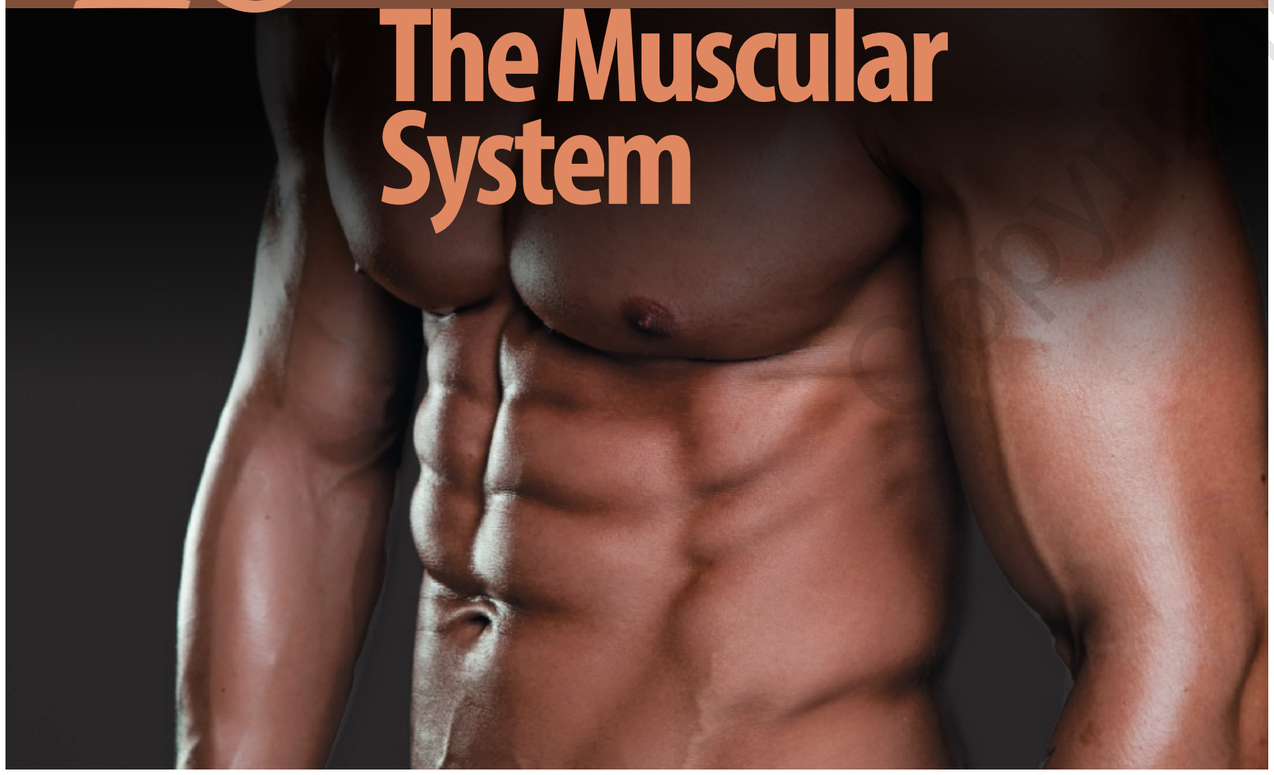
10 The Muscular System



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 function of the body's axial and appendicular muscles. p. 351

10.2 Describe fascicle organization, and explain how levers 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. 359

10.6 Identify the facial expression muscles, and cite their origins, insertions, and actions. p. 360

10.7 Identify the eye and jaw muscles, and cite their origins, insertions, and actions. p. 362

10.8 Identify the tongue, pharynx, and neck muscles, and cite their origins, insertions, and actions. p. 364

10.9 Identify the vertebral column muscles, and cite their origins, insertions, and actions. p. 366

10.10 Identify the trunk muscles, and cite their origins, insertions, and actions. p. 368

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Appendicular Muscles

10.12 Describe the general functions of the muscles of the upper and lower limbs. p. 373

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10.15 Identify the muscles that move the arm, and cite their origins, insertions, and actions. p. 378

10.16 Identify the forearm muscles, and cite their origins, insertions, and actions. p. 380

10.17 Identify the muscles of the hand and fingers, and cite their origins, insertions, and actions. p. 382

10.18 Identify the intrinsic hand muscles, and cite their origins, insertions, and actions. p. 384

10.19 Identify the muscles that move the thigh, and cite their origins, insertions, and actions. p. 386

10.20 Identify the muscles that move the leg, and cite their origins, insertions, and actions. p. 388

10.21 Identify the muscles that move the foot and toes, and cite their origins, insertions, and actions. p. 390

10.22 Identify the intrinsic foot muscles, and cite their origins, insertions, and actions. p. 392

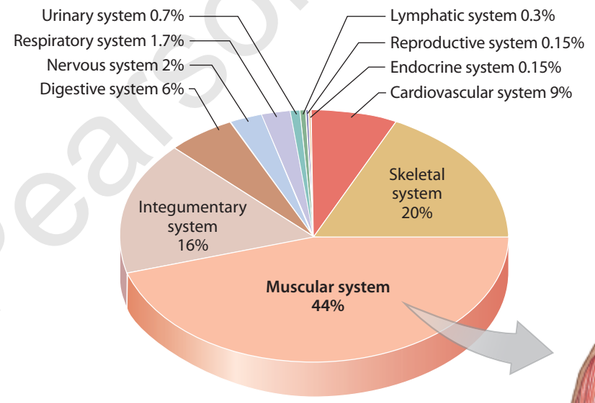
10.23 Describe the deep fascia and its relationship to the various limb muscle compartments. p. 394

Module 10.1

The axial and appendicular muscles have different functions

The skeletal muscles of the muscular system make up almost one-half the weight of your body. As we saw in Chapter 9, skeletal muscle tissue has multiple functions (see Module 9.1).

1 The muscular system contributes more to body weight than does any other organ 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.

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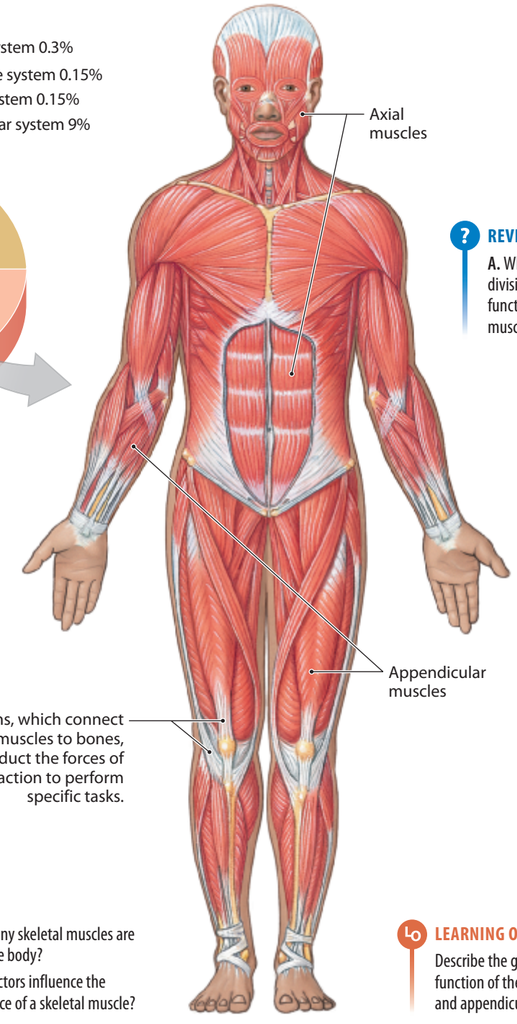
- Origins, Insertions, Actions, and Innervations (Over 60 animations)
- Group Muscle Actions and Joints (Over 50 animations)

2 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.



REVIEW

A. What are the divisions and functions of the muscular system?

REVIEW

B. How many skeletal muscles are there in the body?

C. What factors influence the performance of a skeletal muscle?

LEARNING OUTCOME

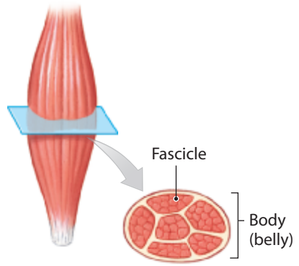
Describe the general function of the body's axial and appendicular muscles.

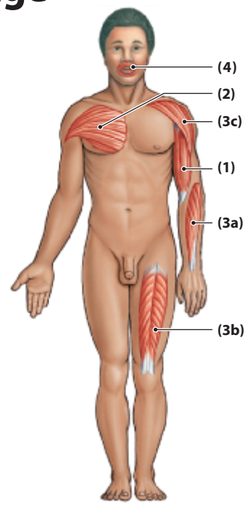
Module 10.2

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

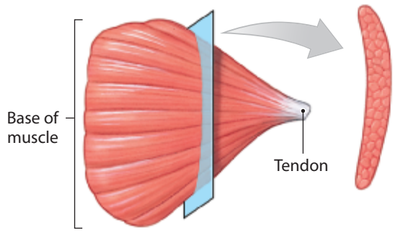
Fascicle Organization

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. Most skeletal muscles in the body are parallel muscles. Some are flat bands with broad attachments (aponeuroses) at each end (see Module 9.2). Others are plump and cylindrical, with tendons at one or both ends. The muscle has a central **body**, also known as the *belly*. A skeletal muscle fiber can contract until it has shortened by about 30 percent. Because the muscle fibers in a parallel muscle are parallel to the long axis of the muscle, when those fibers contract together, the entire muscle shortens by about 30 percent. The tension developed during this contraction depends on the total number of myofibrils the muscle contains.





2 In a **convergent muscle**, such as the pectoralis major, muscle fascicles extending 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** (*penna*, feather), 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.

REVIEW

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

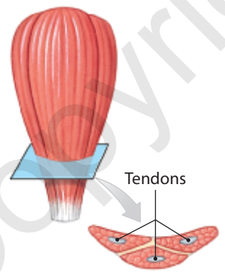
a Extensor digitorum muscle

In a **unipennate** muscle, all the muscle fibers are on the same side of the tendon.

b Rectus femoris muscle

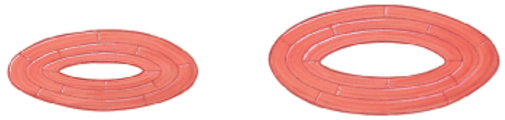
In a **bipennate** muscle, fibers are on both sides of the tendon.

c Deltoid muscle



In a **multipennate** muscle, the tendon branches within the muscle.

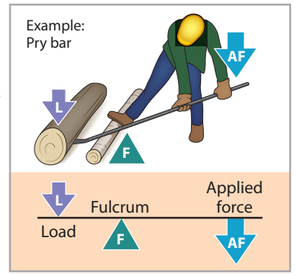
4 In a **circular muscle**, or **sphincter** (SFINK-ter), the fascicles are concentrically arranged to encircle a duct, tube, or opening. When the muscle contracts, the diameter of the opening decreases (constricts).

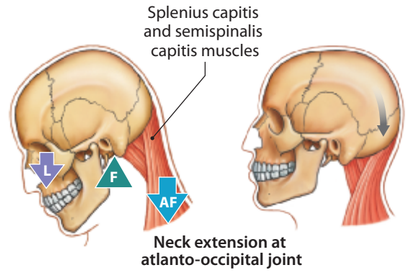


Levers and Leverage

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.

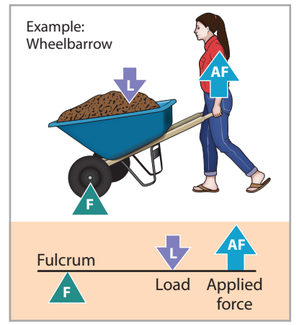
5 In a **first-class lever**, the fulcrum (F) lies between the applied force (AF) and the load (L). First-class levers are like a pry bar: the distance moved depends on the relative sizes of the force and the load and on how far each is from the fulcrum. Our bodies have few first-class levers, but neck extension is one example.

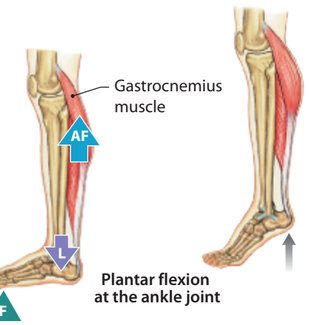




Neck extension at atlanto-occipital joint

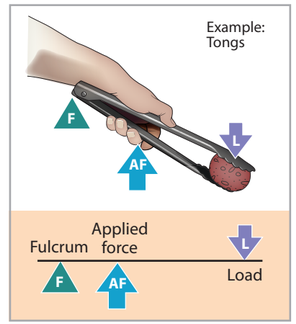
6 In a **second-class lever**, the load is located between the applied force and the fulcrum. A wheelbarrow is a familiar example of a second-class lever. Because the force is always farther from the fulcrum than the load is, a small force can move a larger weight. However, the load moves slowly and covers a short distance. Thus, the effective force is increased at the expense of speed and distance moved.

