biceps brachii muscles of the ventral forelimb, as well as the skin in this area.
6. Look for the **median nerve**, which should follow the brachial artery into the ventral forelimb, and innervates the muscles of the ventral antebrachium of the forelimb.
7. Finally, the most posterior of this plexus is the **ulnar nerve**, often found isolated from the others. Follow the path of this nerve down the brachium to the elbow where it innervates muscles of the antebrachium.

Activity 12-2b The Sacral Plexus

Moving into the hindlimb reveals the sacral plexus, and its three major nerves. This network innervates muscles of the lower limb.

Your job: Locate each of the **boldfaced** nerves here in your specimen and label them on the picture you take of your specimen.

1. With the specimen in the same position as described above, fold back the biceps femoris muscle and look for the large **sciatic nerve**, which supplies information to the muscles of the hindlimb. Follow this nerve towards the gastrocnemius muscle and look for it to branch into two smaller nerves.
2. On the medial side of the hindlimb is the **tibial nerve** and on the lateral side is the **common fibular nerve** (or peroneal nerve). These innervate the inferior part of the hindlimb.

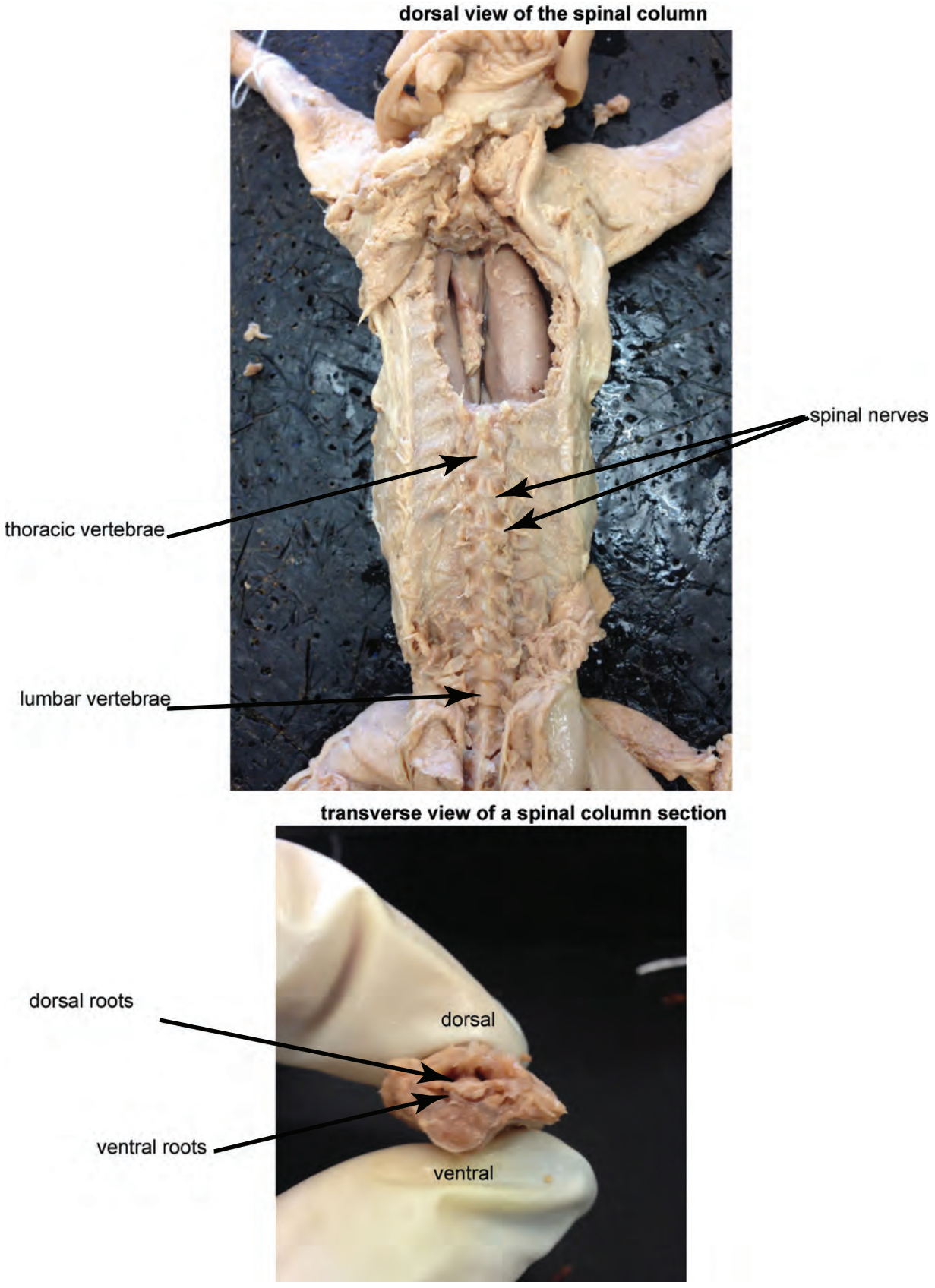
Activity 12-2c The Spinal Cord

The spinal cord can be viewed with a dissection of the posterior muscles on the dorsal surface of the pig. In this section you will need to use bone cutters to remove pieces of the vertebral column and expose a small section of the spinal cord.

Your job: Locate each of the **boldfaced** nerves here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-8** as a reference for the spinal cord.

1. Untie your specimen and turn it over so that the ventral side is down. Again, tie the limbs as was described above.
2. Cut and fold back the large dorsal muscles that cover the vertebral column in the lumbar region of the back.
3. Using bone cutters, remove vertebral arches of three vertebrae. This will expose a part of the spinal cord. Carefully remove each piece of bone.
4. Examine the exposed spinal cord, and look for both the dorsal and ventral roots as they come together to form the spinal nerves.

FIGURE 12-8 Nervous System; Spinal Column (Dorsal View and Transverse View)



5. Find the **dura mater**, forming the outer layer of tissue around the spinal cord. Cut through this dura layer and expose the **arachnoid membrane** (this is the one with the many find extensions that appear like tendrils of the spider web). A dissection microscope may help you view the following structures.
6. Using a dissection probe tease away a part of the **pia mater** membrane that lies directly on the surface of the spinal cord.
7. Cut and remove a small cross-section of spinal cord. Identify the **inner gray horns** and **outer white columns**.

12.3 Endocrine System of the Pig

The following lab activity will help you locate and identify the major glands of the endocrine system, which are similar to those found in humans. For this activity, you can complete this with a new uncut specimen or use the pig you used previously. The cuts described in **Activity 12-3**, below, will prepare the pig for dissection of the remaining systems.

12-3 Endocrine System of the Pig

Materials: Gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string preserved fetal pig (new or saved from the previous activity).

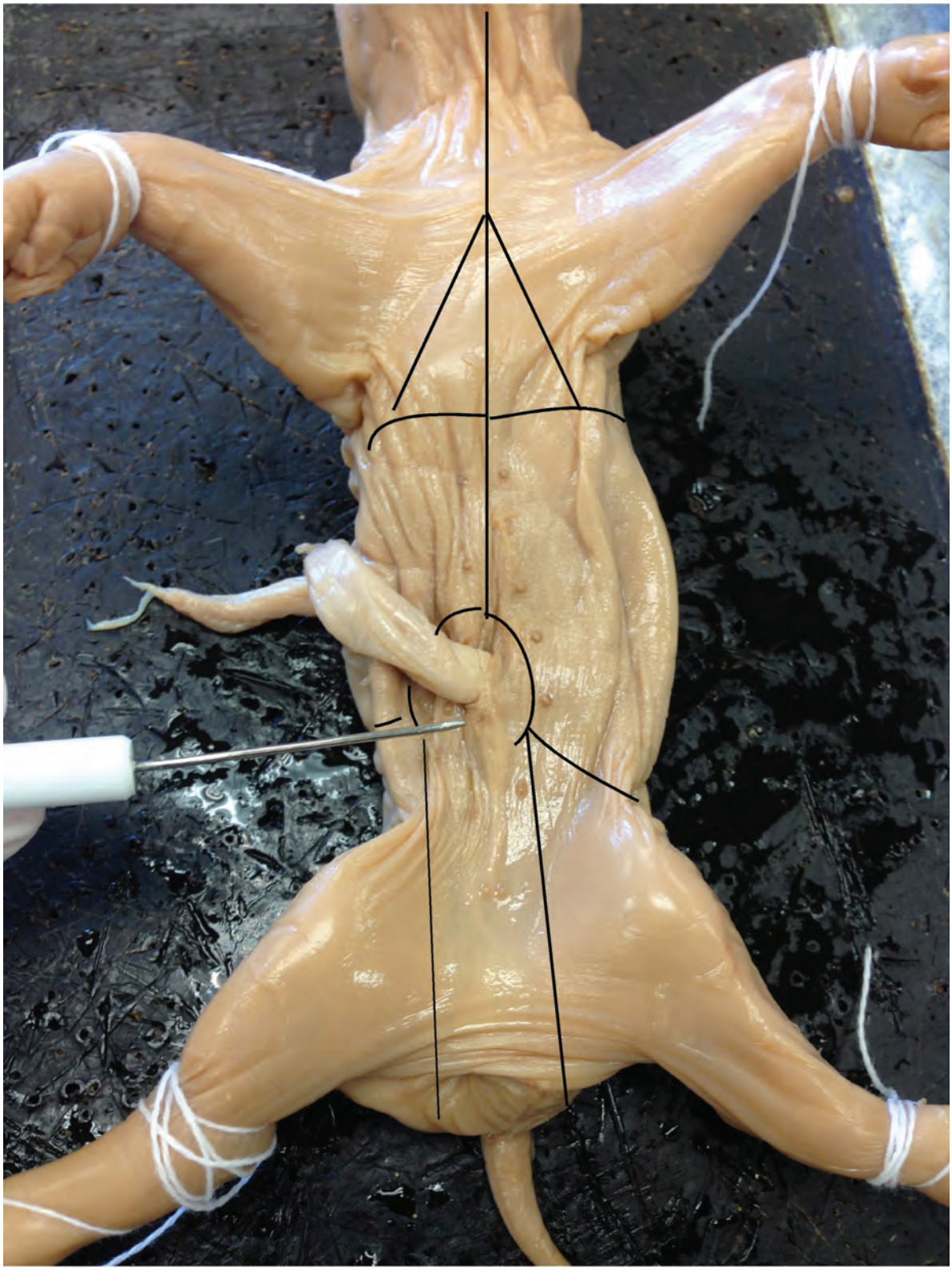
Activity 12-3a Preparing for Dissection

Use the instructions below to open and expose the ventral body cavity of a new specimen. If you have already partially opened the ventral body cavity, as described previously, read through these instructions to allow better access to some of the internal organs. Determine whether your specimen is a male or female first (see **Activity 12-1** and **Figure 12-9**), and then continue.

1. Place the pig ventral side up and tie the limbs open as described previously. One piece of string will pass under the dissection tray and be used to tie both hindlimbs with another piece used to tie both forelimbs.
2. Using scissors cut a midsagittal section through the muscles of the abdomen from just anterior to the umbilical cord and up to the sternum.
3. At the sternum, angle the scissors slightly and continue with a parasagittal cut through the coastal cartilages (you will hear small cracks as you pass through each one), and end at the axillae.
4. At the bottom or posterior margin of the ribs, make two lateral incisions, being careful to point the scissors upwards as to not damage or poke internal organs.
5. Next, cut a flap of skin and muscle towards the umbilical cord. For a female pig, encircle the umbilical cord and continue onto the anus. For a male pig, partially encircle the umbilical cord and continue in two cuts towards the anus. This protects the penis. Cut across the pubis and angle toward the hips.
6. Now you can spread the thoracic and abdominal walls to reveal the internal organs. Hold these flaps down with dissection pins.

FIGURE 12-9 Incision Patterns

Incision pattern for males a) and females b). Notice the small hole just posterior to the umbilical cord for males and the absence of this in females. Note the vagina just superior to the anus in females.

