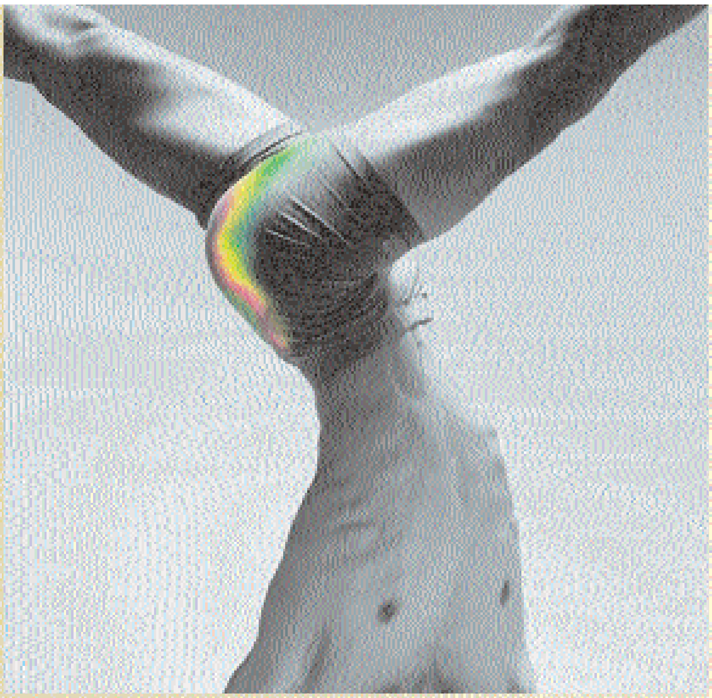


CHAPTER 10

ANATOMY OF THE MUSCULAR SYSTEM

CHAPTER OUTLINE

KEY TERMS

antagonist	origin
fixator	posture
insertion	prime mover
lever	synergist

Survival depends on the ability to maintain a relatively constant internal environment. Such stability often requires movement of the body. For example, we must gather and eat food, defend ourselves, seek shelter, and make tools, clothing, or other objects. Whereas many different systems of the body have *some* role in accomplishing movement, it is the skeletal and muscular systems acting together that actually produce most body movements. We have investigated the architectural plan of the skeleton and have seen how its firm supports and joint structures make movement possible. However, bone and joints cannot move themselves. They must be moved by something. Our subject for now, then, is the large mass of skeletal muscle that moves the framework of the body: the **muscular system** (Figures 10-1 and 10-2).

Movement is one of the most characteristic and easily observed "characteristics of life." When we walk, talk, run, breathe, or engage in a multitude of other physical activities that are under the "willed" control of the individual, we do so by the contraction of skeletal muscle.

There are more than 600 skeletal muscles in the body. Collectively, they constitute 40% to 50% of our body weight. And, together with the scaffolding provided by the skeleton, muscles also determine the form and contours of our body.

Contraction of individual muscle cells is ultimately responsible for purposeful movement. In Chapter 11 the physiology of muscular contraction is discussed. In this preliminary chapter, however, we will learn how contractile units are grouped into unique functioning organs—or muscles.

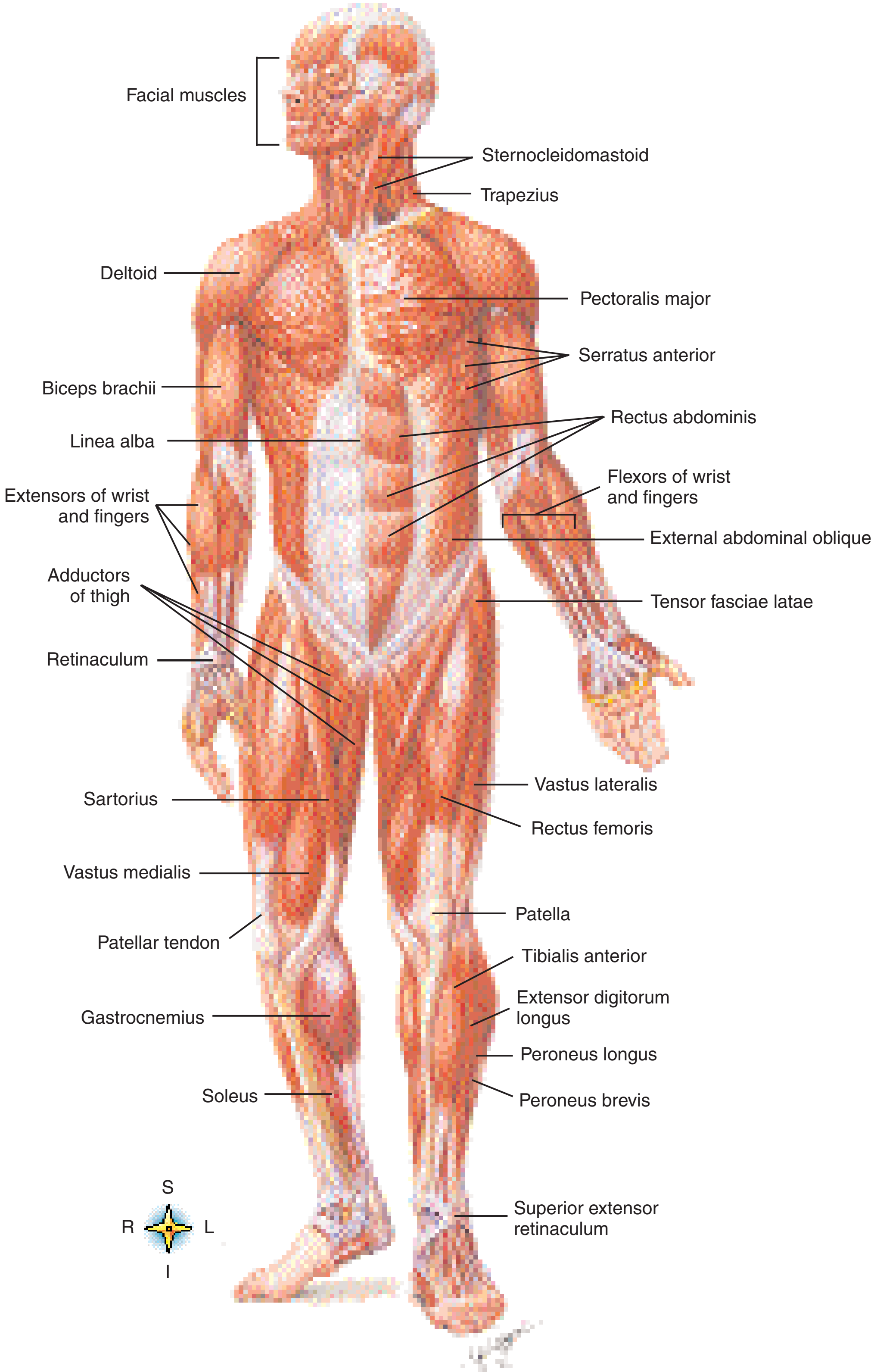


Figure 10-1 General overview of the body musculature. Anterior view.

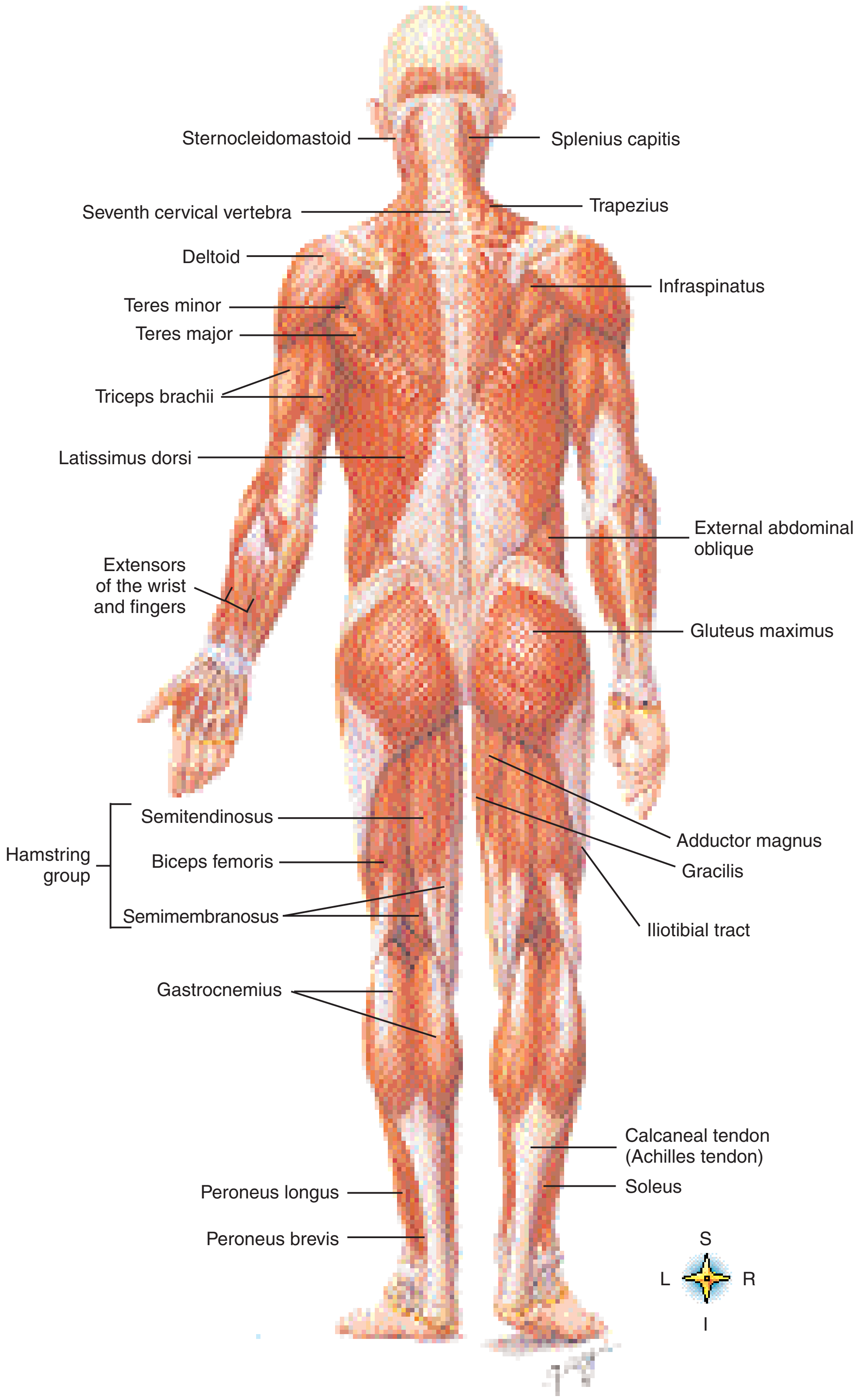


Figure 10-2 **General overview of the body musculature.** Posterior view.

The manner in which muscles are grouped, the relationship of muscles to joints, and how muscles attach to the skeleton determine purposeful body movement. A discussion of muscle shape and how muscles attach to and move bones is followed by information on specific muscles and muscle groups. The chapter will end with a review of the concept of posture.

SKELETAL MUSCLE STRUCTURE

CONNECTIVE TISSUE COMPONENTS

The highly specialized skeletal muscle cells, or *muscle fibers,* are covered by a delicate connective tissue membrane called the **endomysium** (Figure 10-3). Groups of skeletal muscle fibers, called *fascicles,* are then bound together by a tougher connective tissue envelope called the **perimysium.** The muscle as a whole is covered by a coarse sheath called the **epimysium.** Because all three of these structures are continuous with the fibrous structures that attach muscles to bones or other structures, muscles are firmly harnessed to the structures they pull on during contraction. The epimysium, perimysium, and endomysium of a muscle, for example, may be continuous with fibrous tissue that extends from the muscle as a **tendon,** a strong tough cord continuous at its other end with the fibrous periosteum covering a bone. Or the fibrous wrapping of a muscle may extend as a broad, flat sheet of connective tissue called an **aponeurosis,** which usually merges with the fibrous wrappings of another muscle. So tough and strong are tendons and aponeuroses that they are not often torn, even by injuries forceful enough to break bones or tear muscles. They are, however, occasionally pulled away from bones. Fibrous connective tissue surrounding the muscle organ and outside the epimysium and tendon is called **fascia.** *Fascia* is a general term for the fibrous connective tissue found under the skin and surrounding many deeper organs, including skeletal muscles and bones. Fascia just under the skin (the hypodermis) is sometimes called *superficial fascia,* and the fascia around muscles and bones is sometimes called *deep fascia.*

Tube-shaped structures of fibrous connective tissue called **tendon sheaths** enclose certain tendons, notably those of the wrist and ankle. Like the bursae, tendon sheaths have a lining of synovial membrane. Its moist, smooth surface enables the tendon to move easily, almost without friction, in the tendon sheath.

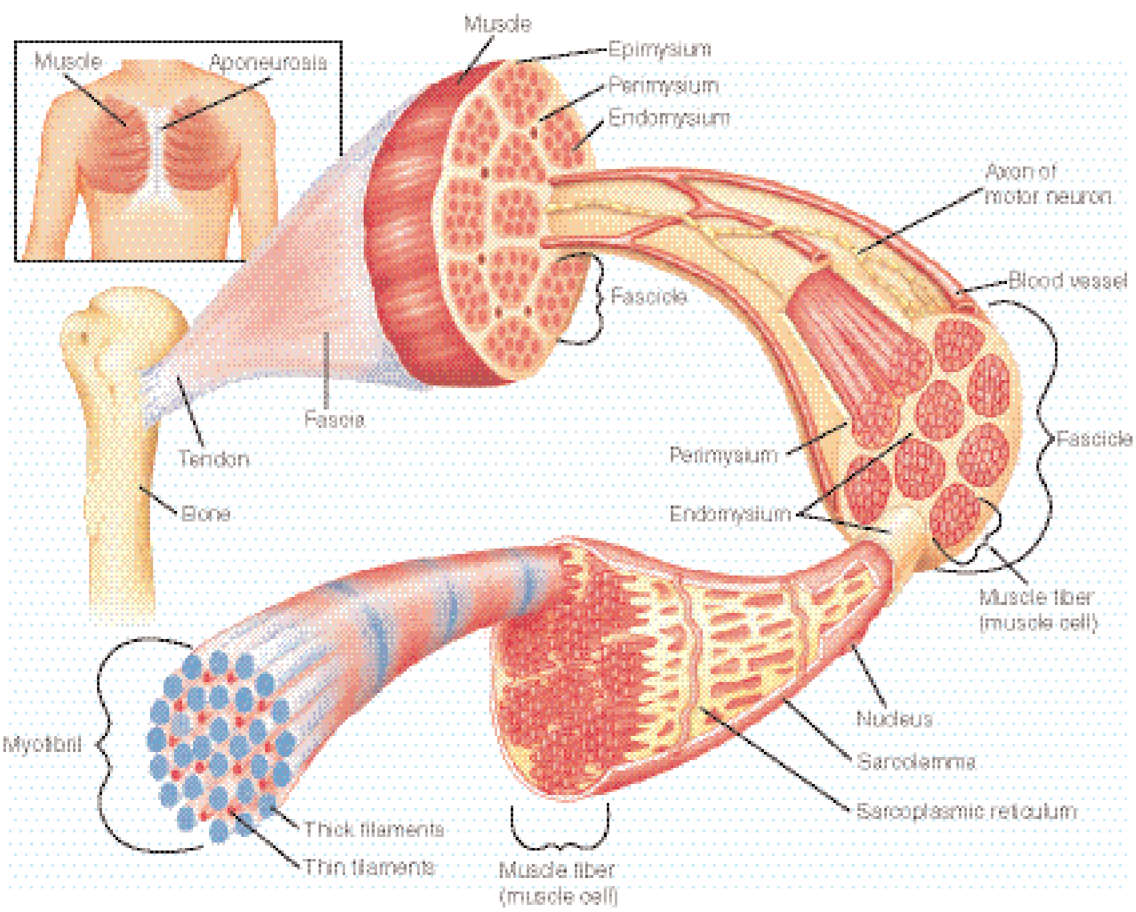


Figure 10-3 **Structure of a muscle organ.** Note that the connective tissue coverings, the epimysium, perimysium, and endomysium, are continuous with each other and with the tendon. Note also that muscle fibers are held together by the perimysium in groups called *fascicles.*

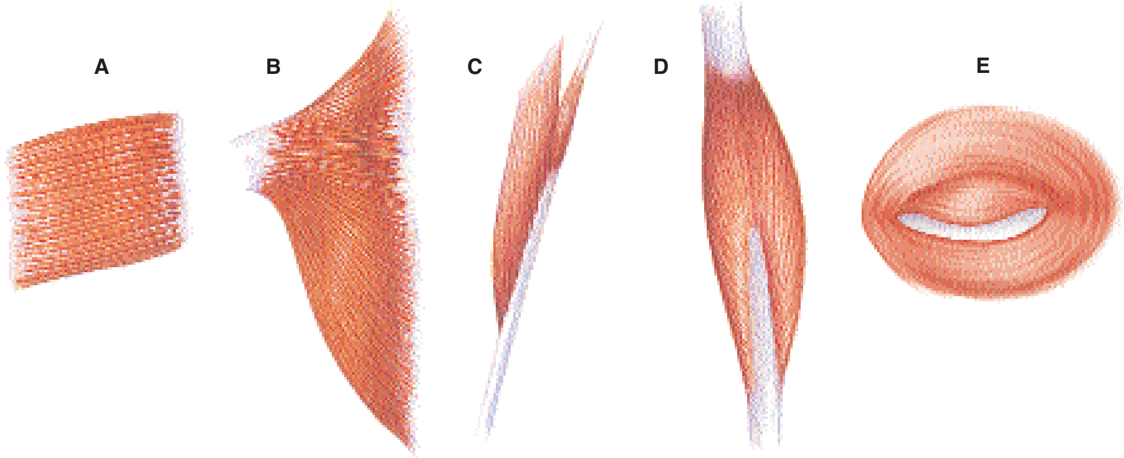


Figure 10-4 **Muscle shape and fiber arrangement.** **A**, Parallel. **B**, Convergent. **C**, Pennate. **D**, Bipennate. **E**, Sphincter.

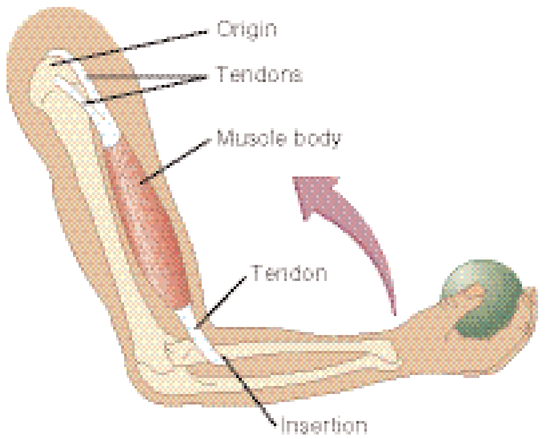


Figure 10-5 **Attachments of a skeletal muscle.** A muscle originates at a relatively stable part of the skeleton (origin) and inserts at the skeletal part that is moved when the muscle contracts (insertion).