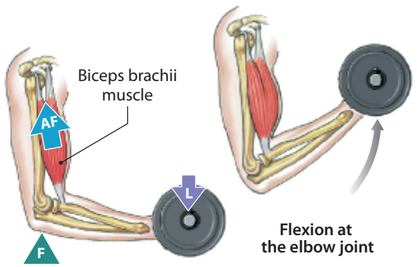




Plantar flexion at the ankle joint

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.





Flexion at the elbow joint

REVIEW

B. Define *lever*, and describe the three classes of levers.

INTEGRATION

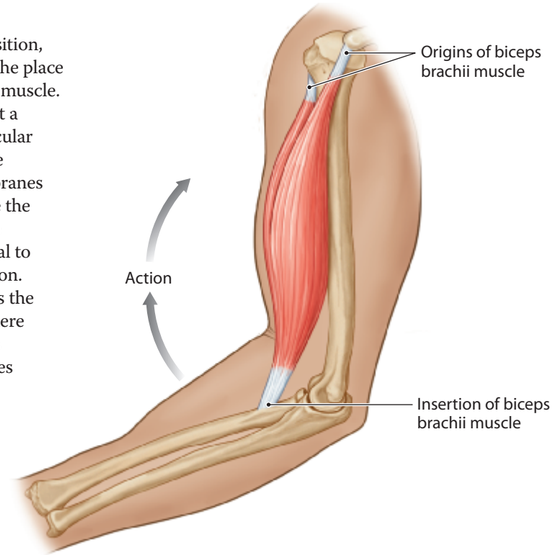
C. The joint between the occipital bone of the skull and the first cervical vertebra (atlas) is which part of which class of lever system?

LEARNING OUTCOME

Describe fascicle organization, and explain how levers affect muscle efficiency.

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).

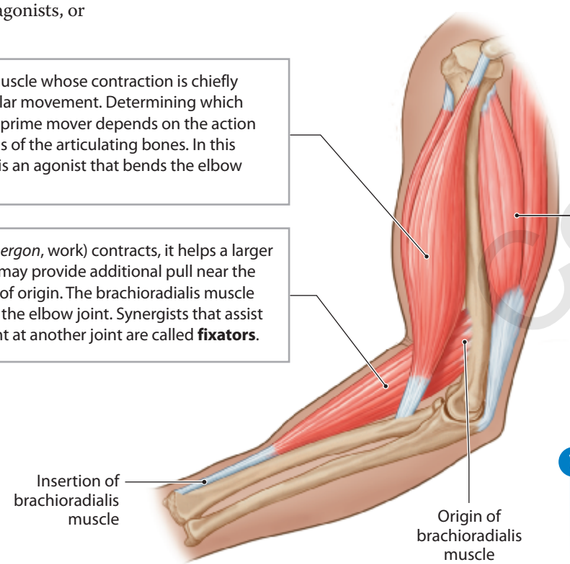


2 When complex movements occur, muscles commonly work in groups rather than individually. Their cooperation improves the efficiency of a particular movement. For example, large muscles of the limbs produce flexion or extension over an extended range of motion. Based on their functions, muscles may be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

When a **synergist** (*syn-*, together + *ergon*, work) contracts, it helps a larger agonist work efficiently. Synergists may provide additional pull near the insertion or may stabilize the point of origin. The brachioradialis muscle assists in flexion and helps stabilize the elbow joint. Synergists that assist an agonist by preventing movement at another joint are called **fixators**.

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 is therefore an antagonist of the biceps brachii muscle, and the biceps brachii is an antagonist of the triceps brachii.



REVIEW

A. Define the term *synergist* as it relates to muscle action.

REVIEW

B. Muscle A abducts the humerus, and muscle B adducts the humerus. What is the relationship between these two muscles?

… their names can provide clues to appearance and/or function

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

Terms Indicating Specific Regions of the Body*	Terms Indicating Position, Direction, or Fascicle Organization	Terms Indicating Structural Characteristics of the Muscle	Terms Indicating Actions
Abdominis (abdomen)	Anterior (front)	**Nature of Origin**	**General**
Ancon (elbow)	External (on the outside)	Biceps (two heads)	Abductor (movement away)
Auricular (auricle of ear)	Extrinsic (outside the structure)	Triceps (three heads)	Adductor (movement toward)
Brachial (brachium)	Inferior (below)	Quadriceps (four heads)	Depressor (lowering movement)
Capitis (head)	Internal (away from the surface)		Extensor (straightening movement)
Carpi (wrist)	Intrinsic (within the structure)	**Shape**	Flexor (bending movement)
Cervicis (neck)	Lateral (on the side)	Deltoid (triangle)	Levator (raising movement)
Coccygeal (coccyx)	Medial (middle)	Orbicularis (circle)	Pronator (turning into prone position)
Costal (rib)	Oblique (slanting)	Pectinate (comblike)	Supinator (turning into supine position)
Cutaneous (skin)	Posterior (back)	Piriformis (pear-shaped)	Tensor (tensing movement)
Femoris (femur)	Profundus (deep)	Platy- (flat)	
Glossal (tongue)	Rectus (straight)	Pyramidal (pyramid)	**Specific**
Hallucis (great toe)	Superficial (toward the surface)	Rhomboid (parallelogram)	Buccinator (trumpeter)
Ilium (groin)	Superior (toward the head)	Serratus (serrated)	Risorius (laugher)
Inguinal (groin)	Transverse (crosswise)	Splenius (bandage)	Sartorius (like a tailor)
Lumbar (lumbar region)		Teres (long and round)	
Nasalis (nose)		Trapezius (trapezoid)	
Nuchal (back of neck)			
Ocular (eye)		**Other Striking Features**	
Oris (mouth)		Alba (white)	
Palpebra (eyelid)		Brevis (short)	
Pollicis (thumb)		Gracilis (slender)	
Popliteal (posterior to knee)		Latae (wide)	
Psoas (loin)		Latissimus (widest)	
Radial (forearm)		Longissimus (longest)	
Scapular (scapula)		Longus (long)	
Temporal (temple)		Magnus (large)	
Thoracic (thorax)		Major (larger)	
Tibial (tibia; shin)		Maximus (largest)	
Ulnar (ulna)		Minimus (smallest)	
		Minor (smaller)	
		Vastus (great)	

*For other regional terms, refer to Module 1.20.

REVIEW

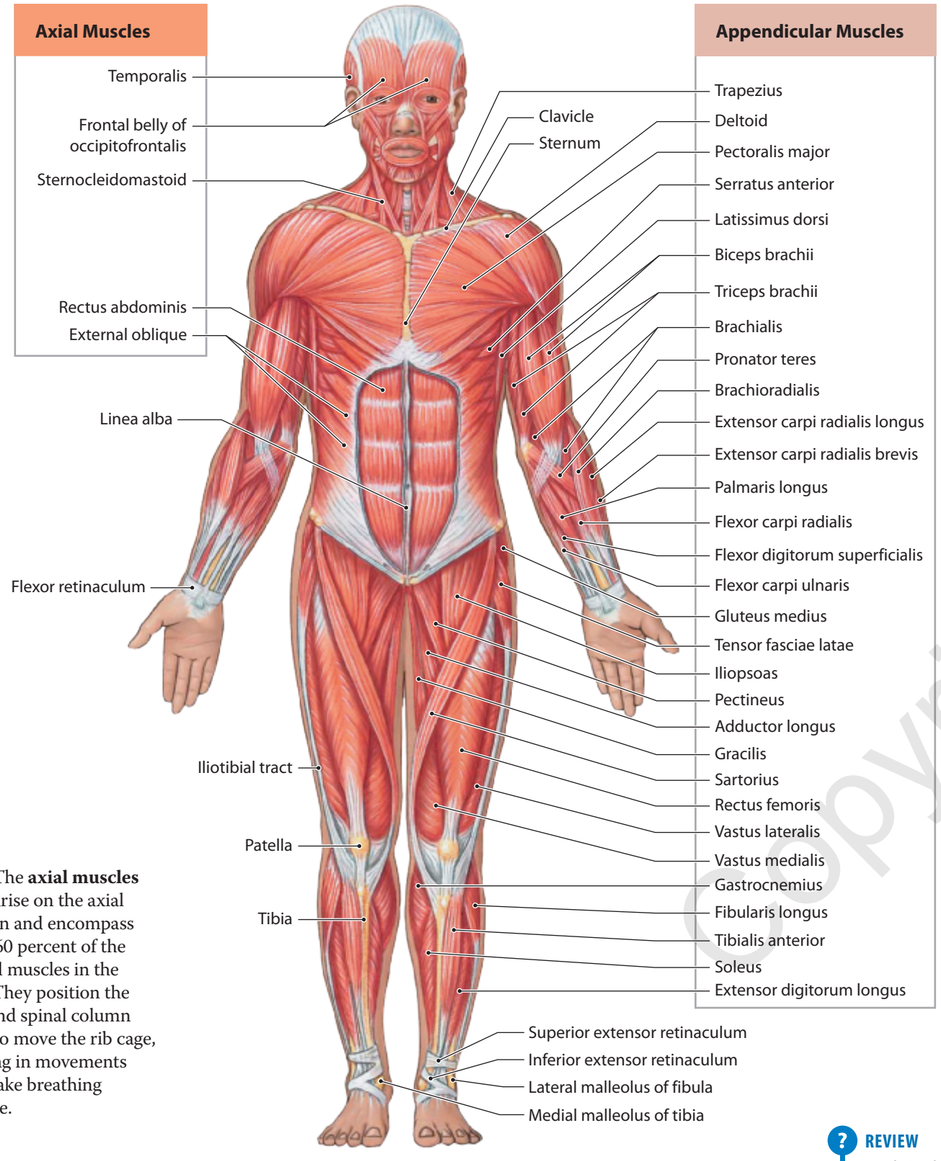
C. What does the name *flexor carpi radialis longus* tell you about this muscle?

LEARNING OUTCOME

Explain how the name of a muscle can help identify its location, appearance, or function.

Module 10.4

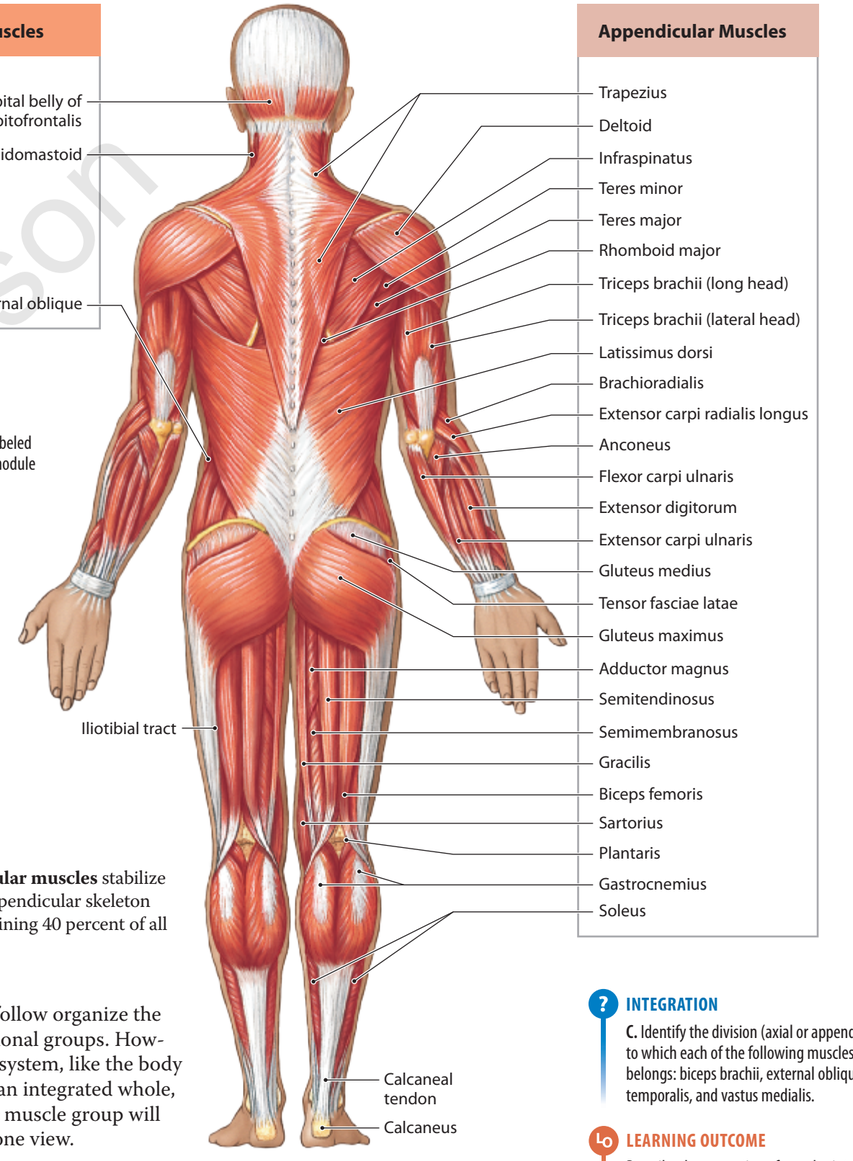
The skeletal muscles can be assigned to the axial division or the appendicular division based on origins and functions



1 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.

