

Organ Systems Overview

MATERIALS

- Freshly killed or preserved rat (predissected by instructor as a demonstration; or for student dissection, one rat for every two to four students) or predissected human cadaver
- Dissection trays
- Twine or large dissecting pins
- Scissors
- Probes
- Forceps
- Disposable gloves
- Human torso model (dissectible)

OBJECTIVES

1. Name the human organ systems, and indicate the major functions of each system.
2. List several major organs of each system, and identify them in a dissected rat, human cadaver or cadaver image, or dissectible human torso model.
3. Name the correct organ system for each organ studied in the laboratory.

PRE-LAB QUIZ

1. Name the structural and functional unit of all living things. _____
2. The small intestine is an example of a(n) _____, because it is composed of two or more tissue types that perform a particular function for the body.
 - a. epithelial tissue
 - b. muscle tissue
 - c. organ
 - d. organ system
3. The _____ system is responsible for maintaining homeostasis of the body via rapid communication.
4. The kidneys are part of the _____ system.
5. The thin muscle that separates the thoracic and abdominal cavities is the _____.

The basic unit or building block of all living things is the **cell**. Cells fall into four different categories according to their structures and functions. Each of these corresponds to one of the four tissue types: epithelial, muscular, nervous, and connective. A **tissue** is a group of cells that are similar in structure and function. An **organ** is a structure composed of two or more tissue types that performs a specific function for the body. For example, the small intestine, which digests and absorbs nutrients, is made up of all four tissue types.

An **organ system** is a group of organs that act together to perform a particular body function. For example, the organs of the digestive system work together to break down foods and absorb the end products into the bloodstream to provide nutrients and fuel for all the body's cells. In all, there are 11 organ systems (**Table 2.1**). The lymphatic system also encompasses a *functional system* called the immune system, which is composed of an army of mobile *cells* that act to protect the body from foreign substances.

Read through this summary of the body's organ systems before beginning your rat dissection or examination of the predissected human cadaver. If a human cadaver is not available, photographs provided in this exercise (Figures 2.3 through 2.6) will serve as a partial replacement.

Table 2.1 Overview of Organ Systems of the Body

Organ system	Major component organs	Function
Integumentary (Skin)	Epidermal and dermal regions; cutaneous sense organs and glands	<ul style="list-style-type: none"> Protects deeper organs from mechanical, chemical, and bacterial injury, and from drying out Excretes salts and urea Aids in regulation of body temperature Produces vitamin D
Skeletal	Bones, cartilages, tendons, ligaments, and joints	<ul style="list-style-type: none"> Supports the body and protects internal organs Provides levers for muscular action Cavities provide a site for blood cell formation
Muscular	Muscles attached to the skeleton	<ul style="list-style-type: none"> Primary function is to contract or shorten; in doing so, skeletal muscles allow locomotion (running, walking, etc.), grasping and manipulation of the environment, and facial expression Generates heat
Nervous	Brain, spinal cord, nerves, and sensory receptors	<ul style="list-style-type: none"> Allows body to detect changes in its internal and external environment and to respond to such information by activating appropriate muscles or glands Helps maintain homeostasis of the body via rapid communication
Endocrine	Pituitary, thymus, thyroid, parathyroid, adrenal, and pineal glands; ovaries, testes, and pancreas	<ul style="list-style-type: none"> Helps maintain body homeostasis, promotes growth and development; produces chemical messengers called hormones that travel in the blood to exert their effect(s) on various target organs of the body
Cardiovascular	Heart, blood vessels, and blood	<ul style="list-style-type: none"> Primarily a transport system that carries blood containing oxygen, carbon dioxide, nutrients, wastes, ions, hormones, and other substances to and from the tissue cells where exchanges are made; blood is propelled through the blood vessels by the pumping action of the heart Antibodies and other protein molecules in the blood protect the body
Lymphatic/immune	Lymphatic vessels, lymph nodes, spleen, thymus, tonsils, and scattered collection of lymphoid tissue	<ul style="list-style-type: none"> Picks up fluid leaked from the blood vessels and returns it to the blood Cleanses blood of pathogens and other debris Houses lymphocytes that act via the immune response to protect the body from foreign substances
Respiratory	Nasal passages, pharynx, larynx, trachea, bronchi, and lungs	<ul style="list-style-type: none"> Keeps the blood continuously supplied with oxygen while removing carbon dioxide Contributes to the acid-base balance of the blood via its carbonic acid–bicarbonate buffer system
Digestive	Oral cavity, esophagus, stomach, small and large intestines, and accessory structures including teeth, salivary glands, liver, and pancreas	<ul style="list-style-type: none"> Breaks down ingested foods to minute particles, which can be absorbed into the blood for delivery to the body cells Undigested residue removed from the body as feces
Urinary	Kidneys, ureters, bladder, and urethra	<ul style="list-style-type: none"> Rids the body of nitrogen-containing wastes, including urea, uric acid, and ammonia, which result from the breakdown of proteins and nucleic acids Maintains water, electrolyte, and acid-base balance of blood
Reproductive	<p>Male: testes, prostate, scrotum, penis, and duct system, which carries sperm to the body exterior</p> <p>Female: ovaries, uterine tubes, uterus, mammary glands, and vagina</p>	<ul style="list-style-type: none"> Provides germ cells called sperm for producing offspring Provides germ cells called eggs; the female uterus houses the developing fetus until birth; mammary glands provide nutrition for the infant

DISSECTION AND IDENTIFICATION The Organ Systems of the Rat

Many of the external and internal structures of the rat are quite similar in structure and function to those of the human, so a study of the gross anatomy of the rat should help you understand our own physical structure. The following instruc-

tions include directions for dissecting and observing a rat. In addition, instructions for observing organs (Activity 4, “Examining the Ventral Body Cavity,” page 18) also apply to superficial observations of a previously dissected human cadaver. The general instructions for observing external structures also apply to human cadaver observations. The photographs (Figures 2.3 through 2.6) will provide visual aids.