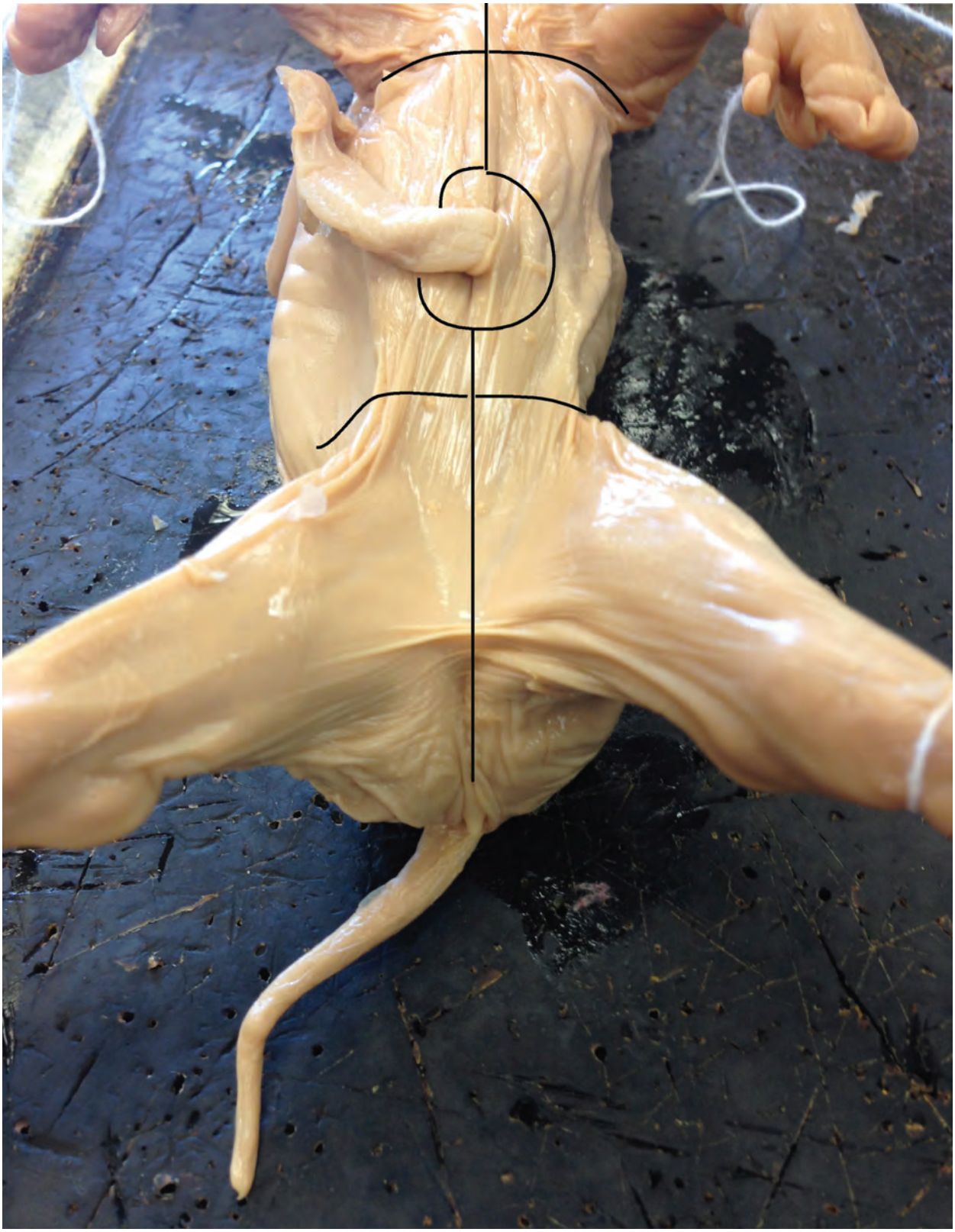


a)

(continues)

FIGURE 12-9 Incision Patterns *(continued)*

b)



Activity 12-3b Endocrine Glands

One aspect of the endocrine glands is the high amount of vascularization, which is necessary due to the passage of hormones through. Take note of this as you identify the various glands. Be careful not to rupture any of the digestive tract or blood vessels as they will be examined in a later activity.

Your job: Locate each of the **boldfaced** endocrine glands here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-10** as a reference for the endocrine glands.

FIGURE 12-10 Major Glands of the Endocrine System

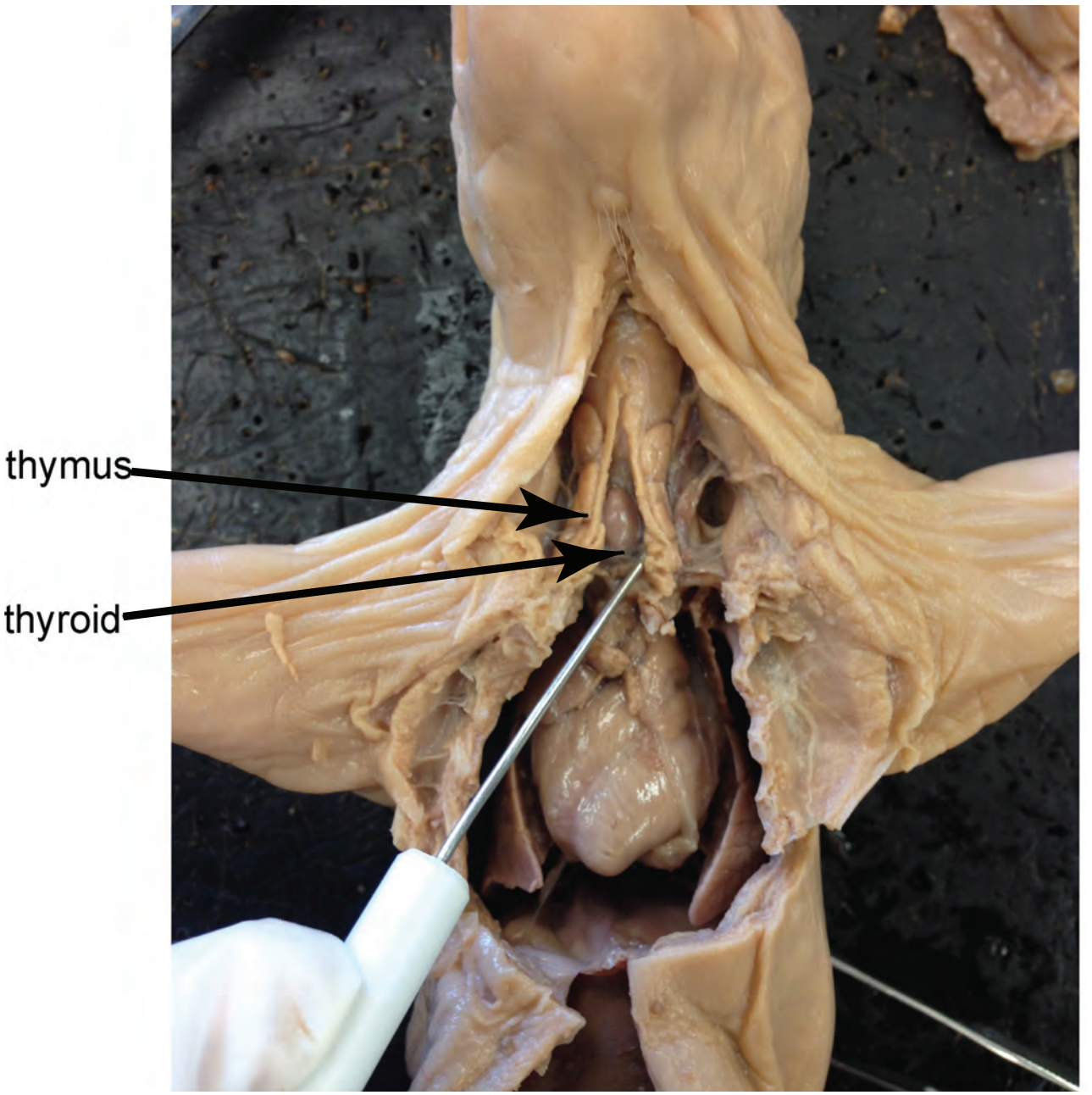


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FIGURE 12-10 Major Glands of the Endocrine System *(continued)*

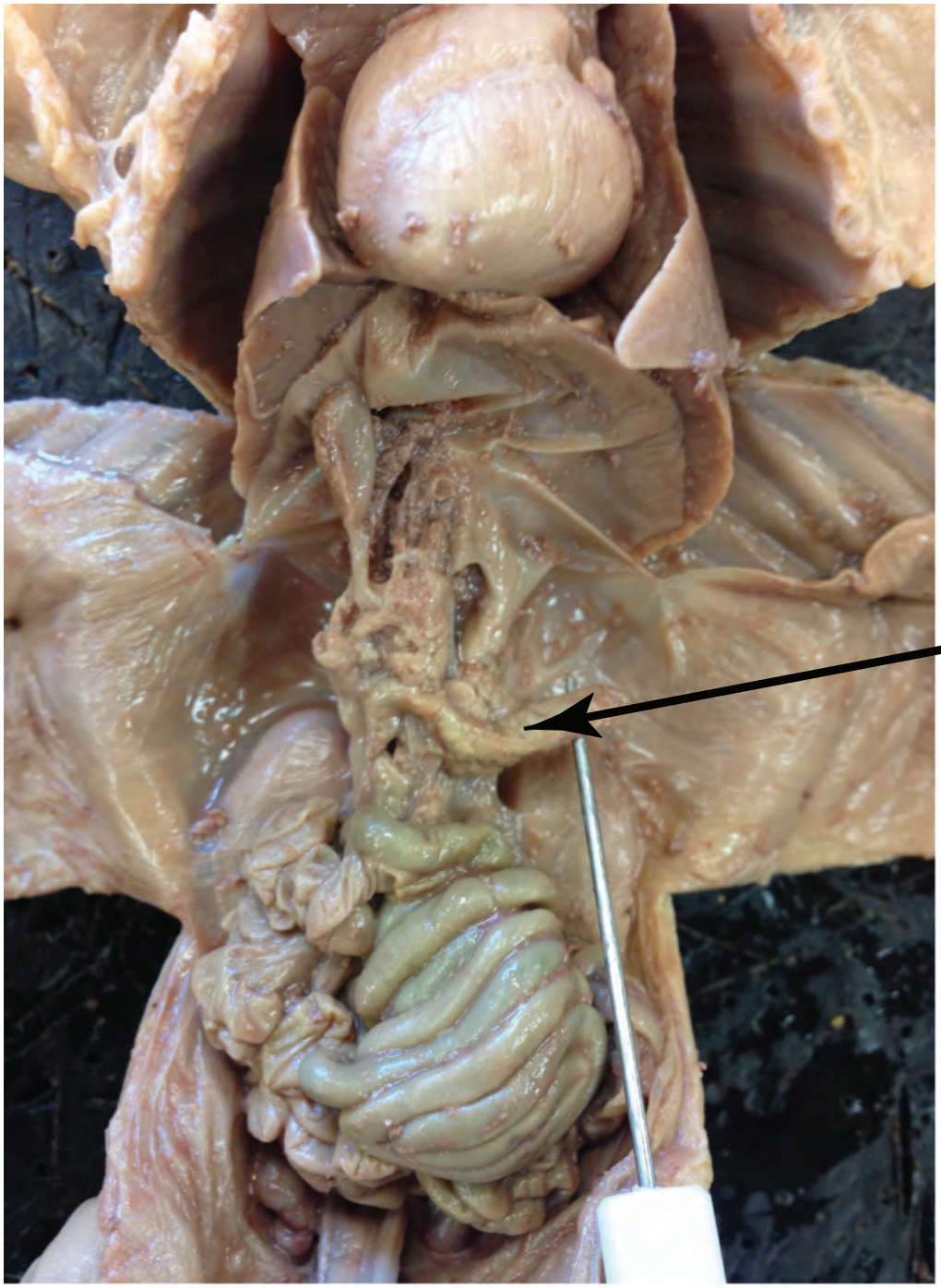

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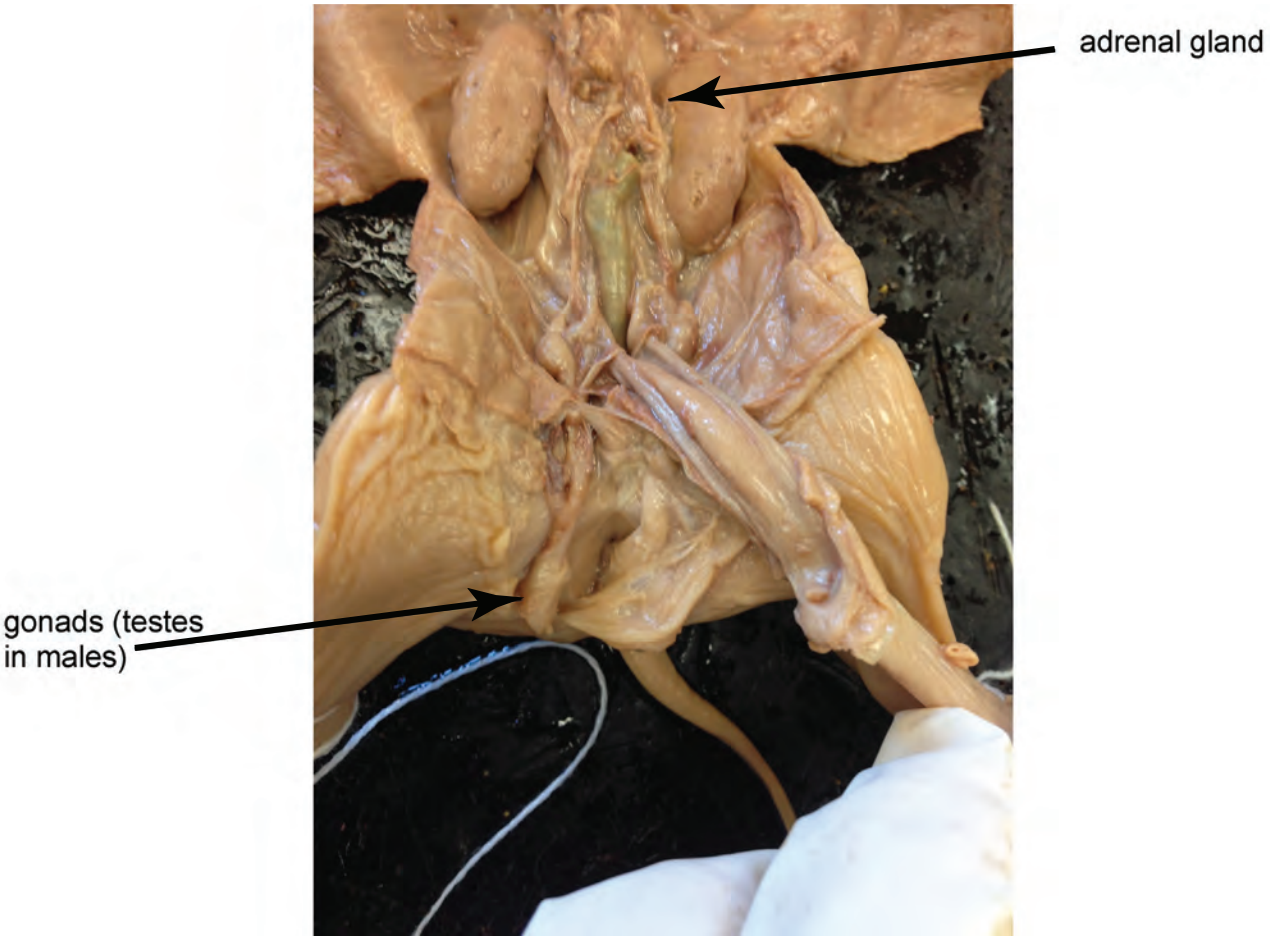
FIGURE 12-10 Major Glands of the Endocrine System *(continued)*



1. With the specimen secured ventral side up and abdominal cavity opened, identify the trachea and the **thyroid gland**, which spans across the air passageway. Note the two lateral lobes and a small isthmus between the lobes. This gland produces triiodothyronine (T3) and thryoxine (T4) which function to increase cellular metabolic rate. Other cells in the gland, the parafollicular cells, secrete calcitonin (CT), which lowers blood levels of calcium.
2. Next, the **thymus gland** can be found below the thyroid, covering the heart and part of the thyroid gland. Thymosin is produced here and stimulates the maturation of T-lymphocytes. In the fetal pig, as it is developing, the thymus is large and easy to spot. As the pig develops and becomes an adult, the thymus will be replaced by adipose tissue.
3. The **pancreas** can be found between the stomach and small intestine, and is a highly glandular piece of tissue. The pancreas contains both endocrine and exocrine cells. The endocrine cells secrete hormones that regulate the amount of glucose in the blood. The two major hormones secreted from these cells are insulin, which lowers blood glucose and stimulates the cells to take in glucose, and glucagon, which stimulates cells to release glucose into the blood. The exocrine cells produce numerous digestive enzymes that are released into the small intestine.

