Name:_____Date____

Dissection of the Rat

Introduction

In this laboratory exercise, the anatomy of the rat will be examined in some detail. You may recall that in your first-year biology course you dissected a grass frog and a fetal pig. You may recognize and remember structures that you learned during that dissection. In Biology 3A, a much more detailed look at mammalian anatomy will be conducted. You will get to know and love your preserved rat over the course of this dissection.

The classification of the Rat
(*Rattus norvegicus*)

Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Mammalia
Order Rodentia
Family Muridae
Genus *Rattus*
Species *norvegicus*



The lab books and diagrams available to you are supplemental. You are expected to follow the directions in this lab. You will be held responsible for being able to locate all the structures. You are expected to have exhausted all possibilities in attempting to locate structures before asking for assistance. Using the available material, instructions and diagrams, most students will be able to locate many structures for themselves. If after an earnest effort, you cannot find a structure, ask for assistance. Remember, this is a learning experience; it is quite permissible to discuss and observe other students' specimens. Compare your dissection with others, for animals often differ, be sure to look at animals of the opposite sex, you will be responsible for both sexes on the lab practical.

The specimen you will receive is a preserved double-injected specimen. Double injected refers to the arteries being filled with a red latex, and the veins being filled with blue latex. You will notice various incisions on the external surface of the rat where the latex was injected.

The rat is a vertebrate, which means that many aspects of its structural organization are common with all other vertebrates, including man. The similarity of structures among related organisms shows evidence of common ancestry. In a way, studying the rat is like studying a human. As the leading theme of this lab, ask yourself: for every structure observed in the rat, there is an equivalent structure in your own body - what is the structure and where is it located.

As the second leading theme, pay attention to the relationships among organs and groups of organs. Structural parts are not "just there" in random locations. Their specific layout within the body contributes to making certain functions possible. Therefore, for every structure seen, you should determine the following:

- What organ system it belongs to
- How it relates to other components
- Its general function
- Its specific function (if applicable

Dissection

Dissecting tools will be used to open the body cavity of the rat and observe the structures. Keep in mind that dissecting does not mean "to cut up"; in fact, it means, "to expose to view". Careful dissecting techniques will be needed to observe all the structures and their connections to other structures. You will not need to use a scalpel. Contrary to popular belief, a scalpel is not the best tool for dissection. Scissors serve better because the point of the scissors can be pointed upwards to prevent damaging organs underneath. Always raise structures to be cut with your forceps before cutting, so that you can see exactly what is underneath and where the incision should be made. Never cut more than is necessary to expose a part.

Grading

Your grade on this laboratory will be assessed per the class participation (observed daily) with checkpoints evaluated.

Glossary of Terms

Dorsal: toward the back / Ventral: toward the belly
Lateral: toward the sides /Median: near the middle
Anterior: toward the head /Posterior: toward the hind end (tail)
Superficial: on or near the surface
Deep: some distance below the surface
Sagittal: relating to the midplane, bisects the left and right sides
Transverse: relating to the plane separating anterior and posterior
Horizontal: relating to the plane separating dorsal and ventral
Proximal: near to the point of reference / Distal: far from the point
Caudal: toward the tail end
Pectoral: relating to the chest and shoulder region
Pelvic: relating to the hip region
Dermal - relating to the skin
Longitudinal - lengthwise

Right & Left - refers to the specimen's right and left, not yours
Abdominal Cavity - related to the area below (posterior) the ribcage
Thoracic Cavity - related to the area above (anterior) the ribcage

Rat External Anatomy

Procedure: Obtain your rat. Rinse it off with water and place it in your dissecting pan to observe the general characteristics. Make sure you know each of the highlighted words.

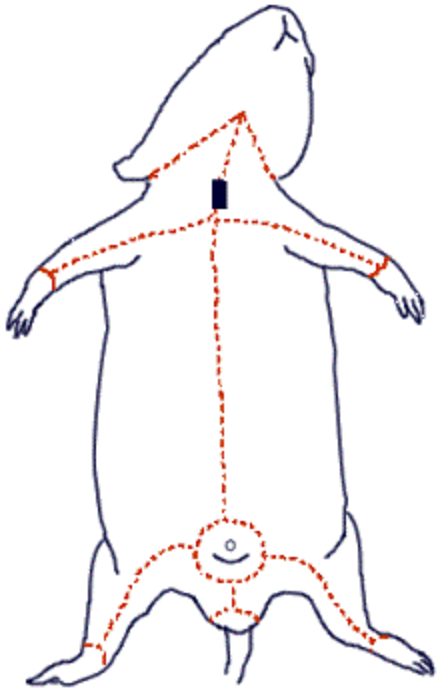
The rat's body is divided into six anatomical regions; Locate the:

cranial region – head
cervical region – neck
pectoral region - area where front legs attach
thoracic region - chest area
abdomen - belly
pelvic region - area where the back legs attach

Place a check mark in boxes to indicate you have located the structure. At each checkpoint, have your teacher evaluate.