Note that four of the organ systems listed in the table (Table 2.1) (integumentary, skeletal, muscular, and nervous) will not be studied at this time because they require microscopic study or more detailed dissection. ■

ACTIVITY 1

Observing External Structures

1. If your instructor has provided a predissected rat, go to the demonstration area to make your observations. Alternatively, if you and/or members of your group will be dissecting the specimen, obtain a preserved or freshly killed rat, a dissecting tray, dissecting pins or twine, scissors, probe, forceps, and disposable gloves. Bring these items to your laboratory bench.

If a predissected human cadaver is available, obtain a probe, forceps, and disposable gloves before going to the demonstration area.

⚠ 2. Don the gloves before beginning your observations. This precaution is particularly important when handling freshly killed animals, which may harbor internal parasites.

3. Observe the major divisions of the body—head, trunk, and extremities. If you are examining a rat, compare these divisions to those of humans. ■

ACTIVITY 2

Examining the Oral Cavity

Examine the structures of the oral cavity. Identify the teeth and tongue. Observe the extent of the hard palate (the portion underlain by bone) and the soft palate (immediately posterior to the hard palate, with no bony support). Notice that the posterior end of the oral cavity leads into the throat,

or pharynx, a passageway used by both the digestive and respiratory systems. ■

ACTIVITY 3

Opening the Ventral Body Cavity

1. Pin the animal to the wax of the dissecting tray by placing its dorsal side down and securing its extremities to the wax with large dissecting pins (Figure 2.1a).

If the dissecting tray is not waxed, you will need to secure the animal with twine as follows. (Some may prefer this method in any case.) Obtain the roll of twine. Make a loop knot around one upper limb, pass the twine under the tray, and secure the opposing limb. Repeat for the lower extremities.

2. Lift the abdominal skin with a forceps, and cut through it with the scissors (Figure 2.1b). Close the scissor blades, and insert them flat under the cut skin. Moving in a cephalad direction, open and close the blades to loosen the skin from the underlying connective tissue and muscle. Now cut the skin along the body midline, from the pubic region to the lower jaw (Figure 2.1c, page 18). Finally, make a lateral cut about halfway down the ventral surface of each limb. Complete the job of freeing the skin with the scissor tips, and pin the flaps to the tray (Figure 2.1d). The underlying tissue that is now exposed is the skeletal musculature of the body wall and limbs. It allows voluntary body movement. Notice that the muscles are packaged in sheets of pearly white connective tissue (fascia), which protect the muscles and bind them together.

3. Carefully cut through the muscles of the abdominal wall in the pubic region, avoiding the underlying organs. Remember, to *dissect* means “to separate”—not mutilate! Now, hold and lift the muscle layer with a forceps and cut through the muscle layer from the pubic region to the bottom of the rib cage. Make two lateral cuts at the base of the rib



(a)



(b)

Figure 2.1 Rat dissection: Securing for dissection and the initial incision. (a) Securing the rat to the dissection tray with dissecting pins. (b) Using scissors to make the incision on the median line of the abdominal region.

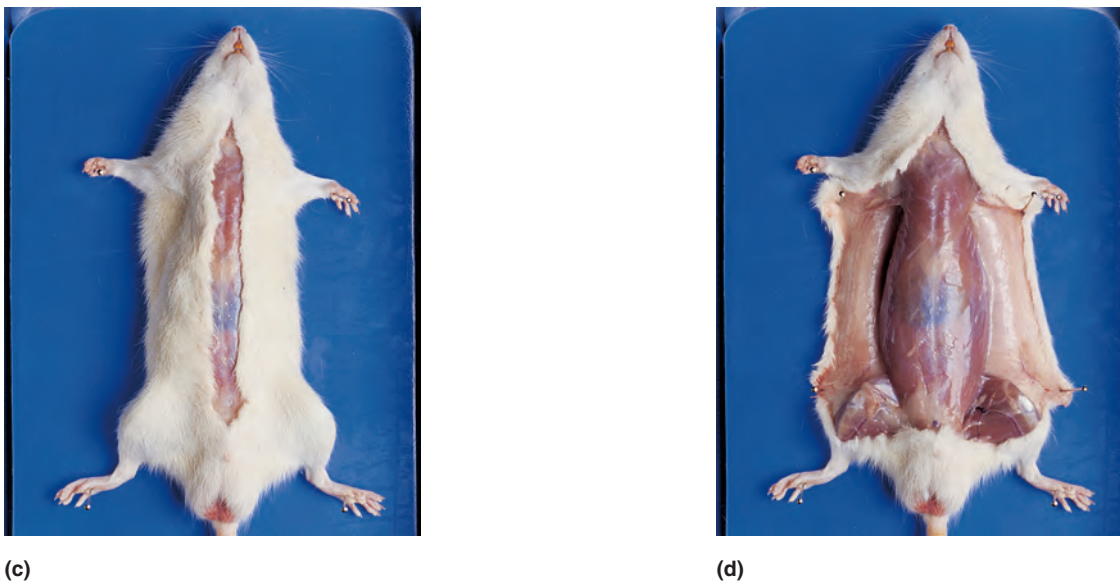


Figure 2.1 (continued) Rat dissection: Securing for dissection and the initial incision. (c) Completed incision from the pelvic region to the lower jaw. (d) Reflection (folding back) of the skin to expose the underlying muscles.

cage (**Figure 2.2**). A thin membrane attached to the inferior boundary of the rib cage should be obvious; this is the **diaphragm**, which separates the thoracic and abdominal cavities. Cut the diaphragm where it attaches to the ventral ribs to loosen the rib cage. Cut through the rib cage on either side. You can now lift the ribs to view the contents of the thoracic cavity. Cut across the flap at the level of the neck, and remove it. ■



Figure 2.2 Rat dissection: Making lateral cuts at the base of the rib cage.

