LEARNING OUTCOMES
These Learning Outcomes correspond by number to this chapter’s modules and indicate what you should be able to do after completing the chapter. They also appear at the end of each module.

Functional Organization of the Muscular System

10.1 Describe the general functions of the body's axial and appendicular muscles. p. 351
10.2 Describe fascicle organization, and explain how fewer, affect muscle efficiency. p. 352
10.3 Explain how the name of a muscle can help identify its location, appearance, or function. p. 354
10.4 Describe the separation of muscles into axial and appendicular divisions. p. 356

Axial Muscles

10.5 Describe the four groups of axial muscles and their general functions. p. 357
10.6 Identify the flexor expression muscles, and cite their origins, insertions, and actions. p. 358
10.7 Identify the eye and jaw muscles, and cite their origins, insertions, and actions. p. 359
10.8 Identify the tongue, pharynx, and neck muscles, and cite their origins, insertions, and actions. p. 360
10.9 Identify the vertebral column muscles, and cite their origins, insertions, and actions. p. 361
10.10 Identify the pelvic floor muscles, and cite their origins, insertions, and actions. p. 362

Appendicular Muscles

10.11 Identify the hand and finger muscles, and cite their origins, insertions, and actions. p. 363
10.12 Identify the intrinsic hand muscles, and cite their origins, insertions, and actions. p. 364
10.13 Identify the extrinsic hand muscles, and cite their origins, insertions, and actions. p. 365
10.14 Identify the muscles that move the thigh, and cite their origins, insertions, and actions. p. 366
10.15 Identify the muscles that move the leg, and cite their origins, insertions, and actions. p. 367
10.16 Identify the muscles that move the foot and toes, and cite their origins, insertions, and actions. p. 368
10.17 Identify the intrinsic foot muscles, and cite their origins, insertions, and actions. p. 369

Muscle System

This section considers the functional organization of the muscular system. The human body contains approximately 700 skeletal muscles that differ widely in size, shape, and function. Although the individual skeletal muscle fibers contract the same way and to the same degree, skeletal muscle performance varies according to muscle fiber organization and how the muscle attaches to the skeleton.

The muscular system is divided into axial and appendicular divisions. Axial muscles support and position the axial skeleton. Appendicular muscles support, move, and brace the limbs.
Module 10.2
Muscular power and range of motion are influenced by fascicle organization and leverage

Fascicle Organization
1. Recall that fascicles are bundles of muscle fibers within a skeletal muscle. In a parallel muscle, such as the biceps brachii, the fascicles are parallel to the long axis of the muscle.
2. In a convergent muscle, such as the pectoralis major, muscle fascicles extend over a broad area, converge on a common attachment site. A convergent muscle is versatile because the stimulation of different portions of the muscle can change the direction of pull. However, when the entire muscle contracts, the muscle fibers do not pull as hard on the attachment site as would a parallel muscle of the same size.
3. In a pennate muscle (pen-nayt), the fascicles form a common angle with the tendon. Because the muscle fibers pull at an angle, contracting pennate muscles do not move their tendons as far as parallel muscles do. But a pennate muscle contains more muscle fibers—and thus more myofibrils—than does a parallel muscle of the same size, so it produces more tension.
4. In a circular muscle, or sphincter (SFINK-ter), the fascicles are concentrically arranged to encircle a duct, tube, or opening.

Muscular power and range of motion are influenced by fascicle organization and leverage

Lever and Leverage
The force, speed, or direction of movement produced by muscle contraction can be modified by attaching the muscle to a lever. A lever is a rigid structure, such as a board or pry bar, used to lift or pry something that pivots on a fixed point called the fulcrum. A lever moves when an applied force is able to overcome any load that would otherwise oppose or prevent such movement. In the body, each bone is a lever and each joint is a fulcrum, and muscles crossing the joint provide the applied force.

5. In a first-class lever, the fulcrum (F) lies between the applied force (AF) and the load (L). First-class levers are like a pry bar: the distance moved depends on the relative sizes of the force and the load and on how far each is from the fulcrum. Our bodies have few first-class levers, but neck extension is one example.
6. In a second-class lever, the load is located between the applied force and the fulcrum. A wheelbarrow is a familiar example of a second-class lever. Because the force is always farther from the fulcrum than the load, a small force can move a larger weight. However, the load moves slowly and covers a short distance. Thus, the effective force is increased at the expense of speed and distance moved.
7. In third-class levers (the most common levers in the body), the force is applied between the load and the fulcrum. Barbecue tongs are a familiar example of a third-class lever. In contrast to second-class levers, speed and distance traveled are increased at the expense of effective force. In the biceps brachii muscle, the load is six times farther from the fulcrum than is the applied force. The effective force is reduced to the same degree.

REVIEW
A. Why does a pennate muscle generate more tension than does a parallel muscle of the same size?

INTEGRATION
C. The joint between the occipital bone of the skull and the first cervical vertebra (atlas) is which part of which class of lever system?
Module 10.3
The origins and insertions of muscles determine their actions, while …

1. In most cases, one end of a muscle is fixed in position, and the other end moves during a contraction. The place where the fixed end attaches is called the origin of the muscle. Most muscles originate at a bone, but some originate at a connective tissue sheath or band such as the intermuscular septa (components of the deep fascia that may separate adjacent skeletal muscles) or at the interosseous membranes of the forearm or leg (see Module 7.17). The site where the movable end attaches to another structure is called the insertion of the muscle. The origin is typically proximal to the insertion when the body is in the anatomical position. However, knowing which end is the origin and which is the insertion is ultimately less important than knowing where the two ends attach and what the muscle accomplishes when it contracts. When a muscle contracts, it produces a specific movement, or action. In general, we will describe actions in terms of movement at specific joints (as in the examples shown in Module 10.2).

2. When complex movements occur, muscles commonly work in groups rather than individually. Their cooperation improves the efficiency of a particular movement. For example, large muscles of the limbs produce flexion or extension over an extended range of motion. Based on their functions, muscles may be described as agonists, antagonists, or synergists.

An agonist, or prime mover, is a muscle whose contraction is chiefly responsible for producing a particular movement. Determining which muscle in a group of muscles is the prime mover depends on the action under way and the relative positions of the articulating bones. In this simple example, the biceps brachii is an agonist that bends the elbow as when doing curls.

An antagonist is a muscle whose action opposes that of a particular agonist. The triceps brachii muscle is an agonist that extends the elbow. It therefore an antagonist of the biceps brachii muscle, which assists in flexion and helps stabilize the elbow joint. Synergists that assist an agonist by preventing movement at another joint are also called fixators.

3. Familiarity with the terms in this table will help you identify and remember specific muscles. Except for the platysma and the diaphragm, the complete names of all skeletal muscles include the term “muscle.” Although the full name, such as the biceps brachii muscle, will usually appear in the text, for simplicity only the descriptive name (biceps brachii) will be used in illustrations and tables.

**Muscle Terminology**

<table>
<thead>
<tr>
<th>Terms Indicating Specific Regions of the Body</th>
<th>Terms Indicating Position, Direction, or Fascicle Organisation</th>
<th>Terms Indicating Structural Characteristics of the Muscle</th>
<th>Terms Indicating Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominis (abdomen)</td>
<td>Anterior (front)</td>
<td>Nature of Origin</td>
<td>General</td>
</tr>
<tr>
<td>Ancon (elbow)</td>
<td>External (on the outside)</td>
<td>Bisceps (two heads)</td>
<td>Abductor (movement away)</td>
</tr>
<tr>
<td>Biceps (brachii)</td>
<td>Extremis (outside the structure)</td>
<td>Triceps (three heads)</td>
<td>Adductor (movement toward)</td>
</tr>
<tr>
<td>Capitis (head)</td>
<td>Inferior (below)</td>
<td>Quadriceps (four heads)</td>
<td>Depressor (lowering movement)</td>
</tr>
<tr>
<td>Carpi (wrist)</td>
<td>Internus (within the structure)</td>
<td>Extensor (straightening movement)</td>
<td>Extensor (straightening movement)</td>
</tr>
<tr>
<td>Carpali (wrist)</td>
<td>Lateral (on the side)</td>
<td>Flexor (bending movement)</td>
<td>Flexor (bending movement)</td>
</tr>
<tr>
<td>Costal (ribs)</td>
<td>Medialis (middle)</td>
<td>Levector (elevating movement)</td>
<td>Levator (elevating movement)</td>
</tr>
<tr>
<td>Cutaneous (skin)</td>
<td>Obliquus (slanting)</td>
<td>Pronator (turning into proper position)</td>
<td>Pronator (turning into proper position)</td>
</tr>
<tr>
<td>Femoris (femur)</td>
<td>Posterior (back)</td>
<td>Supinator (turning into supine position)</td>
<td>Supinator (turning into supine position)</td>
</tr>
<tr>
<td>Glutaealis (gluteus)</td>
<td>Rectus (straight)</td>
<td>Tensor (tensing movement)</td>
<td>Tensor (tensing movement)</td>
</tr>
<tr>
<td>Hallus (great toe)</td>
<td>Superior (toward the head)</td>
<td>Fiber (fibrous)</td>
<td>Specific</td>
</tr>
<tr>
<td>Illium (pelvis)</td>
<td>Transversus (crosswise)</td>
<td>Biceps (two heads)</td>
<td>Biceps (two heads)</td>
</tr>
<tr>
<td>Inguinal (groin)</td>
<td></td>
<td>Triceps (three heads)</td>
<td>Triceps (three heads)</td>
</tr>
<tr>
<td>Ischiadicus (ischiium)</td>
<td></td>
<td>Quadriceps (four heads)</td>
<td>Quadriceps (four heads)</td>
</tr>
</tbody>
</table>