Locate each of the regions : ☐

1.Note the hairy coat that covers the rat and the sensory hairs (whiskers) located on the rat's face, called **vibrissae**.
2. The mouth has a large cleft in the upper lip which exposes large front **incisors**. Rats are gnawing mammals, and these incisors will continue to grow for as long as the rat lives.
3. Note the eyes with the large **pupil** and **nictitating membrane** found at the inside corner of the eye. This membrane can be drawn across the eye for protection. The eyelids are like those found in humans.
4. The ears are composed of the external part, called the **pinna**.
5. Locate the **teats** on the ventral surface of the rat. Only females have teats.
6. Examine the **tail**, the tails of rats do not have hair. Though some rodents, like gerbils, have hair on their tails.
7. Locate the anus, which is ventral to the base of the tale.
8. In the female, find the **vaginal opening**. This will be seen between the anus, at the base of the tail, and the opening of the **urethra**, which is more ventral.
9. On males, you will find a large pair of **scrotal sacs** which contain **testes**. Just anterior to the scrotal sacs is the prepuce, which is a bulge of skin surrounding the penis.



The Muscular and Skeletal System of the Rat

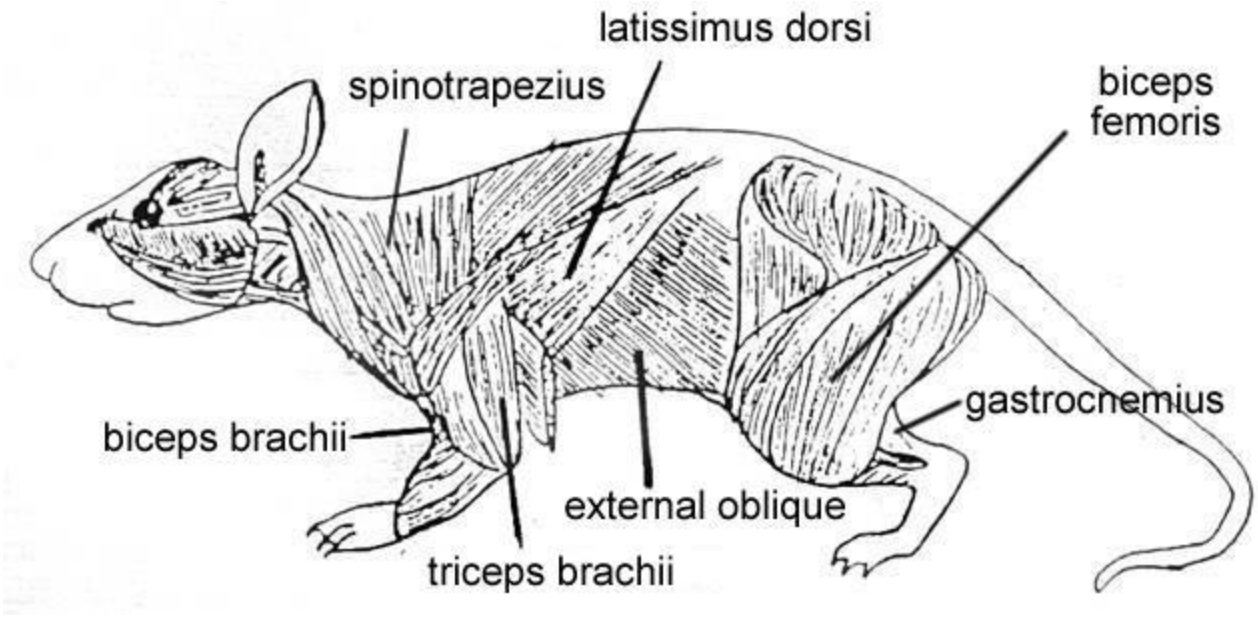
Procedure: Skinning the Rat

You will carefully remove the skin of the rat to expose the muscles below. This task is best accomplished with scissors and forceps where the skin is gently lifted and snipped away from the muscles. You can start at the incision point where the latex was injected and continue toward the tail. Use the lines on the diagram to cut a similar pattern, avoiding the genital area. Gently peel the skin from the muscles, using scissors and a probe to tease away muscles that stick to the skin.

Identify the following muscles and place a different colored pin in each.

