

The Muscular System

Outline

- 10.1 For any movement, muscles can act in one of three ways (pp. 321–322)
- Muscles only pull; they never push, and as a muscle shortens, the insertion is pulled toward the origin. (p. 321)
 - The muscle that provides the major force for the specific movement is called the prime mover or the agonist. (p. 322)
 - Muscles that oppose or reverse a particular movement are called the antagonists, and are usually located on the opposite side of the joint from the agonist. (p. 322)
 - Synergists help the prime movers by adding extra force to the same movement, or by reducing undesirable or unnecessary movements. (p. 322)
 - When synergists immobilize a bone to provide stability for the action of a prime mover, they are acting as fixators.
- 10.2 How are skeletal muscles named? (pp. 322–324; Focus Figure 10.1)
- Criteria used to name skeletal muscles include location, shape, size, direction of muscle fibers, number of origins, location of attachments, or action. A muscle name often incorporates more than one of these criteria. (p. 322)
 - An example of a muscle named for its location is the temporalis, which covers the temporal bone.
 - An example of a muscle named for its shape is the deltoid, which has a triangular shape.
 - Terms such as *maximus*, *minimus*, *longus*, and *brevis* indicate relative muscle size.
 - Terms such as *transversus* and *oblique* are often relative to the body's midline, and indicate the fiber direction of the muscle relative to that line.
 - Biceps, triceps, and quadriceps indicate two, three, or four origins, respectively.
 - An example of a muscle named for its attachment sites is the sternocleidomastoid, which attaches at the origin at the sternum and clavicle, and at the insertion, the mastoid process.
 - Flexor, extensor, or adductor are examples of action terms that are part of many muscle's names.
- 10.3 Fascicle arrangements help determine muscle shape and force (pp. 324–325; Fig. 10.1)
- In skeletal muscles, the common arrangement of the fascicles varies, resulting in muscles with different shapes and functional capabilities. (p. 324; Fig. 10.1)
 - The fascicular pattern is circular when the fascicles are arranged in concentric rings.
 - A convergent muscle has a broad origin and its fascicles converge toward a single tendon of insertion.
 - In a parallel arrangement, the long axis of the fascicles runs parallel to the long axis of the muscle.

- a. A spindle-shaped parallel arrangement of fascicles is sometimes classified as a fusiform muscle.
- 4. In a pennate pattern of arrangement, the fascicles are short and attach obliquely to a central tendon that runs the length of the muscle.
 - a. Unipennate muscles have fascicles that insert into only one side of the tendon.
 - b. Bipennate muscles have fascicles that insert into opposite sides of the tendon, forming a feather-like pattern.
 - c. Multipennate muscles resemble several "feathers" arranged side-by-side.

10.4 Muscles acting with bones form lever systems (pp. 325–327; Figs. 10.2–10.3)

A. Lever systems have several features: (pp. 325–326; Figs. 10.2–10.3)

1. A lever is a rigid bar that moves on a fixed point, or fulcrum, when a force is applied to it.
2. The applied force, or effort, is used to move a resistance, or load.
3. In the body, the joints act as the fulcrums, the bones as the levers, and the muscle contraction as the effort.
4. If the load is close to the fulcrum and the effort is applied far from the fulcrum, the lever is a power lever and relatively little effort applied over a large distance is required to move a large load a short distance.
5. If the load is far from the fulcrum and the effort is applied near the fulcrum, the lever is a speed lever and allows a load to be moved rapidly over a large distance.
6. There are three types of levers: first-class, second-class, and third-class.
 - a. First-class levers have the effort applied at one end and the load at the other end, with the fulcrum in between.
 - b. Second-class levers have the effort applied at one end, the fulcrum at the other end, and the load in between and provide strength but not speed or range of motion.
 - c. Third-class levers have the effort applied between the load and the fulcrum and provide for rapid, extensive movements.

10.5 A muscle's origin and insertion determine its action (pp. 328–384; Figs. 10.4–10.26; Tables 10.1–10.17)

In order to provide a more concise, teachable outline of the more commonly taught muscles, along with their actions, origins, and insertions, the following tables condense the information found in the tables in the main text.

A. Muscles of the Head, Part I: Facial Expression (pp. 331–333; Figs. 10.4, 10.6–10.7; Table 10.1)

1. Muscles of facial expression located in the scalp and face insert into skin or other muscles, rather than bones, and are innervated by cranial nerve VII, the facial nerve.