ACTIVITY 4

Examining the Ventral Body Cavity

1. Starting with the most superficial structures and working deeper, examine the structures of the thoracic cavity. (Refer to **Figure 2.3** as you work.) Choose the appropriate view depending on whether you are examining a rat (a) or a human cadaver (b).

Thymus: An irregular mass of glandular tissue overlying the heart (not illustrated in the human cadaver photograph).

With the probe, push the thymus to the side to view the heart.

Heart: Medial oval structure enclosed within the pericardium (serous membrane sac).

Lungs: Lateral to the heart on either side.

Now observe the throat region to identify the trachea.

Trachea: Tubelike “windpipe” running medially down the throat; part of the respiratory system.

Follow the trachea into the thoracic cavity; notice where it divides into two branches. These are the bronchi.

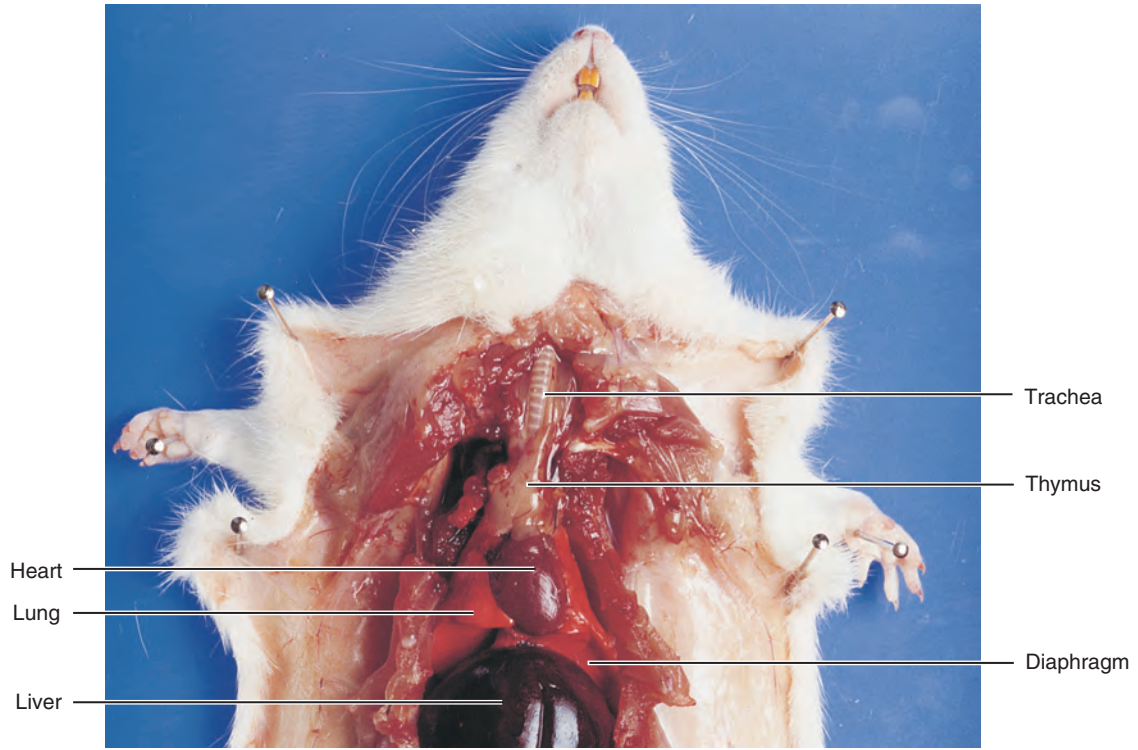
Bronchi: Two passageways that plunge laterally into the tissue of the two lungs.

To expose the esophagus, push the trachea to one side.

