THE MUSCULAR SYSTEM

AN OVERVIEW

Skeletal muscles enable the body to move. Most are firmly anchored to a bone at one end, the *origin* of the muscle, while the other end of the muscle is attached to the bone to be moved, and is known as the *insertion*. The fleshy central portion is termed the *belly*. The ends of a muscle are attached to bone most often by means of a narrow band of connective tissue called a *tendon*. The muscle may also be joined directly to the *periosteum*, the tough connective tissue covering the bone. Finally, muscles may be united with each other or to a bone by means of a broad, flat sheet of tendinous tissue known as a *aponeurosis*.

As you dissect, locate the origins and insertions of the muscles studied. Then free the muscle from other muscles and from the nerves and blood vessels associated with it. The fine, transparent connective tissue that binds adjacent muscles is *deep fascia*, while tougher and more fibrous *superficial fascia* connects the skin to the muscles below. When the muscle has been freed, pull it gently. This will duplicate the muscle's normal contraction. Observe which bones or organs are moved, and which are relatively stable.

ACTIONS OF MUSCLES

The *action* of a muscle results from its contraction. Muscles are generally arranged in *antagonistic* pairs. This means that when a muscle causes a structure to move in one direction, one or more antagonists cause it to move in the opposite direction. Some muscles assist others in their actions, thereby bringing about more efficient movement. These are known as *synergistic* muscles.

Flexion — to bend at a joint, decreasing the angle at that joint. Examples: bending elbow or knee joint.

Extension — to straighten a joint, increasing the angle at that joint.

Adduction — to move an appendage toward the sagittal midline. Example: lowering arms from shoulder level to rest at sides.

Abduction — to move an appendage away from the sagittal midline. Example: raising arms from rest at sides to shoulder level.

Supination — to turn the palm of the hand upward.

Pronation — to turn the palm of the hand downward.

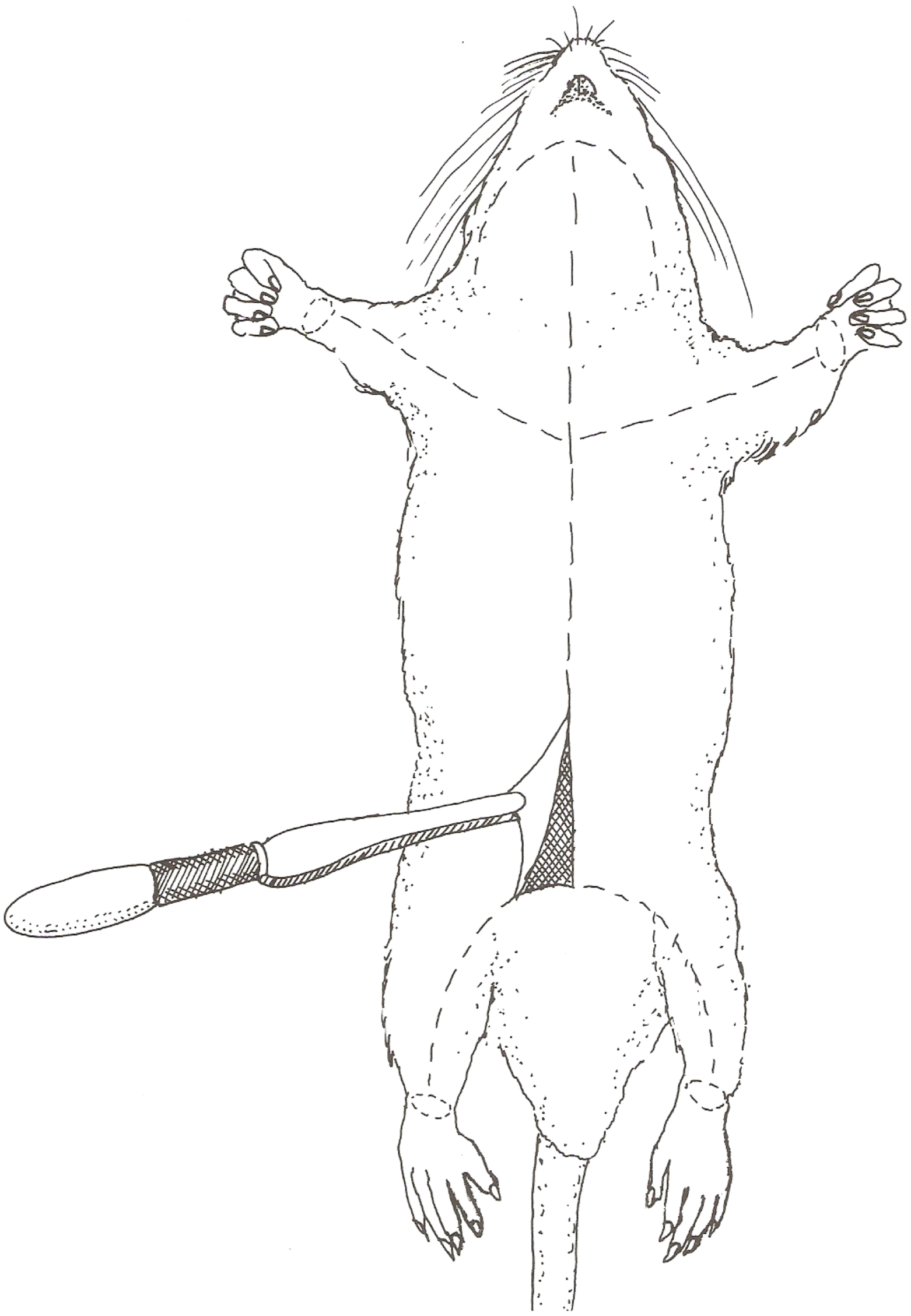
Rotation — to turn on a fixed point. Example: turning the head from side to side.

Circumduction — to move so that the distal end of a limb describes a circle while the proximal end remains fixed, as the vertex of a cone. Example: the movement of the extended arm in drawing a circle on the blackboard.

BEGINNING THE DISSECTION

At this point, your instructor may choose to begin the examination of the oral and abdominal cavities. In many introductory courses, the study of muscles is skipped entirely. Other instructors choose to study the musculature first.

We will begin with a study of muscles and follow this with an examination of the oral and abdominal cavities.



SKINNING THE RAT See *Dissection* procedure on next page.

SKINNING THE RAT

The Dissection

Tie or pin the animal to the dissection pan with limbs extended, ventral surface upward. Use your scalpel, forceps, and blunt probe. Note the lines along which the skin is to be cut in the accompanying illustration (also see photograph, page 54).

Proceed as follows:

1. Make a mid-ventral incision in the skin from the jaw to the external genitalia. **Note:** Be careful to cut the skin only, not the delicate underlying muscle tissue.

2. Lift the skin with forceps and separate the skin from the underlying muscles. You will note that the two are held together by a white fibrous connective tissue, known as the *superficial fascia*. Cut the fascia as you loosen the skin. In female specimens, make a circular incision around each of the papillae of the mammary glands. Note the fat deposits under the skin of mature specimens.

3. Continue to fold back the skin toward the dorsal side. Use the back of your scalpel, a blunt probe, or your fingers to facilitate separation. Note the fine blood vessels and nerves supplying the skin.

4. Cut along the medial surface of the forelimbs and hind limbs and extend to the paws.

5. Leave the skin intact around the urogenital and anal areas (*perineum*). Do not remove the scales of the tail.

6. Turn the rat over. Pin or tie it to the dissection pan with dorsal side up. Complete the skinning of the limbs and the entire dorsal surface from the top of the skull, neck, thorax, and abdomen, to the tail. Do not discard the skin. Use it in addition to wet paper towels to wrap the rat at the close of each dissection session.

At this point, the only areas still covered by skin are: the most anterior part of the head near the nostrils, ears, and around the eyes; the mammary nipples; paws; perineum; and the tail.

Your rat should appear as the one in the photograph, page 55.

Note: If your specimen is a pregnant or lactating female, the *mammary glands* will appear as two pairs of large brown longitudinal glandular masses along the ventral sides of the abdomen and thorax, right below the skin. The *thoracic* glands will extend, on each side, from as far up as the chin to the ends of the rib cage, while the *abdominal* glands will extend to the most posterior parts of the trunk. They should all be removed with the skin.

Look for light brown fibers adhering tightly to the underside of the skin. These are *cutaneous muscles*. They include the:

CUTANEOUS MAXIMUS — This muscle covers most of the sides of the body in the thoracic and abdominal areas. It serves to twitch the skin to avoid irritants. It originates from muscles in the axilla (armpit), the thorax, and abdomen, and inserts on the skin. It is not found in man.

PLATYSMA — This is another cutaneous muscle. It is found on the lateral surface of the head and neck. It moves the skin on the neck and face. The platysma originates from the mid-dorsal area over the neck and inserts in the skin of the face near the ears, eyes, and mouth.

As you continue the dissection trim the fascia, other connective tissue, and fat covering the muscles. Observe the direction in which the muscle fibers lie. The fibers of a single muscle are generally oriented in only one direction. Look for natural separations between muscles, then slit the fascia between muscles

with a dissecting needle or a scalpel. **Caution:** Do not cut the muscle fibers, only the connective tissue between them.

When the study of superficial muscles has been completed, we will *transect* the muscles. This is done by cutting them at right angles to the directions of the fibers at the belly area and folding them back, or *reflecting* them, to their origins and insertions. This will reveal the deeper muscle layers.

We will begin by first examining the superficial muscles on the anterior and posterior ventral surface, then on the lateral, and finally on the dorsal surface. We will then proceed to study some deep muscles. A Self-Quiz for students will be found at the end of this unit.

SUPERFICIAL MUSCLES—VENTRAL VIEW

Turn the rat to expose the ventral surface, as in the photograph on page 55. Note especially the large superficial muscle sheets covering the thorax and abdomen. Their fibers can be clearly seen extending over large body segments. When such muscles contract, they exert strong forces upon the structures to be moved.

We will first study muscles of the ventral neck, thorax, forelimb, abdomen, thigh, and lower hind limb. See the close-up photographs of these regions.

Head and Neck

The Dissection

If not already done, carefully remove the skin from the ventral and lateral surfaces of the head and neck, as shown in the photograph on page 56. In some commercially available embalmed specimens much of the skin has already been removed in this area. This exposes prominent blood vessels, the salivary glands, and the lymph glands, as well as the musculature.

Identify the following muscles in this area:

STERNOHYOID — This superficial muscle consists of two bands of tissue which run along the mid-ventral line of the neck in a posterior to anterior direction. Separate the right from left side and you can see the *trachea* and its cartilage rings lying beneath them. Its name clearly indicates its origin and insertion. It arises from the manubrium of the *sternum* and is inserted into the lower border of the *hyoid*.

STERNOTHYROID — As the previous muscle, this is located in the mid-ventral area of the neck. It is somewhat deeper than the *sternohyoid* and lies lateral to it. As its name indicates, it also originates from the *sternum*, and inserts upon the *thyroid cartilage* of the *larynx*.

THYROHYOID — This is a short muscle which extends from the insertion of the *sternothyroid* in the *larynx* to the *hyoid* bone.

OMOHYOID — Part of the *omohyoid* can be seen superficially, lying between the *sternohyoid* medially and the *sternomastoid* laterally.

STERNOMASTOID — This elongated, "V"-shaped band of muscle extends from the mid-ventral to the lateral surface of the neck. It gives shape to that part of the neck and permits the head to flex upon the trunk. As its name indicates, the sternomastoid extends from its origin in the *sternum* to its insertion upon the *mastoid process* behind the ear.

CLEIDOMASTOID — This muscle lies deep to the *sternomastoid* in rats. It originates in the *clavicle* and also inserts upon the *mastoid process*. In humans the two muscles are joined into one, the sternocleidomastoid muscle.

CLAVOTRAPEZIUS (CLEIDOCERVICALIS) — This is the most lateral of the ventral neck muscles. It originates on the *occipital* bone at the rear of the skull and inserts upon the *clavicle*. It acts to draw the clavicle forward. This is one of the *trapezius* group of muscles, which will be described later (see page 43).

In ventral view, between the two lateral bones of the *mandible*, find the following muscles:

DIGASTRIC — This muscle is unusual in that it has two *belly* portions. The anterior part will clearly be seen as "V"-shaped, along the inner edge of the mandible as far up as the chin. The posterior portion extends to the *occipital* bone at the rear of the skull. The two bellies of the muscle are separated by a *tendon* which attaches them to the hyoid bone. The digastric is the major muscle for *lowering the jaw*.

MYLOHYOID — Between the two sides of the *digastric* muscle, one may see the fibers of the *mylohyoid* run transversely to the mid-ventral area. The origin of this muscle is in the mandible, deep to the *digastric*. Its insertion is in the *hyoid*. This muscle acts to raise the floor of the mouth.

INTERMANDIBULARIS — This small muscle is found anterior to the *mylohoid* right below the chin. It runs transversely from one side of the mandible to the other.

Thorax

The chest area is dominated by the *pectoral* muscles. As in man, there are two of these. In the rat, their relative sizes and positions are different from those in man.

PECTORALIS MAJOR (PECTORALIS SUPERFICIALIS) — This broad, fan-shaped muscle of the anterior chest originates from the upper portion of the *sternum* to insert upon the deltoid ridge of the *humerus*. It acts to draw the forelimb towards the chest (adduction).

PECTORALIS MINOR (PECTORALIS PROFUNDUS) — As the name in parentheses indicates, this is the deeper of the two pectoral muscles. Unlike in humans, it is also the larger muscle. It arises from the posterior portion of the sternum. Its fibers extend anteriorly, deep to those of the *pectoralis major*.

The pectoralis minor is divided into three segments, the most posterior of which is known as the *xiphihumeralis* because of its origin on the *xiphoid process*, the lowest portion of the sternum. The three segments insert upon the *coracoid process* of the *scapula* and the proximal portion of the *humerus*.

Forelimb

With the specimen lying ventral side up, examine and study the superficial muscles of the medial surface of the forelimb.