SIZE, SHAPE, AND FIBER ARRANGEMENT

The structures called *skeletal muscles* are organs. They consist mainly of skeletal muscle tissue plus important connective and nervous tissue components. Skeletal muscles vary considerably in size, shape, and arrangement of fibers. They range from extremely small strands, such as the stapedius muscle of the middle ear, to large masses, such as the muscles of the thigh. Some skeletal muscles are broad in shape and some are narrow. Some are long and tapering and some are short and blunt. Some are triangular, some quadrilateral, and some irregular. Some form flat sheets and others form bulky masses.

Arrangement of fibers varies in different muscles. In some muscles the fibers are parallel to the long axis of the muscle (Figure 10-4, *A*). In some they converge to a narrow attachment (Figure 10-4, *B*), and in some they are oblique and pennate (Figure 10-4, *C*) like the feathers in an old-fashioned plume pen or bipennate (double-feathered) (Figure 10-4, *D*). Fibers may even be curved, as in the sphincters of the face, for example (Figure 10-4, *E*). The direction of the fibers composing a muscle is significant because of its relationship to function. For instance, a muscle with the bipennate fiber arrangement can produce a stronger contraction than a muscle having a parallel fiber arrangement.

1. Identify the connective tissue membrane that: (a) covers individual muscle fibers, (b) surrounds groups of skeletal muscle fibers (fascicles), and (c) covers the muscle as a whole.
2. Name the tough connective tissue cord that serves to attach a muscle to a bone.
3. Name three types of fiber arrangements seen in skeletal muscle.

ATTACHMENT OF MUSCLES

Most of our muscles span at least one joint and attach to both articulating bones. When contraction occurs, one bone usually remains fixed and the other moves. The points of attachment are called the *origin* and *insertion*. The ***origin*** is that point of attachment that does not move when the muscle contracts. Therefore the origin bone is the more stationary of the two bones at a joint when contraction occurs. The ***insertion*** is the point of attachment that moves when the muscle contracts (Figure 10-5). The insertion bone therefore moves toward the origin bone when the muscle shortens. In case you are wondering why both bones do not move, because both are pulled on by the contracting muscle, one of them is normally stabilized by isometric contractions of other muscles or by certain features of its own that make it less mobile.

The terms *origin* and *insertion* provide us with useful points of reference. Many muscles have multiple points of origin or insertion. Understanding the functional relationship of these attachment points during muscle contraction helps in deducing muscle actions. Attachment points of the biceps brachii shown in Figure 10-5 help provide functional information. Distal insertion on the radius of the lower arm causes flexion to occur at the elbow when contraction occurs. It should be realized, however, that origin and insertion are points that may change under certain circumstances. For example, not only can you grasp an object above your head and pull it down, you can also pull yourself up to the object. Although *origin* and *insertion* are convenient terms, they do not always provide the necessary information to understand the full functional potential of muscle action.

MUSCLE ACTIONS

Skeletal muscles almost always act in groups rather than singly. As a result, most movements are produced by the coordinated action of several muscles. Some of the muscles in the group contract while others relax. The result is a movement pattern that allows for the functional classification of muscles or muscle groups. Several terms are used to describe muscle action during any specialized movement pattern. The terms *prime mover (agonist), antagonist, synergist,* and *fixator* are especially important and are discussed in the following paragraphs. Each term suggests an important concept that is essential to an understanding of such functional muscle patterns as flexion, extension, abduction, adduction, and other movements discussed in Chapter 9. The term ***prime mover*** or **agonist** is used to describe a muscle or group of muscles that directly performs a specific movement. The movement produced by a muscle acting as a prime mover is described as the "action" or "function" of that muscle. For example, the biceps brachii shown in Figure 10-5 is acting as a prime mover during flexion of the forearm.

Antagonists are muscles that, when contracting, directly oppose prime movers (agonists). They are relaxed while the prime mover is contracting to produce movement. Simultaneous contraction of a prime mover and its antagonist muscle results in rigidity and lack of motion. The term *antagonist* is perhaps unfortunate, because muscles cooperate, rather than oppose, in normal movement patterns. Antagonists are important in providing precision and control during contraction of prime movers.

Synergists are muscles that contract at the same time as the prime mover. They facilitate or complement prime mover actions so that the prime mover produces a more effective movement.

Fixator muscles generally function as joint stabilizers. They frequently serve to maintain posture or balance during contraction of prime movers acting on joints in the arms and legs.

Movement patterns are complex, and most muscles function not only as prime movers but also as antagonists, synergists, or fixators. A prime mover in a particular movement pattern, such as flexion, may be an antagonist during extension or a synergist or fixator in other types of movement.

1. Identify the point of attachment of a muscle to a bone that: (a) does not move when the muscle contracts; (b) moves when the muscle contracts.
2. What name is used to describe a muscle that directly performs a specific movement?
3. What type of muscles helps maintain posture or balance during contraction of muscles acting on joints in the arms and legs?
4. Name the type of muscles that generally function as joint stabilizers.

LEVER SYSTEMS

When a muscle shortens, the central body portion, called the **belly,** contracts. The type and extent of movement is determined by the load or resistance that is moved, the attachment of the tendinous extremities of the muscle to bone (origin and insertion), and by the particular type of joint involved. In almost every instance, muscles that move a part do not lie over that part. Instead, the muscle belly lies proximal to the part moved. Thus muscles that move the lower arm lie proximal to it, that is, in the upper arm.

Knowledge of **lever systems** is important in understanding muscle action. By definition, a ***lever*** is any rigid bar free to turn about a fixed point called its *fulcrum.* Bones serve as levers, and joints serve as fulcrums of these levers. A contracting muscle applies a pulling force on a bone lever at the point of the muscle's attachment to the bone. This causes the insertion bone to move about its joint fulcrum.

A lever system is a simple mechanical device that makes the work of moving a weight or other load easier. Levers are composed of four component parts: (1) a rigid rod or bar (bone), (2) a fixed pivot, or fulcrum (F), around which the rod moves (joint), (3) a load (L) or resistance that is moved, and (4) a force, or pull (P), which produces movement (muscle contraction). Figure 10-6 shows the three different types of lever arrangements. All three types are found in the human body.

Box 10-1 SPORTS AND FITNESS

Assessing Muscle Strength

Certified athletic trainers and other health care providers are often required to assess muscle strength in the evaluation of athletic injuries. A basic principle of muscle action in a lever system is called the **optimum angle of pull**. An understanding of this principle is required for correct assessment of muscle strength.

Generally, the optimum angle of pull for any muscle is a right angle to the long axis of the bone to which it is attached. When the angle of pull departs from a right angle and becomes more parallel to the long axis, the strength of contraction decreases dramatically. Contraction of the brachialis muscle demonstrates this principle very well. The brachialis crosses the elbow from humerus to ulna. In the anatomical position the elbow is extended and the angle of pull of the brachialis is parallel to the long axis of the ulna (see Figure 10-17, *D*). Contraction of the brachialis at this angle is very inefficient. As the elbow is flexed and the angle of pull approaches a right angle, the contraction strength of the muscle is greatly increased. Therefore to test brachialis muscle strength correctly, the forearm should be flexed at the elbow. Understanding the optimum angle of pull for any given muscle makes a rational approach to correct assessment of functional strength in that muscle possible.

First-Class Levers

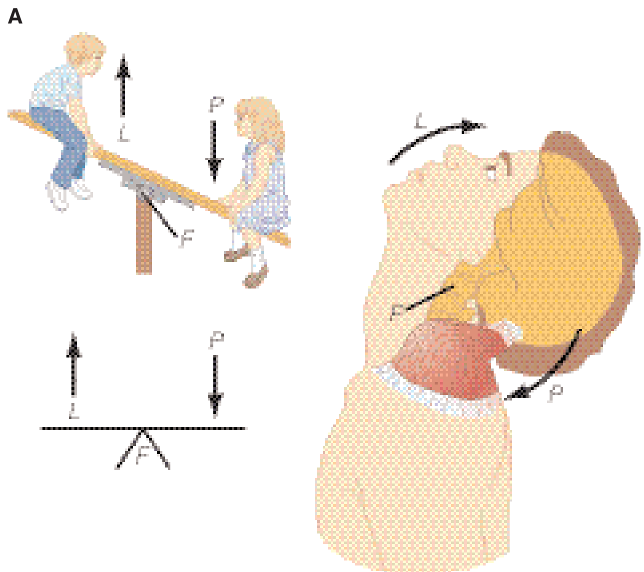
As you can see in Figure 10-6, *A,* the placement of the fulcrum in a first-class lever lies between the effort, or pull *(P),* and the resistance, or load *(W),* as in a set of scales, a pair of scissors, or a child's seesaw. In the body the head being raised or tipped backward on the atlas is an example of a first-class lever in action. The facial portion of the skull is the load, the joint between the skull and atlas is the fulcrum, and the muscles of the back produce the pull. In the human body first-class levers are not abundant. They generally serve as levers of stability.

Second-Class Levers

In second-class levers the load lies between the fulcrum and the joint at which the pull is exerted. The wheelbarrow is often used as an example. The presence of second-class levers in the human body is a controversial issue. Some authorities interpret the raising of the body on the toes as an example of this type of lever (Figure 10-6, *B*). In this example the point of contact between the toes and the ground is the fulcrum, the load is located at the ankle, and pull is exerted by the gastrocnemius muscle through the Achilles tendon. Opening the mouth against resistance (depression of the mandible) is also considered to be an example of a second-class lever.

Third-Class Levers

In a third-class lever the pull is exerted between the fulcrum and resistance or load to be moved. Flexing of the forearm at the elbow joint is a frequently used example of this type of lever (Figure 10-6, *C*). Third-class levers permit rapid and extensive movement and are the most common type found in the body. They allow insertion of a muscle very close to the joint that it moves.



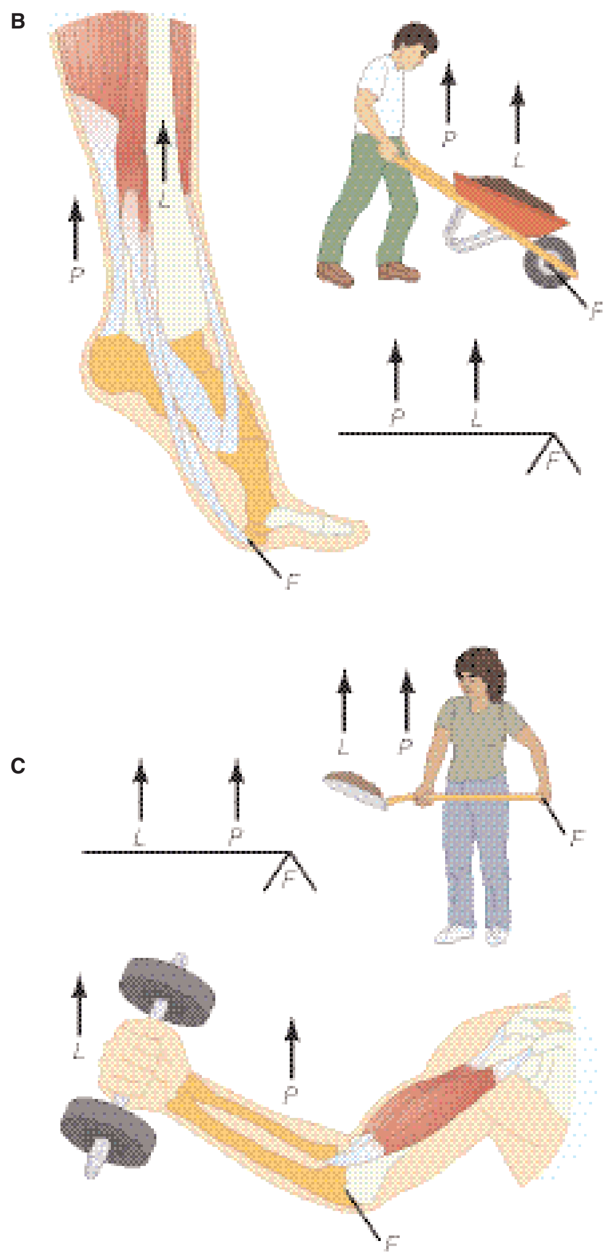


Figure 10-6 **Lever classes.** **A**, Class I: fulcrum *(F)* between the load *(L)* and force or pull *(P);* **B**, Class II: load *(L)* between the fulcrum *(F)* and force or pull *(P);* **C**, Class III: force or pull *(P)* between the fulcrum *(F)* and the load *(L).* The lever rod is yellow in each.

HOW MUSCLES ARE NAMED

The first thing you notice when you start studying the muscles of the body is that the names all seem very mysterious and foreign. Of course, that results from them being essentially Latin words (sometimes with Greek origins). You may also find that from one reference to another, the same muscle will have slightly different names. Sometimes the difference comes from the fact that in science, old terms are often being replaced by newer terms and it takes time for everyone to catch on. With muscles, however, it is common to use *either* Latin or the English version of the Latin name. For example, the deltoid muscle can be correctly called *deltoideus* (Latin) or *deltoid* (Latin-based English). You can see that they both come from the same original name, but they are not exactly the same word. In this edition, we have strived to keep with the English names only.

Latin-based muscle names seem more logical and therefore easier to learn when one understands the reasons for the names. Many of the superficial muscles of the body shown in Figures 10-1 and 10-2 are named using one or more of the following features:

- **Location.** Many muscles are named as a result of location. The *brachialis* (arm) muscle and *gluteus* (buttock) muscles are examples. Table 10-1 is a listing of some major muscles grouped by location.
- **Function.** The function of a muscle is frequently a part of its name. The *adductor* muscles of the thigh adduct, or move, the leg toward the midline of the body. Table 10-2 lists selected muscles grouped according to function.
- **Shape.** Shape is a descriptive feature used for naming many muscles. The *deltoid* (triangular) muscle covering the shoulder is delta, or triangular, in shape.
- **Direction of fibers.** Muscles may be named according to the orientation of their fibers. The term *rectus* means straight. The fibers of the *rectus abdominis* muscle run straight up and down and are parallel to each other.
- **Number of heads or divisions.** The number of divisions or heads (points of origin) may be used to name a muscle. The word part *-cep* means *head.* The *biceps* (two), *triceps* (three), and *quadriceps* (four) refer to multiple heads, or points of origin. The *biceps brachii* is a muscle having two heads located in the arm.
- **Points of attachment.** Origin and insertion points may be used to name a muscle. For example, the *sternocleidomastoid* has its origin on the sternum and clavicle and inserts on the mastoid process of the temporal bone.
- **Size of muscle.** The relative size of a muscle can be used to name a muscle, especially if it is compared to the size of nearby muscles. For example, the *gluteus maximus* is the largest muscle of the gluteal (Greek *glautos,* meaning "buttock") region. Nearby, there is a small gluteal muscle, *gluteus minimus,* and midsize gluteal muscle, *gluteus medius.*

1. Name the four major components of any lever system.
2. Identify the three types of lever systems found in the human body and give one example of each.
3. What type of lever system permits rapid and extensive movement and is the most common type found in the body?
4. List six criteria that may determine a muscle's name and give an example of a specific muscle named using each criterion.

Table 10-1 Selected Muscles Grouped According to Location

Location	Muscles	Term	Meaning
Neck	Sternocleidomastoid	Thigh	
Back	Trapezius	Anterior surface	Quadriceps femoris group
	Latissimus dorsi		Rectus femoris
Chest	Pectoralis major		Vastus lateralis
	Serratus anterior		Vastus medialis
Abdominal wall	External oblique		Vastus intermedius
Shoulder	Deltoid	Medial surface	Gracilis
Upper arm	Biceps brachii		Adductor group (brevis, longus, magnus)
	Triceps brachii	Posterior surface	Hamstring group
	Brachialis		Biceps femoris
Forearm	Brachioradialis		Semitendinosus
	Pronator teres		Semimembranosus
Buttocks	Gluteus maximus	Leg	
	Gluteus minimus	Anterior surface	Tibialis anterior
	Gluteus medius	Posterior surface	Gastrocnemius
	Tensor fascia latae		Soleus
		Pelvic floor	Levator ani
			Coccygeus

Table 10-2 Selected Muscles Grouped According to Function

Part Moved	Example of Flexor	Example of Extensor	Example of Abductor	Example of Adductor
Head	Sternocleidomastoid	Semispinalis capitis		
Upper arm	Pectoralis major	Trapezius Latissimus dorsi	Deltoid	Pectoralis major with latissimus dorsi
Forearm	With forearm supinated: biceps brachii With forearm pronated: brachialis With semisupination or semipronation: brachioradialis	Triceps brachii		
Hand	Flexor carpi radialis and ulnaris Palmaris longus	Extensor carpi radialis, longus, and brevis Extensor carpi ulnaris	Flexor carpi radialis	Flexor carpi ulnaris
Thigh	Iliopsoas Rectus femoris (of quadriceps femoris group)	Gluteus maximus	Gluteus medius and gluteus minimus	Adductor group
Leg	Hamstrings	Quadriceps femoris group		
Foot	Tibialis anterior	Gastrocnemius Soleus	Evertors Peroneus longus Peroneus brevis	Invertor Tibialis anterior
Trunk	Iliopsoas Rectus abdominis	Erector spinae		

HINTS ON HOW TO DEDUCE MUSCLE ACTIONS

To understand muscle actions, you need first to know certain anatomical facts such as which bones muscles attach to and which joints they pull across. Then, if you relate these structural features to functional principles, you may find your study of muscles more interesting and less difficult than you anticipate. Some specific suggestions for deducing muscle actions follow.

1. Start by making yourself familiar with the names, shapes, and general locations of the larger muscles, using Table 10-1 as a guide.
2. Try to deduce which bones the two ends of a muscle attach to from your knowledge of the shape and general location of the muscle. For example, look carefully at the deltoid muscle as illustrated in Figures 10-1 and 10-15. To which bones does it seem to attach? Check your answer with Table 10-10, p. 295.
3. Next, determine which bone moves when the muscle shortens. (The bone moved by a muscle's contraction is its insertion bone; the bone that remains relatively stationary is its origin bone.) In many cases you can tell which is the insertion bone by trying to move one bone and then another. In some cases either bone may function as the insertion bone. Although not all muscle attachments can be deduced as readily as those of the deltoid, they can all be learned more easily by using this deduction method than by relying on rote memory alone.
4. Deduce a muscle's actions by applying the principle that its insertion moves toward its origin. Check your conclusions with the text. Here, as in steps 2 and 3, the method of deduction is intended merely as a guide and is not adequate by itself for determining muscle actions.
5. To deduce which muscle produces a given action (instead of which action a given muscle produces, as in step 4), start by inferring the insertion bone (bone that moves during the action). The body and origin of the muscle will lie on one or more of the bones toward which the insertion moves—often a bone, or bones, proximal to the insertion bone. Couple these conclusions about origin and insertion with your knowledge of muscle names and locations to deduce the muscle that produces the action.