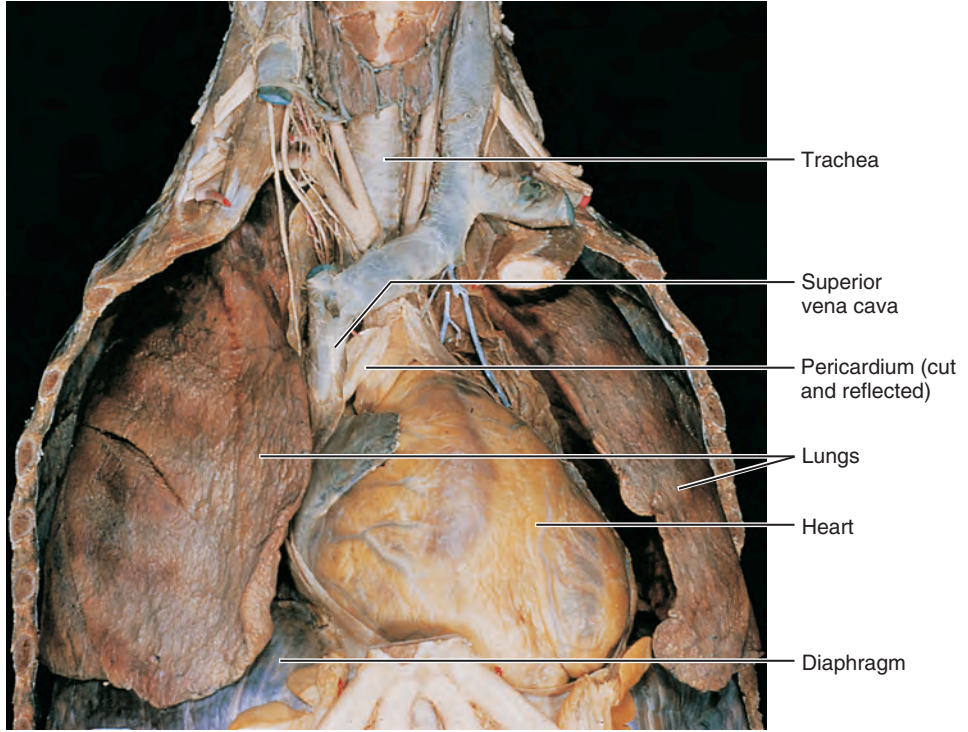
Esophagus: A food chute; the part of the digestive system that transports food from the pharynx (throat) to the stomach.

Diaphragm: A thin muscle attached to the inferior boundary of the rib cage; separates the thoracic and abdominal cavities.

Follow the esophagus through the diaphragm to its junction with the stomach.



(a)



(b)

Figure 2.3 Superficial organs of the thoracic cavity. (a) Dissected rat. (b) Human cadaver.

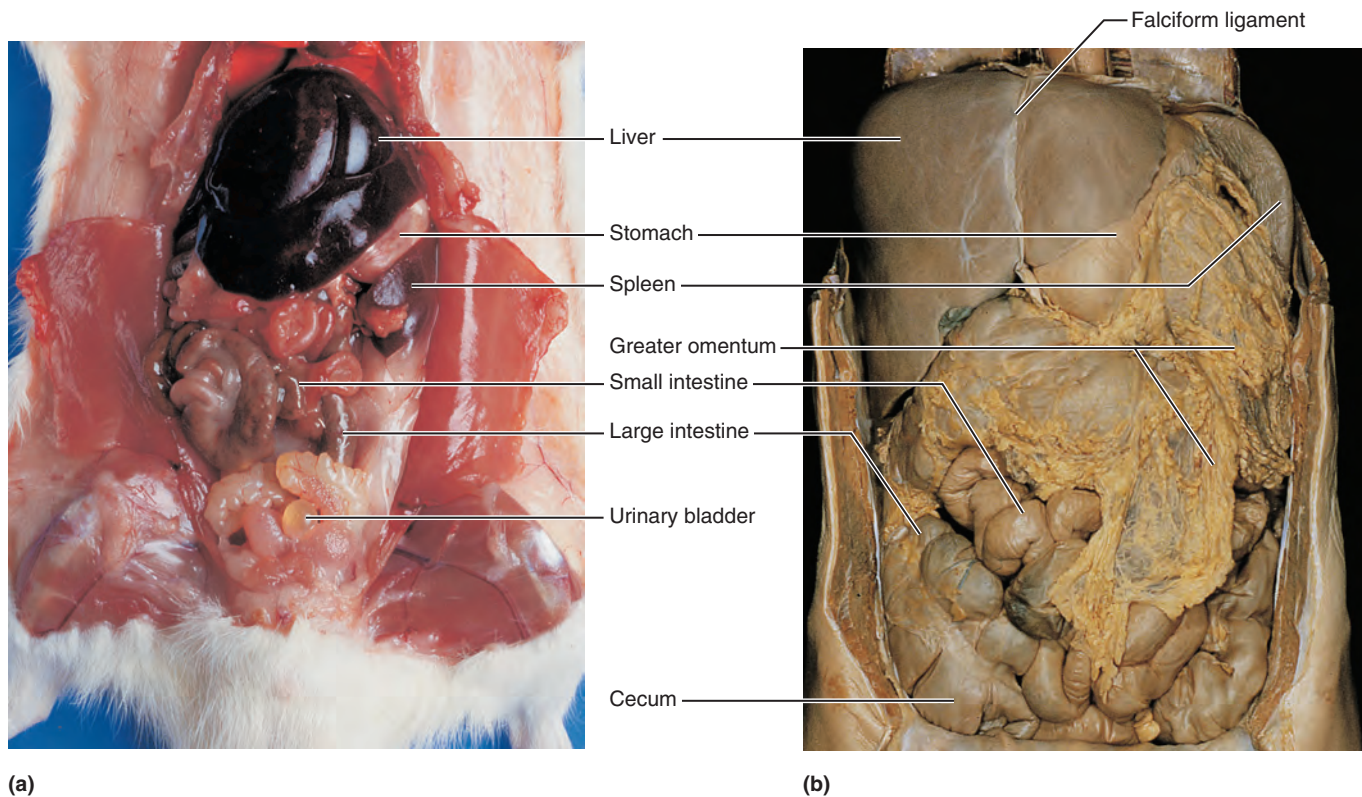


Figure 2.4 Abdominal organs. (a) Dissected rat, superficial view. (b) Human cadaver, superficial view.

Stomach: A curved organ important in food digestion and temporary food storage.

