LABORATORY

34 Dissection of the Fetal Pig: External Parts, Bones, and Muscles

Overview

Beginning with this laboratory session, you will study the gross anatomy of the fetal pig. The pig is a representative member of the best known subclass of mammals—the eutherians, animals with a well-developed placenta. Humans also belong to this subclass. Because of the many anatomical and biochemical similarities between pigs and humans, the pig affords many useful comparisons with human anatomy. In addition, the fetal animal you will use allows you to examine structures unique to the fetus, as well as immature adult structures.

Student Preparation

Prepare for this laboratory by reading the text pages listed in the Textbook Reference Table at the back of this manual. Also, before beginning this dissection, it is important to complete Laboratory 30.

If your school does not provide dissection equipment, bring the instruments designated by your instructor with you to this and the next three laboratory periods.

About This Dissection

The organs and tissues of fetal animals are fragile. Carefully follow the sequence of steps in each exercise; otherwise you might damage an organ that you will need to study in a subsequent lab.

Exercise A Taxonomic Comparison of the Pig and the Human

Objectives

☐ Differentiate between the taxonomic classifications of the pig and the human.

A comparison of the taxonomic classifications of pigs and humans helps to reveal some shared characteristics. The kingdom is the highest level of classification. All animals belong to the kingdom Animalia. Consult your text to fill in the missing taxonomic terms in Table 34A-1 and to answer the questions that follow.

a. At what taxonomic level do pigs and humans differ? _____

_____

Table 34A-1 Taxonomic Comparison of Humans and Pigs

Classification	Humans	Pigs
Kingdom	Animalia	Animalia
Phylum	_____	_____
Subphylum	Vertebrata	_____
Class	_____	Mammalia
Subclass	Eutheria	_____
Order	_____	_____
Family	Hominidae	Suidae
Genus	*Homo*	*Sus*
Species	*H. sapiens*	*S. scrofa*

b. What are the distinguishing features of vertebrates? _____

_____

c. What is the distinguishing feature of eutherians?

_____

d. Humans are members of the order Primates whereas pigs belong to the order Artiodactyla. What are the distinguishing features of artiodactyls? _____

_____

Of primates? _____

Exercise B External Features of the Fetal Pig

Objectives

- ☐ Describe the external anatomical features of the pig.
- ☐ Determine the sex of the fetal pig.

Procedure

1. Line a dissection pan with paper towels.
2. Put on your plastic gloves.
3. Remove your pig from its plastic bag. Pour off any excess preservative into the waste vessel provided.

Your pig's body may be covered by an extremely thin outer layer called the **periderm**, which is easily removed and may be discarded. Human babies do not have a periderm, but may be covered with a cheeselike substance (vernix) instead.

The body is divided into four regions: the head (**cranial region**); the neck (**cervical region**); the trunk (**thoracic**, **lumbar**, and **sacral regions**); and the tail (**caudal region**).

THE HEAD AND NECK

Look at the head in more detail. The characteristic snout is composed of bone and cartilage. The bone at the tip allows the pig to push and root with its snout. Squeeze the snout gently

with your fingers to feel its consistency. The nostrils, also called **external nares**, open into the nasopharynx. Both the nasopharynx and the mouth open into the pharynx.

Use the blunt probe to explore your pig's mouth. You may want to clip the corners of the pig's mouth with your scissors so that it may be opened wider. Pigs are omnivorous (as are humans), eating both animal and plant matter. Notice its baby teeth. Adult pigs have sharp pointed incisors and flattened premolars and molars.

a. How does the inside of the pig's mouth compare with yours? _____

_____

Spread your pig's upper and lower eyelids and look at the eye. Locate the lidlike nictitating membrane in the corner of the eye. The nictitating membrane helps to clean the surface of the eye. *b. Do fetal pigs have eyelashes?* _____

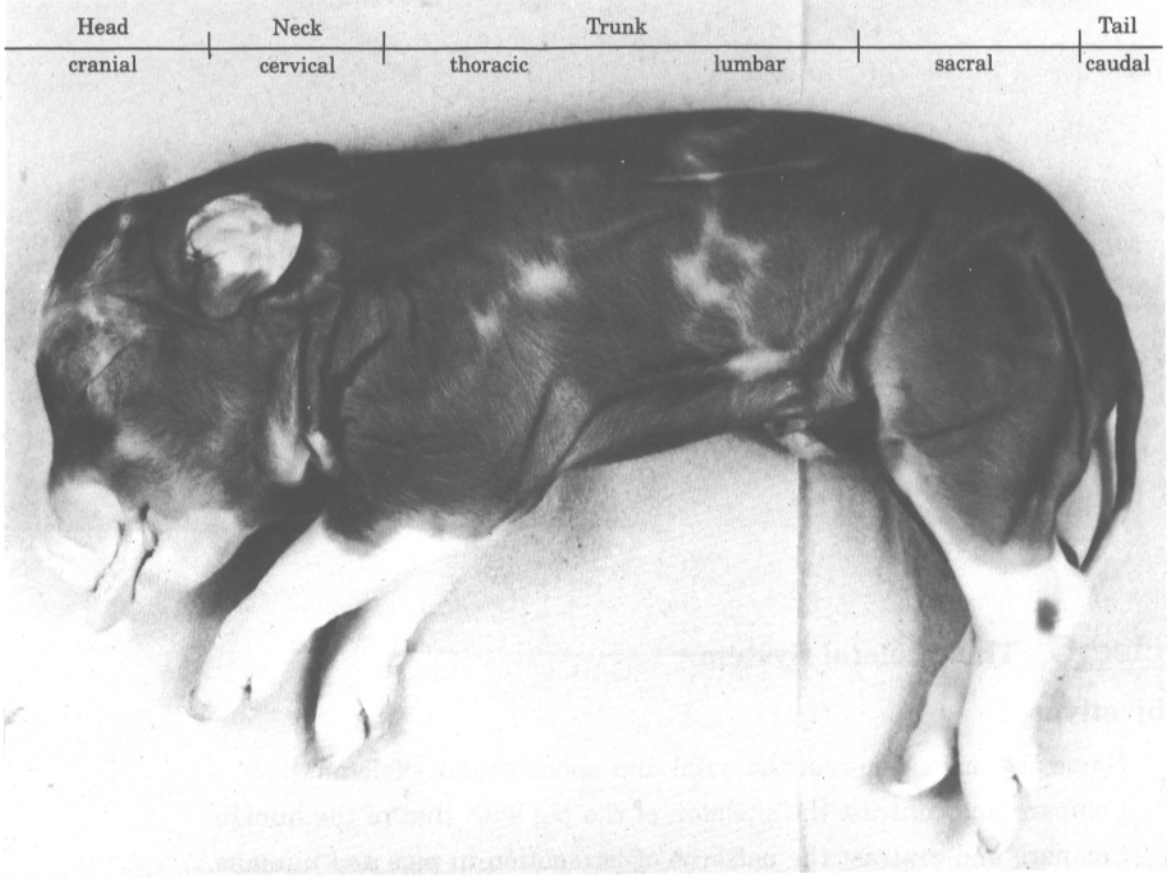
The external ears are called **pinnae**. They are composed of cartilage. *c. How far can you see into the ear?* _____ *Describe what you see.* _____

The pig's neck is short but strong. The slit you see is where blood vessels were exposed for the injection of red and blue latex to mark the arteries and veins, respectively.

THE TRUNK

Turn your pig on its side. The names of the regions of the trunk also describe the vertebral regions of the spinal column. Determine the regions of your pig that correspond to the regions labeled in Figure 34B-1. Use a ball-point pen to mark the division between adjacent regions on the skin of your pig.

Figure 34B-1 *Head, neck, trunk, and tail regions of the fetal pig.*



d. Where is the division between the cervical and thoracic regions? _____

The thoracic region ends at the last rib; the lumbar region begins here and continues to the pelvic girdle (area above the back legs). (Palpation may help you to locate these boundaries.)

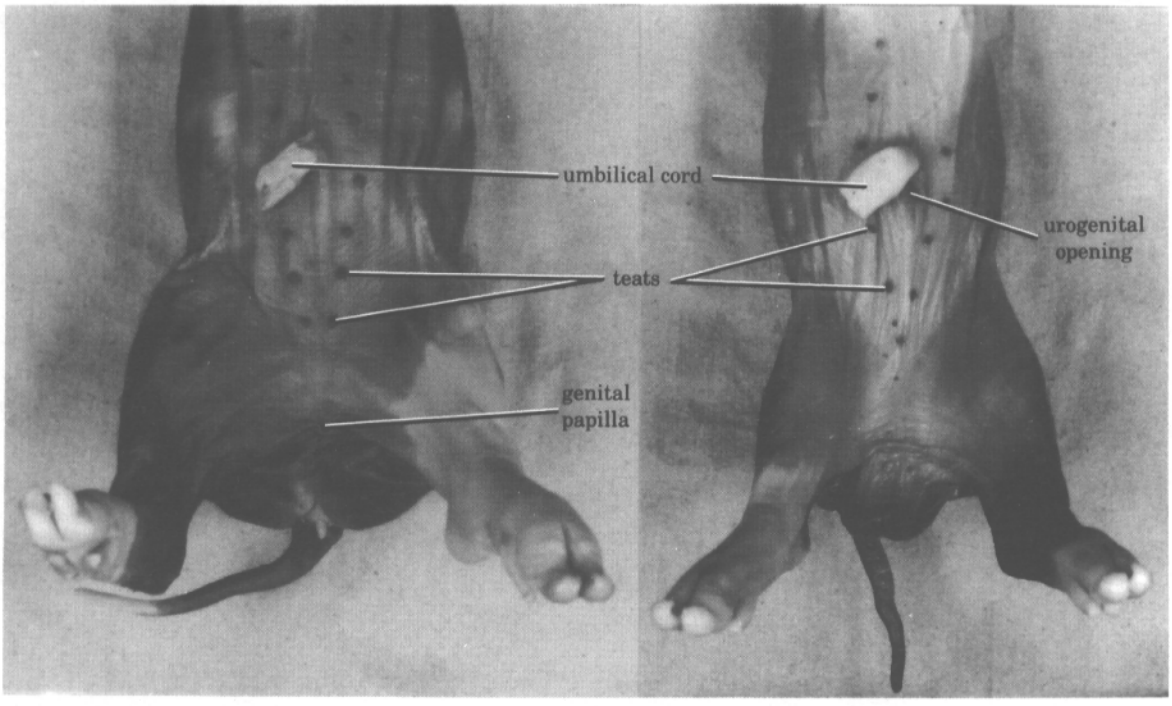
Turn your pig on its back (dorsal surface) to examine its ventral surface. Both male and female pigs have five to eight pairs of teats running along the ventral surfaces. A prominent feature of the trunk is the umbilical cord. Observe the two umbilical arteries (injected with red latex) and the large umbilical vein (injected with blue latex). We will look at the umbilical cord in more detail when we study the circulatory system, so do not cut it off.

The pig's tail is an extension of the sacral region of the vertebral column. Notice that it is not curled in the fetus.

SEXING YOUR FETAL PIG

In male pigs, the **external urogenital opening** is immediately posterior to the umbilical cord (Figure 34B-2b). Ventral to the tail is the **anus**, the exit of the gastrointestinal tract. Ventral to the anus is the **scrotum**, which contains the **testes** in older fetuses. In female pigs, the external urogenital opening is marked by the **genital papilla**, a small protrusion of tissue ventral to the anus (Figure 34B-2a).

Figure 34B-2 *Ventral aspects of (a) the female and (b) the male fetal pig.*



(a) (b)

Exercise C The Skeletal System

Objectives

- ☐ Name the major bones of the axial and appendicular skeletons.
- ☐ Compare and contrast the skeleton of the pig with that of the human.
- ☐ Compare and contrast the patterns of locomotion in pigs and humans.

All vertebrates possess internal skeletons (endoskeletons) that provide mechanical support for their bodies. The endoskeleton also determines an animal's basic body shape and proportions. In conjunction with muscles, the skeleton allows the animal to move. Endoskeletons are divided into two major parts: the **axial** and the **appendicular** skeletons.

You will not dissect the skeletal system of the pig, but you should be able to recognize the major vertebrate skeletal structures. Skeletons or diagrams of vertebrates other than the pig may be available in your classroom (e.g., human, cat, frog, etc.). Refer to the diagram of the adult pig skeleton in Figure 34C-1 and the diagram of the human skeleton in Figure 34C-2 while examining your fetal pig.

THE AXIAL SKELETON

The axial skeleton is composed of the skull, vertebral column, ribs, and sternum.

The **skull** includes the **cranium** and the facial bones. Humans have 14 facial bones and pigs have 19.

*a. What is the main function of the cranium?*_____

The Vertebral Column

The vertebral column is the major support structure of the vertebrate body and the major identifying characteristic of the vertebrates. This column formed of vertebrae protects a vital portion of the nervous system: the delicate spinal cord. Many muscles are attached to the vertebral column, which is subdivided into five regions described in the text that follows.

The Cervical Region Virtually all vertebrates, from the tiniest shrew to the tallest giraffe, have seven cervical vertebrae. The first vertebra is called the atlas, after the mythological Atlas who supported the world on his shoulders.

The Thoracic Region Vertebrae in this region have prominent dorsal processes (projections) and lateral depressions that serve as attachment points for the ribs. Humans have 12 thoracic vertebrae while pigs have 14 or 15.

The Sternum and Ribs The sternum is the ventral attachment point of 7 of the 12 pairs of ribs in humans. In pigs, as in humans, seven pairs of ribs connect via cartilage to the sternum. The pig has a total of 14 pairs of ribs.