Muscle	Action	Origin	Insertion
<i>Muscles of the Scalp</i>			

Epicranius • Frontal belly • Occipital belly	Raises the eyebrows	Epicranial aponeurosis	Skin of eyebrows and nose
	Fixes aponeurosis and pulls scalp posteriorly	Occipital and temporal bones	Epicranial aponeurosis
Muscles of the Face			
Orbicularis oculi	Closes eye	Frontal and maxillary bones	Eyelid
Zygomaticus	Raises lateral corners of the mouth	Zygomatic bone	Skin and muscle at corner of mouth
Risorius	Draws corner of lip laterally	Fascia of masseter	Skin at angle of mouth
Orbicularis oris	Closes lips	Maxilla and mandible	Muscle and skin at angles of the mouth
Mentalis	Wrinkles chin	Mandible	Skin of chin
Buccinator	Compresses cheek	Maxilla and mandible	Orbicularis oris
Platysma	Tenses skin of neck	Fascia of chest	Mandible and skin at corner of mouth

2. Additional muscles of the scalp and face, as well as more detailed descriptions of the actions, origins, and insertions listed in the previous table are found on the pages listed in part A, above.

B. Muscles of the Head, Part II: Mastication and Tongue Movement (pp. 334-335; Figs. 10.4, 10.8; Table 10.2)

1. Muscles involved in mastication (chewing) move the mandible and anchor the tongue, and are innervated by the mandibular branch of cranial nerve V, the trigeminal nerve.

Muscle	Action	Origin	Insertion
Muscles of Mastication			
Masseter	Closes jaw	Zygomatic arch	Angle, ramus of mandible
Temporalis		Temporal fossa	Coronoid process
Buccinator	Compresses cheek	Maxilla, mandible	Orbicularis oris

2. Additional muscles controlling the mandible and tongue, as well as more detailed descriptions of the actions, origins, and insertions listed above are found on the pages listed in part B, above.

C. Muscles of the Anterior Neck and Throat: Swallowing (pp. 336-337; Figs. 10.4, 10.9; Table 10.3)

1. Muscles involved in swallowing are part of the anterior triangle next to the sternocleidomastoid, and work to adjust the position of the larynx, elevate the soft palate to block the nasal cavity, and perform propulsive movements of the pharynx that move food into the esophagus.

2. For a detailed listing of the names, actions, origins, and insertions of muscles involved in swallowing, refer to the pages listed in part C, above.
- D. Muscles of the Neck and Vertebral Column: Head Movements and Trunk Extension (pp. 338–341; Figs. 10.4–10.5, 10.10; Table 10.4)
1. Head movements are produced by muscles originating from the axial skeleton.
 - a. Movements of the head from side to side are accomplished by contraction of muscles on only one side of the neck.
 2. Extension of the back, and maintenance of normal spinal curvatures are produced by deep back muscles originating from the sacrum to the skull.

Muscle	Action	Origin	Insertion
<i>Anterolateral Neck Muscles</i>			
Sternocleidomastoid	Flexes, laterally rotates head	Manubrium, medial clavicle	Mastoid process of temporal bone and superior nuchal line of occipital bone
Scalenes (Anterior, Middle, Posterior)	Elevate ribs 1 and 2	Cervical vertebrae	First two ribs
<i>Intrinsic Muscles of the Back</i>			
Splenius capitis, cervicis	Extends head	Cervical and thoracic vertebrae	Mastoid process of temporal bone, occipital bone, transverse processes of C ₂ –C ₄
Erector Spinae • Iliocostalis • Longissimus • Spinalis	Extends and laterally flexes vertebral column, extends head and rotates toward same side	Iliac crests, ribs	Angles of ribs, cervical vertebrae
		Vertebral column	Cervical and thoracic vertebrae, ribs
		Thoracic and lumbar vertebrae	Thoracic and cervical vertebrae

3. Additional muscles of the neck and vertebral column, as well as more detailed descriptions of the actions, origins, and insertions listed above are found on the pages listed in part D, above.
- E. Deep Muscles of the Thorax: Breathing (pp. 342–343; Figs. 10.4, 10.11; Table 10.5)
1. Deep muscles of the thorax form the anterolateral wall of the thorax and partition the thoracic from the abdominal cavity.
 2. Contraction of these muscles produces changes in the volume of the thoracic cavity, which leads to airflow into and out of the lungs.

Muscle	Action	Origin	Insertion
<i>Muscles of the Thorax</i>			
External intercostals	Elevates ribs	Inferior border of upper rib	Superior border of rib below

Internal intercostals	Compresses and depresses ribcage	Superior border of rib below	Inferior border of upper rib
Diaphragm	Flattens during inspiration	Internal surface of ribcage and sternum, lower costal cartilages, lumbar vertebrae	Central tendon

3. More detailed descriptions of the actions, origins, and insertions listed above are found on the pages listed in part E, above.

