

MUSCULAR SYSTEM

The focus of this exercise is to understand the relationship between structure and function. For this purpose we will focus on the muscles that control the forelimb.

Muscle Function

The majority of muscles you will be studying function by moving skeletal elements. To do this they must span two bones, one of which is relatively fixed with respect to the other. The point of muscle **origin** is on the relatively fixed bone and tends to be proximal while the point of **insertion** is on the more mobile, distal bone. The motion that is exerted when the muscle contracts depends on the angle and point of insertion as well as the flexibility of the joint. As you begin isolating the muscles note their association with the skeletal elements and confirm their function by gentle manipulation.

Muscles function in **antagonistic** groups. For example, several muscles contract to bend the forearm. Muscles antagonistic to this motion contract to straighten the forearm. As you explore the shoulder and arm you should become familiar with the following motions:

- **Flexion/Extension.** Muscles that **flex** or **extend** the forearm are an example of an antagonistic group. When a joint is flexed the distal bone moves toward the proximal bone so that the angle between them decreases. Extending a joint increases the angle between the two bones (Fig. 3.1). While one set of muscles is contracting and getting shorter the other set is relaxing and getting longer. Depending on the angle and position of bone attachment, muscles may also cause bones to rotate or turn within a joint. Watch for this when you study the forelimb.
- **Protract/Retract.** The limb is protracted when it moves parallel to the body axis and toward the head and retracted when it moves toward the tail.
- **Abduct/Adduct.** To help you keep these terms straight, keep in mind their Latin derivation: *Ab* (away from), *ad* (toward) and *ductus* (leading). The defined motion is with respect to a reference point. In the case of the limbs the reference point is the midventral line of the body. Abductor muscles draw a limb away from the midventral line and adductor muscles draw a limb toward the midventral reference point.

The fact a rat is a quadruped has implications for the organization of the skeleton. And the role of the limbs. In the rat the forelimbs function to provide support for the trunk and the scapulae are rotated into a lateral position. The muscles of the chest and inner thigh region function to hold the limbs under the body. As a group, these muscles function as **adductors**. Their antagonists, the **abductors** would have the opposite function.

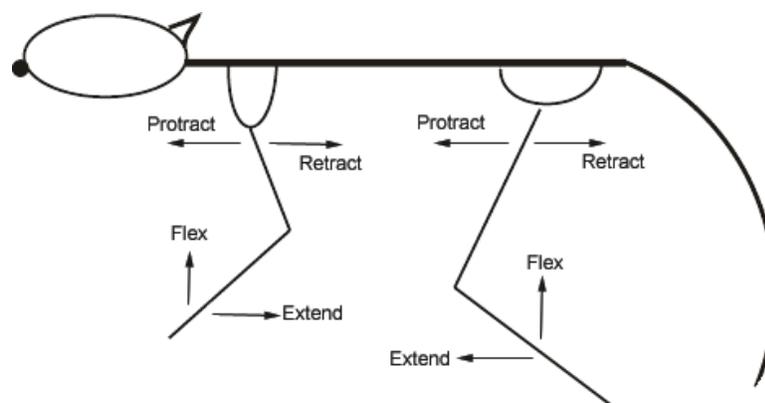


Figure 3.1. The direction of motion associated with the action of antagonistic muscle groups in the rat

As you approach your study of the muscles think in terms of functional groups keeping in mind that the functions of the muscles are limited by the manner in which they attach to the skeletal elements as well as the flexibility of the skeletal element.

External Features

Before you begin dissection it is important to determine if you have a male or a female. That is easier said than done in rats. The two sexes appear similar during the non-breeding season and can be difficult to distinguish. Males can be identified by the presence of a penis that terminates in the **preputial orifice**, which is the external opening of the urogenital system. Males also have a pair of **scrotal sacs**. The size of the scrotal sacs is variable depending on the maturity of the rat and its point in the reproductive cycle (Fig. 3.2). In males the **anus** lies dorsal to the scrotal sacs.

