Some of these special movements are shown in Figure 6.13.

- **Dorsiflexion and plantar flexion.** Up and down movements of the foot at the ankle are given special names. Lifting the foot so that its superior surface approaches the shin (standing on your heels) is called dorsiflexion, whereas depressing the foot (pointing the toes) is called plantar flexion (Figure 6.13e). Dorsiflexion of the foot corresponds to extension of the hand at the wrist, whereas plantar flexion of the foot corresponds to flexion of the hand.
- **Inversion and eversion.** Inversion and eversion are also special movements of the foot (Figure 6.13f). To invert the foot, turn the sole medially. To evert the foot, turn the sole laterally.
- **Supination and pronation.** The terms supination (soo″pĭ-na′shun; "turning backward") and pronation (pro-na′shun; "turning forward") refer to movements of the radius around the ulna (Figure 6.13g). Supination occurs when the forearm rotates laterally so that the palm faces anteriorly, and the radius and ulna are parallel. Pronation occurs when the forearm rotates medially so that the palm faces posteriorly. Pronation brings the radius across the ulna so that the two bones form an X. A helpful memory trick: If you lift a cup of soup up to your mouth *on your palm,* you are supinating ("soup"-inating).
- **Opposition.** In the palm of the hand, the saddle joint between metacarpal 1 and the carpals allows opposition of the thumb (Figure 6.13h). This is the action by which you move your thumb to touch the tips of the other fingers on the same hand. It is this unique action that makes the human hand such a fine tool for grasping and manipulating things.

Interactions of Skeletal Muscles in the Body

Muscles can't push—they can only pull as they contract—so most often body movements are the result of the activity of two or more muscles acting together or against each other. Muscles are arranged in such a way that whatever one muscle (or group of muscles) can do, other muscles can reverse. Because of this, muscles are able to bring about an immense variety of movements.

The muscle that has the major responsibility for causing a particular movement is called the **prime mover.** (This physiological term has been borrowed by the business world to label a person who gets things done.) Muscles that oppose or reverse a movement are **antagonists** (an-tag′o-nists). When a prime mover is active, its antagonist is stretched and relaxed. Antagonists can be prime movers in their own right. For example, the biceps of the arm (prime mover of elbow flexion) is antagonized by the triceps (a prime mover of elbow extension).

Synergists (sin′er-jists; *syn* = together, *erg* = work) help prime movers by producing the same movement or by reducing undesirable movements. When a muscle crosses two or more joints, its contraction will cause movement in all the joints crossed unless synergists are there to stabilize them. For example, the finger-flexor muscles cross both the wrist and the finger joints. You can make a fist without bending your wrist because synergist muscles stabilize the wrist joints and allow the prime mover to act on the finger joints.

Fixators are specialized synergists. They hold a bone still or stabilize the origin of a prime mover so all the tension can be used to move the insertion bone. The postural muscles that stabilize the vertebral column are fixators, as are the muscles that anchor the scapulae to the thorax.

In summary, although prime movers seem to get all the credit for causing certain movements, the actions of antagonistic and synergistic muscles are also important in effecting smooth, coordinated, and precise movements.

Naming Skeletal Muscles

Like bones, muscles come in many shapes and sizes to suit their particular tasks in the body. Muscles are named on the basis of several criteria, each of which focuses on a particular structural or functional characteristic. Paying close attention to these cues can greatly simplify your task of learning muscle names and actions:

- **Direction of the muscle fibers.** Some muscles are named in reference to some imaginary line, usually the midline of the body or the long axis of a limb bone. When a muscle's name includes the term *rectus* (straight), its fibers run parallel to that imaginary line. For example, the rectus femoris is the straight

Are Athletes Looking Good and Doing Better with Anabolic Steroids? *(continued)*

androstenedione, which is converted to testosterone in the body. It is taken orally and much of it is destroyed by the liver soon after ingestion, but the few milligrams that survive temporarily boost testosterone levels. "Wannabe" athletes from the fifth grade up are said to be sweeping the supplement off the drugstore shelves. This is troubling; androstenedione is not regulated by the U.S. Food and Drug Administration (FDA) and its long-term effects are unpredictable. Ongoing studies have found that males who took the supplement developed elevated levels of the female hormone estrogen as well as testosterone (raising their risk of feminizing effects such as enlarged breasts), early puberty, and stunted bone growth.

The question of why athletes use these drugs is easy to answer. Some say they are willing to do almost anything to win, short of killing themselves. Are they unwittingly doing this as well?

muscle of the thigh, or femur. Similarly, the term *oblique* as part of a muscle's name tells you that the muscle fibers run obliquely (at a slant) to the imaginary line.