REVIEW

A. What is the function of the axial muscles?



2 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.

REVIEW

B. Which structures labeled in the figures in this module are not muscles?

INTEGRATION

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

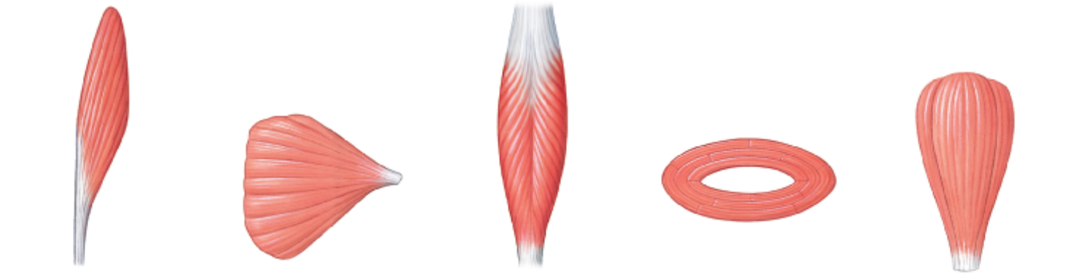
LEARNING OUTCOME

Describe the separation of muscles into axial and appendicular divisions.

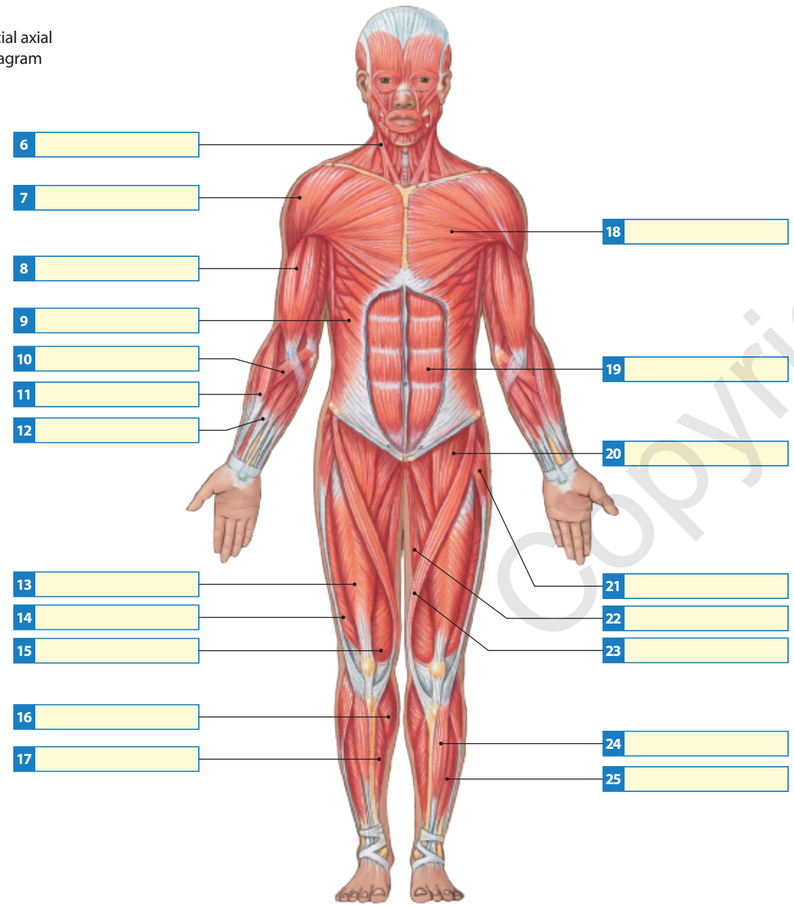
Section 1 Review

Functional Organization of the Muscular System

Labeling: Label each of the muscle types below according to its fascicle organization.



Label each of the indicated superficial axial and appendicular muscles in the diagram to the right.

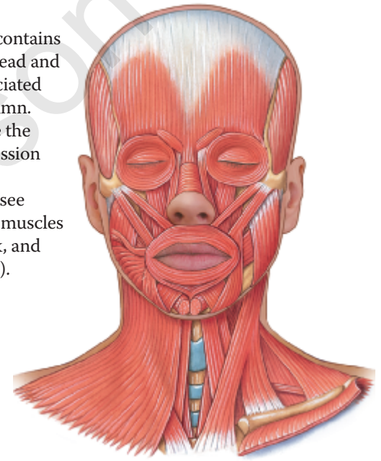


Module 10.5

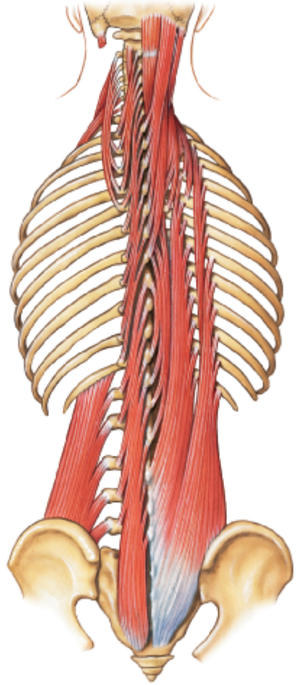
There are four groups of axial muscles

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.

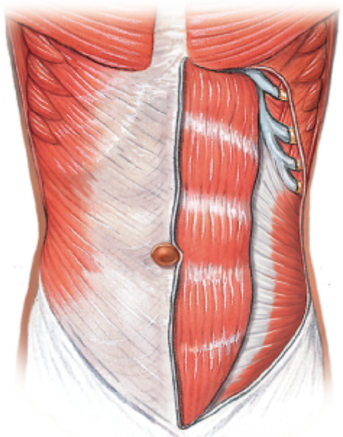
1 The first group contains muscles of the head and neck that are not associated with the vertebral column. These muscles include the muscles of facial expression (see Module 10.6), the extrinsic eye muscles (see Module 10.7), and the muscles of the tongue, pharynx, and neck (see Module 10.8).



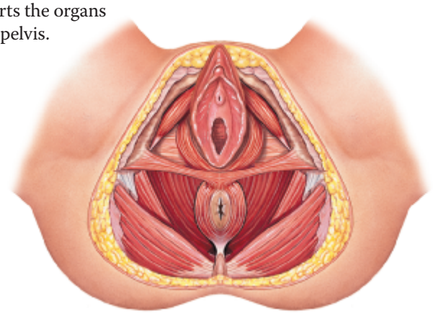
2 The second group—the muscles of the vertebral column—includes numerous muscles of varied size that stabilize, flex, extend, or rotate the vertebral column (see Module 10.9).



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.



? REVIEW

A. The axial muscles stabilize and position which regions of the body?

LO LEARNING OUTCOME

Describe the four groups of axial muscles and their general functions.

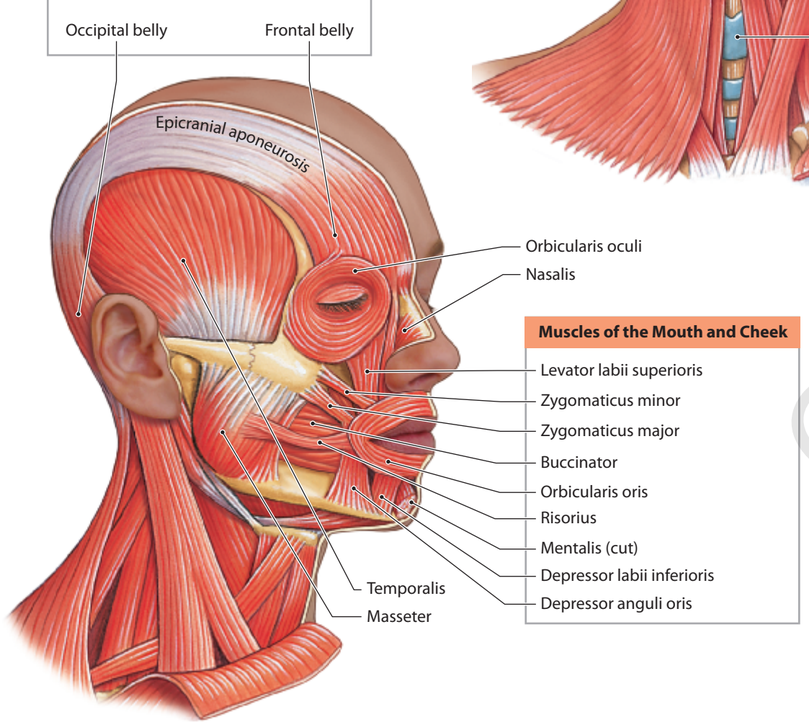
Module 10.6

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.

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

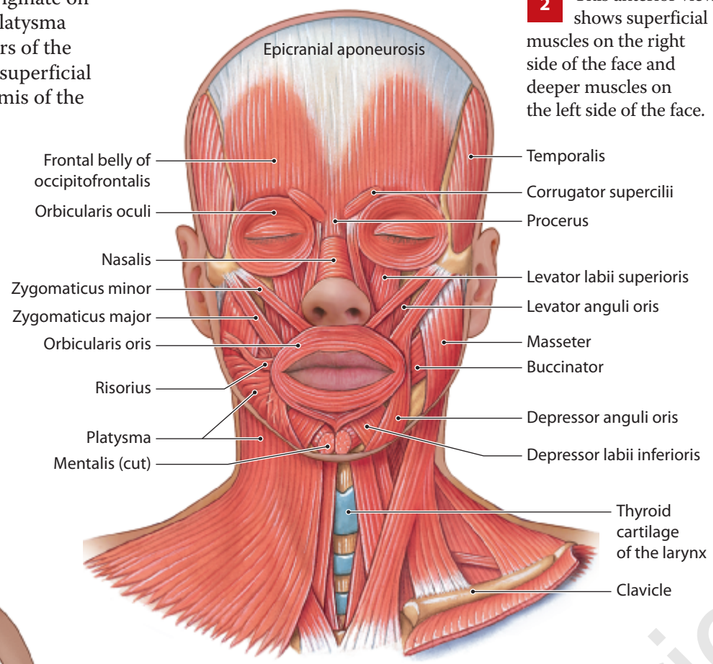
The occipitofrontalis muscle, which forms the scalp, has two bellies that are connected by a collagenous sheet, the **epicranial aponeurosis**.



Muscles of the Mouth and Cheek

- Levator labii superioris
- Zygomaticus minor
- Zygomaticus major
- Buccinator
- Orbicularis oris
- Risorius
- Mentalis (cut)
- Depressor labii inferioris
- Depressor anguli oris

2 This anterior view shows superficial muscles on the right side of the face and deeper muscles on the left side of the face.



REVIEW

A. Name the muscles associated with the mouth, and identify the one involved in whistling.

3 This table groups the muscles of facial expression by region and summarizes their origins, insertions, and actions.

Muscles of Facial Expression

Region and Muscle	Origin	Insertion	Action
Mouth			
Buccinator	Alveolar process of maxilla and alveolar part of mandible	Blends into fibers of orbicularis oris	Compresses cheeks
Depressor labii inferioris	Mandible between the anterior midline and the mental foramen	Skin of lower lip	Depresses lower lip
Levator labii superioris	Inferior margin of orbit, superior to the infra-orbital foramen	Orbicularis oris	Elevates upper lip
Levator anguli oris	Maxilla below the infra-orbital foramen	Corner of mouth	Elevates the corner of the mouth
Mentalis	Incisive fossa of mandible	Skin of chin	Elevates and protrudes lower lip
Orbicularis oris	Maxilla and mandible	Lips	Compresses, purses lips
Risorius	Fascia surrounding parotid salivary gland	Angle of mouth	Draws corner of mouth to the side
Depressor anguli oris	Anterolateral surface of mandibular body	Skin at angle of mouth	Depresses corner of mouth
Zygomaticus major	Zygomatic bone near zygomaticomaxillary suture	Angle of mouth	Retracts and elevates corner of mouth
Zygomaticus minor	Zygomatic bone posterior to zygomaticotemporal suture	Upper lip	Retracts and elevates upper lip
Eye			
Corrugator supercilii	Orbital rim of frontal bone near nasal suture	Eyebrow	Pulls skin inferiorly and anteriorly; wrinkles brow
Levator palpebrae superioris	Tendinous band around optic foramen	Upper eyelid	Elevates upper eyelid
Orbicularis oculi	Medial margin of orbit	Skin around eyelids	Closes eye
Nose			
Procerus	Nasal bones and lateral nasal cartilages	Aponeurosis at bridge of nose and skin of forehead	Moves nose, changes position and shape of nostrils
Nasalis	Maxilla and alar cartilage of nose	Bridge of nose	Compresses bridge, depresses tip of nose; elevates corners of nostrils
Scalp			
Occipitofrontalis			
Frontal belly	Epicranial aponeurosis	Skin of eyebrow and bridge of nose	Raises eyebrows, wrinkles forehead
Occipital belly	Occipital and temporal bones	Epicranial aponeurosis	Tenses and retracts scalp
Neck			
Platysma	Superior thorax between cartilage of 2nd rib and acromion of scapula	Mandible and skin of cheek	Tenses skin of neck; depresses mandible and pulls lower lip inferiorly

REVIEW

B. State whether the following muscles involve the mouth, eye, nose, ear, scalp, or neck: buccinator, corrugator supercilii, mentalis, nasalis, platysma, procerus, and risorius.