The Lumbar Region In humans, the lumbar region is the lower back region (the site of back pain for many). Humans have five lumbar vertebrae while pigs have six or seven. Compared to the thoracic vertebrae, these vertebrae have reduced (shorter and wider) dorsal processes and exhibit long lateral processes.

The Sacral Region The sacrum consists of four (in the pig) or five (in the human) vertebrae fused into a single structure that supports the pelvic girdle.

The Caudal Region In humans, this region consists of four or five vertebrae fused into a vestigial "tail" called the **coccyx**. In the pig, 20 to 23 vertebrae constitute the tail.

THE APPENDICULAR SKELETON

The appendicular skeleton consists of the bones (other than the ribs) lateral to the vertebral column. It includes the pectoral girdle, the forelimbs, the pelvic girdle, and the hindlimbs.

The Pectoral Girdle In humans, the pectoral girdle is formed of two **clavicles** and two **scapulas**. The clavicles are called collar bones and the scapulas are known as shoulder blades. Pigs lack one of these pairs of bones. Examine Figure 34C-1. Which pair is missing? _____ Much of the scapular mass of pigs remains cartilaginous, rather than bony, even in the adult.

Figure 34C-1 *Skeleton of the adult pig.*

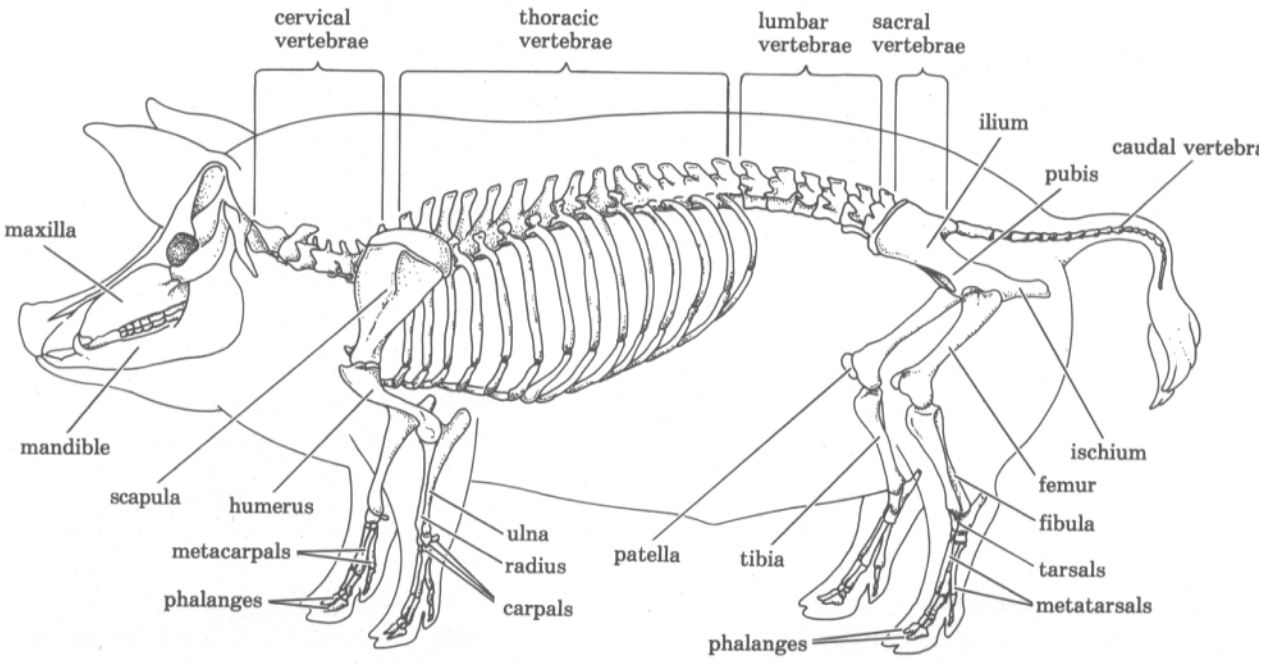
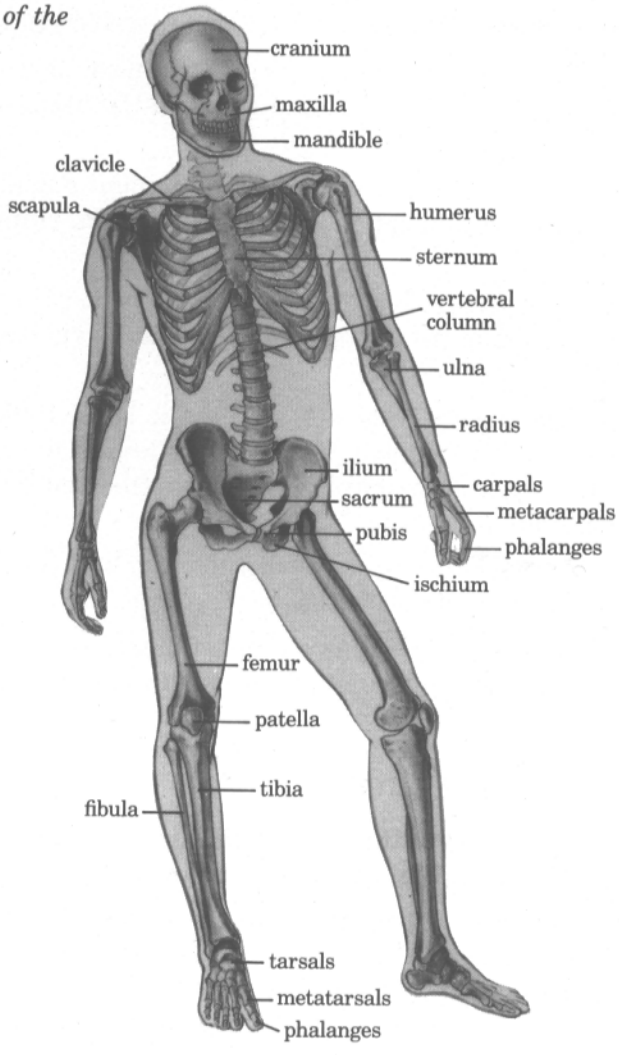


Figure 34C-2 *Skeleton of the adult human.*



Use Figures 34C-1 and 34C-2 to name the upper bone of the forelimb, which is much shorter in the pig than in the human. The bones of the lower forelimb are called the _____ and the _____.

In humans, the radius terminates in the wrist near the thumb. Together, the radius and ulna permit rotation of the forelimb. The bones of the wrist are collectively called **carpals**, and the bones of the palm are collectively called **metacarpals**. Human fingers (**digits**) are composed of bones called **phalanges**. The pig has fewer metacarpals and phalanges than does the human. Examine Figures 34C-1 and 34C-2 and compare the shapes of the carpals, metacarpals, and phalanges in pigs and humans.

The Pelvic Girdle The pelvic girdle (pelvis) in both humans and pigs is composed of three pairs of fused bones (the ilium, ischium, and pubis) connected to and separated dorsally by the fused bones of the sacrum. The pelvic girdle is more elongated in pigs than in humans.

The upper bone in the hindlimb is called the _____ (thigh bone). It joins with the _____ (shin bone) and _____ (calf bone) at the knee. The knee cap is called the **patella**. Like the bones of the forelimb, the bones of the hindlimb are much shorter in the pig than in the human. The bones of the ankle are called **tarsals**. The bones of the foot are called **metatarsals**, and the bones of the digits of the foot (toes) are called **phalanges**.

Look carefully at the feet of your pig. The first digit, which would correspond to your thumb or big toe, is missing. Of the pig's four digits, the middle two are flattened and hoofed. Pigs walk on the tips of their toes, a pattern of locomotion known as **digitigrade.** Since the two middle toes (toes three and four) upon which they walk are hoofed, they are classified as ungulates; the fact that they have an even number of toes places them in the order Artiodactyla. Horses are also ungulates, but walk on the tip of a single hoofed toe, and therefore belong to the order of odd-toed ungulates, Perissodactyla. In contrast, humans use the entire foot for walking, a pattern of locomotion called **plantigrade**.

Exercise D Muscles of the Thorax and Forelimb

Objectives

- ☐ Identify the major muscles of the thorax and forelimb of the pig and describe their functions.
- ☐ Describe how antagonistic muscles function.

Skeletal muscles enable the body to move. Most muscles are attached to bones by small, tough strips of connective tissue called **tendons**. The **origin** (the proximal or less mobile end) of a muscle is usually attached to one bone, and its **insertion** (the other end) is attached to another bone.

Muscles generally work in antagonistic pairs. That is, for every muscle that moves a bone in one direction, another muscle moves the bone in the opposite direction. These are the words used to describe the actions of muscles: to **flex**, to decrease the angle between two bones at a joint; to **extend**, to increase the angle between two bones at a joint; to **adduct**, to move an appendage medially; to **abduct**, to move an appendage laterally.

Procedure

1. Before you start your first dissection, loop two rubber bands together to make them longer. Place your pig, ventral side up, in a dissection pan lined with paper towels. Loop one end of the extended rubber bands around one forelimb near the pig's foot. Bring the rubber band under the pan and loop it around the other forelimb to anchor the limbs. Repeat this procedure with two more linked rubber bands to anchor the hindlimbs.

2. Refer to the numbered parts of Figure 34D-1 corresponding to the instructions that follow. Since we are interested in exposing the muscles on only one side of the pig's body, perform the following operations on only one side of your pig.
3. Make a small midventral incision through the skin only (not the underlying tissue) at the base of the pig's throat. Holding the skin away from the body as much as possible, insert the tip of your scissors into the incision (**1**) and continue cutting in a caudal direction until you are 2 cm from the umbilical cord.

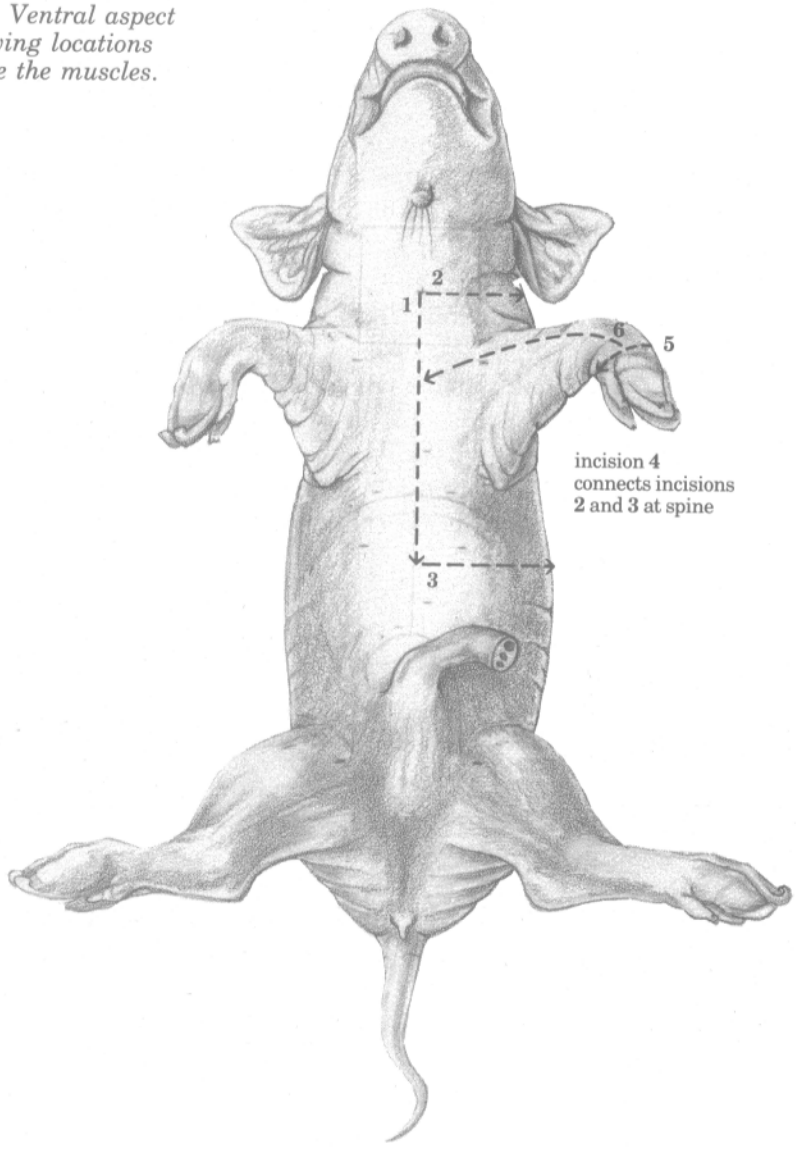


Figure 34D-1 *Ventral aspect of the pig, showing locations of cuts to expose the muscles.*

