

Dissection of the Rat



Class period _____

Lab Station # _____ **Date** _____

Dissection Team Members:

Participation:

_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Rat Anatomy Checklist

Throughout the course of the investigation, you will need to stop and have your instructor check your progress. At each checkpoint, you should have the box initialed by your instructor to ensure adequate progress. You will turn this sheet in at the end of the investigation.

1. External features. [Instructor initials _____]
2. Muscular system [Instructor initials _____]
3. Skeletal system. [Instructor initials _____]
4. Digestive system, stomach opening & small intestine measured. [Instructor initials _____]
5. Excretory system and dissection of the kidney.[Instructor initials _____]
6. Reproductive system[Instructor initials _____]
7. Circulatory system and dissection of the heart [Instructor initials _____]
8. Final check, rat disposal and clean up [Instructor initials _____]

STRUCTURES TO IDENTIFY

These are the structures that you are expected to identify. Check each box as you identify it.

External anatomy

- Cranial & cervical region
- Pectoral & thoracic region
- Belly & Pelvic region
- Vibrissa (whiskers) & incisors
- Pupil & nictitating membrane
- Teats, Tail & anus
- Urinary aperture & vaginal orifice (Female)
- Scrotal sacs & prepuce (male)

Muscular System

- Biceps brachii (arm)
- Triceps brachii
- Biceps femoris (leg)
- External oblique (chest/stomach)
- Pectoralis Major/Minor

Skeletal System

- Ulna
- Radius
- Humerous

Digestive System

- Liver
- Esophagus
- Stomach
- Small intestine
- Large intestine
- Mesentery

Excretory/Reproductive System

- Kidneys
- Ureters
- Adrenal gland
- Ovaries (female only)
- Testes (male only)

Thoracic Cavity

- Heart
- Lungs
- Diaphragm
- Trachea

Circulatory System

- Vena Cava
- Renal Artery
- Right/left external jugular
- Aortic Arch
- Right/left subclavian
- Right/ Left femoral
- Right & left atrium
- Right & left ventricles

Introduction to Dissection of the Rat

In this laboratory exercise, the anatomy of the rat will be examined in some detail. You will get to know and love your preserved rat over the course of this dissection.

The classification of the Rat (*Rattus norvegicus*)

*Find the missing classification levels

Kingdom:

Phylum:

Subphylum:

Class:

Order:

Family: **Muridae**

Genus: **Rattus**

Species: **norvegicus**



You are expected to carefully follow the directions in this lab. You may use a classroom textbook to supplement the illustrations, if needed. 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. You are encouraged to discuss and observe other students' specimens. Compare your specimen with others, for animals often differ; be sure to look at animals of the opposite sex.

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 particular 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 is connected with 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". You are a surgeon, not a butcher! Careful dissecting techniques will be needed to observe all the structures and their connections to other structures. You will probably 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 absolutely necessary to expose a part.

Grading

Your grade on this laboratory will be assessed according to the following criteria

- Class Participation (observed daily)
- Lab Checklist
- Answers to questions in this packet

Class Participation Grading

*Graded each day of dissection.

0 pts	10 pts	20 pts
<p>Instead of participating in the dissection, student:</p> <ul style="list-style-type: none"> • wandered around the room • distracted others from their work • did not participate in cleanup • was disrespectful to the animal specimen or fellow students • exhibited dangerous lab behavior • worked on other "personal projects" 	<p>Student was engaged in the laboratory most of the time, but did not help the team clean up, quit working too early, and/or approached work with immature attitude.</p>	<p>Student...</p> <ul style="list-style-type: none"> • was fully engaged in dissection experience • contributed fairly to the group's success • remained on task • exhibited mature and respectful behavior throughout the period

Glossary of Terms

Right & Left - refers to the *specimen's* right and left, not yours

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

Rat External Anatomy

► Procedure: Obtain your rat. Rinse it off with water, pat it dry with paper towels 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:

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

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 the **nictitating membrane** found at the inside corner of the eye. This membrane can be drawn across the eye for protection. The **eyelids** are similar to those found in humans.
4. The ears are composed of the external part, called the **pinna**, and the **auditory meatus**, the ear canal.
5. Locate the **teats** on the ventral surface of the rat. Check a rat of another sex and determine whether both sexes have teats.
6. Examine the **tail**, the tails of rats do not have hair. (Some rodents, like gerbils, have hair on their tails.)
7. Locate the **anus**, which is ventral to the base of the tale.
8. On female rats, just posterior to the last pair of teats, you will find the **urinary aperture** and behind that the **vaginal orifice** which is in a small depression called the **vulva**.
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 end of the penis has a **urogenital orifice**, where both urine and sperm exit.