4. By gently moving the abdominal organs to one side you can view an **adrenal gland**. While in humans these glands are found above each kidney (suprarenal), in pigs these glands are separate from the kidneys. The glands secrete several hormones. The outer cortex tissue secretes mineralocorticoids, which regulate blood sodium levels, glucocorticoids, which help us respond to stress, and androgens, which are weak sex hormones. On the inside of the gland, the medulla secretes epinephrine and norepinephrine, which are commonly called adrenaline and noradrenaline and are released during stimulation of the sympathetic nervous system.
5. Dorsal to the adrenal glands you can locate a **kidney**. Kidneys secret renin, an enzyme that helps to regulate sodium levels. Also released by the kidneys is erythropoietin, which stimulates the production of red blood cells by the bone marrow.
6. Next, locate the **gonads**, which produce the major sex hormones. If male, locate the testes in a small pouch-like scrotum between the hindlimbs. These secrete testosterone, stimulating the maturation and maintenance of the male sex organs and male development. If female, locate the small **ovaries** in the pelvic cavity, which secrete estrogen and progesterone, hormones that propose the development of the female sex organs and prepare the uterus for gestation of an embryo.

12.4 Circulatory System of the Pig

The following lab activity will help you identify the major arteries and veins of the pig. This is easiest if your specimen has been injected with colored latex, red for arteries and blue for veins. There are several differences between the human and pig systems to be aware of as you progress through the system.

12-4 Circulatory System of the Pig

Materials: Gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string preserved fetal pig (new or saved from the previous activity).

Activity 12-4a Preparing for Dissection

If the thoracic and abdominal cavities of your specimen have not been previously opened, follow the instructions for "Preparing for Dissection" in **Activity 12-3**.

Activity 12-4b Arteries Supplying the Upper Body

The arteries you will identify in this activity are typically those filled with colored latex. There are more than those highlighted here so feel free to locate others in addition to those described below.

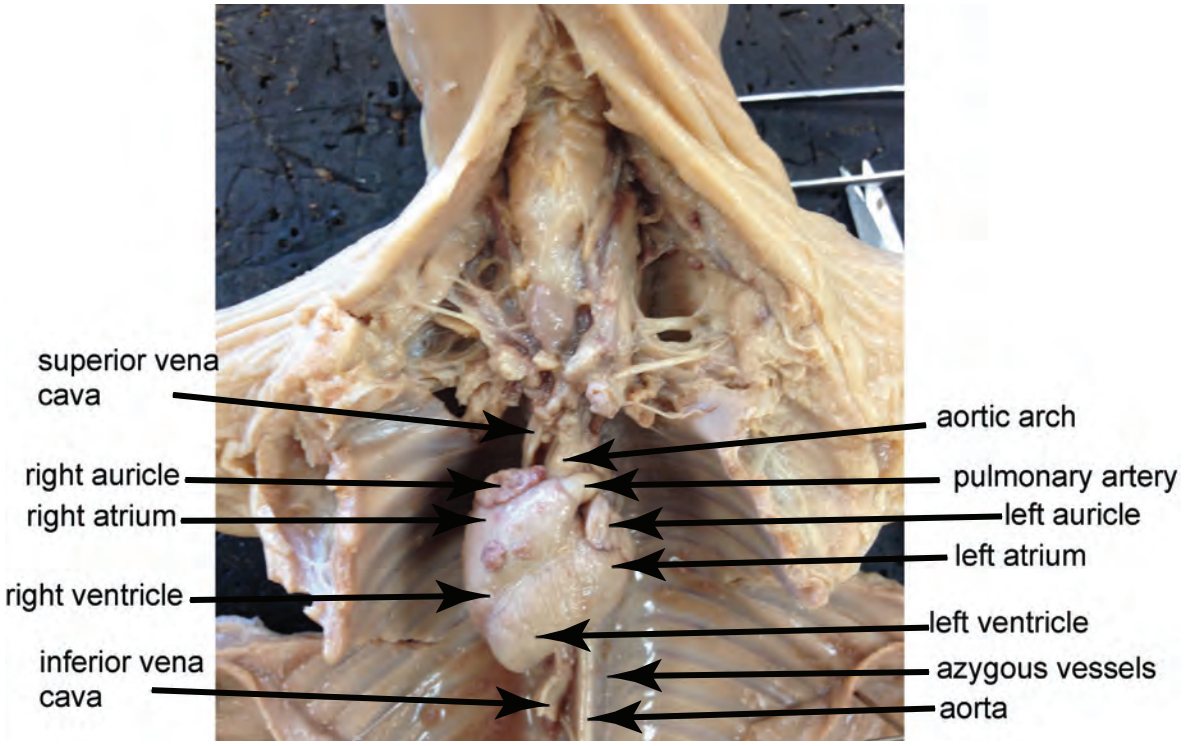
Your job: Locate each of the **boldfaced** vessels here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-11** as help.

1. Starting at the heart, locate the large arteries leaving the right and left ventricles of the heart. Leaving the right ventricle is the **pulmonary trunk**, delivering deoxygenated blood to the lungs. This divides into two branches, the **right** and **left pulmonary arteries**. Leaving the left ventricle is the **aorta**, the main arterial blood vessel delivering oxygenated blood to every major artery of the body.

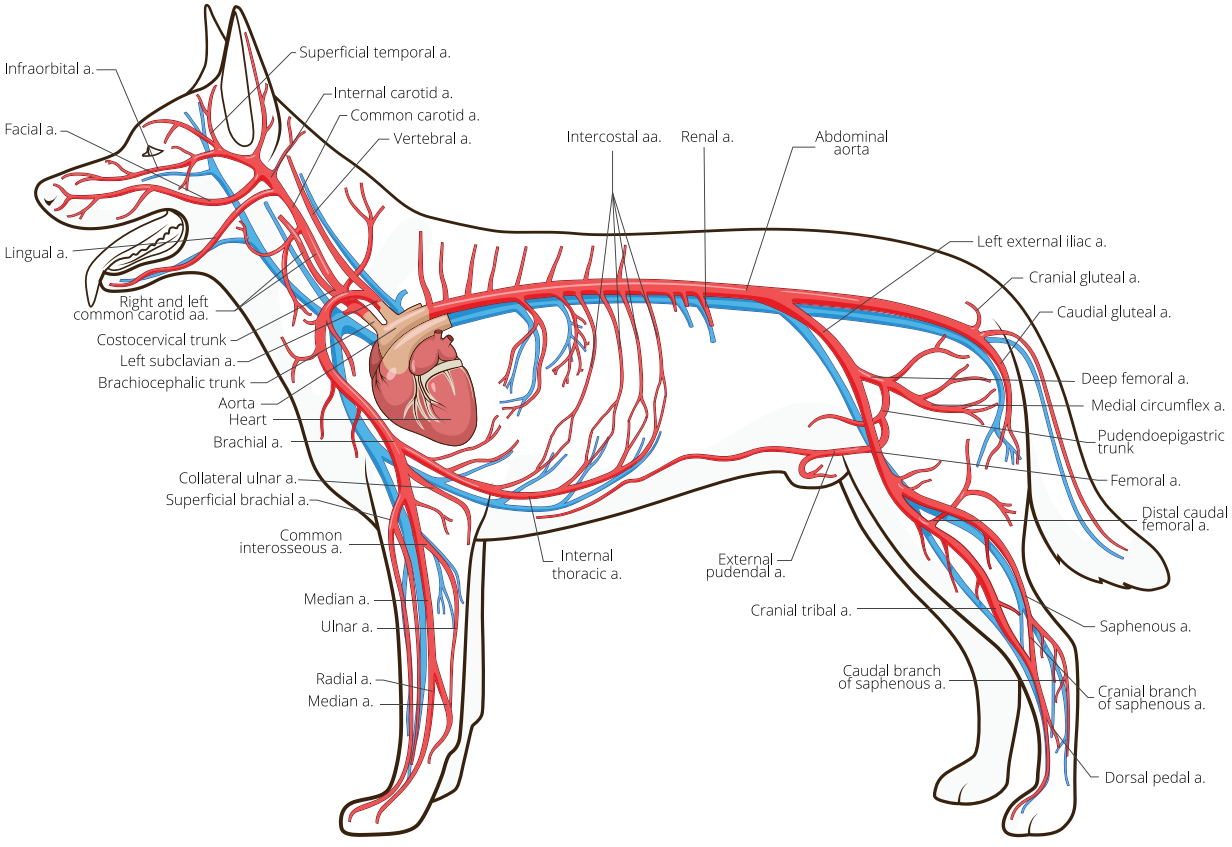
FIGURE 12-11 Vessels

a) Major vessels and heart structures found in the thoracic cavity of the fetal pig. b) Use the vascular system of the dog as a reference *(Shutterstock)*.

a)



b)



2. The aorta curves at the **aortic arch**, the vessels of the forelimbs, head and neck arise from this, and then it continues along the chest and abdomen on the left side of the vertebral column to the pelvis, where it then divides into branches supplying the lower limbs. Anterior to the diaphragm is the **thoracic aorta**. You can view this by moving the left lung to the side. You can find pairs of **intercostal arteries**, which supply the intercostal muscles between the ribs, Also, note the paired **bronchial arteries** which arise from the thoracic aorta and supply the bronchi. The **esophageal arteries**, which leave from the thoracic artery, supply the esophagus.
3. There are two major branches off of the aortic arch: the **brachiocephalic artery** and the **left subclavian artery**. (One difference between pigs and humans is that in humans, there are three branches). The brachiocephalic will supply blood to the head, shoulder and right forelimb. The left subclavian will serve the left shoulder and left forelimb. The brachiocephalic will branch again into the **right subclavian** and **right and left common carotid arteries**. The subclavian on the right is the same as that found on the left. The common carotid will divide into the internal and external branches, with the internal supplying the brain.
4. The subclavian artery branches into the **internal mammary artery**, supplying the pericardium, mediastinum and diaphragm, and the vertebral artery, which supplies the brain.
5. The **costocervical artery** is distal to the vertebral artery and arises from the dorsal surface of the subclavian. This artery sends branches deep into the muscles of the neck and shoulder. The **thyrocervical artery** arises from the cranial aspect of the subclavian and supplies the thyroid glands and neck or chest muscles.
6. At the level of the first rib, the **subscapular artery** branches from the subclavian and continues as the axillary artery. This supplies the dorsal shoulder muscles. The **thoracodorsal artery** is found opposite to the subscapular artery and supplies the shoulder muscles. Just lateral to the first rib is the ventral thoracic artery, and supplies the medial ends of the pectoral muscles. Finally, the **long thoracic artery** is found lateral to the ventral thoracic artery and passes to the pectoral and latissimus dorsi muscles.
7. The **brachial artery** is found as the axillary enters the forelimb. Distal to the elbow you will find the radial and ulnar arteries.

Activity 12-4c Arteries Supplying the Abdominal Cavity and Lower Body

Posterior to the diaphragm, the aorta becomes the **abdominal aorta**, branching into arteries that supply the digestive organs, spleen, urinary system, reproductive organs and lower limb.

1. The first branch off of the abdominal aorta is a **single celiac trunk**. The celiac splits into the **gastrosplenic** and **gastrohepatic arteries**, supplying the stomach, spleen and liver.
2. Just posterior to this is the **single cranial mesenteric artery**. This artery branches around the intestines and wall of the digestive tract. The **adrenolumbar arteries**, found just posterior, are paired arteries that supply the suprarenal glands and then separate into the phrenic and adrenal arteries, supplying blood to the dorsal body wall. Next the **renal arteries** supply the kidneys and emerge from the abdominal aorta.
3. The **gonadal arteries** arise from the aorta near the ends of the kidneys. In females these arteries, called ovarian arteries, pass laterally to supply the ovaries. In males, these are called spermatic arteries, and pass caudally to the internal inguinal ring to the testes.
4. Next, the **lumbar arteries** are six pairs of arteries that arise from the dorsal surface of the aorta and supply the dorsal abdominal wall.

5. An unpaired **caudal mesenteric artery** arises near the aorta's terminal branches near the hindlimb. This supplies the large intestine, and in humans is called the inferior mesenteric artery. Then locate the **iliolumbar arteries** that arise near the caudal mesenteric artery and supply the muscles of the dorsal abdominal wall.
6. Near the sacrum, the aorta branches into the **right and left external iliac arteries**, entering the hindlimbs.
7. Off of the external iliac artery, the **deep femoral** arises and supplies the muscles of the thigh. Continuing along the thigh is the **popliteal artery**, branching into the **anterior** and **posterior tibial arteries**.

Activity 12-4d Veins Draining the Upper Body

Veins are typically the blue latex filled blood vessels, bringing deoxygenated blood back to the heart.