Upper Forelimb

The muscles lying upon the upper forelimb insert upon and act to move the lower forelimb. They include the:

EPITROCHLEARIS — This is a thin muscle lying upon the dorso-medial surface of the humerus. It covers

most of the *long head* of the *triceps brachii* muscle. The epitrochlearis is not found in humans. It arises from the tendon that inserts into the *latissimus dorsi* muscle (see page 43), and inserts into the distal end of the *humerus.* It is an extensor of the lower forelimb.

TRICEPS BRACHII — This large muscle covers much of the dorsal portion of the humerus. It is the major extensor of the lower forelimb. It has three origins, or *heads*. However, since it is primarily a muscle of the lateral surface, it will be described and studied later (see page 44).

BICEPS BRACHII — This muscle, lying upon the anterior portion of the humerus, is the major flexor of the lower forelimb.

As its name indicates, it arises by two heads in the shoulder area. The *long head* arises from the anterior end of the *glenoid cavity* of the *scapula*, the *short head* from the *coracoid process* of the *scapula*. Its main insertion is upon the proximal *radius*.

BRACHIALIS — More anteriorly on the forelimb, note the *brachialis*. The entire muscle is not visible superficially. Separate the surrounding muscles to get a better view. It originates from the lateral surface of the *humerus* and inserts upon the proximal end of the *ulna*. It acts to flex the lower forelimb at the elbow.

Lower Forelimb

The muscles upon the medial surface of the lower forelimb generally serve to *flex* the bones of the paw (metacarpals) or the digits. They consist of many narrow muscle bands from which elongated *tendons* extend to the wrists and digits. These muscles originate in the distal portion of the *humerus* and the proximal portions of the *radius* and *ulna*. Their insertions are upon the *digits* or the *metacarpal* bones.

The names of the muscles clearly indicate their actions. The *flexor* muscles are located primarily upon the medial surface of the lower forelimb, the *extensors* upon the lateral surface.

Some of the muscles seen in medial view are:

Flexor Carpi Ulnaris
Flexor Carpi Radialis
Pronator Teres
Palmaris Longus
Flexor Digitorum Superficialis
Flexor Digitorum Profundus

Abdomen

The abdominal area is not protected by a bony structure as is the thorax. The abdominal organs are held in place by the pressure of the lateral abdominal muscles, which compress the abdominal wall and aid in the flexion of the trunk. The abdominal muscles include:

EXTERNAL OBLIQUE — This is a thin, broad sheet of muscle covering the ventral and lateral abdominal surfaces. It is the most superficial of the three lateral abdominal layers. It originates on the posterior ribs and the *lumbodorsal fascia*, an aponeurosis on the dorsal surface, and inserts on an aponeurosis along the mid-ventral surface. The *linea alba*, a white line of connective tissue along the mid-ventral surface, represents the fusion of the aponeuroses of the right and left sides. The fibers of the external oblique extend caudally and ventrally in an oblique direction across the abdominal surface.

INTERNAL OBLIQUE — Lift the edge of the external oblique where it joins the aponeurosis, as in the photo on page 60, to expose the second layer of abdominal muscles, the *internal oblique.* Its fibers run in a direction opposite to those of the upper layer, namely, ventrally and anteriorly.

TRANSVERSUS ABDOMINIS — This is the deepest of the abdominal muscle layers. Its fibers extend ventrally and slightly caudally, almost parallel to those of the external oblique. The *transversus abdominis* arises from the lower rib and the lumbar vertebrae and inserts along the linea alba by an aponeurosis. The arrangement of the fibers of the three layers gives the abdominal wall its strength. Below the transversus abdominis lies a thin glistening membrane, the *parietal peritoneum*, which lines the abdominal cavity.

The three layers of abdominal muscle are separated and clearly visible in the photograph on page 60.

RECTUS ABDOMINIS — Two parallel muscles lie in the mid-ventral area, on either side of the *linea alba*. They extend from the *pubic symphysis* anteriorly to insert upon the upper *ribs, clavicle,* and *sternum*. They lie deep to the thoracic muscles and deep to the ventral aponeurosis in the abdominal area. They act together with the other abdominal muscles, to compress the abdominal wall and thereby to support the abdominal viscera.

Thigh

GLUTEUS SUPERFICIALIS — At the most anterior portion of the medial surface of the thigh, a small part of this muscle may be seen. In the rat it is more extensive than in many other mammals. As it is best seen in lateral view, it will be more fully described later (see page 45). In humans and other mammals a separate and distinct muscle, the *sartorius*, is located here.

GRACILIS — This thin superficial muscle covers most of the medial thigh. It is a major adductor of the thigh, drawing it toward the mid-line.

In rats, it is divided into two segments:

Gracilis Anterior — originates at the pubic symphysis.

Gracilis Posterior — originates at the ischium.

QUADRICEPS FEMORIS — Four separate muscles are included in this group. They are the *rectus femoris, vastus medialis, vastus lateralis*, and *vastus intermedius*. They all insert together by means of the *patellar tendon* into the tuberosity of the *tibia*. Their combined action is to extend the shank (lower hind leg).

Two of these muscles are superficial and seen in medial view. They are the:

Rectus Femoris — This cigar-shaped muscle lies in the anterior portion of the thigh. It originates in the *ilium* and the anterior border of the acetabulum. It inserts, together with the other muscles of the *quadriceps femoris* group, by means of the *patellar tendon* into the tuberosity of the *tibia*.

Vastus Medialis — This muscle of the *quadriceps* group lies directly posterior to the *rectus femoris*. It arises from the neck and shaft of the femur. Its insertion and action are similar to that of the other *quadriceps femoris* muscles.

The other two *quadriceps femoris* muscles lie more deeply and will be studied on page 52.

SEMITENDINOSUS — This is the most posterior of the thigh muscles. It originates from the *ischium* and from sacral and caudal *vertebrae*, and inserts upon the proximal end of the *tibia*. It acts to flex the shank. This muscle is also prominently seen on the lateral surface.

Other muscles also act as adductors, pulling the leg toward the mid-ventral line of the body. These can be seen only partially, being covered by the *gracilis*. They are more properly deep muscles and will be studied later (see pages 48–49, and the photograph on page 62). They include the following:

Semimembranosus
Adductor Longus
Adductor Brevis
Adductor Magnus
Pectineus
Iliacus

Lower Hind Limb

The extensive *semitendinosus* muscle covers much of the medial lower hind limb. Thus, one can see only a small portion of some very large and important muscles in this area.

GASTROCNEMIUS — This is the chief muscle of the thigh. It is the most medial of these muscles.

TIBIALIS ANTERIOR — This is the most lateral of the lower hind limb muscles.

These muscles will be described more fully when the deeper posterior muscles are studied. (See description on page 45, and photograph on page 67.)

SUPERFICIAL MUSCLES — LATERAL VIEW

Lay the specimen on its side, as shown in the photograph on page 63. Separate the muscles and compare them to the ones labeled in the photograph.

Head

MASSETER — This large, thick, and prominent muscle seen in the area of the cheek is the chief muscle used in chewing. Touch your cheek and gnash your teeth. You will feel this muscle contracting.

The masseter is especially enlarged in rodents, where besides closing the jaw, it moves the lower jaw back and forth for gnawing and grinding.

In the rat, four distinct parts can be identified as separate muscles; two superficial and two deep.

Anterior Superficial Masseter — This is the more dorsal of the two *superficial masseter* muscles. It arises on the lateral surface of the *maxilla*, just posterior to its articulation with the premaxilla, and inserts on the angular process of the mandible.

Posterior Superficial Masseter — This muscle arises from the entire *zygomatic arch* and inserts upon the lateral surface of the *mandible*.

Anterior Deep Masseter — In order to see the deeper masseter it is necessary to transect the superficial muscles. The anterior deep masseter arises just anterior to the *infraorbital fissure* of the *maxilla* and inserts upon the lateral surface of the *mandible*.

Posterior Deep Masseter — This muscle originates in the anterior portion of the *zygomatic arch* and inserts upon the ramus of the *mandible*.

TEMPORALIS — This large muscle right behind the eye is used in chewing. It also acts to close the jaw,

and thus acts *synergistically* with the *masseters*. Touch your temple and gnash your teeth. You will feel this muscle contracting.

The temporalis arises from the *temporal* and *parietal* bones, and passes ventrally, deep to the zygomatic arch, to insert upon the *coronoid process* of the *mandible*.

In addition to the *masseter* and *temporalis* muscles, two deeper muscles are also involved in helping to elevate the mandible and thus close the jaw. These are the:

Lateral Pterygoid
Medial Pterygoid

In this area, where the head and neck meet, you will also see several *glands: salivary, lymph,* and *lacrimal.* These will be described later (see pages 75–76).

SHOULDER AND THORAX

DELTOID — Anchored in the shoulder, this muscle helps to move the upper forelimb. It is not, however, a single muscle as in humans. Two distinct muscles can be identified.

Spinodeltoid — This muscle band is the more posterior of the two *deltoid* muscles. Its fibers run in a dorsal to ventral direction. It originates at the *spinous process* of the *scapula* and inserts upon the *deltoid ridge* of the *humerus*. It acts to draw the humerus posteriorly and to rotate it laterally.

Acromiodeltoid (Cleidobrachialis) — This second *deltoid* muscle is triangular in shape and is located more anteriorly. Its fibers run in an anterior-posterior direction. It arises from the lateral half of the *clavicle* and the *acromion process* of the *scapula* and is also inserted upon the *deltoid ridge* of the *humerus*. It acts to draw the humerus anteriorly and to rotate it medially.

When both the *spinodeltoid* and *acromiodeltoid* contract together, the effect is to abduct the humerus.

TRAPEZIUS — Although these muscles originate mid-dorsally, they pass ventrally and may be readily seen and studied in lateral view. Again, as was true with the *deltoid* group, the *trapezius* is a single muscle in humans, but consists of three separate muscles in the rat. They cover the lateral surface of the shoulder.

Clavotrapezius — This is the most anterior of the three *trapezius* muscles. It is a narrow band which arises on the *occipital* bone to pass laterally and posteriorly. It is inserted upon the *clavicle*. It draws the clavicle forward.

Acromiotrapezius — This thin triangular muscle is the largest of the *trapezius* group in the shoulder region. It covers most of the scapula and upper thorax. It originates from the spinous processes of all of the *cervical* and the first four *thoracic vertebrae*. It inserts upon the *acromion* and spinous process of the *scapula*. It acts to pull the scapula medially.

Spinotrapezius — This is the most posterior of the *trapezius* group. It arises from the *spinous processes* of the lower *thoracic vertebrae* to the third *lumbar vertebra*. Like the acromiotrapezius, it inserts upon the *spinous processes* of the *scapula*. The spinotrapezius acts to pull the *scapula* posteriorly.

The three trapezius muscles act to hold the shoulder in place.

LATISSIMUS DORSI — Although, as its name indicates, this is primarily a muscle of the dorsal surface, it is quite prominent on the lateral and ventral surfaces as well. It is readily seen in several views (see photographs, pages 57, 64, and 69.

The *latissimus dorsi* is a flat, broad muscle, triangular in shape, with an extensive dorsal origin, arising

from the spines of the last five *thoracic vertebrae* and from an extended *aponeurosis* in the lower back, known as the *lumbodorsal fascia*. It then passes antero-laterally to the ventral surface, becoming narrower as its fibers converge, passing under the *axilla* (armpit). It inserts upon the *deltoid ridge* of the *humerus* by means of a narrow tendinous band.

Such an extensive origin and a greatly reduced insertion imply great power in the action of this muscle. It flexes the humerus.

SERRATUS VENTRALIS — Although this is primarily a deeper muscle, parts of its sawtooth-like edges may be seen superficially as well. (See photographs, pages 63 and 64.)

Abdomen

The major superficial abdominal muscle, the *external oblique*, has already been studied in ventral view, on page 40. It is quite extensive laterally as well.

The Forelimb

UPPER FORELIMB — In lateral view the following muscles are seen on the upper forelimb:

Triceps Brachii — This prominent thick muscle covers most of the *humerus*. It is divisible into three parts, the *long head, lateral head,* and *medial head*. Each has a different origin, yet they all join to insert into a common point on the *olecranon process* of the *ulna*. Together they act to extend the lower forelimb.

Long Head — This is the largest and thickest of the three segments. It is a wide band on the dorso-lateral aspect of the forelimb. It arises on the lateral border of the *scapula*.

Lateral Head — This band of muscle is narrower than the *long head* and lies anterior to it. As its name indicates, it can readily be seen in lateral view.

Medial Head — This segment lies deeper to the other two. It is not seen in the photographs of superficial muscles. It can be seen in a later photograph (page 65) when the deeper muscles of the forelimb are exposed. Its origin is in the upper two-thirds of the *humerus.*

Also visible superficially in lateral view are several muscles that have already been seen in medial view when the ventral musculature was studied (see page 40). These include the:

— **Biceps Brachii**
— **Brachialis**.

LOWER FORELIMB — The muscles upon the lateral surface of the lower forelimb generally serve to *extend* the bones of the paw (metacarpals) or the digits. They consist of many narrow muscle bands from which elongated *tendons* extend to the wrists and digits. They originate in the distal portion of the *humerus* and the proximal portions of the *radius* and *ulna*. Their insertions are upon the *digits* or the *metacarpal* bones.

The names of the muscles clearly indicate their actions. The *extensor* muscles are located primarily upon the lateral surface, the *flexors* upon the medial surface.

Some of the muscles seen in lateral view are:

Extensor Carpi Radialis Longus
Extensor Carpi Radialis Brevis
Extensor Digitorum Communis
Extensor Carpi Ulnaris
Extensor Digiti Quarti

The Hip, Thigh, and Hind Limb

Towards the posterior trunk, several muscles may be studied in lateral view.

In the area of the hip, dorsal to the thigh, separate and identify the following muscles. See the photographs on pages 63 and 66.

GLUTEUS SUPERFICIALIS — In the rat this large muscle includes several others usually found in other mammals. These include the *sartorius*, the *gluteus maximus*, and much of the *tensor fasciae latae*. The sartorius is absent in the rat as a distinct muscle. The other two are so closely united, with their common borders fused, that they practically form one sheet.