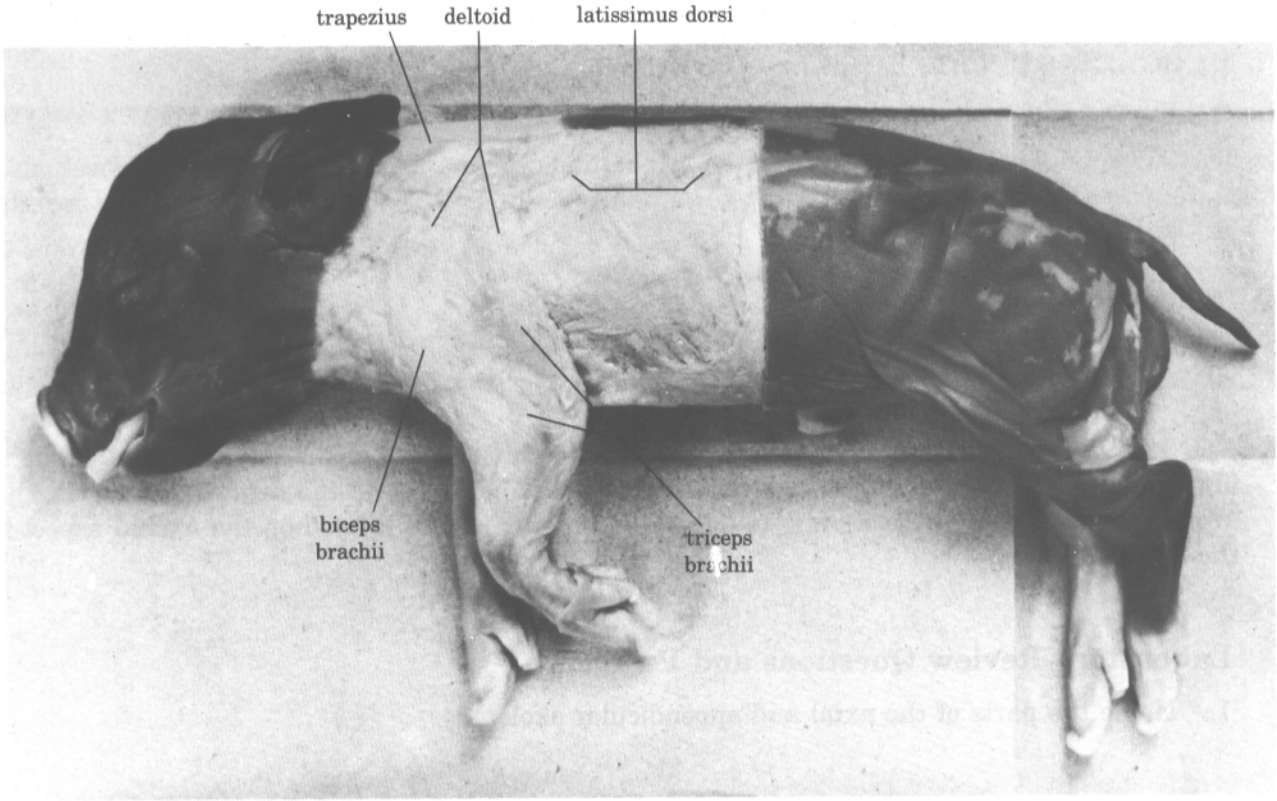
4. Using your scissors, make incisions at the anterior (**2**) and posterior (**3**) ends of the first incision (**1**). Each incision should extend around the side of the pig dorsally toward the spine. You will need to remove the rubber bands temporarily from the pig's legs to complete these incisions.

5. Connect these two incisions by cutting along the spine (**4**). Finally, make an incision all the way around the pig's wrist (**5**) and extend another incision (**6**) on the medial surface of the forelimb from the wrist to the original midventral incision.
6. Ease the skin loose by running your fingers or probe between the skin and the underlying connective tissue, starting at the midventral incision and working toward the dorsal side. In a number of areas, a layer of light brown muscle fibers may be adhering to the underside of the skin. This is the **cutaneous maximus**, which covers the body in the thoracic and abdominal regions. It is responsible for twitching the skin (to remove flies, for example). Humans do not have this muscle layer.
7. Another subcutaneous muscle, the **platysma**, is found laterally on the head and neck. Gently scrape (do not cut) these adhering muscles loose from the underside of the skin with your scalpel. After the skin is removed you will see that the muscles are covered with two layers of connective tissue (**fascia**). The superficial fibrous fascia connects the skin to the muscles below and is easily removed. The deep fascia, which connects muscles to other muscles, is much tougher.
8. Place the pig on its side with the exposed muscles facing you. Be careful in handling these muscles because they are immature and can be easily torn. Use your blunt probe to help in your examination.

MUSCLES OF THE SHOULDER REGION

Use Figure 34D-2 to help you locate and identify the structures discussed in this exercise.

Figure 34D-2 *Muscles of the shoulder and forelimb.*



Latissimus Dorsi

The latissimus dorsi is a broad, flat muscle that has its origin on the vertebrae from the lower thoracic region through the lumbar region. It is directed anteriorly and ventrally, passing under part of the **trapezius** muscle and medially to the forelimb, where it inserts at the proximal end of the humerus.

a. *What is the function of the latissimus dorsi?* _____

_____

Deltoid

In humans, the deltoid is a single large muscle that covers the lateral part of the shoulder. In pigs, this muscle has several parts.

b. *The deltoid inserts at the anterior part of the humerus and is responsible for what type of movement?* _____

_____

To some extent, the latissimus dorsi and the deltoid are **antagonistic** muscles.

c. *What does antagonistic mean in the context of these two muscles?* _____

_____

Trapezius

This broad muscle originates at the base of the skull and extends to the first two-thirds of the thoracic vertebrae. It pulls the scapula medially.

You can see from your specimen that many other muscles are also responsible for movement in the shoulder region.

MUSCLES OF THE FOREARM REGION

Triceps Brachii

This large muscle extends posteriorly along the humerus; its action is to extend the forelimb. It is composed of three parts. The triceps originates at the upper end of the humerus and inserts on the proximal end of the ulna.

Biceps Brachii

The biceps is small, compared with the triceps, and extends along the anterior edge of the humerus. To see it clearly, free the muscle overlying it (the claviobrachialis) and gently push it back. The biceps and triceps act antagonistically.

There are many smaller muscles in the forelimb of the pig. On the lateral aspect of the lower forelimb are the muscles whose primary function is to extend the carpals and digits. Muscles whose primary function is to flex these same parts are located on the medial aspect of the lower forelimb.

Laboratory Review Questions and Problems

1. Name the parts of the axial and appendicular skeletons.

2. Which vertebral column has the most bones in it, the pig's or the human's?

3. What are antagonistic muscles? Give an example from the muscles you dissected today.

4. Describe the differences in location of the genital areas of the male and female pig.

5. Describe the difference between digitigrade and plantigrade locomotion.

6. Describe the meaning of the term ungulate. Why are pigs called even-toed ungulates (order Artiodactyla)?

7. Sketch an animal such as a dog, cat, or horse. Label it with the following terms: dorsal, ventral, anterior, posterior, caudal, pedal, cranial, proximal, and distal.

LABORATORY 35

Dissection of the Fetal Pig: Digestive and Respiratory Systems

Overview

Some unicellular heterotrophs obtain nutrients in a usable form directly from their environment. Most multicellular heterotrophs, however, must process their food before its nutrients are available to their cells. This processing (digestion) is accomplished as the food passes through a special organ system called the **alimentary canal**. Once processed and absorbed into the body, the nutrients can be further metabolized by cells to yield carbon dioxide, water, and energy.

All heterotrophic organisms require oxygen to metabolize carbon compounds during cellular respiration. In unicellular organisms, diffusion of oxygen across the cell membrane is sufficient. In large multicellular organisms, including vertebrates, the **respiratory system** has evolved and is responsible for bringing oxygen into contact with the blood. The circulatory system then distributes oxygen to the body's tissues. In today's laboratory we will explore the anatomy of the mammalian digestive and respiratory systems.

Student Preparation

Prepare for this laboratory by reading the text pages listed in the Textbook Reference Table at the back of this manual.

If dissecting equipment is not supplied in the laboratory, bring your scalpel, probe, dissecting needles, and scissors.

Exercise A Exposing the Internal Organs of the Fetal Pig

Today you will study the internal anatomy of the fetal pig. Keep in mind that the arrangement of the internal organs in the fetal pig is similar to that in the human body.

Be careful when handling and moving the internal organs; they are fragile. If two of you are working with one pig, be sure that both of you are involved in the dissection process. To assure that incisions are properly positioned, discuss each step with your partner. If any structures are poorly preserved in your specimen, be sure to locate them in another animal.

Objectives

- ☐ Use appropriate dissection techniques to expose the internal organs of a representative vertebrate.

Procedure

Use Figure 35A-1 as a guide for making the incisions outlined in this section. The numbers in the directions match the numbers in the figure.

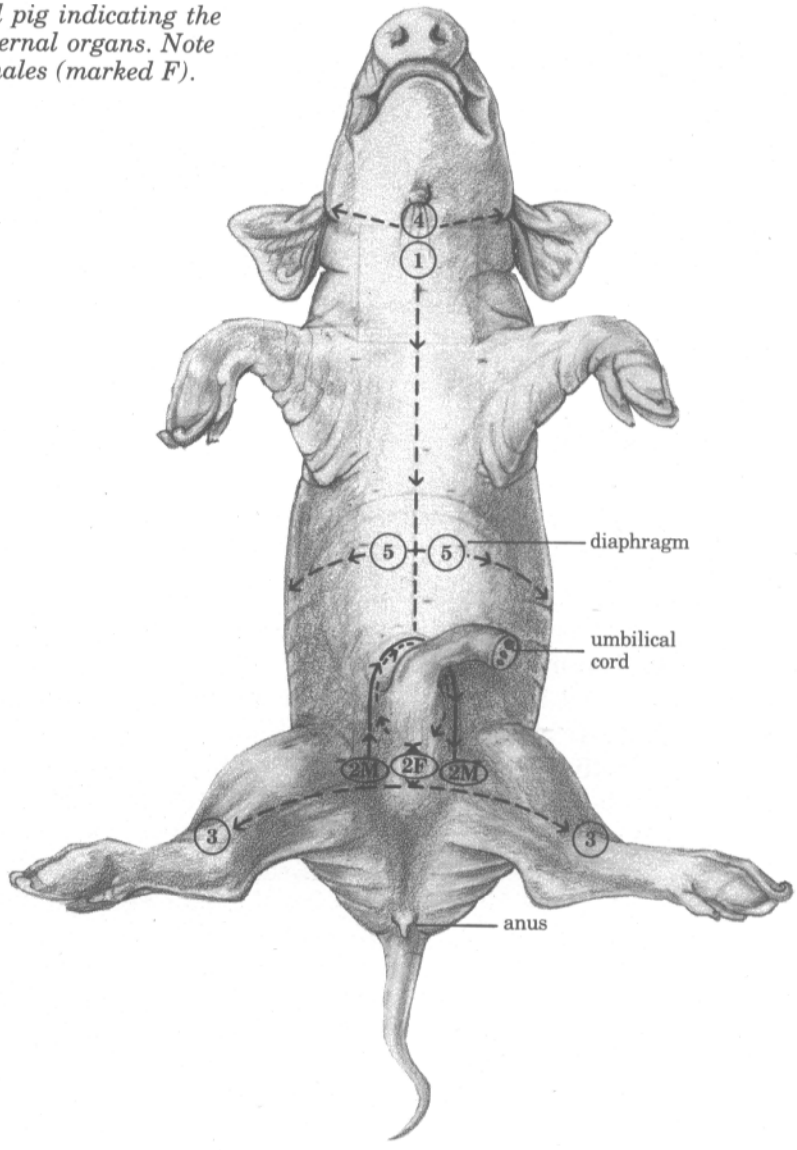


Figure 35A-1 *Ventral view of the fetal pig indicating the position of incisions for exposing the internal organs. Note incisions for males (marked M) and females (marked F).*

1. Secure the pig on its back in a dissection pan using rubber bands as in the previous laboratory. Cutting only through the top layer of muscle, make the first incision (1) midventrally from the tuft of hair under the pig's chin to an area approximately 2 cm anterior to the umbilical cord. Do not cut too deeply or you may damage the internal organs.

2. What is the sex of your pig? If your specimen is a male, make a second incision (2M) that partially encircles the umbilical cord anteriorly and then extends posteriorly as two parallel incisions. All incisions made between the hindlimbs of males should be shallow to avoid damaging the testes.

   If your specimen is a female, the second incision (2F) should completely encircle the umbilical cord and continue as a single incision posteriorly to the region between the hindlimbs.

3. In the region between the hindlimbs, make a third incision (3) in the shape of a half-moon that extends from side to side.

   Pour any fluid that may be in the body cavity into a liquid-waste disposal vessel, and then gently rinse the cavity with water. From the anterior end of your midventral

incision, make a fourth incision (4) extending outward in both directions to the lower (ventral) sides of the neck. Do not cut too deeply in this area; cut through only the skin.

4. Feel the pig's chest to locate the lower margin of the rib cage. Just below the ribs, make a fifth incision (5) extending from side to side. A sheet of tissue, the **diaphragm,** is connected to the ventral body wall in this area. Use your scalpel to free the diaphragm from the body wall. Open up the anterior skin flaps. Some pigs have been overinjected with blue and red latex. The excess latex frequently forms a mass in the abdominal cavity. Remove this carefully.
   a. Which two body cavities are separated by the diaphragm? _____
5. Remove the ventral part of the rib cage by cutting through the ribs on both sides of the sternum with a pair of scissors. Be careful not to damage the lungs and the heart, the two major organs of the thorax.
6. Look for a dark tubular structure extending from the umbilical cord anteriorly to the liver. This is the **umbilical vein**. Tie two pieces of thread around the vein approximately 1 cm apart and cut the vein between the two threads (the threads tied around the umbilical vein will help you to identify this structure in a later laboratory). Now the skin flap surrounding the umbilical cord may be reflected outward.
7. Pin the anterior and posterior skin flaps beneath your pig.

Exercise B Structures of the Head and Neck

Objectives

☐ Identify the name and location of the major glands present in the head and neck of the fetal pig.

Procedure

1. In the neck region, locate the **thymus gland**. This is a whitish, bilobed body (the left lobe is usually larger) partially covering the anterior portion of the heart and extending forward along the trachea to the larynx. In adults, the thymus gland will be considerably reduced in size. Record the shape and color of this organ.

   _____

2. Locate the **thyroid gland** beneath the thymus. It is a reddish, oval mass that is more solid than the thymus.
   a. Compare the size, shape, and consistency of the thyroid and thymus glands.