**Other Striking Features**

- Alba (white)
- Brevis (short)
- Gracilis (slender)
- Latae (wide)
- Latissimus (restless)
- Longissimus (longest)
- Margo (large)
- Major (larger)
- Maximus (largest)
- Minimus (smallest)
- Medius (middle)
- Vastus (great)

*For other regional terms, refer to Module 1.20.*
Module 10.4

The skeletal muscles can be assigned to the axial division or the appendicular division based on origins and functions.

### Axial Muscles
- Temporals
- Frontal belly of occipitofrontalis
- Sternocleidomastoid
- Rectus abdominis
- External oblique
- Linea alba
- Flexor retinaculum

### Appendicular Muscles
- Trapézius
- Deltoïd
- Infraéminus
- Tensor minor
- Tensor major
- Rhomboïd major
- Triceps brachii (long head)
- Triceps brachii (lateral head)
- Latissimus dorsi
- Brachioradialis
- Extensor carpi radialis longus
- Anconeus
- Flexor carpi ulnaris
- Extensor digitorum longus
- Extensor carpi ulnaris
- Gluteus medius
- Tensor fasciae latae
- Gluteus maximus
- Adductor magnus
- Semimembranosus
- Gastrocnemius
- Soleus

### Instructors
- Identify the division (axial or appendicular) to which each of the following muscles belongs: biceps brachii, external oblique, temporalis, and vastus medialis.

### Review
- Identify the following muscles from the figures in this module:
  - Rhomboid major
  - Occipital belly of occipitofrontalis
  - Sternocleidomastoid
  - Obliquus

###Learning Outcome
Describe the separation of muscles into axial and appendicular divisions.

**Axial Muscles**

- The axial muscles arise on the axial skeleton and encompass about 60 percent of the skeletal muscles in the body. They position the head and spinal column and also move the rib cage, assisting in movements that make breathing possible.

**Appendicular Muscles**

- The appendicular muscles stabilize or move the appendicular skeleton and include the remaining 40 percent of all skeletal muscles.

The modules that follow organize the muscles into functional groups. However, the muscular system, like the body itself, functions as an integrated whole, and more than one muscle group will usually be seen in one view.
There are four groups of axial muscles

The axial musculature stabilizes and positions the head, neck, and trunk. Based on location and/or function, we can divide the axial muscles into the four groups shown here. The groups do not always have distinct anatomical boundaries. For example, a function such as the extension of the vertebral column involves muscles along its entire length.

1. The first group contains muscles of the head and neck that are not associated with the vertebral column. These muscles include the muscles of facial expression (see Module 10.6), the extrinsic eye muscles (see Module 10.7), and the muscles of the tongue, pharynx, and neck (see Module 10.8).

2. The second group—the muscles of the vertebral column—includes numerous muscles of varied size that stabilize, flex, extend, or rotate the vertebral column (see Module 10.9).

3. The third group consists of the oblique and rectus muscles of the trunk (see Module 10.10). These muscles are broad sheets or bands that form the muscular walls of the thoracic and abdominopelvic cavities.

4. The fourth group—the muscles of the pelvic floor (see Module 10.11)—spans the pelvic outlet and supports the organs of the pelvis.

Module 10.5
There are four groups of axial muscles

A. The axial muscles stabilize and position which regions of the body?
The muscles of facial expression are important in eating and useful for communication

All the muscles of facial expression originate on the surface of the skull, except for the platysma of the neck. At their insertions, the fibers of the epimysium are woven into those of the superficial fascia (subcutaneous layer) and the dermis of the skin. Thus, when they contract, the skin moves, allowing you to have facial expressions.

The lateral view below shows the major facial muscles. Note the abundance of muscles involved in movements of the lips.

The occipitofrontalis muscle, which forms the scalp, has two bellies that are connected by a collagenous sheet, the epicranial aponeurosis.

**Muscles of the Mouth and Cheek**

- **Temporalis**
- **Corrugator supercilii**
- **Levator labii superioris**
- **Depressor labii inferioris**
- **Masseter**

**Muscles of Facial Expression**

<table>
<thead>
<tr>
<th>Region and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mouth</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buccinator</td>
<td>Alveolar process of maxilla and alveolar part of mandible</td>
<td>Blends into fibers of orbicularis oris</td>
<td>Compresses cheeks</td>
</tr>
<tr>
<td>Depressor labii inferioris</td>
<td>Mandible between the anterior midline and the mental foramen</td>
<td>Skin of lower lip</td>
<td>Depresses lower lip</td>
</tr>
<tr>
<td>Levator labii superioris</td>
<td>Inferior margin of orbit, superior to the infra-orbital foramen</td>
<td>Orbicularis oris</td>
<td>Elevates upper lip</td>
</tr>
<tr>
<td>Levator anguli oris</td>
<td>Alveolus between the infra-orbital foramen</td>
<td>Corner of mouth</td>
<td>Elevates the corner of the mouth</td>
</tr>
<tr>
<td>Mentalis</td>
<td>Incisive fossa of mandible</td>
<td>Skin of chin</td>
<td>Elevates and protrudes lower lip</td>
</tr>
<tr>
<td>Orbicularis oris</td>
<td>Massa lateralis and mandible</td>
<td>Lips</td>
<td>Compresses, purses lips</td>
</tr>
<tr>
<td>Risorius</td>
<td>Fossa surrounding patent salivary gland</td>
<td>Angle of mouth</td>
<td>Draws corner of mouth to the side</td>
</tr>
<tr>
<td>Depressor anguli oris</td>
<td>Anterolateral surface of mandibular body</td>
<td>Skin at angle of mouth</td>
<td>Depresses corner of mouth</td>
</tr>
<tr>
<td>Zygomaticus major</td>
<td>Zygomatic bone near zygomaticomaxillary suture</td>
<td>Angle of mouth</td>
<td>Retracts and elevates corner of mouth</td>
</tr>
<tr>
<td>Zygomaticus minor</td>
<td>Zygomatic bone posterior to zygomaticomaxillary suture</td>
<td>Upper lip</td>
<td>Retracts and elevates upper lip</td>
</tr>
<tr>
<td><strong>Eye</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrugator supercilii</td>
<td>Orbital rim of frontal bone near nasal suture</td>
<td>Eyebrow</td>
<td>Pulls skin inferiorly and anteriorly; wrinkles brow</td>
</tr>
<tr>
<td>Levator palpebrae superioris</td>
<td>Tendinous band around optic foramen</td>
<td>Upper eyelid</td>
<td>Elevates upper eyelid</td>
</tr>
<tr>
<td>Orbicularis oculi</td>
<td>Medial margin of orbit</td>
<td>Skin around eyelids</td>
<td>Closes eye</td>
</tr>
<tr>
<td><strong>Nose</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procarius</td>
<td>Nasal bones and lateral nasal cartilages</td>
<td>Aponeurosis at bridge of nose and skin of forehead</td>
<td>Moves nose, changes position and shape of nostrils</td>
</tr>
<tr>
<td>Nasalis</td>
<td>Massa lateralis and cartilage of nose</td>
<td>Bridge of nose</td>
<td>Compresses bridge, depresses tip of nose; elevates corners of nostrils</td>
</tr>
<tr>
<td><strong>Scalp</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occipitofrontalis</td>
<td>Epicanthal aponeurosis</td>
<td>Bridge of nose</td>
<td>Raises eyebrows, wrinkles forehead</td>
</tr>
<tr>
<td>Temporalis</td>
<td>Orbital and temporal branches</td>
<td>Epicanthal aponeurosis</td>
<td>Tenses and retracts scalp</td>
</tr>
<tr>
<td><strong>Neck</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platysma</td>
<td>Superficial fascia between cartilage of 2nd rib and anterior margin of clavicle</td>
<td>Mandible and skin of cheek</td>
<td>Tenses skin of neck, depresses mandible and pulls lower lip inferiorly</td>
</tr>
</tbody>
</table>

**INTEGRATION**

C. Explain how a person is able to consciously move the skin on the scalp but is not able to consciously move the skin of the thigh.

