20D-3 Objectives

- Differentiate between muscle origin and insertion
- Describe the function of muscle pairs

20D-3 Muscles and Body Movements

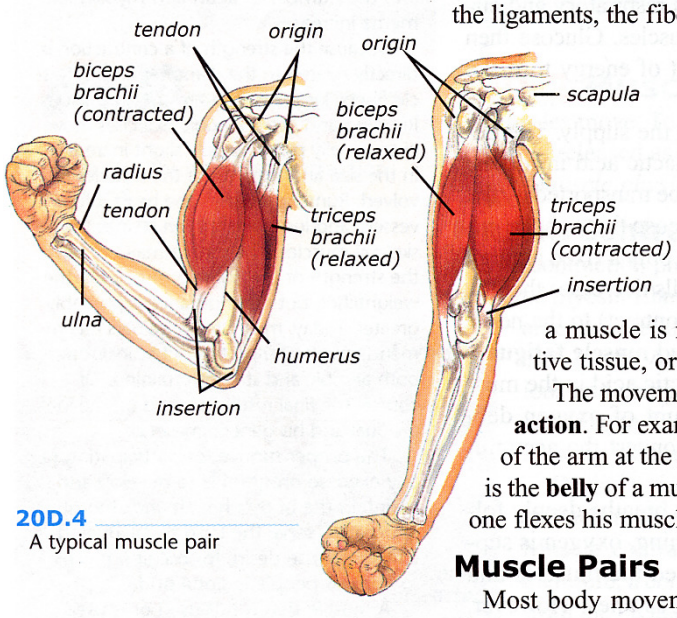
There are nearly seven hundred skeletal muscles in the human body. These muscles may be tiny, like those that move the lens in the eye; or large, like the trapezius of the upper back, which moves the spine, head, and shoulders.

Muscle Attachments

Skeletal muscles produce movements by pulling tendons, which in turn exert force on bones. There is a secure union at the tendon-bone junction because, like the ligaments, the fibers of the tendons intertwine with the fibers of the periosteum. Most muscle tendons extend over the joint and fasten to the bones that form that joint. When the muscle contracts, one bone is drawn toward the other. Usually one of the bones involved remains more or less stationary while the other bone moves.

The attachment of the muscle's tendon to the more stationary bone is the **origin** of the muscle. The attachment of the other muscle tendon to the more movable bone is the **insertion**. However, the origin or insertion of a muscle is not always a bone; it can be the skin, a layer of connective tissue, or even another muscle.

The movement performed by the muscle when it contracts is called its **action**. For example, the action of the biceps brachii muscle is the flexing of the arm at the elbow. The fleshy portion between the origin and insertion is the **belly** of a muscle. This is the part of the muscle that is seen when someone flexes his muscles.



20D.4 A typical muscle pair

Muscle Pairs

Most body movements are a result of at least two skeletal muscles functioning together. During the flexing of the arm at the elbow, the biceps brachii muscle is the **prime mover** because it performs the action. The triceps brachii, which is relaxed and stretched during this movement, is the **antagonist*** (an TAG uh nist) because it performs the opposite action. When the arm extends, the triceps brachii is the prime mover and the biceps brachii is the antagonist.

* **antagonist:** ant- or anta- (against) + -agonist (Gk. AGONIZESTHAI, to struggle)

Characteristics Used to Name Muscles

Size
pectoralis major—large muscle in the pectoral (chest) region
pectoralis minor—small muscle in the pectoral region
gluteus maximus—largest (maximum) muscle of the gluteus (buttocks) region

Shape
deltoid—triangular-shaped muscle
trapezius—trapezoid-shaped muscle

Location
tibialis anterior—muscle located on the anterior region of the tibia
external and *internal oblique*—muscles of the ribs that are on the outside and inside
rectus femoris—muscle near the femur
temporal—muscle near the temporal bone
orbicularis oculi—muscle near the eye (ocular organ)
epicranius—muscle that goes around (*epi-*) the head (*-cranium*)

Action
masseter (muh SEE tur)—a muscle that is involved in mastication (chewing)
adductor group—adducts the thigh
flexors or *extensors* of the hand—flexes or extends the hand

Number of Attachments
biceps brachii—a muscle that has two origins (*bi-*, two; *-ceps*, head) and is located in the arm (brachial) region
triceps brachii—three origins

Direction of Fibers
external oblique—a muscle that is located near the outside of the body and has fibers arranged obliquely (in a slanting direction)