For example, if you wish to determine the prime mover for the action of raising the upper arms straight out to the sides, you infer that the muscle inserts on the humerus, because this is the bone that moves. It moves toward the shoulder—that is, the clavicle and scapula—so that probably the muscle has its origin on these bones. Because you know that the deltoid muscle fulfills these conditions, you conclude, and rightly so, that it is the muscle that raises the upper arms sideways.

IMPORTANT SKELETAL MUSCLES

The major skeletal muscles of the body are listed, grouped, and illustrated in the tables and figures that follow. Begin your study with an overview of important superficial mus-

Table 10-3 Muscles of Facial Expression and of Mastication

Muscle	Origin	Insertion	Function	Nerve Supply
Muscles of Facial Expression				
Occipitofrontalis (epicranius)	Occipital bone	Tissues of eyebrows	Raises eyebrows, wrinkles forehead horizontally	Cranial nerve VII
Corrugator supercilii	Frontal bone (superciliary ridge)	Skin of eyebrow	Wrinkles forehead vertically	Cranial nerve VII
Orbicularis oculi	Encircles eyelid		Closes eye	Cranial nerve VII
Zygomaticus major	Zygomatic bone	Angle of mouth	Laughing (elevates angle of mouth)	Cranial nerve VII
Orbicularis oris	Encircles mouth		Draws lips together	Cranial nerve VII
Buccinator	Maxillae	Skin of sides of mouth	Permits smiling Blowing, as in playing a trumpet	Cranial nerve VII
Muscles of Mastication				
Masseter	Zygomatic arch	Mandible (external surface)	Closes jaw	Cranial nerve V
Temporalis	Temporal bone	Mandible	Closes jaw	Cranial nerve V
Pterygoids (lateral and medial)	Undersurface of skull	Mandible (medial surface)	Grates teeth	Cranial nerve V

cles, shown in Figures 10-1 and 10-2. The remaining figures in this chapter illustrate individual muscles or important muscle groups.

Basic information about many muscles is given in Tables 10-3 to 10-15. Each table has a description of a group of muscles that move one part of the body. The actions listed for each muscle are those for which it is a prime mover. Remember, however, that a single muscle acting alone rarely accomplishes a given action. Instead, muscles act in groups as prime movers, synergists, antagonists, and fixators to bring about movements.

MUSCLES OF FACIAL EXPRESSION

The muscles of facial expression (Table 10-3) are unique in that at least one of their points of attachment is to the deep layers of the skin over the face or neck. Contraction of these muscles (Figure 10-7) produces a variety of facial expressions.

The **occipitofrontalis** (ahk-SIP-it-o-front-AL-is), or *epicranius,* is in reality two muscles. One portion lies over the forehead (frontal bone); the other covers the occipital bone in back of the head. The two muscular parts, or bellies, are joined by a connective tissue aponeurosis that covers the top of the skull. The frontal portion of the occipitofrontalis raises the eyebrows (surprise) and wrinkles the skin of the forehead horizontally. The **corrugator supercilii** (COR-u-GA-tor su-per-SIL-i) draws the eyebrows together, producing vertical wrinkles above the nose (frowning). The **orbicularis oculi** (or-BIC-u-LAR-us OK-u-li) encircles and closes the eye (blinking), whereas the **orbicularis oris** (OR-us) and **buccinator** (BUK-si-NA-tor) pucker the mouth (kissing) and press the lips and cheeks against the teeth. The **zygomaticus** (ZI-go-MAT-i-kus) **major** draws the corner of the mouth upward (laughing).

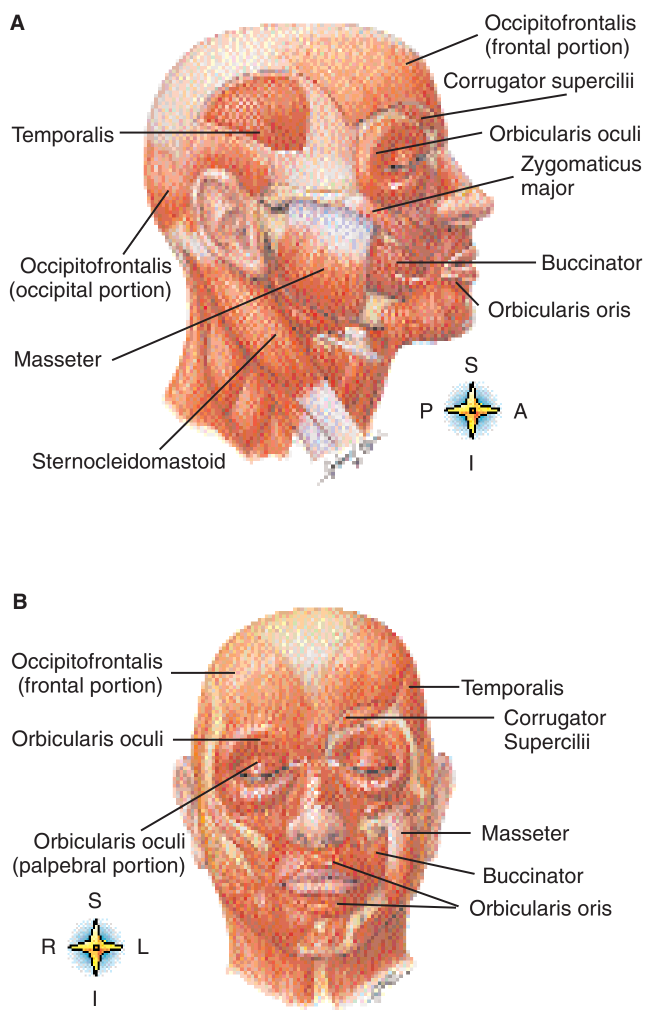


Figure 10-7 Muscles of facial expression and mastication. **A**, Lateral view. **B**, Anterior view.

MUSCLES OF MASTICATION

The muscles of **mastication** (mass-ti-KA-shun) shown in Figure 10-7 are responsible for chewing movements. These powerful muscles (see Table 10-3) either elevate and retract the mandible (**masseter,** mas-SE-ter, and **temporalis,** tem-po-RAL-is) or open and protrude it while causing sideways movement (**pterygoids,** TER-i-goids). The pull of gravity helps open the mandible during mastication, and the buccinator muscles play an important function by holding food between the teeth as the mandible moves up and down and from side to side.

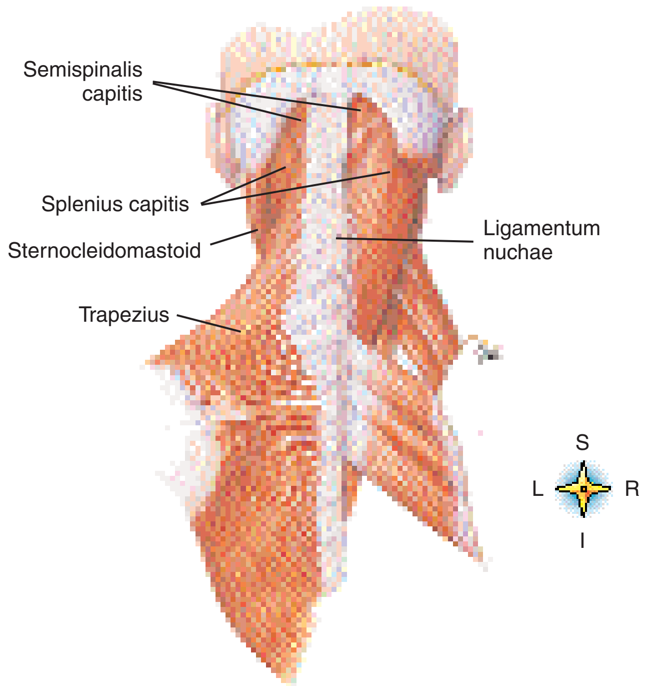


Figure 10-8 Muscles that move the head. Posterior view of muscles of the neck and the back.

MUSCLES THAT MOVE THE HEAD

Paired muscles on either side of the neck are responsible for head movements (Figure 10-8). Note the points of attachment and functions of important muscles in this group listed in Table 10-4. When both **sternocleidomastoid** (STER-no-KLI-do-MAS-toyd) muscles (Figure 10-7) contract at the same time, the head is flexed on the thorax—hence the name "prayer muscle." If only one muscle contracts, the head and face are turned to the opposite side. The broad *semispinalis capitis* (sem-e-spi-NAL-is KAP-i-tis) is an extensor of the head and helps to bend it laterally. Acting together, the **splenius capitis** (SPLE-ne-us KAP-i-tis) muscles serve as strong extensors that return the head to the upright position after flexion. When either muscle acts alone, contraction results in rotation and tilting toward that side. The bandlike **longissimus capitis** (lon-JIS-i-mus KAP-i-tis) muscles are covered and not visible in Figure 10-8. They run from the neck vertebrae to the mastoid process of the temporal bone on either side and cause extension of the head when acting together. One contracting muscle will bend and rotate the head toward the contracting side.

Table 10-4 Muscles That Move the Head

Muscle	Origin	Insertion	Function	Nerve Supply
Sternocleidomastoid	Sternum Clavicle	Temporal bone (mastoid process)	Flexes head (prayer muscle) One muscle alone, rotates head toward opposite side; spasm of this muscle alone or associated with trapezius called *torticollis* or wryneck	Accessory nerve
Semispinalis capitis	Vertebrae (transverse processes of upper six thoracic, articular processes of lower four cervical)	Occipital bone (between superior and inferior nuchal lines)	Extends head; bends it laterally	First five cervical nerves
Splenius capitis	Ligamentum nuchae	Temporal bone (mastoid process)	Extends head	Second, third, and fourth cervical nerves
	Vertebrae (spinous processes of upper three or four thoracic)	Occipital bone	Bends and rotates head toward same side as contracting muscle	
Longissimus capitis	Vertebrae (transverse processes of upper six thoracic, articular processes of lower four cervical)	Temporal bone (mastoid process)	Extends head Bends and rotates head toward contracting side	Multiple innervation

> **Quick Check**
> 1. What is meant by the terms *origin* and *insertion?*
> 2. Which muscle of facial expression has two parts, one lying over the forehead and the other covering the back of the skull?
> 3. What group of muscles provides chewing movements?
> 4. What is the action of the sternocleidomastoid muscle?

TRUNK MUSCLES

MUSCLES OF THE THORAX

The muscles of the thorax are of critical importance in respiration (discussed in Chapter 24). Note in Figure 10-9 and Table 10-5 that the **internal** and **external intercostal** (IN-ter-KOS-tal) **muscles** attach to the ribs at different places and their fibers are oriented in different directions. As a result, contraction of the external intercostals elevates and the internal intercostals depress the ribs—important in the breathing process. During inspiration the dome-shaped **diaphragm** (DI-a-fram) flattens, thus increasing size and volume of the thoracic cavity. As a result, air enters the lungs.

MUSCLES OF THE ABDOMINAL WALL

The muscles of the anterior and lateral abdominal wall (Figure 10-10 and Table 10-6) are arranged in three layers, with the fibers in each layer running in different directions much like the layers of wood in a sheet of plywood. The result is a very strong "girdle" of muscle that covers and supports the abdominal cavity and its internal organs.

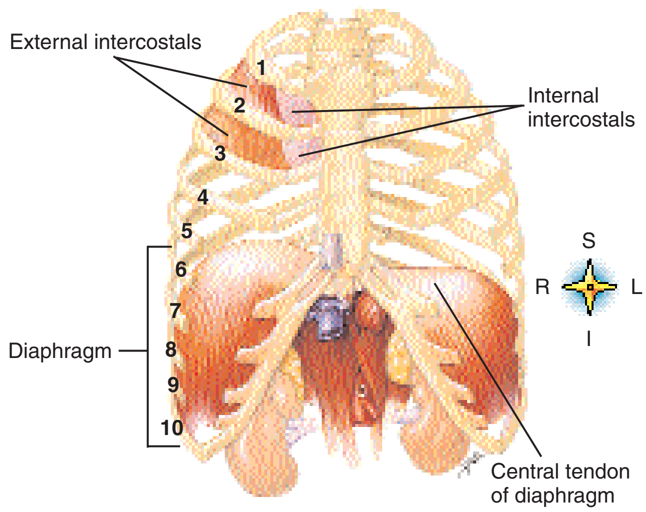


Figure 10-9 **Muscles of the thorax.** Anterior view. Note relationship of internal and external intercostal muscles and placement of diaphragm.

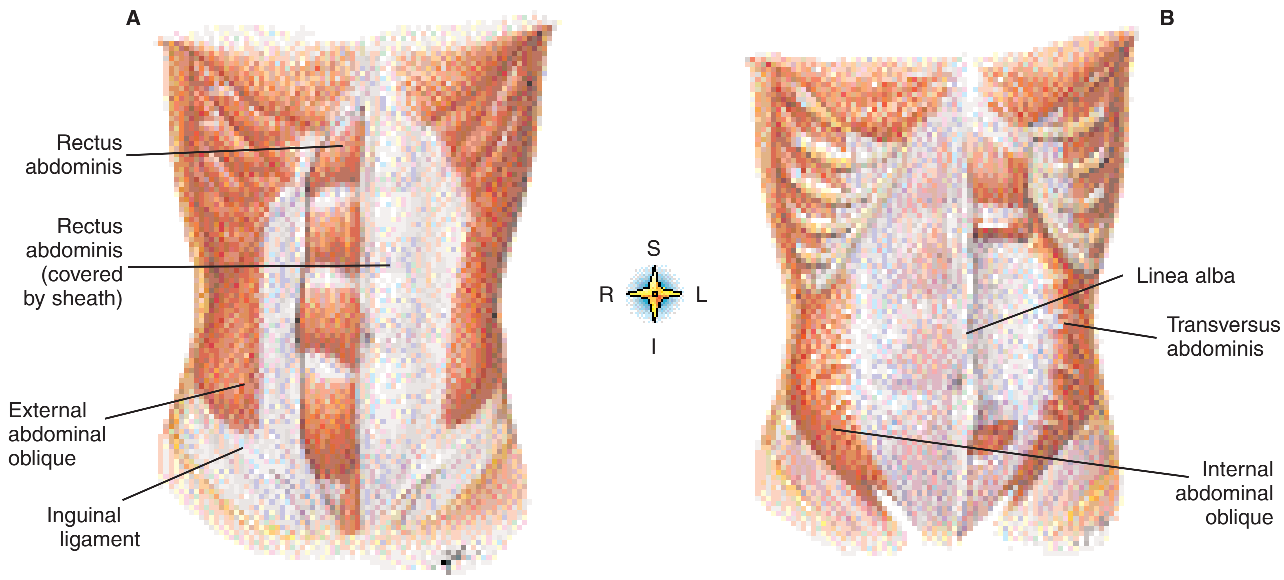


Figure 10-10 **Muscles of the trunk and abdominal wall.** **A**, Anterior view showing superficial muscles. **B**, Anterior view showing deeper muscles.

Table 10-5 Muscles of the Thorax

Muscle	Origin	Insertion	Function	Nerve Supply
External intercostals	Rib (lower border; forward fibers)	Rib (upper border of rib below origin)	Elevate ribs	Intercostal nerves
Internal intercostals	Rib (inner surface, lower border; backward fibers)	Rib (upper border of rib below origin)	Depress ribs	Intercostal nerves
Diaphragm	Lower circumference of thorax (of rib cage)	Central tendon of diaphragm	Enlarges thorax, causing inspiration	Phrenic nerves

Table 10-6 Muscles of the Abdominal Wall

Muscle	Origin	Insertion	Function	Nerve Supply
External oblique	Ribs (lower eight)	Pelvis (iliac crest and pubis by way of inguinal ligament) Linea alba by way of an aponeurosis	Compresses abdomen Rotates trunk laterally Important postural function of all abdominal muscles is to pull front of pelvis upward, thereby flattening lumbar curve of spine; when these muscles lose their tone, common figure faults of protruding abdomen and lordosis develop	Lower seven intercostal nerves and iliohypogastric nerves
Internal oblique	Pelvis (iliac crest and inguinal ligament) Lumbodorsal fascia	Ribs (lower three) Linea alba	Same as external oblique	Last three intercostal nerves; iliohypogastric and ilioinguinal nerves
Transversus abdominis	Ribs (lower six) Pelvis (iliac crest, inguinal ligament) Lumbodorsal fascia	Pubic bone Linea alba Ribs (costal cartilage of fifth, sixth, and seventh ribs)	Same as external oblique	Last five intercostal nerves; iliohypogastric and ilioinguinal nerves
Rectus abdominis	Pelvis (pubic bone and symphysis pubis)	Sternum (xiphoid process)	Same as external oblique; because abdominal muscles compress abdominal cavity, they aid in straining, defecation, forced expiration, childbirth, etc.; abdominal muscles are antagonists of diaphragm, relaxing as it contracts and vice versa Flexes trunk	Last six intercostal nerves
Quadratus lumborum	Iliolumbar ligament; iliac crest	Last rib; transverse process of vertebrae (L1-L4)	Flexes vertebral column laterally; depresses last rib	Lumbar

The three layers of muscle in the anterolateral (side) abdominal walls are arranged as follows: the outermost layer, or **external oblique;** a middle layer, or **internal oblique;** and the innermost layer, or **transversus abdominis.** In addition to these sheetlike muscles, the band-shaped (or strap-shaped) **rectus abdominis** muscle runs down the midline of the abdomen from the thorax to the pubis. In addition to protecting the abdominal viscera, the rectus abdominis flexes the spinal column.

MUSCLES OF THE BACK

Considering the large number of us that suffer from back pain, strain, and injury either occasionally or chronically, you can imagine the importance of the back muscles to health and fitness. The superficial back muscles play a major role in moving the head and limbs, and so are listed elsewhere in this chapter. For now, we will concentrate on the deep muscles of the back. These deep back muscles not only allow us to move our vertebral column, helping us to bend this way and that, but also stabilize our trunk so that we can maintain a stable posture. These muscles really get a workout when we lift something heavy because they have to hold the body straight while the load is trying to bend the back.

The **erector spinae** group consists of a number of long, thin muscles that travel all the way down our backs (Figure 10-11). These muscles extend (straighten or pull back) the vertebral column and also flex the back laterally and rotate it a little. Even deeper than the erector spinae muscles are several additional back muscles. The **interspinales** and **multifides groups**, for example, each connect one vertebra to the next—also helping to extend the back and neck or flex them to the side. Table 10-7 and Figure 10-11 summarize some of the important deep back muscles.