F. Muscles of the Abdominal Wall: Trunk Movements and Compression of Abdominal Viscera (pp. 344–345; Figs. 10.4, 10.12; Table 10.6)

1. The abdominal muscles protect and support the viscera, and run in different directions from each other to impart great strength to the abdominal wall.
2. The abdominal muscles attach to each other along the midline by broad aponeuroses, forming the linea alba, a tendinous raphe.

Muscle	Action	Origin	Insertion
<i>Muscles of the Anterolateral Abdominal Wall</i>			
Rectus abdominis	Flexes and rotates vertebral column	Pubic crest and symphysis	Xiphoid process, lower costal cartilages
External oblique	Flexes vertebral column, rotates and flexes vertebral column laterally, compresses abdomen	Lower ribs	Linea alba, pubic crest, tubercle, iliac crest
Internal oblique		Lumbar fascia, iliac crest	Linea alba, pubic crest, costal margin and lower ribs
Transversus abdominis	Compresses abdomen	Lumbar fascia, iliac crest, lower costal cartilages	Linea alba, pubic crest

3. More detailed descriptions of the actions, origins, and insertions of the abdominal muscles listed above are found on the pages listed in part F, above.

G. Muscles of the Pelvic Floor and Perineum: Support of Abdominopelvic Organs (pp. 346–347; Figs. 10.4, 10.13; Table 10.7)

1. The muscles of the pelvic floor and perineum close the inferior opening of the pelvis, support pelvic organs, control release of feces and urine, and participate in erection of the penis and clitoris.
2. For a detailed listing of the muscles that comprise the perineum and pelvic floor, as well as actions, origins, and insertions, refer to the pages listed in part G, above.

H. Superficial Muscles of the Anterior and Posterior Thorax: Movements of the Scapula and Arm (pp. 348–351; Figs. 10.4–10.5, 10.14; Table 10.8)

1. The superficial thorax muscles run from the ribs and vertebral column to the shoulder girdle, and both fix the scapula and create greater range of motion of arm movements.

Muscle	Action	Origin	Insertion
Muscles of the Anterior Thorax			
Pectoralis minor	Fixes ribs, protracts and depresses scapula	Ribs 3–5	Coracoid process
Serratus anterior	Rotates scapula	Ribs 1–8	Vertebral border of scapula
Subclavius	Fixes, depresses pectoral girdle	Costal cartilage of rib 1	Clavicle
Muscles of the Posterior Thorax			
Trapezius	Fixes, elevates, retracts, and rotates scapula	Occipital condyle, vertebral column	Acromion, spine of scapula, lateral third of clavicle
Levator scapulae	Elevates, adducts scapula	Vertebral transverse processes	Medial border of scapula
Rhomboids (major, minor)	Fixes scapula	Vertebral spinous processes	

2. Additional muscles moving the scapula and arm, as well as more detailed descriptions of the actions, origins, and insertions listed above are found on the pages listed in part H, above.

1. **Muscles Crossing the Shoulder Joint: Movements of the Arm (Humerus)** (pp. 352–354; Figs. 10.4–10.5, 10.15; Table 10.9)
 1. All muscles acting on the shoulder joint to move the arm originate from the pectoral girdle.
 2. Muscles originating anterior to the shoulder flex the arm, while those originating posterior to the shoulder extend the arm.

Muscle	Action	Origin	Insertion
Muscles Moving the Arm			
Pectoralis major	Flexes, adducts, medially rotates arm	Clavicle, sternum, costal cartilages	Greater tubercle
Deltoid	Abducts arm	Acromion, spine of scapula, lateral third of clavicle	Deltoid tuberosity
Latissimus dorsi	Extends, adducts, medially rotates arm	Vertebrae, ribs, iliac crest, inferior angle of scapula	Humerus
Subscapularis	Medially rotates arm	Subscapular fossa	Lesser tubercle

Supraspinatus	Abducts arm	Supraspinous fossa	Greater tubercle
Infraspinatus	Laterally rotates arm	Infraspinous fossa	
Teres minor		Lateral border of scapula	
Teres major	Extends, medially rotates, adducts arm	Inferior angle of scapula	Lesser tubercle
Coracobrachialis	Flexes, adducts arm	Coracoid process	Humerus

3. More detailed descriptions of the actions, origins, and insertions of the muscles moving the shoulder listed above are found on the pages listed in part I, above.