   _____

   b. What is the function of the thymus?

   _____

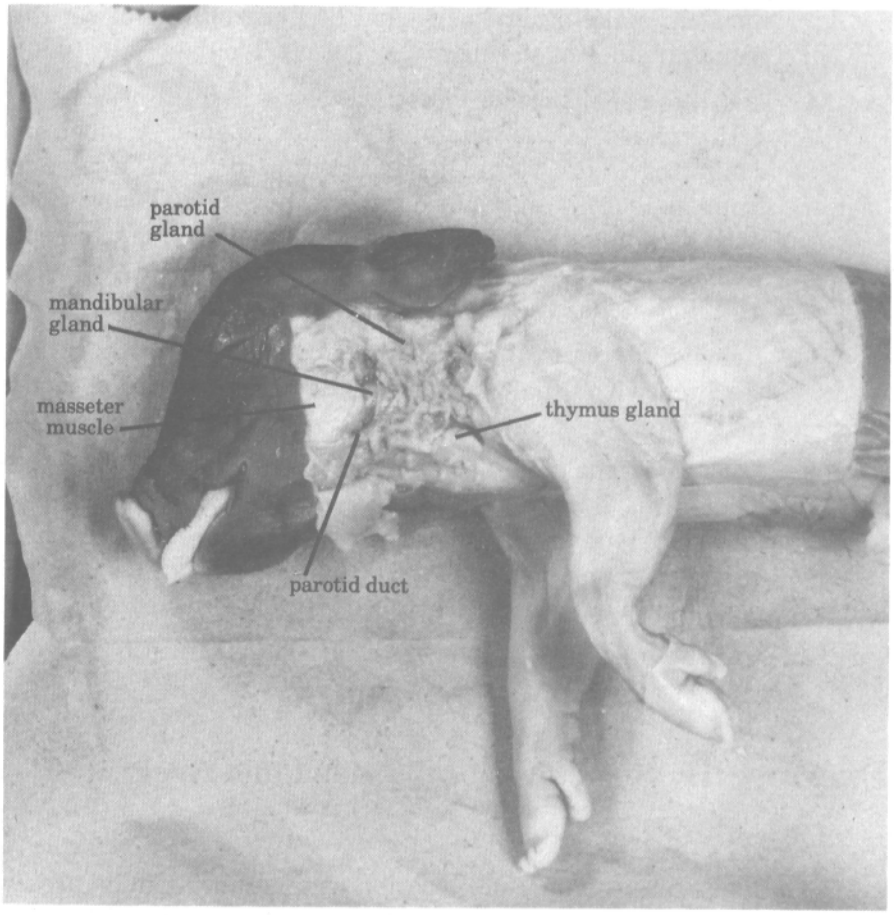
   c. What is the function of the thyroid gland?

   _____

3. To expose the salivary glands in the neck region, work on the side of the animal that you used during your dissection of the muscles in the forelimb. Starting from the original cut used to expose the forelimb muscles, cut through the skin to the base of the ear as shown in Figure 35B-1. Continue the cut anteriorly to the corner of the eye, and then toward the chin.

   Reflect the skin outward. Carefully tease away the connective tissue and muscles that cover the **parotid gland**, a large triangular salivary gland that extends from the midline

Figure 35B-1 *Dissection of the head and neck region.*



of the neck anteriorly to the edge of the ear. The parotid duct runs just under the large, rounded masseter muscle and empties into the mouth.

d. Judging from its location, what do you think is the function of the masseter muscle?

_____

4. The **submaxillary** salivary gland is small and oval and lies directly below the parotid gland. Cut through the middle of the parotid gland toward the ear. Do not cut so deeply that you damage the submaxillary gland. *e. Record the size, shape, and color of the submaxillary gland.*_____

*f. Can you find any lymph nodes in this area? If so, describe their appearance and location. What is the function of the lymph nodes?*_____

_____

_____

5. The third salivary gland, the **sublingual**, is flat and narrow. It may be difficult to locate. It partially surrounds and covers the anterior half of the submaxillary duct. The ducts for both the submaxillary and sublingual glands lead to the floor of the mouth.

*g. What is the major function of the salivary glands?*_____

Exercise C The Oral Cavity

Objectives

☐ Identify the name, location, and function of the major structures in the oral cavity of the fetal pig.

Procedure

1. The mouth opens into the oral cavity. The area between the lips and teeth is called the **vestibule**. On the same side as the exposed salivary glands, remove the muscle and connective tissue of the cheek.
2. Carefully slice away the bone of the jaws to expose the developing teeth. Extract a tooth and examine it. The **crown** projects through the gums, the **neck** of the tooth is surrounded by the gums, and the **root** is embedded in the jawbone.
3. To examine the oral cavity in more detail, cut through the corners of the mouth and back through the jaws toward the ears. This will allow the lower jaw to lie flat.
4. The roof of the oral cavity is made up of the **hard palate** and the **soft palate**. *a. Which one has ridges?* _____
5. Locate the opening to the **nasopharynx** just posterior to the soft palate. The soft palate divides the oropharynx (ventral) from the nasopharynx (dorsal) (Figure 35C-1). Unlike humans, the pig does not have a fingerlike process, the uvula, dangling from the posterior aspect of its soft palate. In humans, the nasopharynx is referred to as the throat.
6. Can you locate the openings to the **esophagus** and the **trachea**? *b. What do the esophagus and trachea lead into?* _____

   The opening to the trachea is called the **glottis**. A loose piece of tissue, the **epiglottis**, is located on the anterior edge of the glottis. *c. What is the purpose of the epiglottis?*

   _____
7. On the floor of the oral cavity is the tongue. Notice that the surface of the tongue is covered by tiny bumps called **sensory papillae** supplied with nerve endings. Your own tongue is covered with taste buds that carry out the same function.

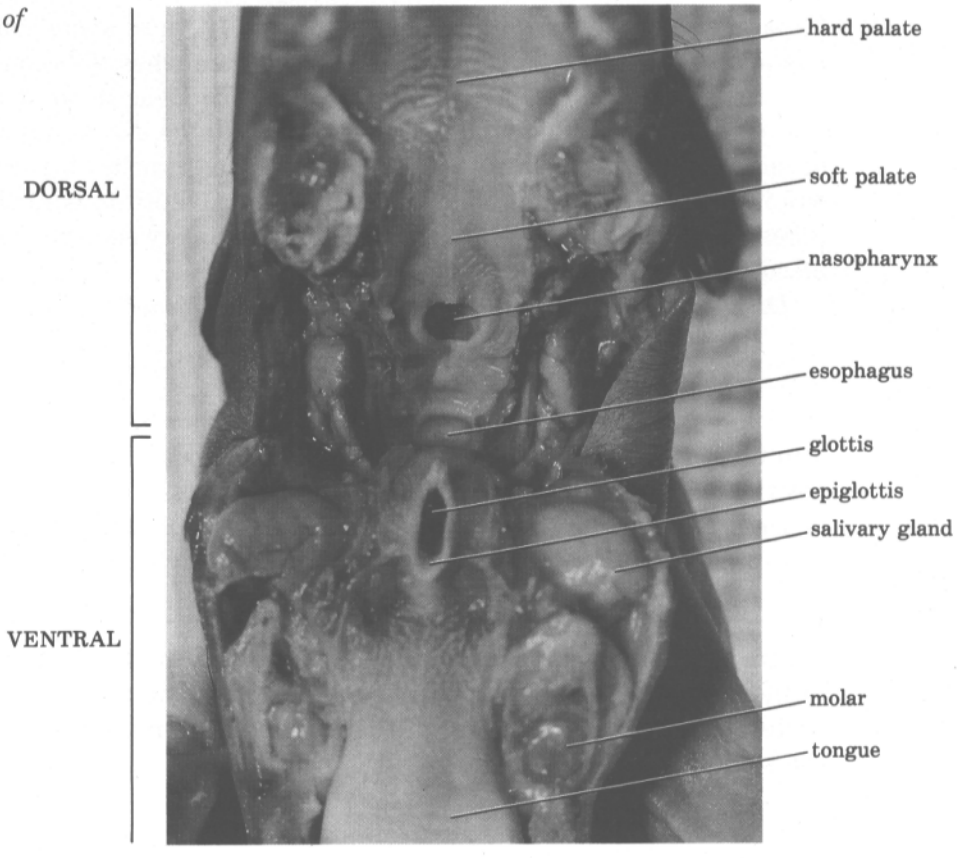


Figure 35C-1 *Structures of the oral cavity.*

Exercise D The Upper Portions of the Respiratory and Digestive Systems

Objectives

☐ Identify the name and location of the major anatomical structures in the upper portions of the digestive and respiratory systems of the fetal pig.

Procedure

1. In mammals, air enters the **external nares** (nostrils) and passes through the nasal chambers above the hard palate to the internal nares of the nasopharynx. Cut through the soft palate longitudinally to expose the nasopharynx of your pig.
2. From the oropharynx, air passes through the glottis into the **larynx**. Make a longitudinal slit into the larynx to expose the vocal cords. These are inconspicuous flaps of tissue on the ventrolateral surfaces of the larynx. The larynx is commonly referred to as the "voice box" or the "Adam's apple" in humans.
3. The **trachea** extends from the larynx to the lungs. Rings of cartilage prevent this tube from collapsing. Try to identify the tough, white threadlike **vagus nerve** running along the side of the trachea.
4. Carefully examine lung tissue in the vicinity of the heart. Above the diaphragm, the coelom is divided into **pleural cavities** containing the lungs. The heart is contained in the **pericardial sac**, located between the two pleural cavities.

   The lungs of the fetal pig are filled with fluid rather than with air because the fetus has never breathed. *a. Which lung is larger?* _____ *b. How many lobes does each lung have?* _____
5. Gently push the heart to one side and carefully tease away some of the anterior lung tissue to expose the point where the trachea branches to become the **bronchi**. The bronchi are stiffened by plates of cartilage instead of rings as in the trachea. Are you able to see the network of smaller tubules called **bronchioles** extending from the bronchi? The bronchial system continues to branch until the branches become microscopic in size and end in grapelike clusters of small sacs called **alveoli**. It is in the alveoli that gas exchange takes place. Carbon dioxide and oxygen diffuse between the air in the alveoli and the blood in the capillaries of the lung tissue.

   c. Describe the path that air follows from the external nares to the alveoli of the lungs.

   _____

   _____
6. You already cut away the diaphragm as you exposed the thoracic cavity. Review the position of the diaphragm in relation to the lungs.

   d. Describe how the diaphragm, along with the muscles of the rib cage, is responsible for drawing air into the lungs.

   _____
7. Locate the esophagus, a collapsed tube dorsal to the trachea, and trace it from the mouth to the stomach. Insert your blunt probe through the opening of the esophagus and direct it posteriorly. Follow the course of the esophagus through the neck and thoracic regions to the stomach.

Exercise E The Liver and Pancreas

Objectives

☐ Identify the location and function of the liver and pancreas in the fetal pig.

Procedure

Use Figure 35E-1 to help you locate and identify the structures discussed in this exercise.

1. Pin back the skin flaps of the thoracic and abdominal cavities. The **liver** is the largest organ of the abdominal cavity. *a. Describe its shape, size, and color. Into how many lobes is it divided?*_____

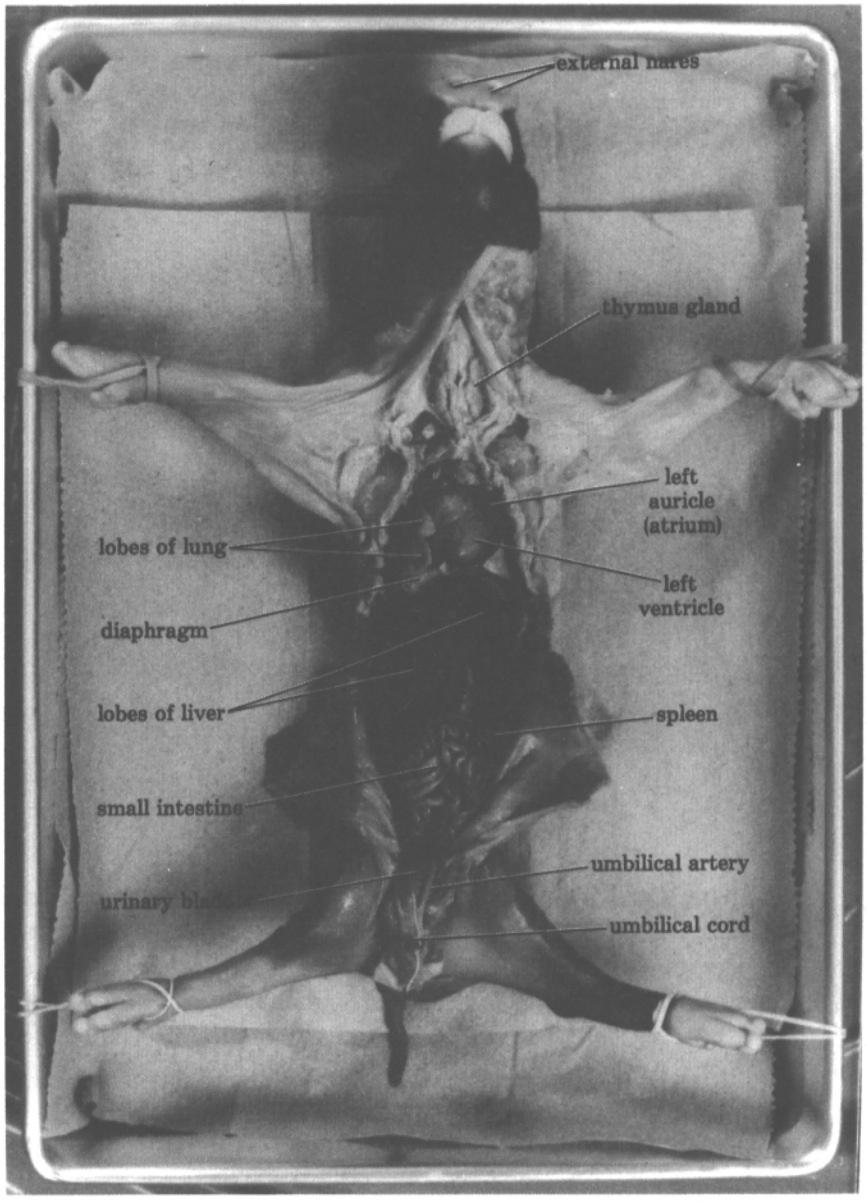


Figure 35E-1 *Ventral view of the fetal pig with internal organs labeled.*

2. Lift the right central lobe of the liver and locate the **gallbladder**. This saclike structure is the storage site for bile. Notice the small cystic duct that leads from the gallbladder and joins the hepatic ducts from the liver to form the common bile duct, which empties into the **duodenum**. The duodenum is the portion of the small intestine that leads away from the stomach.
3. Locate the **pancreas**—a granular mass lying near the stomach and the duodenum (you may need to move the small intestines to find it). The pancreatic duct leads from the pancreas into the duodenum. Since the duct is embedded in the mass of pancreatic tissue, it may be difficult to find. Locate the duct where it enters the duodenum and trace it back to the pancreas.

b. What role does the pancreas play in digestion? _____

_____

c. What is the purpose of bile?