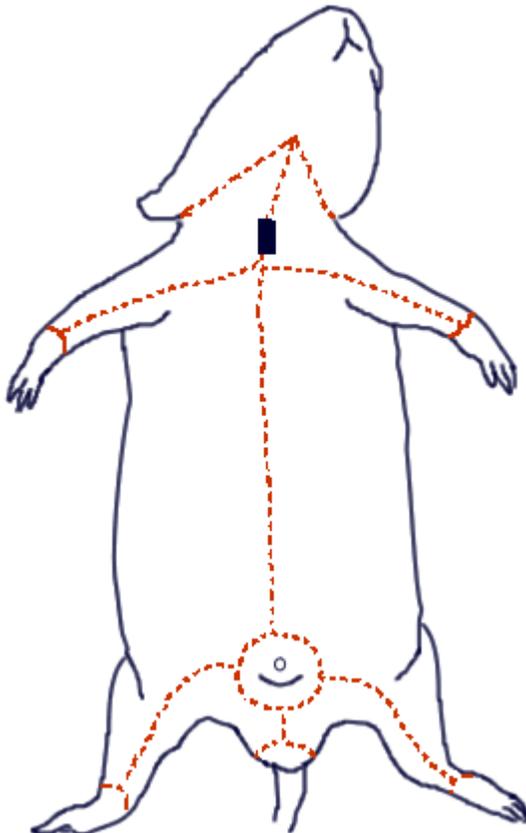
***External Anatomy Checkpoint 1** – Have your instructor initial lab before continuing

The Muscular system of the rat

► Procedure: Skinning the Rat (***only skin parts indicated on check list**)

You will carefully remove some of the skin of the rat to expose the muscles below. You will only need to remove the skin from the areas indicated under muscular system on the check list. This task is best accomplished with scissors and forceps where the skin is gently lifted and snipped away from the muscles. Use the lines on the diagram above as a guide when making your cuts for each of these areas. Gently peel the skin from the muscles, using scissors and a probe to tease away muscles that stick to the skin.

Muscles are attached to bones by connective tissue called **tendons** that adhere to spines, knobs, and ridges on bones. You will need to refer to the rat skeleton to determine where the muscles are attached to bones. The end attached to the bone that does not move during contraction is called the **origin**. The end of the muscle that attaches to the bone that does move is called the **insertion**. The movement caused by the contraction of the muscle is called the **action**. Muscles can be easily identified from one another by their shape and overlap.



Identify the following muscles:

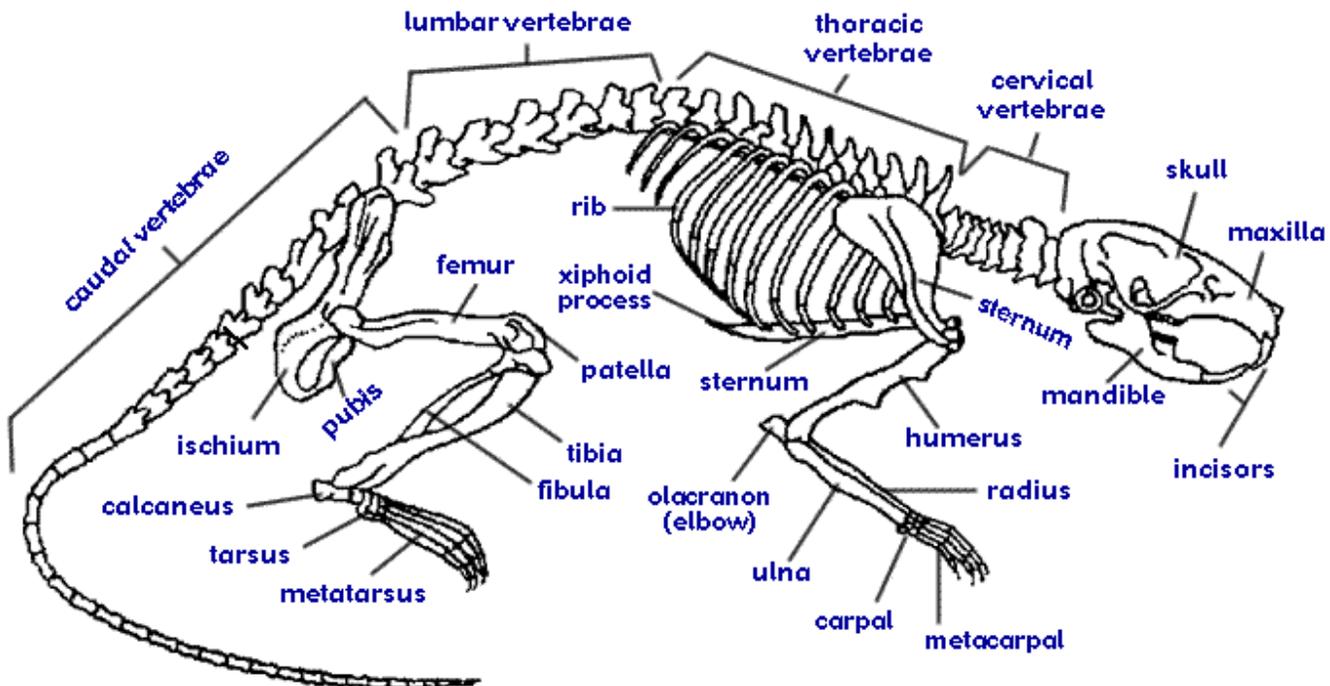
1. **Biceps brachii** - located on the anterior surface of the humerus. Action: flexes lower arm
2. **Triceps brachii** - located on the sides and back of the upper arm. Action: extends lower arm
3. **Biceps femoris** - located on the side of the thigh, in two bundles. Action: flexes the lower leg
4. **External Oblique** - located on the sides of the abdomen. Action: flexes body wall.
5. **Pectoralis Major/Minor** - located in chest area. Action: adducts arm (draws it forward)