Tensor Fasciae Latae — This is the most anterior portion of the muscle. It is thin, fan-shaped, and covers the anterior portion of the thigh. It originates from the crest of the *ilium* and inserts upon the white sheet of fascia (fascia lata) covering the thigh, the knee, and part of the tibia.

As its name indicates, it "tenses" or pulls upon the *fascia lata*.

Gluteus Maximus — This is a large but thin muscle in the gluteal area. In humans it is enlarged and forms the primary tissue of the *buttocks*.

Its anterior border is fused to the *tensor fasciae latae*. It arises from the *ilium* and *sacrum* and inserts upon the proximal portion of the *femur*. It, together with the deeper *gluteal* muscles, abducts the thigh.

VASTUS LATERALIS — A portion of this muscle may be seen lying between the *tensor fasciae latae* and the *biceps femoris*. It belongs to the group of muscles known as the *quadriceps femoris*, described on page 41.

BICEPS FEMORIS — This large muscle covers most of the posterior thigh. It originates as three distinct heads, *anterior, posterior, and accessory*, from the *ischium* and from the caudal *vertebrae*. The three heads broaden, then unite to insert by means of a tendon into the distal end of the *femur* and the proximal *tibia*. The *biceps femoris* acts to abduct the thigh and flex the shank.

SEMITENDINOSUS — This muscle is located at the posterior dorsal border of the *biceps femoris* muscle and covers the most posterior portion of the thigh. It also originates from the *ischium* and from sacral and caudal *vertebrae*, and inserts upon the proximal end of the *tibia*. It acts to flex the shank.

Lower Hind Limb

The extensive *biceps femoris* muscle covers not only the thigh, but almost the entire lower hind limb. Thus, one can see only the posterior ends of some very large and important muscles in this area. These are the:

Gastrocnemius — The chief muscle of the calf. This is the more dorsal of the two muscles.

Tibialis Anterior — The more ventral muscle which lies upon the tibia.

These muscles will be described more fully when the deeper muscles of the limb are studied. (See descriptions on page 49, and photograph on page 67.)

Several *extensors* and *flexors* of the metatarsals and digits may also be seen in the deeper dissections.

SUPERFICIAL MUSCLES — DORSAL VIEW

Turn the rat dorsal side upwards in the dissection pan. All of the muscles seen have already been named

in lateral view and need not be repeated. Many of these have their origins along the vertebral column on the dorsal mid-line. To study these muscles in dorsal view, turn to the labeled photographs, pages 69 to 71.

DEEP MUSCLES

Introduction

The dissection of the deeper muscles should be done on one side only, leaving the superficial muscles on the second side intact. In this way you can compare the superficial muscles on one side with the deeper muscles on the other side. This procedure also permits later utilization of superficial muscles for review and study. Moreover, if for some reason the deeper muscles on one side are improperly dissected or destroyed, those of the second side are then still available. Similarly, dissect the deeper muscles of only one forelimb and one hind limb, leaving the superficial muscles intact upon the second limb.

In order to expose the deeper muscles it is best to *transect* the superficial muscles. This is done by cutting each of them at right angles to the direction of the fibers at the central belly area. The muscles are then folded back, or *reflected*, to their origins and insertions. They can thus easily be reconstructed at any time in order to examine the relationship of the deeper muscles to those of the superficial layers.

You will find that the deeper muscles are quite different from those above them. The variations in shapes, lengths, and directions of the fibers, as well as their actions, are revealed only after they have been exposed. It is impossible to guess about them by viewing the superficial muscles alone. For example, could we predict the unusual shape of the *serratus ventralis* muscle, seen in the photo, page 59, by merely viewing the superficial thoracic musculature? Such examples abound when the rat musculature is considered in its entirety.

The description of the deeper muscles will repeat the pattern followed for the superficial muscles; first the anterior and posterior ventral areas, then the lateral, and finally the dorsal region. A Self-Quiz is found at the end of the entire unit on muscles.

DEEP MUSCLES — VENTRAL VIEW

Neck

Since the area is relatively small and the muscles closely associated with each other, the deeper muscles of the neck have already been dissected and described together with the superficial muscles (see pages 38–39). The deeper muscles of the neck include the:

Sternothyroid
Thyrohyoid
Omohyoid
Cleidomastoid

Thorax

The Dissection

Again locate the *pectoralis major* and *pectoralis minor* muscles. Transect and reflect these muscles to expose the deeper muscles of the thorax and the scapula. Refer to the photograph on page 59.

SERRATUS VENTRALIS — This is a large, fan-shaped flat muscle. Its name is derived from the sawtooth-

like edges of the muscle strips. It arises by a number of long, narrow strips from the lateral surfaces of the first seven *ribs* to insert upon the medial surface of the *scapula* near its vertebral border. In quadrupeds it forms, together with the *pectoralis*, a muscular sling that transfers much of the weight of the body to the pectoral girdle and appendages. In humans, the *serratus anterior* is homologous to the serratus ventralis.

Levator Scapulae — This is a completely separate muscle in man. In many mammals, however, including the rat, it is virtually continuous with the anterior portion of the *serratus ventralis*. Its origins are in the *transverse processes* of the last four cervical *vertebrae*, while its insertion is together with the *serratus ventralis* upon the *scapula*. It acts to draw the scapula ventrally and anteriorly.

SCALENUS — This is a long muscle lying longitudinally along the ventro-lateral surface of the neck and thorax. In many mammals it is divisible into three separate muscles: the *scalenus anterior, medius*, and *posterior*. In the rat, however, the anterior portion is absent.

Scalenus Medius — This is the larger and more readily identifiable of the two scalenus muscles. Both the medius and posterior segments originate together from the *transverse processes* of the second to the seventh *cervical vertebrae*. The *scalenus medius* inserts on the ventral surface of the first to sixth *ribs*. It is a flexor of the neck and also draws the ribs anteriorly.

Scalenus Posterior — The origins and actions of the muscle are the same as those of the *scalenus medius*. Its insertion is less extensive, however, only upon the fourth and fifth *ribs*.

TRANSVERSUS COSTARUM — This muscle is not found in humans. In rats, it is located near the mid-ventral line where it crosses diagonally from its origin in the central *sternum* to its insertion on the first *rib*. It acts together with the scalenus muscles. It covers a part of the anterior *rectus abdominis* muscle.

RECTUS ABDOMINIS — This muscle was described earlier (see page 41), when the superficial abdominal muscles were studied. It extends, however, to the thorax as well, where it lies deep to the *pectoral* muscles. It extends anteriorly to the top of the *sternum* and posteriorly to the *pubic symphysis*. It lies parallel to its partner on either side of the mid-ventral line.

On the ventral surface of the *scapula* two muscles may be clearly seen.

SUBSCAPULARIS — This large, flat muscle arises from and occupies the *subscapular fossa* of the scapula. It inserts on the proximal humerus to adduct and rotate it medially.

TERES MAJOR — This muscle originates from and covers the axillary and posterior borders of the *scapula*. It is inserted upon the medial surface of the humerus.

EXTERNAL INTERCOSTALS

The fibers of the *external intercostals* extend between the ribs, directed in a caudo-ventral direction. As their name indicates, they are the more superficial of the *intercostal* muscles.

INTERNAL INTERCOSTALS

The fibers of the *internal intercostals* are directed in a caudo-dorsal direction, at right angles to those of the external intercostals.

The intercostals draw the ribs together during respiration. The rib cage is raised by the *external intercostals* during inspiration and lowered by the *internal intercostals* during expiration. The internal intercostals are located along the entire inter-space between the ribs, from dorsal side to sternum, while the external intercostals cover the dorsal and lateral, but not the ventral, part of the inter-space.

Forelimb

Upper Forelimb

The Dissection

Fully separate and expose the superficial muscles of the medial surface. Transect and reflect the *epitrochlearis* and the *biceps brachii*. Find the following muscles:

CORACOBRACHIALIS — This deeper muscle is covered by the *biceps brachii* and the *brachialis*. It extends from the *scapula* to the distal portion of the *humerus*, and acts as a weak adductor of the humerus.

ANCONEUS — This small deep muscle originates in the latero-distal surface of the *humerus* to insert in the proximal portion of the *ulna*. It acts to extend the lower forelimb.

Lower Forelimb

The Dissection

Separate the *flexor* muscles in the lower forelimb. Pull on their tendons. Note which parts move. Transect and reflect the superficial muscles. Again separate the deeper muscles, pull at their tendons, and note which parts of the hand or digits move.

The muscles in this area have already been named (see page 40).

Thigh and Hind Limb

The Dissection

Expose the medial surface of the thigh. Locate, transect, and reflect the *gracilis* and the *semitendinosus* muscles. Separate and fully expose the following deeper muscles:

SEMIMEMBRANOSUS — Much of this large muscle is hidden by the *semitendinosus* and the *gracilis*. It originates from the *ischium* and is inserted into the *tibia*. It acts to extend the thigh.

ADDUCTOR MAGNUS — This is the largest of the *adductor* muscles of the medial thigh. It becomes fully visible when the gracilis is transected and reflected. It arises from the *pubis* to insert into the *tibia*.

ADDUCTOR LONGUS — This muscle lies anterior to the *adductor magnus*. It arises from the *pubis* and inserts into the *femur*.

ADDUCTOR BREVIS — This adductor of the thigh is shorter than the *adductor longus*, as its name indicates. Its origin is also on the *pubis* and its insertion is on the *femur*.

PECTINEUS — This muscle lies directly anterior to the adductor longus. It also originates on the *pubis*

and inserts on the *femur*. It too is an adductor of the thigh.

ILIACUS — Only a small portion of this long muscle, extending from the inner body wall, can be seen upon the thigh. It arises from the fifth and sixth lumbar *vertebrae* to insert upon the lesser trochanter of the *femur*. It draws the femur laterally.

In some mammals, the *iliacus* and the *psoas major* muscles join to form the *iliopsoas*. This is not the case in the rat.

Lower Hind Limb

GASTROCNEMIUS — This is the major muscle of the calf. Once this extensive superficial muscle has been transected and reflected, deeper muscles in this area may be studied. It is visible on both the medial surface and the lateral surface. It originates as two separate heads, the *lateral* and the *medial*, on the distal ends of the femur, and inserts upon the heel bone, the *calcaneus*, by means of the long, tough *Achilles tendon*. The *gastrocnemius* acts as an extensor of the foot. The thick, belly-like shape of the muscle gives it its name.

SOLEUS — This muscle lies deep to the *gastrocnemius*. It originates upon the *fibula* and inserts together with the *gastrocnemius* upon the *calcaneus* by means of the *Achilles tendon*. Thus the Achilles tendon serves both muscles. The *soleus* acts to extend the hind foot at the ankle.

PERONEUS LONGUS and **PERONEUS BREVIS** — It is necessary to separate the muscles of the lower hind limb to better study these muscles. As their names indicate, both have their origins in the *fibula*; the *longus* also has origins in the *tibia*. Both muscles become tendinous, pass under the *lateral malleolus* and across the upper surface of the foot, to insert upon one *tarsal* bone and one *metatarsal* bone.

TIBIALIS POSTERIOR — As its name indicates, this muscle covers the posterior portion of the *tibia*. It has origins in both the *tibia* and *fibula*. It inserts upon two of the *tarsal* bones. It is an extensor of the hind foot.

TIBIALIS ANTERIOR — This muscle covers the anterior surface of the *tibia*. It is the most anterior muscle of the lower hind limb. It has its origin in the *tibia* and its insertion upon one *tarsal* and one *metatarsal* bone.

Other muscles of the lower hind limb, primarily *flexors* of the foot and digits, are the:

Plantaris
Flexor Digitorum Longus
Flexor Hallucis Longus
Flexor Digitorum Brevis

DEEP MUSCLES — LATERAL VIEW

Shoulder

The Dissection

Lay your specimen on its side. Transect the *latissimus dorsi*, *spinotrapezius*, *spinodeltoid*,

acromiotrapezius, and *clavotrapezius* muscles. This will expose the deeper muscles in the shoulder area. Many of the muscles here are involved in supporting the pectoral girdle and the limbs. The primary point of attachment is the vertebral column.

Look for the *scapula*. It is covered by several muscles:

SUPRASPINATUS and **INFRASPINATUS** — The *spinous process* of the *scapula* separates two large muscle bundles. The one anterior to the spine, known as the *supraspinatus*, occupies the *supraspinous fossa* of the scapula, while the one posterior to the spine, the *infraspinatus* muscle, occupies the *infraspinous fossa*. They lie deep to the *acromiotrapezius* muscle. The supraspinatus is inserted into the head of the *humerus*, while the infraspinatus inserts into the greater tubercle of the *humerus*. The supraspinatus extends the humerus, while the infraspinatus rotates it laterally.

TERES MAJOR — This muscle was already seen in ventral view. Most of this thick muscle, however, lies upon the dorsal surface of the scapula, posterior to the *infraspinatus*, and covers the axillary border of the *scapula*. The *teres major* is inserted upon the medial surface of the *humerus* at the insertion of the latissimus dorsi muscle.

TERES MINOR — This is a much smaller muscle. It originates on the axillary border of the *scapula* and inserts on the greater tuberosity of the *humerus*. It assists the *infraspinatus* in rotating the humerus laterally.

RHOMBOIDEUS — Find the vertebral border of the scapula. Note the muscle fibers that attach the scapula to the vertebrae in the mid-dorsal line. Because of their shape, the muscle that they form is called *rhomboideus*. It may be seen on the photograph, page 65.

Three distinct divisions of the rhomboideus muscle are identified:

Rhomboideus Thoracis (Rhomboideus Major) — This is the largest of the *rhomboid* group, and is shaped like a quadrilateral. It originates in the spines of the fourth to the seventh cervical *vertebrae* and inserts in the vertebral border of the *scapula*.