MUSCLES OF THE PELVIC FLOOR

Structures in the pelvic cavity are supported by a reinforced muscular floor that guards the outlet below. The muscular pelvic floor filling the diamond-shaped outlet is called the

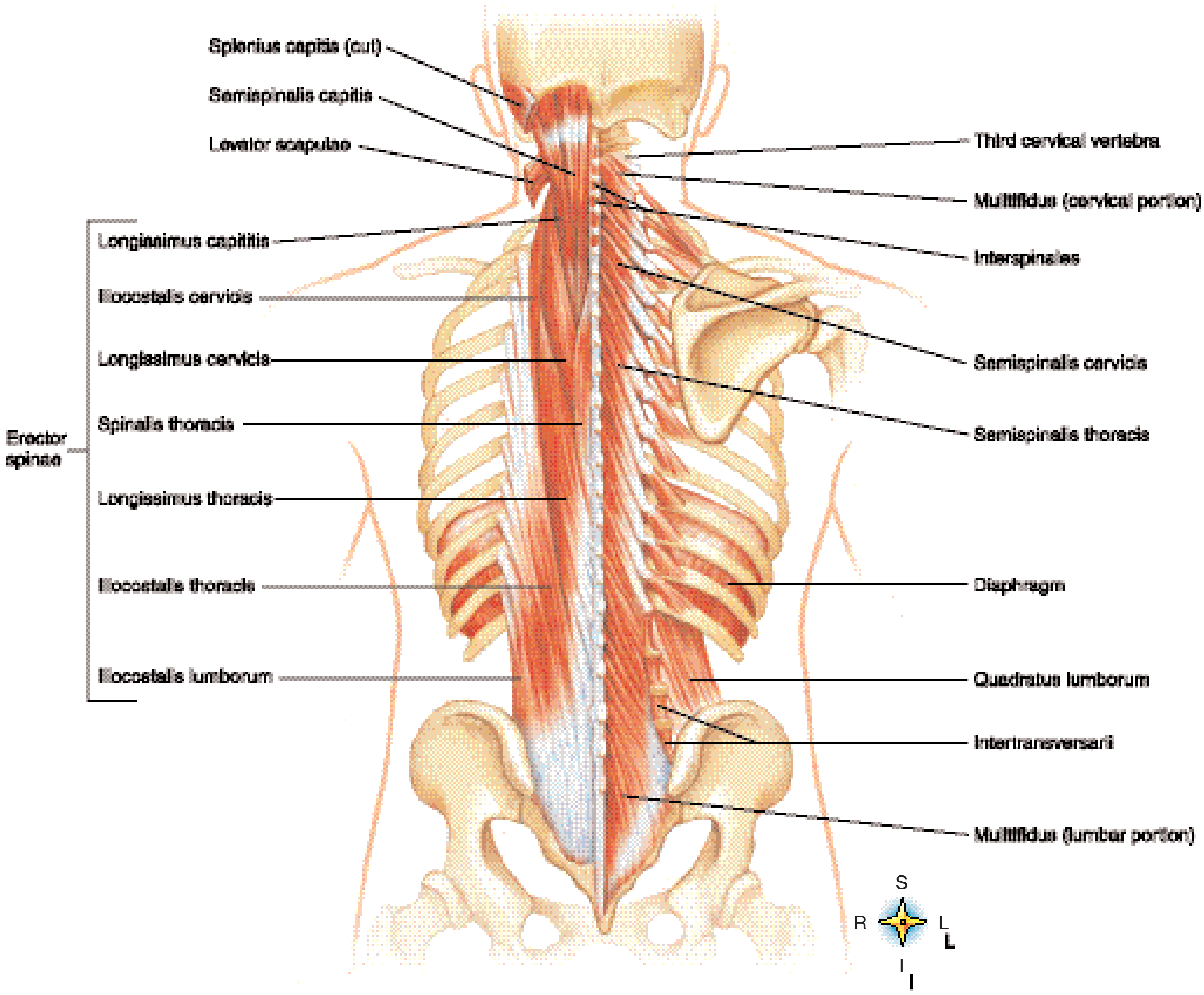


Figure 10-11 **Muscles of the back.** Posterior view showing the deeper muscles of the back.

Table 10-7 Muscles of the Back

Muscle	Origin	Insertion	Function	Nerve Supply
Erector spinae group				
Iliocostalis group	Various regions of the pelvis and ribs	Ribs and vertebra (superior to origin)	Extends, laterally flexes vertebral column	Spinal, thoracic, or lumbar nerves
Longissimus group	Cervical and thoracic vertebrae, ribs	Mastoid process, upper cervical vertebrae, or upper lumbar vertebrae	Extends head, neck, or vertebral column	Cervical, or thoracic and lumber nerves
Spinalis group	Lower cervical or lower thoracic/upper lumbar vertebrae	Upper cervical or middle/upper thoracic vertebrae (superior to origin)	Extends neck or vertebral column	Cervical or thoracic nerves
Transversospinales group				
Semispinalis group	Transverse processes of vertebrae (T2-T11)	Spinous processes of vertebrae (C2-T4)	Extends neck or vertebral column	Cervical or thoracic nerves
Multifidus group	Transverse processes of vertebrae; sacrum and ilium	Spinous processes of (next superior) vertebrae	Extends, rotates vertebral column	Spinal nerves
Rotatores group	Transverse processes of vertebrae	Spinous processes of (next superior) vertebrae	Extends, rotates vertebral column	Spinal nerves
Splenius	Spinous processes of vertebrae (C7-T1 or T3-T6)	Lateral occipital/mastoid or transverse processes of vertebrae (C1-C4)	Rotates, extends neck and flexes neck laterally	Cervical nerves
Interspinales group	Spinous processes of vertebrae	Spinous processes (of next superior vertebra)	Extends back and neck	Spinal nerves

Table 10-8 Muscles of the Pelvic Floor

Muscle	Origin	Insertion	Function	Nerve Supply
Levator ani	Pubis and spine of ischium	Coccyx	Together with coccygeus muscles form floor of pelvic cavity and support pelvic organs	Pudendal nerve
Ischiocavernosus	Ischium	Penis or clitoris	Compress base of penis or clitoris	Perineal nerve
Bulbospongiosus				
Male	Bulb of penis	Perineum and bulb of penis	Constricts urethra and erects penis	Pudendal nerve
Female	Perineum	Base of clitoris	Erects clitoris	Pudendal nerve
Deep transverse perinei	Ischium	Central tendon (median raphe)	Support pelvic floor	Pudendal nerve
Sphincter urethrae	Pubic ramus	Central tendon (median raphe)	Constrict urethra	Pudendal nerve
Sphincter externus anii	Coccyx	Central tendon (median raphe)	Close anal canal	Pudendal and S4

perineum (per-i-NE-um). Passing through the floor are the anal canal and urethra in both sexes and the vagina in the female.

The two **levator ani** and **coccygeus** muscles form most of the pelvic floor. They stretch across the pelvic cavity like a hammock. This diamond-shaped outlet can be divided into two triangles by a line drawn from side to side between the ischial tuberosities. The **urogenital triangle** is anterior (above) to this line, extending to the symphysis pubis, and the **anal triangle** is posterior (behind it), ending at the coccyx. Note in Figure 10-12 that structures in the urogenital triangle include the **ischiocavernosus** and **bulbospongiosus** muscles associated with the penis in the male or vagina in the female. Constriction of muscles called **sphincter urethrae,** which encircle the urethra in both sexes, helps control urine flow. The anal triangle allows passage of the anal canal. The terminal portion of the canal is surrounded by the **external anal sphincter,** which regulates defecation. The origin, insertion, function, and innervation of important muscles of the pelvic floor are listed in Table 10-8. The coc-

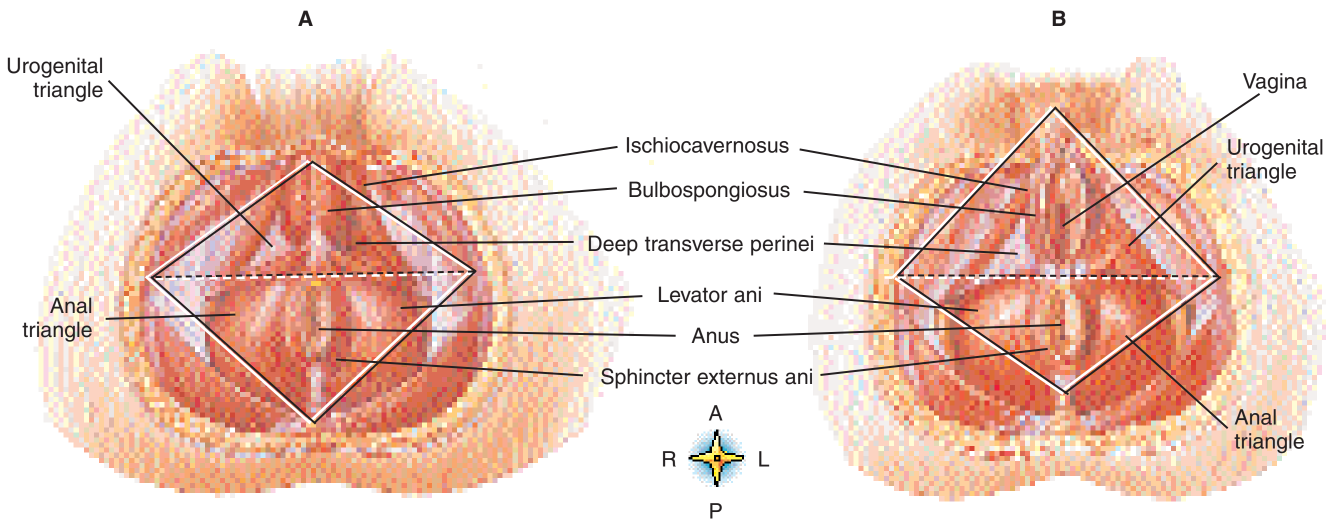


Figure 10-12 **Muscles of the pelvic floor.** **A**, Male, inferior view. **B**, Female, inferior view.

Table 10-9 Muscles Acting on the Shoulder Girdle

Muscle	Origin	Insertion	Function	Nerve Supply
Trapezius	Occipital bone (protuberance)	Clavicle	Raises or lowers shoulders and shrugs them	Spinal accessory; second, third, and fourth cervical nerves
	Vertebrae (cervical and thoracic)	Scapula (spine and acromion)	Extends head when occiput acts as insertion	
Pectoralis minor	Ribs (second to fifth)	Scapula (coracoid)	Pulls shoulder down and forward	Medial and lateral anterior thoracic nerves
Serratus anterior	Ribs (upper eight or nine)	Scapula (anterior surface, vertebral border)	Pulls shoulder down and forward; abducts and rotates it upward	Long thoracic nerve
Levator scapulae	C1-C4 (transverse processes)	Scapula (superior angle)	Elevates and retracts scapula and abducts neck	Dorsal scapular nerve
Rhomboid				
Major	T1-T4	Scapula (medial border)	Retracts, rotates, fixes scapula	Dorsal scapular nerve
Minor	C6-C7	Scapula (medial border)	Retracts, rotates, elevates, and fixes scapula	Dorsal scapular nerve

cygeus muscles lie behind the levator ani and are not visible in Figure 10-12.

1. Name the skeletal muscles that produce respiratory movements.
2. Name two functions of the rectus abdominis muscle.
3. What is the perineum?

UPPER LIMB MUSCLES

The muscles of the upper limb include those acting on the shoulder or pectoral girdle and muscles located in the arm, forearm, and hand.

MUSCLES ACTING ON THE SHOULDER GIRDLE

Attachment of the upper extremity to the torso is by muscles that have an anterior location (chest) or posterior placement (back and neck). Six muscles (Table 10-9 and Figure 10-13) that pass from the axial skeleton to the shoulder or pectoral girdle (scapula and clavicle) serve not only to "attach" the upper extremity to the body but do so in such a way that extensive movement is possible. The clavicle can be elevated and depressed and moved forward and back. The scapula is capable of even a greater variety of movements.

The **pectoralis** (pek-to-RAL-is) **minor** lies under the larger pectoralis major muscle on the anterior chest wall. It helps "fix" the scapula against the thorax and also raises the ribs during forced inspiration. Another anterior chest wall muscle—the **serratus** (ser-RAY-tus) **anterior**—helps hold the scapula against the thorax to prevent "winging" and is a strong abductor that is useful in pushing or punching movements.

The posterior muscles acting on the shoulder girdle include the **levator scapulae** (le-VAY-tor SCAP-yoo-le), which

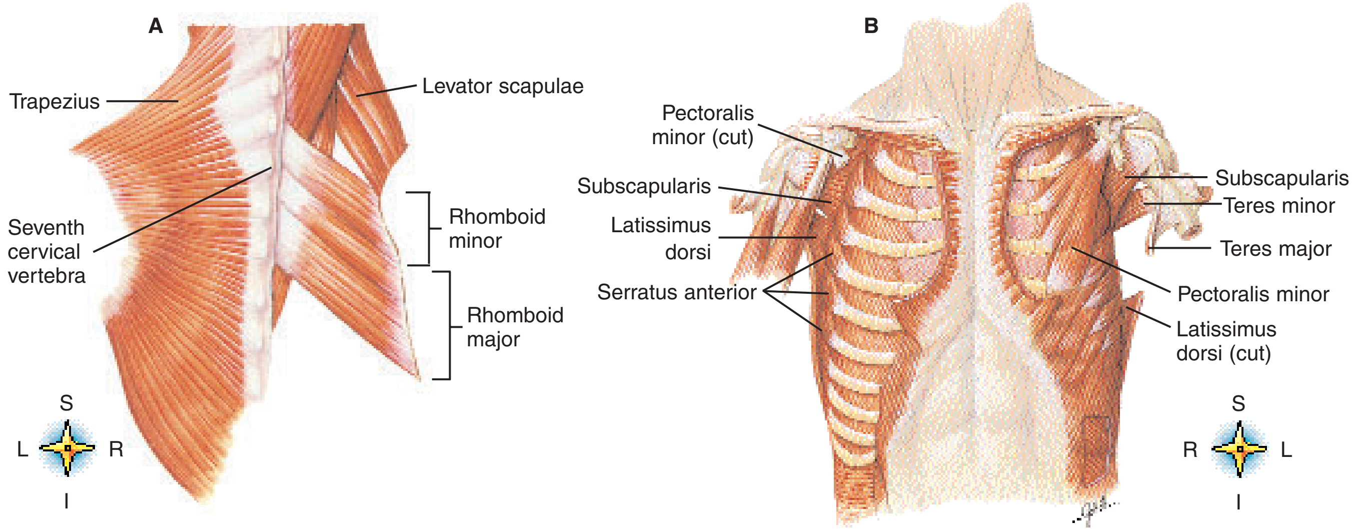


Figure 10-13 **Muscles acting on the shoulder girdle.** **A**, Posterior view. Trapezius has been removed on the right to reveal the deeper muscles. **B**, Anterior view. Pectoralis major has been removed on both sides. The pectoralis minor also has been removed on the right side.

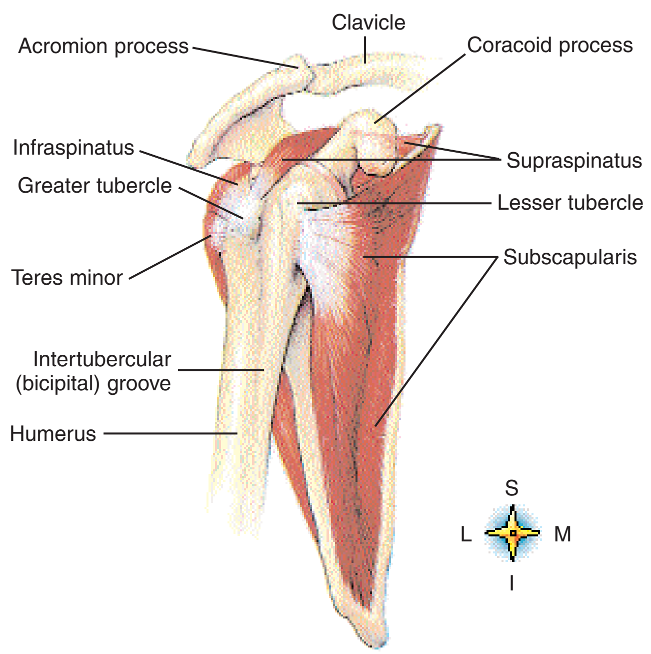


Figure 10-14 **Rotator cuff muscles.** Note the tendons of the teres minor, infraspinatus, supraspinatus, and subscapularis muscles surrounding the head of the humerus.

elevates the scapula; the **trapezius** (trah-PEE-zee-us), which is used to "shrug" the shoulders; and the **rhomboideus** (rom-BOID-ee-us) **major** and **minor** muscles, which serve to adduct and elevate the scapula.

MUSCLES THAT MOVE THE UPPER ARM

The shoulder is a synovial joint of the ball-and-socket type. As a result, extensive movement is possible in every plane of motion. Muscles that move the upper arm can be grouped according to function as flexors, extensors, abductors, adductors, and medial and lateral rotators (Table 10-10; Figure 10-15). The actions listed in Table 10-10 include primary actions and important secondary functions.

The **deltoid** (DEL-toid) is a good example of a multifunction muscle. It has three groups of fibers and may act as three separate muscles. Contraction of anterior fibers will flex the

Box 10-2 SPORTS AND FITNESS

Shoulder Joint Stability

The disparity in size between the large and nearly hemispheric head of the humerus and the much smaller and shallow glenoid cavity of the scapula is of great clinical significance. Because the head of the humerus is more than two times larger than the shallow glenoid concavity that receives it, only about one quarter of the articular surface of the humeral head is in contact with the fossa in any given position of the joint. This anatomical fact helps explain the inherent instability of the shoulder—our most mobile joint. The soft tissues surrounding the shoulder, such as the joint capsule, ligaments, and adjacent muscles, provide the primary restraint against excessive motion and potential dislocation.

Unfortunately, only a thin articular capsule surrounds the shoulder joint. It is extremely loose and does not function to keep the articulating bones of the joint in contact. This fact is obviously correlated with both the great range of motion (ROM) possible at this articulation and its tendency to dislocate as a result of athletic injury or other trauma. The tendons of the supraspinatus, infraspinatus, teres minor, and subscapularis muscles (called the **SITS** muscles) all blend with and strengthen the articular capsule. The musculotendinous cuff resulting from this fusion is called the **rotator cuff** (Figure 10-14). The rotator cuff provides the necessary strength to help prevent anterior, superior, and posterior displacement of the humeral head during most types of activity.

Table 10-10 Muscles That Move the Upper Arm

Muscle	Origin	Insertion	Function	Nerve Supply
Axial*				
Pectoralis major	Clavicle (medial half) Sternum Costal cartilages of true ribs	Humerus (greater tubercle)	Flexes upper arm Adducts upper arm anteriorly; draws it across chest	Medial and lateral anterior thoracic nerves
Latissimus dorsi	Vertebrae (spines of lower thoracic, lumbar, and sacral) Ilium (crest) Lumbodorsal fascia	Humerus (intertubercular groove)	Extends upper arm Adducts upper arm posteriorly	Thoracodorsal nerve
Scapular*				
Deltoid	Clavicle Scapula (spine and acromion)	Humerus (lateral side about half-way down—deltoid tubercle)	Abducts upper arm Assists in flexion and extension of upper arm	Axillary nerve
Coracobrachialis	Scapula (coracoid process)	Humerus (middle third, medial surface)	Adduction; assists in flexion and medial rotation of arm	Musculocutaneous nerve
Supraspinatus†	Scapula (supraspinous fossa)	Humerus (greater tubercle)	Assists in abducting arm	Suprascapular nerve
Teres minor†	Scapula (axillary border)	Humerus (greater tubercle)	Rotates arm outward	Axillary nerve
Teres major	Scapula (lower part, axillary border)	Humerus (upper part, anterior surface)	Assists in extension, adduction, and medial rotation of arm	Lower subscapular nerve
Infraspinatus†	Scapula (infraspinatus border)	Humerus (greater tubercle)	Rotates arm outward	Suprascapular nerve
Subscapularis†	Scapula (subscapular fossa)	Humerus (lesser tubercle)	Medial rotation	Suprascapular nerve

**Axial* muscles originate on the axial skeleton.
Scapular muscles originate on the scapula.
†Muscles of the rotator cuff.

arm whereas lateral fibers abduct and posterior fibers serve as extensors. Four other muscles serve as both a structural and functional cap or cuff around the shoulder joint and are referred to as the **rotator cuff muscles** (Figure 10-14). They include the **infraspinatus, supraspinatus, subscapularis,** and **teres minor.**

MUSCLES THAT MOVE THE FOREARM

Selected superficial and deep muscles of the upper extremity are shown in Figure 10-16. Recall that most muscles acting on a joint lie proximal to that joint. Muscles acting directly on the forearm, therefore, are found proximal to the elbow and attach the bones of the forearm (ulna and radius) to the humerus or scapula above. Table 10-11 lists the muscles acting on the lower arm, giving the origin, insertion, function, and innervation of each. Figure 10-17 shows the detail of attachment of several important muscles in this group.