***Muscular Checkpoint 2** – Have your instructor initial lab before continuing

Skeletal System of the Rat

► Procedure: Exposing the bones of the leg.

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. Remove the muscles from one arm to reveal the **ulna**, **radius**, and **humerus**. Note the size of the radius



***Skeletal Checkpoint 3** – Have your instructor initial lab before continuing

The Digestive System of the Rat

► Procedure: Use scissors to 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 thin layer of muscle that separates the thoracic cavity from the abdominal cavity. The diaphragm is a helpful directional marker.

2. **Do not remove or cut the heart!** 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 **bronchial tubes** branch from the trachea and enter the **lungs** on either side. The lungs are composed of large spongy tissues that take up a large amount of the thoracic cavity. Bronchial tubes may be difficult to locate because they are embedded in the lungs.

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 covers several regions:

visceral peritoneum - covers the internal organs

mesenteries - attach the internal organs to the dorsal body wall

omentia - connect organ to organ

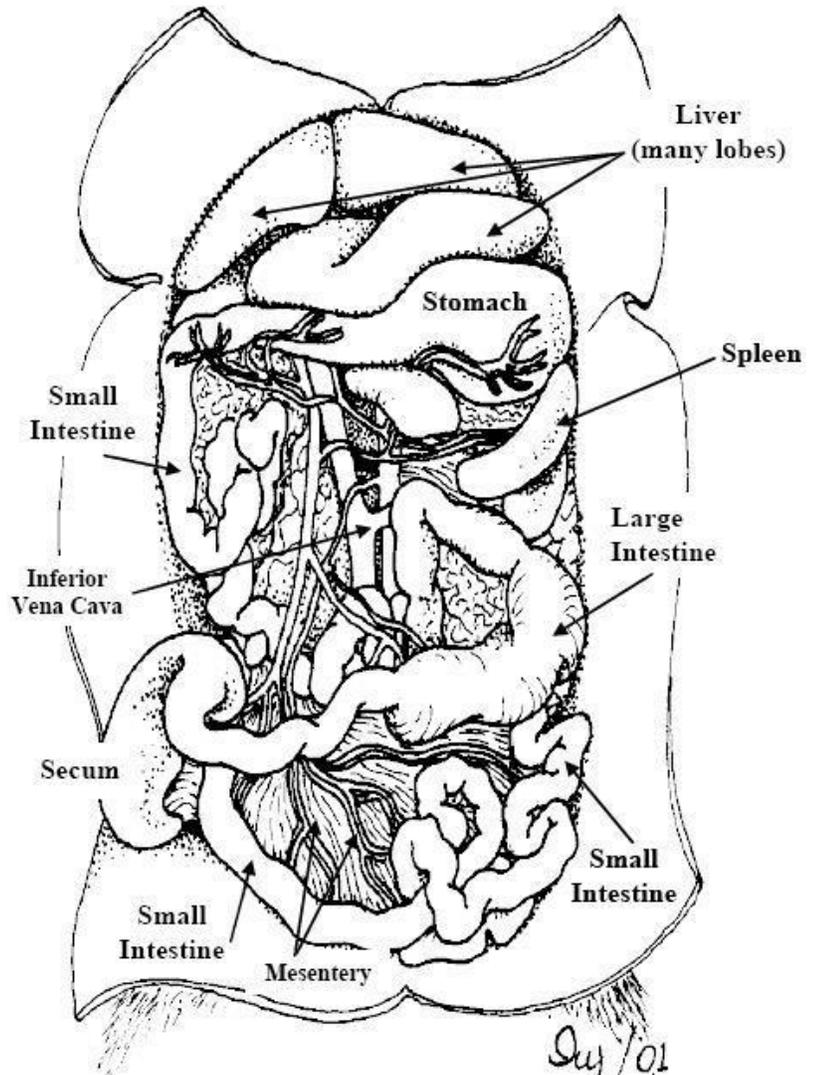
2. Locate the **liver**, which is a dark colored organ suspended just under the diaphragm. The liver has many functions, one of which is to produce bile which aids in digesting fat. The liver also stores glycogen and transforms wastes into less harmful substances. Rats do not have a gall bladder which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