1. **Biceps brachii** - located on the anterior surface of the humerus. ☐
2. **Triceps brachii** - located on the sides and back of the upper arm. ☐
3. **Spinotrapezius** - located across the dorsal thoracic region of the rat. ☐
4. **Latissimus dorsi** - located posterior (and partially covered) by the spinotrapezius. ☐
5. **Biceps femoris** - located on the side of the thigh, in two bundles ☐
6. **Tibialis Anterior** - located on the front of the leg. ☐
7. **Gastrocnemius** - located on lower leg, bulk of the calf muscle. Attaches to heel by the **Achilles Tendon**.
8. **External Oblique** - located on the sides of the abdomen. ☐
9. **Gluteus Maximus** - located on the lower back and rear. ☐
10. **Pectoralis Major/Minor** - located in chest ☐

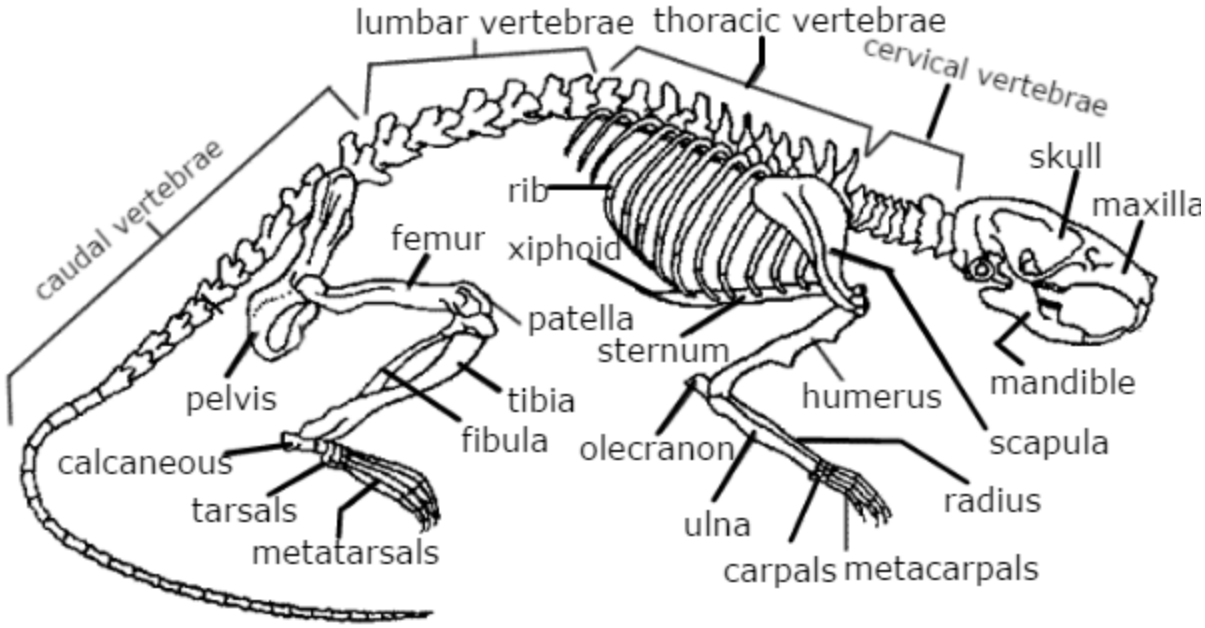
Checkpoint Pin the muscles listed above on a skinned rat and identify each.



Procedure: Exposing the bones of the leg.

Procedure: Carefully tease away the biceps femoris and gastrocnemius to expose the 3 leg bones: **Tibia**, **Fibula**, and **Femur** and the small **patella** (kneecap). You can also see the **ligaments** around the knee that attach the bones of the lower leg to the femur and the achilles tendon which attaches the gastrocnemius to the ankle. ☐

Note that the joint of the hip is called a ball and socket joint. Examine how the bones fit into the pelvis. ☐



*** Study the diagram to learn the bones of the rat.

Checkpoint Bones exposed and identified.

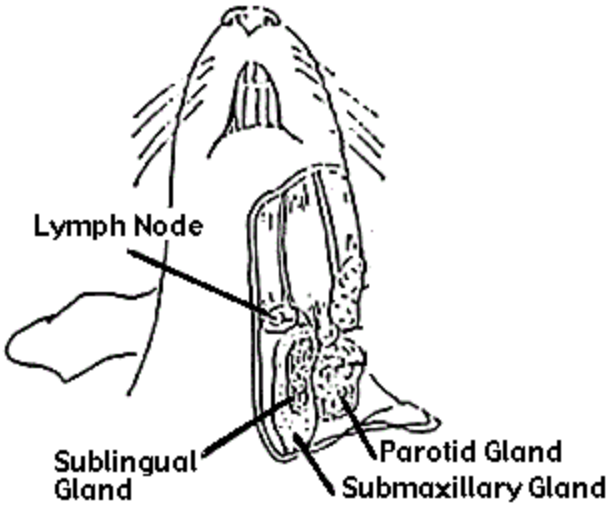
Structures of the Head and Neck

1. Locate the salivary glands, which are on the sides of the neck, between muscles. Carefully remove the skin of the neck and face to reveal these glands. Salivary glands are soft spongy tissue that secrete saliva and amylase (an enzyme that helps break down food). There are three salivary glands - the **sublingual**, **submaxillary**, and **parotid**. ☐

2. Find the **lymph glands** which lie anterior to the salivary glands. Lymph glands are circular and are pressed against the jaw muscles. They are not always visible in the rat. ☐

3. Tease away the muscles of the neck to reveal the **trachea**. The trachea is identifiable by its ringed cartilage which provides support. The **esophagus** lies underneath the trachea, though it is easier to locate in the abdominal cavity where it enters the stomach. ☐

4. Locate the **larynx**, which is just anterior to the trachea. The larynx is the voice box, and it allows rats to make squeaking noises. ☐



Checkpoint Pin the salivary glands, the larynx and the trachea.