1. Pull the heart away from the lung and locate the exposed lung root, which contains a **pulmonary vein**. This passes blood from the lungs back to the dorsal side of the heart, entering the left atrium. Next find the **anterior vena cava** and **posterior vena cava**, bringing deoxygenated blood back to the right atrium from the body.
2. Locate a number of small vessels that feed into the anterior vena cava. There is a pair of **internal thoracic (mammary) veins** that drain the ventral chest wall, and lie on either side of the body midline. Pushing the heart towards the left lung will reveal the **azygos vein**, arching over the right lung root and joining the anterior vena cava. The **intercostal veins** drain from the intercostal muscles into the azygos veins.
3. The **axillary vein** is the major vein draining from the upper limb. The largest branch into the axillary is the **subscapular vein**.
4. The **external jugular veins** drain from each side of the head, and merge with the **subclavian vein**. Once joined with the subclavian, the vessel becomes the **brachiocephalic vein**. The **internal jugular vein** drains from the brain and spinal cord. Just superior to the hyoid bone is the **transverse jugular vein**, connecting the left and right external jugular veins.
5. At the ends of the subclavian vein, a pair of **brachiocephalic veins** unites at the anterior vena cava.
6. Veins from the forelimb drain into the **common axillary** vein and **transverse scapular vein**. Veins found here include the **radial vein** on the lateral side, the **ulnar vein** on the medial side, and the **brachial vein** near the elbow. Finally, the **cephalic vein** joins the transverse scapular vein.

Activity 12-4e Veins Draining the Abdominal Cavity and Lower Body

Veins are typically the blue latex filled blood vessels, bringing deoxygenated blood back to the heart, here draining into the posterior vena cava. (**Figure 12-11**)

1. A major vein, the **common iliac vein** is found along the dorsal pelvis wall, and joins the **posterior vena cava**. The **internal iliac vein** joins with the common iliac in the pelvic cavity, draining from the rectum, bladder, and internal reproductive organs. A **large external iliac vein** joins distal to this point, and is a continuation of the **femoral vein** from the hindlimb. The **caudal vein** drains the tail.
2. On the way back to the heart, you will pass the **lumbar veins**, draining from the abdominal muscles, the **gonadal veins**, draining the reproductive organs (internal spermatic veins in males and ovarian veins in females), the **renal veins** draining from the kidneys and the **adrenolumbar veins**, draining the adrenal glands.

3. **Hepatic veins** are those that drain blood from the liver and into the posterior vena cava, though this can be hard to view sometimes. The hepatic portal vein, draining blood from the intestines and other digestive organs. The **superior mesenteric vein** is a largest branch to the portal vein, draining from the small and large intestines as well as the pancreas. The **inferior mesenteric** drains from the large intestine and the **gastrosplenic vein** will drain the stomach and spleen, and lies on the dorsal side of the stomach.
4. Veins that are often linked to the arteries in a similar region are found in the hindlimb are the **popliteal vein**, draining the foot and calf, uniting to form the saphenous vein meeting up at the femoral vein.
5. Locate the **femoral vein**, which is a superficial vein on the anterior surface of the thigh. This becomes the external iliac vein.

12.5 Lymphatic System of the Pig

The following lab activity will help you locate and identify the structures of the lymphatic system. The lymphatic system protects the body against infection, collects extra interstitial liquid and transports dietary fats not able to enter the capillaries at the digestive organs. The liquid of this system is called lymph and travels in lymphatic vessels and passes through lymph nodes. The major organs of this system include the thymus gland, spleen, tonsils, lymph nodes and lymphatic nodules. Nodules are similar to nodes but smaller and more scattered throughout the body.

12-5 Lymphatic System of the Pig

Materials: gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string
preserved fetal pig (new or saved from the previous activity)

Activity 12-5a Preparing for Dissection

If the thoracic and abdominal cavities of your specimen have not been previously opened, follow the instructions for "Preparing for Dissection" in **Activity 12-3**.

Activity 12-5b The Pig Lymphatic System

While most structures of the lymphatic system are relatively easy to identify, the lymph vessels are often flattened and difficult to find. The larger lymphatic ducts near the subclavian veins may be visible, and sometimes blue latex has leaked into the vessels.

Your job: Locate each of the **boldfaced** structures here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-12** as a reference for the lymphatic system.

1. Locate the **thymus gland**, found anterior to the heart. This may have already been located if you completed the Endocrine activity.
2. Gently move aside the organs of the thoracic cavity. The brown **thoracic duct** lies along the dorsal surface of the descending aorta. Look for the internal valves that cause the duct to expand over the valve. This vessel receives lymph from the hindlimbs, abdomen and left forelimb as well as the left chest neck and head.

3. On the right side of the thorax, locate the **right lymphatic duct**, draining from the right forelimb, and right chest, neck and head. This is an uneven drainage of the ducts that occurs in humans as well.
4. Now move to the jaw and locate on either side, between the parotid salivary gland and the masseter muscle, the brown, kidney shaped **lymph nodes**. Here, phagocytes are produced that remove debris and pathogens from the lymph. These are distributed throughout the body.
5. Finally, locate the **spleen**, a red, flattened organ on the left side, just posterior to the stomach. This organ removes old red blood cells from circulation and helps to recycle iron from the hemoglobin. The spleen can also participate in an immune response.

FIGURE 12-12 Major Organs of the Lymphatic System

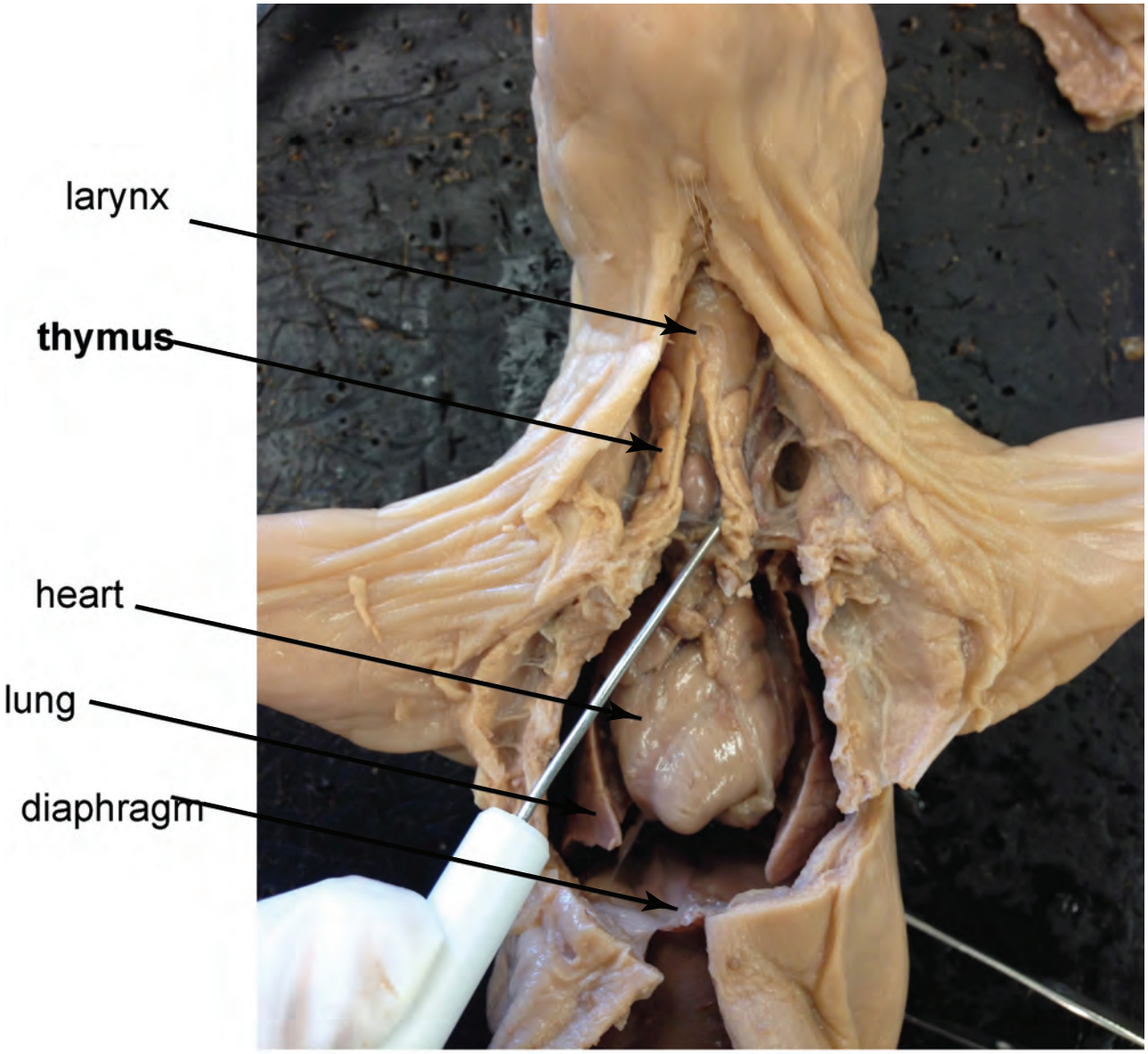


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FIGURE 12-12 Major Organs of the Lymphatic System *(continued)*