median or cystic lobe - located atop the organ, there is a 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 liver is raised



3. The **esophagus** pierces the diaphragm and moves food from the mouth to the stomach. It is distinguished from the trachea by its lack of cartilage rings. **Why would the trachea need rings, and not the esophagus?**

4. Locate the **stomach** on the right side(usually) just under the liver. The functions of the stomach include food storage, physical breakdown of food, and the digestion of protein. The opening between the esophagus and the stomach is called the cardiac sphincter. **Why is it important to have a muscular ring here?** The outer margin of the curved stomach is called the **greater curvature**, the inner margin is called the **lesser curvature**.

5. Slit the stomach lengthwise along the greater curvature, and notice the ridges inside, called **rugae**. **What might be their function? Are there any food remnants in the stomach?** The attachment between the stomach and the intestine is called the **pyloric sphincter**. **Why is it important to have a muscular ring here?**

6. 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 old red blood cells and blood storage. **Why do red blood cells need to be recycled so frequently?** A person can live without a spleen, but they're more likely to get sick as it helps the immune system function efficiently.

7. 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. The **greater omentum** is the membranous curtain of tissue that hangs from the stomach and contains lymph nodes, blood vessels, and fat. Find the pancreas by looking for a thin, almost membrane looking structure that has the consistency of cottage cheese (glands frequently have this texture).

8. The **small intestine** is a slender coiled tube that receives partially digested food from the stomach (via the pyloric sphincter). It consists of three sections: **duodenum**, **ileum**, and **jejunum**.

9. Use your scissors to cut the **mesentery** of the small intestine, but do not remove it from its attachment to the stomach and rectum. If you are careful you will be able to stretch it out and untangle it so that you can see the relative lengths of the large and the small intestine. **Write down your observations! Measure both and write it down.** Cut a piece (1 -2 cm long) of the small intestine. Open it and wash it clean. Examine it under the dissecting microscope. The velvet texture of the lining of the small intestine is created by numerous minute projections, the **villi**. The absorptive surface is greatly increased by the presence of villi.

10. 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**. The colon is where the final stages of digestion and water absorption occur and it contains a variety of bacteria to aid in digestion.

11. Locate the **cecum** - a large sac in the lower third of the abdominal cavity, it is a dead-end pouch and is in the same location as the appendix in humans. It also is the point at which the small intestine becomes the large intestine. The large cecum is characteristic of nonruminant mammalian herbivores. Large numbers of anaerobic bacteria and protozoa live here and digest cellulose in the diet. The colon is short and leads on to the rectum, which may contain hard, rounded, dry fecal pellets.

12. Locate the **rectum** - the short, terminal section of the colon between the descending colon and the anus. The rectum temporarily stores feces before they are expelled from the body.