Muscle Actions
- *Flexion:* decreases angle between bones
- *Extension:* increases angle between bones
- *Abduction:* moves bone away from midline of body
- *Adduction:* moves bone toward midline of body
- *Rotation:* produces a turning or revolving movement around an axis
- *Elevation:* produces an upward movement
- *Depression:* produces a downward movement

Thus, the biceps and triceps of the arm are an *antagonistic pair* because they *have opposite actions.*

Antagonistic pairs of muscles perform and control most body movements. The muscles that assist the prime mover are the *synergists** (SIN ur JISTS), or fixators. A synergist usually contracts at the same time as the prime mover in order to stabilize a particular joint. For example, as the biceps muscle flexes the arm

synergist: syn- (together) + -ergist (Gk. ERGON, work)

Table 20D-2 Major Skeletal Muscles of the Human Body

Muscle	Origin	Insertion	Action
Epicranius	Lower part of occipital	Skin of forehead	Raises eyebrows and wrinkles forehead
Orbicularis oculi	Wall of orbit	Skin around eyelid	Closes eye
Orbicularis oris	Muscle fibers around mouth	Skin at corner of mouth	Draws lips together
Buccinator	Maxilla and mandible	Orbicularis oris	Compresses cheek as in blowing air
Masseter	Zygomatic arch	Mandible	Elevates (closes) jaw
Temporal	Temporal bone	Mandible	Elevates (closes) jaw
Sternocleidomastoid	Sternum and clavicle	Temporal bone (mastoid process)	Flexes neck; rotates head
Pectoralis major	Clavicle, sternum, and true ribs	Proximal humerus	Adducts upper arm anteriorly
Pectoralis minor	Ribs	Scapula	Pulls shoulder down and forward
Rectus abdominis	Pubic bone	Ribs and sternum	Compresses abdomen; flexes trunk
External oblique	Lower eight ribs	Ilium and pubic	Compresses abdomen
Internal oblique	Ilium and connective tissue in lumbar region	Lower ribs, pubic, and the opposite internal oblique	Compresses abdomen
Transversus abdominis	Same as internal oblique	The opposite transversus abdominis	Compresses abdomen
External intercostals	Lower border of rib above	Upper border of rib below	Elevate ribs
Internal intercostals	Upper border of rib below	Lower border of rib above	Depress ribs during forceful expiration
Trapezius	Occipital and upper vertebrae	Clavicle and scapula	Raises or lowers shoulders
Latissimus dorsi	Lower vertebrae, lower ribs, and ilium	Humerus	Extends and adducts upper arm posteriorly
Longissimus capitis	Upper vertebrae	Mastoid process	Extends and rotates head
Deltoid	Clavicle and scapula	Proximal humerus	Abducts upper arm
Biceps brachii	Scapula	Proximal radius	Flex forearm
Triceps brachii	Scapula and humerus	Proximal ulna	Extend forearm
Flexors of hand and fingers	Distal humerus	Metacarpal, carpal, and palm	Flex hand at wrist
Extensors of hand and fingers	Distal humerus	Metacarpals	Extend hand at wrist
Rectus femoris	Ilium	Patella and tibia	Flexes thigh and extends lower leg
Gluteus maximus	Ilium, sacrum, and coccyx	Femur	Extends thigh
Adductor group	Pubic and ischium	Femur	Adducts thigh
Hamstring group	Ischium and femur	Fibula and tibia	Extends thigh
Tibialis anterior	Tibia	Tarsal and metatarsal	Flexes and inverts foot
Gastrocnemius	Lower femur	Calcaneus (Achilles tendon)	Extends foot and flexes lower leg
Soleus	Tibia and fibula	Calcaneus (Achilles tendon)	Extends foot (plantar flexion)