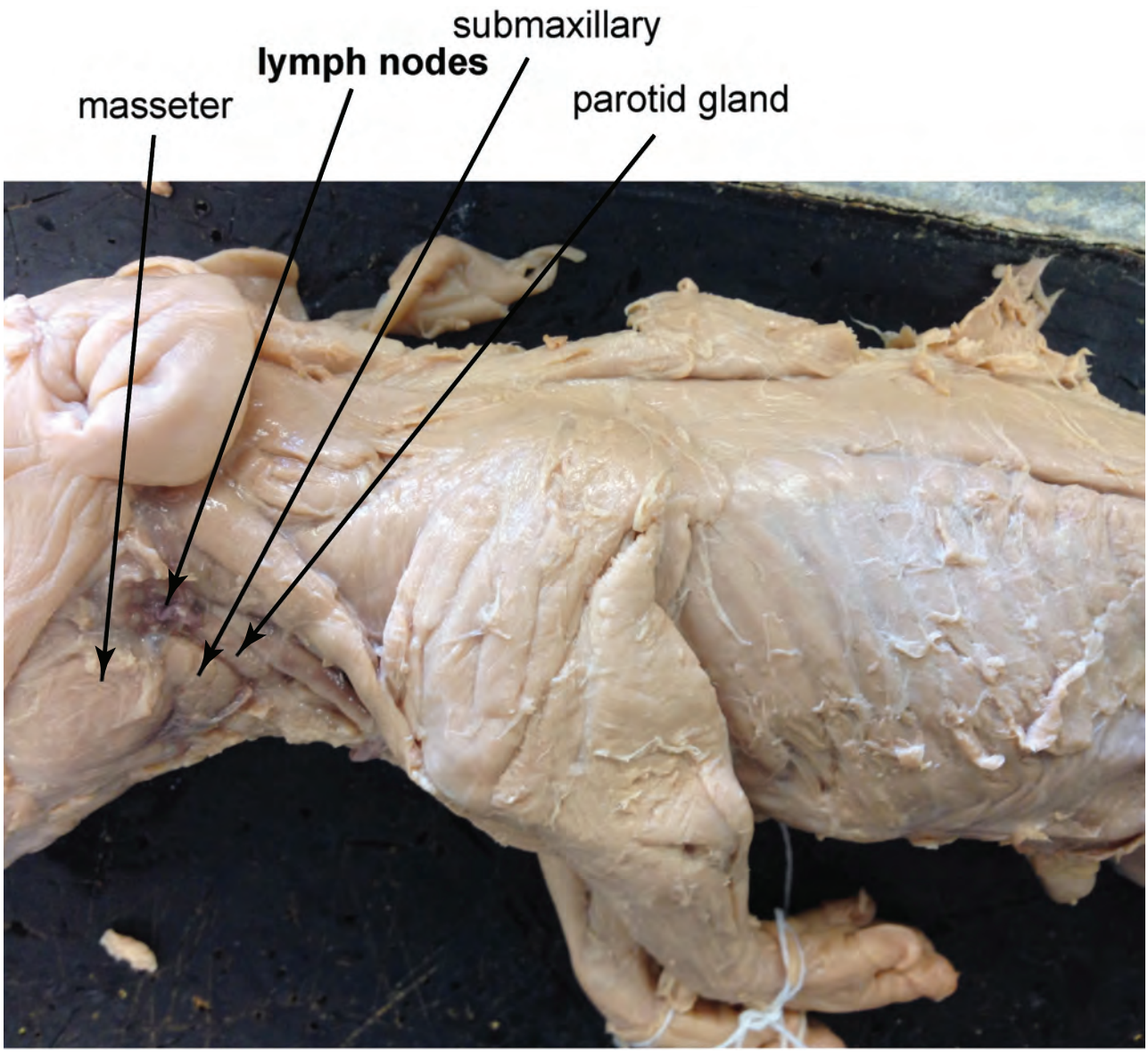

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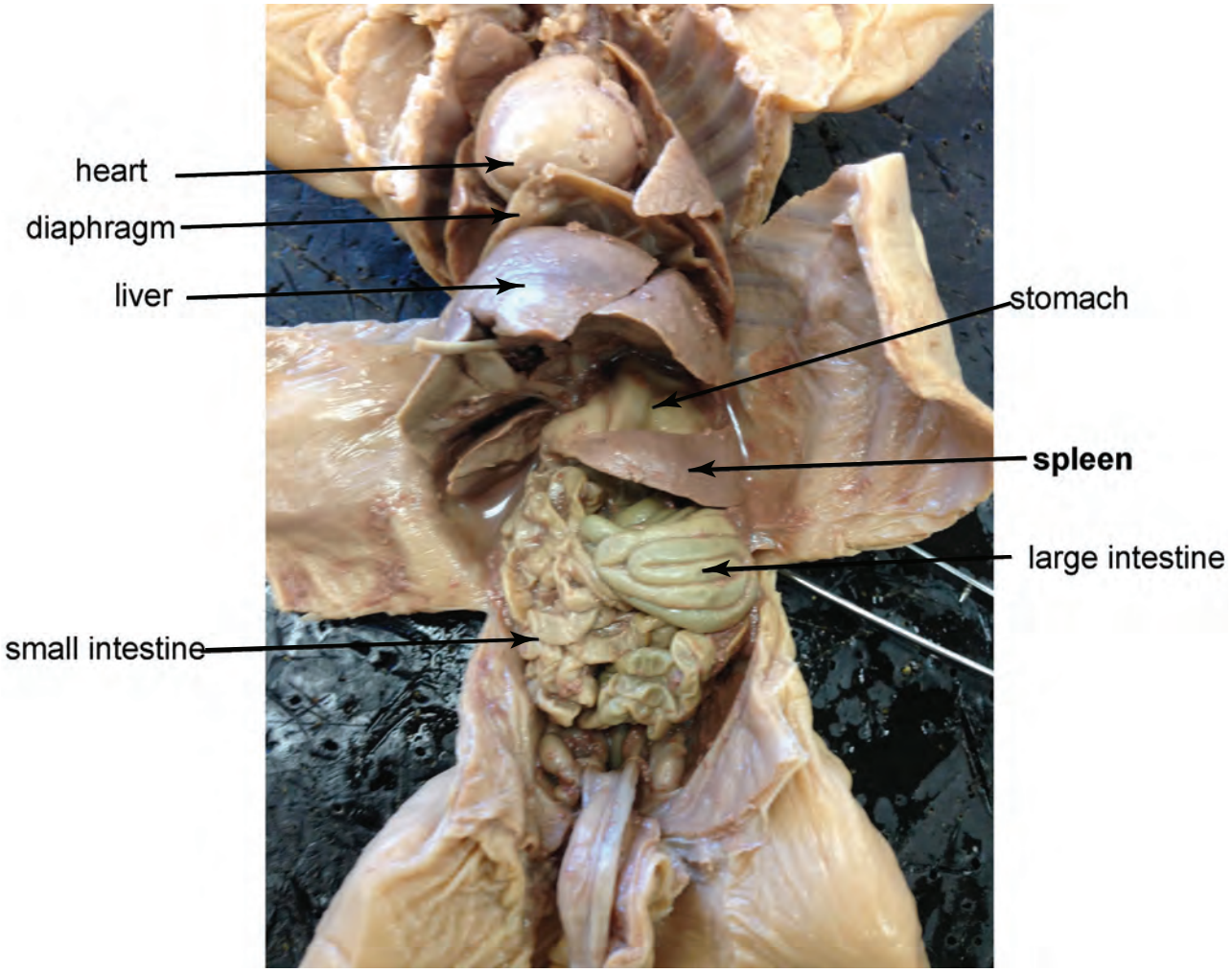
FIGURE 12-12 Major Organs of the Lymphatic System *(continued)*



12.6 Respiratory System of the Pig

The following lab activity will help you locate and identify the structures of the respiratory system. Its major function is to convert the deoxygenated blood into oxygenated blood.

12-6 Respiratory System of the Pig

Materials: gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string preserved fetal pig, plastic tubing, (new or saved from the previous activity)

Activity 12-6a Preparing for Dissection

If the thoracic and abdominal cavities of your specimen have not been previously opened, follow the instructions for "Preparing for Dissection" in **Activity 12-3**.

Activity 12-6b Nasal Cavity and Pharynx

The nasal cavity and pharynx are locations that receive the air as it passes by the two nostrils, or external nares, and pass by the internal nares, which connect the posterior of the nasal cavity with the pharynx (throat). The pharynx is similar to humans in that it is separated into three regions: the anterior nasopharynx followed by the oropharynx which is found behind the mouth, and laryngopharynx, which is where the pathway splits into the esophagus (for food) and larynx (for sound and air).

Your job: Locate each of the **boldfaced** structures here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-13** as a reference for the respiratory system.

1. Start with an examination of the **rostrum**, the flattened snout of the animal, and locate the **external nares**.
2. Using scissors, cut through the cheeks on either side of the mouth until you reach the **pharynx**. Spread the mouth open so that you can examine the oral cavity and pharynx.
3. Find the **hard palate**, the **soft palate** and **internal nares**, where the cavity meets up with the nasopharynx.
4. Then locate the nasopharynx, oropharynx and laryngopharynx.

Activity 12-6c Larynx and Trachea

The larynx of the pig has fewer cartilages (five) than the human's nine. The largest is the thyroid cartilage, which is a visually prominent ventral cartilage. Caudal to this is the cricoid cartilage, the only one to pass completely around the respiratory tract. A pair of arytenoid cartilages is found on the dorsal surface of the larynx, anterior to the cricoid. Finally, the epiglottis will cover the glottis, a passageway for air) during swallowing, preventing food from entering the airway. Found inside the larynx are the vocal cords for sound production. The false vocal cords, which are known as the vestibular ligaments, protect the posterior vocal ligaments, which are thought of as the true vocal folds, those that vibrate to produce sounds.

FIGURE 12-13 Major Organs of the Respiratory System

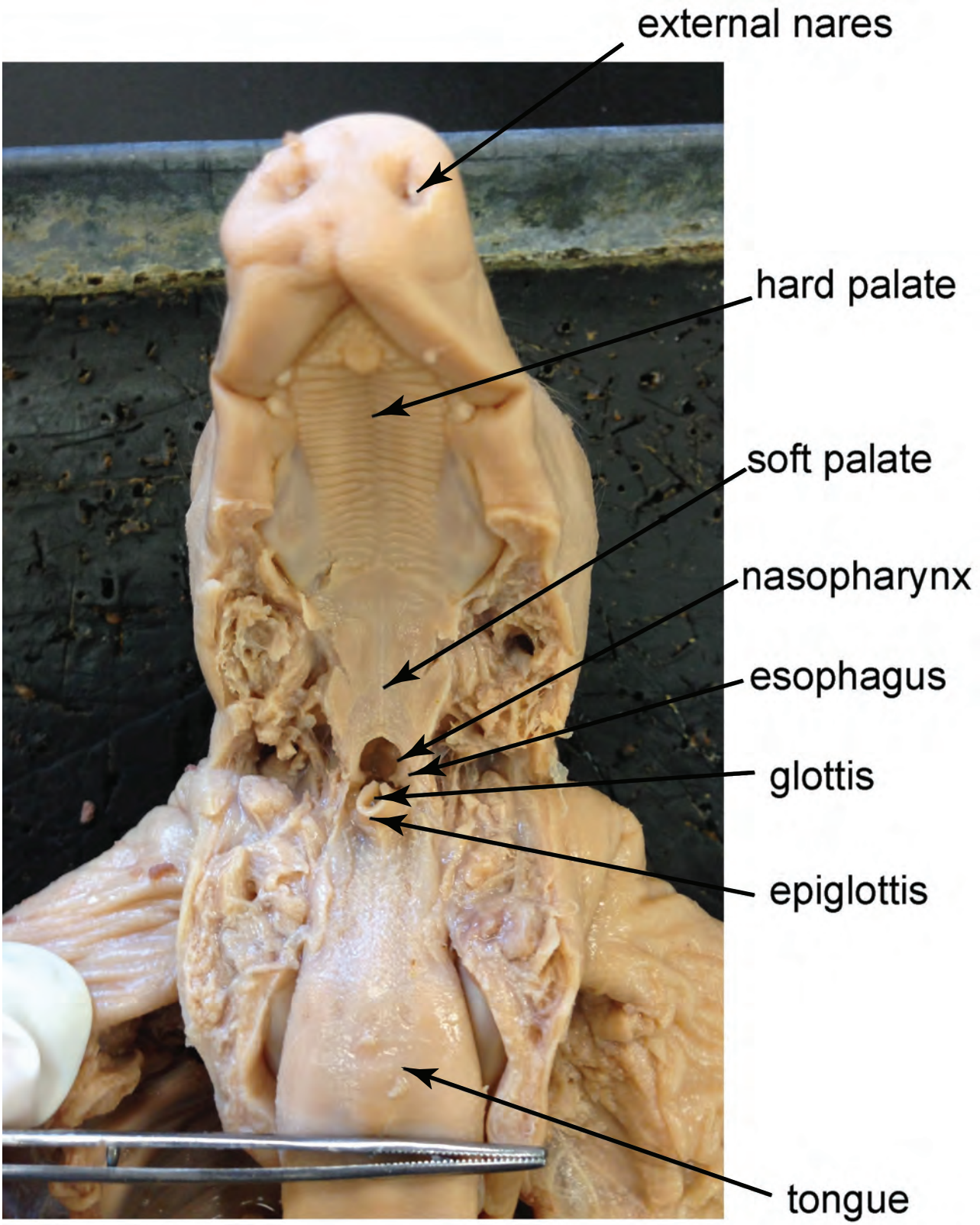


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FIGURE 12-13 Major Organs of the Respiratory System *(continued)*

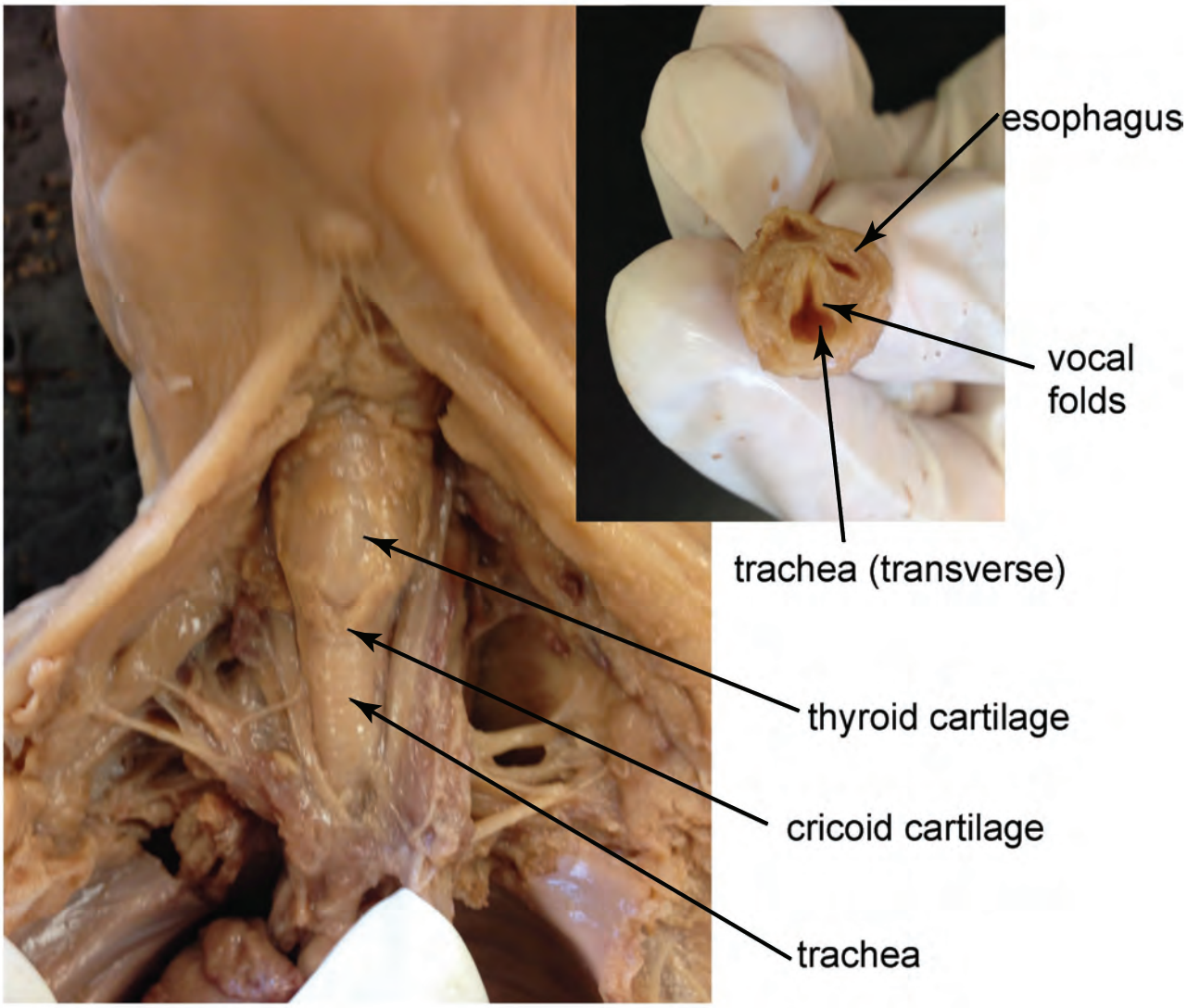

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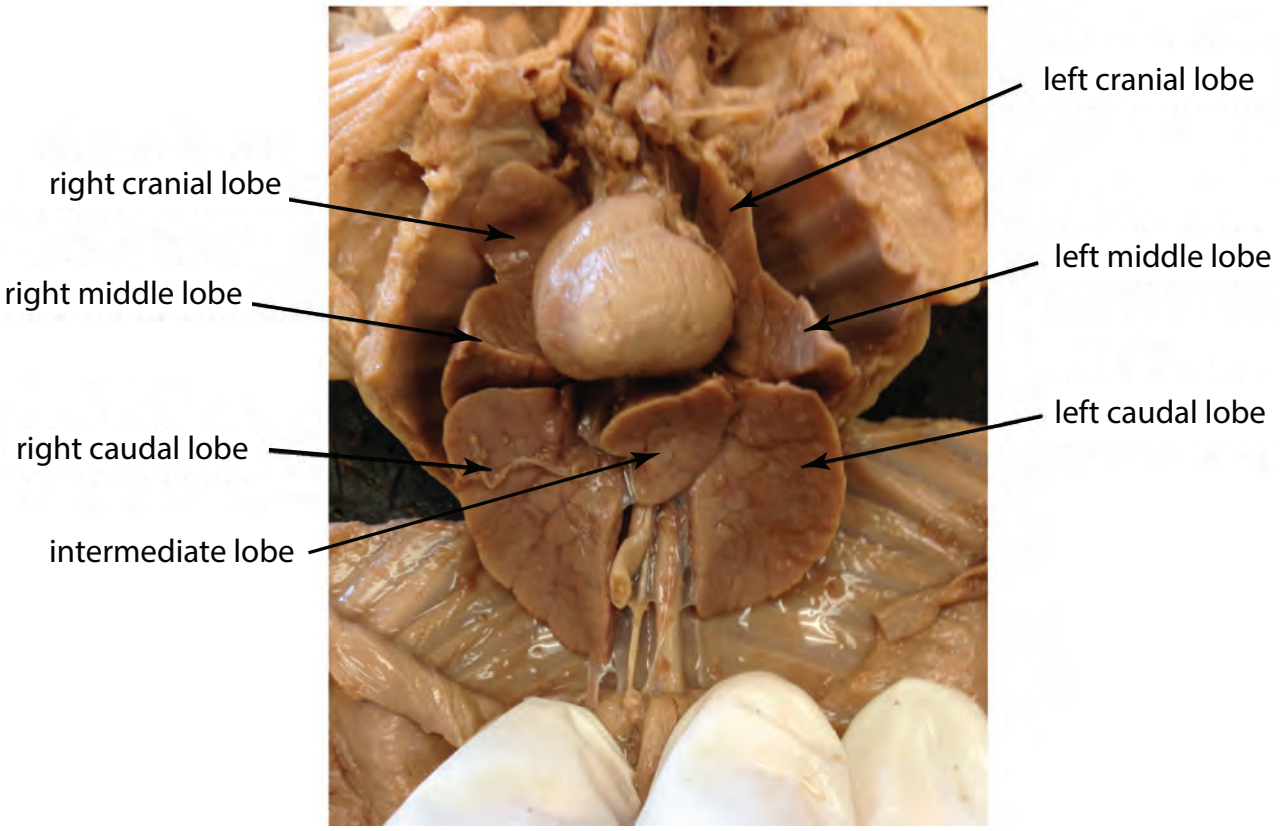
FIGURE 12-13 Major Organs of the Respiratory System *(continued)*



