Investigation: Rat Dissection

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*

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

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)

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**Rat External Anatomy**

**Procedure**

Obtained 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

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

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

**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.

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.

**Structures of the Head and Neck**

1. Locate the salivary glands, which 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 making squeaking noises.

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 feature do you find on 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? ______________________

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**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.

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**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 gall bladder, 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 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 finals stages of digestion and water absorption occurs 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: ________________________________

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**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.

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**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.
2. Trace these vessels to where they connect to the aorta and vena cava (two large vessels of the abdominal cavity)
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. 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).
5. 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).
6. 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 **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 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 and Further Investigation**

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?