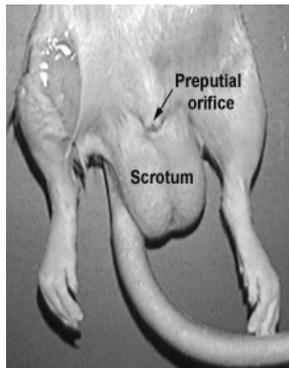


Figure 3.2. Ventral view of a male rat.

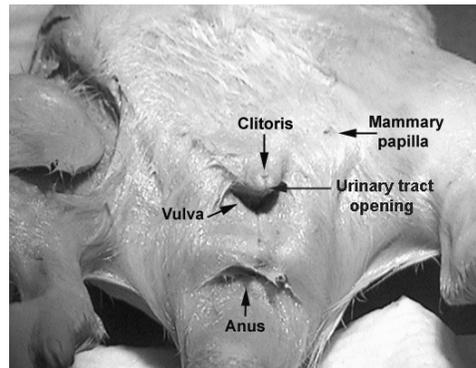


Figure 3.3. Ventral view of a female rat.

Females can be hard to distinguish from males because they have an enlarged **clitoris** that is similar in size to a male penis (Fig. 3.3). Dorsal to the clitoris is the opening to the urinary tract. There are also two other openings dorsal to the **clitoris**. The **vulva**, which is a depression into which the vagina opens and the **anus**, the terminal opening to the digestive tract.

You will learn about other differences when you study the urogenital system.

Skinning the Rat

*As you begin skinning use care to avoid damage to the underlying muscles. Use your fingers and a blunt probe to loosen the skin before cutting. Carefully examine underlying structures before using forceps to remove fat or connective tissue that might obscure the muscles. Note the location and arrangement of underlying structures and avoid damaging them. Skin only the **right** side. This means the rat's right side. Skin on the left side can be loosened about 2 cm from the midline.*

- *Beginning at the neck, use a probe to loosen the skin posteriorly along the midventral line. Then, keeping the scissors against the skin cut carefully from the neck to about an inch above the pubic area. If your rat is a male, cut to the right of the preputial orifice and into the groin area on each side. Do not cut into the scrotal sac. In females cut to the right of the urinary orifice and into the groin area.*
- *Extend your cut anteriorly to the base of the chin and then laterally along the zygomatic arch*

and under the base of the ear to the middorsal line. As this skin is removed you will see the **platysma** a layer of muscle which gives rise to the facial muscles. Do not worry about removing the platysma.

- Now turn the rat over and loosen the skin along the middorsal line to the midback region. Then use scissors to cut the skin. There will be a layer of muscle that will be associated with the skin. This is the **cutaneus trunci**. It originates from the midventral line and pectoral muscles near the armpit and inserts on the skin along the middorsal line. It functions to tighten the skin over the trunk. Use your fingers to loosen the skin from a dorsal to a ventral position taking care to avoid damaging the back and chest muscles. As you continue to loosen the skin ventrally watch for a large sheath of muscle, the **latissimus dorsi** which will lie under the cutaneus trunci. The



latissimus dorsi originates on the thoracic and lumbar vertebrae and inserts on the humerus. To view underlying muscles, you will need to cut the cutaneus trunci near the armpit (Fig. 3.4).

- Loosen and cut the skin along the forearm and carefully remove it near the wrist.

Remember: muscles lie in layers on top of each other. When freeing muscles from adjacent muscles, use forceps and the blunt end of a probe to lift one layer off the other. Work parallel to the angle of striation and preserve the origin and insertion of each muscle. Do not cut muscles unless necessary to see underlying structures.

Figure 3.4. Cutaneus trunci originating from muscles near the armpit. It should be cut along the line indicated by the stick. A portion of the pectoralis muscles can be seen lying under the stick.