Rhomboideus Cervicis (Rhomboideus Minor) — This is a thin muscle band, arising from the spines of the first three cervical vertebrae and, like the *rhomboideus thoracis*, is inserted into the vertebral border of the *scapula*.

Rhomboideus Capitus — This thin, ribbon-like muscle originates in the *occipital* bone of the skull and inserts on the vertebral border of the *scapula*.

The action of these three *rhomboideus* muscles is to draw the scapula medially and cranially as well as to give support to the scapula and the forelimbs. If these muscles are cut, the scapula loses its connection to the backbone and it and the forelimb dangle freely.

LEVATOR SCAPULAE — This muscle, previously described on page 47, is also located in this area.

SPLENIUS — Another muscle in this area is the *splenius*. It arises from along the second thoracic vertebra, passes to the skull, and inserts upon the *squamosal* bone. It draws the head dorso-laterally.

SERRATUS DORSALIS — Transect the *rhomboideus* muscle. This will free the scapula and the forelimb from the trunk. They will remain attached by means of blood vessels and nerves only. The *serratus dorsalis* lies deep to the *rhomboideus*. Like the *serratus ventralis*, previously described on pages 46–47, it is also serrated, or sawtooth-like, in its attachment to the ribs. Two distinct segments may be identified.

Serratus Dorsalis Anterior — These fibers originate from the *occipital* bone and the spines of the first and second thoracic *vertebrae* and insert into the fourth to the ninth *ribs*.

Serratus Dorsalis Posterior — These fibers originate in the spines of the latter thoracic and in the lumbar *vertebrae*, and insert into the ninth to the thirteenth *ribs*.

Both segments of the *serratus dorsalis* muscle act to draw the ribs forward.

Forelimb

Upper Forelimb

The Dissection

Transect and reflect the *triceps brachii (long and lateral heads)* and the *brachialis* muscles. Expose and separate the other muscles in this area. Several deeper muscles will be seen.

TRICEPS BRACHII, MEDIAL HEAD — This is the third segment of the *triceps brachii*. It is located deep to the *lateral head*. It originates from the proximal shaft of the *humerus* and inserts together with the *long* and *lateral heads* in the olecranon process of the *ulna*. It acts together with the other heads of the triceps brachii to extend the lower forelimb.

CORACOBRACHIALIS — This muscle is located deep to the *biceps brachii* and *brachialis* muscles. It originates together with the short head of the biceps brachii in the *coracoid process* of the *scapula*. It is inserted into the distal half of the shaft of the *humerus*.

Lower Forelimb

The Dissection

Separate and examine the muscles of this area. These have been previously noted on page 44. Pull upon each muscle and its tendon to see which parts of the hand or digits will move.

One important muscle, more deeply located, has not yet been studied.

SUPINATOR — This muscle is the *antagonist* of the *pronator teres*. As its name indicates, it acts to supinate the lower forelimb by rotating the radius, causing it to cross the ulna. This results in the ventral surface of the paw being turned upwards. The origin of the *supinator* is in the latero-distal portion of the *humerus* and its insertion is in the shaft of the *radius*.

Hip

The Dissection

Find the *tensor fasciae latae*, *gluteus superficialis*, and *biceps femoris* muscles. Transect and reflect them.

GLUTEUS MEDIUS — This thick muscle lies right below the *gluteus superficialis*. It arises from an extensive area of the *ilium* and inserts into the greater trochanter of the *femur*. It is an abductor of the thigh.

GLUTEUS MINIMUS (GLUTEUS PROFUNDUS) — This muscle lies deep to the *gluteus medius*. It arises from the dorsal border of the *ilium* and also inserts into the greater trochanter of the *femur*. It is a rotator of the femur.

PIRIFORMIS — This deep muscle is almost continuous with the *gluteus medius* and is difficult to separate and distinguish from it. It arises from the *sacrum* and inserts together with the gluteus medius into the greater trochanter of the *femur*. It too is an abductor of the thigh.

Thigh

The Dissection

The *tensor fasciae latae, gluteus superficialis,* and *biceps femoris* muscles have already been transected and reflected. Do the same to the *rectus femoris*. Note the deeper muscles of the thigh. Separate them. Identify the following:

QUADRICEPS FEMORIS — Parts of this extensive muscle were already studied on the medial surface; see page 41. It includes four distinct muscles, the *rectus femoris, vastus medialis, vastus lateralis,* and *vastus intermedius*. They all insert together by means of the *patellar tendon* into the tuberosity of the *tibia*. They are the major extensors of the shank.

The two muscles best seen in deeper lateral view of the thigh are the:

Vastus Lateralis — A small portion of this muscle may be seen superficially in lateral view. The entire muscle may be viewed in deeper dissection. It lies between the *tensor fasciae latae* and the *biceps femoris*. It arises from the *greater trochanter* and the *third trochanter* of the *femur* and inserts together with the other muscles of the quadriceps femoris group into the tuberosity of the *tibia*.

Vastus Intermedius — This is the deepest muscle of the quadriceps femoris group. It is necessary to transect and reflect the *vastus lateralis* in order to see this muscle. It arises from the *shaft* of the femur. Its insertion and action are similar to the other muscles of this group.

Other muscles in this area also act to move the thigh. These smaller muscles originate in various parts of the *os coxae* and insert upon the *femur*. They include the:

Obturator Externus
Obturator Internus
Gemellus Superior
Gemellus Inferior
Quadratus Femoris.

Lower Hind Limb

Most of the muscles in this area have already been studied in medial view (see page 49). They include the:

Gastrocnemius
Soleus
Peroneus Longus and **Brevis**
Tibialis Posterior and **Anterior**

The Dissection

Several extensor muscles should be separated, traced, and their actions determined. This can be done by pulling upon their tendons and noting which parts of the foot or digits move.

These muscles include the:

EXTENSOR DIGITORUM LONGUS — This muscle has its origin in the *distal* portion of the *femur*. It inserts upon the distal *phalanx* of *digits* two to five. It acts to extend digits two to five.

PERONEUS DIGITI QUARTI and **QUINTI** — As their names indicate, these muscles extend the digits. One inserts into the fourth *metatarsal*, the other into the fifth. They both orginate in the *fibula*.

DEEP MUSCLES, THORACIC, LUMBAR, AND SACRAL REGIONS — DORSAL VIEW

The Dissection

Turn the rat dorsal side upwards. If not yet done, transect and reflect the following muscles:

— clavotrapezius
— acromiotrapezius
— spinotrapezius
— latissimus dorsi

In addition, the very prominent *lumbodorsal fascia*, the glistening white aponeurosis covering most of the lumbodorsal surface, should be cut to reveal the deeper muscles below.

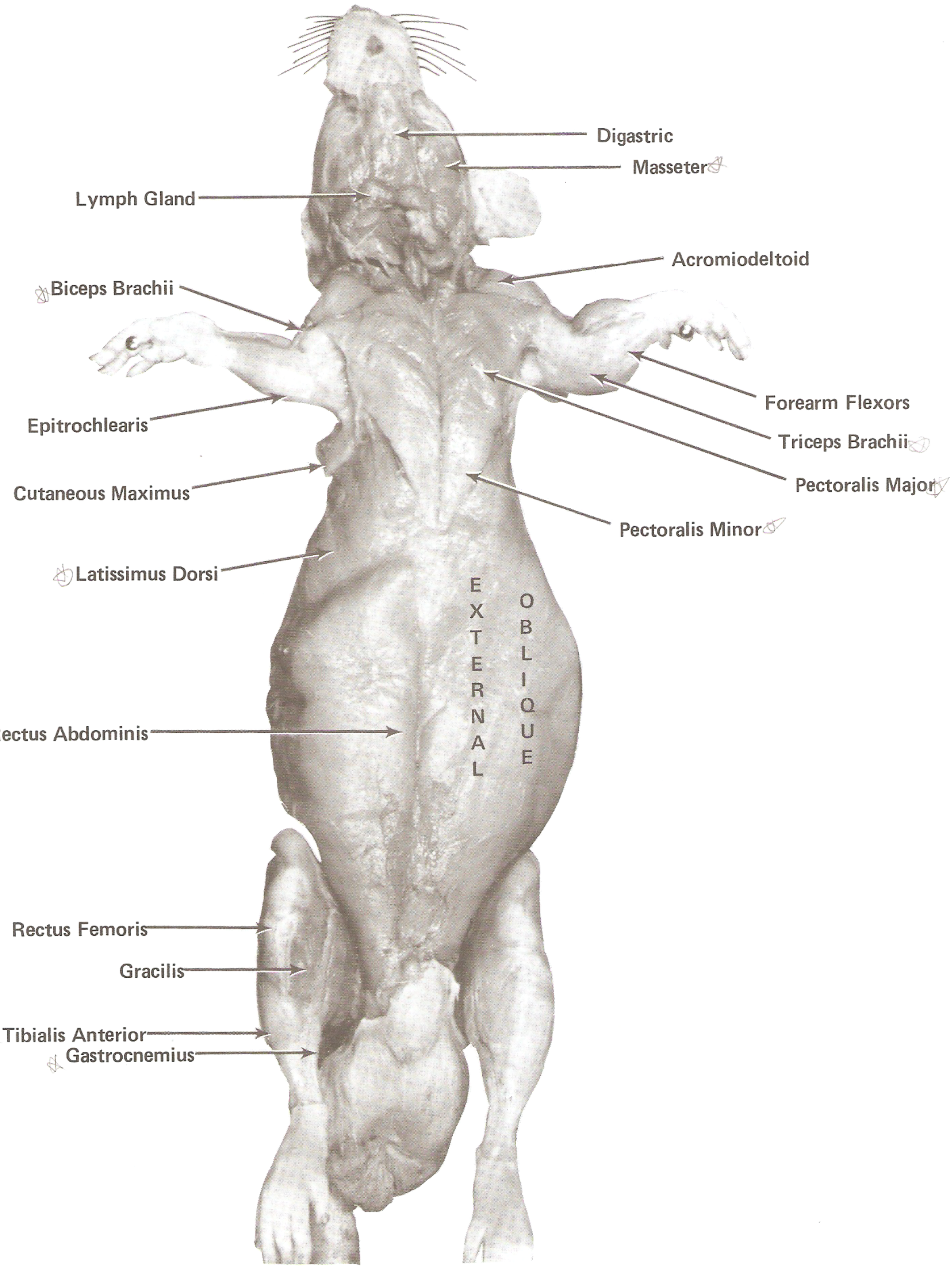
LONGUS COLLI — This muscle originates on the transverse processes and centra of the *cervical* and first few *thoracic vertebrae* and inserts upon the first to sixth *cervical vertebrae*. It acts to flex the neck.

LONGUS CAPITIS — This muscle originates on the third to seventh *cervical vertebrae* and inserts upon the anterior portion of the *occipital* bone. It acts to lower the head.

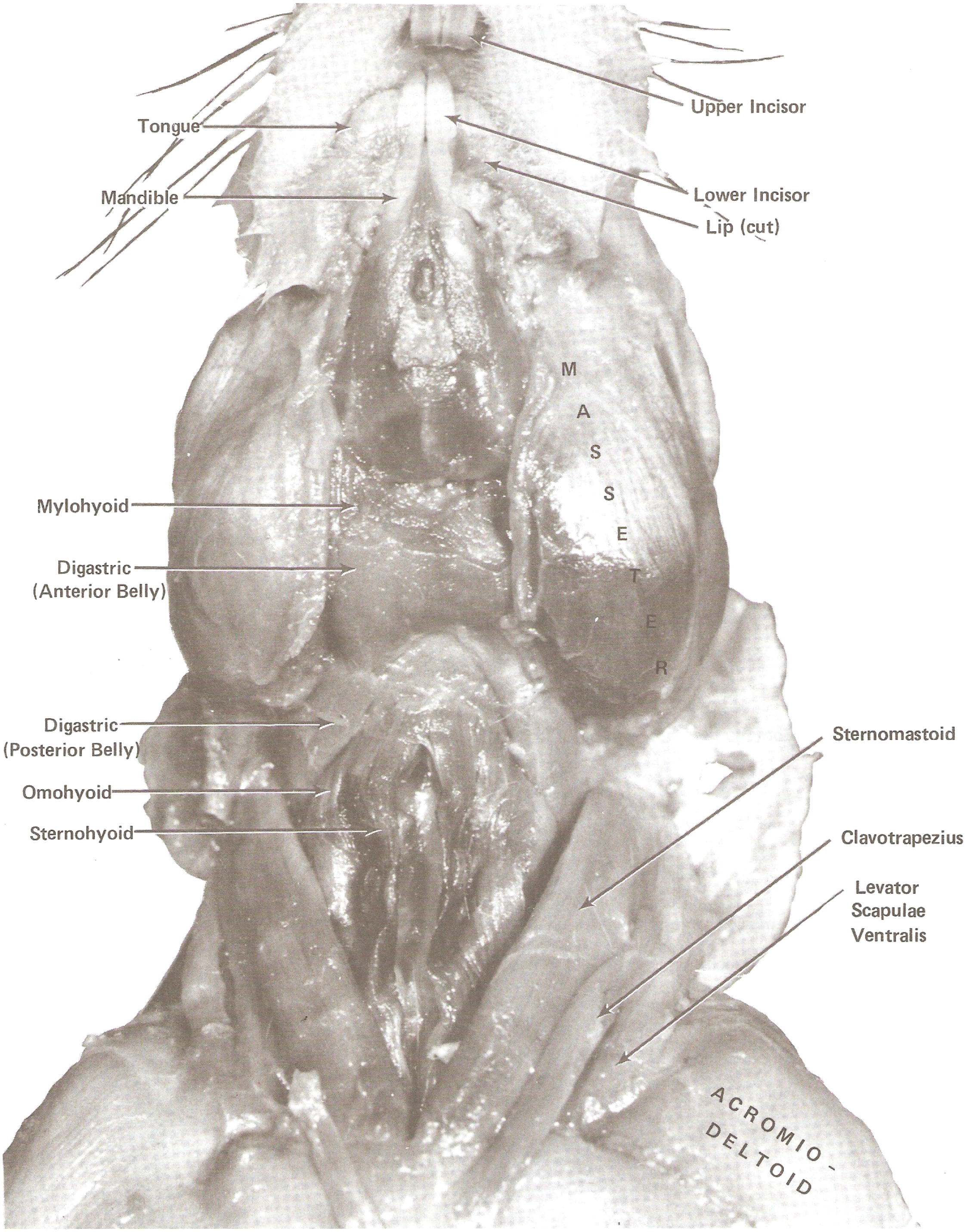
RECTUS CAPITIS — This muscle originates on the first *cervical vertebra* (atlas) and inserts upon the *occipital* bone. It acts to raise the head.