Moving out of the larynx is the trachea, an airway that is kept open by pieces of hyaline cartilages, called tracheal rings. Between the ends of the tracheal rings, which do not completely surround the trachea, is the trachealis muscle. Dorsal to the trachea is the esophagus which food passes down.

1. Begin by cutting completely through the neck muscle to the body of the cervical vertebrae. Carefully cut through any remaining connective tissue that could still be holding onto the larynx.
2. Locate the **thyroid** and **cricoid** cartilages of the larynx and find the **epiglottis** over the passageway.
3. Locate the **trachea**, below the larynx, and the **tracheal rings** that line the passageway.
4. Remove the muscle and soft tissue around the larynx. Carefully sever the pharynx and trachea to remove the larynx from the body.
5. Make a median incision on the dorsal surface of the larynx. Carefully open the larynx to view the elastic vocal cords between the thyroid and cricoid cartilages. The vestibular ligaments are found anteriorly whereas the vocal ligaments are found posteriorly.
6. Finally, examine the sectioned end of the trachea and feel the tracheal rings.

Activity 12-6d Bronchi and Lungs

The bronchial tree is the airway of the lungs. The left and right primary bronchi form from the descending trachea, and penetrate the lungs at a hilum of each lung. From there, the bronchi continue to branch into smaller passageways. One difference between the pigs and humans is that pigs' lungs have more lobes than human lungs. In the four lobes of the pig, the apical bronchus supplies the apical lobe. The right primary bronchi supply the cardiac, intermediate and diaphragmatic lobes. There are three lobes of the left lung (the apical, cardiac and diaphragmatic), served by the left primary bronchus.

The lungs are surrounded by a serous membrane, the pleura, consisting of the visceral pleura on the lung surface and the parietal pleura holding the membrane to the thoracic wall. These membranes are filled with serous fluid, called pleural fluid.

1. Follow the trachea to where it splits into the **left** and **right primary bronchi** and note the **hilum**, where the vessels enter and exit the organ. Look for the apical bronchus that is found anteriorly to the primary bronchus.
2. Identify the four **right** and **three left lobes**.
3. Find the glossy visceral pleura on the lung's surface and the parietal on the thoracic wall.
4. Dividing the thoracic cavity from the abdominal cavity is the **diaphragm**, a major muscle in respiration. If you notice a white "thread" along the heart, this is the phrenic nerve, which controls the diaphragm during inspiration.
5. Use a plastic pipette or straw and push it into the laryngopharynx. Exhale carefully into the tube and look for an expansion of the lungs as they fill with air.
6. Carefully, dissect away some lung tissue around the left primary bronchus. Using a scalpel, make an incision along the bronchi entering a lobe. Take note of the spongy appearance.

12.7 Digestive System of the Pig

The following lab activity will help you locate and identify the structures of the digestive system found in the pig, one that is very similar to that found in humans.

12-7 Digestive System of the Pig

Materials: gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string preserved fetal pig, (new or saved from the previous activity)

Activity 12-7a Preparing for Dissection

If the thoracic and abdominal cavities of your specimen have not been previously opened, follow the instructions for "Preparing for Dissection" in **Activity 12-3**.

Activity 12-7b The Oral Cavity, Salivary Glands, Pharynx and Esophagus

The oral cavity, or mouth, begins with the vestibule, the space between the teeth and lips, or teeth and cheek tissue. The hard palate consisting of bone forms the roof of the cavity and on the posterior end consists of the soft palate, which consists of mucus membrane

and cartilage. There are salivary glands in the oral cavity. Beyond the oral cavity, the pharynx connects the mouth to the esophagus.

Both pigs and humans have 32 teeth. In mature pigs there are 3 incisors, 1 canine, 4 premolars and no molars on one side of both the top and bottom of the jaw. In comparison, adult humans have 2 incisors, 1 canine, 2 premolars and 3 molars.

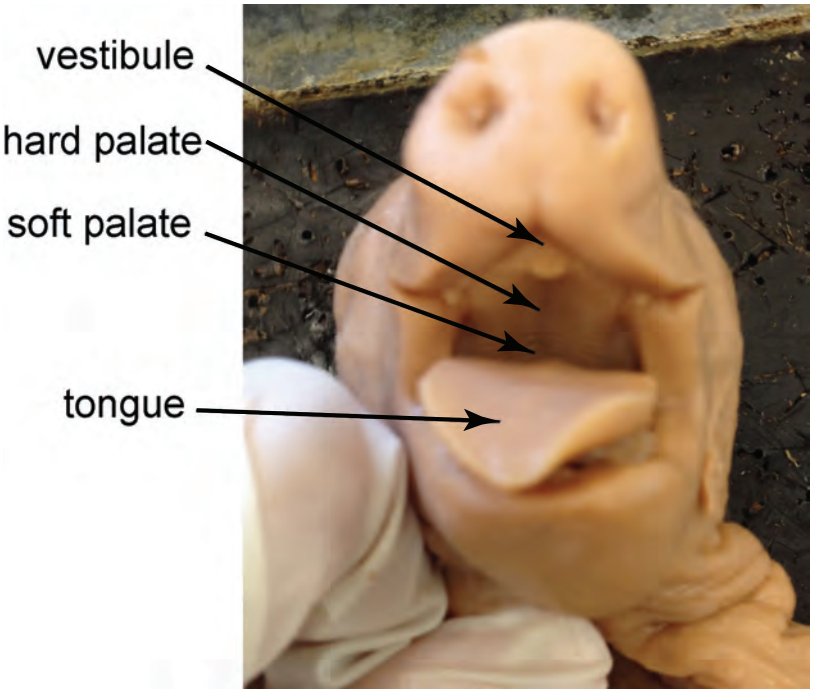
Your job: Locate each of the **boldfaced** structures here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-14** as a reference for the digestive system.

1. Open the mouth and observe the **papillae** (raised bumps on the tongue's surface), which contain the taste buds. These help to move food in the mouth during chewing and swallowing. Lifting the tongue will reveal the **lingual frenulum**, the thin tissue that attaches the tongue to the floor of the oral cavity.
2. You may notice that the fetal pig does not have a fully developed dental structure. Using the information above, try to identify those that may have emerged from the gingivae or gums.
3. Locate the **pharynx** at the posterior end of the mouth and divide this into its three main regions: the nasopharynx, located dorsal to the soft palate; the oropharynx, located in the posterior region to the oral cavity; and the laryngopharynx, located around the epiglottis and opening to the esophagus.
4. Carefully remove the connective tissue between the jaw and ear (if already completed in an earlier section, move onto the next step).
5. Locate the small, dark, bean-shaped structures (lymph nodes) and the salivary glands (light orange or tan colored textured tissue). The large **parotid gland** is found inferior to the ear on the surface of the masseter muscle. Trace the **parotid duct**, which is found leaving from this gland and passing over the muscle to enter the oral cavity. Locate the **submandibular gland**, found inferior to the parotid gland and the **sublingual gland**, which is anterior to this.
6. Back inside the pharynx, find the opening to the **esophagus**, which is located posterior to the larynx. This collapsible tube connects the laryngopharynx to the stomach. Move aside the organs in the thoracic cavity to follow the esophagus through the diaphragm and into the stomach.

FIGURE 12-14 Organs of the Digestive System

a) Oral cavity, b) salivary glands, c) primary organs and accessory organs of the abdominopelvic cavity d) internal view of the stomach

a)



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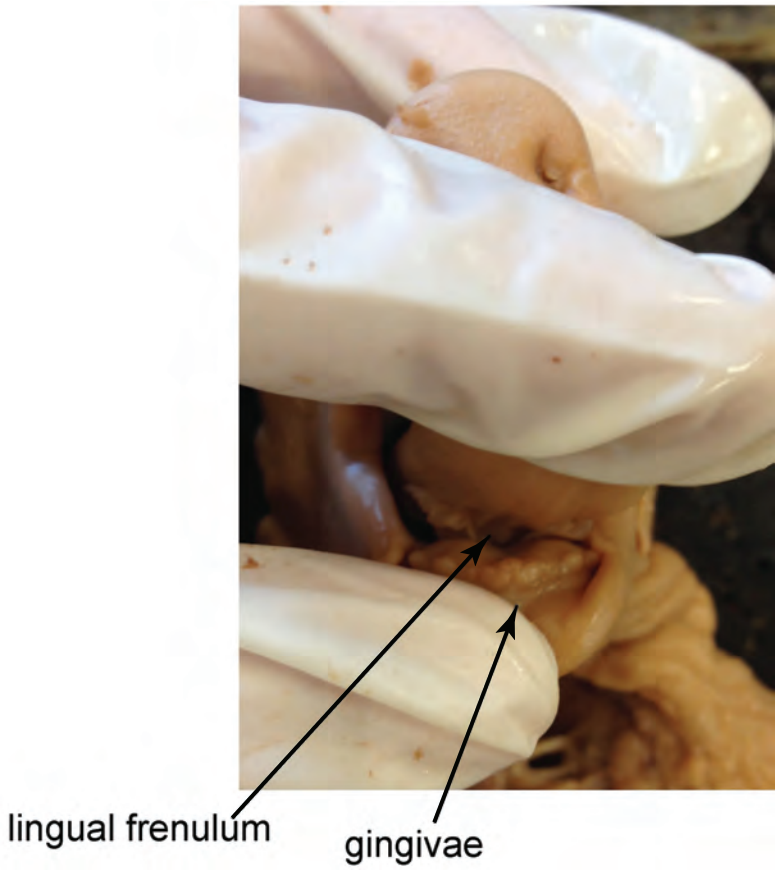

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FIGURE 12-14 Organs of the Digestive System *(continued)*

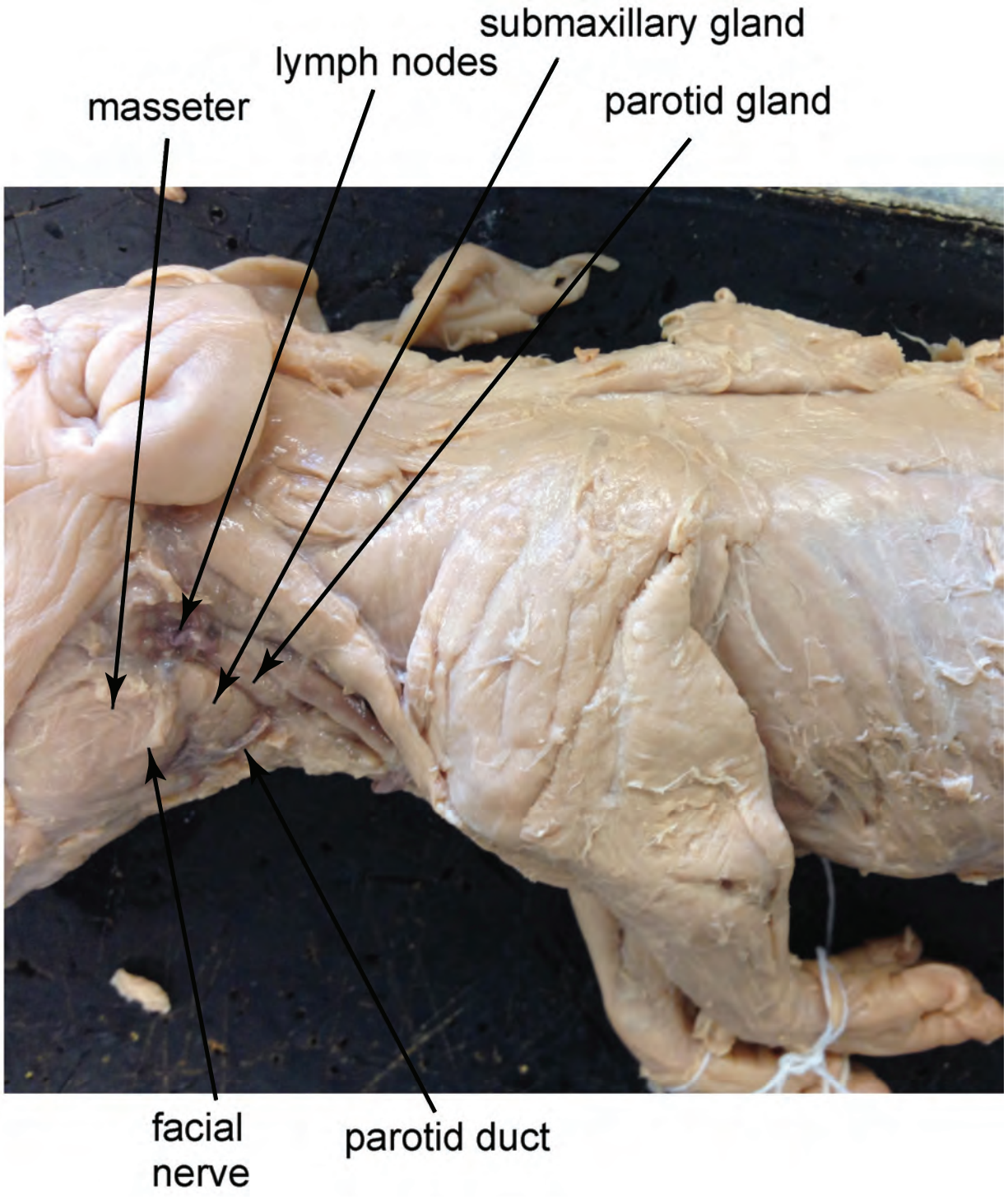

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FIGURE 12-14 Organs of the Digestive System *(continued)*