_____

Exercise F Structures of the Lower Digestive System

Objectives

☐ Identify the name, location, and function of the structures of the lower portion of the alimentary canal of the fetal pig.

Procedure

1. Locate the **stomach** below the diaphragm. The stomach is bean-shaped. The end that attaches to the esophagus is called the **cardiac** end (near the heart). The portion that empties into the duodenum is the **pyloric** end. On the dorsal side of the cardiac end is a blind pouch called the **diverticulum** of the stomach.
2. With your scissors, slit the stomach lengthwise just in front of the blood vessels that run along its greater curve. Examine and describe the stomach contents, if any.

_____

Clean out the stomach. Locate the anterior (cardiac) sphincter and posterior (pyloric) sphincter muscles that control the entry and exit of food materials. Note the **rugae** or folds on the internal surface of the stomach. These help to churn the food and mix it with digestive juices.

The contents of the fetal pig's digestive tract are called meconium, and are composed of epithelial cells sloughed off from the digestive tract, sebaceous secretions, hair, and amniotic fluid swallowed by the fetus. Its green color is due to the pigment biliverdin, contained in bile.

3. The **small intestine** is divided into three portions, the **duodenum**, which extends from the stomach to the level of the right kidney, the **jejunum**, and the **ileum**. These last two regions are sometimes difficult to distinguish in the fetal pig. The parts of the small intestine are coiled and held together by **mesenteries**. If your instructor so directs, cut these mesenteries and unravel the small intestine. Measure its length.
4. Remove a 10-mm section of the small intestine, slit it lengthwise, and open it out in a Petri dish filled with water. Use your blunt probe to flatten it. Using either a hand lens or a dissection microscope, look at the **villi**. These small projections are where nutrient and water absorption occurs.

a. Why does the small intestine have so many villi? _____

_____

5. At the juncture where the ileum joins the large intestine (**colon**), a blind pouch (**cecum**) is formed. In humans, the appendix extends from the end of a short cecum. The **colon** extends from the cecum to the **rectum**, the prominent portion of the large intestine terminating at the **anus**.
b. What is the major function of the large intestine? _____

_____

c. Do you think that its internal surface also has villi? _____ *Why or why not?*

_____

(If you are unsure of your answer, slit the large intestine open and study its internal surface.)

6. The passage of food through the alimentary canal is controlled by valves at the cardiac and pyloric ends of the stomach, between the ileum of the small intestine and the colon, and at the anus. These valves are composed of circular bands of muscle and are known as sphincters. Review and locate the position of these valves in the alimentary canal.

Laboratory Review Questions and Problems

1. How does the mammalian respiratory system function? What is the role of the diaphragm in ventilation of the lungs?

2. What is the purpose of the alveoli in the lungs? What functional similarity do alveoli have to the gill filaments of fish?

3. How does the epiglottis prevent the inhalation of food?

4. Why is it advantageous for the stomach to be below the diaphragm rather than above it?

5. Differentiate between the functions of the small intestine and the large intestine.

LABORATORY

36 Dissection of the Fetal Pig: Circulatory System

Overview

The circulatory system of higher animals consists of a continuous network of vessels that nourishes the body, supplies its cells with oxygen, and rids its cells of wastes. Nutrients are added to the blood as it passes through the capillaries associated with the small intestine and oxygen is added as blood passes through the capillaries of the alveoli in the lungs. Carbon dioxide is also removed in these same lung capillaries, while solute wastes are removed in the capillaries of the kidney. The heart provides the force that drives blood through this system. The lymph vessels, which constitute a minor but important adjunct and collateral circulatory system, return excess tissue fluid to the general circulation, purifying it as it passes through the lymph nodes.

The hearts of different classes of vertebrates exhibit different levels of complexity. The mammalian heart is the most complex and may be thought of as two, fused, two-chamber hearts, one governing flow of blood to the lungs (the **pulmonary system**) and the other governing flow of blood to the rest of the body (the **systemic system**).

Student Preparation

Prepare for this laboratory by reading the textbook pages listed in the Textbook Reference Table at the back of this manual. Many of the questions raised during this dissection can be answered from your textbook, other books, or lectures. Familiarize yourself with the flow of blood through the heart by studying the appropriate figures in your textbook. If dissecting equipment is not supplied in the laboratory, bring your scalpel, probe, dissecting needles, and scissors.

Exercise A Major Vascular Connections of the Heart

The vascular system of your pig has been injected with colored latex to help you differentiate between arteries and veins. The systemic arteries contain red latex, and the systemic veins contain blue latex.

Use your probe to expose and follow the pathways of blood vessels to and from the major body organs. In general, you will find that vessels in the anterior portion of your pig lie closer to the surface than do those in the posterior region. The positions of the body organs relative to the vessels will help you to identify some of the blood vessels you will be searching for. If the organs in the abdominal region hamper your study, gently push them aside.

Objectives

- ☐ Identify the major vessels associated with the heart of a fetal pig, including the inferior and superior vena cava, aortic arch, pulmonary arteries and veins, coronary arteries, and the ductus arteriosus.
- ☐ Describe the importance of the ductus arteriosus and foramen ovale in regulating fetal circulation.

Procedure

For this exercise and those that follow, use Figure 36A-1 as a schematic diagram to help you locate specific arteries and veins.

1. Use elastic bands to position your pig as you did in Laboratory 34. Reflect back the flaps of skin and pin them under your pig.
2. The right side of the heart is on your left.

   *a. Why?*_____

   _____

   *b. Are you looking at the heart's dorsal or ventral surface?*_____
3. Push the heart gently to the left. Locate the veins (injected with blue latex) bringing blood to the **right atrium** from the systemic circulation. These are the **anterior (superior) vena cava** and the **posterior (inferior) vena cava**. Identify these two veins.

   *c. Which is larger, the anterior or the posterior vena cava?*_____

   d. What do you think is responsible for this difference in size?

   _____
4. Trace the posterior vena cava posteriorly to the diaphragm. *e. Does it pass through the diaphragm as it continues its path?*_____
5. Most of the blood that enters the right atrium from the venae cavae passes to the **right ventricle**, then enters the trunk of the **pulmonary artery** [which extends dorsally and to the pig's left (your right)] as it courses toward the lungs. The pulmonary artery may be injected with blue latex, which indicates that this artery carries deoxygenated blood (usually a characteristic of veins). (Make a small incision in the vessel if you want to check.) *f. Does the pulmonary trunk leave from the dorsal or the ventral side of the heart?*_____
6. Identify the two **pulmonary arteries**, which leave the pulmonary trunk and carry deoxygenated blood to the lungs.

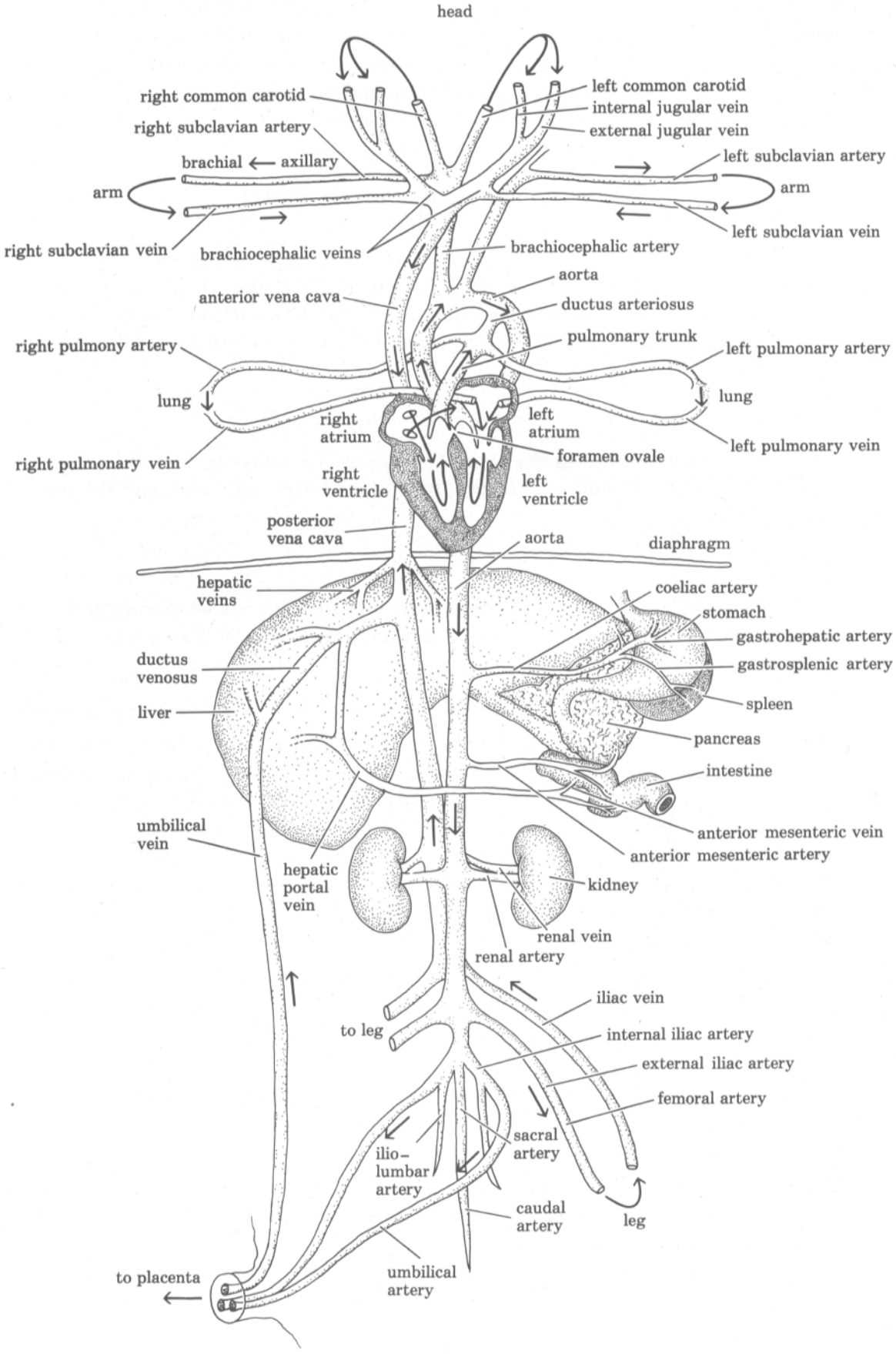
   g. Why are these vessels called arteries even though they carry deoxygenated blood?

   _____
7. In the mammalian fetus, only a small amount of blood actually enters the pulmonary system. Instead, most blood empties directly into the systemic system through two cross-connections: the **foramen ovale**, an opening between the two atria of the heart, and the **ductus arteriosus**, a shunt between the pulmonary trunk and the arch of the systemic aorta (Figure 36A-1). These fetal structures close after birth, becoming, respectively, part of the wall between the atria and a tough strand of connective tissue binding the pulmonary trunk to the aorta.

   h. Why is it not necessary for the fetus's blood to pass to the lungs?

   _____

Figure 36A-1 *Circulation in the fetal pig.*



8. Carefully move the lungs and the heart so that the **pulmonary veins** are visible. Locate the vessels that leave the lungs and enter the left atrium of the heart. What color is the latex (if any) inside these veins? Why?
9. Gas exchange takes place in the placenta. (This will be studied later in more detail.) At birth, the lungs take over from the placenta, and pulmonary circulation is established by closure of the foramen ovale and ductus arteriosus.

Exercise B Systemic Circulation Anterior to the Heart

Systemic circulation begins with the **aorta**. The aorta leaves the heart anteriorly and immediately makes a "hairpin" turn to the left (called the **aortic arch**); at this point, as it courses posteriorly, it becomes the **dorsal aorta**. As its name implies, the dorsal aorta lies mid-dorsally, along the spine. From the aortic arch and the dorsal aorta arise all of the major arteries of the body.

Objectives

☐ Identify the major vessels in the thorax and neck of a fetal pig, including the brachiocephalic (or innominate) artery, brachial arteries and veins, carotid arteries, and jugular veins.