Checkpoint:

1. What are the four bones in the hindlimb of the rat? _____

2. What are the three bones in the forelimb of the rat? _____

3. Where does the trachea lead? _____ The esophagus? _____

4. What features do you find in females, but not males? _____

5. What tendon connects the gastrocnemius to the calcaneus? _____

6. What muscle was removed to expose the femur? _____

7. What two muscles can be found on the dorsal side of the rat? _____

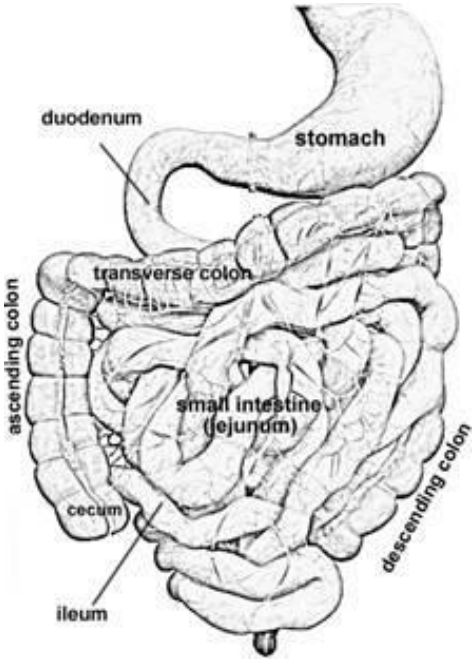
8. What muscle covers the ventral, abdominal region? _____

9. What muscle covers the ventral, pectoral region? _____

10. What structure is responsible for rat vocalization? _____

Rat Dissection - The Thoracic Organs

▶ Procedure: *Cut through the abdominal wall of the rat following the incision marks in the picture. Be careful not to cut too deeply and keep the tip of your scissors pointed upwards. Do not damage the underlying structures. Once you have opened the body cavity, you will need to rinse it in the sink.*



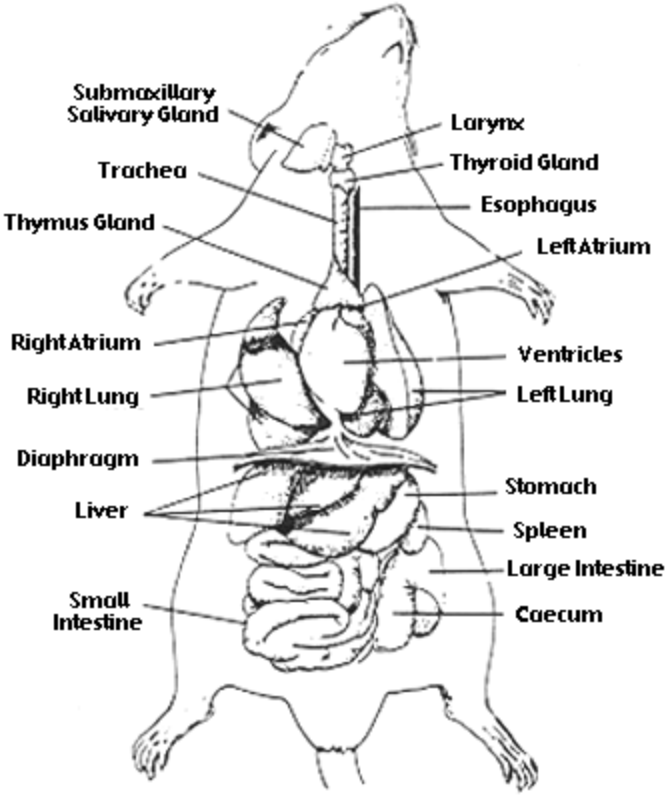
1. Locate the **diaphragm**, which is a layer of muscle that separates the thoracic from the abdominal cavity. ❑
2. The **heart** is centrally located in the thoracic cavity. The two dark colored chambers at the top are the **atria** (single: atrium), and the bottom chambers are the **ventricles**. The heart is covered by a thin membrane called the **pericardium**. (We will come back to the heart later.) ❑
3. Locate the **thymus gland**, which lies directly over the upper part of the heart. The thymus functions in the development of the immune system and is much larger in young rats than it is in older rats. ❑
4. The **lungs** are spongy organs that lie on either side of the heart and should take up most of the thoracic cavity. ❑

The Abdominal Organs

1. The **coelom** is the body cavity within which the viscera (internal organs) are located. The cavity is covered by a membrane called the **peritoneum**, which is very thin and web-like; you may need to use forceps to remove some of this membrane to see the organs clearly. ❑