2. Examine the superficial structures of the abdominopelvic cavity. Lift the **greater omentum**, an extension of the peritoneum that covers the abdominal viscera. Continuing from the stomach, trace the rest of the digestive tract (**Figure 2.4**).

Small intestine: Connected to the stomach and ending just before the saclike cecum.

Large intestine: A large muscular tube connected to the small intestine and ending at the anus.

Cecum: The initial portion of the large intestine.

Follow the course of the large intestine to the rectum, which is partially covered by the urinary bladder.

Rectum: Terminal part of the large intestine; continuous with the anal canal (not visible in this dissection).

Anus: The opening of the digestive tract (through the anal canal) to the exterior.

Now lift the small intestine with the forceps to view the mesentery.

Mesentery: An apronlike serous membrane; suspends many of the digestive organs in the abdominal cavity. Notice that it is heavily invested with blood vessels and, more likely than not, riddled with large fat deposits.

Locate the remaining abdominal structures.

Pancreas: A diffuse gland; rests dorsal to and in the mesentery between the first portion of the small intestine and the stomach. You will need to lift the stomach to view the pancreas.

Spleen: A dark red organ curving around the left lateral side of the stomach; considered part of the lymphatic system and often called the red blood cell “graveyard.”

Liver: Large and brownish red; the most superior organ in the abdominal cavity, directly beneath the diaphragm.

3. To locate the deeper structures of the abdominopelvic cavity, move the stomach and the intestines to one side with the probe.

Examine the posterior wall of the abdominal cavity to locate the two kidneys (**Figure 2.5**).

Kidneys: Bean-shaped organs; retroperitoneal (behind the peritoneum).

Adrenal glands: Large endocrine glands that sit on top of the superior margin of each kidney; considered part of the endocrine system.

Carefully strip away part of the peritoneum with forceps, and attempt to follow the course of one of the ureters to the bladder.

Ureter: Tube running from the indented region of a kidney to the urinary bladder.

Urinary bladder: The sac that serves as a reservoir for urine.

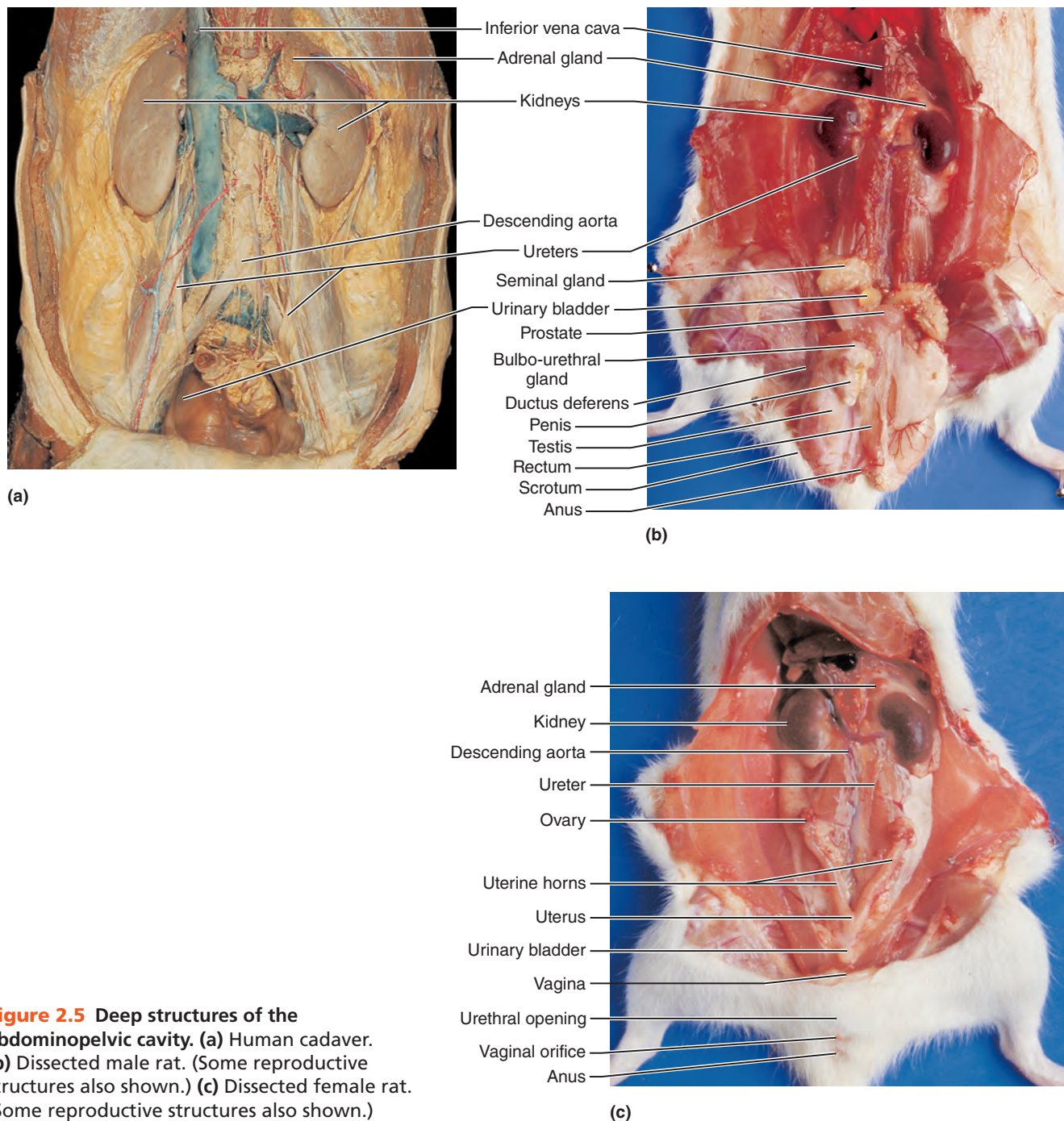


Figure 2.5 Deep structures of the abdominopelvic cavity. (a) Human cadaver. (b) Dissected male rat. (Some reproductive structures also shown.) (c) Dissected female rat. (Some reproductive structures also shown.)