MUSCLES THAT MOVE THE WRIST, HAND, AND FINGERS

Muscles that move the wrist, hand, and fingers can be **extrinsic muscles** or **intrinsic muscles.** The term *extrinsic* means *from the outside* and refers to muscles originating outside of the part of the skeleton moved. Extrinsic muscles originating in the forearm can pull on their insertions in the wrist, hand, and fingers to move them. The term *intrinsic*, meaning *from within,* refers to muscles that are actually within the part moved. Muscles that begin and end at different points within the hand can produce fine finger movements, for example.

Extrinsic muscles acting on the wrist, hand, and fingers are located on the anterior or the posterior surfaces of the forearm (Figure 10-18). In most instances the muscles located on the anterior surface of the forearm are flexors, and those on the posterior surface are extensors of the wrist, hand, and fingers (Table 10-12).

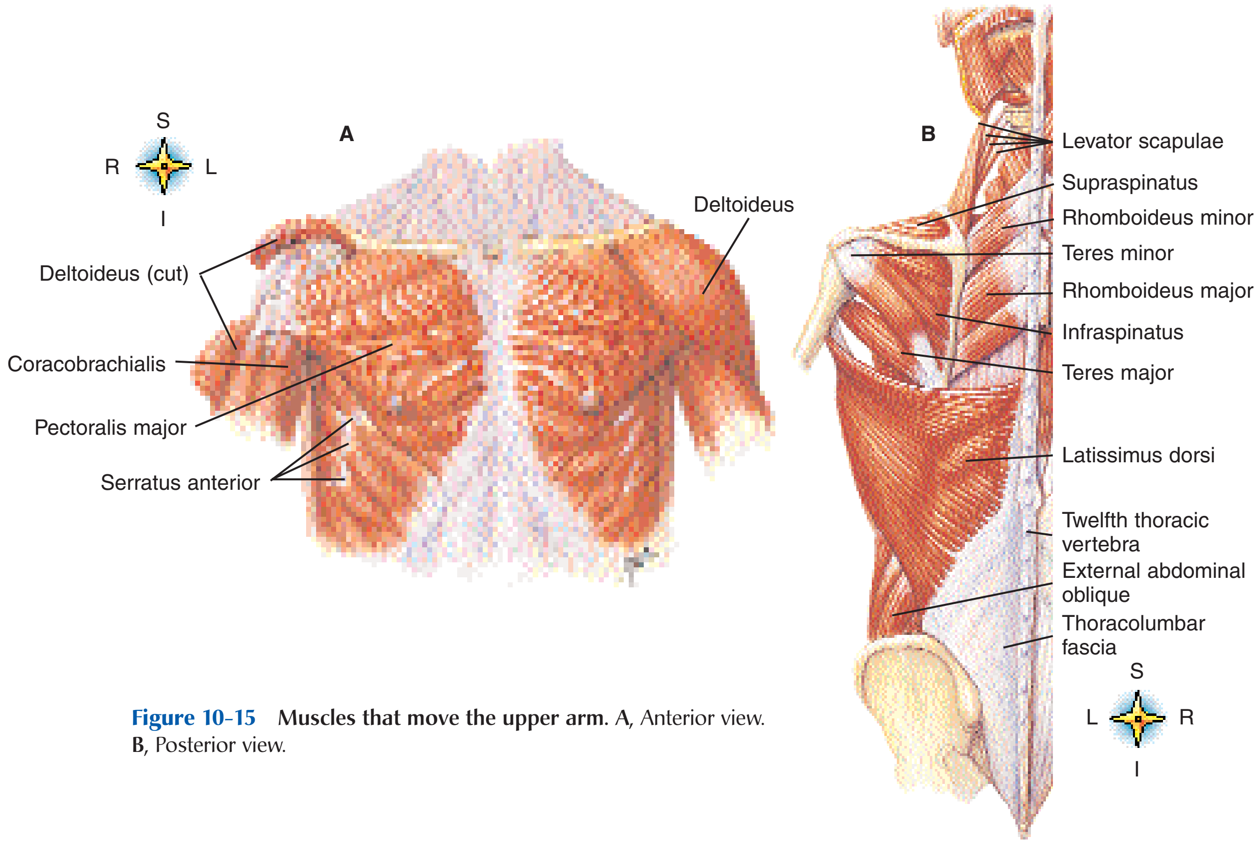


Figure 10-15 **Muscles that move the upper arm.** **A**, Anterior view. **B**, Posterior view.

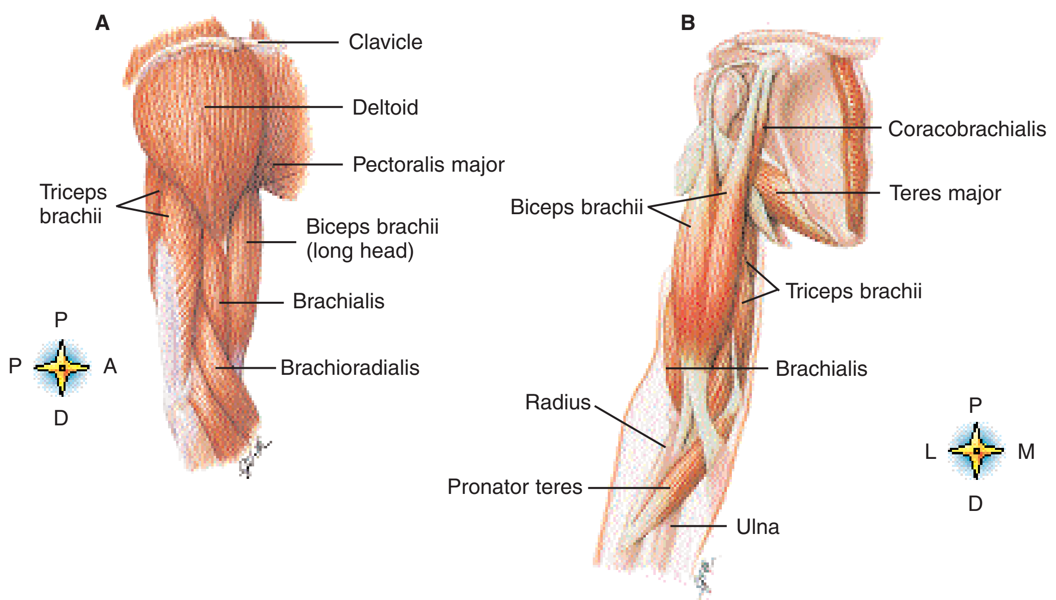


Figure 10-16 **Muscles acting on the forearm.** **A**, Lateral view of the right shoulder and arm. **B**, Anterior view of the right shoulder and arm (deep). Deltoid and pectoralis major muscles have been removed to reveal deeper structures.

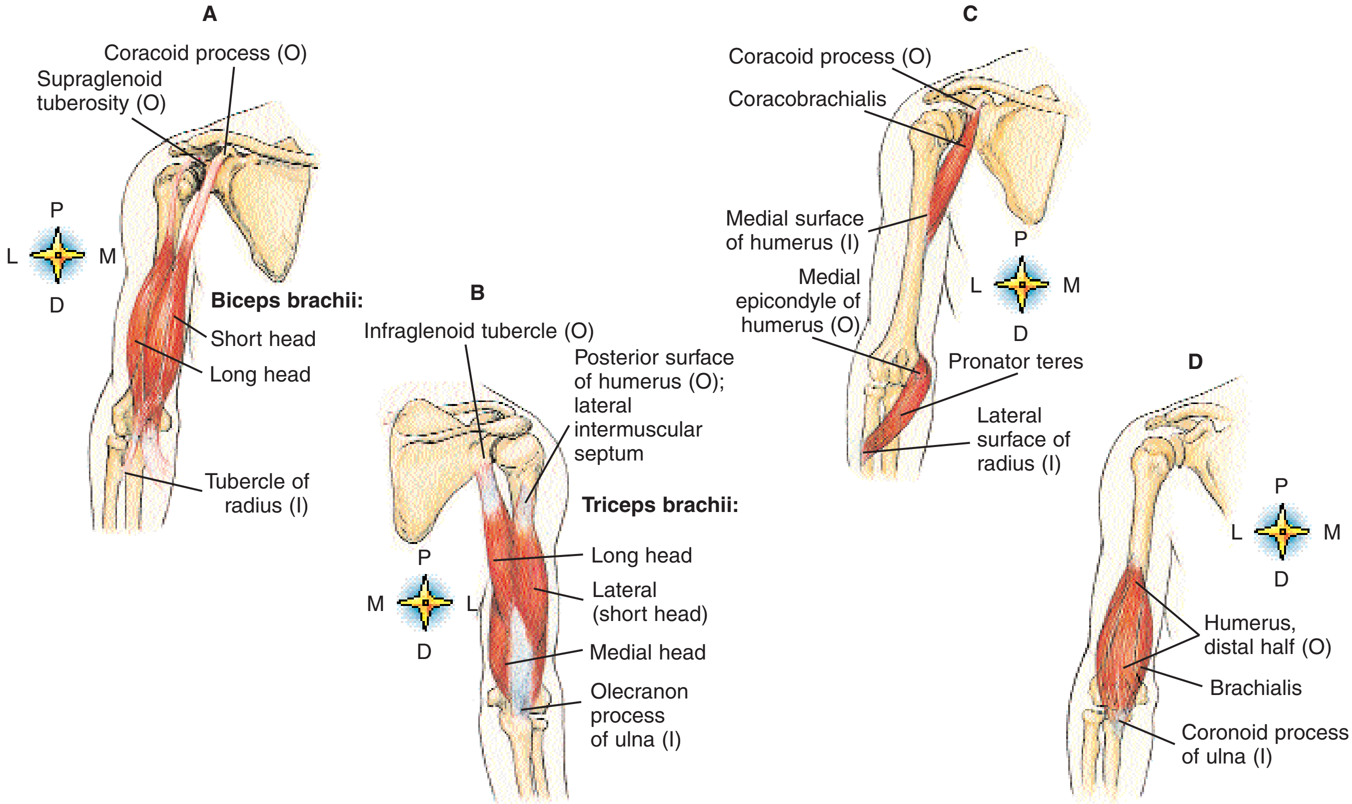


Figure 10-17 **Muscles acting on the forearm.** **A,** Biceps brachii. **B,** Triceps brachii. **C,** Coracobrachialis and pronator teres. **D,** Brachialis. *O,* Origin; *I,* insertion.

Table 10-11 Muscles That Move the Forearm

Muscle	Origin	Insertion	Function	Nerve Supply
Flexors				
Biceps brachii	Scapula (supraglenoid tuberosity)	Radius (tubercle at proximal end)	Flexes supinated forearm	Musculocutaneous nerve
	Scapula (coracoid)		Supinates forearm and hand	
Brachialis	Humerus (distal half, anterior surface)	Ulna (front of coronoid process)	Flexes pronated forearm	Musculocutaneous nerve
Brachioradialis	Humerus (above lateral epicondyle)	Radius (styloid process)	Flexes semipronated or semisupinated forearm; supinates forearm and hand	Radial nerve
Extensor				
Triceps brachii	Scapula (infraglenoid tuberosity) Humerus (posterior surface—lateral head above radial groove; medial head, below)	Ulna (olecranon process)	Extends lower arm	Radial nerve
Pronators				
Pronator teres	Humerus (medial epicondyle) Ulna (coronoid process)	Radius (middle third of lateral surface)	Pronates and flexes forearm	Median nerve
Pronator quadratus	Ulna (distal fourth, anterior surface)	Radius (distal fourth, anterior surface)	Pronates forearm	Median nerve
Supinator				
Supinator	Humerus (lateral epicondyle) Ulna (proximal fifth)	Radius (proximal third)	Supinates forearm	Radial nerve

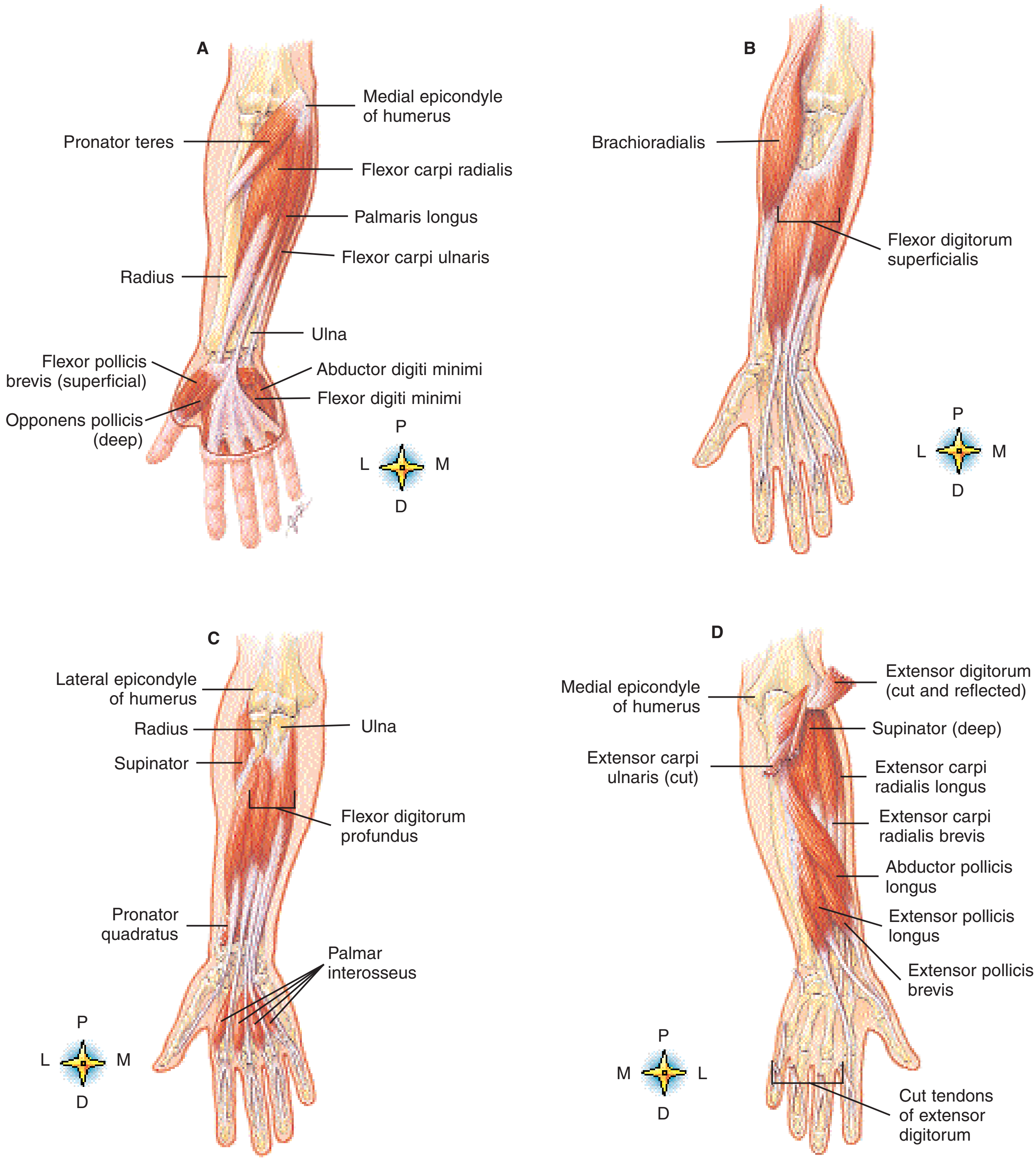


Figure 10-18 **Muscles of the forearm. A,** Anterior view shows right forearm (superficial). Brachioradialis muscle has been removed. **B,** Anterior view shows right forearm (deeper than *A*). Pronator teres, flexor carpi radialis and ulnaris, and palmaris longus muscles have been removed. **C,** Anterior view shows right forearm (deeper than *A* or *B*). Brachioradialis, pronator teres, flexor carpi radialis and ulnaris, palmaris longus, and flexor digitorum superficialis muscles have been removed. **D,** Posterior view shows deep muscles of the right forearm. Extensor digitorum, extensor digiti minimi, and extensor carpi ulnaris muscles have been cut to reveal deeper muscles.