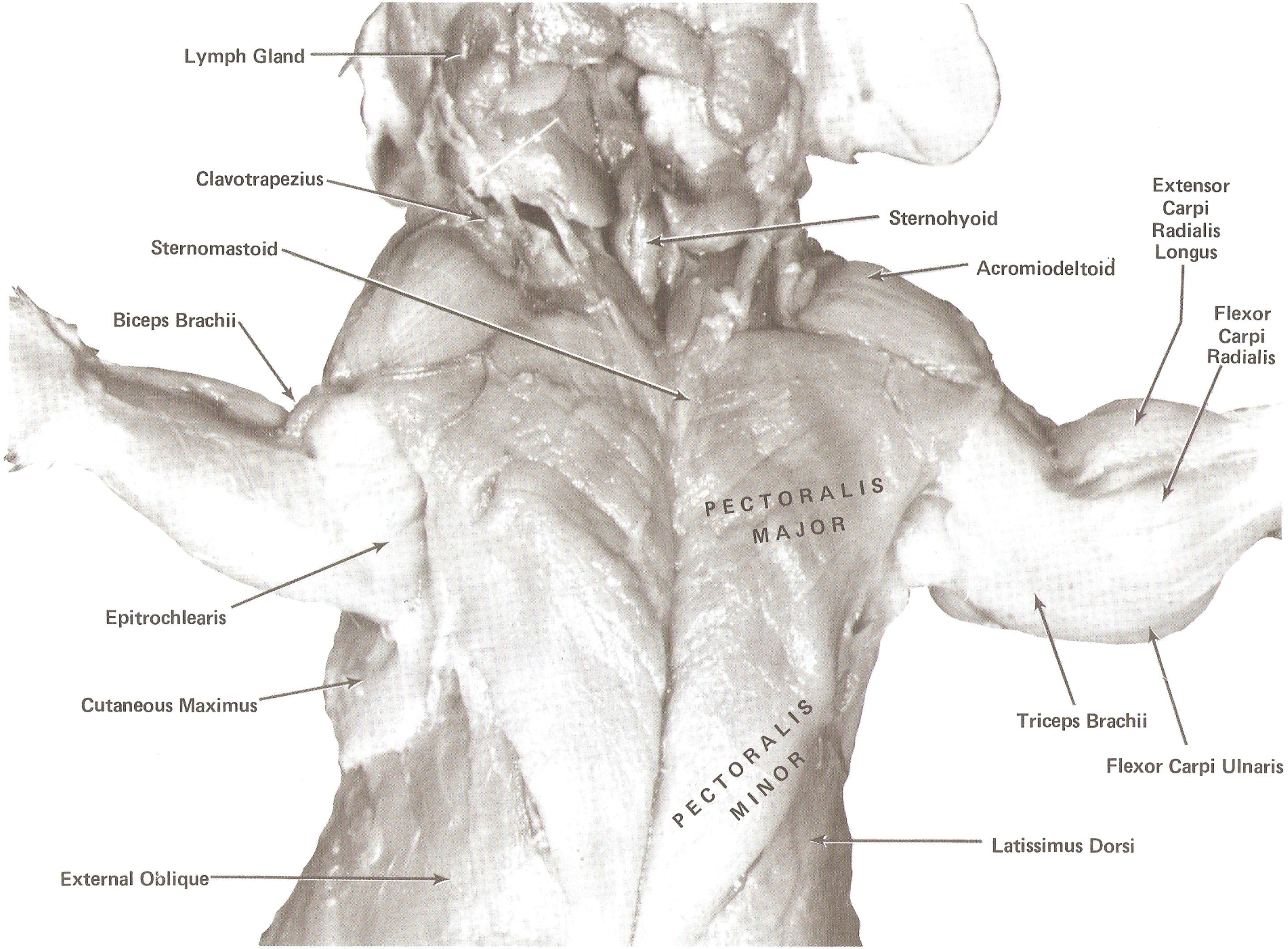
Other muscles keep the lower spine erect. They act as extensors of the spine. They include the:

iliocostalis
longissimus dorsi
spinalis.

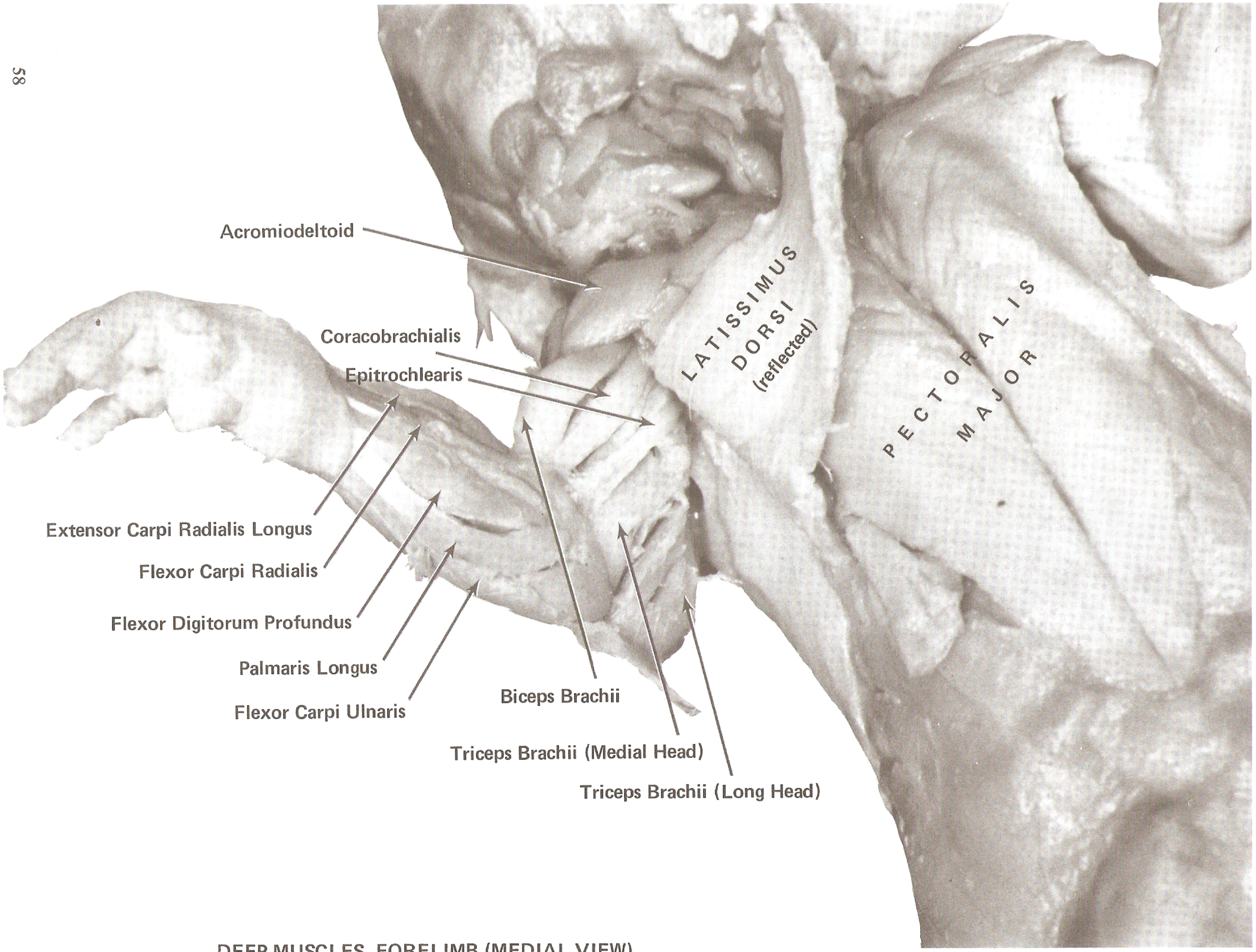


SUPERFICIAL MUSCLES (VENTRAL VIEW)

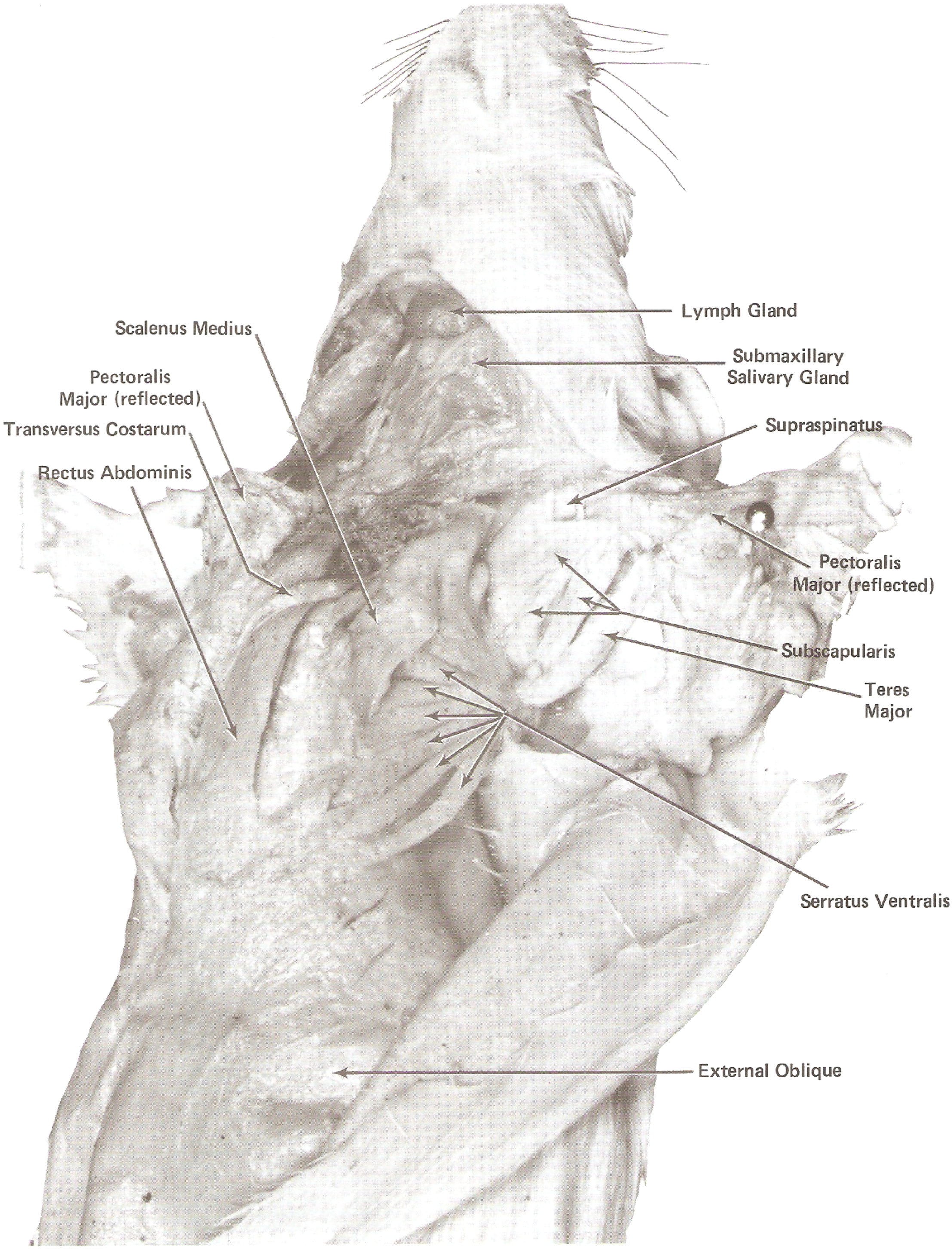

Tongue
Mandible
Mylohyoid
Digastric
(Anterior Belly)
Digastric
(Posterior Belly)
Omohyoid
Sternohyoid
Upper Incisor
Lower Incisor
Lip (cut)
M
A
S
S
E
T
E
R
Sternomastoid
Clavotrapezius
Levator
Scapulae
Ventralis
ACROMIO -
DELTOID



SUPERFICIAL MUSCLES OF THORAX AND FORELIMBS (VENTRAL VIEW)

