

# VERTEBRATE ANATOMY DISSECTION OF THE RAT

## Introduction

For the next several weeks you will be studying the anatomy of the rat as a means of understanding the body plan of vertebrates, particularly mammals. Although at first glance the anatomy of the rat appears to be quite different from that of a dog or human, these differences are mainly in size and proportion. Therefore, by studying the anatomy of the rat, you gain a better understanding not only of human anatomy but also of other vertebrates as well.

Before beginning your examination of the rat, refer to the third paragraph on page 60 of your laboratory manual for a description of important anatomical terms that you will encounter throughout the dissection instructions. When making comparisons between human and rat anatomy, keep in mind that the posture of these two vertebrates is quite different. A rat, like most other mammals, walks on four legs, and its trunk is parallel to the ground. A human walks on two legs and the trunk is perpendicular to the ground. As a result, the terms dorsal and ventral in describing the rat correspond to the terms posterior and anterior in the human. Similarly, the terms anterior and posterior in the rat correspond to superior and inferior in the human.

## External Anatomy

Before examining the internal anatomy of the rat, note that the body is divided into a **head** and a **trunk**, separated by the neck region. Locate on the head the following structures:

The **external ears** or **pinna** are folds of skin supported by elastic cartilage which direct sound waves to the **external auditory canal**. The **eyes** have an **upper and lower eyelid** and a small **nictitating membrane** at the medial corner of the eye. The **mouth** is bordered by the **upper and lower lips**. Notice the long sensory hairs called **vibrissae** on either side of the cleft (**philtrum**) which runs between the mouth and the **external nares**.

The trunk consists of an anterior **thorax** and a posterior **abdomen** separated internally by the muscular **diaphragm**, which you will see later during the internal dissection. Locate the following structures on the trunk:

On the ventral surface of the trunk are two rows of **mammary papillae**, which extend from the **axillary** (armpit) **region** to the **inguinal** (groin) **region** on either side of the midline. In rats there are usually 12 pairs which are most prominent in pregnant or lactating females. Also visible on the ventral surface is the **anus** just beneath the base of the tail. Slightly anterior to the anus are the **urogenital openings**. In females there are two separate openings: the anterior **urethral orifice** leading from the urinary system and the more posterior **vaginal orifice** leading from the reproductive tract. In males the urinary and reproductive systems share a single opening at the tip of the **penis** which is hidden in a fold of skin (**prepuce**) located between two prominent **scrotal sacs** which house the **testes**. You will study the internal anatomy of the systems leading to these

openings later in the dissection. The **post-anal tail** is sparsely covered with hair and bears reptile-like **scales** of epidermal origin. There are two pairs of appendages attached to the trunk, the **hindlimbs** arising from the **pelvic** (hip) region and the forelimbs arising from the **pectoral** (shoulder) region. Each **digits** on each foot bear a **claw**, a keratinized epidermal derivative, comparable in origin to the nails of primates and the hooves of ungulates.

### Skin

The skin of the rat bears a thick covering of **hair** which is unique to mammals and provides insulation, necessary for maintaining a stable internal body temperature. The skin consists of two layers: the **epidermis**, made up of keratinized stratified squamous epithelium, and the thicker underlying **dermis**, made up predominately of dense irregular fibrous connective tissue. The dermis contains blood vessels, sensory nerve endings, adipose tissue, and several epithelial structures derived from the epidermis. These structures include the following in most mammals:

1. **Sweat glands** - tubular structures opening via **pores** on the surface of the skin
2. **Hair follicles** - invaginations from the epidermis which give rise to individual hairs. The portion of the hair contained within the follicle is called the **root**. The portion that emerges from the skin is called the **shaft**.
3. **Sebaceous glands** - alveolar oil producing glands which open into hair follicles. (Also associated with each hair follicle is a tiny **arrector pili** muscle which can contract reflexively to cause the hair to stand up and increase the insulating capacity of the coat.)

Using the skin model, the cross section of skin in your slide box, and the illustrations provided, identify the above structures.