J. *Muscles Crossing the Elbow Joint: Flexion and Extension of the Forearm* (p. 355; Figs. 10.4–10.5, 10.15; Table 10.10)

1. There are two compartments in the arm: anterior flexors and posterior extensors, both acting on the forearm.

Muscle	Action	Origin	Insertion
Posterior Muscles			
Triceps brachii	Extends forearm	Scapula, humerus	Olecranon
Anterior Muscles			
Biceps brachii	Flexes, supinates forearm	Coracoid process, glenoid cavity	Radial tuberosity
Brachialis	Flexes forearm	Humerus	Coronoid process
Brachioradialis			Radial styloid process

2. Additional muscles crossing the elbow joint, as well as more detailed descriptions of the actions, origins, and insertions listed above are found on the page listed in part J, above.

K. *Muscles of the Forearm: Movements of the Wrist, Hand, and Fingers* (pp. 356–359; Figs. 10.4–10.5, 10.16–10.17; Table 10.11)

1. Muscles of the forearm are divided by fascia into two compartments: anterior flexors and posterior extensors.

Muscle	Action	Origin	Insertion
Anterior Superficial Muscles			
Pronator teres	Pronates forearm	Medial epicondyle of humerus, coronoid process	Radius
Flexor carpi radialis	Flexes wrist, abducts hand	Medial epicondyle of humerus	Second and third metacarpals
Palmaris longus	Tenses skin and fascia of palm		Palmar aponeurosis

Flexor carpi ulnaris	Flexes wrist, adducts hand	Medial epicondyle, olecranon	Pisiform, hamate, and fifth metacarpal
Flexor digitorum superficialis	Flexes wrist and middle phalanges of fingers 2–5	Medial epicondyle of humerus	Middle phalanges of fingers 2–5
Anterior Deep Muscles			
Flexor pollicis longus	Flexes distal phalanx of thumb	Radius, interosseous membrane	Distal phalanx of thumb
Flexor digitorum profundus	Flexes distal phalanges	Coronoid process of ulna, interosseous membrane	Distal phalanges of fingers 2–5
Pronator quadratus	Pronates forearm	Ulna	Radius

2. More detailed descriptions of the actions, origins, and insertions listed above are found on the pages listed in part K, above.

Muscle	Action	Origin	Insertion
Posterior Superficial Muscles			
Brachioradialis	Flexes forearm	Humerus	Radial styloid process
Extensor carpi radialis longus	Extends and abducts wrist	Lateral epicondyle of humerus	Second metacarpal
Extensor carpi radialis brevis			Third metacarpal
Extensor digitorum	Extends fingers		Distal phalanges of fingers 2–5
Extensor carpi ulnaris	Extends, adducts wrist	Lateral epicondyle of humerus, ulna	Fifth metacarpal
Posterior Deep Muscles			
Supinator	Supinates forearm	Lateral epicondyle of humerus, ulna	Radius
Abductor pollicis longus	Abducts and extends thumb	Radius, ulna, interosseous membrane	First metacarpal, trapezium
Extensor pollicis (brevis, longus)	Extends thumb		Proximal, distal phalanx of thumb

3. More detailed descriptions of the actions, origins, and insertions of forearm muscles listed above are found on the pages listed in part K, above.

L. Summary of Actions of Muscles Acting on the Arm, Forearm, and Hand (pp. 360–361; Fig. 10.18; Table 10.12)

M. Intrinsic Muscles of the Hand: Fine Movements of the Fingers (pp. 362–364; Fig. 10.19; Table 10.13)

1. Intrinsic muscles of the hand are located entirely in the palm, and are involved in producing fine movements: adduction and abduction of the fingers and opposition of the thumb.

Muscle	Action	Origin	Insertion
Thenar Muscles	Abducts, adducts, flexes, and opposes thumb	Flexor retinaculum, carpals, metacarpals II–IV	Proximal phalanx and metacarpal I
Hypothenar Muscles	Abducts, flexes little finger, opposes thumb	Carpals and flexor retinaculum	Proximal phalanx of little finger

2. For a detailed listing of the names, actions, origins, and insertions of muscles of the hand, refer to the pages listed in part M, above.

N. Muscles Crossing the Hip and Knee Joints: Movements of the Thigh and Leg (pp. 365–371; Figs. 10.4–10.5, 10.20–10.21; Table 10.14)

1. Fascia divide the thigh into three compartments: anterior, posterior, and medial.
 - a. The anterior compartment is made up of mostly thigh flexor muscles.
 - b. The posterior compartment consists primarily of the hamstrings, involved in extension.
 - c. The medial compartment consists of the adductor muscles, which adduct the thigh and assist the anterior flexors.