Muscle Disorders

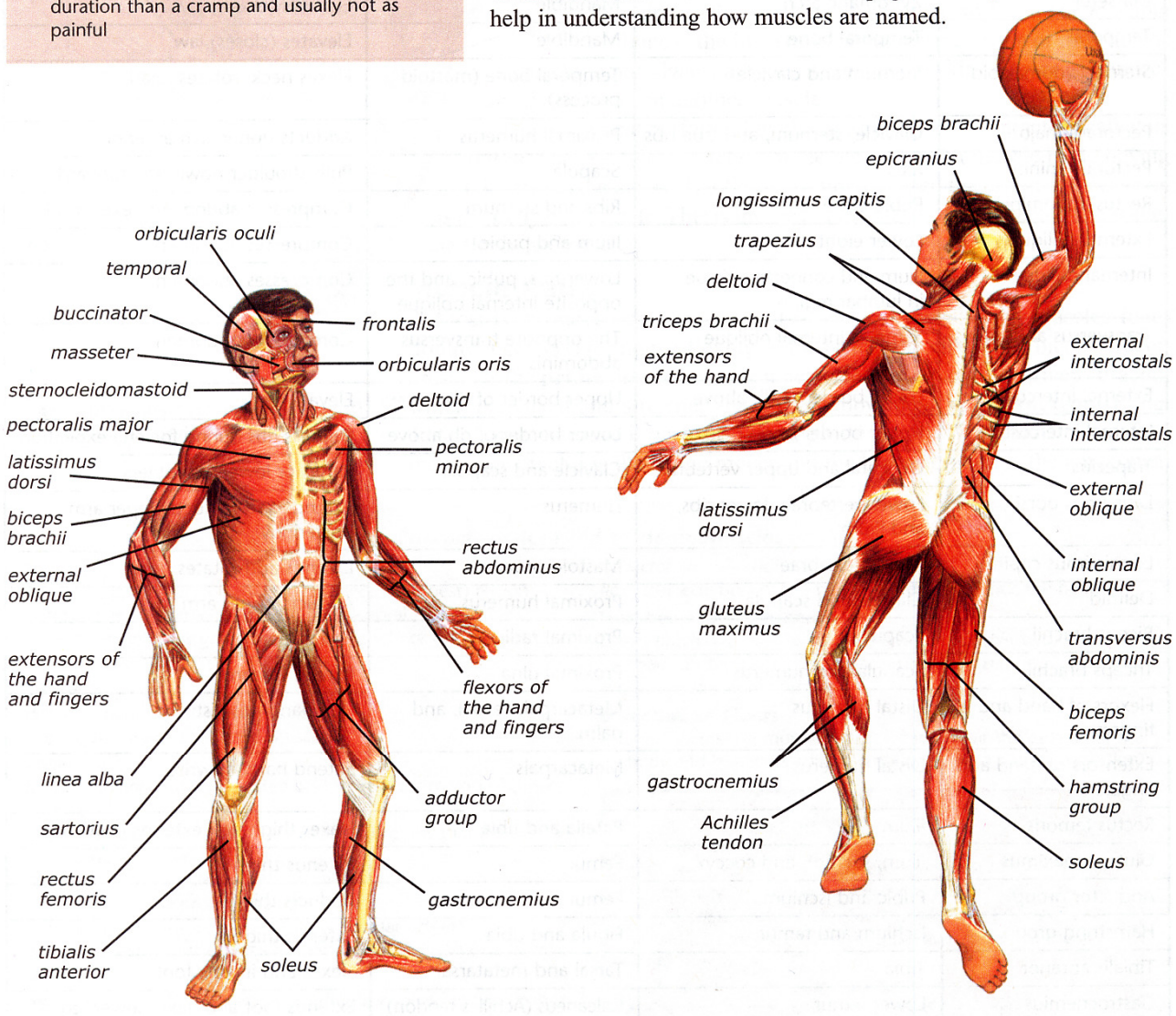
- *Atrophy:* a great reduction in muscle fibers and possible replacement by fibrous tissue
- *Convulsions:* violent, involuntary contractions of an entire group of muscles; characteristic of epileptic seizures and drug withdrawals
- *Cramps:* painful, involuntary contractions in those muscles that have been used heavily and have suffered from fatigue
- *Muscular dystrophy:* a progressively crippling disease of unknown cause in which the muscles gradually weaken and atrophy
- *Paralysis:* inability to move a muscle; usually because of some nervous system failure
- *Shin splints:* soreness on the front of the lower leg due to straining a muscle; often as a result of walking up and down hills
- *Spasm:* an involuntary contraction of shorter duration than a cramp and usually not as painful

at the elbow, the deltoid and pectoralis major muscles also contract to hold the upper arm and shoulder in a stable position.

Muscles have different roles at various times, depending on the action. During one action a particular muscle may function as a prime mover, but during other actions it may serve as an antagonist or synergist.