2. Locate the **liver**, which is a dark colored organ suspended just under the diaphragm. The liver has many functions, one of which is to produce bile, which aids in digesting fat. The liver also transforms wastes into less harmful substances. Rats do not have a gallbladder, which is used for storing bile in other animals. There are four parts to the liver: ❑

median or cystic lobe - located at the top, there is an obvious central cleft
left lateral lobe - large and partially covered by the stomach
right lateral lobe - partially divided into an anterior and posterior lobule, hidden from view by the median lobe
caudate lobe - small and folds around the esophagus and the stomach, seen most easily when stomach is raised



3. The **esophagus** pierces the diaphragm at a spot called the **hiatus** and moves food from the mouth to the stomach. It is easiest to locate where it enters the stomach. ❑

4. Locate the **stomach** on the left side just under the diaphragm. The functions of the stomach include food storage, physical breakdown of food, and the digestion of protein. ❑

The outer margin of the curved stomach is called the **greater curvature**, the inner margin is called the **lesser curvature**. You can make a slit in the stomach and see what is inside it. Most of the contents should be partly digested rat food. ❑

At each end of the stomach (on the inside) is a muscular valve. The opening between the esophagus and the stomach is called the **cardiac sphincter**. The opening between the stomach and the intestine is called the **pyloric sphincter**. ❑

5. The **spleen** is about the same color as the liver and is attached to the greater curvature of the stomach. It is associated with the circulatory system and functions in the destruction of blood cells and blood storage

A person can live without a spleen, but they're more likely to get sick as it helps the immune system function. ❑

6. The **pancreas** is a brownish, flattened gland found in the tissue between the stomach and small intestine. The pancreas produces digestive enzymes that are sent to the intestine via small ducts (the pancreatic duct). The pancreas also secretes insulin, which is important in the regulation of glucose metabolism. ❑

7. The **small intestine** is a slender coiled tube that receives partially digested food from the stomach (via the pyloric sphincter). The coils of the small intestine are held together by a membrane called the **mesentery**. ❑

The small intestine has three sections: **duodenum**, **jejunum** and **ileum**, (Listed in order from the stomach to the large intestine.) The duodenum is the first stretch of the intestine leading from the stomach, it is mostly straight. The jejunum and ileum are both curly parts of the intestine, with the ileum being the last section before the small intestine becomes the large intestine. ❑

8. Locate the **colon**, which is the large greenish tube that extends from the small intestine and leads to the anus. The colon is also known as the **large intestine**. Food entering the colon from the small intestine is controlled by the ileocecal valve. The colon is where the final stages of digestion and water absorption occur and it contains a variety of bacteria to aid in digestion. The colon consists of five sections: ❑

- **cecum** - large sac where the small and large intestine meet (the ileocecal valve regulates passage of materials)
- **ascending colon** – food travels upward.
- **transverse colon** – a short section that is parallel to the diaphragm
- **descending colon** – the section of the large intestine that travels back down toward the rectum.
- **rectum** - the short, terminal section of the colon that leads to the anus. The rectum temporarily stores feces before they are expelled from the body.

▶ Pin the organs of the digestive cavity. 

Checkpoint: Test Your Knowledge

1. Lies under the stomach and secretes insulin _____
2. The section of large intestine between the ascending and descending colon: _____
3. Connects the mouth to the stomach: _____
4. Thin membrane that covers the heart: _____
5. Muscle that separates the abdominal cavity from the thoracic cavity: _____
6. Destroys old blood cells and lies within the folds of the small intestine: _____
7. The lobe of the liver that has an obvious central cleft: _____
8. Another name for the large intestine: _____
9. Organs of the respiratory system that lie on either side of the heart: _____
10. Large organ of the thoracic cavity that lies just under (posterior) to the diaphragm: _____
11. The last section of the colon, storage of feces: _____
12. The pouch of the colon that is found just where the small intestine joins it: _____
13. Valve that regulates the passage of food from the stomach to the small intestine: _____
14. Thin membrane that covers the organs of the abdominal cavity: _____
15. The first section of the small intestine: _____
16. The section of large intestine that is parallel to the diaphragm: _____
17. Structure related to the immune system, lies at the top of the heart: _____
18. Valve the regulates passage of materials from the small to the large intestine: _____
19. The opening in the diaphragm where the esophagus passes through: _____
20. Section of small intestine that comes after the duodenum: _____