**LEARNING OUTCOME**

Identify the facial expressive muscles, and cite their origins, insertions, and actions.

**REVIEW**

8. State whether the following muscles involve the mouth, yes, no, ear, scalp, or neck: buccinator, corrugator supercilii, mentalis, nasalis, platysma, procerus, and risorius.

10. Identify the facial expression muscles, and summarize their origins, insertions, and actions.
Module 10.7

The extrinsic eye muscles position the eye...

1. One additional muscle, the medial rectus, can be seen in this medial view of the right eye.

2. Five of the six extrinsic eye muscles are visible in this lateral view of the right eye.

3. This anterior view of the right eye shows the direction of eye movements produced by the contraction of each extrinsic eye muscle operating independently.

4. This anterior view of the right orbit shows the origins of the extrinsic eye muscles.

5. This lateral view shows the largest superficial muscles of mastication (chewing) of the right side of the head.

6. In the lateral view below, the pterygoid muscles are visible after removal of the superficial muscles and the right ramus of the mandible.

7. Review:
   - Which muscles have their origin on the lateral pterygoid plates and their insertion on the medial surface of the ramus of the mandible?

LEARNING OUTCOME

Identify the eye and jaw muscles, and cite their origins, insertions, and actions.

Muscles of Mastication

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masseter</td>
<td>Zygomatic arch</td>
<td>Lateral surface of mandible</td>
<td>Elevates mandible and closes the jaws</td>
</tr>
<tr>
<td>Temporals</td>
<td>Along temporal lines of skull</td>
<td>Condylar process of mandible</td>
<td>Elevates mandible</td>
</tr>
<tr>
<td>Pterygoids (medial and lateral)</td>
<td>Lateral pterygoid plate</td>
<td>Medial surface of ramus of the mandible</td>
<td>Elevates the mandible and closes the jaw, or slides the mandible from side to side</td>
</tr>
</tbody>
</table>

INTEGRATION

C. If you were contracting and relaxing your masseter, what would you probably be doing?

Section 2: Axial Muscles

Chapter 10: The Muscular System

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Module 10.8
The muscles of the tongue are closely associated with the muscles of the pharynx and neck

1. This lateral view shows the tongue muscles after removal of the left half of the mandible.

2. This lateral view shows the major groups of the muscles of the pharynx. Their roles in swallowing are discussed in Module 22.8.

3. The anterior muscles of the neck are primarily involved in positioning the mandible, hyoid bone, and larynx.

4. This is a superior view of an isolated mandible. Several muscles extending from the hyoid bone to the mandible form the muscular floor of the mouth and support the tongue.

**Muscles of the Tongue**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genioglossus</td>
<td>Medial surface of mandible around chin</td>
<td>Body of tongue, hyoid bone</td>
<td>Depresses and retracts tongue</td>
</tr>
<tr>
<td>Hyoglossus</td>
<td>Body and greater horn of hyoid bone</td>
<td>Side of tongue</td>
<td>Depresses and retracts tongue</td>
</tr>
<tr>
<td>Palatoglossus</td>
<td>Anterior surface of soft palate</td>
<td>Side of tongue</td>
<td>Elevates palate, depresses soft palate</td>
</tr>
<tr>
<td>Styloglossus</td>
<td>Stylohyoid process of temporal bone</td>
<td>Along the side of tongue</td>
<td>Retracts tongue, elevates side of tongue</td>
</tr>
</tbody>
</table>

**Muscles of the Pharynx**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal constrictors</td>
<td>Pharyngeal process of opisthenor, medial surfaces of mandible, horns of hyoid bone, cricoid and thyroid cartilages of larynx</td>
<td>Medial raphe attached to cricoid bone</td>
<td>Constrict pharynx to propel an ingested food mass into the esophagus</td>
</tr>
<tr>
<td>Laryngeal elevators</td>
<td>Soft palate, cartilage around inferior portion of auditory tube, stylohyoid process</td>
<td>Thyroid cartilage</td>
<td>Elevates larynx</td>
</tr>
<tr>
<td>Palatal muscles</td>
<td>Petrous part of temporal bone and adjacent soft tissues</td>
<td>Soft palate</td>
<td>Elevates soft palate</td>
</tr>
</tbody>
</table>

**Anterior Muscles of the Neck**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digastric</td>
<td>Inferior surface of mandible at chin and mastoid region</td>
<td>Hyoid bone</td>
<td>Depresses mandible or elevates larynx</td>
</tr>
<tr>
<td>Geniohyoid</td>
<td>Medial surface of mandible at chin</td>
<td>Hyoid bone</td>
<td>As above and pulls hyoid bone anteriorly</td>
</tr>
<tr>
<td>Styloglossus</td>
<td>Mylohyoid line of mandible</td>
<td>Hyoid bone</td>
<td>Depresses hyoid bone or depresses mandible</td>
</tr>
<tr>
<td>Palatoglossus</td>
<td>Superior border of scapula near scapular notch</td>
<td>Hyoid bone</td>
<td>Depresses hyoid bone and larynx</td>
</tr>
<tr>
<td>Styloglossus</td>
<td>Cricoid and mandibulum</td>
<td>Hyoid bone</td>
<td>Depresses hyoid bone and larynx</td>
</tr>
<tr>
<td>Styloglossus</td>
<td>Mandible and first costal cartilage</td>
<td>Thyroid cartilage of larynx</td>
<td>Depresses hyoid bone and larynx</td>
</tr>
<tr>
<td>Styloglossus</td>
<td>Stylohyoid process</td>
<td>Thyroid cartilage of larynx</td>
<td>Elevates larynx</td>
</tr>
<tr>
<td>Thyrohyoid</td>
<td>Stylohyoid process</td>
<td>Thyroid cartilage of larynx</td>
<td>Elevates larynx</td>
</tr>
<tr>
<td>Sternohyoid</td>
<td>Sternohyoid process</td>
<td>Thyroid cartilage of larynx</td>
<td>Elevates larynx</td>
</tr>
<tr>
<td>Sternomandibularis</td>
<td>One head attaches to sternal end of clavicle, the other head attaches to mastoid process</td>
<td>Mastoid region of skull and lateral portion of superior maxillary line</td>
<td>Flies the neck, one alone bends head toward shoulder and rotates neck</td>
</tr>
</tbody>
</table>

**LEARNING OUTCOME**

Identify the tongue, pharynx, and neck muscles, and cite their origins, insertions, and actions.
Module 10.9
The muscles of the vertebral column support and align the axial skeleton

The muscles of the vertebral column are arranged in several layers. They include muscles originating or inserting on the ribs and the processes of the vertebral column. Although this mass of muscles extends from the sacrum to the skull, each muscle group is composed of numerous separate muscles of various lengths.

Muscles of the Vertebral Column

<table>
<thead>
<tr>
<th>Group and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinalis cervicis</td>
<td>Superior portion of nuchal ligament and spinous processes of C7–T6</td>
<td>Spinous processes</td>
<td>Stabilizes vertebral column in extension</td>
</tr>
<tr>
<td>Iliocostalis cervicis</td>
<td>Superior borders of vertebrae and thoracic ribs</td>
<td>Transverse processes of ribs</td>
<td>Extends vertebral column, elevates ribs</td>
</tr>
<tr>
<td>Iliocostalis thoracis</td>
<td>Superior borders of inferior seven ribs</td>
<td>Upper ribs and transverse process of first lumbar vertebra</td>
<td>Stabilizes thoracic vertebrae</td>
</tr>
<tr>
<td>Iliocostalis lumborum</td>
<td>Iliac crest, sacrum, and sacrospinalis muscles</td>
<td>Inferior surfaces of inferior seven ribs</td>
<td>Extends vertebral column, depresses ribs</td>
</tr>
</tbody>
</table>

REVIEW
A. List the spinal flexor muscles.