***Digestive Checkpoint 4** – Have your instructor initial lab before continuing

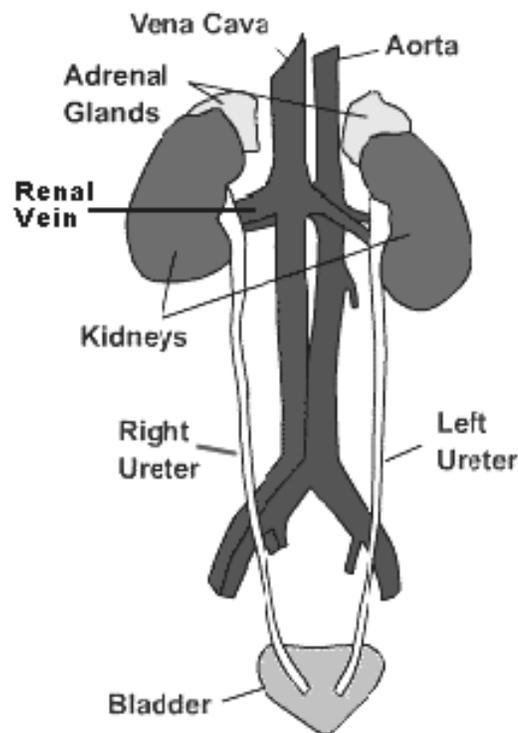
The Excretory system of the Rat

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 & egg) The reproductive system also provides an environment for the developing embryo and regulates hormones related to sexual development.

The primary organs of the excretory system are the **kidneys**. These organs are 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.

1. Locate the kidneys. Note the veins and arteries that connect with the kidneys.

2. 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). Blood is filtered through the kidneys once every 45 minutes.



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

***Excretory system and dissection of kidney Checkpoint 5** – Have your instructor initial lab before continuing

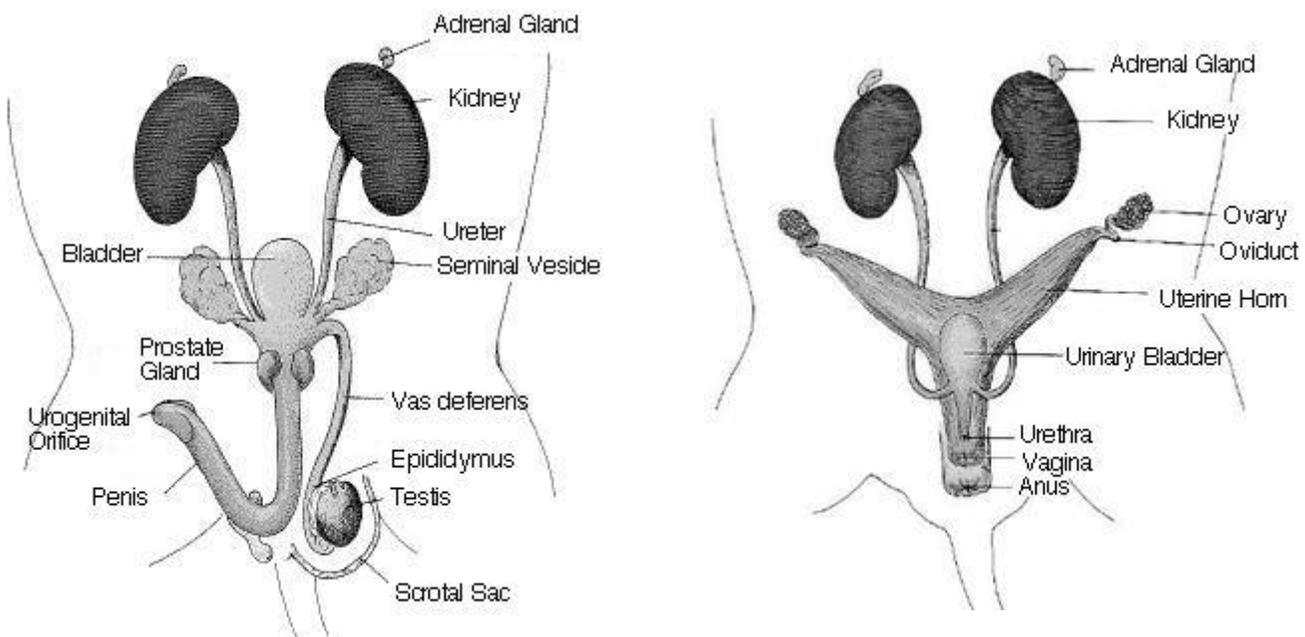
The Reproductive system of the Rat

Male Reproductive Organs (refer to diagram below)

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 **epididymus**, which collects and stores sperm cells. The tubular **vas deferens** moves sperm from the epididymus to the **urethra**, which carries sperm through the penis and out of 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).

Female Reproductive organs (refer to diagram below)

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**. Oviducts are extremely tiny and may be difficult to find without a dissecting scope.



Please be sure to observe the reproductive features of both sexes. This will require looking at the rat of another group.