- **Relative size of the muscle.** Such terms as *maximus* (largest), *minimus* (smallest), and *longus* (long) are often used in the names of muscles—for example, the gluteus maximus is the largest muscle of the gluteus muscle group.
- **Location of the muscle.** Some muscles are named for the bone with which they are associated. For example, the temporalis and frontalis muscles overlie the temporal and frontal bones of the skull, respectively.
- **Number of origins.** When the term *biceps, triceps,* or *quadriceps* forms part of a muscle name, one can assume that the muscle has two, three, or four origins, respectively. For example, the biceps muscle of the arm has two heads, or origins, and the triceps muscle has three.
- **Location of the muscle's origin and insertion.** Occasionally, muscles are named for their attachment sites. For example, the sternocleidomastoid muscle has its origin on the sternum (*sterno*) and clavicle (*cleido*) and inserts on the *mastoid* process of the temporal bone.
- **Shape of the muscle.** Some muscles have a distinctive shape that helps to identify them. For example, the deltoid muscle is roughly triangular (*deltoid* means "triangular").
- **Action of the muscle.** When muscles are named for their actions, terms such as *flexor, extensor,* and *adductor* appear in their names. For example, the adductor muscles of the thigh all bring about its adduction, and the extensor muscles of the wrist all extend the wrist.

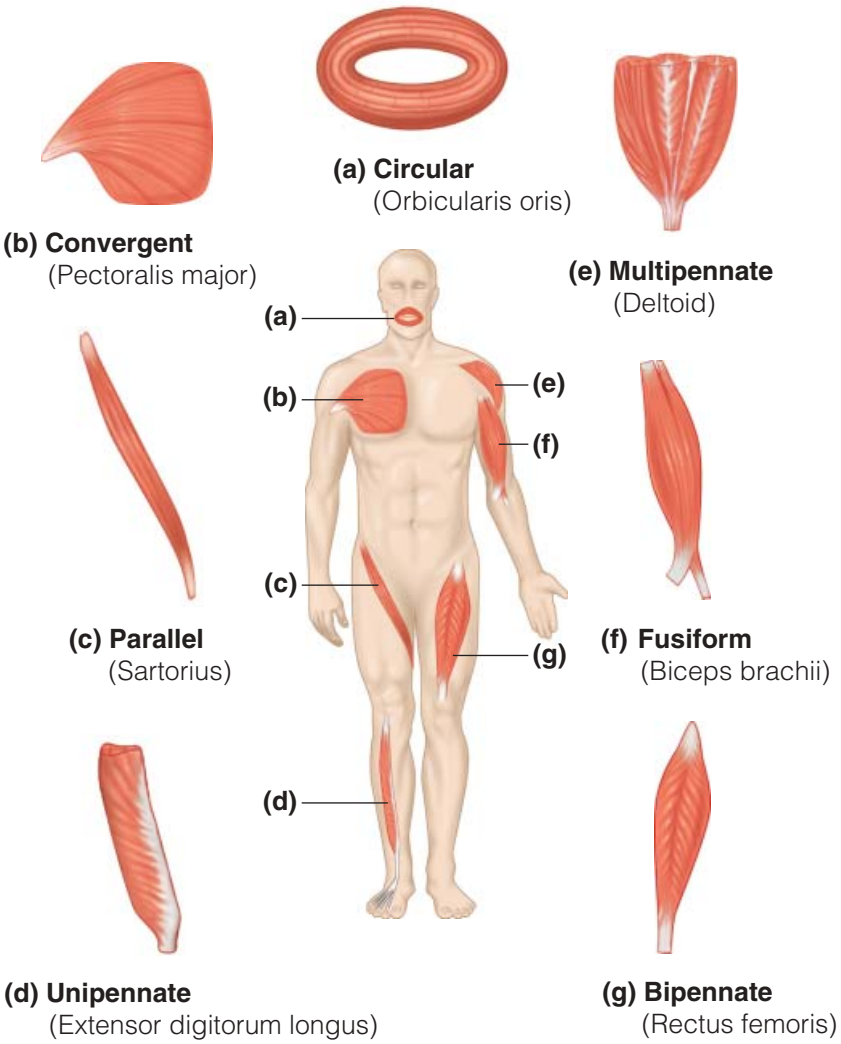

FIGURE 6.14 Relationship of fascicle arrangement to muscle structure.

Arrangement of Fascicles

Skeletal muscles consist of fascicles, but fascicle arrangements vary, producing muscles with different structures and functional properties. The most common patterns of fascicle arrangement are described next.

The pattern is **circular** when the fascicles are arranged in concentric rings (Figure 6.14a). Circular muscles are typically found surrounding external body openings which they close by contracting. A general term for such muscles is *sphincters* ("squeezers"). Examples are the orbicularis muscles surrounding the eyes and mouth.

In a **convergent** muscle, the fascicles converge toward a single insertion tendon. Such a muscle is triangular or fan-shaped like the pectoralis major muscle of the anterior thorax (Figure 6.14b).