### Skinning the Rat

Place your rat on its back in a dissecting pan. In laboratory specimens there is usually an incision through the skin on the ventral surface of the neck for embalming and injection of the blood vessels with colored latex. Insert a blunt probe into this incision and loosen the skin from the underlying muscles of the body wall. Using your scissors, extend the incision posteriorly to a point just in front of the urogenital opening(s). Loosen the skin as you go and be careful not to cut the underlying tissues. Cut to the side of the urogenital and anal openings on either side and up around the base of the tail until the two incisions meet.

Return to the neck region and extend the mid-ventral incision anteriorly to the middle of the lower jaw. Next, make a lateral incision from the angle of the lower jaw upward to a point just behind the ear on each side. (Do not connect these incisions mid-dorsally.)

Make a lateral incision from the ventral midline in the anterior thoracic (chest) region to the wrist along the medial surface of each forelimb, and make a circular incision through the skin around the wrists. Similarly, make a lateral incision from the ventral midline just anterior to the urogenital opening(s) to the ankle along the medial surface of each hindlimb and make a circular incision around

the ankles.

Beginning at the ventral incisions, separate the skin from the underlying musculature until you reach the dorsal midline. Use your fingers and blunt probe to tease away the fibrous connective tissue (fascia) attaching the skin to the body. There is a large muscle called the **cutaneous maximus** which arises from the surface of other muscles in the armpit and fans out to insert on the under surface of the skin posterior to the shoulder along the flanks and back of the rat. Cut through the middle of this muscle on each side so that the proximal portion remains attached to the armpit.

You should now have separated the skin from all of the body except the tail, the urogenital/anal region, and the face and top of the head. Leave the skin attached to the body at the back of the neck between the ears and wrap it around the rat each time you are finished working on your dissection. This will help to prevent the muscles from drying out.

## Digestive System

The rat has a **complete** digestive system which consists of a series of hollow tubular organs and associated glands extending from the mouth to the anus. Each organ plays a sequential role in food processing, which involves physical breakdown, chemical breakdown, storage, transportation, absorption, and defecation. We will begin with selected organs associated with the mouth, and proceed posteriorly through the neck region, thoracic cavity, and abdominal cavities. Identify each of the organs or structures indicated in boldface below, and note the role of each in the overall digestive process.

Mouth: Separate the upper and lower lips and note the large pair of **incisors**, typical of all rodents, at the front of the upper and lower jaws. Examine the **skull** on the mounted rat skeleton provided in lab, and note that rats have only one pair of incisors and three pairs of **molars** on each jaw. There are no canines or premolars in rodents. How does this pattern of dentition differ from humans? How does it relate to feeding habits?

Throat region: A pair of large, dark **submandibular salivary glands** are located ventrally just behind the lower jaws. Do not confuse these glands with lymph nodes which are also located in this region and are smaller, rounded structures superficial to the salivary glands. A slightly smaller pair of **parotid salivary glands** are dorsal and lateral to the submandibular glands below the ear. Ducts from these glands carry saliva to the mouth cavity to begin chemical digestion of starch and lubricate the food for swallowing.

Neck region: locate the **esophagus** which transports food and fluids from the **pharynx** to the stomach in the abdominal cavity. It is found just behind and parallel to the **trachea** or windpipe. You will have to tease away some of the connective tissue surrounding the trachea and reflect it to one side to see the esophagus. Be careful not to remove the lobes of the **thyroid gland**, which are located on either side of the trachea just posterior to the larynx or voice box.

### Opening the Abdominal and Thoracic Cavities

In order to see the remaining organs of the digestive system, the body cavities of the thorax and abdomen must be opened. With the rat lying on its back, make an initial midventral incision in the abdominal wall about an inch anterior to the genital region. The body wall is very thin at this point. Be careful not to cut too deeply. Lift the body wall away from the underlying organs and continue the midventral incision posteriorly to a point just anterior to the urogenital opening(s). Then continue the incision anteriorly toward the thoracic region. At the anterior end of the abdominal cavity you will encounter the **diaphragm**, a sheet of muscle and connective tissue that separates the abdominal cavity internally from the thoracic cavity. Continue the incision through the ventral thoracic wall, veering slightly to the left of the midline to avoid cutting through the bony sternum (breast bone). The costal cartilages in this area are much easier to cut through than bone. When you reach the anterior end of the thoracic cavity move back to the midline at the base of the neck. You should now be able to trace the trachea from the neck

region down into the thoracic cavity.