A number of intrinsic muscles are responsible for precise movements of the hand and fingers. Examples include the **lumbrical** (LUM-bri-kal) and **interosseous** (in-ter-OS-ee-us) muscles, which originate from and fill the spaces between the metacarpal bones and then insert on the phalanges of the fingers. As a group, the intrinsic muscles abduct and adduct the fingers and aid in flexing them. Eight additional muscles serve the thumb, enabling it to be placed in opposition to the fingers in tasks requiring grasping and manipulation. The **opponens pollicis** (o-PO-nenz POL-i-cis) is a particularly im-

Table 10-12 Muscles That Move the Wrist, Hand, and Fingers

Muscle	Origin	Insertion	Function	Nerve Supply
Extrinsic				
Flexor carpi radialis	Humerus (medial epicondyle)	Second metacarpal (base of)	Flexes hand Flexes forearm	Median nerve
Palmaris longus	Humerus (medial epicondyle)	Fascia of palm	Flexes hand	Median nerve
Flexor carpi ulnaris	Humerus (medial epicondyle) Ulna (proximal two thirds)	Pisiform bone Third, fourth, and fifth metacarpals	Flexes hand Adducts hand	Ulnar nerve
Extensor carpi radialis longus	Humerus (ridge above lateral epicondyle)	Second metacarpal (base of)	Extends hand Abducts hand (moves toward thumb side when hand supinated)	Radial nerve
Extensor carpi radialis brevis	Humerus (lateral epicondyle)	Second, third metacarpals (bases of)	Extends hand	Radial nerve
Extensor carpi ulnaris	Humerus (lateral epicondyle) Ulna (proximal three fourths)	Fifth metacarpal (base of)	Extends hand Adducts hand (moves toward little finger side when hand supinated)	Radial nerve
Flexor digitorum profundus	Ulna (anterior surface)	Distal phalanges (fingers 2 to 5)	Flexes distal interphalangeal joints	Median and ulnar nerves
Flexor digitorum superficialis	Humerus (medial epicondyle) Radius Ulna (coronoid process)	Tendons of fingers	Flexes fingers	Median nerve
Extensor digitorum	Humerus (lateral epicondyle)	Phalanges (fingers 2 to 5)	Extends fingers	Radial nerve
Intrinsic				
Opponens pollicis	Trapezium	Thumb metacarpal	Opposes thumb to fingers	Median nerve
Abductor pollicis brevis	Trapezium	Proximal phalanx of thumb	Abducts thumb	Median nerve
Adductor pollicis	Second and third metacarpals Trapezoid Capitate	Proximal phalanx of thumb	Adducts thumb	Ulnar nerve
Flexor pollicis brevis	Flexor retinaculum	Proximal phalanx of thumb	Flexes thumb	Median and ulnar nerves
Abductor digiti minimi	Pisiform	Proximal phalanx of fifth finger (base of)	Abducts fifth finger Flexes fifth finger	Ulnar nerve
Flexor digiti minimi brevis	Hamate	Proximal and middle phalanx of fifth finger	Flexes fifth finger	Ulnar nerve
Opponens digiti minimi	Hamate Flexor retinaculum	Fifth metacarpal	Opposes fifth finger slightly	Ulnar nerve
Interosseous (palmar and dorsal)	Metacarpals	Proximal phalanges	Adducts second, fourth, fifth fingers (palmar) Abducts second, third, fourth fingers (dorsal)	Ulnar nerve
Lumbricales	Tendons of flexor digitorum profundus	Phalanges (2 to 5)	Flexes proximal phalanges (2 to 5) Extends middle and distal phalanges (2 to 5)	Median nerve (phalanges 2 and 3) Ulnar nerve (phalanges 4 and 5)

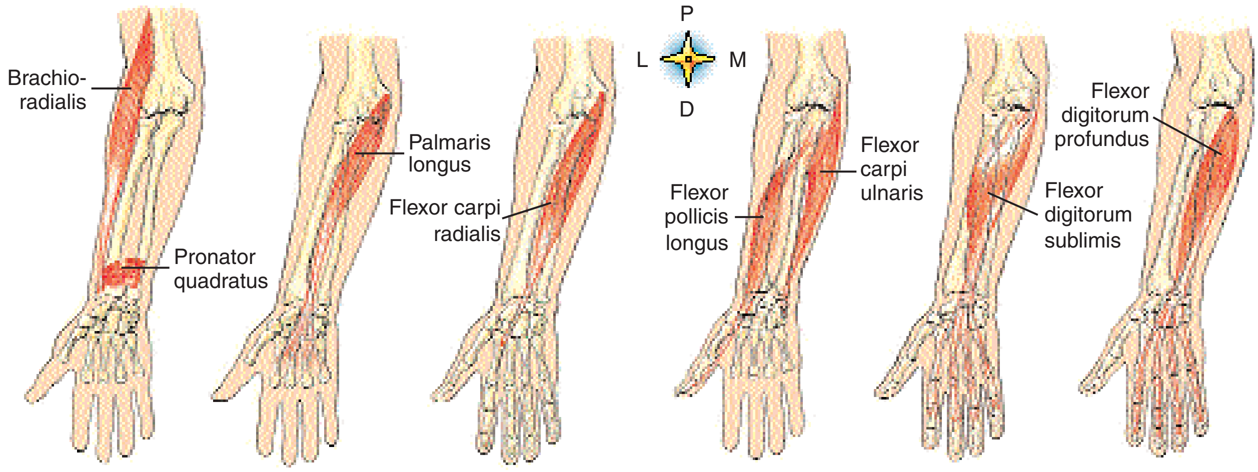


Figure 10-19 **Some muscles of the anterior aspect of the right forearm.**

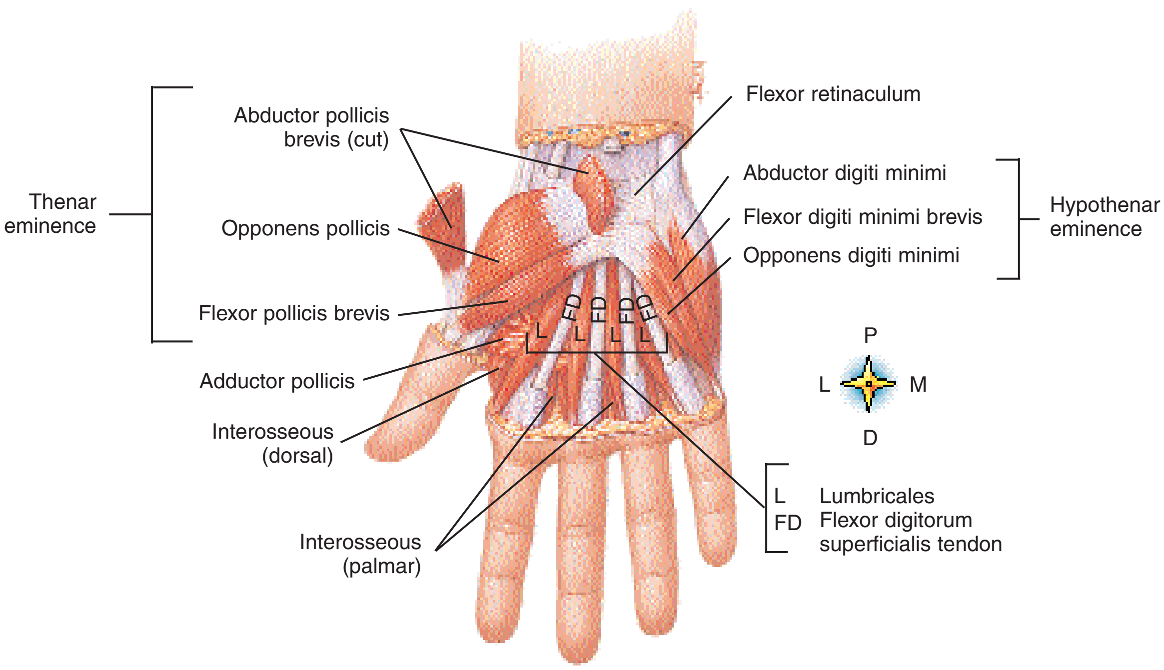


Figure 10-20 **Intrinsic muscles of the hand.** Anterior (palmar) view.

portant thumb muscle. It allows the thumb to be drawn across the palm to touch the tip of any finger—a critical movement for many manipulative-type activities. Figure 10-19 shows the placement and points of attachment for various individual extrinsic muscles acting on the wrist, hand, and fingers. Figure 10-20 shows a detailed illustration of many of the intrinsic muscles of the hand.

> 1. What are the functions of the deltoid muscle?
> 2. What is the function of the biceps brachii muscle?
> 3. Distinguish extrinsic from intrinsic muscles of the hand and wrist.

LOWER LIMB MUSCLES

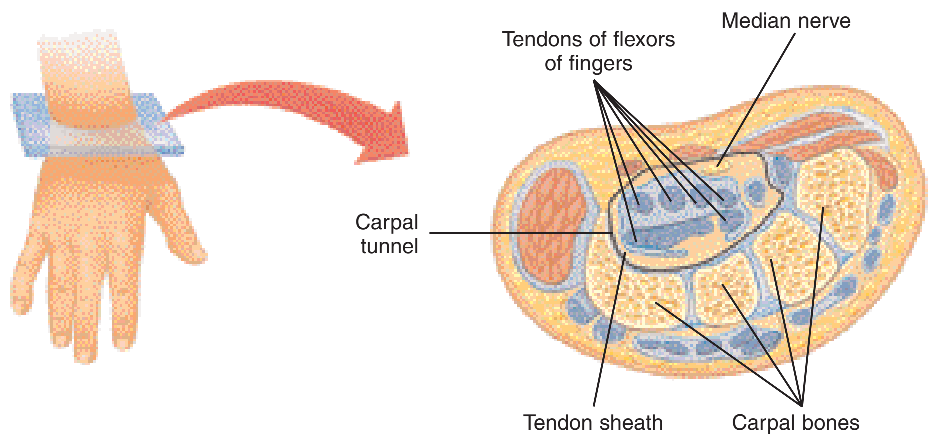
The musculature, bony structure, and joints of the pelvic girdle and lower extremity function in locomotion and maintenance of stability. Powerful muscles at the back of the hip, at the front of the thigh, and at the back of the leg also serve to raise the full body weight from a sitting to a standing position. The muscles of the lower limb include those acting on the hip or pelvic girdle, as well as muscles located in the thigh, leg, and foot. Unlike the highly mobile shoulder girdle, the pelvic girdle is essentially fixed. Therefore our study of muscles in the lower extremity begins with those arising from the pelvic girdle and passing to the femur, producing their effects at the hip joint by moving the thigh.

Box 10-3 HEALTH MATTERS

Carpal Tunnel Syndrome

Some epidemiologists specialize in the field of occupational health, the study of health matters related to work or the workplace. Many problems seen by occupational health experts are caused by repetitive motions of the wrists or other joints. Word processors (typists) and meat cutters, for example, are at risk of developing conditions caused by repetitive motion injuries.

One common problem often caused by such repetitive motion is **tenosynovitis** (ten-o-sin-o-VYE-tis)— inflammation of a tendon sheath. Tenosynovitis can be painful, and the swelling characteristic of this condition can limit movement in affected parts of the body. For example, swelling of the tendon sheath around tendons in an area of the wrist known as the *carpal tunnel* can limit movement of the wrist, hand, and fingers. The figure shows the relative positions of the tendon sheath and median nerve within the carpal tunnel. If this swelling, or any other lesion in the carpal tunnel, presses on the *median nerve,* a condition called **carpal tunnel syndrome** may result. Because the median nerve connects to the palm and radial side (thumb side) of the hand, carpal tunnel syndrome is characterized by weakness, pain, and tingling in this part of the hand. The pain and tingling may also radiate to the forearm and shoulder. Prolonged or severe cases of carpal tunnel syndrome may be relieved by injection of antiinflammatory agents. A permanent cure is sometimes accomplished by surgical cutting or removal of the swollen tissue pressing on the median nerve.



The carpal tunnel. The median nerve and muscles that flex the fingers pass through a concavity in the wrist called the carpal tunnel.

MUSCLES THAT MOVE THE THIGH AND LOWER LEG

Table 10-13 identifies muscles that move the thigh and lists the origin, insertion, function, and nerve supply of each (Figure 10-21). Refer to Figures 10-1 and 10-2 and Figures 10-21 through 10-24, which show individual muscles, as you study the information provided in the table. Muscles acting on the thigh can be divided into three groups: (1) muscles crossing the front of the hip, (2) the three **gluteal** (GLOO-tee-al) muscles and the **tensor fasciae latae** (TEN-sor FASH-ee LAT-tee), and (3) the thigh adductors.

Table 10-14 identifies muscles that move the lower leg. Again, see Figures 10-1 and 10-2 and refer to Figures 10-25 and 10-26 as you study the table.

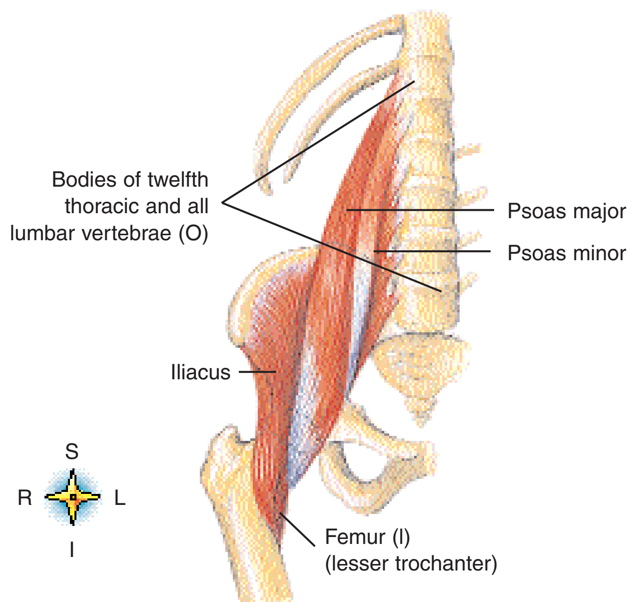


Figure 10-21 **Iliopsoas muscle (iliacus, psoas major, and psoas minor muscles).** *O,* Origin; *I,* insertion.

Table 10-13 Muscles That Move the Thigh

Muscle	Origin	Insertion	Function	Nerve Supply
Iliopsoas (iliacus, psoas major, and psoas minor)	Ilium (iliac fossa) Vertebrae (bodies of twelfth thoracic to fifth lumbar)	Femur (lesser trochanter)	Flexes thigh Flexes trunk (when femur acts as origin)	Femoral and second to fourth lumbar nerves
Rectus femoris	Ilium (anterior, inferior spine)	Tibia (by way of patellar tendon)	Flexes thigh Extends lower leg	Femoral nerve
Gluteal group				
Maximus	Ilium (crest and posterior surface) Sacrum and coccyx (posterior surface) Sacrotuberous ligament	Femur (gluteal tuberosity) Iliotibial tract	Extends thigh—rotates outward	Inferior gluteal nerve
Medius	Ilium (lateral surface)	Femur (greater trochanter)	Abducts thigh—rotates outward; stabilizes pelvis on femur	Superior gluteal nerve
Minimus	Ilium (lateral surface)	Femur (greater trochanter)	Abducts thigh; stabilizes pelvis on femur Rotates thigh medially	Superior gluteal nerve
Tensor fasciae latae	Ilium (anterior part of crest)	Tibia (by way of iliotibial tract)	Abducts thigh Tightens iliotibial tract	Superior gluteal nerve
Adductor group				
Brevis	Pubic bone	Femur (linea aspera)	Adducts thigh	Obturator nerve
Longus	Pubic bone	Femur (linea aspera)	Adducts thigh	Obturator nerve
Magnus	Pubic bone	Femur (linea aspera)	Adducts thigh	Obturator nerve
Gracilis	Pubic bone (just below symphysis)	Tibia (medial surface behind sartorius)	Adducts thigh and flexes and adducts leg	Obturator nerve

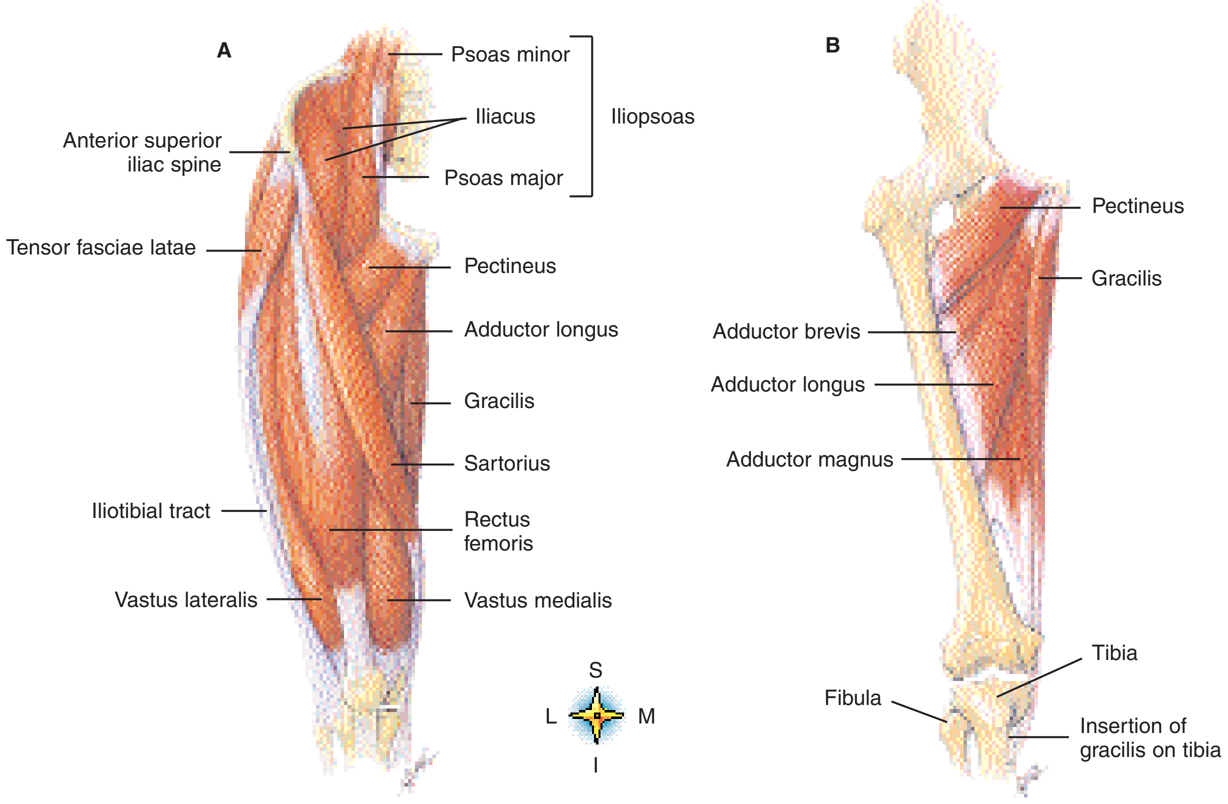


Figure 10-22 **Muscles of the anterior thigh.** **A**, Anterior view of the right thigh. **B**, Adductor region of the right thigh. Tensor fasciae latae, sartorius, and quadriceps muscles have been removed.