Muscles of the Vertebral Column

Note that this table lists many extensors of the vertebral column, but few flexors. Why? The vertebral column does not have a massive series of flexor muscles because (1) many of the large trunk muscles flex the vertebral column when they contract, and (2) most of the body weight lies anterior to the vertebral column, and (3) gravity tends to flex the spine when unsupported by the extensor muscles.

REVIEW
B. Which muscles enable you to extend your neck?

LEARNING OUTCOMES
Identify the vertebral column muscles, and cite their origins, insertions, and actions.

REVIEW
C. What might account for a lack of massive flexor muscles?
Module 10.10
The oblique and rectus muscles form the muscular walls of the trunk

1. The oblique and rectus muscle groups share embryonic origins. As shown below, the scalene muscles extend from the cervical vertebrae in the neck to the first two ribs.

2. The illustration below shows superficial muscles on the right side of the body and deeper muscles of the oblique and rectus groups on the left side.

3. Major landmarks of the inferior surface of the diaphragm.

4. Review

   a. Which muscle forms the deepest layer of the abdominal wall muscles?

5. Learning Outcome

   Identify the trunk muscles, and cite their origins, insertions, and actions.

---

### Oblique and Rectus Muscles

<table>
<thead>
<tr>
<th>Group and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oblique Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalenae</td>
<td>Transverse and costal processes of cervical vertebrae</td>
<td>Superior surfaces of first two ribs</td>
<td>Elevate ribs or flex neck</td>
</tr>
<tr>
<td>External intercostals</td>
<td>Inferior border of each rib</td>
<td>Superior border of more inferior rib</td>
<td>Elevate ribs</td>
</tr>
<tr>
<td>Internal intercostals</td>
<td>Superior border of each rib</td>
<td>Inferior border of the preceding rib</td>
<td>Depress ribs</td>
</tr>
<tr>
<td>Transversus thoracis</td>
<td>Int. surface of sternum</td>
<td>Cartilages of ribs</td>
<td>Depress ribs</td>
</tr>
<tr>
<td>External oblique</td>
<td>External and internal borders of ribs 5–12</td>
<td>Linea alba and iliac crest</td>
<td>Compresses abdomen, depresses ribs, flexes or bends spine</td>
</tr>
<tr>
<td>Internal oblique</td>
<td>Lumbodorsal fascia and iliac crest</td>
<td>Inferior ribs, epiphysical process, and linea alba</td>
<td>Compresses abdomen, depresses ribs, flexes or bends spine</td>
</tr>
<tr>
<td>Transversus abdominis</td>
<td>Cartilages of ribs 6–12, iliac crest, and lumbodorsal fascia</td>
<td>Linea alba and pubis</td>
<td>Compresses abdomen</td>
</tr>
<tr>
<td>Rectus Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diaphragm</td>
<td>Xiphoid process, cartilages of ribs 4–12, and anterior surface of lumbar vertebrae</td>
<td>Central tendinous sheet</td>
<td>Contraction expands thoracic cavity, compresses abdominopelvic cavity</td>
</tr>
<tr>
<td>Rectus abdominis</td>
<td>Superior surface of pubis around symphysis</td>
<td>Inferior surfaces of costal cartilages (ribs 5–7) and xiphoid process</td>
<td>Depresses ribs, flexes vertebral column, compresses abdomen</td>
</tr>
</tbody>
</table>

---

### REVIEW

A. Which muscle connects the ribs and sternum to the pubic bones?
B. Describe the action of the external oblique.
The pelvic diaphragm does not completely close the pelvic outlet, because the urethra, vagina, and anus pass through them to open at the exterior. Muscular sphincters surround their openings and permit voluntary control of urination and defecation. Muscles, nerves, and blood vessels also pass through the pelvic outlet as they travel to or from the lower limbs.

The muscles of the pelvic floor support the organs of the abdominopelvic cavity.

**Module 10.11**

The muscles of the pelvic floor form the perineal region, an area divided into the anal triangle posteriorly and the urogenital triangle anteriorly.

**Muscles of the Pelvic Floor**

<table>
<thead>
<tr>
<th>Group and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urogenital Triangle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulbospongiosus</td>
<td>Females</td>
<td>Collagen sheath at base of clitoris; fibers run on either side of urethral and vaginal opening</td>
<td>Central tendon of perineum</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>Collagen sheath at base of penis; fibers cross over urethra</td>
<td>Median raphe and central tendon of perineum</td>
</tr>
<tr>
<td>Ischiocavernosus</td>
<td>Females</td>
<td>Ischial ramus and tuberosity</td>
<td>Pubic symphysis anterior to base of penis or clitoris</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>Ischial ramus</td>
<td>Central tendon of perineum</td>
</tr>
<tr>
<td><strong>Deep transverse perineal muscle</strong></td>
<td>Females</td>
<td>Ischial ramus and pubic rami</td>
<td>To median raphe; inner fibers encircle urethra</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>Ischial and pubic rami</td>
<td>To median raphe at base of penis; inner fibers encircle urethra</td>
</tr>
<tr>
<td><strong>Anal Triangle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pelvic diaphragm</td>
<td>Ischial spine</td>
<td>Lateral, inferior borders of sacrum and coccyx</td>
<td>Flexes coccygeal joints; tenses and supports pelvic floor</td>
</tr>
<tr>
<td>Levator ani</td>
<td>Ischial spine, pubis</td>
<td>Coccyx and median raphe</td>
<td>Tenses floor of pelvis; flexes coccygeal joints, elevates and retracts anus</td>
</tr>
<tr>
<td>Iliococcygeus</td>
<td>Inner margins of pubis</td>
<td>Coccyx and median raphe</td>
<td>Tenses floor of pelvis; flexes coccygeal joints, elevates and retracts anus</td>
</tr>
<tr>
<td>Pubococcygeus</td>
<td>Coccyx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External anal sphincter</td>
<td>Coccyx</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUPERFICIAL MUSCLES**  
**DEEP MUSCLES**

**Superficial Dissections**

- Urogenital Triangle
- Ischiocavernous
- Bulbospongiosus
- Superficial transverse perineal

**Deep Dissections**

- Urogenital Triangle
- Pubococcygeus
- Iliococcygeus
- Coccygeus
- External anal sphincter
- Deep transverse perineal muscle
- Central tendon of perineum

**ANAL TRIANGLE**

- Pubococcygeus
- Iliococcygeus
- Levator ani
- Coccygeus
- External anal sphincter
- Deep transverse perineal muscle

The pelvic diaphragm is divided into the urogenital and anal triangles. The urogenital triangle contains the urethra, vagina, and anus, while the anal triangle contains the muscles of the external anal sphincter and the coccygeus muscle.

**REVIEW**

A. Which muscles make up the pelvic diaphragm?

B. In females, what is the action of the bulbospongiosus?

C. The coccygeus extends from the sacrum and coccyx to which structure?

**LEARNING OUTCOME**

Identify the pelvic floor muscles, and cite their origins, insertions, and actions.
The appendicular muscles stabilize, position, and support the limbs

In the following modules, we will group the appendicular muscles by their actions and origins. We can describe actions in two ways, one focused on the bone and one on the joint. The first way describes actions in terms of the region affected. For example, we say a muscle such as the biceps brachii performs “flexion of the forearm.” The second way, used by specialists, such as kinesiologists and physical therapists, identifies the joint involved. In this approach, we say the action of the biceps brachii muscle is “flexion at (or of) the elbow.” We will use this second way of describing muscle actions.
Module 10.13
The largest appendicular muscles originate on the trunk

In general, muscles originating on the trunk control gross (large-scale) movements of the limbs. These muscles are often large and powerful. Distally, the limb muscles get smaller and more numerous, and their movements become more precise.

Appendicular muscles that originate on the large bones of the limb girdles and the proximal bones of the limbs dominate the posterior trunk.

1. Identify to which division, axial or appendicular, the following muscles belong: deltoid, external oblique, gluteus maximus, pectoralis major, platysma, and rectus femoris.

2. Appendicular muscles that originate on the large bones of the limb girdles and the proximal bones of the limbs dominate the posterior trunk.

REVIEW
A. Which axial muscle is often known as the “six-pack” in physically fit people?

B. Describe the appearance of the appendicular muscles as you move proximally to distally.

LEARNING OUTCOME
Identify the principal appendicular muscles.
Module 10.14

Muscles that position each pectoral girdle originate on the occipital bone, superior vertebrae, and ribs

The muscles that position the pectoral girdles also anchor the pectoral girdles to the axial skeleton. Although these muscles have a smaller range of motion compared with other appendicular muscles, they help to increase upper limb mobility.