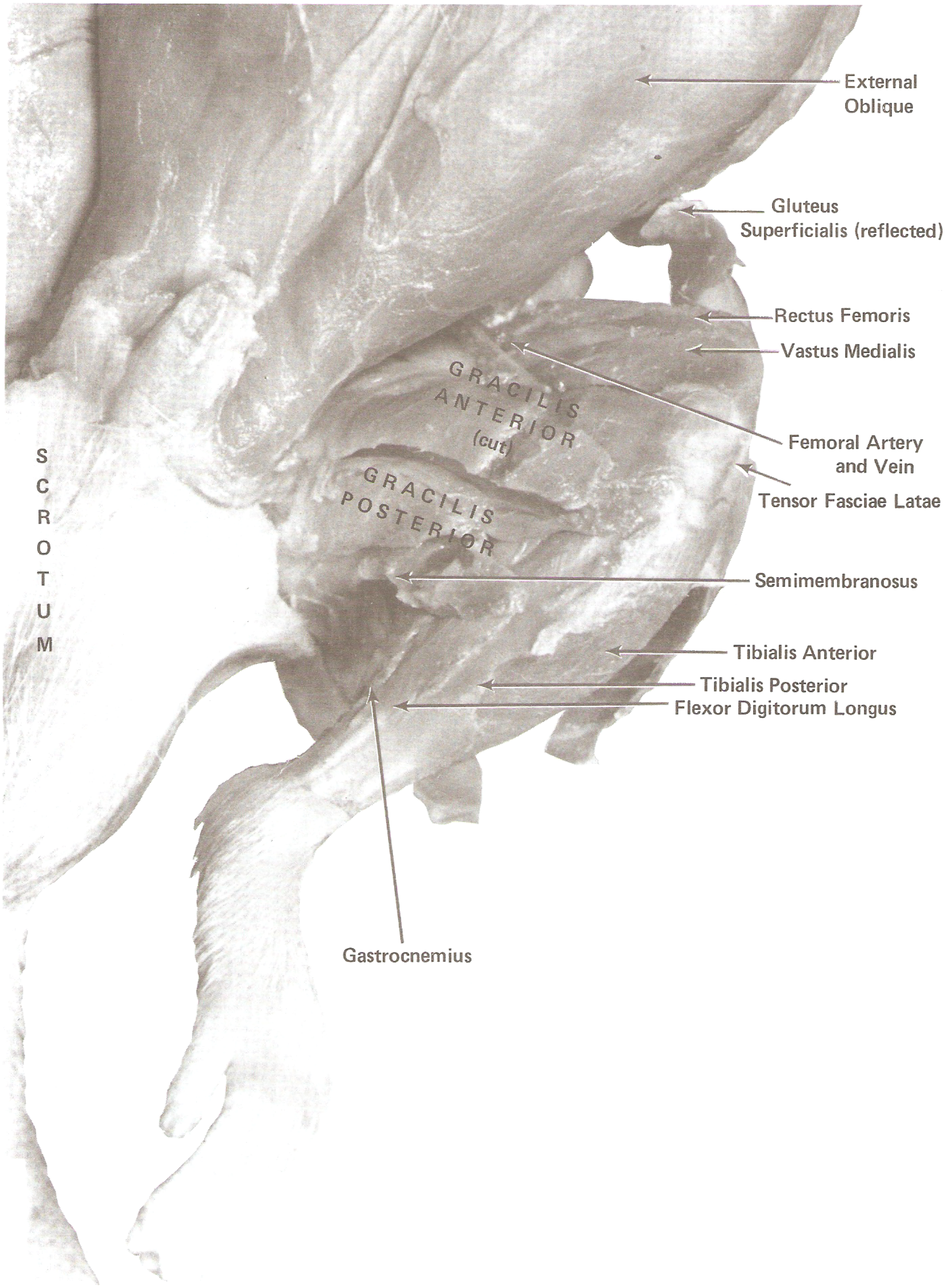


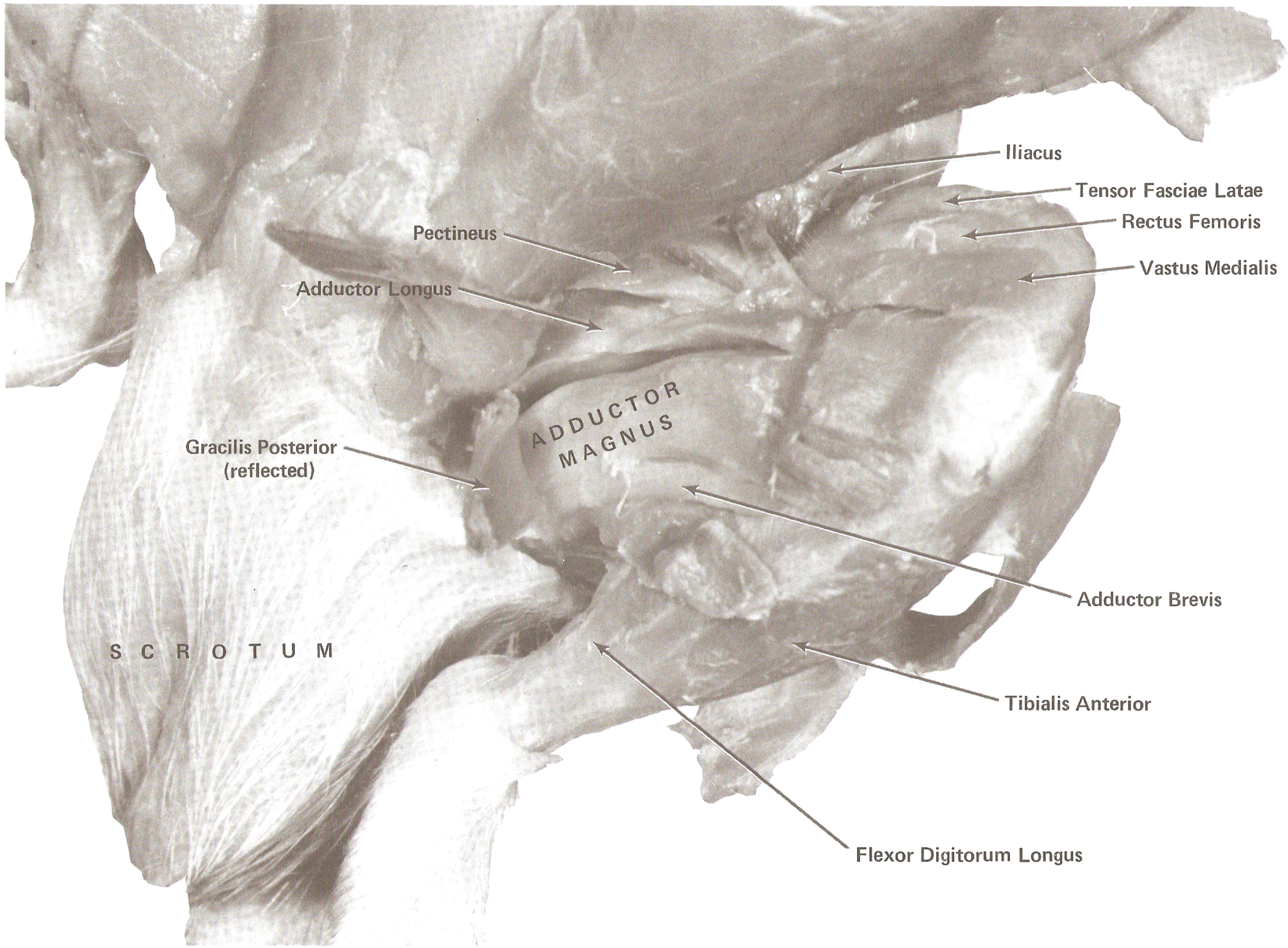
DEEP MUSCLES, FORELIMB (MEDIAL VIEW)



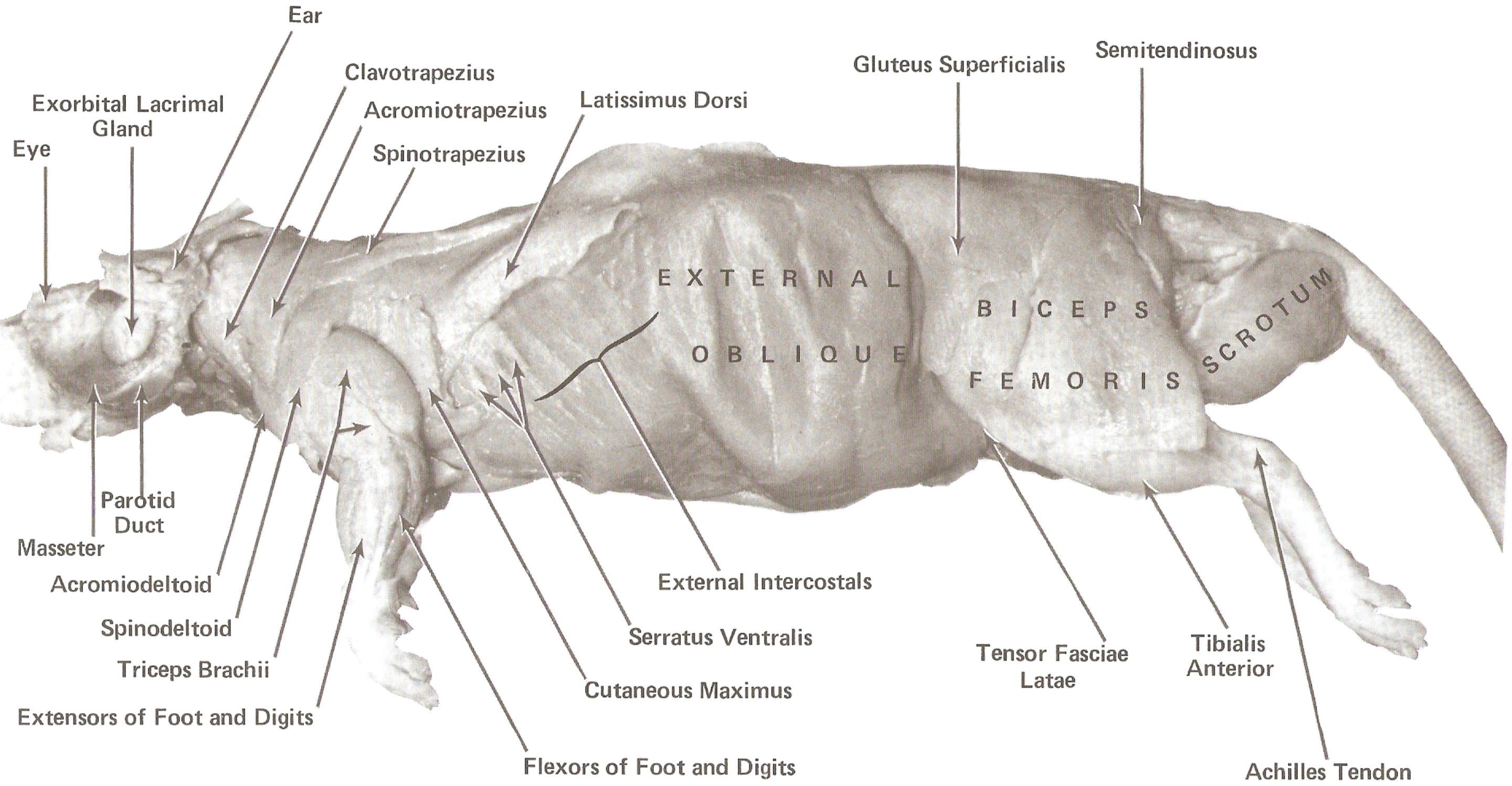
DEEP MUSCLES, THORAX (VENTRAL VIEW)

THREE LAYERS OF ABDOMINAL MUSCLES

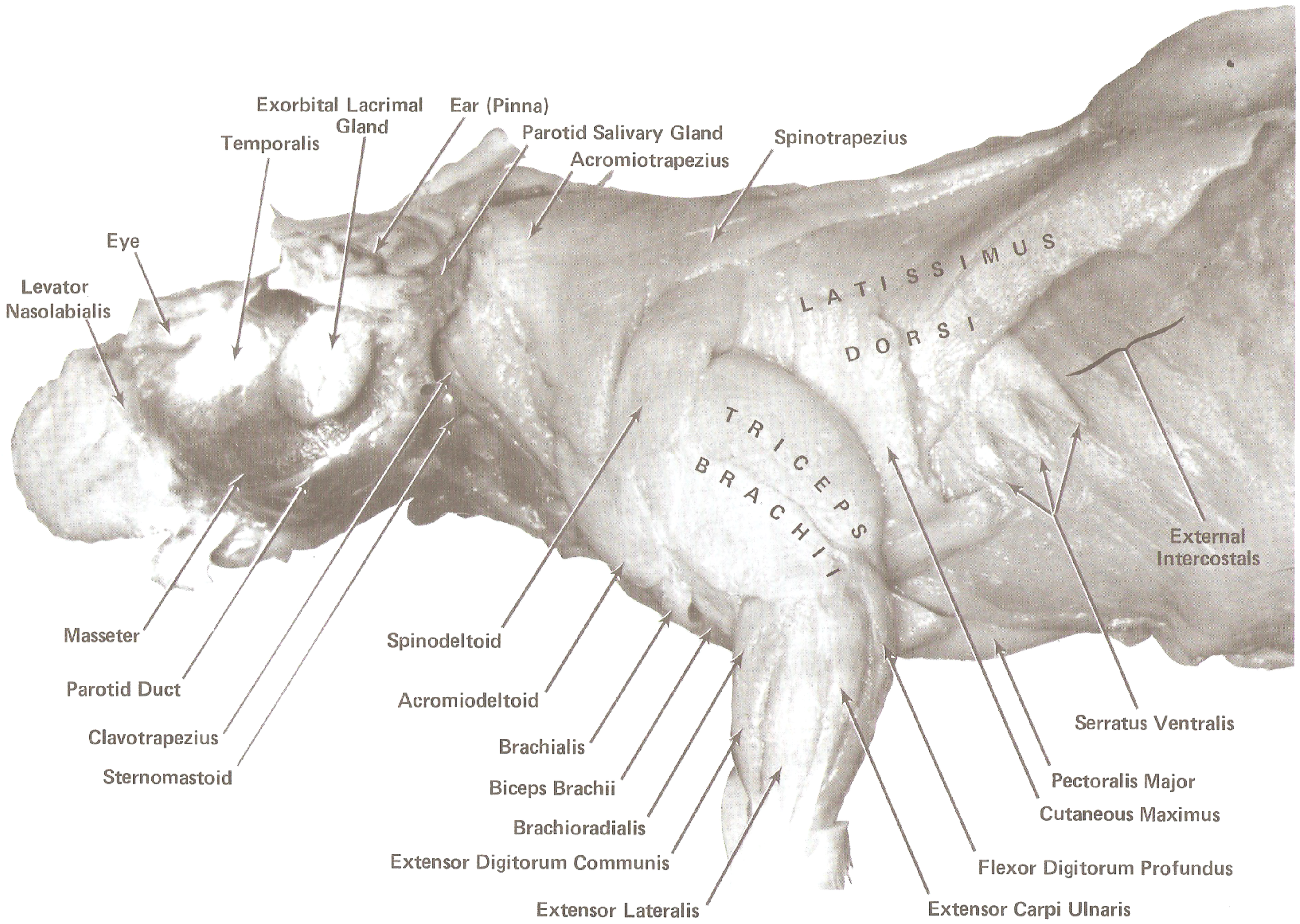

External Oblique
Gluteus Superficialis (reflected)
Rectus Femoris
Vastus Medialis
GRACILIS ANTERIOR (cut)
Femoral Artery and Vein
Tensor Fasciae Latae
GRACILIS POSTERIOR
Semimembranosus
SCROTUM
Tibialis Anterior
Tibialis Posterior
Flexor Digitorum Longus
Gastrocnemius