INTEGRATION

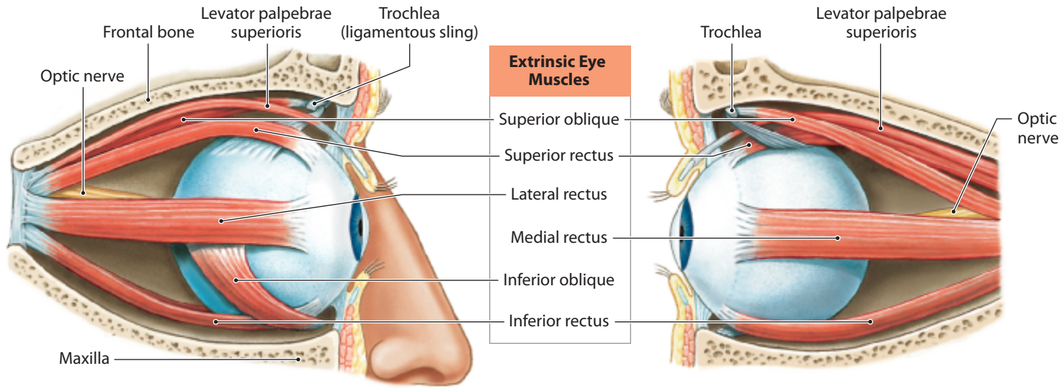
C. Explain how a person is able to consciously move the skin on the scalp but is not able to consciously move the skin of the thigh.

LEARNING OUTCOME

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

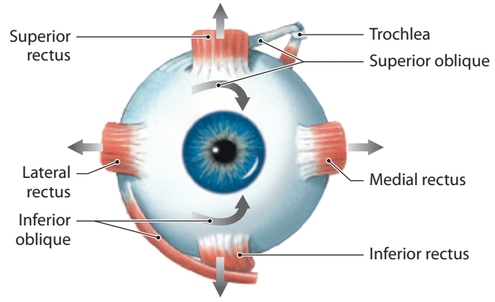
The extrinsic eye muscles position the eye …

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

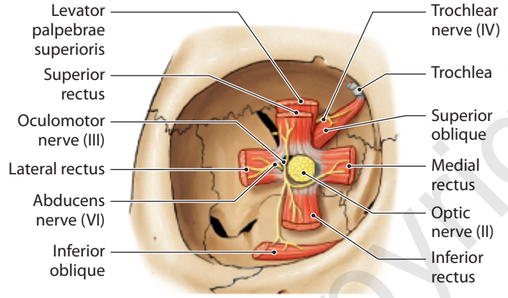


2 One additional muscle, the medial rectus, can be seen in this medial view of the right eye.

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.



Extrinsic Eye Muscles

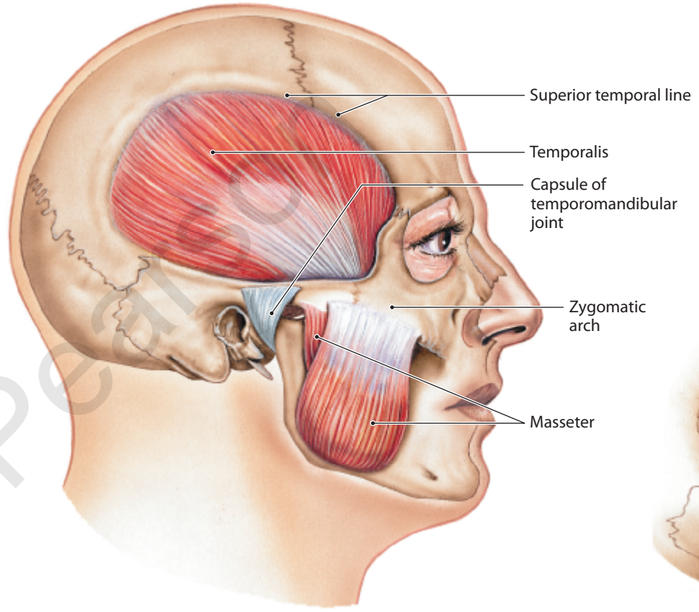
Muscle	Origin	Insertion	Action
Inferior rectus	Sphenoid around optic canal	Inferior, medial surface of eyeball	Eye looks inferiorly
Medial rectus	Sphenoid around optic canal	Medial surface of eyeball	Eye looks medially
Superior rectus	Sphenoid around optic canal	Superior surface of eyeball	Eye looks superiorly
Lateral rectus	Sphenoid around optic canal	Lateral surface of eyeball	Eye looks laterally
Inferior oblique	Maxilla at anterior portion of orbit	Inferior, lateral surface of eyeball	Eye rolls, looks superiorly and laterally
Superior oblique	Sphenoid around optic canal	Superior, lateral surface of eyeball	Eye rolls, looks inferiorly and laterally

REVIEW

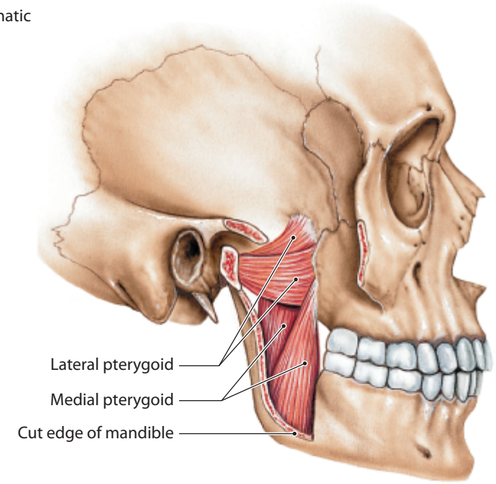
A. Name the extrinsic eye muscles.

… and the muscles of mastication move the lower jaw

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.



REVIEW

B. Which muscles have their origin on the lateral pterygoid plates and their insertion on the medial surface of the ramus of the mandible?

Muscles of Mastication

Muscle	Origin	Insertion	Action
Masseter	Zygomatic arch	Lateral surface of ramus of mandible	Elevates mandible and closes the jaws
Temporalis	Along temporal lines of skull	Coronoid process of mandible	Elevates mandible
Pterygoids (**medial** and **lateral**)	Lateral pterygoid plate	Medial surface of ramus of the mandible	Medial: Elevates the mandible and closes the jaws, or slides the mandible from side to side Lateral: Opens jaws, protrudes the mandible, or slides the mandible from side to side

INTEGRATION

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

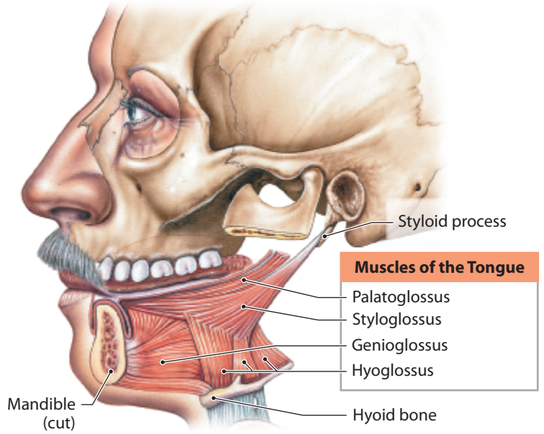
LEARNING OUTCOME

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

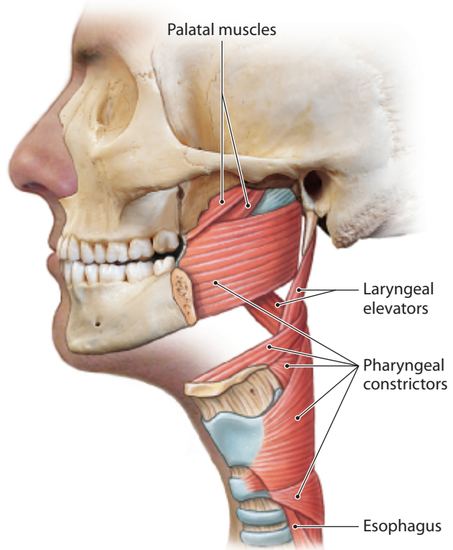
Module 10.8

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.



Muscles of the Tongue

Muscle	Origin	Insertion	Action
Genioglossus	Medial surface of mandible around chin	Body of tongue, hyoid bone	Depresses and protracts tongue
Hyoglossus	Body and greater horn of hyoid bone	Side of tongue	Depresses and retracts tongue
Palatoglossus	Anterior surface of soft palate	Side of tongue	Elevates tongue, depresses soft palate
Styloglossus	Styloid process of temporal bone	Along the side to tip and base of tongue	Retracts tongue, elevates side of tongue

Muscles of the Pharynx

Muscle	Origin	Insertion	Action
Pharyngeal constrictors	Pterygoid process of sphenoid, medial surfaces of mandible, horns of hyoid bone, cricoid and thyroid cartilages of larynx	Median raphe attached to occipital bone	Constrict pharynx to propel an ingested food mass into the esophagus
Laryngeal elevators	Soft palate, cartilage around inferior portion of auditory tube, styloid process	Thyroid cartilage	Elevate larynx
Palatal muscles	Petrous part of temporal bone and adjacent soft tissues, sphenoidal spine and adjacent soft tissues	Soft palate	Elevate soft palate

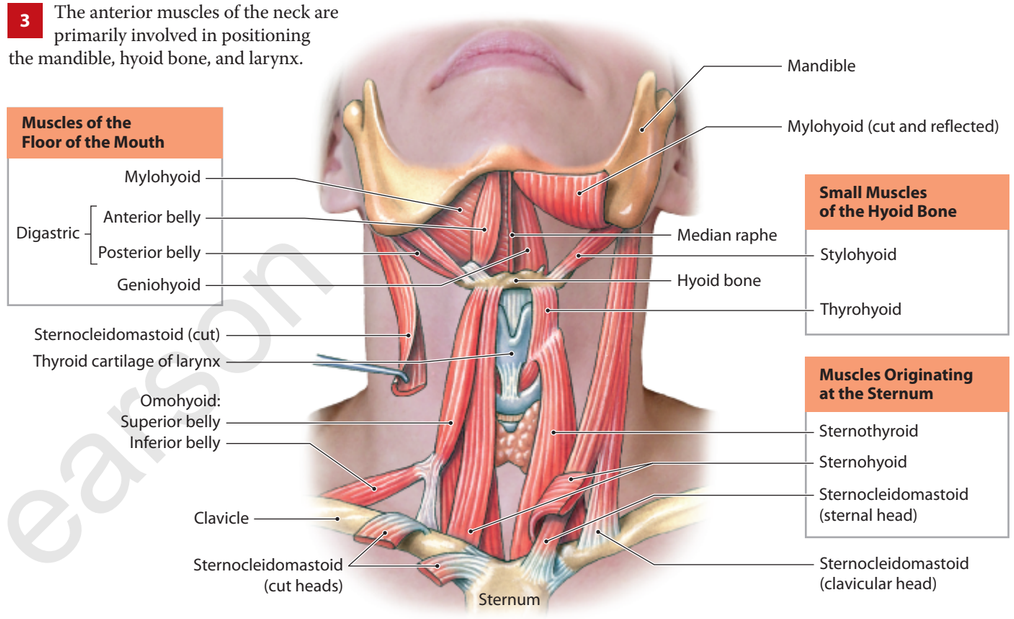
REVIEW

A. List the muscles of the tongue.

REVIEW

B. Which muscles elevate the soft palate?

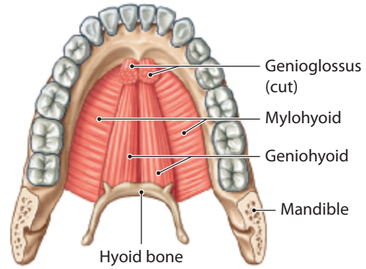
3 The anterior muscles of the neck are primarily involved in positioning the mandible, hyoid bone, and larynx.