Use the pictures and the list in table 3.1 to locate the muscles of interest. As you isolate muscles try to trace them from their origin to their insertion. Note the angle and location of where they attach to bones as

well as the direction of their striations. This will affect their function. Once you have a muscle isolated try to determine its function by gently moving the limb. If the muscle bulges slightly when you move the limb, you are probably recreating the function of the muscle. Try to locate an antagonist to each muscle you study. Check with the instructor to confirm that you have correctly determined the function.

Terms used in human anatomy are provided in table 3.1 since they are more familiar than those from veterinary texts. Some muscle functions or origins and insertions are given, others you will need to deduce by careful dissection and manipulation of the specimen. Complete the table then visit the *Biology 110* web site and use the link to the muscle function table to confirm your thoughts. Refer to figures 3.5-3.7 for help in locating and identifying muscles.

Table 3.1. Superficial muscles of the back, chest and arm of a rat.

Muscle	Origin	Insertion	Action
Pectoralis major			
Pectoralis minor			
Brachialis		Ulna	
Biceps brachii	Scapula	Radius	
Triceps brachii			
Teres major			Retract arm
Spinodeltoid			Retract arm
Clavodeltoid			Protract arm
Levator scapulae ventralis	Atlas, skull		Moves scapula anteriorly
Clavotrapezius	skull, cervical vertebrae		Move clavicle anteriorly
Acromiotrapezius			Support/rotate scapula
Spinotrapezius			Support/rotate scapula
Latissimus dorsi			Retract arm
Serratus ventralis	ribs, cervical vertebrae		Supports the trunk

Two additional muscles are of note:

Infraspinatus. This muscle covers the lateral surface of the scapula below the spine and inserts on the humerus.

Supraspinatus. This muscle covers the lateral surface of the scapula above the spine and inserts on the humerus.

What would the opposing functions of these muscles be?

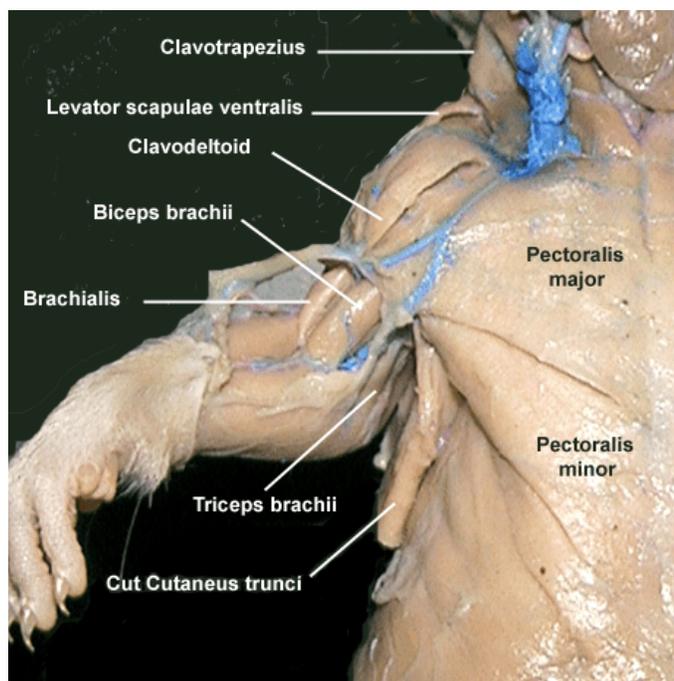


Figure 3.5. Ventral view of the thoracic area with as medial view of the forearm muscles.