Rat - Circulatory System

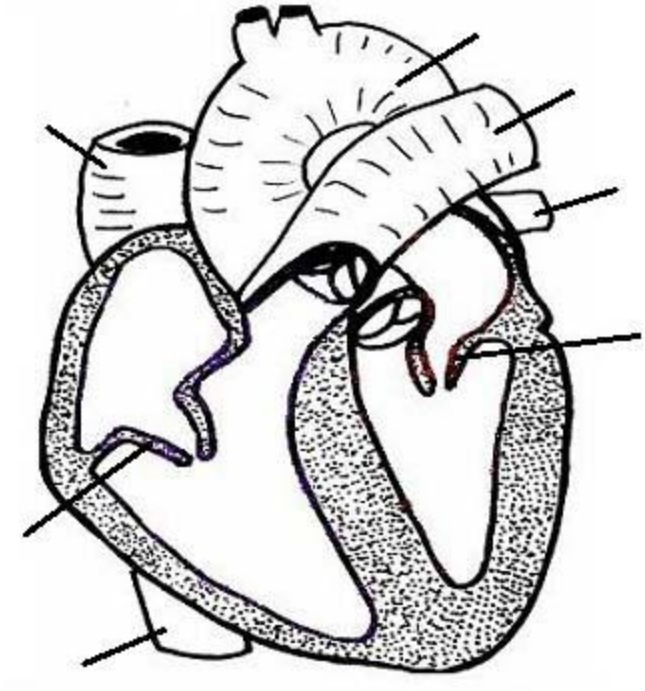
The general structure of the circulatory system of the rat is almost identical to that of humans. Pulmonary circulation carries blood through the lungs for oxygenation and then back to the heart. Systemic circulation moves blood through the body after it has left the heart. You will begin your dissection at the heart. It is important that you do not cut the vessels as you carefully remove any muscles and surrounding tissue to expose them. Your rat should be double injected so that arteries and veins are visible as blue and pink.

Trace the Flow of Blood Inside the Heart

The heart of the rat is too small to view many of the structures listed below. Use models of human hearts or images in the dissection guides to identify the structures and label them on the diagram.

1. Blood from the posterior portion of the body enters the right atrium of the heart through the **inferior vena cava** and the **superior vena cava**.
2. Blood flows from the **right atrium** to the **right ventricle** via the tricuspid valve.
3. Blood is then pumped through the **pulmonary semilunar valve** and into the **pulmonary trunk** where blood travels to the lungs.
4. Blood then flows through the pulmonary arteries to the lungs where it is oxygenated and then returns from the lungs to enter the left atrium via four **pulmonary veins**. Only one of these is visible on the diagram, a tiny vessel on the right side.
5. Blood goes from the **left atrium** to the l**eft ventricle** via the **bicuspid** (or mitral) valve.
6. Blood leaves the left ventricle of the heart through the aortic semilunar valve and enters the **aorta**. The aorta has a visible arch with vessels that lead to the head before the artery descends into the rat's thoracic cavity.

Label the diagram using the descriptions and bold words. Trace the flow of blood using arrows. ❑



Branches of the Aorta

The aorta has four general areas. Locate each of these on your rat.

- ascending aorta - the upper part of the vessel that starts at the atrium ❑
- aortic arch - the place where the aorta bends to the left. ❑
- descending aorta - after the bend, the aorta can be traced toward the diaphragm ❑
- abdominal aorta - the aorta passes through the diaphragm and supplies blood to the lower extremities ❑

1. **Coronary arteries** are located on top of the heart and supply the heart itself with blood. ❑

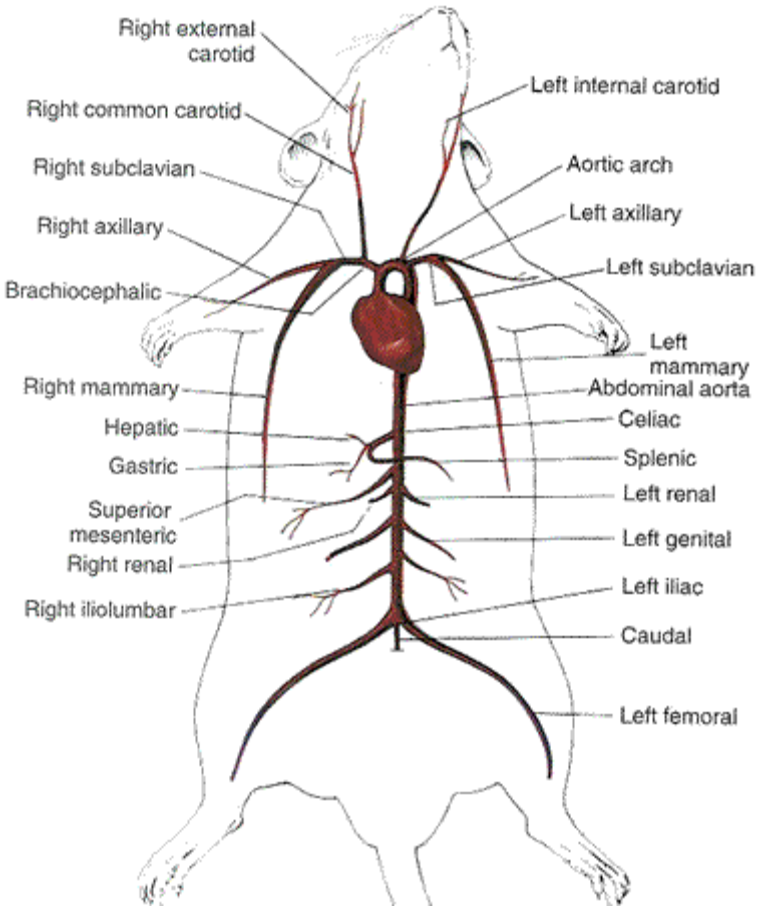
2. The first visible branch from the aorta is the **brachiocephalic artery**, it divides into the **right common carotid artery**, which supplies the right side of the neck, and the **right subclavian artery**, which supplies the right shoulder and arms. Locate the carotid arteries on your rat, they will be obvious arteries that travel up the side of the next. ❑