Anterior Muscles of the Neck

Muscle	Origin	Insertion	Action
Digastric	Inferior surface of mandible at chin and mastoid region	Hyoid bone	Depresses mandible or elevates larynx
Geniohyoid	Medial surface of mandible at chin	Hyoid bone	As above and pulls hyoid bone anteriorly
Mylohyoid	Mylohyoid line of mandible	Median raphe that runs to hyoid bone	Elevates hyoid bone or depresses mandible
Omohyoid	Superior border of scapula near scapular notch	Hyoid bone	Depresses hyoid bone and larynx
Sternohyoid	Clavicle and manubrium	Hyoid bone	Depresses hyoid bone and larynx
Sternothyroid	Manubrium and first costal cartilage	Thyroid cartilage of larynx	Depresses hyoid bone and larynx
Stylohyoid	Styloid process	Hyoid bone	Elevates larynx
Thyrohyoid	Thyroid cartilage of larynx	Hyoid bone	Elevates thyroid, depresses hyoid
Sternocleidomastoid	One head attaches to sternal end of clavicle; the other head attaches to manubrium	Mastoid region of skull and lateral portion of superior nuchal line	Flexes the neck; one alone bends head toward shoulder and rotates neck

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.



REVIEW

C. Which muscles associated with the hyoid form the floor of the mouth?

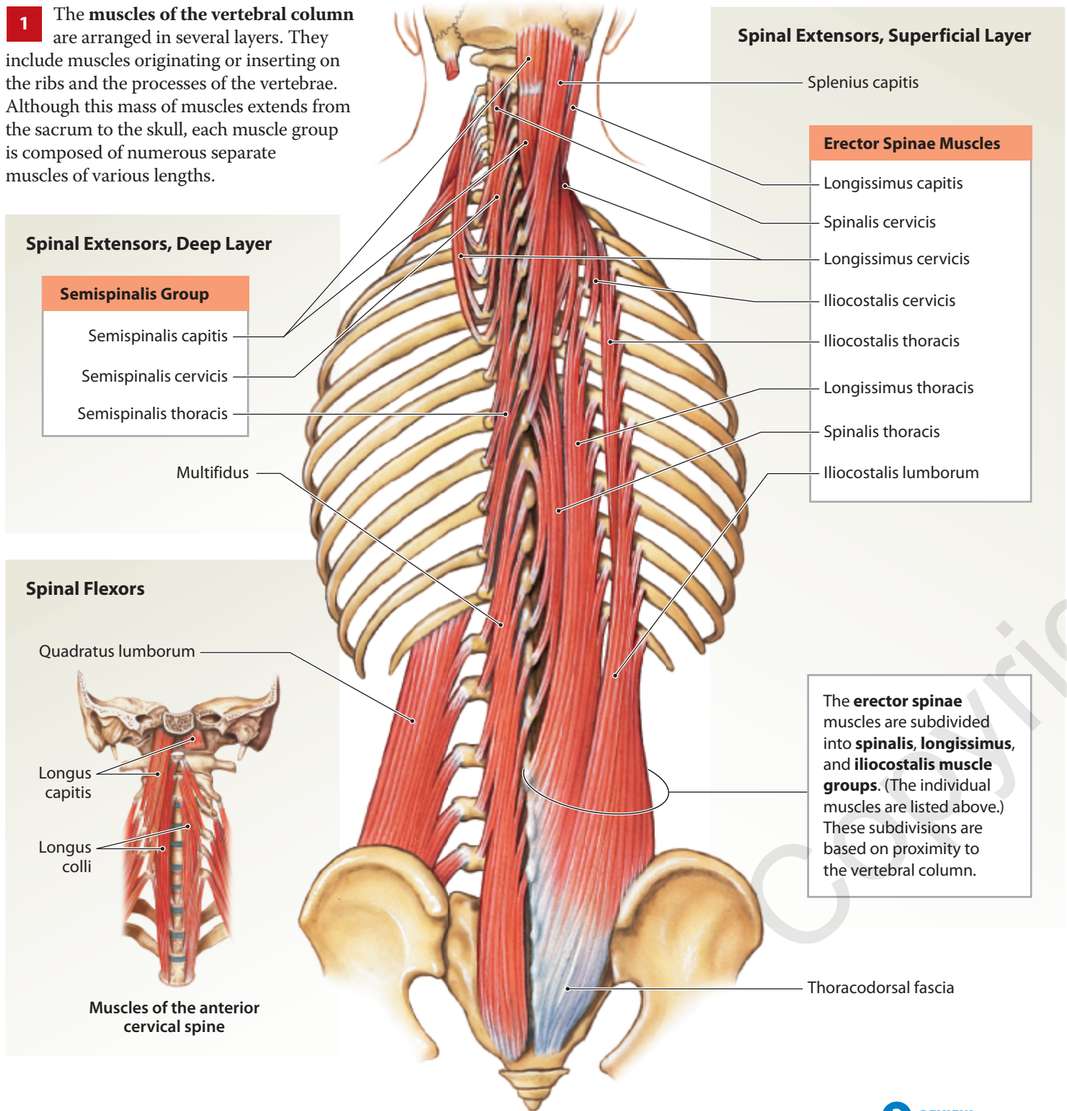
LEARNING OUTCOME

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

1 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 vertebrae. Although this mass of muscles extends from the sacrum to the skull, each muscle group is composed of numerous separate muscles of various lengths.



REVIEW

A. List the spinal flexor muscles.

REVIEW

B. Which muscles enable you to extend your neck?

2 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 unopposed by the extensor muscles.

Muscles of the Vertebral Column

Group and Muscle		Origin	Insertion	Action
Spinal Extensors — Superficial Layer				
Splenius (splenius capitis, splenius cervicis)		Spinous processes and ligaments connecting inferior cervical and superior thoracic vertebrae	Mastoid process, occipital bone of skull, and superior cervical vertebrae	Together, the two sides extend neck; alone, each rotates and laterally flexes neck to that side
Erector spinae				
SPINALIS GROUP	**Spinalis cervicis**	Inferior portion of ligamentum nuchae and spinous process of C_7	Spinous process of axis	Extends neck
	Spinalis thoracis	Spinous processes of inferior thoracic and superior lumbar vertebrae	Spinous processes of superior thoracic vertebrae	Extends vertebral column
LONGISSIMUS GROUP	**Longissimus capitis**	Transverse processes of inferior cervical and superior thoracic vertebrae	Mastoid process of temporal bone	Together, the two sides extend head; alone, each rotates and laterally flexes neck to that side
	Longissimus cervicis	Transverse processes of superior thoracic vertebrae	Transverse processes of middle and superior cervical vertebrae	Together, the two sides extend head; alone, each rotates and laterally flexes neck to that side
	Longissimus thoracis	Broad aponeurosis and transverse processes of inferior thoracic and superior lumbar vertebrae; joins iliocostalis	Transverse processes of superior vertebrae and inferior surfaces of ribs	Extends vertebral column; alone, each produces lateral flexion to that side
ILIOCOSTALIS GROUP	**Iliocostalis cervicis**	Superior borders of vertebrosternal ribs near the angles	Transverse processes of middle and inferior cervical vertebrae	Extends or laterally flexes neck, elevates ribs
	Iliocostalis thoracis	Superior borders of inferior seven ribs medial to the angles	Upper ribs and transverse process of last cervical vertebra	Stabilizes thoracic vertebrae in extension
	Iliocostalis lumborum	Iliac crest, sacral crests, and spinous processes	Inferior surfaces of inferior seven ribs near their angles	Extends vertebral column, depresses ribs
Spinal Extensors — Deep Layer				
SEMISPINALIS GROUP	**Semispinalis capitis**	Articular processes of inferior cervical and transverse processes of superior thoracic vertebrae	Occipital bone, between nuchal lines	Together, the two sides extend head; alone, each extends and laterally flexes neck
	Semispinalis cervicis	Transverse processes of T_1–T_5 or T_6	Spinous processes of C_2–C_5	Extends vertebral column and rotates toward opposite side
	Semispinalis thoracis	Transverse processes of T_6–T_{10}	Spinous processes of C_5–T_4	Extends vertebral column and rotates toward opposite side
	Multifidus	Sacrum and transverse processes of each vertebra	Spinous processes of the third or fourth more superior vertebrae	Extends vertebral column and rotates toward opposite side
Spinal Flexors				
Longus capitis		Transverse processes of cervical vertebrae	Base of the occipital bone	Together, the two sides flex the neck; alone, each rotates head to that side
Longus colli		Anterior surfaces of cervical and superior thoracic vertebrae	Transverse processes of superior cervical vertebrae	Flexes or rotates neck; limits hyperextension
Quadratus lumborum		Iliac crest and iliolumbar ligament	Last rib and transverse processes of lumbar vertebrae	Together, they depress ribs; alone, each side laterally flexes vertebral column

REVIEW

C. What might account for a lack of massive flexor muscles?

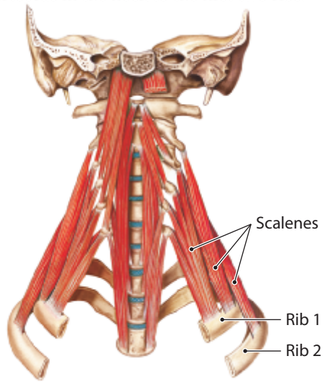
LEARNING OUTCOME

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

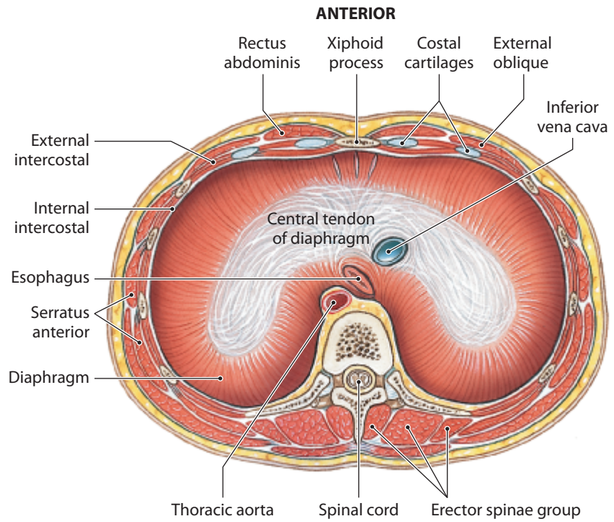
Module 10.10

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.

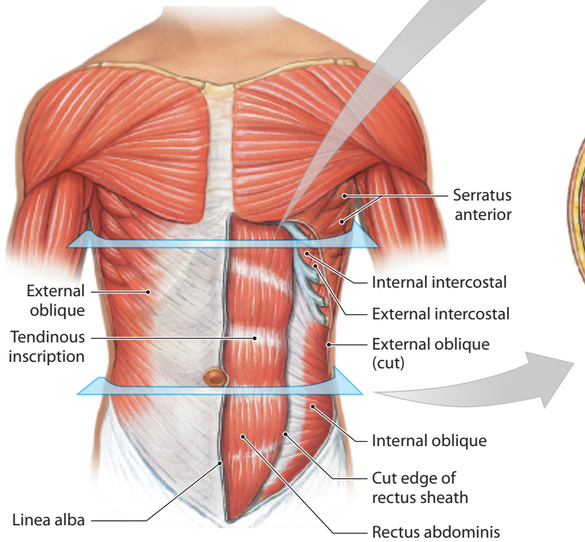


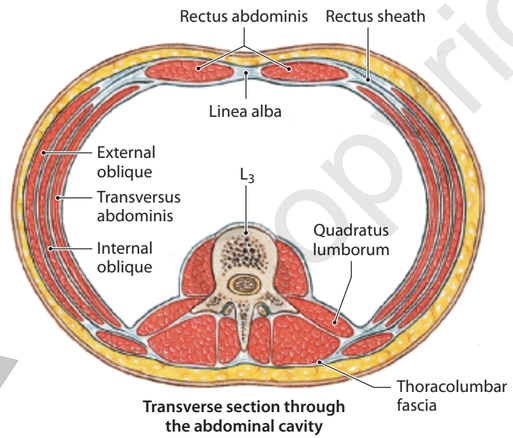
Anterior view, frontal section



Superior view of the diaphragm

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.