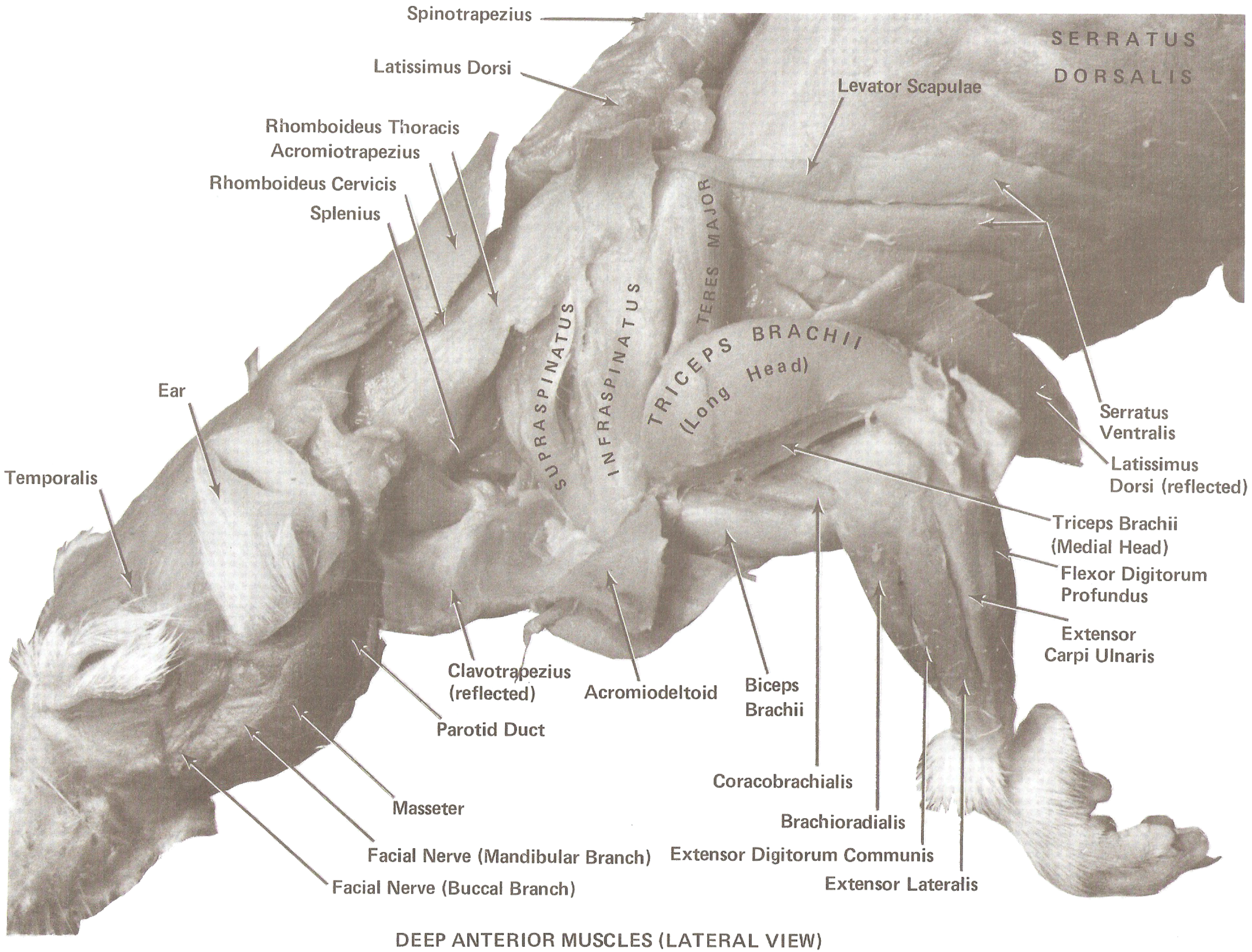
DEEP MUSCLES, HIND LIMB (MEDIAL VIEW)



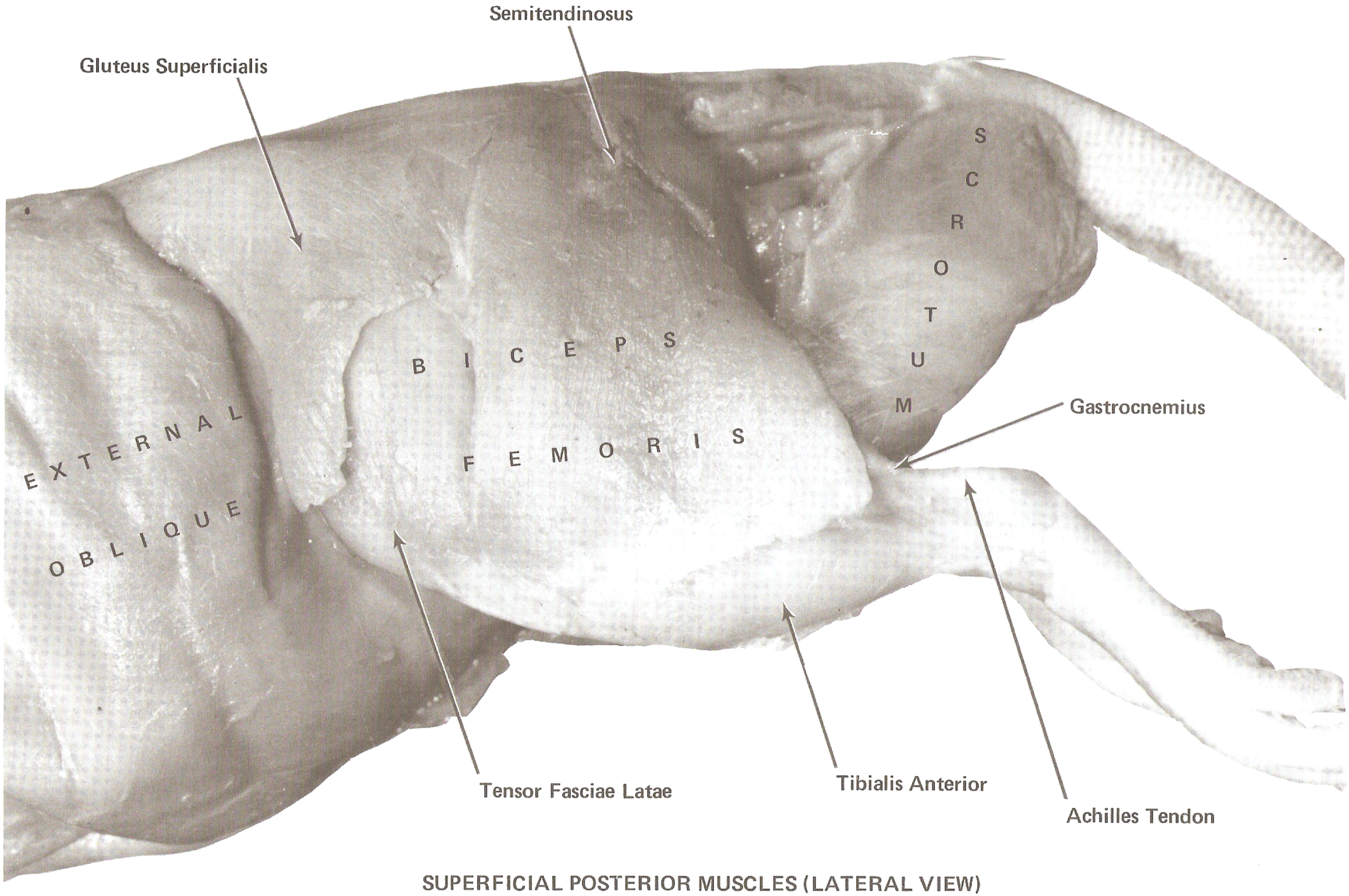
SUPERFICIAL MUSCLES (LATERAL VIEW)



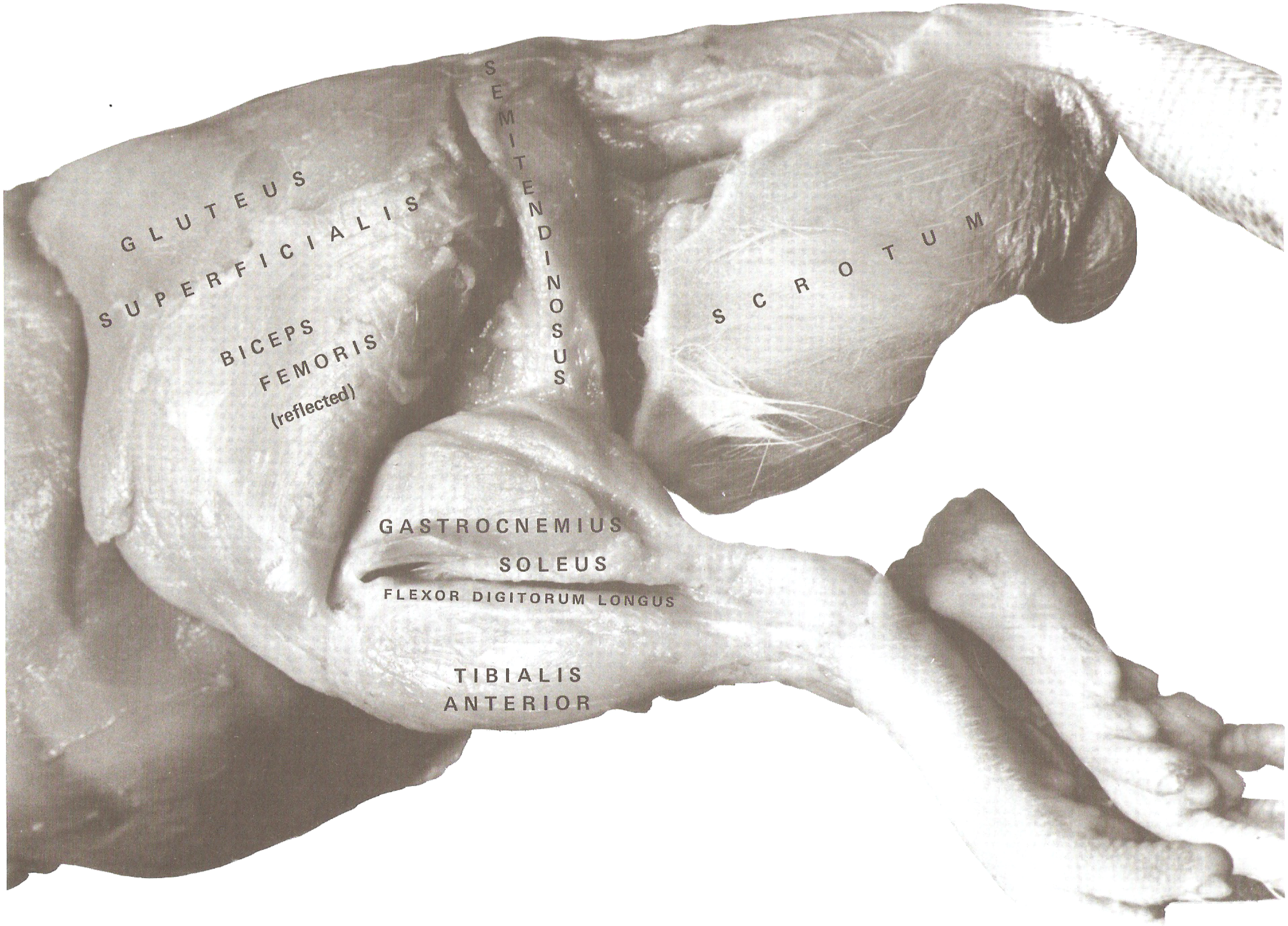
SUPERFICIAL ANTERIOR MUSCLES (LATERAL VIEW)