Any movement of the body is the result of a muscle's *pulling* on its "insertion bone." Muscles never push; they only pull. A person may be able to push an object, such as a wheelbarrow, but only because the prime movers, especially the hips and legs, are pulling on the bones of the legs and feet. In other words, although one's body is able to push, the muscles can only pull.

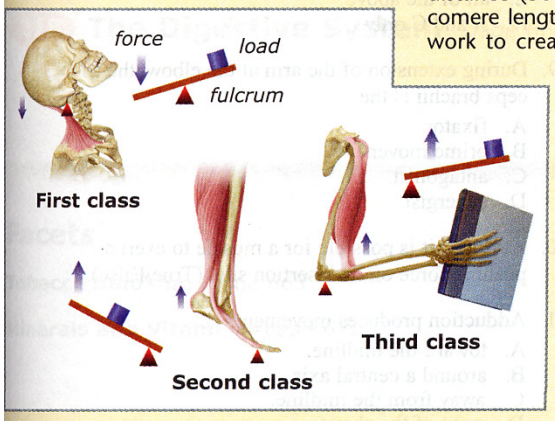
Most of the well-known muscles are described and illustrated below and on the preceding pages. While learning the muscles, it may help to realize that various characteristics of the muscles are used to name them. The information in the boxes on page 650 may help in understanding how muscles are named.



20D.5
Major muscles of the human body

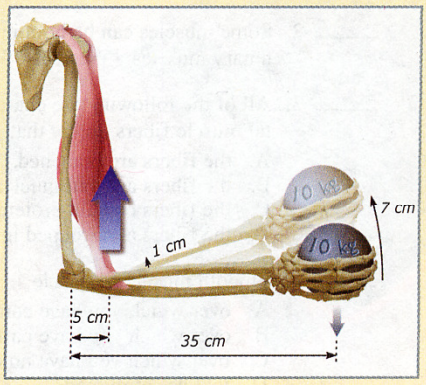
Facets of Biology — Body Mechanics

A lever is a rigid bar capable of moving around a pivot point known as the fulcrum. There are three types of levers, depending on the position of the load, the force, and the fulcrum. Most levers are used to gain either a force advantage (less force required to move a load a short distance) or a distance/speed advantage (large force required to move a load a long distance).



In the human body, bones function as levers, the joints as fulcrum points, and the muscles as the force needed to move the load. Examples of all three types of levers are found in the human body. An example of a first-class lever in the body is the atlantooccipital joint that joins the cranium to the vertebral column. The joint is the fulcrum, the muscles that depress the head (chin to chest) provide the force, and the weight of the back of the head is the load. A second-class lever is used when a person rises up on his toes. The flexion of the arm at the elbow demonstrates a third-class lever.

Since muscles can contract only a short distance (30%–40% of the original sarcomere length), most human body levers work to create a distance-speed advantage. What is a distance-speed advantage? An examination of the elbow joint will help illustrate. The elbow is an example of a third-class lever. On average, the biceps brachii muscle attaches 5 cm distal to the joint (fulcrum point), and the hand is about 35 cm away from the joint. The load arm (35 cm) is seven times longer than the power arm (5 cm). This means that if the power arm moves 1 cm, the load at the end of the load arm moves 7 cm. Additionally, if the power arm moves 1 cm in one second, the load must move 7 cm in one second. Therefore, this lever has both a distance and speed advantage. These advantages enable the body to move with greater speed and maneuverability than if other types of levers were used.



One disadvantage in this example is that the short power arm must exert seven times the downward force exerted by the object held in the hand. For example, if a 10 kg weight is held in the hand, the muscle must exert 70 kg of force to raise the weight. Of course, this is only a mechanical disadvantage in that it requires greater force to move the weight than the weight actually exerts on the hand. This does not imply that God made any mistakes when He created man. Genesis 1:31 states that all of creation was very good. God made human bodies to last. It was only after sin entered the world that bodies began to degenerate and develop problems.

Key Terms 20D-3

origin insertion action belly prime mover antagonist

Review Questions 20D-3

1. Compare and contrast the following: prime mover, antagonistic pairs of muscles, synergistic muscles.
2. Give an example of a muscle's name based upon the muscle's (a) size, (b) shape, (c) location, (d) action, (e) number of attachments, and (f) direction of fibers.

Thought Questions

1. How can you push your pencil while the muscles performing the action are not pushing?
2. The ability to build up oxygen debt is essential for humans. Discuss some advantages you have because of this ability.