***Reproductive system Checkpoint 6** – Have your instructor initial lab before continuing

The Circulatory system of the Rat

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. Use the diagrams on pg. 12 to locate the veins and arteries listed on page 2 under circulatory system.

Veins (see diagram page 12)

Veins carry used blood back to the heart and lungs. The lungs re-oxygenate the blood and the heart pumps it back to the rest of the body. If your rat has been double injected with latex then the veins will be blue. If you look at your arm you can see some bluish veins very close to the skin. **Is your blood blue? Explain.**

Look in your rat specimen for the veins listed on page 2 under circulatory system.

Arteries (see diagram page 12)

Arteries carry oxygenated blood to the muscles and organs that need it. Blood is essential for life. Blood carries nutrients to the body, helps repair cells and tissues, fights against disease, and assists in cleansing toxins. Without blood, we would all be dead. If your rat has been double injected with latex then the arteries will be a bright red.

Heart

After completing the procedures above dealing with veins and arteries, remove the heart from the pericardial sack. You will need to sever the arteries and veins connecting the heart to the circulatory system. **Do this slowly and carefully so that you do not cut more than is necessary.** Leave as much of the veins and arteries attached to the heart as possible. Identify the aorta, left and right atrium, and left and right ventricle. Carefully insert your probe into these opening and work it into the center of the heart.

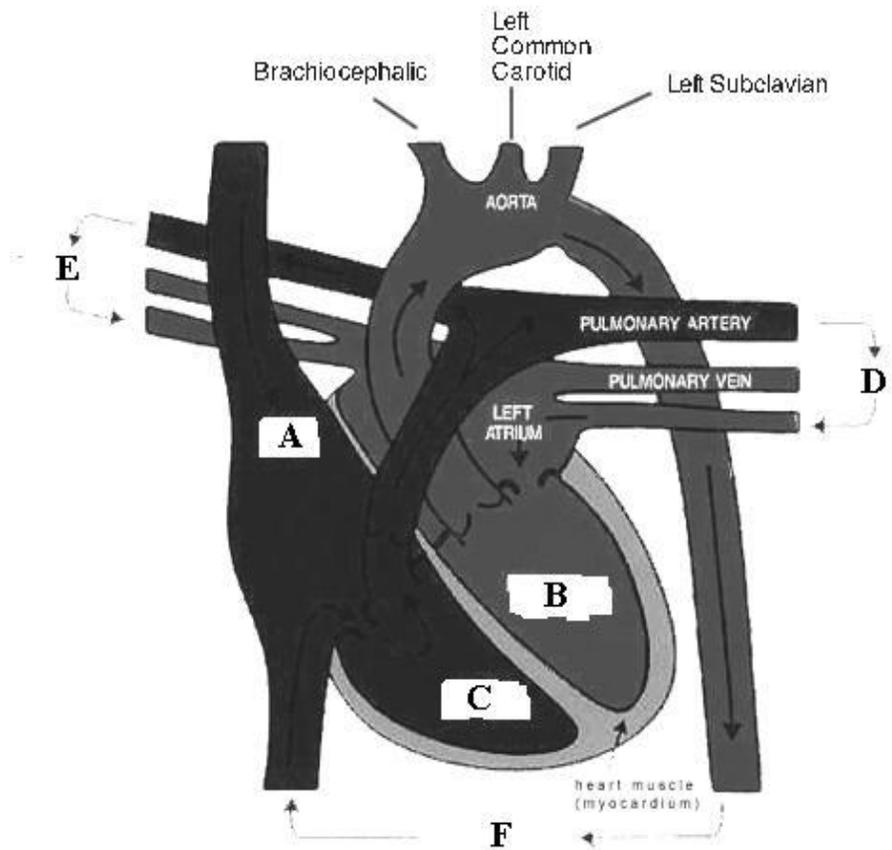
Finally, make an incision between the left and right ventricles with your scalpel. Try to locate the bicuspid and semilunar valves which open and close the ventricles.

Trace the Flow of Blood Inside the Heart

1. Blood from the posterior portion of the body enters the right atrium of the heart through the **inferior vena cava**. The inferior vena cava is also referred to as the **caudal vena cava**.
2. Blood from the anterior parts of the rat enter the heart from the **right and left superior vena cava**, also known as the **cranial vena cava**.
3. Blood flows from the **right atrium** to the **right ventricle** via the **tricuspid valve**.
4. Blood is then pumped through the **pulmonary semilunar valve** and into the **pulmonary trunk**, which divides into the **left and right pulmonary arteries** - these are the only arteries in the body that carry deoxygenated blood.
5. 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**.
5. Blood goes from the **left atrium** to the **left ventricle** via the **bicuspid (or mitral) valve**.