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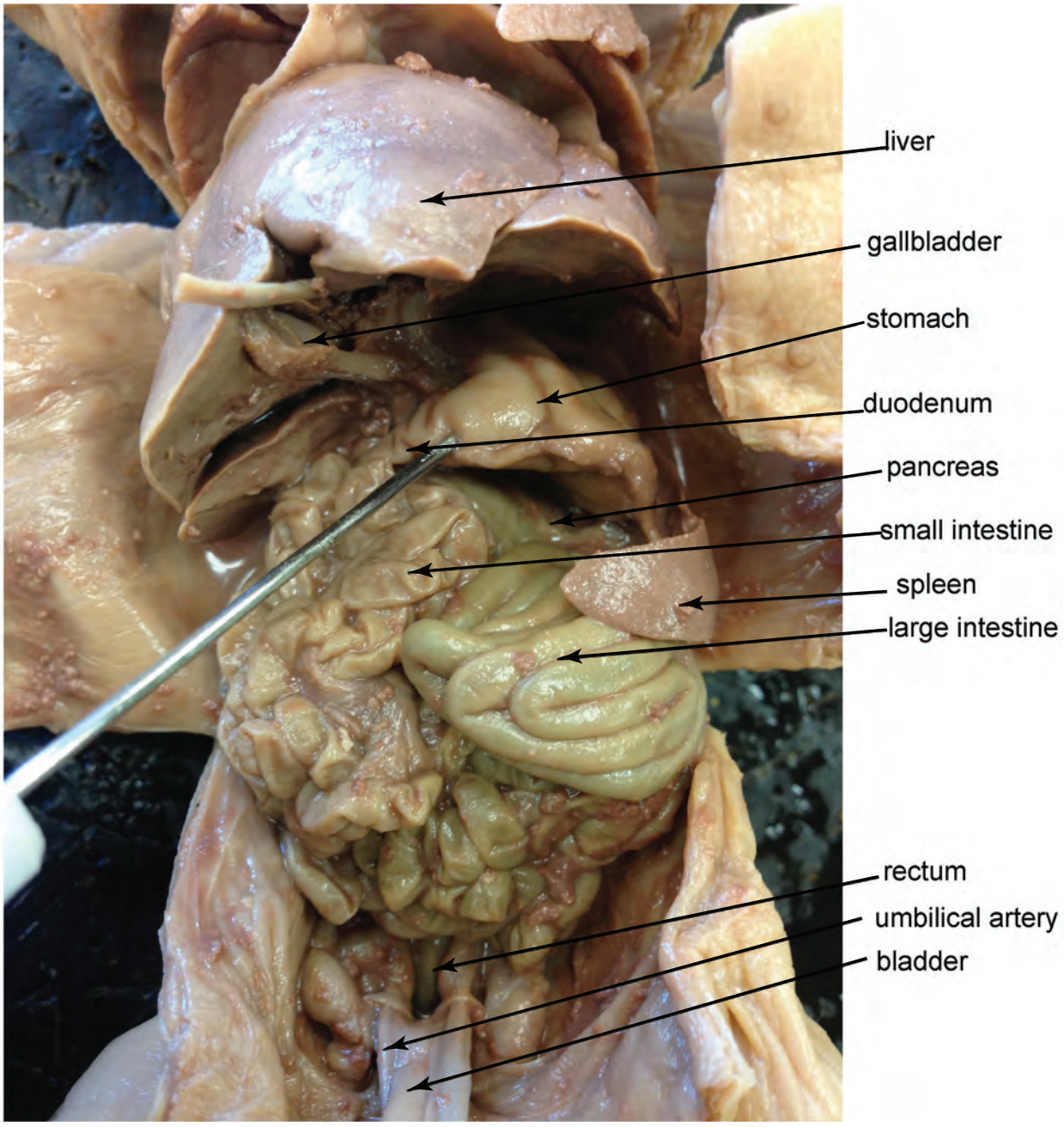

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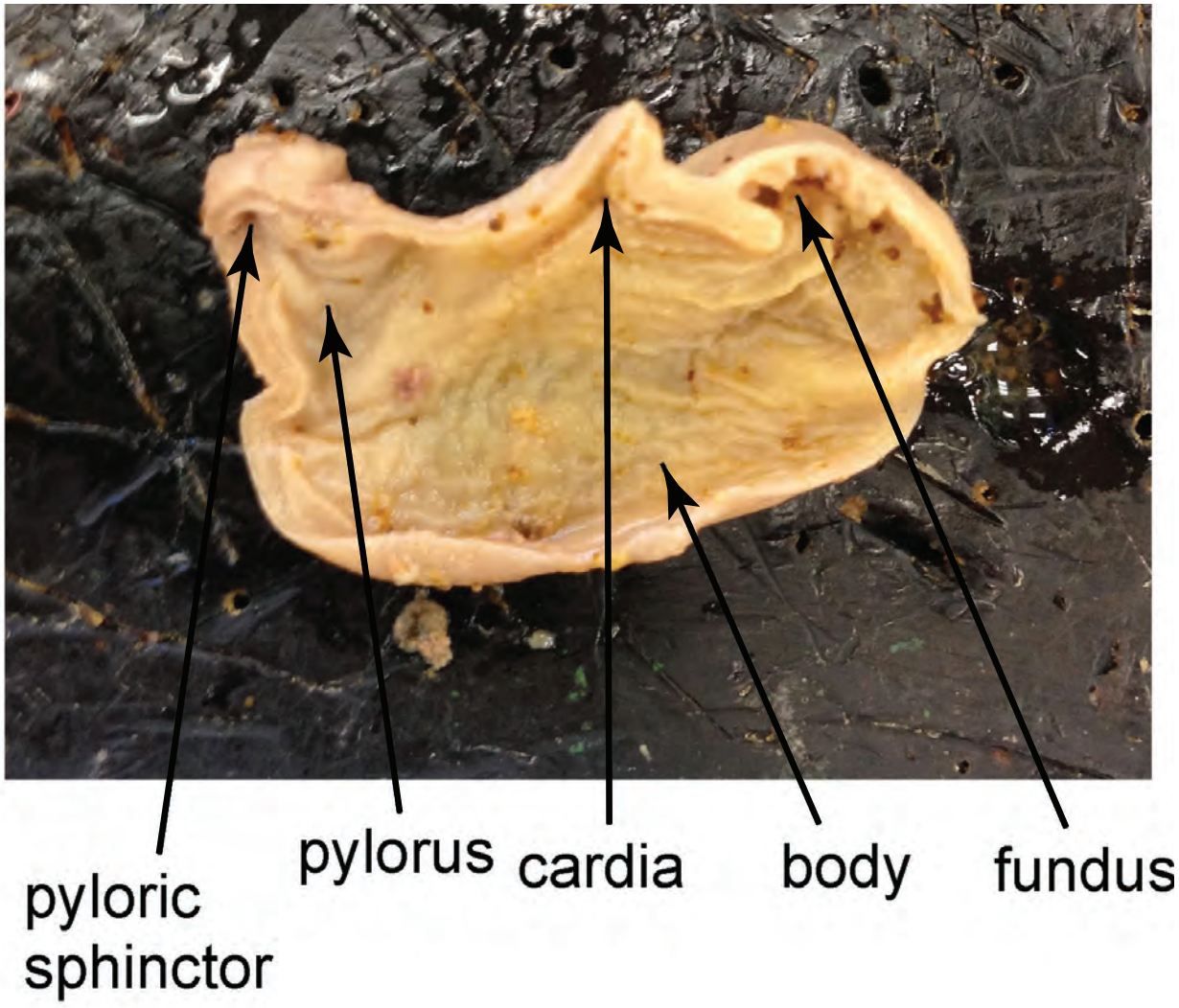
FIGURE 12-14 Organs of the Digestive System *(continued)*



e)

Activity 12-7c **The Abdominal Cavity: Stomach and Spleen**

Moving into the abdominal cavity, the major organ is the stomach which contains four major regions: the **cardia**, connected to the esophagus; the **fundus**, a curved upward pouch moving above the esophagus; the **body**, the major region of the stomach; and the **pylorus**, the posterior and exit region of the stomach. The pylorus ends with the pyloric sphincter, which connects the stomach with the duodenum of the small intestines and provides control over the release of stomach contents into the small intestines for digestion.

1. Move aside any tissue covering the abdominal cavity and remove any of the greater omentum, a fold of the peritoneum that is attached to the stomach and dorsal wall.
2. Find the **stomach** and locate the four regions introduced above as well as the **greater** and **lesser curvatures**: the lateral and medial margins of the organ, respectively.

3. Make an incision along the length of the greater curvature and into the duodenum. Open the stomach and observe any contents. Inside you should be able to locate the pyloric sphincter as well as the large folds in the tissue called **rugae**.
4. Posterior to the stomach is a long, thin organ called the spleen, an organ of the lymphatic system.

Activity 12-7d Small and Large Intestines

The small intestines are broken up into three regions: the **duodenum** is a short, C-shaped segment that receives the chyme from the stomach as well as secretions from the pancreas and liver or gallbladder. Next, the **jejunum**, which is the longest segment, is followed at the end by the **ileum**, which joins the large intestine. The large intestine also contains three segments: the **cecum** is the widest of all sections and has the large pouch-like segments. The longest of the segments is the **colon**, running upwards, over and down the abdominal cavity. Finally, the **rectum** is the last segment. The peritoneum that surrounds and attaches the intestines to the abdominal wall is the **mesentery**, or **mesocolon** in the large intestine. The organization of the long passageway is held in place by these sheets of tissue.

1. Starting at the small intestine, try to identify the three segments. Run your fingers along the ileum until you reach the point of connection between the small and large intestine: the **ileocecal sphincter**, the valve that controls the movement of chyme into the large intestine.
2. Continue the cut you made in the stomach into the duodenum for several inches. Open the cut tissue and hold open with dissecting pins. If you have a magnifying lens, use it to view the **villi**. You can also feel the villi of the intestine with your fingertip.
3. For the large intestine, first pull the loops of small intestine out of the abdominal cavity. Now you can trace the **cecum** to the **colon** and into the **rectum**, finally leading into the **anus**.

Activity 12-7e Accessory Organs: Liver, Gallbladder and Pancreas

There are a number of organs outside of the primary gastrointestinal tract that assist and are necessary for proper digestive function. The largest of these is the liver, which is, in fact, the largest organ of the abdominal cavity. The liver is found posterior to the diaphragm and is segmented into five lobes: right and left central, right and left lateral and a caudate lobe. (In humans, the liver is only segmented into four lobes.) The liver is held to the abdominal cavity wall with the falciform ligament. On the posterior wall of the liver is the gallbladder, a dark green sac that works closely with the liver by storing extra bile, made by the liver, for release into the small intestine. In addition to producing bile for emulsification of dietary fats, the liver also stores and metabolizes nutrients that arrive from the intestines via the hepatic portal vein. Bile travels down the common hepatic duct, merging with the cystic duct from the gallbladder and empties into the duodenum.

Posterior to the stomach is the pancreas, another accessory organ that produces the majority of the digestive enzymes and buffers for release into the duodenum via the pancreatic duct.

1. Easy to locate first is the large brown **liver**. Distinguish between the five lobes and locate the **gallbladder** on the posterior margin as well as the **falciform ligament**.
2. Locate the **common hepatic duct**, **cystic duct** and **common bile duct** based on the description given above.
3. Locate the **pancreas**. The head of the pancreas is found near the duodenum and the tail is near the stomach and spleen. Near the head of the pancreas, carefully locate the **pancreatic duct**.

12.8 Urinary System of the Pig

The following lab activity will help you locate and identify the structures of the urinary system found in the pig, one that is very similar to that found in humans.

12-8 Urinary System of the Pig

Materials: gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string preserved fetal pig, (new or saved from the previous activity)

Activity 12-8a Preparing for Dissection

If the thoracic and abdominal cavities of your specimen have not been previously opened, follow the instructions for "Preparing for Dissection" in **Activity 12-3**.

Activity 12-8b Kidney Anatomy: External

Your job: Locate each of the **boldfaced** structures here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-15** as a reference for the urinary system.