Procedure

1. The **brachiocephalic** (or **innominate**) **artery** is the first vessel to branch from the aortic arch (Figure 36A-1). Follow this vessel and its branches. *a. What regions of the body does the brachiocephalic artery supply with blood?*

_____

2. The brachiocephalic artery gives rise to the **right subclavian artery** going to the forelimb. Its name changes to the **axillary artery** as it passes through the shoulder region and then to the **brachial artery** as it continues into the upper forelimb. The **radial** and **ulnar** branches are found in the forelimb. (The radius and ulna are the two major bones of the forelimb.)
3. The **left subclavian artery** is the second vessel to leave the aortic arch. It divides into several branches in the shoulder area and then passes to the arm as does the right subclavian artery.
   b. Where do the subclavian arteries carry their oxygenated blood?

_____

4. Several smaller arteries branch from the subclavian arteries to feed the muscles of the chest and back. Follow one of the subclavian arteries as far as possible into the forelimb you used for identifying muscles. Carefully clip and pull back some of the muscles. Use your probe to free tissue from the arteries as you proceed. Can you identify the axillary, brachial, radial, and ulnar arteries?
5. The **brachial veins** return from the forelimbs. The radial and ulnar portions of the brachial veins are found in the lower forelimbs. Try to identify these veins.
6. Shortly after the right subclavian artery leaves the brachiocephalic artery, it splits into the right and left **common carotid arteries**, which course anteriorly through the neck. Each of these divides into the **internal** and **external common carotid arteries** (Figure 36A-1).

7. Extend your dissection into the head and neck region. You may have to remove considerable muscle tissue in order to properly expose the vessels in this region. Can you locate the internal and external carotids?
8. Look for a white "fiber" running alongside the carotid arteries; this is the **vagus nerve**. If you find it, can you trace it all the way to the heart?
   c. *What is the function of the vagus nerve?* _____
   Where is it coming from? _____
9. The **jugular veins** on both sides of the neck drain the head region. There are **internal** and **external jugular veins** as there are internal and external carotid arteries. The jugular veins, together with the subclavian veins, empty into the **V**-shaped **brachiocephalic vein**, which leads into the superior vena cava.

Exercise C Systemic Circulation Posterior to the Heart

Objectives

☐ Identify the major vessels posterior to the heart of a fetal pig, including the dorsal aorta, anterior mesenteric artery and vein, renal arteries and veins, femoral and deep femoral branches of the iliac artery, caudal and sacral arteries, umbilical arteries and vein, ductus venosus, and the hepatic portal system.

Procedure

1. The **dorsal aorta** is the posterior extension of the aortic arch (Figure 36A-1). Trace the path of the dorsal aorta starting at its origin in the thoracic cavity. It will be necessary to move the lungs and other internal organs gently aside.
   a. *What is the muscular partition through which the aorta passes as it leaves the thoracic cavity?* _____
   b. *Which regions of the body are supplied with blood by arteries arising from the dorsal aorta?* _____
2. Carefully lift your pig's liver and stomach. With your dissecting needle, pick away the sheet of tissue connecting the dorsal aorta to the pig's back (dorsal mesentery) so that you may see where the **coeliac artery** leaves the dorsal aorta. Tributaries from the coeliac artery send blood to the stomach, spleen, and liver.
3. Just posterior to the coeliac artery is the **anterior mesenteric artery**, which serves the pancreas and duodenum of the small intestine (Figure 36A-1).
4. The **renal arteries** are easily seen as short branches from the dorsal aorta to the kidneys. The **renal veins** drain into the inferior vena cava. (Sometimes there are two of them on one or on both sides.)
5. At the posterior end of the dorsal aorta, the **external iliac arteries** branch into the hind legs. These then branch to form the **femoral** and the **deep femoral arteries** in the thigh. Returning from each leg is an **iliac vein**, which joins the inferior vena cava.
6. Can you find the small extension of the dorsal aorta that supplies blood to the tail? It is called the **sacral artery** as it leaves the dorsal aorta, but becomes the **caudal artery** in the tail.
7. Posterior to the junction of the external iliac arteries and the dorsal aorta, the **internal iliac arteries** branch from the dorsal aorta. These eventually enlarge to form a pair of **umbilical arteries**. After birth, the umbilical arteries become modified. In the region of the bladder, they become the round ligaments supporting the bladder. In other regions

they function as tributaries to the pelvic region in the adult. Make a fresh, clean cut through the umbilical cord to reveal the arrangement of arteries and veins in cross section.

8. After nutrients, wastes, and gases are exchanged with the maternal circulation in the placenta, enriched blood flows back to the fetus via the **umbilical vein** (the vein that you had tied with a thread). When the umbilical vein reaches the liver, it becomes the **ductus venosus**. It may be necessary to pick away some of the substance of the liver to see the relationship between these two vessels. Most of the blood flowing through the ductus venosus returns directly to the posterior vena cava, but some enters associated branches that supply the tissues of the liver. The ductus venosus enters the posterior vena cava posterior to the hepatic veins that drain the liver in the adult. The ductus venosus is not functional in the adult, since blood is no longer flowing in the umbilical veins.
9. After the birth of the pig, the umbilical vein is modified to become the round ligament suspending the liver from the ventral body wall. The ductus venosus closes and becomes the fibrous **ligamentum venosum**. Several days after birth, the umbilical cord dries and falls off, leaving a scar (the navel), characteristic of some placental animals.
10. The vascular network draining the small intestines does not empty directly into the posterior vena cava as do the veins draining the other abdominal organ systems. Instead, the **hepatic portal vein** leaves the intestines and enters the liver. A portal system is composed of a portal vein that receives blood from the capillary network of one organ (in this case the intestine) and transports it to another organ (in this case the liver) before finally arriving at the posterior vena cava to return blood to the heart. The hepatic portal receives the **gastrosplenic vein** from the stomach and spleen, the **gastroduodenal vein** from the stomach and duodenum, and the **anterior mesenteric vein** from the small intestines. Locate the hepatic portal system in Figure 36A-1.
    c. *Why is it important for blood from the intestines to be filtered by the liver before entering the general circulation?*

    _____
11. The inferior vena cava crosses the diaphragm and then enters the heart at the **right atrium**. The **anterior vena cava** drains the forelimbs and head region.

Exercise D The Heart: Removal and Inspection

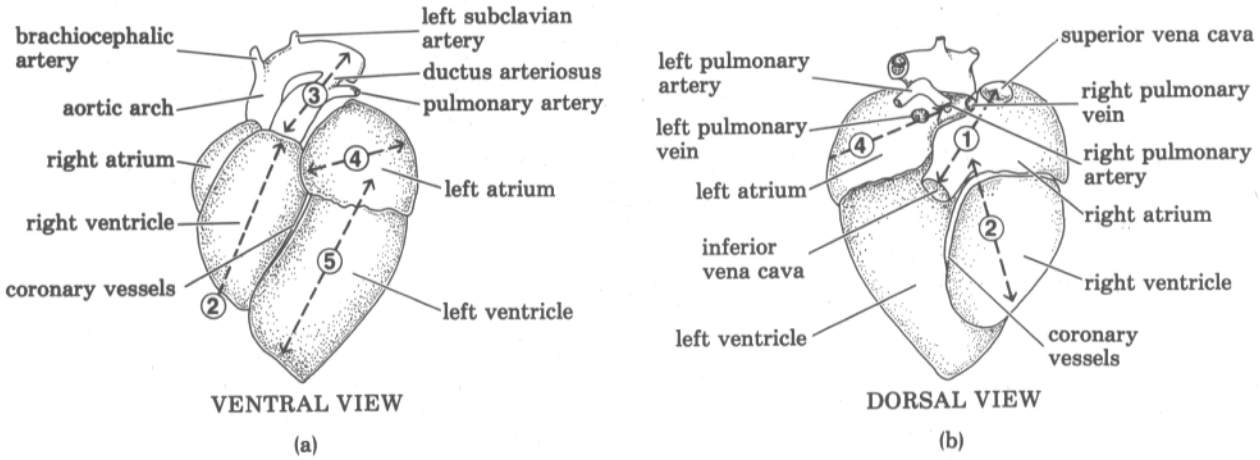
Objectives

- ☐ Trace the path of blood through the heart of a fetal pig, identifying by name all of the structures through which it passes.

Procedure

1. Cut all blood vessels leading into and away from the heart, leaving approximately 3 to 5 millimeters of each vessel attached to the heart. Do not cut the esophagus. Remove the heart. Strip off the pericardium (whitish membranous covering around the heart) if it is still present, and remove any connective tissue covering the heart and the attached blood vessels.
2. Keep the heart oriented as it was in the thoracic cavity (ventral surface facing you, Figure 36D-1a). Locate the vena cava, the dorsal aorta, and the trunk of the pulmonary artery. Look behind the left atrium for the **coronary artery**. This artery comes directly from the aorta and supplies blood to the heart itself. The **coronary vein** enters the right atrium on the dorsal surface of the inferior vena cava.

Figure 36D-1 *(a) Ventral and (b) dorsal views of the heart, showing incisions.*



a. Why must the heart have its own arteries and veins? _____

_____

When blood flow in the coronary arteries is diminished or occluded altogether, a "coronary" (heart attack) occurs.

3. With the dorsal side of the heart facing you (Figure 36D-1b), cut through the inferior and superior venae cavae with dissecting scissors (cut (1)). With your forceps and dissecting needle, remove any latex that occludes your view into the right atrium. *b. Describe what you see.*

_____

_____

4. Next, make an incision into the right ventricle on the dorsal side as indicated in Figure 36D-1b (cut (2)). Remove the latex from the right ventricle. You should now be able to see the **semilunar valve** at the junction of the right ventricle and the pulmonary artery. You should also be able to see the tricuspid valve between the right atrium and the right ventricle. If you have trouble opening the ventricle far enough, extend cut (2) on the ventral surface as indicated in Figure 36D-1a (cut (2)).

5. Now examine the ductus arteriosus. With the heart's ventral surface facing you, make an incision through the ductus arteriosus (indicated as cut (3) in Figure 36D-1a). Examine the interior of this vessel.
   c. Do you see any difference in the thickness of the walls of the aorta and the pulmonary trunk joined by the ductus arteriosus? _____ *Would you expect to see any difference?* _____

6. With the heart's dorsal surface facing you, make an incision through the left atrium as indicated in Figure 36D-1a and b (cut (4)). Note the arrangement of the pulmonary veins from the inside of the atrium. Now look at the atrial side of the **bicuspid valve**, which separates the atrium from the left ventricle.

7. Cut into the ventral side of the left ventricle (Figure 36D-1a, cut (5)) and observe the bicuspid valve from the ventricular side.
   d. Identify and describe the "heart strings" that keep this valve from closing too far.

_____

_____

8. Note the thickness of the muscular walls of the two ventricles and the two atria.
   e. Are the ventricles of different thicknesses? _____ *f. How might you account for any difference you may see?* _____

   _____

   g. Does the thickness of the atrial walls differ from that of the ventricular walls? _____

9. Compare your findings with the demonstration dissection of an adult pig heart on display.
   h. What structures are associated with the fetal pig heart that are not found in the adult heart?

   _____

Laboratory Review Questions and Problems

1. Describe how the ductus arteriosus, ductus venosus, and the umbilical arteries and vein each affect the route of blood in the fetus.

2. What changes occur in the pulmonary circulation of the pig shortly after birth?

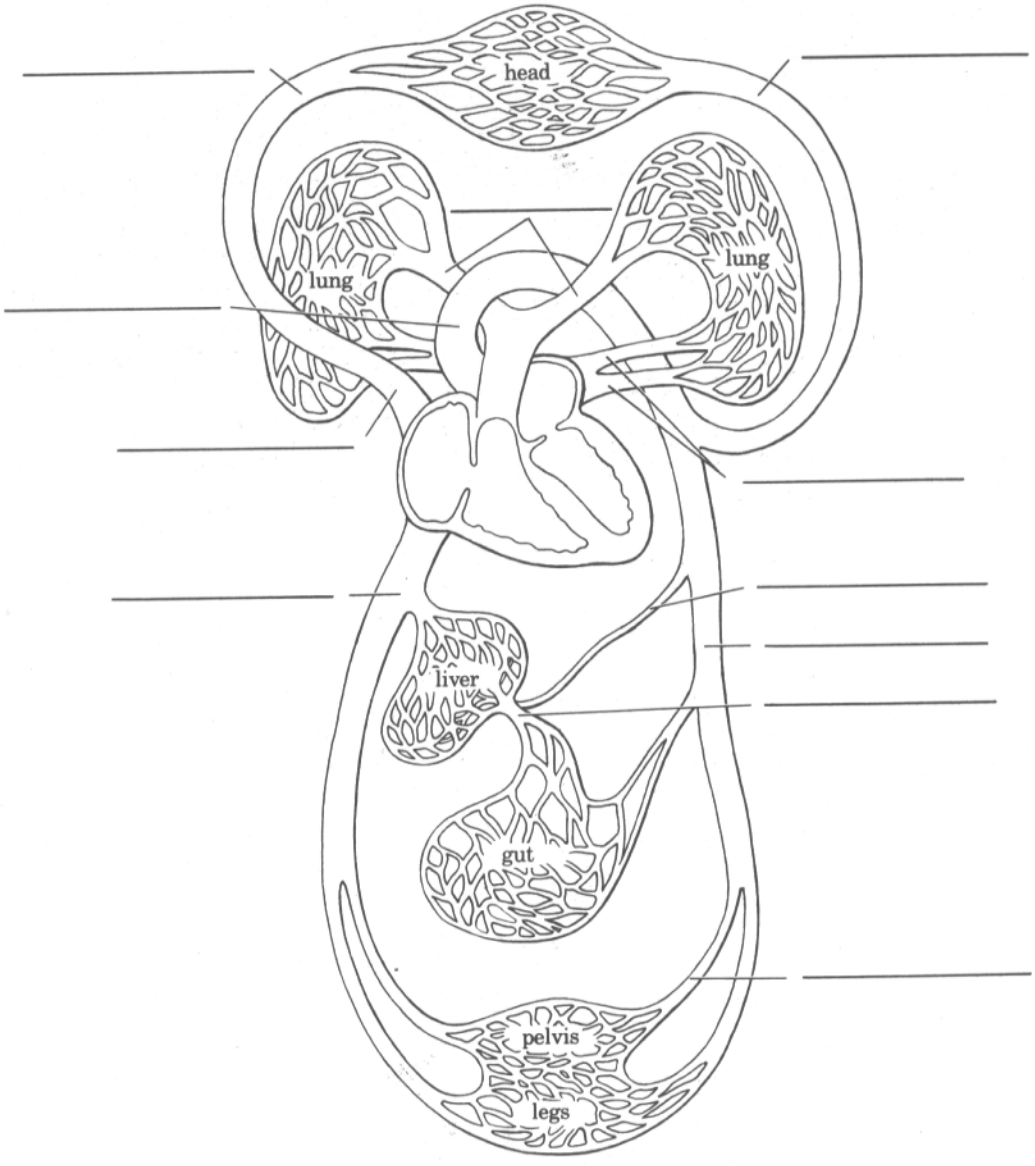
3. Why would blockage of a coronary artery result in a heart attack?