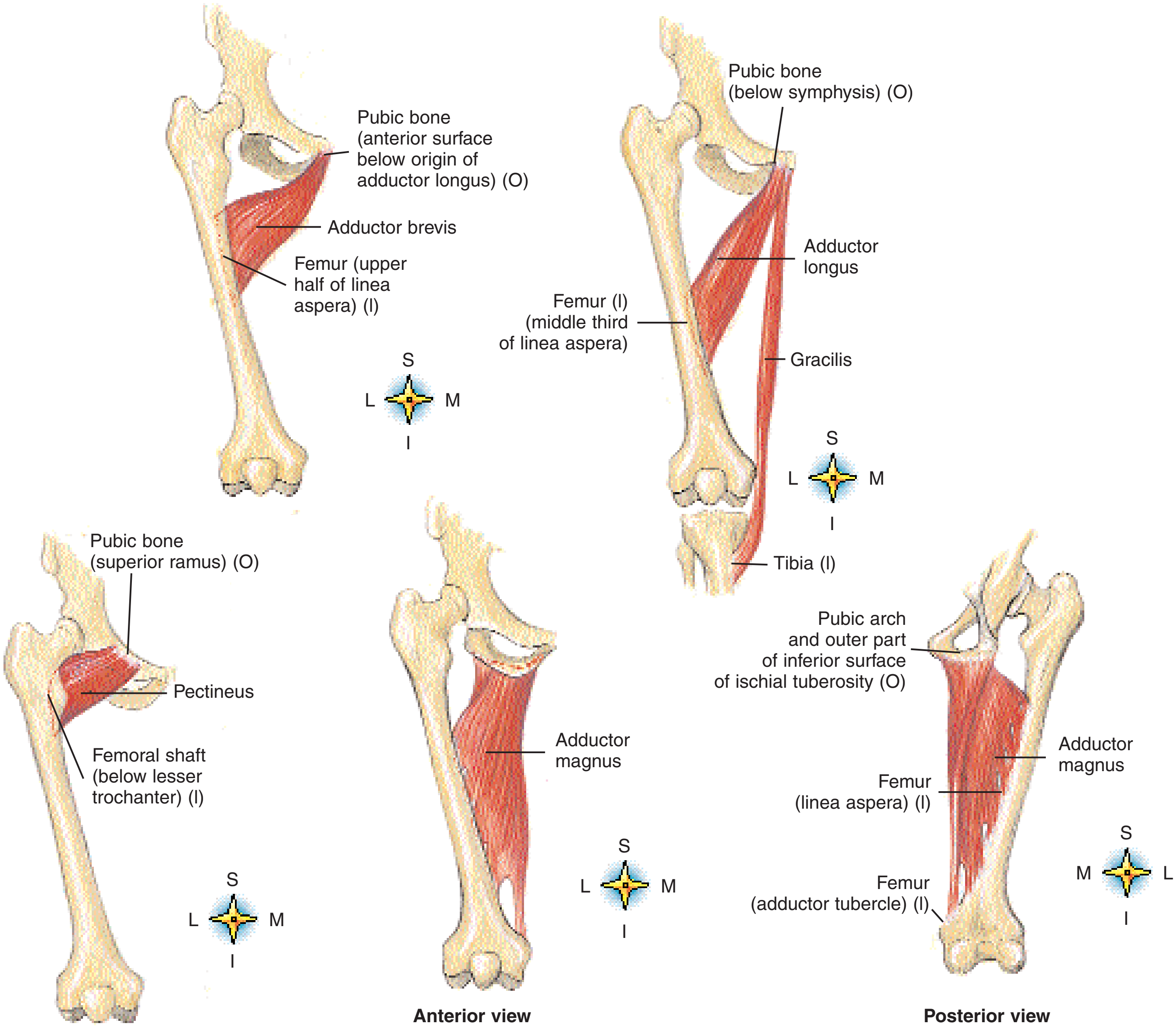


Figure 10-23 **Muscles that adduct the thigh.** *O,* Origin; *I,* insertion.

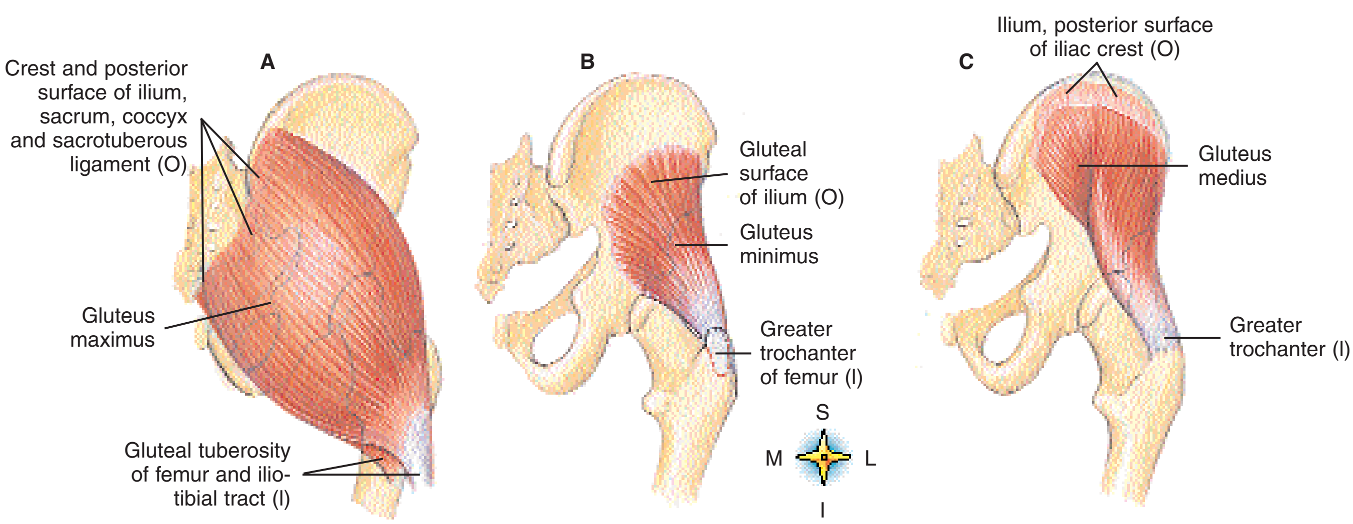


Figure 10-24 **Gluteal muscles. A,** Gluteus maximus. **B,** Gluteus minimus. **C,** Gluteus medius.

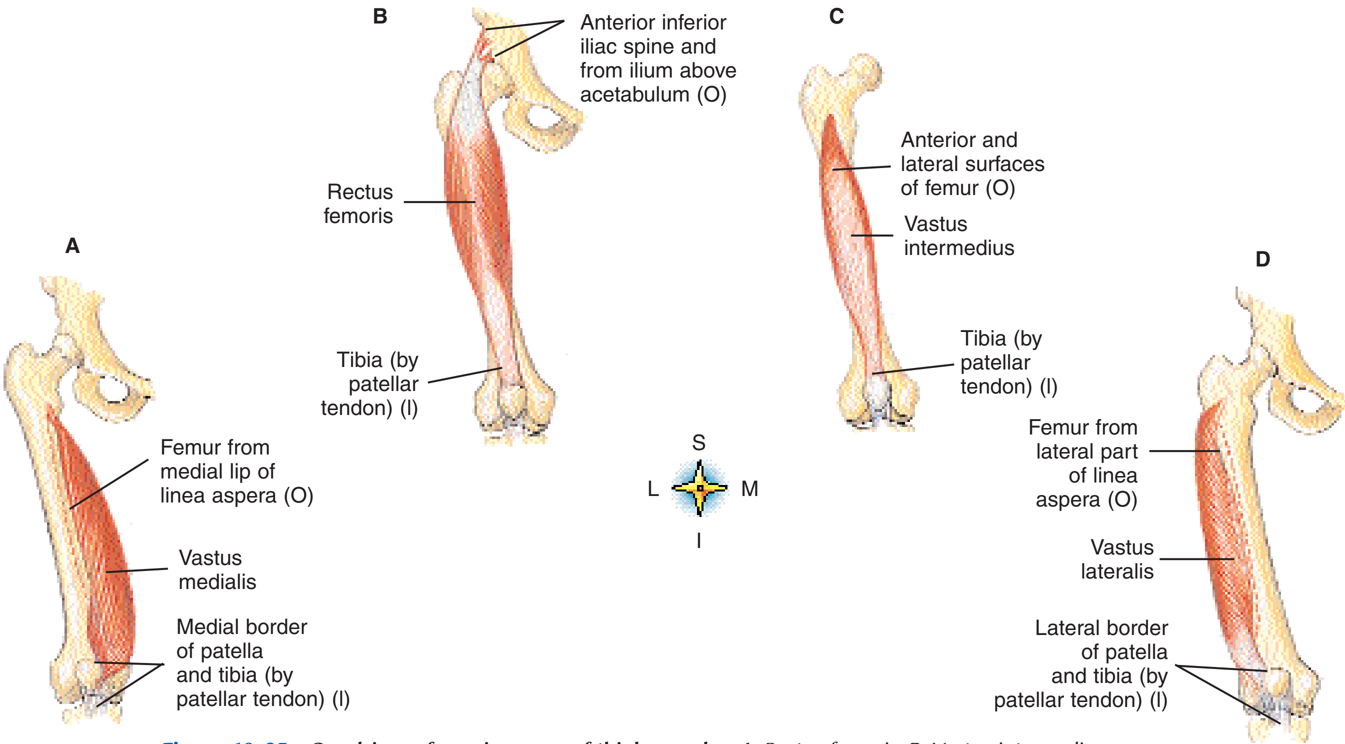


Figure 10-25 **Quadriceps femoris group of thigh muscles.** **A**, Rectus femoris. **B**, Vastus intermedius. **C**, Vastus medialis. **D**, Vastus lateralis. *O*, Origin; *I*, insertion.

Table 10-14 Muscles That Move the Lower Leg

Muscle	Origin	Insertion	Function	Nerve Supply
Quadriceps femoris group				
Rectus femoris	Ilium (anterior inferior spine)	Tibia (by way of patellar tendon)	Flexes thigh Extends leg	Femoral nerve
Vastus lateralis	Femur (linea aspera)	Tibia (by way of patellar tendon)	Extends leg	Femoral nerve
Vastus medialis	Femur	Tibia (by way of patellar tendon)	Extends leg	Femoral nerve
Vastus intermedius	Femur (anterior surface)	Tibia (by way of patellar tendon)	Extends leg	Femoral nerve
Sartorius	Coxal (anterior, superior iliac spines)	Tibia (medial surface of upper end of shaft)	Adducts and flexes leg Permits crossing of legs tailor fashion	Femoral nerve
Hamstring group				
Biceps femoris	Ischium (tuberosity)	Fibula (head of)	Flexes leg	Hamstring nerve (branch of sciatic nerve)
	Femur (linea aspera)	Tibia (lateral condyle)	Extends thigh	Hamstring nerve
Semitendinosus	Ischium (tuberosity)	Tibia (proximal end, medial surface)	Extends thigh	Hamstring nerve
Semimembranosus	Ischium (tuberosity)	Tibia (medial condyle)	Extends thigh	Hamstring nerve

MUSCLES THAT MOVE THE ANKLE AND FOOT

Muscles listed in Table 10-15 and shown in Figure 10-27 are responsible for movements of the ankle and foot. These muscles, called **extrinsic foot muscles,** are located in the leg but exert their actions by pulling on tendons that insert on bones in the ankle and foot. Extrinsic foot muscles are responsible for such movements as dorsiflexion, plantar flexion, inversion, and eversion of the foot. Muscles located within the foot itself are called **intrinsic foot muscles** (Figure 10-28). They are responsible for flexion, extension, abduction, and adduction of the toes.

The extrinsic muscles listed in Table 10-15 may be divided into four functional groups: (1) dorsal flexors, (2) plantar flexors, (3) invertors, and (4) evertors of the foot.

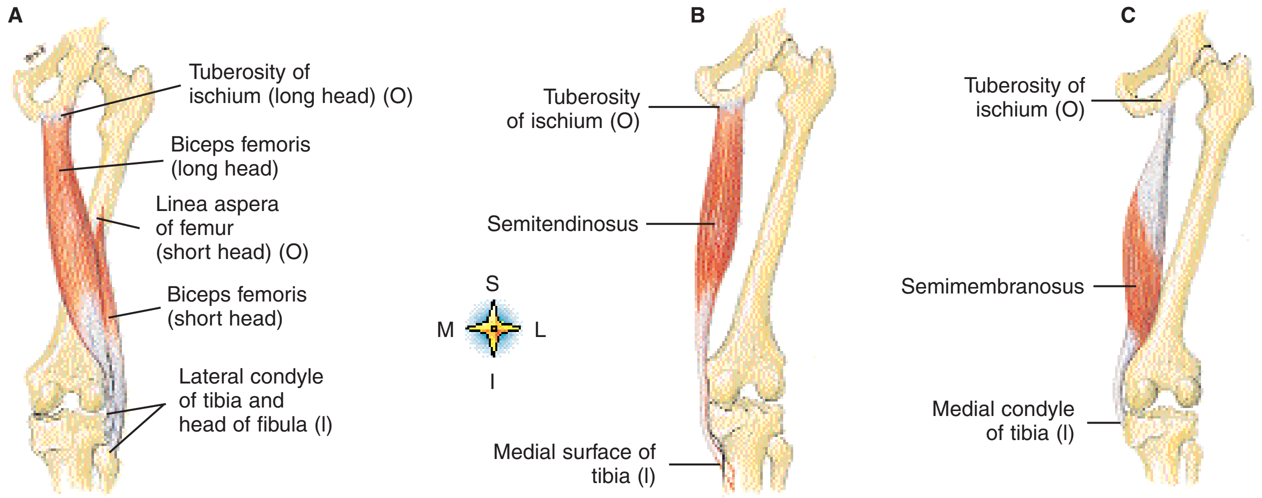


Figure 10-26 **Hamstring group of thigh muscles.** **A**, Biceps femoris. **B**, Semitendinosus. **C**, Semimembranosus. *O*, Origin; *I*, insertion.

Table 10-15 Muscles That Move the Foot

Muscle	Origin	Insertion	Function	Nerve Supply
Extrinsic				
Tibialis anterior	Tibia (lateral condyle of upper body)	Tarsal (first cuneiform) Metatarsal (base of first)	Flexes foot Inverts foot	Common and deep peroneal nerves
Gastrocnemius	Femur (condyles)	Tarsal (calcaneus by way of Achilles tendon)	Extends foot Flexes lower leg	Tibial nerve (branch of sciatic nerve)
Soleus	Tibia (underneath gastrocnemius) Fibula	Tarsal (calcaneus by way of Achilles tendon)	Extends foot (plantar flexion)	Tibial nerve
Peroneus longus	Tibia (lateral condyle) Fibula (head and shaft)	First cuneiform Base of first metatarsal	Extends foot (plantar flexion) Everts foot	Common peroneal nerve
Peroneus brevis	Fibula (lower two thirds of lateral surface of shaft)	Fifth metatarsal (tubercle, dorsal surface)	Everts foot Flexes foot	Superficial peroneal nerve
Peroneus tertius	Fibula (distal third)	Fourth and fifth metatarsals (bases of)	Flexes foot Everts foot	Deep peroneal nerve
Extensor digitorum longus	Tibia (lateral condyle) Fibula (anterior surface)	Second and third phalanges (four lateral toes)	Dorsiflexion of foot; extension of toes	Deep peroneal nerve
Intrinsic				
Lumbricales	Tendons of flexor digitorum longus	Phalanges (2 to 5)	Flex proximal phalanges Extend middle and distal phalanges	Lateral and medial plantar nerve
Flexor digiti minimi brevis	Fifth metatarsal	Proximal phalanx of fifth toe	Flexes fifth (small) toe	Lateral plantar nerve
Flexor hallucis brevis	Cuboid Medial and lateral cuneiform	Proximal phalanx of first (great) toe	Flexes first (great) toe	Medial and lateral plantar nerve
Flexor digitorum brevis	Calcaneous Plantar fascia	Middle phalanges of toes (2 to 5)	Flexes toes two through five	Medial plantar nerve
Abductor digiti minimi	Calcaneous	Proximal phalanx of fifth (small) toe	Abducts fifth (small) toe Flexes fifth toe	Lateral plantar nerve
Abductor hallucis	Calcaneous	First (great) toe	Abducts first (great) toe	Medial plantar nerve

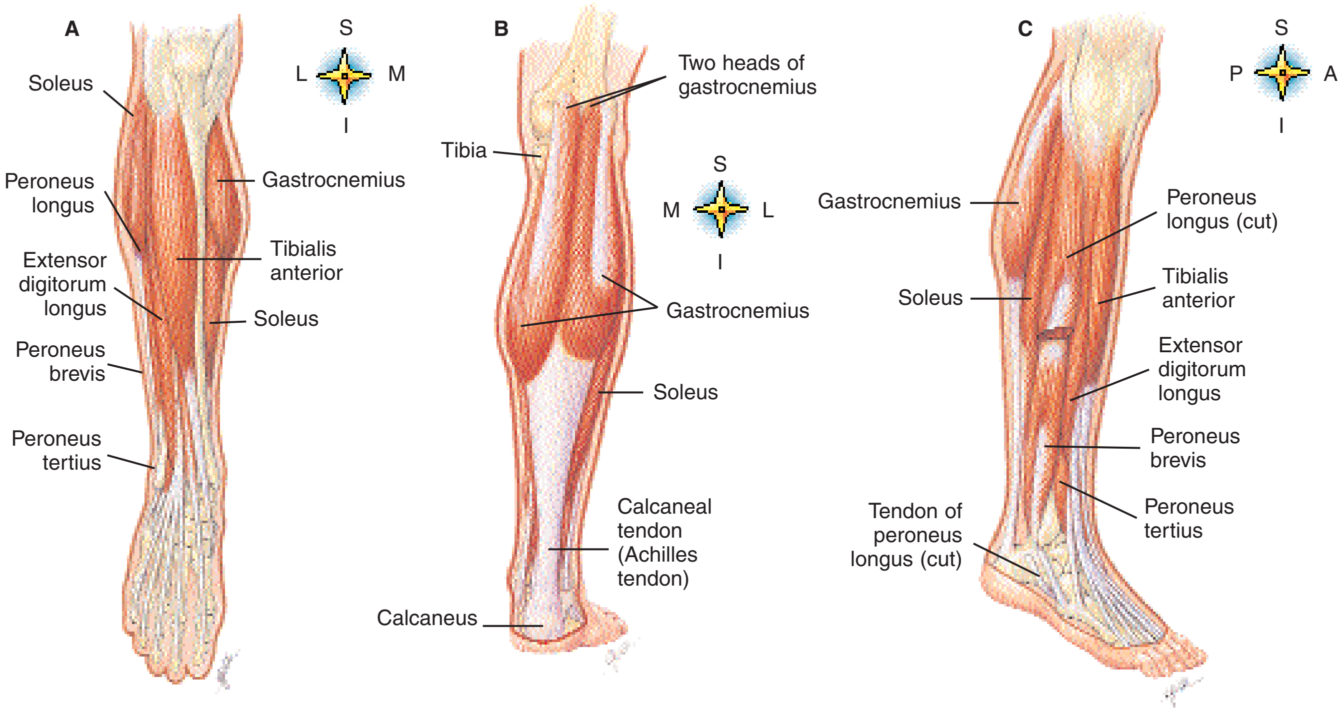


Figure 10-27 **Superficial muscles of the leg.** **A**, Anterior view. **B**, Posterior view. **C**, Lateral view.

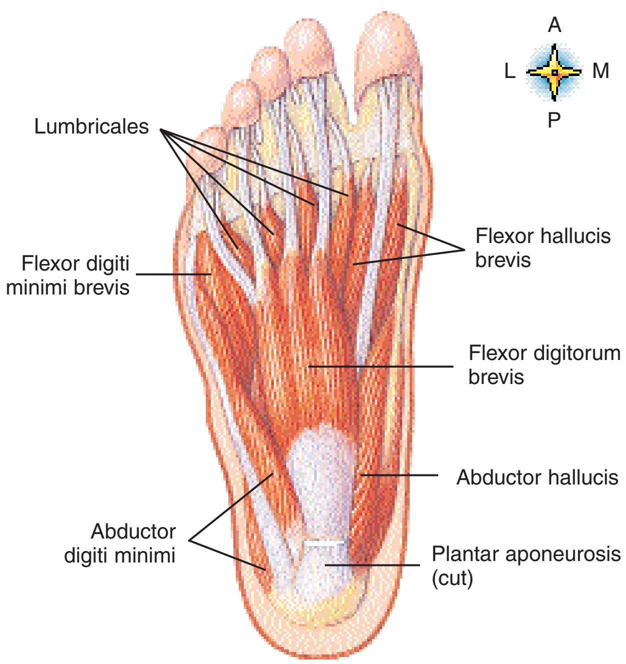


Figure 10-28 **Intrinsic muscles of the foot.** Inferior (plantar) view.