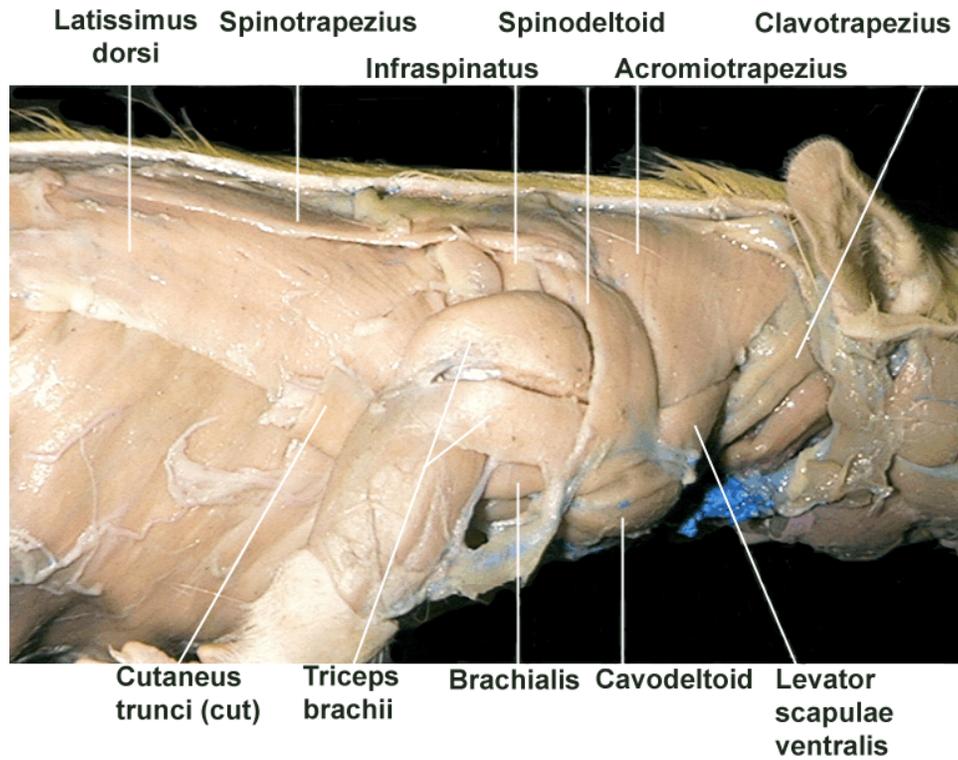


Figure 3.6. Lateral view of back, shoulder, and forearm rat muscles.

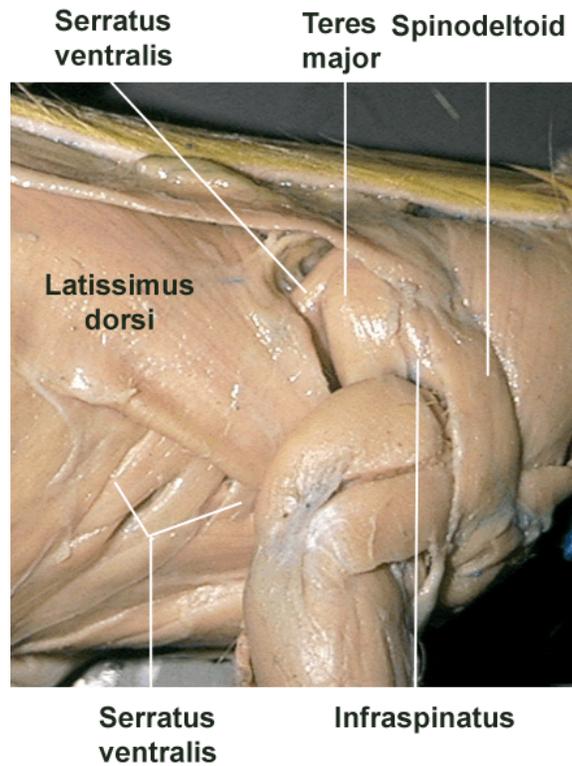


Figure 3.7. Lateral view of thoracic, and scapular muscles of the rat. Note how the serratus ventralis originates on the ribs and passes under the latissimus dorsi to insert on the scapula.