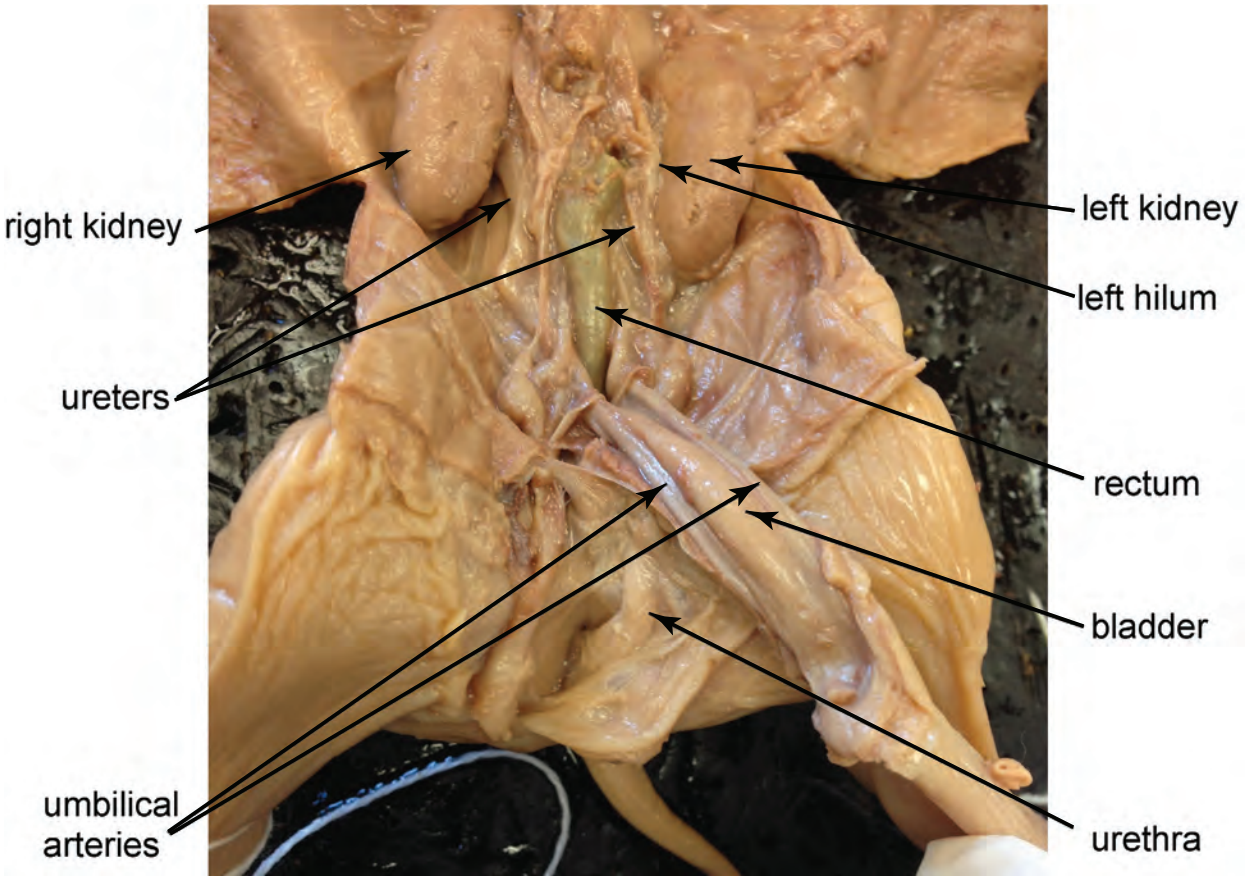
1. Move all of the previously viewed abdominal organs to the left to reveal the two large, bean shaped **kidneys**. These are termed retroperitoneal as they are found outside of and behind the peritoneal cavity. Around each kidney is surrounded by a layer of perirenal fat, making up the adipose capsule. Carefully pull off this tissue layer to expose the organ. Deep to this, a fibrous sac called the renal capsule surrounds the kidney.
2. Anterior but not attached to the kidneys, are the **adrenal glands**. In humans, these are attached to the superior portion of each kidney.
3. After completely removing the surrounding peritoneum and renal capsule, locate and identify the **renal hilum** (a concave marking on the medial surface), as well as the **renal artery**, **vein** and **ureter** that are found in the hilum.
4. Follow the ureter from the kidney along the dorsal body wall to the **urinary bladder**. Since this is a fetal pig, you might be able to locate the umbilical arteries on either side of the bladder. The urethra leaves the bladder and empties into either the penis of the male or vagina of the female.

Activity 12-8c Kidney Anatomy: Internal

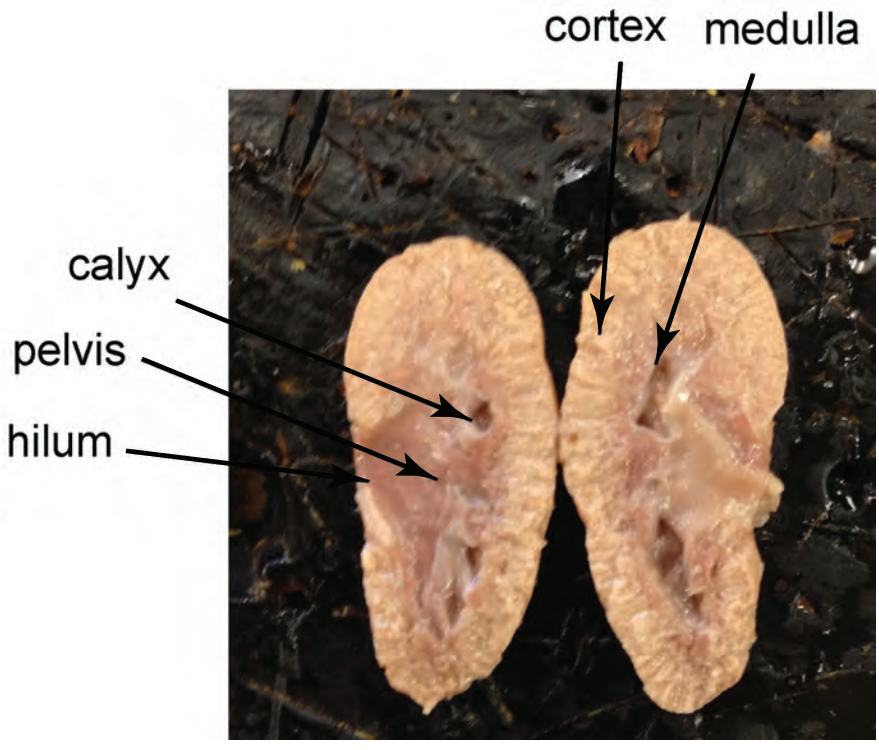
1. Carefully remove a kidney from the pig by cutting any vessels or tissue holding the organ to the body wall. Make a frontal cut of the organ (similar to how you cut open the kidney in Chapter 10 of this manual).
2. Locate the outer **cortex** layer and inner **medulla** layer that contain the **renal pyramids** and **renal columns**.
3. On the interior of the kidney, locate the hollow **renal pelvis** and its branches, called the **major calyces** and **minor calyces**.

FIGURE 12-15 Organs of the Urinary System

a) kidney, bladder and passageways, b) kidney cross-section



a)



b)

12.9 Reproductive System of the Pig

The following lab activity will help you locate and identify the structures of the reproductive system found in the pig, one that is very similar to that found in humans. However, differences do exist between the two species that will be highlighted below. Once you are done observing the reproductive system of your pig, look for one of the opposite sex in your class, which will allow for a comparison between the both.

12-9 Reproductive System of the Pig

Materials: gloves, safety glasses, lab coat, dissecting tray, dissecting tools, string preserved fetal pig, (new or saved from the previous activity)

Activity 12-9a Preparing for Dissection

If the thoracic and abdominal cavities of your specimen have not been previously opened, follow the instructions for "Preparing for Dissection" in **Activity 12-3**.

Activity 12-9b Reproductive System of the Male and Female Pig

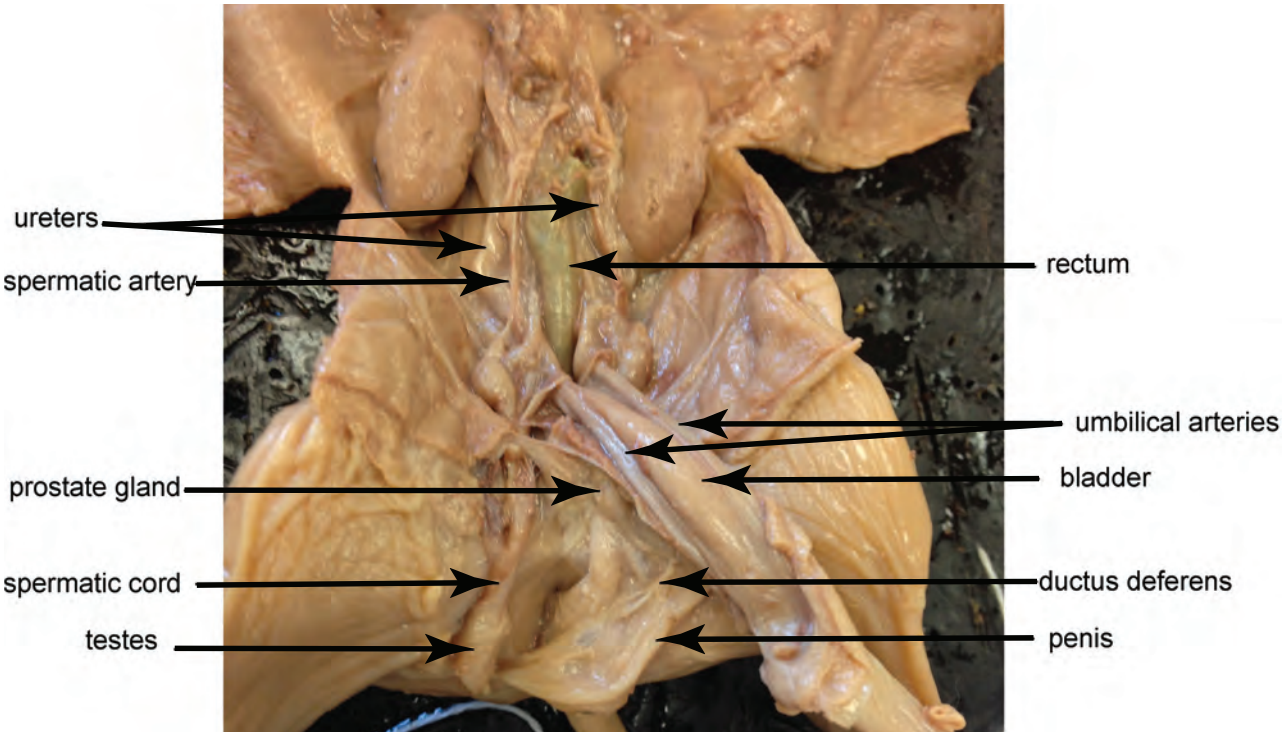
Male humans and pigs share similar reproductive organs. The male testes, which produce the spermatozoa are found outside of the body cavity and housed in the scrotum. Ventral to the scrotum is the penis, a tubular shaft, which the urethra uses to excrete urine. In the pig, the retractable penis is housed inside the body, or external urogenital orifice. Female systems are also similar between humans and pigs, however there are several important differences. One such difference is in the shape of the uterus which branches into left and right horns in the pig to accommodate litters of multiple twins and possible different fathers, whereas in humans there is no branching. A second difference is that in pigs, the urethra and vagina share a similar passageway, like in males, whereas in humans, these are separate passageways.

Your job: Locate each of the **boldfaced** structures here in your specimen and label them on the picture you take of your specimen. Use **Figure 12-16** as a reference for the reproductive system.

If your specimen is a male:

1. Locate and identify the **scrotum** ventral to the anus and the penis, which is ventral to the scrotum.
2. On the lateral side of each testis, find the **epididymis**, where the spermatozoa are stored. Next locate the **spermatic cord** that lead away from each testes and consist of the spermatic artery, vein and nerve, as well as the ductus deferens.
3. Trace this cord into the abdominal cavity and carefully separate the cord from the connective tissue holding it in place. Look for where the ductus deferens loops over the ureter and passes posterior to the bladder.
4. The rest of the reproductive structures can be viewed by cutting through the pelvic girdle. To do so, carefully with bone cutters, locate the pubic symphysis as the midline of the pelvic bone. Once this is cut, spread the thighs to expose the structures. This must be done carefully as the urethra is found directly behind the bone.

FIGURE 12-16 Organs of the Reproductive Systems in Males



5. The **prostate gland** is a large mass of tissue around the urethra. Anterior to this are the **seminal vesicles**, which release seminal fluid into the ductus deferens.
6. Tracing the urethra forward, leads to the **proximal penis**. On either side of the urethra are the **bulbourethral** glands.
7. Locate the penis, in the external urogenital orifice. Carefully make a transverse cut of the penis and locate the **penile urethra**, or spongy urethra, which is the part of the urethra that passes through the penis. Around the urethra is the cylindrical erectile tissues called the **corpus spongiosum** as well as the paired **corpora cavernosa** on the dorsal side.

If your specimen is a female:

1. Locate and identify the paired **ovaries**, found on the dorsal body wall, inferior to the kidneys.
2. On the surface of and around the ovaries are the coiled **uterine tubes**. Try and locate the **ovarian ligament** that extends from the uterus to the ovary, attaching the ovary to the dorsal body wall.
3. Observe the **uterus**, which is Y-shaped and has two uterine horns continuing into the uterine body. The uterine tubes lead into the uterine horns, where ova are implanted once fertilized.
4. Find the **broad ligament** connecting the uterine horns to the body wall, and the **round ligament** found along the middle of the uterine horn and anchors the horn in position.

5. The rest of the reproductive structures can be viewed by cutting through the pelvic girdle. To do so, carefully with bone cutters, locate the pubic symphysis as the midline of the pelvic bone. Once this is cut, spread the thighs to expose the structures. This must be done carefully as the urethra and vagina are found directly behind the bone.
6. Follow the uterus body caudally into the pelvic body. This leads into the **vagina**, which is continuous with the uterus. Also, locate the **urethra**, emerging from the urinary bladder.
7. The vagina and urethra unite at the urethral orifice, a common passageway for both the urinary and reproductive systems.
8. Finally, locate the **urogenital orifice** which is surrounded by folds of skin called the labia majora and covered by the genital papilla; all of which is called the vulva.