3. At the most anterior part of the bend in the aortic arch is the **left common carotid artery**, which supplies blood up the left side of the neck. If you are careful you can follow the common carotid to where it branches into the **internal and external carotid.** ☐
4. Immediately to the left of the left common carotid artery is the **left subclavian artery**, which supplies blood to the left shoulder and arm. The subclavian artery becomes the axillary artery as it enters the forearm. ☐

▶ Procedure: Carefully tease away the muscles and tissue so that the subclavian, the axillary and the right common carotid can be seen. Checkpoint

Trace The Branches of the Abdominal Aorta

Many of the arteries that branch from the aorta in this part of the rat are small and fragile. You may not be able to find all of them, but with careful dissection a few can be exposed. They are often named for the organ or structure the vessel supplies blood to. Find at least three of the vessels listed for your checkpoint. If you cannot find the vessel, do not check the box.



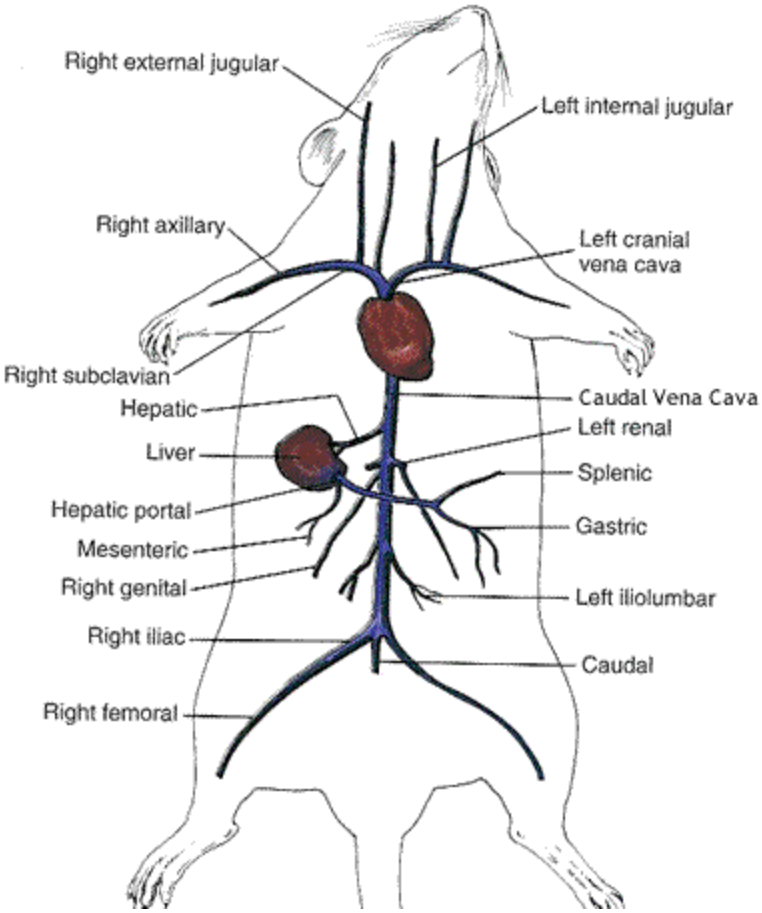
1. The first arterial branch from the abdominal aorta (below the diaphragm) is the **celiac artery** which branches to arteries that supply the stomach **(gastric artery**), liver (**hepatic artery**), spleen and pancreas (**splenic artery**) . ☐
2. The second artery arising from the abdominal artery is the **superior mesenteric artery**, which is larger than the celiac, and delivers blood directly to the small intestine. ☐
3. The **renal arteries** are short and lead directly to the kidneys. These are probably the easiest to locate. ☐
4. Just posterior to the renal arteries are the **genital arteries**, which lead to the testes or the ovaries. ☐
5. Farther along the abdominal aorta, you can find the **iliolumbar arteries** which lead to the dorsal muscles of the back.
6. Next, the **inferior mesenteric artery** leads to the intestinal mesenteries. ☐
7. The abdominal aorta gives rise to the **caudal artery**, which goes on into the tail.
8. The abdominal aorta finally divides to form the **iliac arteries**, which deliver blood to the pelvis and hind legs. ☐
9. The iliac arteries lead to the **femoral artery** in the leg. ☐