*Make sure to label the diagram of heart below

Label missing parts (A, B, C) and the destination of blood before returning (D,E,F)
A.
B.
C.
D.
E.
F.



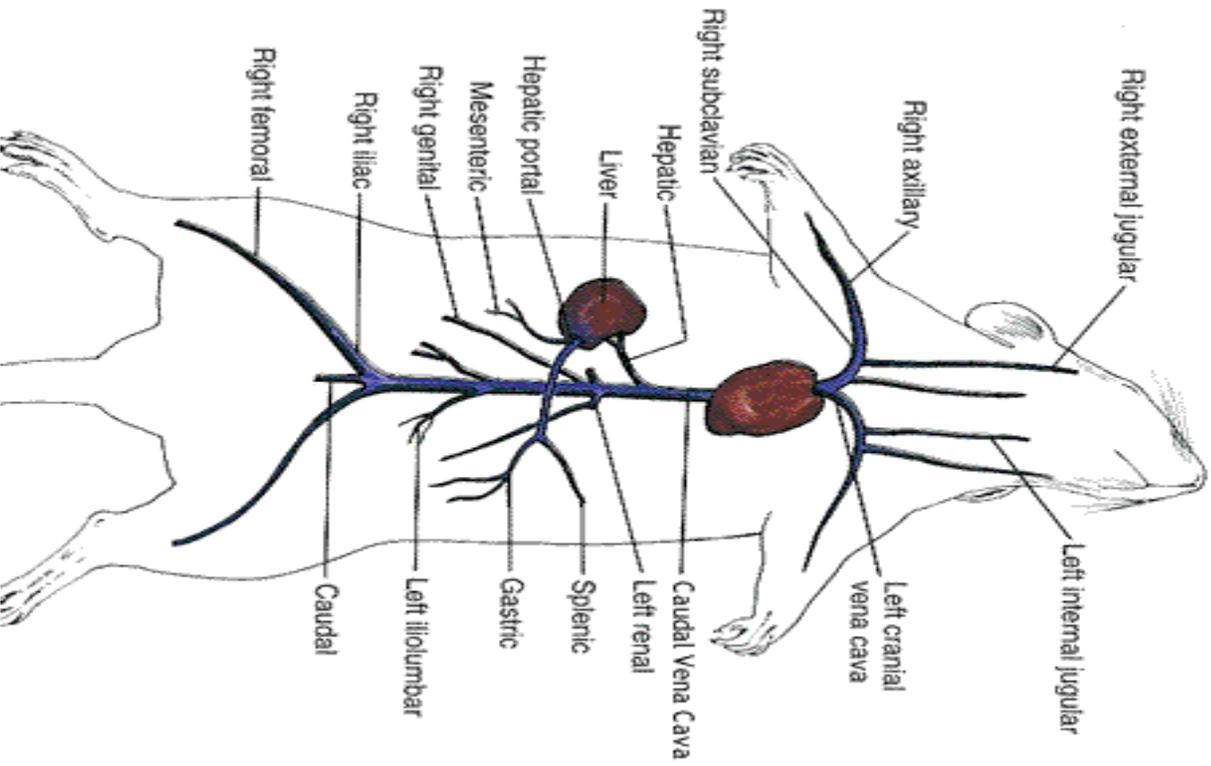
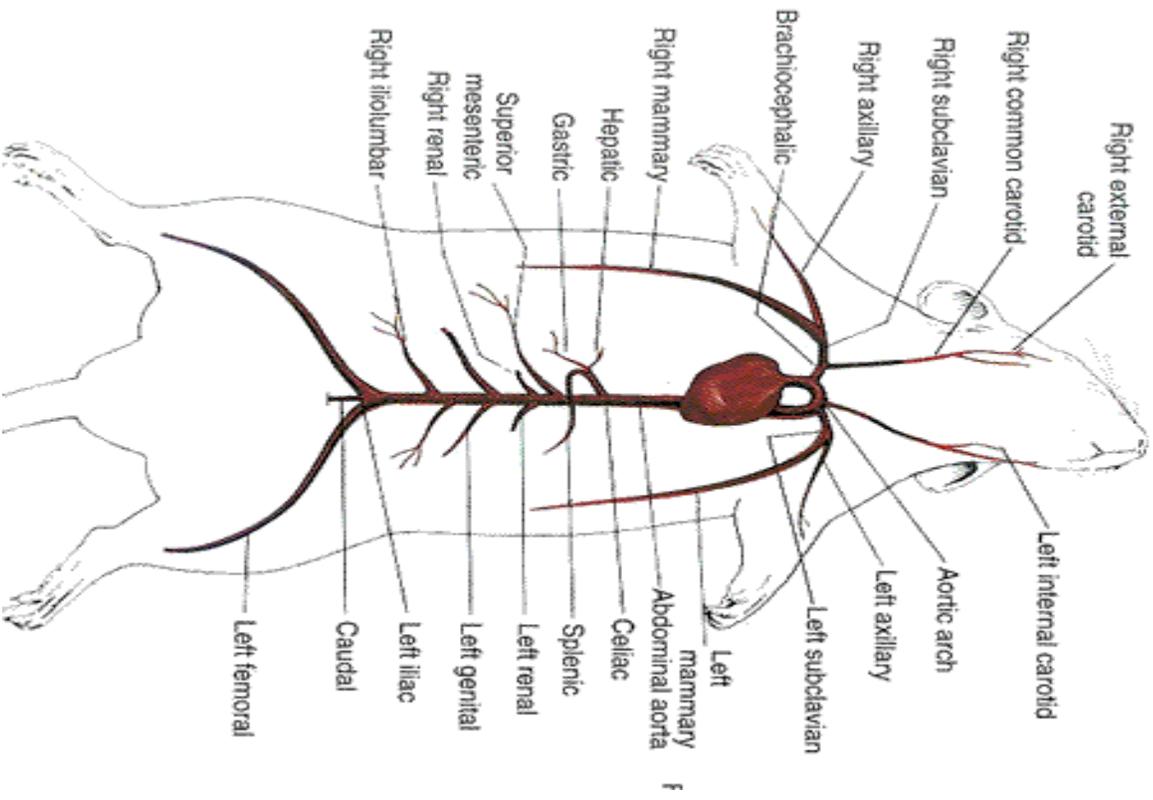
***Circulatory system & dissection of heart Checkpoint 7** – Have your instructor initial lab before continuing