Some deep muscles of the chest, notably the pectoralis minor and serratus anterior, work with the trapezius and levator scapulae of the back to position and stabilize each pectoral girdle.

The broad trapezius is the largest muscle in this group. The rhomboid major and rhomboid minor muscles and levator scapulae lie deep to the trapezius.

The large, superficial trapezius muscles, commonly called the “traps,” cover the back and portions of the neck, reaching to the base of the skull. These muscles are innervated by more than one nerve. For this reason, specific regions can be made to contract independently. As a result, their actions are quite varied.

### Muscles That Position the Pectoral Girdle

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levator scapula</td>
<td>Transverse processes of first four cervical vertebrae</td>
<td>Vertebral border of scapula near superior angle</td>
<td>Elevates scapula</td>
</tr>
<tr>
<td>Pectoralis minor</td>
<td>Anterior-superior surfaces of ribs 2–4, 2–3, or 3–5, depending on anatomical variation</td>
<td>Coracoid process of scapula</td>
<td>Depresses and protracts shoulder; rotates scapula so glenoid cavity moves inferiorly (downward rotation); elevates ribs if scapula is stationary</td>
</tr>
<tr>
<td>Rhomboid major</td>
<td>Spinous processes of superior thoracic vertebrae</td>
<td>Vertebral border of scapula from spine to inferior angle</td>
<td>Adducts scapula and performs downward rotation</td>
</tr>
<tr>
<td>Rhomboid minor</td>
<td>Spinous processes of vertebrae C7–T1</td>
<td>Vertebral border of scapula near spine</td>
<td>Adducts scapula and performs downward rotation</td>
</tr>
<tr>
<td>Serratus anterior</td>
<td>Anterior and superior margins of ribs 1–8 or 1–9</td>
<td>Anterior surface of vertebral border of scapula</td>
<td>Protracts shoulder; rotates scapula so glenoid cavity moves superiorly (upward rotation)</td>
</tr>
<tr>
<td>Subclavius</td>
<td>First rib</td>
<td>Clavicle (inferior border)</td>
<td>Depresses and protracts shoulder</td>
</tr>
</tbody>
</table>

The large, superficial trapezius muscles, commonly called the “traps,” cover the back and portions of the neck, reaching to the base of the skull. These muscles are innervated by more than one nerve. For this reason, specific regions can be made to contract independently. As a result, their actions are quite varied.

### REVIEW

A. Identify the largest of the superficial muscles that position the pectoral girdle.

B. Which muscles enable you to shrug your shoulders?

C. Which muscle originates on the first rib and inserts on the inferior border of the clavicle?

### LEARNING OUTCOME

Identify the pectoral girdle muscles, and cite their origins, insertions, and actions.
The action of muscles positioning the arm can be understood by considering their direction of pull relative to the center of the glenoid cavity. The arrows indicate the line of force, or line of action, produced when a muscle contracts.

Collectively, the supraspinatus, infraspinatus, teres minor, and subscapularis muscles and their associated tendons form the rotator cuff. The acronym SITS (representing the first letter of each muscle) can help you remember these four muscles.

Sports that involve throwing a ball, such as baseball or football, place considerable strain on the rotator cuff, and rotator cuff injuries are relatively common.
Module 10.16
Muscles that move the forearm and hand originate on the scapula, humerus, radius, or ulna

1. This posterior view shows the superficial muscles involved in extension at the elbow and wrist.

2. This anterior view shows the superficial muscles involved in flexion at the elbow and wrist.

3. The muscles involved in pronation and supination are the pronator teres, supinator, and pronator quadratus. Both the pronator teres and supinator originate on both the humerus and ulna and rotate the radius without either flexing or extending the elbow. The pronator quadratus muscle originates on the ulna and assists in pronation (see Module 8.5).

4. In this anterior view of the forearm, the flexor retinaculum is a wide band of connective tissue that stabilizes the tendons of the flexor muscles.

5. Anconeous

6. Flexor carpi radialis

7. Pronator teres

8. Extensor carpi radialis brevis

9. Extensor carpi ulnaris

10. Supinator

LEARNING OUTCOME
Identify the flexor muscles, and cite their origins, insertions, and actions.
Module 10.17
Muscles that move the hand and fingers originate on the humerus, radius, ulna, and interosseous membrane

In anterior view, the large flexor digitorum superficialis covers the smaller digital flexors.

Muscles That Move the Hand and Fingers

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abductor pollicis longus</td>
<td>Proximal dorsal surfaces of ulna and radius</td>
<td>Lateral margin of first metacarpal bone</td>
<td>Abduction at carpometacarpal joint of thumb and wrist</td>
</tr>
<tr>
<td>Extensor digitorum</td>
<td>Lateral epicondyle of humerus</td>
<td>Posterior surfaces of the phalanges, fingers 2–5</td>
<td>Extension at finger joints and wrist</td>
</tr>
<tr>
<td>Extensor pollicis brevis</td>
<td>Shaft of radius distal to origin of abductor pollicis longus</td>
<td>Base of proximal phalanx of thumb</td>
<td>Extension at carpometacarpal joint of thumb; abduction at wrist</td>
</tr>
<tr>
<td>Extensor pollicis longus</td>
<td>Posterior and lateral surfaces of ulna and interosseous membrane</td>
<td>Base of distal phalanx of thumb</td>
<td>Extension at carpometacarpal joint of thumb; abduction at wrist</td>
</tr>
<tr>
<td>Extensor indicis</td>
<td>Posterior surface of ulna and interosseous membrane</td>
<td>Posterior surface of phalanges of index finger (2), with tendon of extensor digitorum</td>
<td>Extension at joints at points of index finger</td>
</tr>
<tr>
<td>Extensor digiti minimi</td>
<td>By extensor tendon to lateral epicondyle of humerus and from intermuscular septa</td>
<td>Posterior surface of proximal phalanx of little finger (3)</td>
<td>Extension at joints of little finger</td>
</tr>
<tr>
<td>Flexor digitorum superficialis</td>
<td>Medial epicondyle of humerus, adjacent anterior surfaces of ulna and radius</td>
<td>Malleolar surfaces of middle phalanges of fingers 2–5</td>
<td>Flexors at proximal interphalangeal, metacarpophalangeal, and wrist joints</td>
</tr>
<tr>
<td>Flexor digitorum profundus</td>
<td>Medial and posterior surfaces of ulna, medial surface of coronoid process, and interosseous membrane</td>
<td>Base of distal phalanges of fingers 2–5</td>
<td>Flexors at distal interphalangeal joints and, to a lesser degree, proximal interphalangeal joints and wrist joints</td>
</tr>
<tr>
<td>Flexor pollicis longus</td>
<td>Anterior shaft of radius, interosseous membrane</td>
<td>Base of distal phalanx of thumb</td>
<td>Flexion at carpometacarpal joint of thumb</td>
</tr>
</tbody>
</table>

In posterior view, the muscles that extend the fingers can only be seen after removal of the muscles involved in wrist movements. The deepest digital extensor muscles are those associated with movements of the thumb.

Synovial tendon sheaths are tubular bursae that surround tendons where they cross bony surfaces. The tendons of the flexor muscles pass through such sheaths as they pass deep to the flexor retinaculum. Inflammation of the flexor retinaculum and synovial tendon sheaths can restrict movement and put pressure on the distal portions of the median nerve, a mixed (sensory and motor) nerve that innervates the hand. This condition, known as carpal tunnel syndrome, causes tingling, numbness, weakness, and chronic pain in the wrist and hand.

As you study these muscles, you will notice that extensor muscles usually lie along the posterior and lateral surfaces of the forearm, whereas flexors are typically found on the anterior and medial surfaces. Remember, the limb must be in the anatomical position for this to be true. This information can be quite useful when you are trying to identify a particular muscle on a quiz or a lab practical.

LEARNING OUTCOME
Identify the muscles of the hand and fingers, and cite their origins, insertions, and actions.
Fine control of the hand involves small intrinsic muscles that originate on the carpal and metacarpal bones. These intrinsic muscles are responsible for (1) flexion and extension of the fingers at the metacarpophalangeal joints, (2) abduction and adduction of the fingers at the metacarpophalangeal joints, and (3) opposition and reposition (relaxed position) of the thumb. No muscles originate on the phalanges, and only tendons extend across the distal joints of the fingers.