Transverse section through the abdominal cavity

REVIEW

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

Oblique and Rectus Muscles

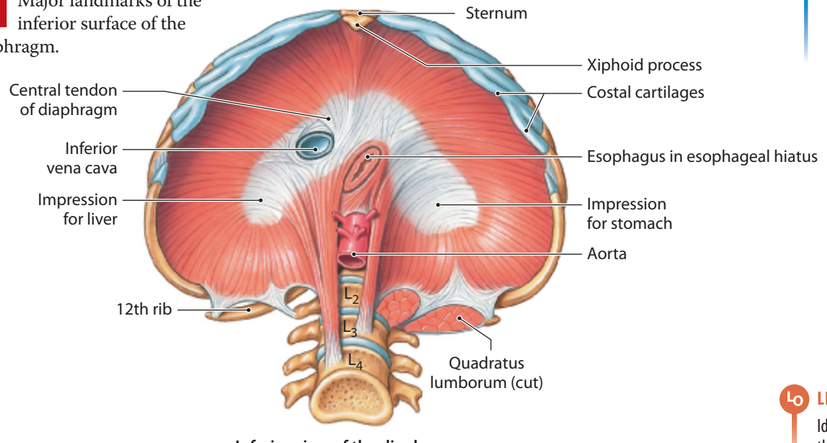
Group and Muscle	Origin	Insertion	Action
Oblique Group			
CERVICAL REGION — **Scalenes**	Transverse and costal processes of cervical vertebrae	Superior surfaces of first two ribs	Elevate ribs or flex neck
THORACIC REGION — **External intercostals**	Inferior border of each rib	Superior border of more inferior rib	Elevate ribs
Internal intercostals	Superior border of each rib	Inferior border of the preceding rib	Depress ribs
Transversus thoracis	Posterior surface of sternum	Cartilages of ribs	Depress ribs
ABDOMINAL REGION — **External oblique**	External and inferior borders of ribs 5–12	Linea alba and iliac crest	Compresses abdomen, depresses ribs, flexes or bends spine
Internal oblique	Lumbodorsal fascia and iliac crest	Inferior ribs, xiphoid process, and linea alba	Compresses abdomen, depresses ribs, flexes or bends spine
Transversus abdominis	Cartilages of ribs 6–12, iliac crest, and lumbodorsal fascia	Linea alba and pubis	Compresses abdomen
Rectus Group			
THORACIC REGION — **Diaphragm**	Xiphoid process, cartilages of ribs 4–10, and anterior surfaces of lumbar vertebrae	Central tendinous sheet	Contraction expands thoracic cavity, compresses abdominopelvic cavity
ABDOMINAL REGION — **Rectus abdominis**	Superior surface of pubis around symphysis	Inferior surfaces of costal cartilages (ribs 5–7) and xiphoid process	Depresses ribs, flexes vertebral column, compresses abdomen

REVIEW

B. Which muscle connects the ribs and sternum to the pubic bones?

C. Describe the action of the external oblique.

3 Major landmarks of the inferior surface of the diaphragm.



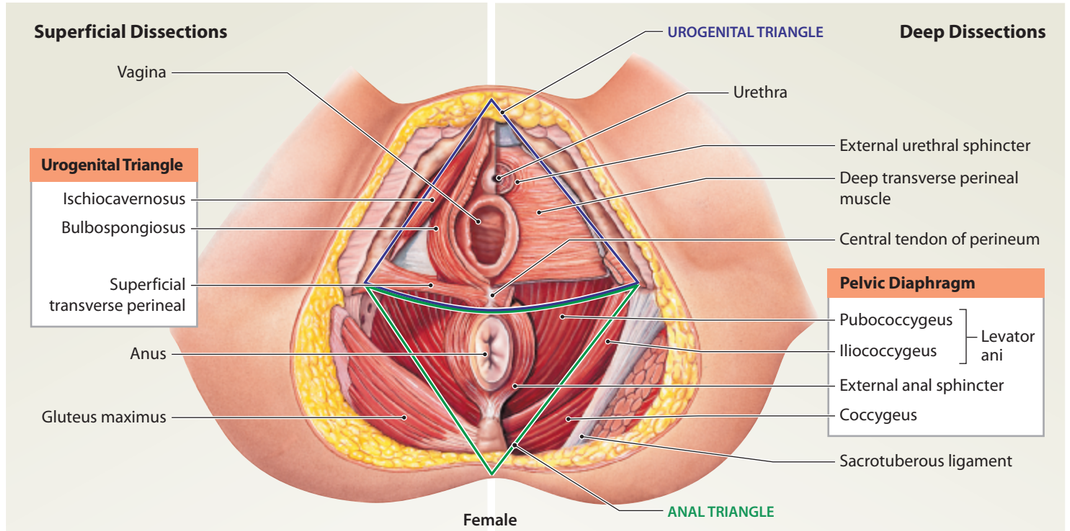
Inferior view of the diaphragm

LEARNING OUTCOME

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

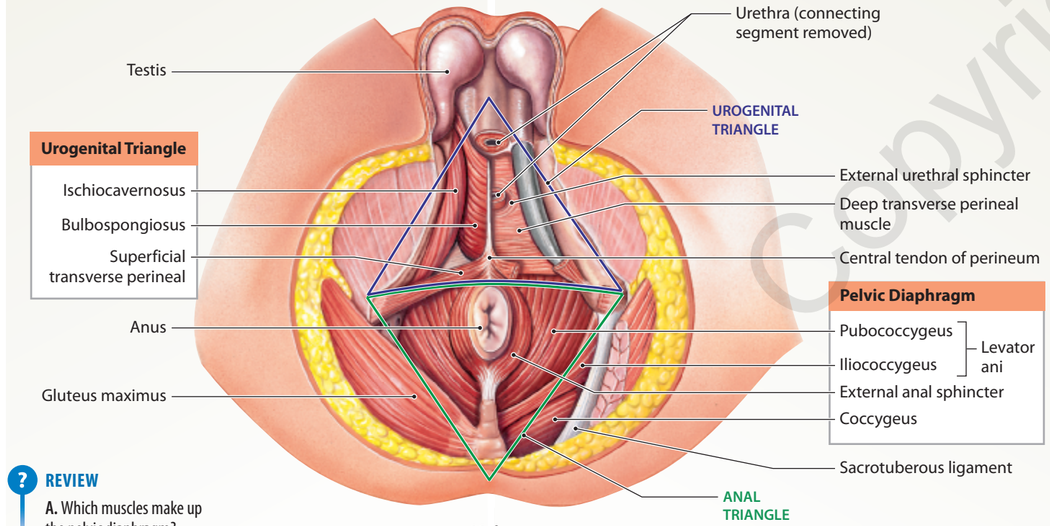
Module 10.11

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



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

2 There are no differences between the deep perineal musculature of females and males.



REVIEW

A. Which muscles make up the pelvic diaphragm?

Muscles of the Pelvic Floor

Group and Muscle	Origin	Insertion	Action
Urogenital Triangle			
SUPERFICIAL MUSCLES — **Bulbospongiosus**			
Females	Collagen sheath at base of clitoris; fibers run on either side of urethral and vaginal opening	Central tendon of perineum	Compresses and stiffens clitoris; narrows vaginal opening
Males	Collagen sheath at base of penis; fibers cross over urethra	Median raphe and central tendon of perineum	Compresses base and stiffens penis; ejects urine or semen
SUPERFICIAL MUSCLES — **Ischiocavernosus**	Ischial ramus and tuberosity	Pubic symphysis anterior to base of penis or clitoris	Compresses and stiffens penis or clitoris
SUPERFICIAL MUSCLES — **Superficial transverse perineal**	Ischial ramus	Central tendon of perineum	Stabilizes central tendon of perineum
DEEP MUSCLES — **Deep transverse perineal muscle**	Ischial ramus	Perineal body	Stabilizes central tendon of perineum
DEEP MUSCLES — **External urethral sphincter**			
Females	Ischial and pubic rami	To median raphe; inner fibers encircle urethra	Closes urethra; compresses vagina and greater vestibular glands
Males	Ischial and pubic rami	To median raphe at base of penis; inner fibers encircle urethra	Closes urethra; compresses prostate and bulbourethral glands
Anal Triangle			
Pelvic diaphragm			
Coccygeus	Ischial spine	Lateral, inferior borders of sacrum and coccyx	Flexes coccygeal joints; tenses and supports pelvic floor
Levator ani			
Iliococcygeus	Ischial spine, pubis	Coccyx and median raphe	Tenses floor of pelvis; flexes coccygeal joints; elevates and retracts anus
Pubococcygeus	Inner margins of pubis	Coccyx and median raphe	Tenses floor of pelvis; flexes coccygeal joints; elevates and retracts anus
External anal sphincter	Coccyx	Encircles anal opening	Closes anal opening

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.

REVIEW

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

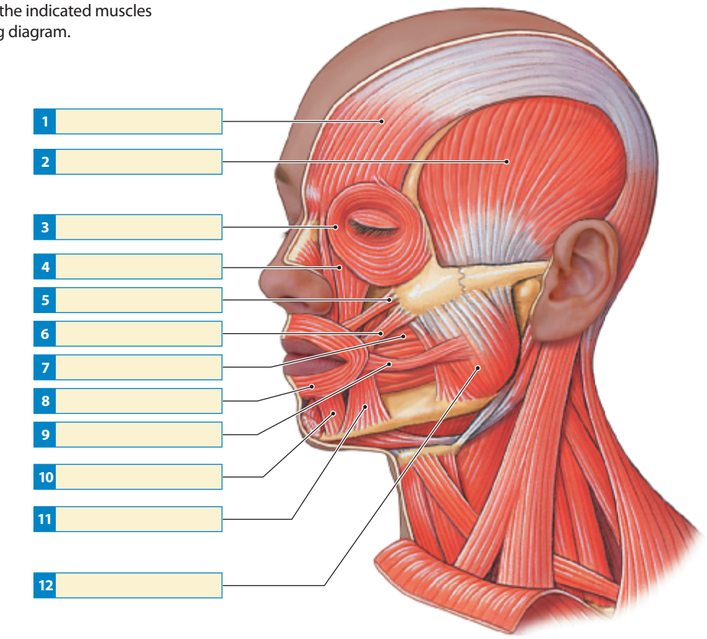
C. The coccygeus extends from the sacrum and coccyx to which structure?

LEARNING OUTCOME

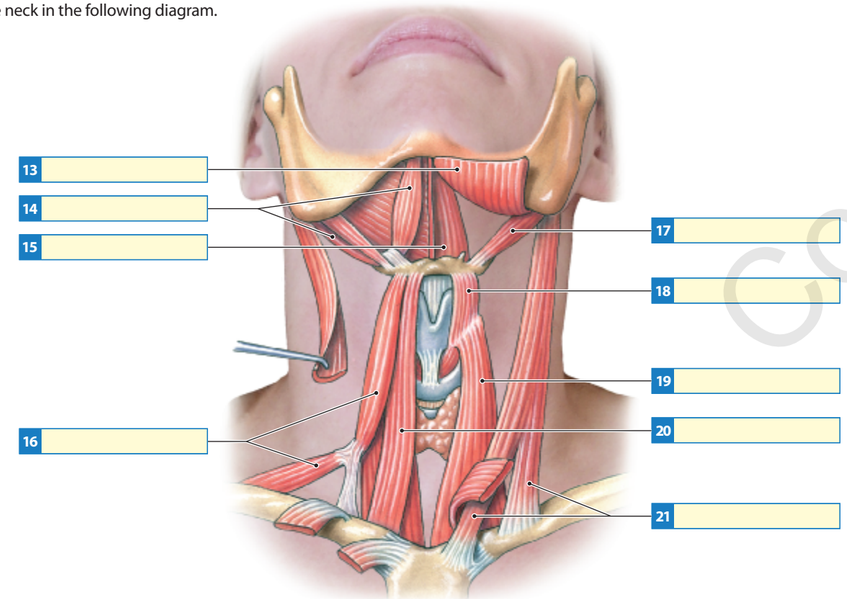
Identify the pelvic floor muscles, and cite their origins, insertions, and actions.

Section 2 Review
Axial Muscles

Labeling: Label each of the indicated muscles of the face in the following diagram.

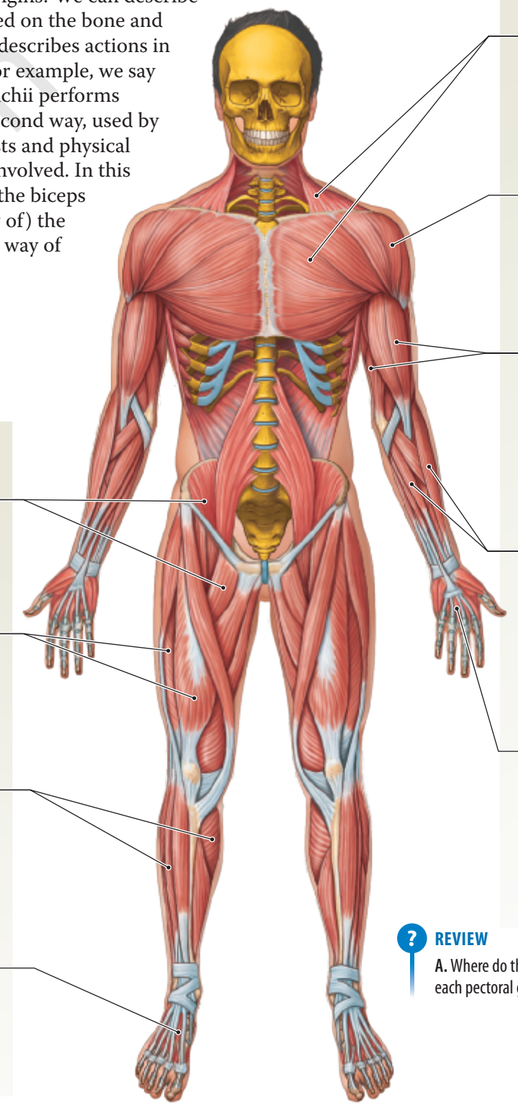


Label each of the indicated muscles of the neck in the following diagram.