Final Check

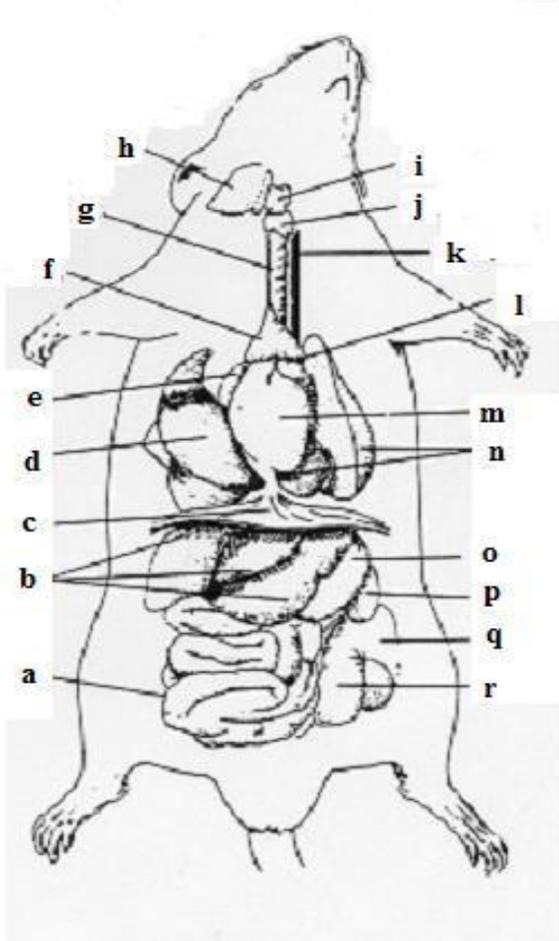
Can you confidently identify all of the structures listed on pg. 2? These are the structures that you will be tested on. As there are many variations amongst living organisms, **it is strongly suggested that you spend some time looking at the rat of other groups.** Color, location, and size of organs will vary from one rat to another. Once you feel confident in your ability to identify the parts on pg. 2, ask your teacher to complete the final check point.

Final Checkpoint—have Your teacher initial lab before continuing.

*label the rat internal diagram on page 13



**Rat diagram:
Label the rat anatomy**



a.	e.	i.	m.	q.
b.	f.	j.	n.	r.
c.	g.	k.	o.	
d.	h.	l.	p.	