### Intrinsic Muscles of the Hand

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmaris brevis</td>
<td>Palmar aponeurosis</td>
<td>Skin of medial border of hand</td>
<td>Moves skin on medial border toward median of palm</td>
</tr>
<tr>
<td>Adductor pollicis</td>
<td>Metacarpal and carpal bones</td>
<td>Proximal phalanx of thumb</td>
<td>Abduction of thumb</td>
</tr>
<tr>
<td>Palmar interosseus (3–4)</td>
<td>Sides of metacarpal bones (f, fl, and)</td>
<td>Bases of proximal phalanges of fingers 2, 4, and 5</td>
<td>Abduction at metacarpophalangeal joints of fingers 2, 4, and 5; flexion at metacarpophalangeal joints; extension at interphalangeal joints</td>
</tr>
<tr>
<td>Dorsal interosseus (4)</td>
<td>Each originates from opposing faces of two metacarpal bones (i and ii, ii and iii, iii and iv, iv and v)</td>
<td>Bases of proximal phalanges of fingers 2–4</td>
<td>Abduction at metacarpophalangeal joints of fingers 2 and 4; flexion at metacarpophalangeal joints; extension at interphalangeal joints</td>
</tr>
<tr>
<td>Opponens digiti minimi</td>
<td>Trapeziun and flexor retinaculum</td>
<td>Proximal phalanx of little finger</td>
<td>Abduction of little finger and flexion at its metacarpophalangeal joint</td>
</tr>
<tr>
<td>Flexor digiti minimi brevis</td>
<td>Trapeziun and flexor retinaculum</td>
<td>Proximal phalanx of little finger</td>
<td>Flexion and adduction of little finger</td>
</tr>
<tr>
<td>Opponens pollicis</td>
<td>Trapeziun and flexor retinaculum</td>
<td>First metacarpal bone</td>
<td>Opposition of thumb</td>
</tr>
<tr>
<td>Opponens digiti minimi</td>
<td>Trapeziun and flexor retinaculum</td>
<td>Fifth metacarpal bone</td>
<td>Opposition of fifth metacarpal bone</td>
</tr>
</tbody>
</table>

### Clinical Note

**Trigger finger**

Trigger finger is a condition in which a finger gets stuck in a bent position and opens with a painful snap (like a trigger being released). It is caused by inflammation and thickening of the tendon sheath that covers the flexor digitorum tendon. The inflammation narrows the opening the tendon normally glides through. Treatment usually begins with rest and a hydrocortisone injection but may require surgery.

**In Review**

1. Which muscles originate in the phalanges?
2. If there are no muscles in the fingers, how are we able to move them?
3. Identify the intrinsic hand muscles, and cite their origins, insertions, and actions.

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**Section 3: Appendicular Muscles**

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**Trigger finger**

Trigger finger is a condition in which a finger gets stuck in a bent position and opens with a painful snap (like a trigger being released). It is caused by inflammation and thickening of the tendon sheath that covers the flexor digitorum tendon. The inflammation narrows the opening the tendon normally glides through. Treatment usually begins with rest and a hydrocortisone injection but may require surgery.

**In Review**

1. Which muscles originate in the phalanges?
2. If there are no muscles in the fingers, how are we able to move them?
3. Identify the intrinsic hand muscles, and cite their origins, insertions, and actions.
Module 10.19

The muscles that move the thigh originate on the pelvis and associated ligaments and fasciae

1. The gluteal group covers the posterior and lateral surfaces of the pelvis.

2. This dissection of the gluteal region in posterior view shows five of the six lateral rotators.

3. This anterior view shows the isolated iliopsoas muscle group and the adductor group.

---

**Muscles That Move the Thigh**

<table>
<thead>
<tr>
<th>Group and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluteal Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gluteus maximus</td>
<td>Iliac crest, posterior gluteal line, and lateral surface of ilium; sacrum, coccyx, and thoracolumbar fascia</td>
<td>Iliobial tract and gluteal tuberosity of femur</td>
<td>Extension and lateral rotation at hip</td>
</tr>
<tr>
<td>Gluteus medius</td>
<td>Anterior iliac crest of ilium, lateral surface between posterior and anterior gluteal lines</td>
<td>Greater trochanter of femur</td>
<td>Abduction and medial rotation at hip</td>
</tr>
<tr>
<td>Gluteus minimus</td>
<td>Lateral surface of ilium between anterior and anterior gluteal lines</td>
<td>Greater trochanter of femur</td>
<td>Abduction and medial rotation at hip</td>
</tr>
<tr>
<td>Tensor fasciae latae</td>
<td>Iliac crest and lateral surface of anterior superior iliac spine</td>
<td>Iliobial tract</td>
<td>Extensors of the knee and lateral rotation of the hip</td>
</tr>
</tbody>
</table>

| Lateral Rotator Group | | |
|----------------------|-----------------|-----------------|-----------------|
| Obturator internus   | Lateral and medial margins of obturator foramen | Externus: trochanteric fossa of femur; internus: medial surface of greater trochanter | Lateral rotation at hip |
| Piriformis           | Anterolateral surface of sacrum | Greater trochanter of femur | Lateral rotation and abduction at hip |
| Gemellus superior    | Ischial spine and tuberosity | Medial surface of greater trochanter with tendon of obturator internus | Lateral rotation at hip |
| Gemellus inferior    | | | |

| Adductor Group | | |
|----------------|-----------------|-----------------|-----------------|
| Adductor brevis | Inferior ramus of pubis | Linea aspera of femur | Adduction, flexion, and medial rotation at hip |
| Adductor longus | Inferior ramus of pubis anterior to adductor brevis | Linea aspera of femur | Adduction, flexion, and medial rotation at hip |
| Adductor magnus | Inferior ramus of pubis posterior to adductor brevis and ischial tuberosity | Linea aspera and adductor tubercle of femur | Adduction at hip; superior part produces flexion and medial rotation; inferior part produces extension and lateral rotation |
| Pectineus | Superior ramus of pubis | Pectineal line inferior to lesser trochanter of femur | Flexion, medial rotation, and adduction at hip |
| Gracilis | Inferior ramus of pubis | Medial surface of tibia inferior to medial condyle | Flexion at knee; adduction and medial rotation at hip |

| Iliopsoas Group* | | |
|------------------|-----------------|-----------------|-----------------|
| Iliacus | Iliac fossa of ilium | Femoral distal to lesser trochanter; tendon fused with that of psoas major | Flexion at hip |
| Psoas major | Anterior surfaces and transverse processes of vertebrae (T12-L5) | Lesser trochanter in company with iliacus | Flexion at hip or lumbar intervertebral joints |

---

*The psoas major and iliacus are often considered collectively as the iliopsoas
**Role in abduction is debatable.

One method for understanding the actions of these diverse muscles is to consider their orientation around the hip joint. Muscles originating on the surface of the pelvis and inserting on the femur will produce characteristic movements determined by their position relative to the acetabulum. Many of the muscles that act on the hip are very large, and they have insertions that extend over a broad area. As a result, these muscles often have more than one action line and therefore produce more than one action at the hip. For example, the action of the adductor magnus varies depending on the portion of the muscle is activated; when the entire muscle contracts, it produces a combination of flexion, extension, and adduction at the hip.
**Flexors of the knee** originate on the pelvic girdle and extend along the posterior and medial surfaces of the thigh. Collectively, the four knee extensor muscles are called the quadriceps femoris.

**Extensors of the Knee** originate on the femoral surface and extend along the anterior and lateral surfaces of the thigh. The vastus lateralis muscle is the only one that crosses both the knee and hip joints.