4. What are some structural differences between arteries and veins? How are these differences related to their respective functions?

5. Which veins carry oxygenated blood in fetal circulation? Which veins carry oxygenated blood in adult circulation?

6. What is the function of the hepatic portal vein? What is the difference between the hepatic portal artery and the hepatic artery?

7. Using what you have learned from this laboratory, label the major arteries and veins shown in the accompanying schematic diagram.



LABORATORY 37

Dissection of the Fetal Pig: Urogenital and Nervous Systems

Overview

In one way or another, every organ system in the body of a multicellular animal is devoted to maintaining the dynamic steady-state of the organism. That is, under changing external and internal conditions the organism is able to maintain reasonable constancy. During this laboratory, we will examine two systems responsible for integration and control in the animal body—the urinary system and the nervous system.

The **urinary system** serves as the drainage system of the body, removing wastes and regulating the composition of the blood. Since the reproductive system shares some anatomical structures with the urinary system, we will study these functionally separate systems together.

The **nervous system** integrates the activities of all other organ systems, coordinates muscular movement, and interprets the information that allows the organism to respond to its environment. Its activities are closely coordinated with, and reinforced by, those of various endocrine organs throughout the body. The nervous and endocrine systems function together as a control system that regulates the behavioral and physiological activities necessary to the maintenance of homeostasis in the external and internal environments and to the process of reproduction.

Student Preparation

Prepare for this laboratory by reading the text pages listed in the Textbook Reference Table at the back of this manual.

If dissecting equipment is not provided in the laboratory, bring your scalpel, probe, scissors, and dissecting needles.

Exercise A Gross Anatomy of the Urinary System

Objectives

- ☐ Identify the name, location, and function of various parts of the urinary system in the fetal pig.

Procedure

1. Use elastic bands to position your pig as you did in Laboratory 36. Reflect back the flaps of skin and pin them under your pig.
2. Carefully lift up the abdominal viscera and reflect them anteriorly and to the right. With your dissecting needle, expose the left **kidney** and its **ureter** by picking away the **peritoneum** that covers them. The peritoneum is the sheet of tissue that lines the body cavity (coelom). Locate the **hilus**—a central depression in the surface of the kidney. Here,

the **renal artery** enters the kidney, and the ureters and the **renal vein** exit (see Figure 36A-1). We will study the internal organization of the kidney after we examine the male and female reproductive systems.

3. Trace the ureters from the hilus to the **allantoic bladder**. Lift the bladder and find the **urethra**, which transports urine from the bladder to the outside of the animal.
   a. What is urine and what are its contents?

   _____

   The **allantoic duct** leads from the bladder into the umbilical cord, but since wastes filtered by the kidney travel to the placenta through the umbilical veins, the allantoic duct is not functional. After the pig is born, the allantoic duct closes and the allantoic bladder becomes the **urinary bladder**.

4. Note the differences in orientation of the urinary and genital structures in the female (Figure 37B-1) and male (Figure 37C-1). In the female pig, the urethra is short; posteriorly, it unites with the vagina to form the **urogenital sinus**, a passageway opening to the exterior. In the male, the urethra is much longer and reaches from the bladder through the penis to the external urogenital opening.
   b. Name two products that pass through the male urethra.

   _____

   c. Which products pass through the female urethra?

   _____

Exercise B The Female Reproductive System

Objectives

☐ Identify by name, location, and function the various structures that make up the reproductive system of the female fetal pig.

Procedure

1. The external reproductive structures of the female are collectively known as the **vulva**. The pig's vulva includes the **genital papilla** (Figure 37B-1) on the outside of the body; the "lips" or **labia** on either side of the slitlike urogenital opening; the **clitoris**, a small rounded body of erectile tissue on the ventral floor of the urogenital sinus; and the opening of the **urogenital sinus** itself.
2. The clitoris of the female and the penis of the male are homologous structures. In the female, the urethra opens caudal to the clitoris, while in the male, the tissues of the penis fold around and enclose the urethra.
3. Follow the urogenital sinus (the common passage for both the urethra and the vagina) anteriorly and locate the thick-walled muscular vagina that is continuous with the **uterus**. Insert your scissors into the opening of the urogenital sinus lateral to the genital papilla. Cut open this portion of the reproductive tract to see where the ducts of the vagina and urethra enter the urogenital sinus (Figure 37B-1).
4. The uterus of the pig consists of the muscular **cervix** at the entrance to the uterus, the **corpus** or body, and two **uterine horns**. In pigs, fetuses are relatively evenly spaced along the uterine horns. In humans, the uterus has no horns and the fetus develops within the uterine body.

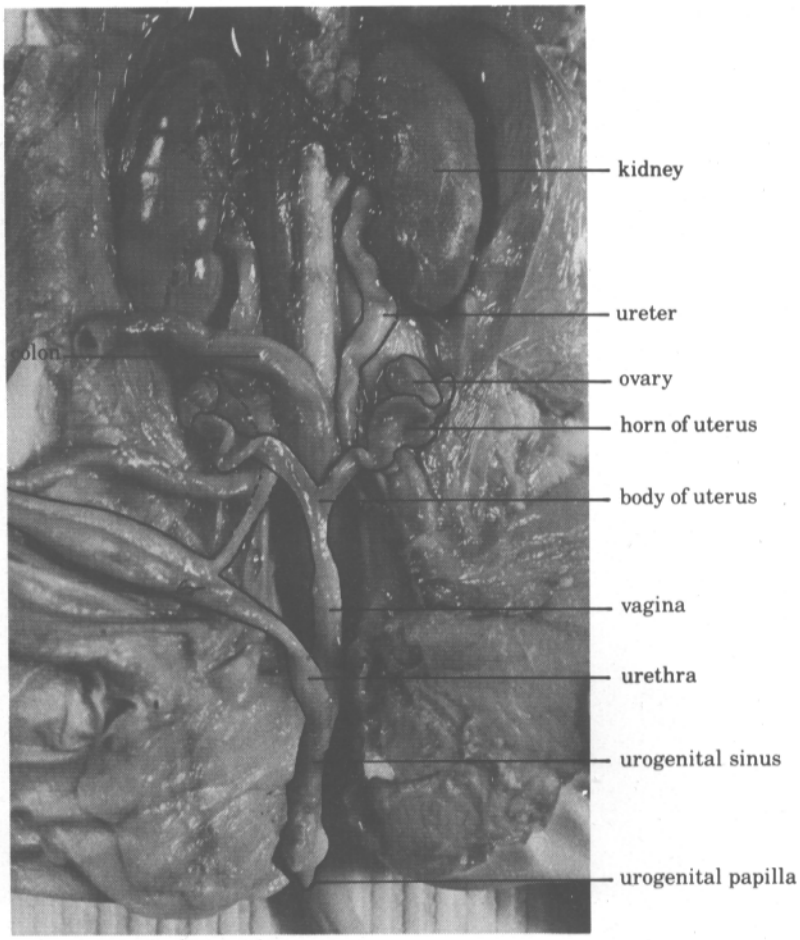


Figure 37B-1 *Abdominal region of a female fetal pig, showing the urinary and reproductive structures (note that the left ureter has been cut to allow examination of the bladder).*

5. The **Fallopian tubes** or **oviducts** extend from the uterine horns to the ovaries. Use a hand lens to see if you can locate the widened ends of the oviducts (**ostia**). The **ovaries** are small, bean-shaped structures lying just posterior to the kidneys. They should be yellow in color. Unlike sperm, which are produced continuously throughout the life of the adult male, all of the eggs that a female will ever produce during her lifetime are already present in the ovary. The eggs will mature and be ovulated after proper hormonal stimulation.
6. The **broad ligament**, a mesentery originating on the dorsal body wall, supports the ovaries, the oviducts, and the uterine horns. The short, thick mesentery that supports the ovary is called the **round ligament**. It also extends from the lateral wall.

Exercise C The Male Reproductive System

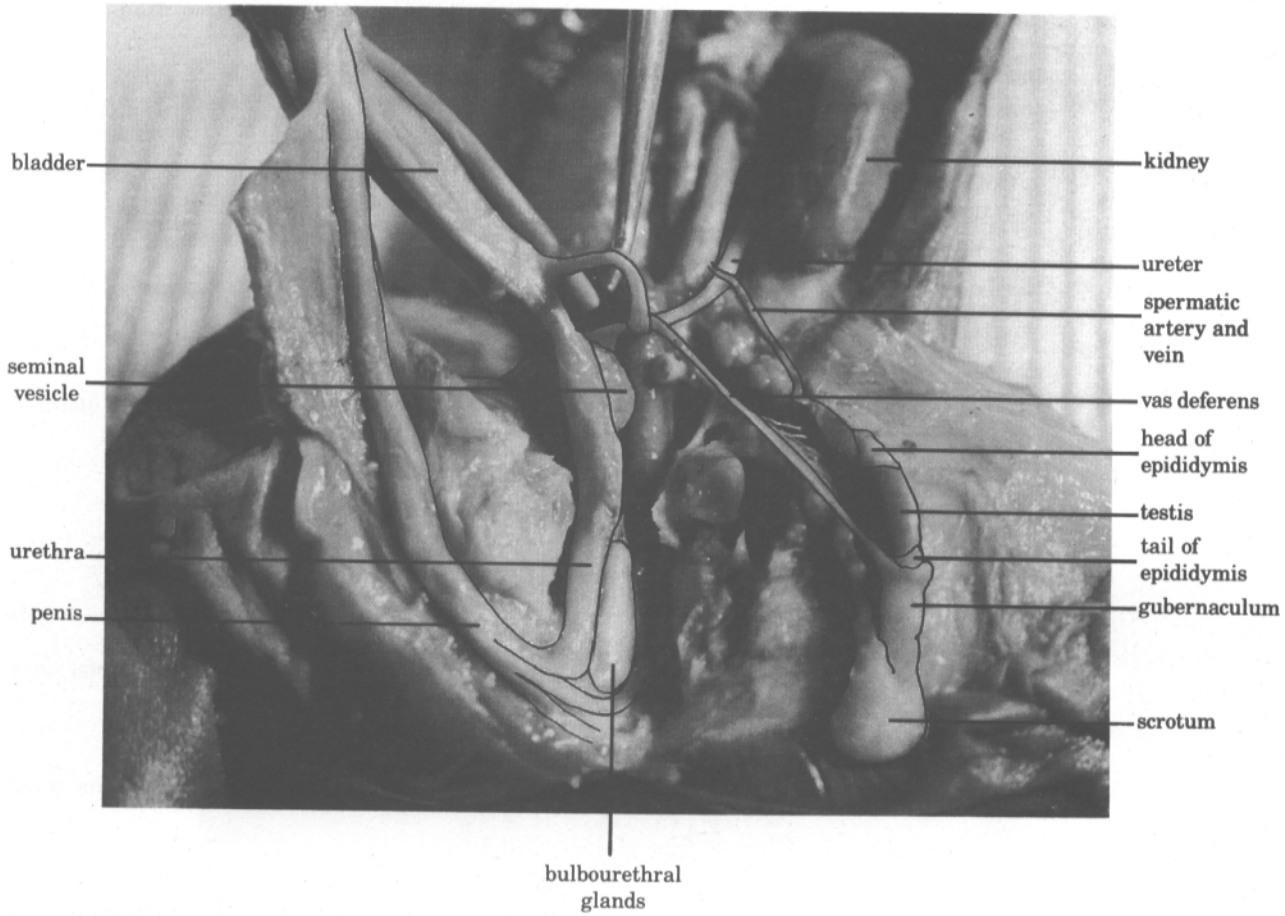
Objectives

☐ Identify by name, location, and function the various structures that make up the reproductive system of the male fetal pig.

Procedure

1. It is easier to trace the reproductive tract of the male pig by starting with the sperm-producing organs, the **testes** (Figure 37C-1). Depending on the degree of maturity of your

Figure 37C-1 *Abdominal region of a male fetal pig, showing the urinary and reproductive structures.*



pig, the testes can be found anywhere between the kidneys and the scrotum. During development, the testes undergo a posterior migration (descent) into two external pouches, the scrotal sacs or, collectively, the **scrotum**. Sperm production requires that the testes be situated near the outside of the body where body temperatures are lower than those found internally.

a. Why do you think that a lower body temperature is required for the production of sperm?