Module 10.12
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.



Lower Limb

Muscles That Move the Thigh
These muscles originate in the pelvic region and typically insert on the femur.

Muscles That Move the Leg
These muscles originate on the pelvis and femur and insert on the tibia and/or fibula.

Extrinsic Muscles That Move the Foot and Toes
These muscles originate on the tibia and fibula and insert on the tarsals, metatarsals, and/or phalanges.

Intrinsic Muscles of the Foot
These muscles originate primarily on the tarsal and metatarsal bones and insert on the phalanges.

Upper Limb

Muscles That Position the Pectoral Girdle
These muscles originate on the axial skeleton and insert on the clavicle and scapula.

Muscles That Move the Arm
These muscles originate on the pectoral girdle and the thoracic cage and insert on the humerus.

Muscles That Move the Forearm and Hand
These muscles primarily originate on the pectoral girdle and arm and insert on the radius, ulna, and/or carpals.

Extrinsic Muscles of the Hand and Fingers
These muscles primarily originate on the humerus, radius, and ulna and insert on the metacarpals and phalanges.

Intrinsic Muscles of the Hand
These are the muscles that perform fine movements. They originate primarily on the carpal and metacarpal bones and insert on the phalanges.

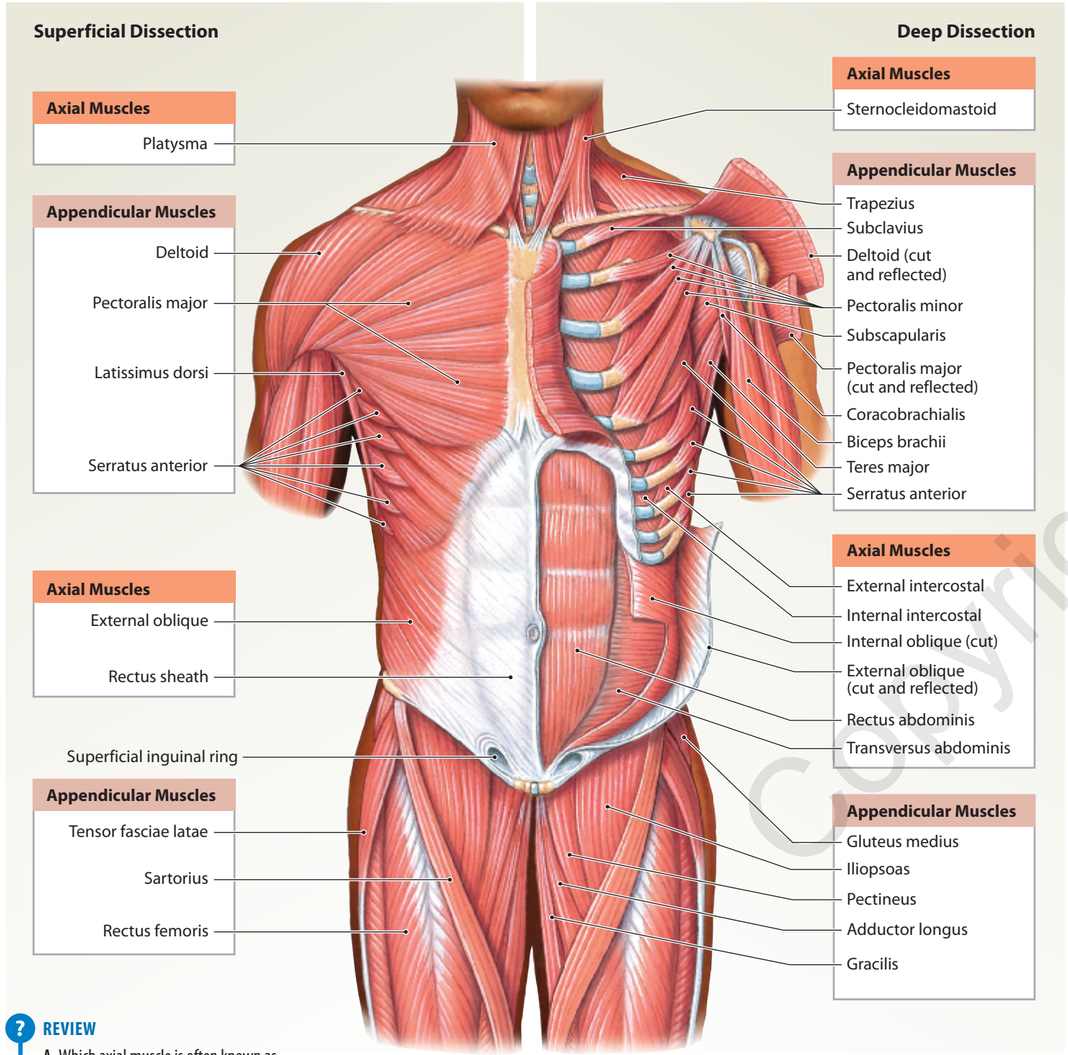
REVIEW
A. Where do the muscles that position each pectoral girdle originate?

LEARNING OUTCOME
Describe the general functions of the muscles of the upper and lower limbs.

Module 10.13

The largest appendicular muscles originate on the trunk

1 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.

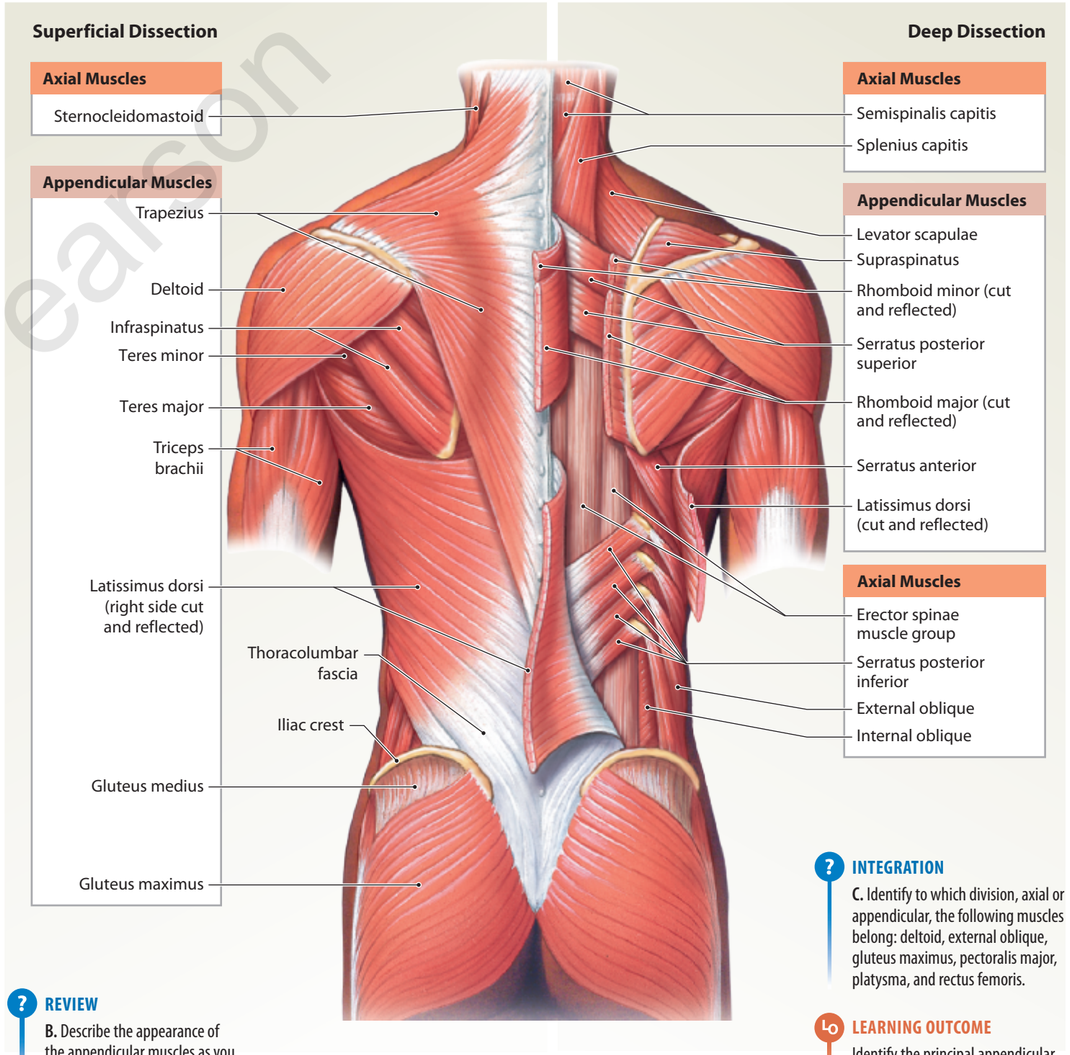


Anterior view

REVIEW

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

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



Posterior view

REVIEW

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

INTEGRATION

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

LEARNING OUTCOME

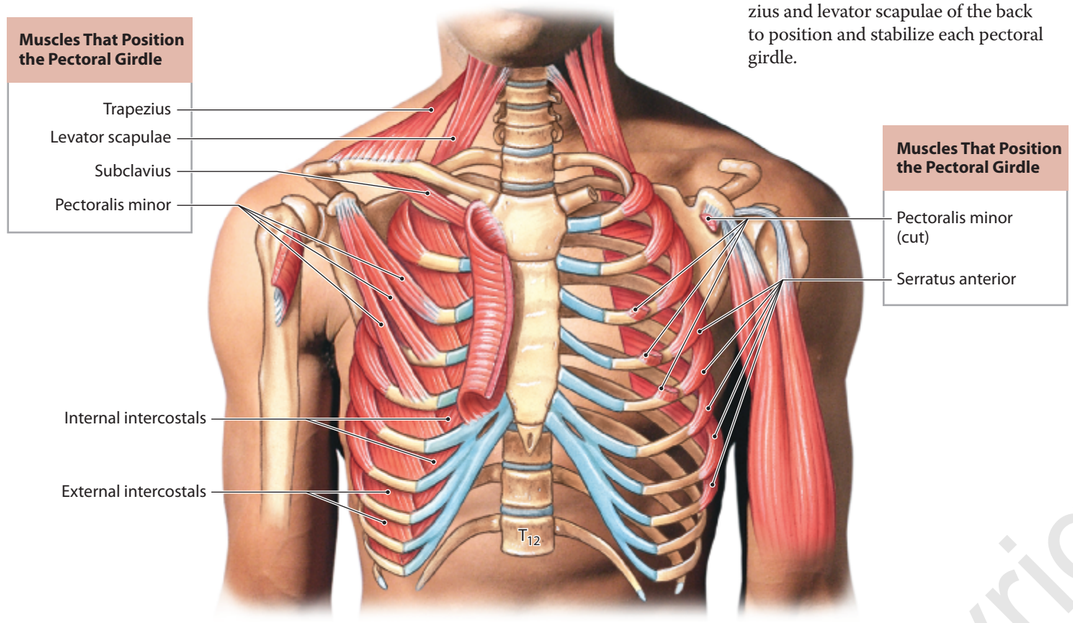
Identify the principal appendicular muscles.

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.