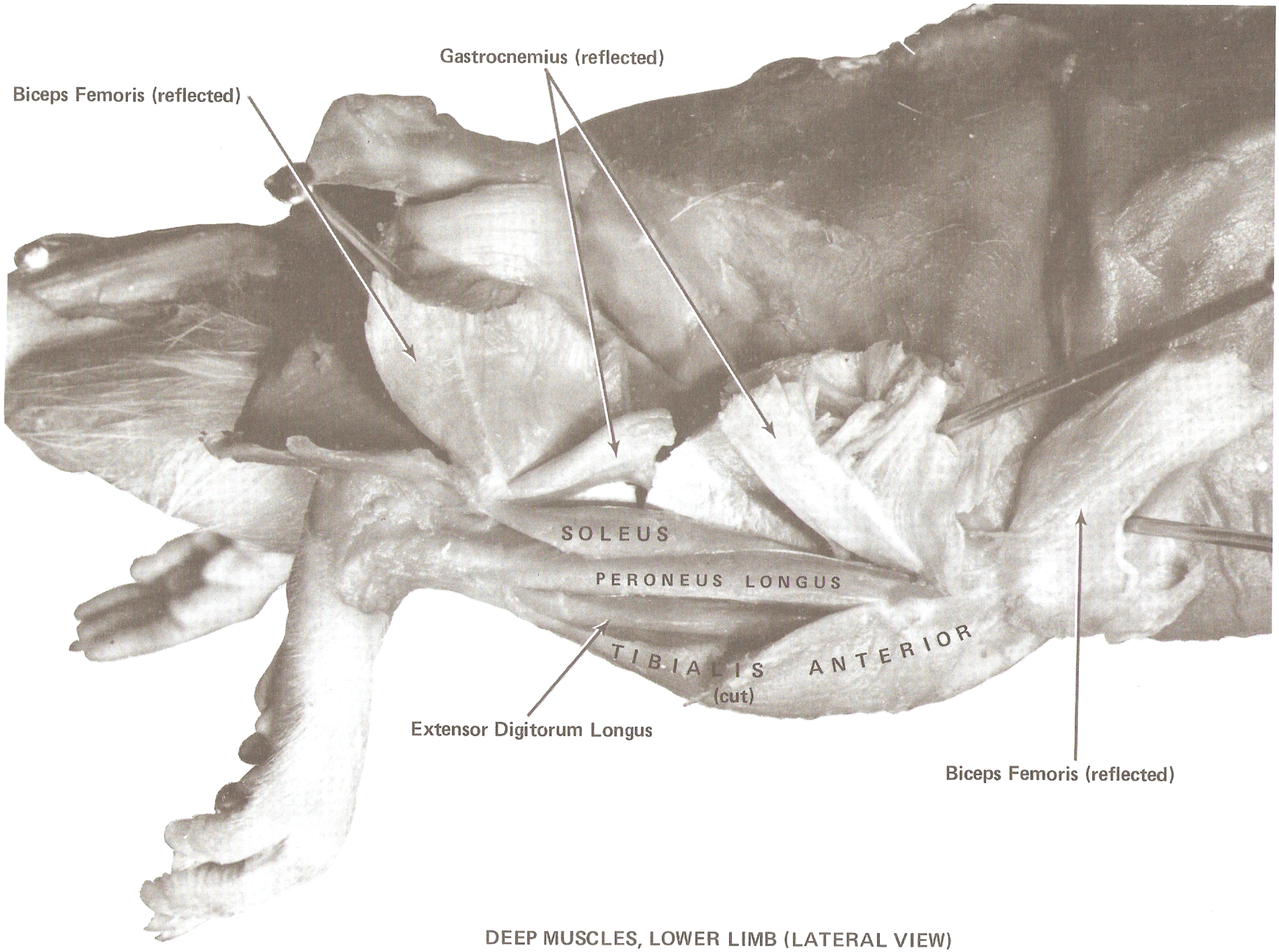
DEEP ANTERIOR MUSCLES (LATERAL VIEW)



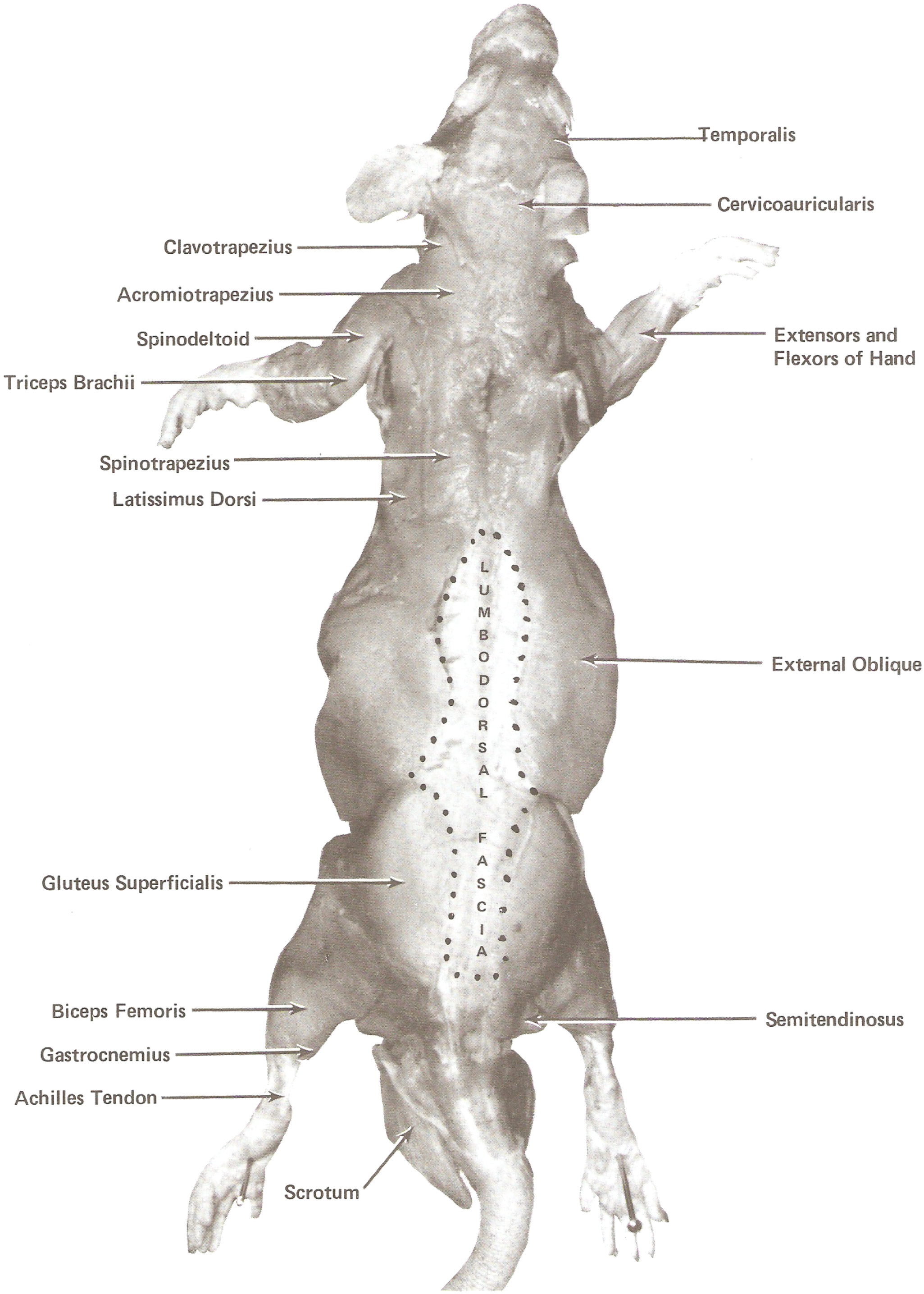
SUPERFICIAL POSTERIOR MUSCLES (LATERAL VIEW)



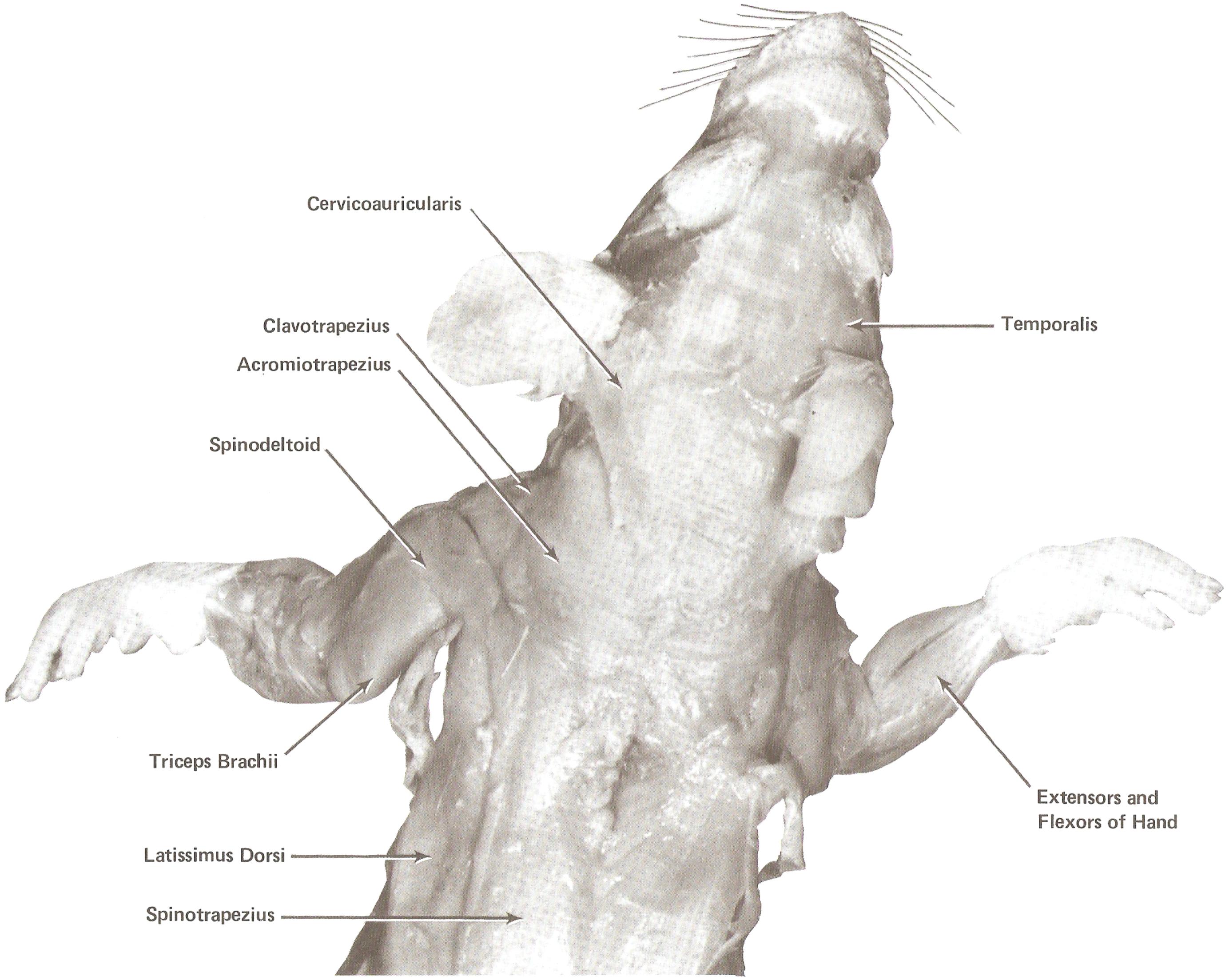
DEEP POSTERIOR MUSCLES (LATERAL VIEW)



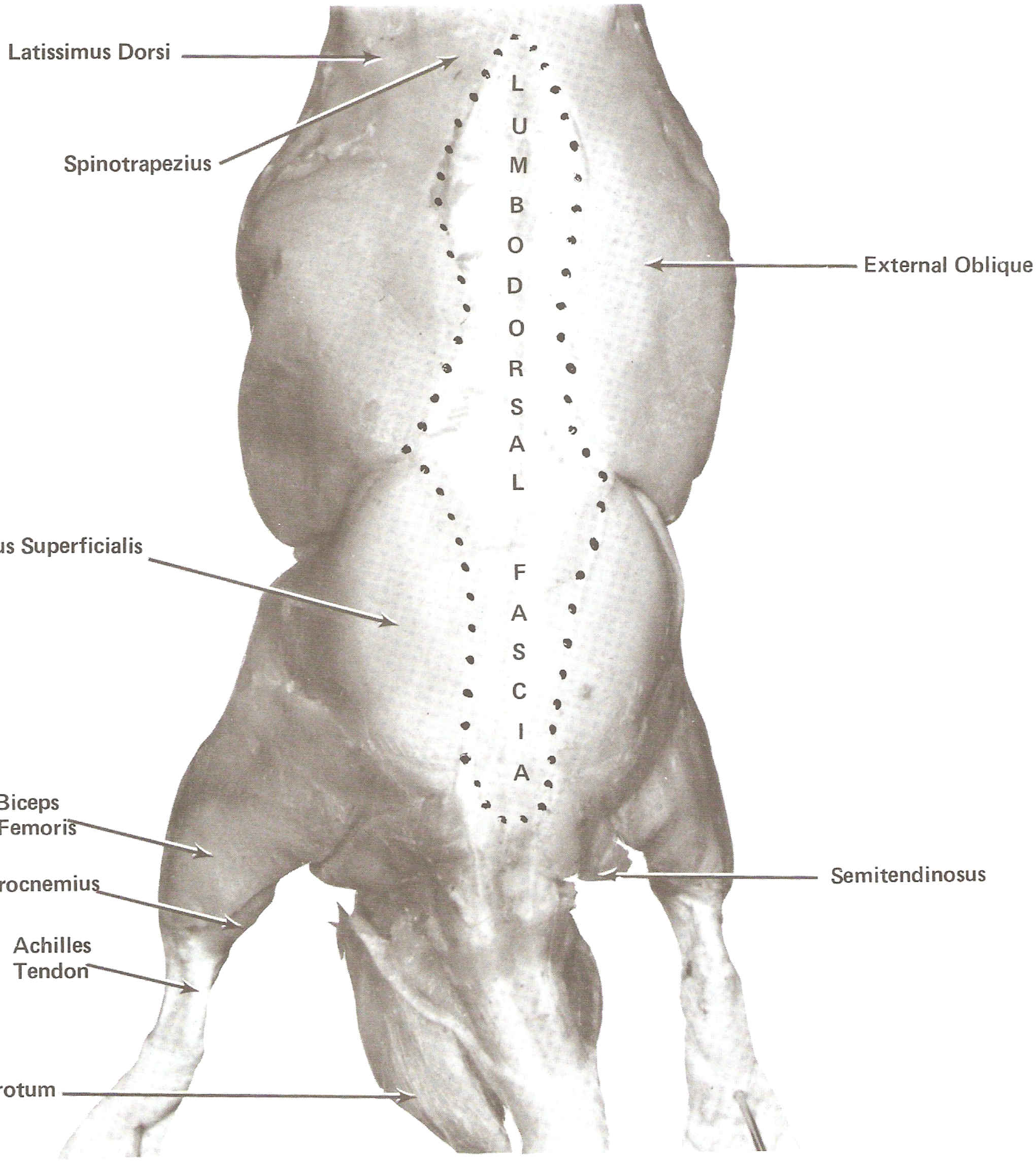
DEEP MUSCLES, LOWER LIMB (LATERAL VIEW)



SUPERFICIAL MUSCLES (DORSAL VIEW)



SUPERFICIAL ANTERIOR MUSCLES (DORSAL VIEW)



SUPERFICIAL POSTERIOR MUSCLES (DORSAL VIEW)