The superficial muscles located on the posterior surface of the leg form the bulging "calf." The common tendon of the **gastrocnemius** (gas-trok-NEE-me-us) and **soleus** is called the **calcaneal,** or *Achilles,* **tendon.** It inserts into the calcaneus, or heel bone. By acting together, these muscles serve as powerful flexors (plantar flexion) of the foot.

Dorsal flexors of the foot, located on the anterior surface of the leg, include the **tibialis** (tib-ee-AL-is) **anterior, peroneus tertius** (per-o-NEE-us TER-shus), and **extensor digitorum longus.** In addition to functioning as a dorsiflexor of the foot the extensor digitorum longus also everts the foot and extends the toes.

Quick Check
1. Name the three gluteal muscles.
2. What is the function of the gastrocnemius muscle?

POSTURE

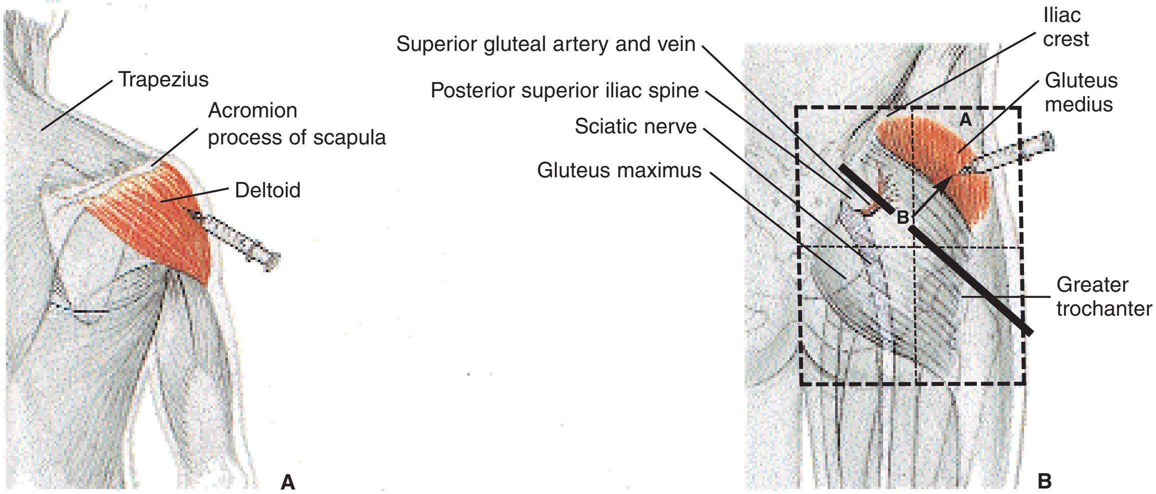
We have already discussed the major role of muscles in movement and heat production. We shall now turn our attention to a third way in which muscles serve the body as a whole—that of maintaining the posture of the body. Let us consider a few aspects of this important function.

The term ***posture*** means simply maintaining optimal body position. "Good posture" means many things. It means body alignment that most favors function; it means position that requires the least muscular work to maintain, which puts the least strain on muscles, ligaments, and bones; often it means keeping the body's center of gravity over its base. Good posture in the standing position, for example, means head and chest held high; chin, abdomen, and buttocks pulled in; knees bent slightly; and feet placed firmly on the ground about 6 inches (15 cm) apart. Good posture in a sitting position varies with the position that one is trying to maintain. Good posture during exercise, such as riding a

Box 10-4 HEALTH MATTERS

Intramuscular Injections

Many drugs are administered by intramuscular injection. If the amount to be injected is 2 ml or less, the deltoid muscle is often selected as the site of injection. Note that in part *A* of this figure the needle is inserted into the muscle about two fingers' breadth below the acromion process of the scapula and lateral to the tip of the acromion. If the amount of medication to be injected is 2 to 3 ml, the gluteal area shown in part *B* of the figure, is often used. Injections are made into the gluteus medius muscle near the center of the upper outer quadrant, as shown in the illustration. Another technique of locating the proper injection site is to draw an imaginary diagonal line from a point of reference on the back of the bony pelvis (posterior superior iliac spine) to the greater trochanter of the femur. The injection is given about three fingers' breadth above and one third of the way down the line. It is important to avoid the sciatic nerve and the superior gluteal blood vessels during the injection. Proper technique requires a knowledge of the underlying anatomy.



Intramuscular injection sites. A, Deltoid injection site for small doses. **B**, Gluteal injection site for larger doses.

horse or dribbling a basketball, means moving or tensing different parts of the body frequently to avoid falling.

HOW POSTURE IS MAINTAINED

Gravity pulls on the various parts of the body at all times, and because bones are too irregularly shaped to balance themselves on each other, the only way the body can be held in any particular position is for muscles to exert a continual pull on bones in the opposite direction from gravity or other forces that pull on body parts. When the body is in a standing position, gravity tends to pull the head and trunk forward and downward; muscles (head and trunk extensors) must therefore pull backward and upward on them. For instance, gravity pulls the lower jaw downward; muscles must pull upward on it. Muscles exert this pull against gravity by virtue of their property of **tonicity.** Tonicity, or **muscle tone,** literally means *tension* and refers to the continuous, low level of sustained contraction maintained by all skeletal muscles. Because tonicity is absent during deep sleep, muscle pull does not then counteract the pull of gravity. Hence, we cannot sleep standing up. Interestingly, astronauts in the low-gravity conditions of space station missions can sleep in a standing position, as long as they are secured inside special sleeping bags on the wall of the space station.

Many structures other than muscles and bones play a part in the maintenance of posture. The nervous system is responsible for the existence of muscle tone and also regulates and coordinates the amount of pull exerted by the individual muscles. The respiratory, digestive, circulatory, excretory, and endocrine systems all contribute something toward the ability of muscles to maintain posture. This is one of many examples of the important principle that all body functions are interdependent.

The importance of posture can perhaps be best evaluated by considering some of the effects of poor posture. Poor posture throws more work on muscles to counteract the pull of gravity and therefore leads to fatigue more quickly than good posture. Poor posture puts more strain on ligaments. It puts abnormal strains on bones and may eventually produce deformities. It also interferes with various functions such as respiration, heart action, and digestion.

CYCLE OF LIFE

Muscular System

Acting together, the muscular, skeletal, and nervous systems permit us to move in a coordinated and controlled way. However, it is the contraction, or shortening, of muscles that ultimately provides the actual movement necessary for physical activity. Dramatic changes occur in the muscular system throughout the cycle of life. Muscle cells may increase or decrease in size and ability to shorten most effectively at different periods in life. In addition to age-related changes, many pathological conditions occurring at different ages may also affect the muscular system.

Because of the functional interdependence of the musculoskeletal and nervous systems, life cycle changes affecting the muscles often manifest in other components of the functional unit. During infancy and childhood the ability to coordinate and control the strength of muscle contraction permits a sequential series of development steps to occur. A developing youngster learns to hold the head up, roll over, sit up, stand alone, and then walk and run as developmental changes permit better control and coordination of muscular contraction.

Degenerative changes associated with advancing age often result in replacement of muscle cell volume with nonfunctional connective tissue. As a result, the strength of muscular contraction diminishes. Recent findings show that much if not all of this age-related decrease in muscle strength actually results from disuse atrophy (see Box 11-6 in Chapter 11) and thus may be avoidable. Pathological conditions associated with specific age ranges can also affect one or more components of the functional unit that permits us to move smoothly and effortlessly.

THE BIG PICTURE

Skeletal Muscles and the Whole Body

As you read through this chapter, what struck you most was probably the large number of individual muscles and their many actions. Although learning the names, locations, origins, insertions, and other details of the major muscles is a worthwhile endeavor, such an activity can cause you to lose sight of the "big picture." Step back from the details a moment to appreciate the fact that the muscles work as coordinated teams of biological engines that move the various components of the flexible skeleton.

As a matter of fact, in this chapter you learned that the fibrous wrappings of each muscle are continuous with its tendons, which in turn are continuous with the fibrous structure of the bone to which they are attached. Thus we can see that the muscular and skeletal systems are in essence *a single structure*. This fact is very important in seeing a "big picture" comprising many individual muscles and bones. The entire *skeletomuscular system*, as it is often called, is actually a single, continuous structure that comprises a coordinated, dynamic framework for the body.

Taking another step back, an even bigger picture comes into focus. Other systems of the body must play a role in the actions of the skeletomuscular system. For example, the nervous system senses changes in body position and degrees of movement—permitting integration of feedback loops that ultimately regulate the muscular contractions that maintain posture and produce movements. The cardiovascular system maintains blood flow in the muscles, and the urinary and respiratory systems rid the body of wastes produced in the muscles. The respiratory and digestive systems bring in oxygen and nutrients necessary for muscle function.

The picture is still not complete, however. We will see even more when Chapter 11 continues the story of muscle function by delving into the details of how each muscle works as an engine to drive the movement of the body.

CASE STUDY

Patricia Rider, age 42, came to the health clinic complaining of pain in her right hand and fingers, especially at night, for the past 2 months. She works as a sewing machine operator at a local factory making men's pants. Ms. Rider thinks of herself as being in good health. She walks daily and follows a low-fat diet. Family history is negative for cancer, arthritis, heart disease, and diabetes. Physical examination reflects a positive Tinel's sign (tingling sensation radiating from the wrist to the hand) with gentle tapping on the inside of the right wrist with a reflex hammer.

1. After a complete physical examination, Ms. Rider is diagnosed with carpal tunnel syndrome. Which of the following nerves is usually involved with this diagnosis?
   - **A.** Femoral
   - **B.** Median
   - **C.** Ulna
   - **D.** Radial
2. The physician has ordered that Ms. Rider wear a right wrist splint held in place by an Ace bandage. Which one of the following is the BEST rationale for this treatment?
   - **A.** It will stabilize the joint, thus reducing the pain in this area at night, while allowing Ms. Rider to remove the splint and continue her work as a sewing machine operator during the day.
   - **B.** It will decrease the swelling associated with the injury.
   - **C.** It will remind Ms. Rider to avoid heavy lifting using this extremity and thus decrease the likelihood of reinjury to the area.
   - **D.** It will decrease the repetitive motions of the wrist and prevent continuous injury.
3. During the routine examination, Ms. Rider is found to have a slight separation of muscle when she is asked to lift her head off the examination table while in a supine position. Which muscle do you expect to show this separation based on the above description?
   - **A.** External oblique
   - **B.** Internal oblique
   - **C.** Rectus abdominis
   - **D.** Transversus abdominis
4. During the physical examination, the physician tests Ms. Rider's right brachialis muscle strength. Which one of the following correctly describes this procedure?
   - **A.** The forearm should be flexed at the elbow.
   - **B.** The forearm should be extended at the elbow.
   - **C.** Ms. Rider is asked to extend her elbow and push against a hard surface.
   - **D.** Ms. Rider is asked to lift a heavy object above her head.

CHAPTER SUMMARY

INTRODUCTION (Figures 10-1 and 10-2)

A. There are more than 600 skeletal muscles in the body
B. From 40% to 50% of our body weight is skeletal muscle
C. Muscles, along with the skeleton, determine the form and contour of our body

SKELETAL MUSCLE STRUCTURE (Figure 10-3)

A. Connective tissue components
1. Endomysium—delicate connective tissue membrane that covers specialized skeletal muscle fibers
2. Perimysium—tough connective tissue binding together fascicles
3. Epimysium—coarse sheath covering the muscle as a whole
4. These three fibrous components may become a tendon or an aponeurosis

B. Size, shape, and fiber arrangement (Figure 10-4)
1. Skeletal muscles vary considerably in size, shape, and fiber arrangement
2. Size—range from extremely small to large masses
3. Shape—variety of shapes, such as broad, narrow, long, tapering, short, blunt, triangular, quadrilateral, irregular, flat sheets, or bulky masses
4. Arrangement—variety of arrangements, such as parallel to long axis, converge to a narrow attachment, oblique, pennate, bipennate, or curved; the direction of fibers is significant due to its relationship to function

C. Attachment of muscles (Figure 10-5)
1. Origin—point of attachment that does *not* move when the muscle contracts
2. Insertion—point of attachment that moves when the muscle contracts

D. Muscle actions
1. Most movements are produced by the coordinated action of several muscles; some muscles in the group contract while others relax
   - **a.** Prime mover (agonist)—a muscle or group of muscles that directly performs a specific movement
   - **b.** Antagonist—muscles that, when contracting, directly oppose prime movers; relax while prime mover (agonist) is contracting to produce movement; provide precision and control during contraction of prime movers
   - **c.** Synergists—muscles that contract at the same time as the prime movers; they facilitate prime

mover actions to produce a more efficient movement
   d. Fixator muscles—joint stabilizers

E. Lever systems
   1. In the human body bones serve as levers and joints serve as fulcrums; contracting muscle applies a pulling force on a bone lever at the point of the muscle's attachment to the bone, causing the insertion bone to move about its joint fulcrum
   2. Lever system—composed of four component parts (Figure 10-6)
      a. Rigid bar (bone)
      b. Fulcrum (F) around which the rod moves (joint)
      c. Load (L) that is moved
      d. Pull (P) that produces movement (muscle contraction)
   3. First-class levers
      a. Fulcrum lies between the pull and the load
      b. Not abundant in the human body; serve as levers of stability
   4. Second-class levers
      a. Load lies between the fulcrum and the joint at which the pull is exerted
      b. Presence of these levers in the human body is a controversial issue
   5. Third-class levers
      a. Pull is exerted between the fulcrum and load
      b. Permit rapid and extensive movement
      c. Most common type of lever found in the body

HOW MUSCLES ARE NAMED

A. Muscle names can be in Latin or English (this book uses English)
B. Muscles are named using one or more of the following features:
   1. Location, function, shape
   2. Direction of fibers—named according to fiber orientation
   3. Number of heads or divisions
   4. Points of attachment—origin and insertion points
   5. Relative size—small, medium, or large
C. Hints on how to deduce muscle actions

IMPORTANT SKELETAL MUSCLES

A. Muscles of facial expression—unique in that at least one point of attachment is to the deep layers of the skin over the face or neck (Figure 10-7; Table 10-3)
B. Muscles of mastication—responsible for chewing movements (Figure 10-7; Table 10-3)
C. Muscles that move the head—paired muscles on either side of the neck are responsible for head movements (Figure 10-8; Table 10-4)

TRUNK MUSCLES

A. Muscles of the thorax—critical importance in respiration (Figure 10-9; Table 10-5)
B. Muscles of the abdominal wall—arranged in three layers, with fibers in each layer running in different directions to increase strength (Figure 10-10; Table 10-6)
C. Muscles of the back—bend or stabilize the back (Figure 10-11; Table 10-7)
D. Muscles of the pelvic floor—support the structures in the pelvic cavity (Figure 10-12; Table 10-8)

UPPER LIMB MUSCLES

A. Muscles acting on the shoulder girdle—muscles that attach the upper extremity to the torso are located anteriorly (chest) or posteriorly (back and neck); these muscles also allow extensive movement (Figure 10-13; Table 10-9)
B. Muscles that move the upper arm—the shoulder is a synovial joint allowing extensive movement in every plane of motion (Figure 10-15; Table 10-10)
C. Muscles that move the forearm—found proximally to the elbow and attach to the ulna and radius (Figures 10-16 and 10-17; Table 10-11)
D. Muscles that move the wrist, hand, and fingers—these muscles are located on the anterior or posterior surfaces of the forearm (Figures 10-18 through 10-20; Table 10-12)

LOWER LIMB MUSCLES

A. The pelvic girdle and lower extremity function in locomotion and maintenance of stability
B. Muscles that move the thigh and lower leg (Figures 10-1, 10-2, 10-21 through 10-26; Tables 10-13 and 10-14)
C. Muscles that move the ankle and foot (Figures 10-27 and 10-28; Table 10-15)
   1. Extrinsic foot muscles are located in the leg and exert their actions by pulling on tendons that insert on bones in the ankle and foot; responsible for dorsiflexion, plantar flexion, inversion, and eversion
   2. Intrinsic foot muscles are located within the foot; responsible for flexion, extension, abduction, and adduction of the toes

POSTURE

A. Maintaining the posture of the body is one of the major roles muscles play
B. "Good posture"—body alignment that most favors function, requires the least muscular work to maintain, keeping the body's center of gravity over its base
C. How posture is maintained
   1. Muscles exert a continual pull on bones in the opposite direction from gravity
   2. Structures other than muscle and bones have a role in maintaining posture
      a. Nervous system—responsible for the existence of muscle tone and also regulation and coordination of the amount of pull exerted by individual muscles
      b. Respiratory, digestive, excretory, and endocrine systems all contribute to maintain posture

CYCLE OF LIFE: MUSCULAR SYSTEM

A. Muscle cells—increase or decrease in number, size, and ability to shorten at different periods

B. Pathological conditions at different periods may affect the muscular system

C. Life cycle changes—manifested in other components of functional unit:

1. Infancy and childhood—coordination and controlling of muscle contraction permits sequential development steps

D. Degenerative changes of advancing age result in replacement of muscle cells with nonfunctional connective tissue

1. Diminished strength

REVIEW QUESTIONS

1. Define the terms *endomysium, perimysium,* and *epimysium.*
2. Identify and describe the most common type of lever system found in the body.
3. Give an example of a muscle named by: location, function, shape, fiber direction, number of heads, points of attachment.
4. Name the main muscles of the back, chest, abdomen, neck, shoulder, upper arm, lower arm, thigh, buttocks, leg, and pelvic floor.
5. Name the main muscles that flex, extend, abduct, and adduct the upper arm; that raise and lower the shoulder.
6. Name the main muscles that flex and extend the lower arm; that flex and extend the wrist and hand.
7. Name the main muscles that flex, extend, abduct, and adduct the thigh; that flex and extend the lower leg and thigh; that flex and extend the foot.
8. Name the main muscles that flex, extend, abduct, and adduct the head.
9. Name the main muscles that move the abdominal wall; that move the chest wall.

CRITICAL THINKING QUESTIONS

1. Identify the muscles of facial expression. What muscles permit smiling and frowning?
2. How do the origin and insertion of a muscle relate to each other in regard to actual movement?
3. When the biceps brachii contracts, the elbow flexes. When the triceps brachii contracts, the elbow extends. Explain the role of both muscles in terms of agonist and antagonist in both of these movements.
4. Can you describe how posture is maintained?
5. Describe the clinical significance regarding the difference in size between the large head of the humerus and the small and shallow glenoid cavity of the scapula.
6. If a typist complained of weakness, pain, and tingling in the palm and thumb side of the hand, what type of problem might he or she be experiencing? Explain specifically what was happening to cause this discomfort.
7. Baseball players, particularly pitchers, often incur rotator cuff injuries. List the muscles that make up the rotator cuff and explain the importance of these muscles and their role in joint stability.