In a **parallel** arrangement, the length of the fascicles run parallel to the long axis of the muscle. These muscles are straplike (Figure 6.14c). A modification of the parallel arrangement, called **fusiform,** results in a spindle-shaped muscle with an expanded belly (midsection) like the biceps brachii muscle of the arm (Figure 6.14f).

In a **pennate** (pen′āt; "feather") pattern, short fascicles attach obliquely to a central tendon. In the extensor digitorum muscle of the leg, the fascicles insert into only one side of the tendon and the muscle is *unipennate* (Figure 6.14d). If the fascicles insert into opposite sides of the tendon or from several different sides, the muscle is *bipennate* (Figure 6.14g) or *multipennate* (Figure 6.14e), respectively.

A muscle's fascicle arrangement determines its range of motion and power. The longer and the more nearly parallel the fascicles are to a muscle's long axis, the more the muscle can shorten, but such muscles are not usually very powerful. Muscle power depends more on the total number of muscle

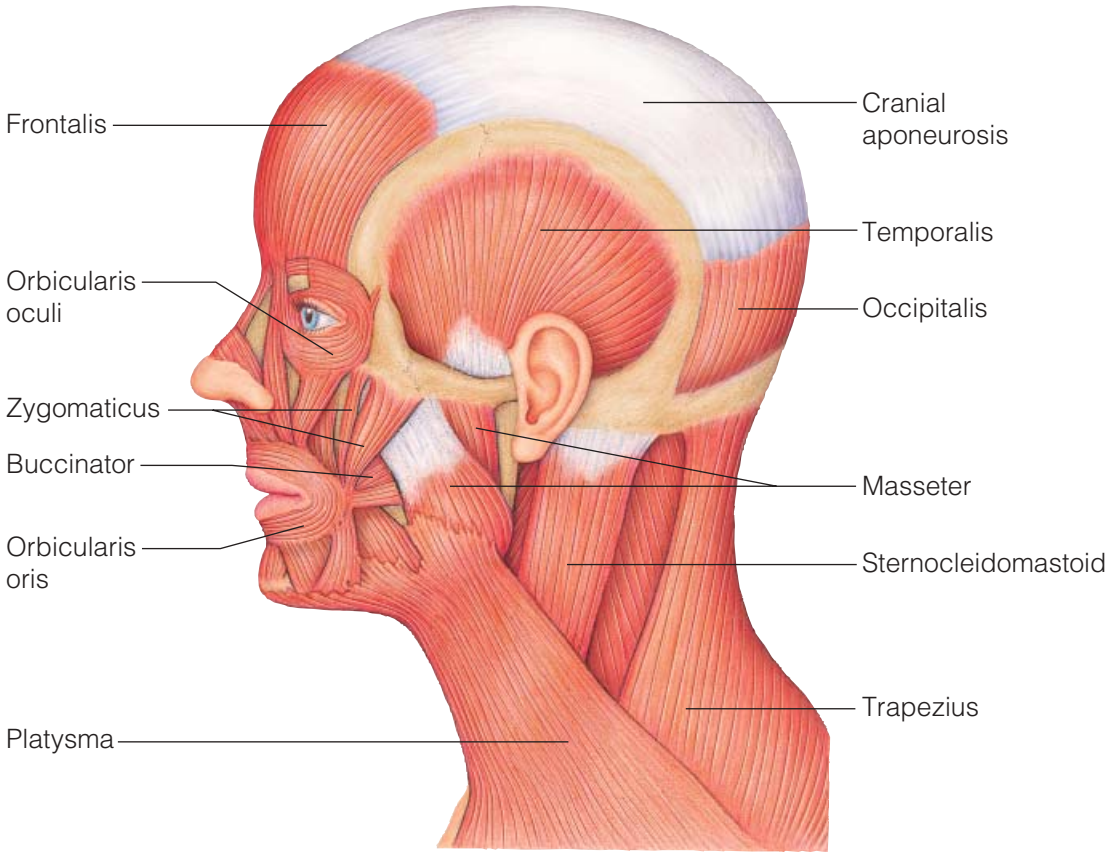

FIGURE 6.15 **Superficial muscles of the face and neck.**

cells in the muscle. The stocky bipennate and multipennate muscles, which pack in the most fibers, shorten very little but are very powerful.

Gross Anatomy of Skeletal Muscles

It is beyond the scope of this book to describe the hundreds of skeletal muscles of the human body. Only the most important muscles are described here. In addition, all the superficial muscles considered are summarized in Tables 6.3 and 6.4 and are illustrated in overall body views in Figures 6.21 and 6.22, which accompany the tables (pp. 210–213).