---

### Muscles That Move the Leg

<table>
<thead>
<tr>
<th>Group and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flexors of the Knee</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps femoris</td>
<td>Ischial tuberosity and linea aspera of femur</td>
<td>Head of fibula, lateral condyle of tibia</td>
<td>Flexion at knee; extension and lateral rotation at hip</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>Ischial tuberosity</td>
<td>Posterior surface of medial condyle of tibia</td>
<td>Flexion at knee; extension and medial rotation at hip</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>Ischial tuberosity</td>
<td>Proximal, medial surface of tibia near ischion of gracilis</td>
<td>Flexion at knee; extension and medial rotation at hip</td>
</tr>
<tr>
<td>Popliteus</td>
<td>Anterior superior iliac spine</td>
<td>Medial surface of tibia near tibial tuberosity</td>
<td>Flexion at knee; extension and lateral rotation at hip</td>
</tr>
<tr>
<td><strong>Extensors of the Knee</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>Anterior inferior iliac spine and superior acetabular rim of ilium</td>
<td>Tibial tuberosity by patellar ligament</td>
<td>Extension at knee; flexion at hip</td>
</tr>
<tr>
<td>Vastus intermedius</td>
<td>Anterolateral surface of femur and linea aspera (distal half)</td>
<td>Tibial tuberosity by patellar ligament</td>
<td>Extension at knee</td>
</tr>
<tr>
<td>Vastus lateralis</td>
<td>Anterior and inferior to greater trochanter of femur and along linea aspera (proximal half)</td>
<td>Tibial tuberosity by patellar ligament</td>
<td>Extension at knee</td>
</tr>
<tr>
<td>Vastus medialis</td>
<td>Entire length of linea aspera of femur</td>
<td>Tibial tuberosity by patellar ligament</td>
<td>Extension at knee</td>
</tr>
</tbody>
</table>

---

**REVIEW**

A. Which muscle flexes the knee?

B. Name the muscle of the quadriceps femoris.

C. Identify the muscle whose origin is on the lateral condyle of the femur.

---

This cross-sectional view shows the positions of the major thigh muscles relative to the femur. Together, the vastus muscles cradle the rectus femoris muscle the way a bun surrounds a hot dog. All four muscles insert on the patella via the quadriceps tendon.
The extrinsic muscles that move the foot and toes originate on the tibia and fibula

### Module 10.21

These views show the multiple muscle layers in the posterior aspect of the leg.

### Superficial Dissection

- **Ankle Extensors**
  - Plantaris
  - Gastrocnemius
  - Soleus

### Deep Dissection

- **Ankle Extensors (Deep)**
  - Tibialis posterior
  - Fibularis longus
  - Fibularis brevis
  - Gastrocnemius

- **Digital Extensors**
  - Flexor digitorum longus
  - Flexor hallucis longus

### Deep Dissection

- **Calcaneus (cut and removed)**

### Review

1. Name the muscles involved in extending the ankle.
2. Name the muscles involved in flexing the toes.

### Learning Outcome

- Identify the muscles that move the foot and toes, and cite their origins, insertions, and actions.

### Integration

- How would a torn calcaneal tendon affect movement at the ankle?

### Extrinsic Muscles That Move the Foot and Toes

<table>
<thead>
<tr>
<th>Group and Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action at the Ankle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>Lateral condyle and proximal shaft of tibia</td>
<td>Base of first metatarsal bone and medial cuneiform bone</td>
<td>Flexion (dorsiflexion) at ankle; inversion of foot</td>
</tr>
<tr>
<td>Fibularis tertius</td>
<td>Distal anterior surface of fibula and interosseous membrane</td>
<td>Dorsal surface of fifth metatarsal bone</td>
<td>Flexion (dorsiflexion), eversion of foot</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>Membranous condyles</td>
<td>Calcaneus by calcaneal tendon</td>
<td>Extension (plantar flexion) at ankle; inversion of foot; flexion at knee</td>
</tr>
<tr>
<td>Fibularis brevis</td>
<td>Medial margin of fibula</td>
<td>Base of fifth metatarsal bone</td>
<td>Eversion of foot and extension (dorsiflexion) at ankle</td>
</tr>
<tr>
<td>Fibularis longus</td>
<td>Lateral condyle of tibia, head and proximal shaft of fibula</td>
<td>Base of first metatarsal bone and medial cuneiform bone</td>
<td>Extension of foot and extension (dorsiflexion) at ankle; supports longitudinal arch</td>
</tr>
<tr>
<td>Plantaris</td>
<td>Lateral suprapatellar ridge</td>
<td>Posterior portion of calcaneus</td>
<td>Extension (plantar flexion) at ankle; flexion at knee</td>
</tr>
<tr>
<td>Soleus</td>
<td>Head and proximal shaft of fibula and adjacent posterior medial shaft of tibia</td>
<td>Calcaneus by calcaneal tendon (with gastrocnemius)</td>
<td>Extension (plantar flexion) at ankle</td>
</tr>
<tr>
<td><strong>Action at the Toes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexor digitorum longus</td>
<td>Posteromedial surface of tibia</td>
<td>Inferior surfaces of distal phalanges, toes 2–5</td>
<td>Flexion at joints of toes 2–5</td>
</tr>
<tr>
<td>Flexor hallucis longus</td>
<td>Posterior surface of fibula</td>
<td>Inferior surface, distal phalanges of great toe</td>
<td>Flexion at joints of great toe</td>
</tr>
<tr>
<td>Extensor digitorum longus</td>
<td>Lateral condyle of tibia, anterior surface of fibula</td>
<td>Superior surfaces of phalanges, toes 2–5</td>
<td>Extension at joints of toes 2–5</td>
</tr>
<tr>
<td>Extrinsic hallucis longus</td>
<td>Anterior surface of fibula</td>
<td>Superior surface, distal phalanges of great toe</td>
<td>Extension at joints of great toe</td>
</tr>
</tbody>
</table>

The largest muscles associated with ankle movement are the **gastrocnemius** and **soleus**. These muscles produce ankle extension (plantar flexion), a movement essential to walking and running (see Module 8.4). The muscles that move the toes are much smaller, and they originate on the surface of the tibia, fibula, or both. Large tendon sheaths surround the tendons of the tibialis anterior, extensor digitorum longus, and extensor hallucis longus muscles where they cross the ankle joint. The positions of these sheaths are stabilized by the **superior extensor retinaculum** and **inferior extensor retinaculum**, tough supporting bands of collagen fibers.
Module 10.22
The intrinsic muscles of the foot originate on the tarsal and metatarsal bones and associated tendons and ligaments

Intrinsic muscles are more numerous on the inferior surface of the foot and occur in several layers.

- **Superficial Muscles of the Sole of the Foot**
  - Abductor hallucis
  - Abductor digiti minimi
  - Flexor hallucis brevis
  - Flexor digitorum brevis
  - Flexor digitorum longus
  - Quadratus plantae
  - Lumbricalis
  - Tendons of flexor digitorum brevis
- **Deep Muscles of the Sole of the Foot**
  - Abductor hallucis
  - Adductor hallucis
  - Abductor digiti minimi
  - Flexor hallucis brevis
  - Flexor digitorum brevis
  - Flexor digitorum longus
  - Quadratus plantae
  - Abductor hallucis
  - Tendons of flexor digitorum brevis

**Intrinsic Muscles of the Foot**

- **Muscle**
  - Flexor hallucis brevis
  - Flexor digitorum brevis
  - Flexor digitorum longus
  - Quadratus plantae
  - Lumbricalis
  - Flexor digiti minimi brevis
  - Extensor hallucis brevis
  - Adductor hallucis
  - Extensor digitorum brevis

- **Origin**
  - Cuboid and lateral cuneiform bones of the foot
  - Calcaneus (subtendon of inferior extensor retinaculum)
  - Calcaneus, (medial, inferior surfaces)
  - Calcaneus (superior and lateral surfaces)
  - Calcaneus (medial, inferior surfaces)
  - Calcaneus (superior and lateral surfaces)
  - Calcaneus (medial, inferior surfaces)
  - Calcaneus (medial, inferior surfaces)

- **Insertion**
  - Proximal phalanx of great toe
  - Sides of middle phalanges, toes 2–5
  - Tendons of extensor digitorum longus, toes 2 to 5
  - Dorsal surfaces of toes 1–4
  - Dorsal surface of the base of proximal phalanx of great toe
  - Proximal phalanx of great toe

- **Action**
  - Flexion at metatarsalophalangeal joint of great toe
  - Flexion at proximal interphalangeal joints of toes 2–5
  - Flexion at joints of toes 2–5
  - Extension at proximal interphalangeal joints of toes 2–5
  - Flexion at joints of toes 2–5
  - Extension at metatarsalophalangeal joints of toe 5
  - Extension of great toe
  - Flexion at metatarsalophalangeal joints of toes 3–5
  - Abduction at metatarsalophalangeal joint of great toe
  - Abduction at metatarsalophalangeal joints of toes 3 and 4
  - Abduction at metatarsalophalangeal joint of toe 5

**ADDITIONAL INFORMATION**

- As you see in this cross section, most of the muscle mass in the foot lies inferior to the metatarsal bones. Many of these muscles are flexors that tense during ankle extension and help you "push off" when walking. This anatomical arrangement provides padding and assists in maintaining the arches of the foot.