Muscle	Action	Origin	Insertion
<i>Anterior and Medial Muscles: Iliopsoas and Sartorius</i>			
Iliacus	Flexes thigh at trunk, flexes vertebral column laterally	Iliac fossa, crest, and sacrum	Lesser trochanter
Psoas major		Lumbar vertebrae	
Sartorius	Flexes, abducts, medially rotates thigh, flexes knee	Anterior superior iliac spine	Medial proximal tibia
<i>Muscles of the Medial Compartment: Adductor Group, Pectineus, and Gracilis</i>			
Adductor magnus	Adducts, flexes, extends, medially rotates thigh	Ischial and pubic rami, ischial tuberosity	Linea aspera
Adductor longus		Pubis	
Adductor brevis			
Gracilis		Pubis, ischial ramus	Tibia
<i>Muscles of the Anterior Compartment: Quadriceps Femoris Group and Tensor Fasciae Latae</i>			

Rectus femoris	Extends knee, flexes thigh	Anterior inferior iliac spine, acetabulum	Patella, tibial tuberosity via patellar ligament
Vastus lateralis	Extends knee	Greater trochanter, linea aspera	
Vastus medialis		Linea aspera	
Vastus inter-medius		Proximal shaft of femur	

Muscle	Action	Origin	Insertion
Posterior Muscles			
Gluteus maximus	Extends thigh	Ilium, sacrum, coccyx	Gluteal tuberosity of femur, iliotibial tract
Gluteus medius	Abducts, medially rotates thigh	Ilium	Greater trochanter
Gluteus minimus			
Posterior Compartment of the Thigh: Hamstrings			
Biceps femoris	Extends thigh, flexes knee	Ischial tuberosity, linea aspera	Head of fibula, lateral condyle of tibia
Semitendinosus		Ischial tuberosity	Tibia
Semimembranosus			Medial condyle of tibia, lateral condyle of femur

2. For a detailed listing of the names, actions, origins, and insertions of muscles acting on the thigh and leg, refer to the pages listed in part N, above.

O. Muscles of the Leg: Movements of the Ankle and Toes (pp. 372–377; Figs. 10.22–10.24; Table 10.15) 10.4, 5

1. The leg muscles moving the ankle and toes are divided into three compartments by deep fascia: anterior, lateral, and posterior.

Muscle	Action	Origin	Insertion
Muscles of the Anterior Compartment			
Tibialis anterior	Dorsiflexes foot	Tibia, interosseous membrane	Medial cuneiform, metatarsal I
Extensor digitorum longus	Extends toes	Tibia, fibula, interosseous membrane	Middle and distal phalanges of toes 2–5
Fibularis (peroneus) tertius	Dorsiflexes and everts foot	Fibula, interosseous membrane	Metatarsal V

Extensor hallucis longus	Extends great toe		
Muscles of the Lateral Compartment			
Fibularis (peroneus) longus	Plantar flexes and everts foot	Fibula	Metatarsal I, medial cuneiform
Fibularis (peroneus) brevis			Metatarsal V
Superficial Muscles of the Posterior Compartment: Triceps Surae and Plantaris			
Gastrocnemius	Plantar flexes foot	Medial and lateral condyles of femur	Calcaneus
Soleus		Tibia, fibula, interosseous membrane	
Deep Muscles of the Posterior Compartment			
Flexor digitorum longus	Plantar flexes and inverts foot, flexes toes	Posterior tibia	Tendon passes behind medial malleolus to distal phalanges of toes 2–5
Flexor hallucis longus	Plantar flexes and inverts foot, flexes great toe	Fibula, interosseous membrane	Tendon passes under plantar surface of foot to distal phalanx of great toe
Tibialis posterior	Inverts foot	Tibia, fibula, interosseous membrane	Tendon passes behind medial malleolus, under arch, to tarsals and metatarsals II–IV

2. More detailed descriptions of the actions, origins, and insertions of the muscles of the leg listed above are found on the pages listed in part O, above.

P. Intrinsic Muscles of the Foot: Toe Movement and Arch Support (pp. 378–381; Fig. 10.25; Table 10.16)

1. Intrinsic muscles of the foot are responsible for producing movements of the toes, or support of the arches.

2. For a detailed listing of the names, actions, origins, and insertions of muscles of the foot, refer to the pages listed in part P, above.

Q. Summary of Actions of Muscles Acting on the Thigh, Leg, and Foot (pp. 382–383; Fig. 10.26; Table 10.17)