▶ Procedure:Attempt to locate the vessels above, find at least three of them. Checkpoint

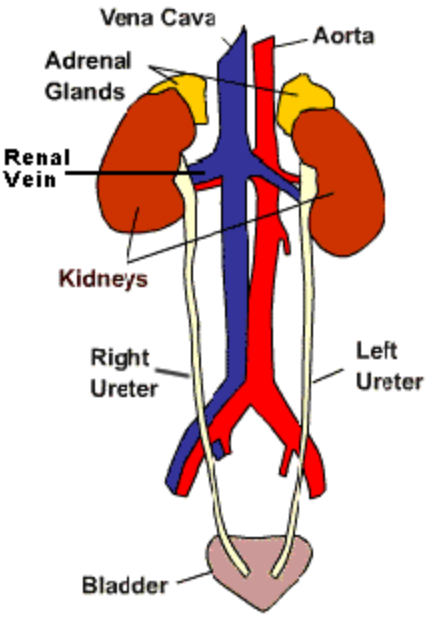
Trace the Systemic Veins

1. The **left and right superior vena cava** conduct blood from the upper part of the body into the right atrium. Trace these veins from the atrium until you find the small internal **jugular vein** and continues as the **subclavian vein**. ❑
2. The subclavian vein divides into the **external jugular vein** and the **axillary vein.** ❑
3. The inferior vena cava carries blood from the lower part of the body to the right atrium. The **hepatic vein** drains the liver and enters the inferior vena cava near the diaphragm. ❑
4. **Renal veins** drain the kidneys. ❑
5. **Genital veins** lead from the gonads and enter the inferior vena cava. ❑
6. The **iliac and femoral veins** drain the legs. ❑
7. The **caudal vein** drains the tail. ❑

▶Procedure: Expose the inferior vena cava and the area where it branches into the femoral and caudal veins. Checkpoint



Urogenital System



The excretory and reproductive systems of vertebrates are closely integrated and are usually studied together as the urogenital system. However, they do have different functions: the excretory system removes wastes and the reproductive system produces gametes (sperm & eggs) and provides an environment for the developing embryo.

Excretory Organs

1. The primary organs of the excretory system are the **kidneys**. Locate these large bean shaped structures located toward the back of the abdominal cavity on either side of the spine. **Renal arteries and veins** supply the kidneys with blood. ❑

    Trace these vessels to where they connect to the aorta and vena cava (two large vessels of the abdominal cavity) ❑

2. Locate the delicate **ureters** that attach to the kidney and lead to the **bladder**. Wiggle the kidneys to help locate these tiny tubes. ❑

3. Procedure: Remove a single kidney (without damaging the other organs) and dissect it by cutting it longitudinally. Locate the **cortex** (the outer area) and the **medulla** (the inner area). ❑

4. The **urethra** carries urine from the bladder to the **urethral orifice** (this orifice is found in different areas depending on whether you have a male or female rat). ❑

5. The small yellowish glands embedded in the fat atop the kidneys are the **adrenal glands**. ❑

**You are responsible for knowing the structures of both sexes. Locate the structures in your own rat and then observe the structures of the opposite sex from another group's rat.

The Reproductive Organs of the Male Rat

1. The major reproductive organs of the male rat are the **testes** (singular: testis) which are located in the **scrotal sac**. Cut through the sac carefully to reveal the testis. On the surface of the testis is a coiled tube called the **epididymis**, which collects and stores sperm cells. The tubular **vas deferens** moves sperm from the epididymis to the **urethra**, which carries sperm through the penis and out the body. ❑

2. The lumpy brown glands located to the left and right of the urinary bladder are the **seminal vesicles**. The gland below the bladder is the **prostate gland** and it is partially wrapped around the penis. The seminal vesicles and the prostate gland secrete materials that form the seminal fluid (semen). ❑

The Reproductive Organs of the Female Rat

1. The short gray tube lying dorsal to the urinary bladder is the **vagina**. The vagina divides into two **uterine horns** that extend toward the kidneys. This duplex uterus is common in some animals and will accommodate multiple embryos (a litter). In contrast, a simple uterus, like the kind found in humans, has a single chamber for the development of a single embryo. ❑

2. At the tips of the uterine horns are small lumpy glands called **ovaries**, which are connected to the uterine horns via **oviducts**. ❑

▶ Pin the organs of the urogenital system. Checkpoint

Checkpoint and Synthesis

1.What tube connects the kidney to the bladder? _____
2. What vessels connect to the kidney? _____
3. Urine exits through what external opening on both male and female rats? _____

4. Compare the location of the urethral orifice on male and female rats.

5. What is the function of the excretory system?

6. Why are the kidneys considered major organs responsible for maintaining HOMEOSTASIS? (you may need to look this up.)

7. The word "vasectomy" is derived from the tube known as the vas deferens. What is a vasectomy?

8. How does the anatomy of a female rat differ from that of a human?