Make a pair of lateral incisions through the body wall immediately posterior to the diaphragm. Then carefully detach the diaphragm from the inner surface of the body wall. This will make it possible to spread open the rib cage to reveal the contents of the thoracic cavity without tearing the diaphragm. Finally make a pair of lateral incisions through the body wall at the posterior end of the abdominal cavity just in front of the urogenital region. This will allow you to examine the organs of the abdominal cavity. Before continuing you may need to rinse out them out in the sink under slow running tap water to remove excess preservative and coagulated blood.

Thoracic Cavity: The only digestive organ located here is the **esophagus**. Most of the thoracic cavity is occupied by the **heart** within its pericardial sac and the **lungs**. Carefully pull the left lung medially and look behind it. The esophagus can be seen running along the left side of the vertebral column parallel to the aorta, the largest artery in the body. At the posterior end of the thoracic cavity the esophagus penetrates the diaphragm before entering the stomach.

Abdominal Cavity: Spread open the flaps in the body wall made by your lateral incisions. The abdominal cavity is lined by a thin membrane called the peritonium. That portion lining the inner body wall is the **parietal peritoneum**. The portion covering the outer surface of abdominal organs is called the **visceral peritoneum**. These membranes are continuous via **mesenteries** which anchor the visceral organs to the body wall and contain blood vessels, lymph glands and adipose tissue. Locate the following digestive organs. They are listed in the order that food moves through them. Do not do any additional cutting in this part of the dissection unless specifically directed to do so. Everything you need to find can be seen by gently moving organs from one side to the other.

**Stomach:** The stomach functions as both a storage and digestive organ and lies just behind the diaphragm on the left side of the abdominal cavity. At its lower end is a muscular constriction called the **pyloric sphincter** which regulates the movement of food from the stomach into the small intestine. Slit the stomach open longitudinally and note the folds in the stomach wall called **rugae**.

**Small intestine:** After leaving the stomach via the pyloric sphincter, food enters a short segment of the small intestine called the **duodenum**, which receives secretions from two accessory glands which contribute to the digestion and absorption of food, as well as secretions from the wall of the duodenum itself. The first of these is the **pancreas** which is located in the mesentery running between the stomach and duodenum. It produces several digestive enzymes and buffers which empty into the duodenum via the pancreatic duct. The second is the **liver**, a large, multilobed, dark red organ filling much of the right anterior portion of the abdominal cavity. It produces a yellow/green fluid called bile which is carried to the duodenum by the **common bile duct**. Although most mammals possess a bulb-like gall bladder which stores and concentrates bile, this structure is absent in the rat. Bile contains bile salts which facilitate the digestion and

absorption of fats.

The remainder of the small intestine consists of two segments the **jejunum** and **ileum**, which constitute most of its length. These segments are responsible for most of the actual digestion and absorption of food. In addition the ileum absorbs some of the water and electrolytes secreted into the tract by digestive glands. Intestinal contents leave the ileum and enter the large intestine (**colon**) via the **ileocecal** valve.

Large intestine: This organ continues the process of concentrating feces by reabsorbing water and electrolytes from the intestinal contents. With the exception of some vitamins produced by intestinal flora, no additional nutrient absorption occurs. At the junction of the small and large intestines is a long, dead-end sac called the **cecum**. It is quite large in rodents and other herbivorous mammals and provides an opportunity for microorganisms to further digest cellulose. In humans, it is much shorter and bears a tiny extension called the vermiform **appendix**, which is absent in rats. The remainder of the large intestine continues as the **ascending, transverse, and descending colon**, which empties into a pouch-like structure called the **rectum**. The rectum is located deep within the pelvic canal and cannot be seen at this time. It accumulates fecal material prior to defecation through the anus which was located previously.

Other prominent abdominal organs that you may wish to locate at this time are the **spleen, kidneys, urinary bladder, and uterus**. They will be described further in the dissection of the appropriate organ systems.