_____

b. Can you think of any mammals whose testes are not located in an external scrotum? (Hint: These mammals are not primarily land animals.) _____

A cord of tissue, the **gubernaculum**, attaches the testes to the caudal end of the scrotum. It does not grow as rapidly as other parts of the body and thus helps to "pull" the testes posteriorly. The following description applies to fully descended testes.

2. The **testes** are small firm bodies that produce sperm in the adult male. Each testis exists in its own **inguinal pouch** within the scrotum; each inguinal pouch is formed by an outpocketing of the abdominal wall and adheres to the inner surface of the scrotal sac. Open one of the scrotal sacs and expose the testis. A tough, white cord connects the posterior end of the testis to the inner face of the inguinal pouch.

3. The **spermatic cord** is an elongated structure that emerges from each testis. Pull the cord gently to see it move through a small opening, the **inguinal canal**, in the posterior abdominal wall. This is the site of the outpocketing of the abdominal wall during descent

of the testes. In human males, this canal is the site of inguinal hernias, a condition in which a loop of the intestine extends through the inguinal canal into the scrotum.

c. Pigs do not develop inguinal hernias. What basic anatomical difference between humans and quadrupeds explains this difference?

_____

4. The spermatic cord is composed of the **vas deferens** (the site of a vasectomy in human males), the spermatic artery, spermatic vein, and spermatic nerve. The vas deferens loops up and over the ureter at the base of the bladder and then continues posteriorly to enter the urethra. Notice where the vas deferens enters the urethra. Locate the **epididymis**—a tightly coiled tube that lies along one side of the testis. The epididymis is continuous with the vas deferens. Sperm move from the tubules inside the testes to the epididymis and then to the vas deferens for transport to the outside. *d. Where in the reproductive tract are mature sperm stored?* _____
5. Now carefully remove the tissue from around the penis and the urethra. Leave the penis intact but completely free of tissue. Be careful not to damage nearby genital glands. Trace the penis backward until it joins the urethra.
6. The **seminal vesicles** are a pair of small glands situated on the dorsal surface of the urethra where the two vasa deferentia enter. The **prostate gland** is a small body situated between the bases of the seminal vesicles. **Cowper's** (or **bulbourethral**) **glands** are two elongated structures lying on either side of the junction of the urethra and the penis. These three glands all secrete fluids that together with sperm, make up the ejaculate or **seminal fluid**.

   e. Do females have any of these glands? _____

Exercise D Internal Structure of the Kidney

You have previously located the kidneys during dissections of the urogenital, circulatory, and digestive systems. The two kidneys are bean-shaped structures lying in the lumbar region on either side of the spine. They lie outside the peritoneum, the sheet of tissue that completely lines the abdominal cavity, and are often surrounded by a protective layer of fat. Sitting on top of the kidney is a light-colored body, the **adrenal gland**.

Objectives

☐ Identify the name, location, and function of the various internal structures of the kidney.

Procedure

1. Remove all viscera from the abdominal cavity. Free one of the kidneys by cutting the ureter, renal artery, and renal vein, leaving about 1 mm of each attached to the kidney. Remove the kidney from the body cavity.
2. Place the kidney on a paper towel, with the broad, flat surface of the kidney against the table. Cut the kidney in half lengthwise in the plane of the table.
3. Examine the cut surface of one of the kidney halves. The **renal sinus** is the central cavity. It contains fat, branches of the renal vessels, and the **renal pelvis** (Figure 37D-1).
4. The renal pelvis is the funnel-like expanded portion of the ureter, located inside the kidney where urine collects before moving into the ureter.
5. The tissue of the kidney is organized into two major areas. The **renal cortex** is the outer layer of kidney tissue. Blood entering the kidney via extensions of the renal artery is

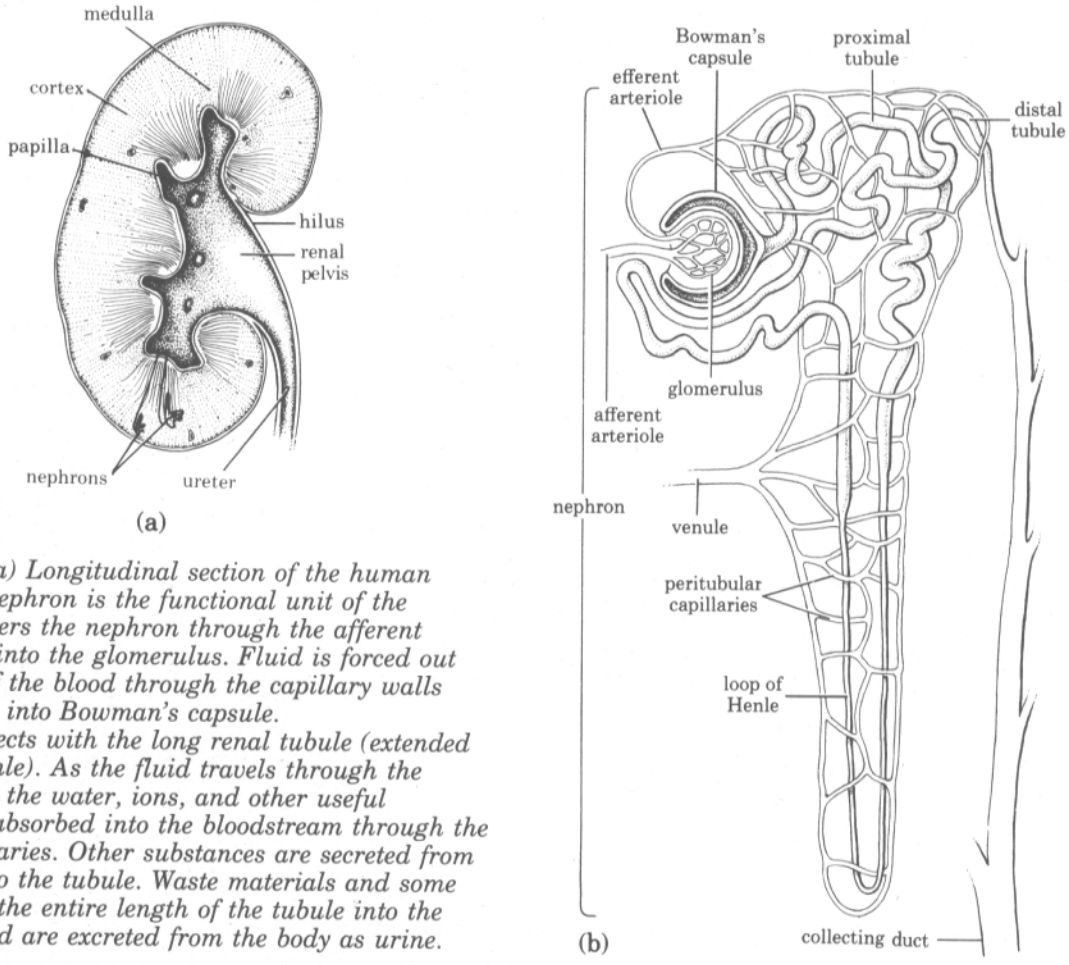


Figure 37D-1 *(a) Longitudinal section of the human kidney. (b) The nephron is the functional unit of the kidney. Blood enters the nephron through the afferent arteriole leading into the glomerulus. Fluid is forced out by the pressure of the blood through the capillary walls of the glomerulus into Bowman's capsule. The capsule connects with the long renal tubule (extended as the loop of Henle). As the fluid travels through the tubule, almost all the water, ions, and other useful substances are reabsorbed into the bloodstream through the peritubular capillaries. Other substances are secreted from the capillaries into the tubule. Waste materials and some water pass along the entire length of the tubule into the collecting duct and are excreted from the body as urine.*

filtered in knots of capillaries (glomeruli) surrounded by cup-shaped expansions of the kidney tubules, called **Bowman's capsules.**

6. The **renal medulla** lies beneath the cortex and contains the **loops of Henle**, extensions of the kidney tubule, or **nephron**. It is the renal medulla that concentrates the filtrate from the proximal portions of the nephron. The tissues surrounding the loops of Henle help to create the osmotic gradient required in the concentration process. Selected materials are returned to the blood. Consult Figure 37D-1 to see the relationships between Bowman's capsule, the loop of Henle, and other parts of the nephron, the basic filtration unit of the kidney.

   a. *Desert mammals have extremely long loops of Henle associated with their kidney tubules. Why?* _____

   _____

7. The **renal papilla** is a cone-shaped projection of the medullary tissue into the pelvis of the kidney. Pigs have only one papilla, whereas humans have many.

Exercise E The Brain and Spinal Cord

Objectives

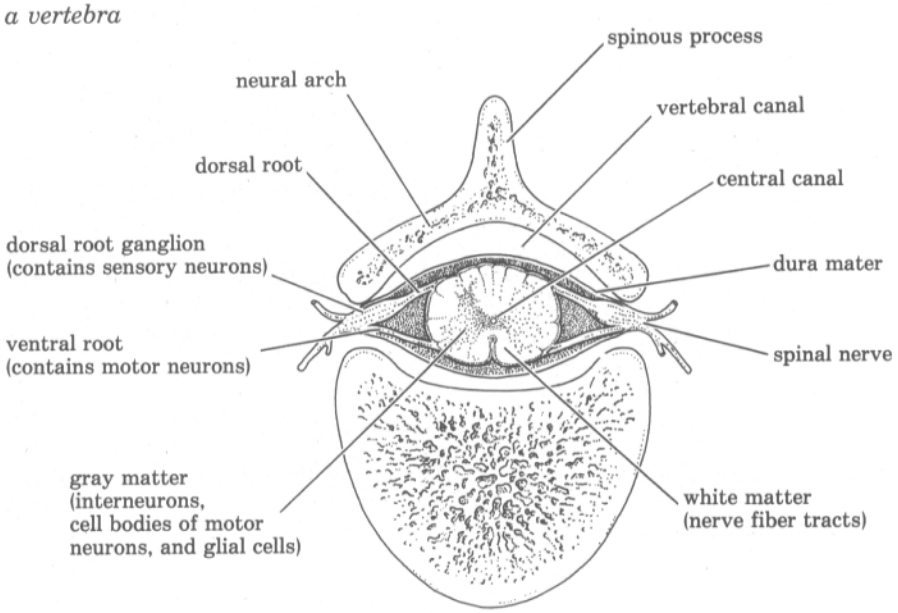
☐ Identify by name and location the various parts of the brain and spinal cord of a fetal pig.

Procedure

1. Place your pig on the dissection tray, ventral side down. Use extreme care in working through this dissection; the fetal nervous tissue is delicate and easily damaged.
2. Remove a strip of skin and muscle about 1 cm wide from the base of the neck along the mid-dorsal line of the back to the tail. Then, using scissors and a scalpel, cut away the dorsal **neural arches** (Figure 37E-1) of several vertebrae. You should be able to see the spinal cord and the origins of some of the spinal nerves.
   a. What part of the central nervous system do the neural arches enclose?

_____

Figure 37E-1 *Cross section of a vertebra and the spinal cord.*



3. Each spinal nerve is composed of two roots: the **dorsal root**, which contains **sensory neurons**, and the **ventral root**, which contains **motor neurons**. These unite into a single nerve a short distance from the **spinal cord**. All spinal nerves are called mixed nerves because they carry impulses both to and from the spinal cord. The **dorsal root ganglia** are swellings on the the dorsal roots containing cell bodies of the sensory neurons.
   *b. Do all nervous impulses go to and from the brain?*_____
   c. What pathway is followed by a nervous impulse during a reflex action?

_____

_____

4. Remove a short section of the spinal cord and look at it in cross section. The **gray matter**, in the shape of an "H," is composed of the cell bodies of motor and associative neurons. The white area is made up of neuron fibers conveying messages to and from the brain.
5. Use your scissors and scalpel to cut the skin and the muscles of the dorsal surface of the head from the base of the snout to the spinal cord. From this incision, make a transverse cut toward the angle of each jaw and make another set of transverse cuts behind each ear. Reflect the skin flaps outward to expose the skull.
6. Make two anterior–posterior cuts through the skull about 2 cm apart. At the posterior end of the two cuts, make another cut to join the cuts. The brain can now be exposed by carefully breaking and removing small pieces of the skull.

7. A set of three membranes (the **meninges**) covers both the brain and the spinal cord. The tough, fibrous outer **dura mater** sticks to the underside of the cranial and spinal bones. The middle layer is called the **arachnoid**. The thin inner layer, the **pia mater**, adheres to the surface of the brain and the spinal cord.
   *d. What is the major function of the meninges?*_____
   *e. What are the cranial nerves?*_____
   *Do you see any of these in your dissection?*_____
8. Carefully sever the spinal cord at the base of the brain and remove the brain. The brain is composed of two large **cerebral hemispheres** (right and left), which are separated by a longitudinal groove. The smaller mass ventral to the **cerebrum** is the **cerebellum**. Ventral to the cerebellum are the **medulla** and the **pons**. The fetal brain is too soft to permit actual dissection. Your instructor may provide a sheep's brain for identification of the various structures.

Laboratory Review Questions and Problems

1. Describe the anatomical route followed by sperm from the testes to the outside.

2. Describe the anatomical route followed by eggs from the ovary to the uterus.

3. How is seminal fluid produced in the male?

4. Describe the differences in the external genitalia of the male and female pig.

5. What is a urogenital sinus? Of what is this composed in the female pig? What is its equivalent in the male pig?

6. Draw a longitudinal section of the kidney, label its parts, and give the function for each.

7. Does the fetal kidney need to function in placental mammals? Why or why not?

8. Why are spinal nerves called mixed nerves? What is the difference between gray matter and white matter?