**REVIEW**

- A. What are the functions of the superior and inferior retinacula of the foot?
- B. Identify the intrinsic muscles that flex the great toe.
- C. Which intrinsic foot muscles originate on and insert on tendons?
Module 10.23

The deep fascia divides the limb muscles into separate compartments

Fibrous partitions of the deep fascia in the limbs form intermuscular septa that separate muscles into sections called compartments. The muscles within each compartment have compatible functions (such as flexion or extension), and each has a characteristic blood supply and innervation. Because of this structural separation, infection or excess pressure is usually restricted to the affected compartment.

Compartments are clinically important. For example, trauma to a limb can cause bleeding, which elevates pressures and compresses blood vessels and nerves within the compartment. A lack of blood flow leads to “blood starvation,” or ischemia. This condition, called compartment syndrome, can lead to the paralysis or death of the affected muscles if the pressure is not relieved within 2–4 hours.
Appendicular Muscles

Labeling: Label each of the indicated muscles that move the thigh and leg in the diagram at right.

1. 
2. 
3. 
4. 
5. 
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23. 
24. 
25. 

Label each of the indicated muscles that move the forearm and hand in the diagram at right.

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
11. 
12. 
13. 
14. 
15. 
16. 
17. 
18. 
19. 
20. 
21. 
22. 
23. 
24. 
25. 

Label each of the indicated muscles that move the foot and toes in the diagram below.

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
11. 
12. 
13. 
14. 
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16. 
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18. 
19. 
20. 
21. 
22. 
23. 
24. 
25. 

Study Outline

 SECTION 1 • Functional Organization of the Muscular System

Module 10.1  The axial and appendicular muscles have different functions p. 351

1. Skeletal muscle accounts for almost half the weight of your body.
2. The muscular system is divided into the axial and appendicular muscles.
3. The axial muscles support and position the axial skeleton, and the appendicular muscles supply and move the limbs.

Module 10.2  Muscular power and range of motion are influenced by fascicle organization and leverage p. 352

4. Muscle fascicles can be organized as parallel, convergent, pennate (unipennate, bipennate, or multipennate), or circular (sphincter).
5. A lever is a rigid structure that pivots on a fixed point called a fulcrum. In the body, bones act as levers, and joints act as fulcnums.
6. Levers are classified as first-class, second-class, and third-class levers. Third-class levers are the most common levers in the body.

Module 10.3  The origins and insertions of muscles determine their actions, while their names can provide clues to appearance and/or function p. 354

7. Each muscle can be identified by its origin, insertion, and action.
8. The site of attachment at the fixed end of the muscle is the origin, the site where the movable end of the muscle attaches to another structure is called the insertion. The movement produced when a muscle contracts is the action.
9. A muscle can be classified as an agenst, or prime mover, an antagonist, or a synergist.
10. Muscle terminology is associated with the location of the muscle, as well as its position, fascicle organization, structural characteristics, actions, and other features.

Module 10.4  The skeletal muscles can be assigned to the axial division or the appendicular division based on origins and functions p. 356

11. About 60 percent of the skeletal muscles in the body are axial muscles. The remaining are appendicular muscles.

 SECTION 2 • Axial Muscles

Module 10.5  There are four groups of axial muscles p. 359

12. The first group of axial muscles is the muscles of the head and neck that are not associated with the vertebral column. These are the muscles of the face, extrinsic eye, tongue, pharynx, and neck.
13. The second group of axial muscles is the muscles of the vertebral column. The third group of muscles is the muscles of the trunk, and the muscles of the pelvic floor form the fourth group.

Module 10.6  The muscles of facial expression are important in eating and useful for communication p. 360

14. The muscles of facial expression originate on the surface of the skull. They insert on the superficial fascia and dermis of the skin.
15. The muscles of the mouth and cheek are levator labii superioris, zygomaticus minor, zygomaticus major, buccinator, levator anguli oris, orbicularis oris, risorius, mentalis, depressor labii inferioris, and depressor anguli oris.

Module 10.7  The extrinsic eye muscles position the eye, and the muscles of mastication move the lower jaw p. 362

16. The extrinsic eye muscles are inferior rectus, medial rectus, superior rectus, lateral rectus, inferior oblique, and superior oblique.
17. The muscles of mastication are masseter, temporalis, medial pterygoid, and lateral pterygoid.

Module 10.8  The muscles of the tongue are closely associated with the muscles of the pharynx and neck p. 364

18. The muscles of the tongue are genioglossus, hyoglossus, palatoglossus, and styloglossus.
19. The muscles of the pharynx are the pharyngeal constrictors, laryngeal elevators, and palatal muscles.
20. The anterior muscles of the neck are digastric, genioglossus, mylohyoid, omohyoid, sternohyoid, sternothyroid, styloglossus, thyrohyoid, and sternocleidomastoid.

Module 10.9  The muscles of the vertebral column support and align the axial skeleton p. 366

21. The erector spinae muscles are subdivided into the spinalis, longissimus, and iliocostalis muscle groups.

Module 10.10  The oblique and rectus muscles form the muscular walls of the trunk p. 368

22. The oblique muscles include the scalenes, external and internal intercostals, transversus thoracis, external and internal obliques, and transversus abdominis.
23. The rectus group includes the diaphragm and rectus abdominis.
Section 3 • Appendicular Muscles

Module 10.12
Muscles that position each pectoral girdle originate on the trunk. Limb muscles get smaller, more numerous, and more precise as they are located more distally on the limb.

Module 10.13
The largest appendicular muscles originate on the clavicle, scapula, and more proximal to the limbs, the upper arm, forearm, hand, and fingers.

Module 10.14
The muscles that move the arm are biceps brachii, brachialis, and anconeus. The elbow extensors are rhomboid major, and rhomboid minor.

Module 10.15
The muscles that move the arm originate on the clavicle, scapula, thoracic cage, and vertebral column.

Module 10.16
Muscles that move the forearm and hand originate on the scapula, humerus, radius, or ulna.

Module 10.17
Muscles that move the hand and fingers originate on the humerus, radius, ulna, and interosseous membrane.

Module 10.18
The intrinsic muscles of the hand originate on the carpals and metacarpals, and associated tendons and ligaments.

Module 10.19
The muscles that move the thigh originate on the pelvic and associated ligaments and fasciae.

Module 10.20
The muscles that move the leg originate on the pelvis and femur.

Module 10.21
The extrinsic muscles that move the foot and toes originate on the tibia and fibula.

Module 10.22
The intrinsic muscles of the foot originate on the tarsal and metatarsal bones and associated tendons and ligaments.

Module 10.23
The deep fascia divides the limb muscles into separate compartments.

Chapter Review Questions

True/False: Indicate whether each statement is true or false.

Matching: Match each lettered action with the most closely related muscle.

The intrinsic muscles of the foot stabilize the positions of the tendons descending from the leg. These muscles are more numerous on the inferior surface of the foot and occur in several layers. These intrinsic muscles are responsible for flexion and extension of the interphalangeal joints, as well as abduction and adduction of the metatarsophalangeal joints.
Bodybuilding and lookin’ good

Bodybuilders spend many hours in the gym lifting free weights to develop their muscles. Larger muscles and greater muscle definition are the goals, and looking “ripped” requires a lot of dedication. To sculpt their arms, for example, bodybuilders do a lot of biceps curls (flexion at the elbow holding weights in the anatomical position) and triceps curls (extension at the elbow).

As a 10-year-old, Jerry and his friends would go to the beach at Lion’s Park, known locally as “Muscle Beach” because all the local bodybuilders would go there in the summer to work out and show off for the girls. Some female bodybuilders even started going there. Jerry was always amazed by the size, shape, and strength of these musclemen and vowed that someday he would become one of them. As he reached puberty, Jerry became a fitness fanatic who worked out many hours a day. As he learned more about bodybuilding, he avoided the massive, heavily muscled look for one of a more athletic, lean, and well-defined musculature. Everyone came to admire his “six-pack abs,” especially his girlfriend, DJ.

1. Explain why doing both biceps curls and triceps curls helps achieve larger, well-toned arms.

2. Which exercises would be best for shaping your abdominal muscles into “six-pack abs”?

Sports, muscles, and joints

Jennifer is a high school freshman and an up-and-coming volleyball player on the junior varsity team. It is her intent to join the varsity team as a sophomore. One element of her game that she knows she needs to improve upon is her vertical jump. She has committed her offseason workouts to spending more time in the weight room strengthening the muscles involved in jumping. From what you have just learned about the muscular system, answer the following questions and design a weightlifting program to help Jennifer achieve her goals.

3. Identify the actions involved at the hip, knee, and ankle joints when a person is jumping.

4. Which muscles are involved in each of these actions?

5. What kind of exercises would you suggest Jennifer perform in the weight room to increase the strength in these muscles?