4. In the midline of the body cavity lying between the kidneys are the two principal abdominal blood vessels. Identify each.

Inferior vena cava: The large vein that returns blood to the heart from the lower body regions.

Descending aorta: Deep to the inferior vena cava; the largest artery of the body; carries blood away from the heart down the midline of the body.

5. You will perform only a brief examination of reproductive organs. If you are working with a rat, first determine whether the animal is a male or female. Observe the ventral body surface beneath the tail. If a saclike scrotum and an opening for the anus are visible, the animal is a male. If three

body openings—urethral, vaginal, and anal—are present, it is a female.

Male Animal

Make a shallow incision into the **scrotum**. Loosen and lift out one oval **testis**. Exert a gentle pull on the testis to identify the slender **ductus deferens**, or **vas deferens**, which carries sperm from the testis superiorly into the abdominal cavity and joins with the urethra. The urethra runs through the penis of the male and carries both urine and sperm out of the body. Identify the **penis**, extending from the bladder to the ventral body wall. You may see other glands of the male rat’s reproductive system (Figure 2.5b), but you don’t need to identify them at this time.

Female Animal

Inspect the pelvic cavity to identify the Y-shaped **uterus** lying against the dorsal body wall and beneath the bladder (Figure 2.5c). Follow one of the uterine horns superiorly to identify an **ovary**, a small oval structure at the end of the uterine horn. (The rat uterus is quite different from the uterus of a human female, which is a single-chambered organ about the size and shape of a pear.) The inferior undivided part of the rat uterus is continuous with the **vagina**, which leads to the body exterior. Identify the **vaginal orifice** (external vaginal opening).

If you are working with a human cadaver, proceed as indicated next.

Male Cadaver

Make a shallow incision into the **scrotum** (Figure 2.6a). Loosen and lift out the oval **testis**. Exert a gentle pull on the testis to identify the slender **ductus (vas) deferens**, which carries sperm from the testis superiorly into the abdominal

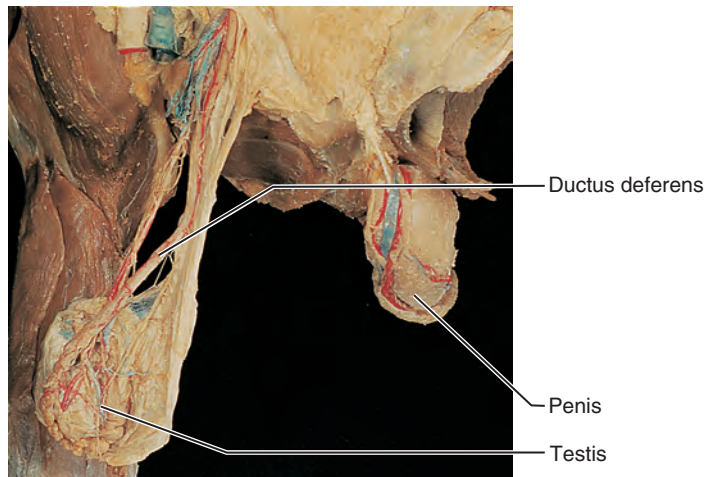
cavity (Figure 2.6b) and joins with the urethra. The urethra runs through the penis of the male and carries both urine and sperm out of the body. Identify the **penis**, extending from the bladder to the ventral body wall.

Female Cadaver

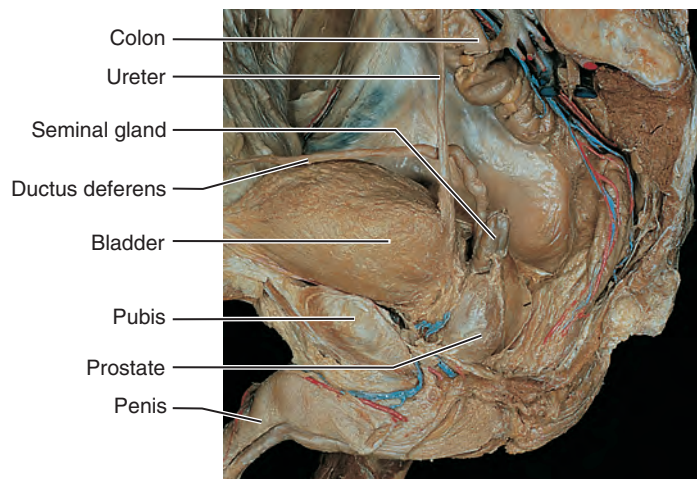
Inspect the pelvic cavity to identify the pear-shaped **uterus** lying against the dorsal body wall and superior to the bladder. Follow one of the **uterine tubes** superiorly to identify an **ovary**, a small oval structure at the end of the uterine tube (Figure 2.6c). The inferior part of the uterus is continuous with the **vagina**, which leads to the body exterior. Identify the **vaginal orifice** (external vaginal opening).