Head and Neck Muscles

The head muscles (Figure 6.15) are an interesting group. They have many specific functions but are usually grouped into two large categories—facial muscles and chewing muscles. Facial muscles are unique because they are inserted into soft tissues such as other muscles or skin. When they pull on the skin of the face, they permit us to smile faintly, grin widely, frown, pout, deliver a kiss, and so forth. The chewing muscles begin the breakdown of food for the body.

Facial Muscles

Frontalis The frontalis covers the frontal bone as it runs from the cranial aponeurosis to the skin of the eyebrows, where it inserts. This muscle allows you to raise your eyebrows, as in surprise, and to wrinkle your forehead. At the posterior end of the cranial aponeurosis is the small **occipitalis** muscle, which covers the posterior aspect of the skull and pulls the scalp posteriorly.*

Orbicularis Oculi The orbicularis oculi (or-bik″u-la′ris ok′u-li) has fibers that run in circles around

*Although the current references on anatomic terminology refer to the frontalis and occipitalis as the *frontal* and *occipital bellies* of the *epicranius* ("over the cranium") muscle, we will continue to use the terms frontalis and occipitalis here.

the eyes. It allows you to close your eyes, squint, blink, and wink.

Orbicularis Oris The orbicularis oris is the circular muscle of the lips. Because it closes the mouth and protrudes the lips, it is often called the "kissing" muscle.

Buccinator The fleshy buccinator (bu′sĭ-na″tor) muscle runs horizontally across the cheek and inserts into the orbicularis oris. It flattens the cheek (as in whistling or blowing a trumpet). It is also listed as a chewing muscle because it compresses the cheek to hold the food between the teeth during chewing.

Zygomaticus The zygomaticus (zi″go-mat′i-kus) extends from the corner of the mouth to the cheekbone. It is often referred to as the "smiling" muscle because it raises the corners of the mouth upward.

Chewing Muscles

The buccinator muscle, which is a member of this group, is described with the facial muscles.

Masseter The masseter (mă-se′ter) covers the angle of the lower jaw as it runs from the zygomatic process of the temporal bone to the mandible. This muscle closes the jaw by elevating the mandible.

Temporalis The temporalis is a fan-shaped muscle overlying the temporal bone. It inserts into the mandible and acts as a synergist of the masseter in closing the jaw.

Neck Muscles

For the most part, the neck muscles, which move the head and shoulder girdle, are small and strap-like. Only two neck muscles are considered here.

Platysma The platysma is a single sheetlike muscle that covers the anterolateral neck (see Figure 6.15). It originates from the connective tissue covering of the chest muscles and inserts into the area around the mouth. Its action is to pull the corners of the mouth inferiorly, producing a downward sag of the mouth.

Sternocleidomastoid The paired sternocleidomastoid (ster″no-kli″do-mas′toid) muscles are two-headed muscles, one found on each side of the neck. Of the two heads of each muscle, one arises from the sternum and the other arises from the clavicle. The heads fuse before inserting into the mastoid process of the temporal bone. When both sternocleidomastoid muscles contract together, they flex your neck. (It is this action of bowing the head that has led some people to call these muscles the "prayer" muscles.) If just one muscle contracts, the head is rotated toward the opposite side.

Homeostatic Imbalance

In some difficult births, one of these muscles may be injured and develop spasms. A baby injured in this way has *torticollis* (tor″ti-kol′is), or wryneck.

Trunk Muscles

The trunk muscles include (1) those that move the vertebral column (most of which are posterior antigravity muscles); (2) anterior thorax muscles, which move the ribs, head, and arms; and (3) muscles of the abdominal wall, which help to move the vertebral column and, most importantly, form the muscular "natural girdle" of the abdominal body wall.

Anterior Muscles (Figure 6.16)

Pectoralis Major The pectoralis (pek″to-ra′lis) major is a large fan-shaped muscle covering the upper part of the chest. Its origin is from the sternum, shoulder girdle, and the first six ribs. It inserts on the proximal end of the humerus. This muscle forms the anterior wall of the axilla and acts to adduct and flex the arm.

Intercostal Muscles The intercostal muscles are deep muscles found between the ribs. (Although they are not shown in Figure 6.16, which only shows superficial muscles, they are illustrated in Figure 6.21.) The external intercostals are important in breathing because they help to raise the rib cage for breathing air in. The internal intercostals, which lie deep to the external intercostals, depress the rib cage, which helps to move air out of the lungs when you exhale forcibly.

Muscles of the Abdominal Girdle The anterior abdominal muscles (rectus abdominis, external and internal obliques, and transversus abdominis) form a natural "girdle" that reinforces the body trunk. Taken together, they resemble the structure of plywood because the fibers of each muscle or muscle pair run in a different direction. Just as plywood is exceptionally strong for its thickness, the abdominal muscles form a muscular wall that is well suited for its job of containing and protecting the abdominal contents.