6. When you have finished your observations, rewrap or store the dissection animal or cadaver according to your instructor’s directions. Wash the dissecting tools and equipment with laboratory detergent. Dispose of the gloves. Then wash and dry your hands before continuing with the examination of the human torso model. ■

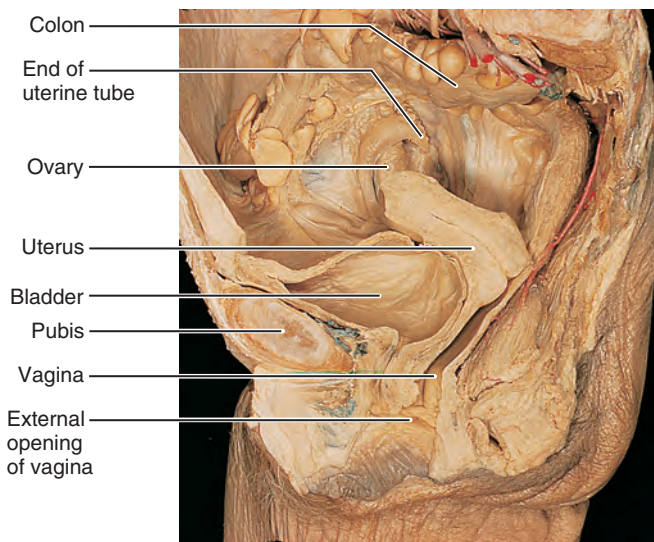
Figure 2.6 Human reproductive organs. (a) Male external genitalia. (b) Sagittal section of the male pelvis. (c) Sagittal section of the female pelvis.



(a)



(b)



(c)

ACTIVITY 5

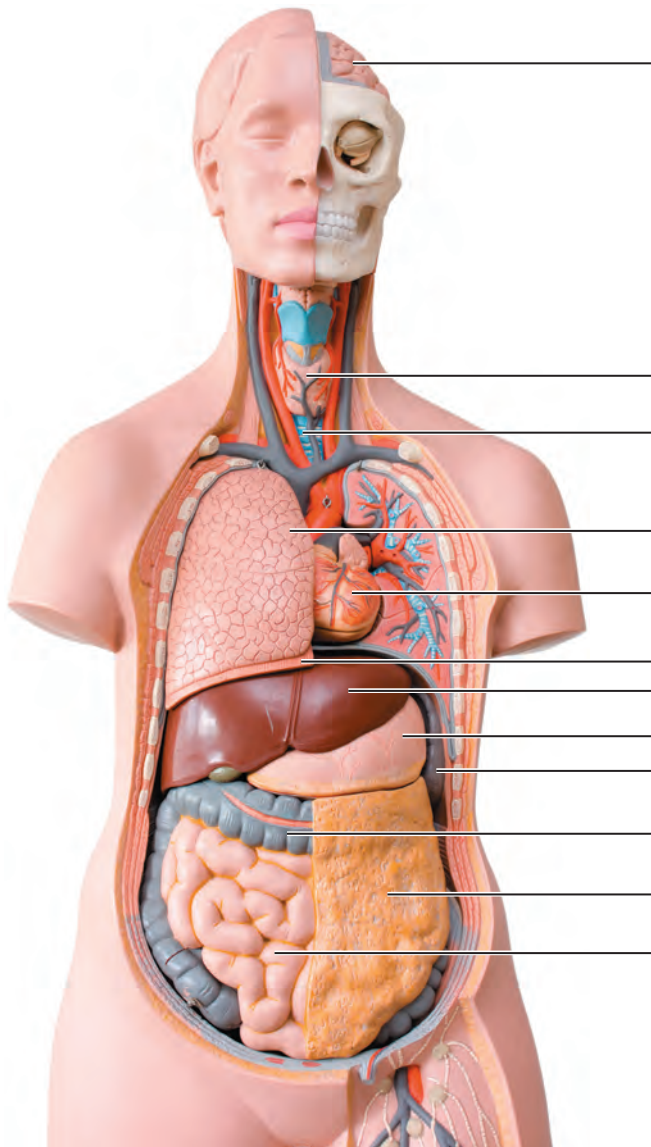
Examining the Human Torso Model

1. Examine a human torso model to identify the organs listed next to the photograph of the human torso model (Figure 2.7). (If a torso model is not available, Figure 2.7 may be used for this part of the exercise). Some model organs will have to be removed to see the deeper organs.
2. Using the terms to the right of the figure (Figure 2.7), label each organ supplied with a leader line in the figure (Figure 2.7).
3. Place each of the organs listed in the correct body cavity or cavities. For organs found in the abdominopelvic cavity, also indicate which quadrant they occupy.

Dorsal body cavity _____

Thoracic cavity _____

Abdominopelvic cavity _____



- Adrenal gland
- Aortic arch
- Brain
- Bronchi
- Descending aorta
- Diaphragm
- Esophagus
- Greater omentum
- Heart
- Inferior vena cava
- Kidneys
- Large intestine
- Liver
- Lungs
- Pancreas
- Rectum
- Small intestine
- Spinal cord
- Spleen
- Stomach
- Thyroid gland
- Trachea
- Ureters
- Urinary bladder

Figure 2.7 Human torso model.

4. Determine which organs are found in each abdominopelvic region, and record below.

Umbilical region: _____

Epigastric region: _____

Hypogastric region: _____

Right iliac region: _____

Left iliac region: _____

Right lumbar region: _____

Left lumbar region: _____

Right hypochondriac region: _____

Left hypochondriac region: _____

Now, assign each of the organs just identified to one of the organ system categories listed below.

Digestive: _____

Urinary: _____

Cardiovascular: _____

Endocrine: _____

Reproductive: _____

Respiratory: _____

Lymphatic/immune: _____

Nervous: _____

GROUP CHALLENGE

Odd Organ Out

Each box below contains four organs. One of the listed organs in each case does *not* share a characteristic that the other three do. Circle the organ that doesn't belong with the others, and explain why it is singled out. What characteristic is it missing? Sometimes there may be multiple

reasons why the organ doesn't belong with the others. Include as many as you can think of, but make sure the organ does not have the key characteristic(s). Use the table (Table 2.1) and the pictures in your lab manual to help you select and justify your answer.

1. Which is the "odd organ"?	Why is it the odd one out?
Stomach Teeth Small intestine Oral cavity	
2. Which is the "odd organ"?	Why is it the odd one out?
Thyroid gland Thymus Spleen Lymph nodes	
3. Which is the "odd organ"?	Why is it the odd one out?
Ovaries Prostate gland Uterus Uterine tubes	
4. Which is the "odd organ"?	Why is it the odd one out?
Stomach Small intestine Esophagus Large intestine	

Name _____

Lab Time/Date _____

EXERCISE 2

Organ Systems Overview

REVIEW SHEET

1. Use the key below to indicate which body systems perform the following functions. (Some body systems are used more than once.) Then, circle the organ systems (in the key) that are present in all subdivisions of the ventral body cavity.

Key: a. cardiovascular d. integumentary g. nervous j. skeletal
b. digestive e. lymphatic/immune h. reproductive k. urinary
c. endocrine f. muscular i. respiratory

- _____ 1. rids the body of nitrogen-containing wastes
_____ 2. is affected by removal of the thyroid gland
_____ 3. provides support and levers on which the muscular system acts
_____ 4. includes the heart
_____ 5. protects underlying organs from drying out and from mechanical damage
_____ 6. protects the body; destroys bacteria and tumor cells
_____ 7. breaks down ingested food into its building blocks
_____ 8. removes carbon dioxide from the blood
_____ 9. delivers oxygen and nutrients to the tissues
_____ 10. moves the limbs; facilitates facial expression
_____ 11. conserves body water or eliminates excesses
_____ and _____ 12. facilitate conception and childbearing
_____ 13. controls the body by means of chemical molecules called hormones
_____ 14. is damaged when you cut your finger or get a severe sunburn

2. Using the key above, choose the *organ system* to which each of the following sets of organs or body structures belongs.

- | | |
|---|---|
| _____ 1. thymus, spleen,
lymphatic vessels | _____ 5. epidermis, dermis,
cutaneous sense organs |
| _____ 2. bones, cartilages,
tendons | _____ 6. testis, ductus deferens,
urethra |
| _____ 3. pancreas, pituitary,
adrenal glands | _____ 7. esophagus, large
intestine, rectum |
| _____ 4. trachea, bronchi,
lungs | _____ 8. muscles of the thigh,
postural muscles |

3. Using the key below, place the following organs in their proper body cavity. Letters may be used more than once.

Key: a. abdominopelvic b. cranial c. spinal d. thoracic

- | | | | | | |
|-------|--------------------|-------|--------------------|-------|------------|
| _____ | 1. stomach | _____ | 4. liver | _____ | 7. heart |
| _____ | 2. esophagus | _____ | 5. spinal cord | _____ | 8. trachea |
| _____ | 3. large intestine | _____ | 6. urinary bladder | _____ | 9. rectum |

4. Using the organs listed in question 3 above, record, by number, which would be found in the abdominal regions listed below.

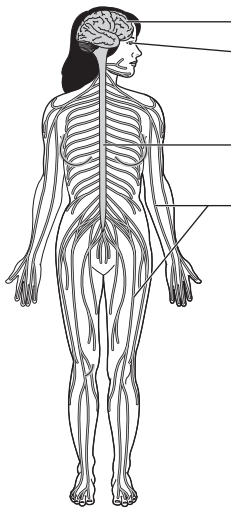
- | | | | |
|-------|------------------------|-------|------------------------------|
| _____ | 1. hypogastric region | _____ | 4. epigastric region |
| _____ | 2. right lumbar region | _____ | 5. left iliac region |
| _____ | 3. umbilical region | _____ | 6. left hypochondriac region |

5. The levels of organization of a living body are as follows: chemicals, _____, _____, _____, _____, and organism.

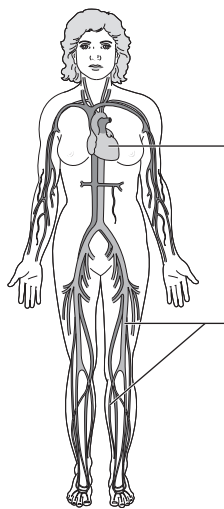
6. Define *organ*. _____

7. Using the terms provided, correctly identify all of the body organs indicated with leader lines in the drawings below. Then name the organ systems by entering the name of each on the answer blank below each drawing.

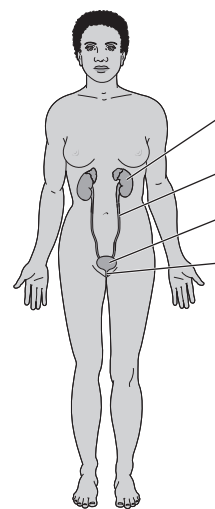
Key: blood vessels heart nerves spinal cord urethra
 brain kidney sensory receptor ureter urinary bladder



a. _____



b. _____



c. _____

8. Why is it helpful to study the external and internal structures of the rat? _____