1 Several 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.



Anterior view

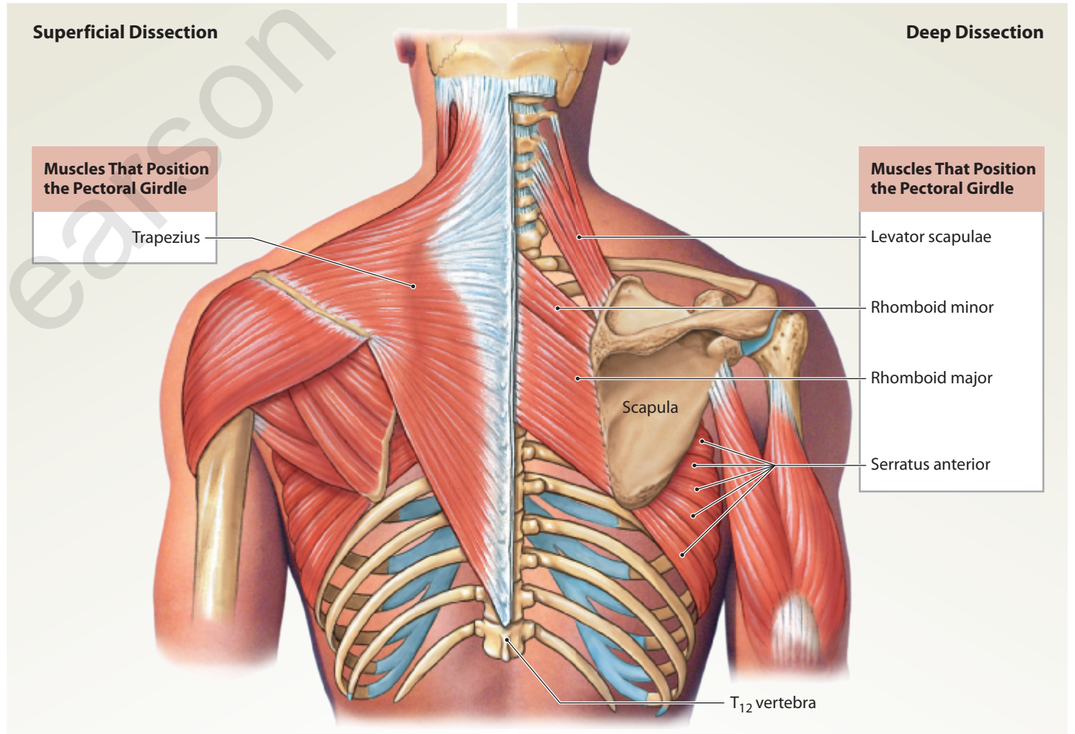
Muscles That Position the Pectoral Girdle

Muscle	Origin	Insertion	Action
Levator scapulae	Transverse processes of first four cervical vertebrae	Vertebral border of scapula near superior angle	Elevates scapula
Pectoralis minor	Anterior-superior surfaces of ribs 2–4, 2–5, or 3–5, depending on anatomical variation	Coracoid process of scapula	Depresses and protracts shoulder; rotates scapula so glenoid cavity moves inferiorly (downward rotation); elevates ribs if scapula is stationary
Rhomboid major	Spinous processes of superior thoracic vertebrae	Vertebral border of scapula from spine to inferior angle	Adducts scapula and performs downward rotation
Rhomboid minor	Spinous processes of vertebrae C_7–T_1	Vertebral border of scapula near spine	Adducts scapula and performs downward rotation
Serratus anterior	Anterior and superior margins of ribs 1–8 or 1–9	Anterior surface of vertebral border of scapula	Protracts shoulder; rotates scapula so glenoid cavity moves superiorly (upward rotation)
Subclavius	First rib	Clavicle (inferior border)	Depresses and protracts shoulder
Trapezius	Occipital bone, ligamentum nuchae, and spinous processes of thoracic vertebrae	Clavicle and scapula (acromion and scapular spine)	Depends on active region and state of other muscles; may (1) elevate, retract, depress, or rotate scapula upward, (2) elevate clavicle, or (3) extend neck

2 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.

REVIEW

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



Posterior view

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

B. Which muscles enable you to shrug your shoulders?

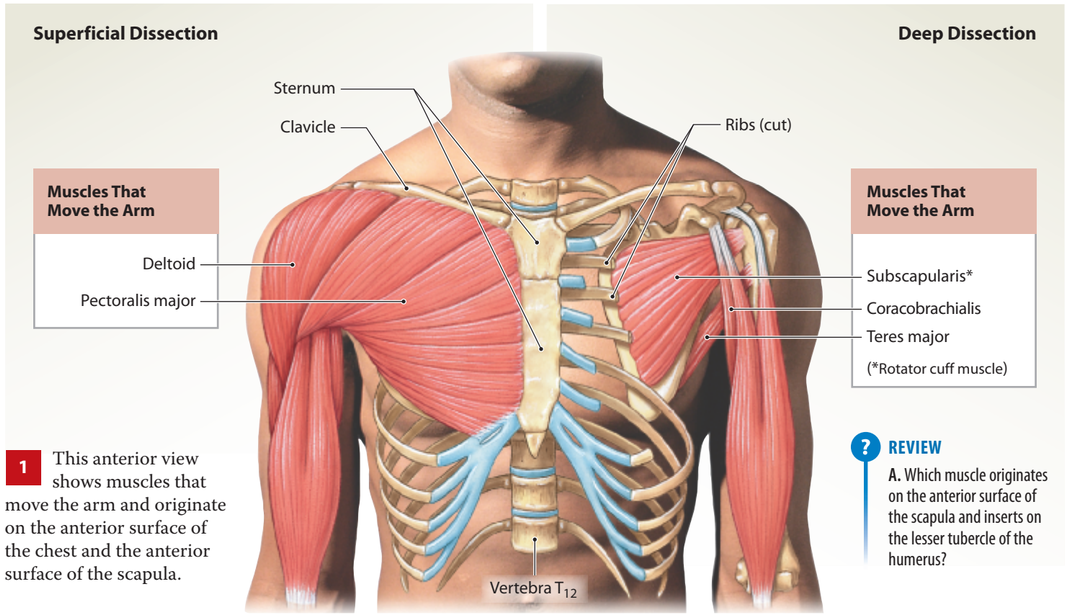
C. Which muscle originates on the first rib and inserts on the inferior border of the clavicle?

LEARNING OUTCOME

Identify the pectoral girdle muscles, and cite their origins, insertions, and actions.

Module 10.15

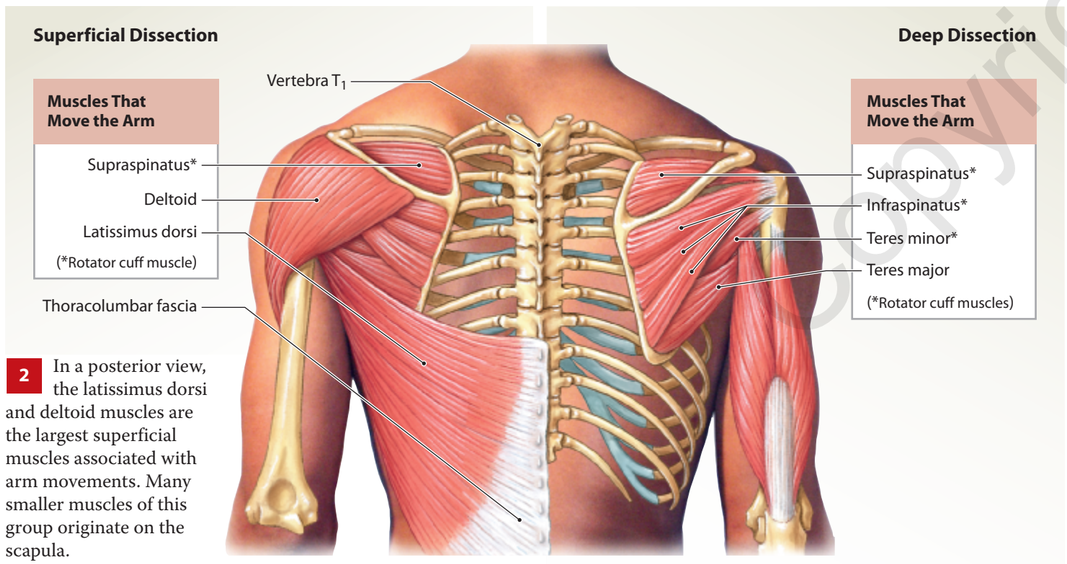
Muscles that move the arm originate on the clavicle, scapula, thoracic cage, and vertebral column



1 This anterior view shows muscles that move the arm and originate on the anterior surface of the chest and the anterior surface of the scapula.

REVIEW

A. Which muscle originates on the anterior surface of the scapula and inserts on the lesser tubercle of the humerus?



2 In a posterior view, the latissimus dorsi and deltoid muscles are the largest superficial muscles associated with arm movements. Many smaller muscles of this group originate on the scapula.

Muscles That Move the Arm

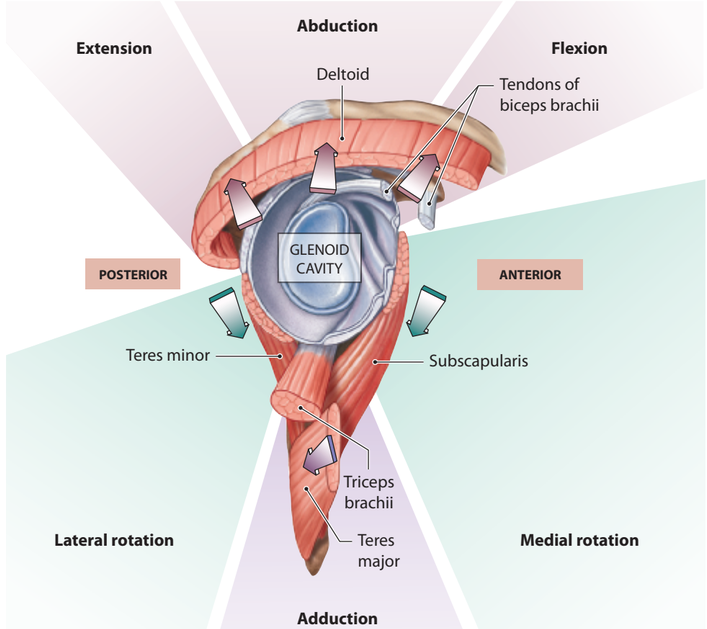
Muscle	Origin	Insertion	Action
Deltoid	Clavicle and scapula (acromion and adjacent scapular spine)	Deltoid tuberosity of humerus	Whole muscle: abduction at shoulder; anterior part: flexion and medial rotation; posterior part: extension and lateral rotation
Supraspinatus*	Supraspinous fossa of scapula	Greater tubercle of humerus	Abduction at shoulder
Subscapularis*	Subscapular fossa of scapula	Lesser tubercle of humerus	Medial rotation at shoulder
Teres major	Inferior angle of scapula	Passes medially to reach the medial lip of intertubercular groove of humerus	Extension, adduction, and medial rotation at shoulder
Infraspinatus*	Infraspinous fossa of scapula	Greater tubercle of humerus	Lateral rotation at shoulder
Teres minor*	Lateral border of scapula	Passes laterally to reach the greater tubercle of humerus	Lateral rotation at shoulder
Coracobrachialis	Coracoid process	Medial margin of shaft of humerus	Adduction and flexion at shoulder
Pectoralis major	Cartilages of ribs 2–6, body of sternum, and inferior, medial portion of clavicle	Crest of greater tubercle and lateral lip of intertubercular groove of humerus	Flexion, adduction, and medial rotation at shoulder
Latissimus dorsi	Spinous processes of inferior thoracic and all lumbar vertebrae, ribs 8–12, and lumbodorsal fascia	Floor of intertubercular groove of the humerus	Extension, adduction, and medial rotation at shoulder

* Rotator cuff muscles

3 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.

REVIEW

B. Define *line of action*.



REVIEW

C. Name the muscle that abducts the arm.

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.

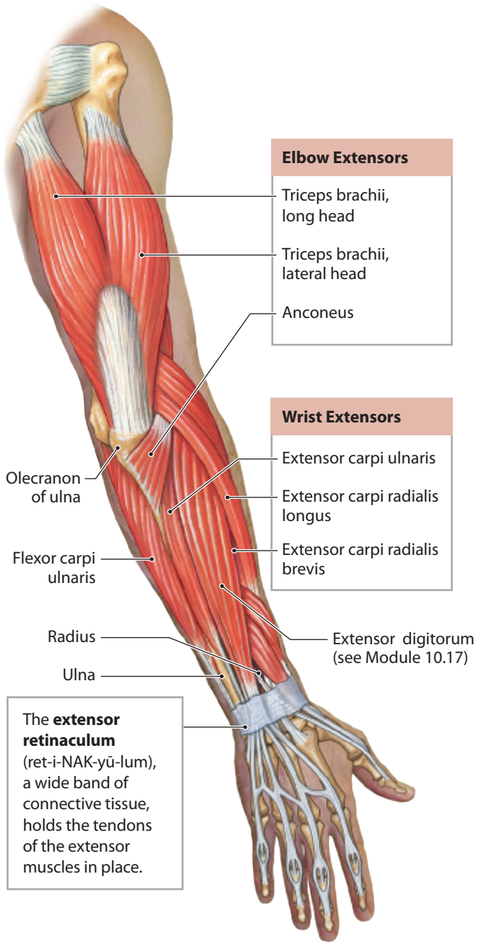
LEARNING OUTCOME

Identify the muscles that move the arm, and cite their origins, insertions, and actions.

Module 10.16

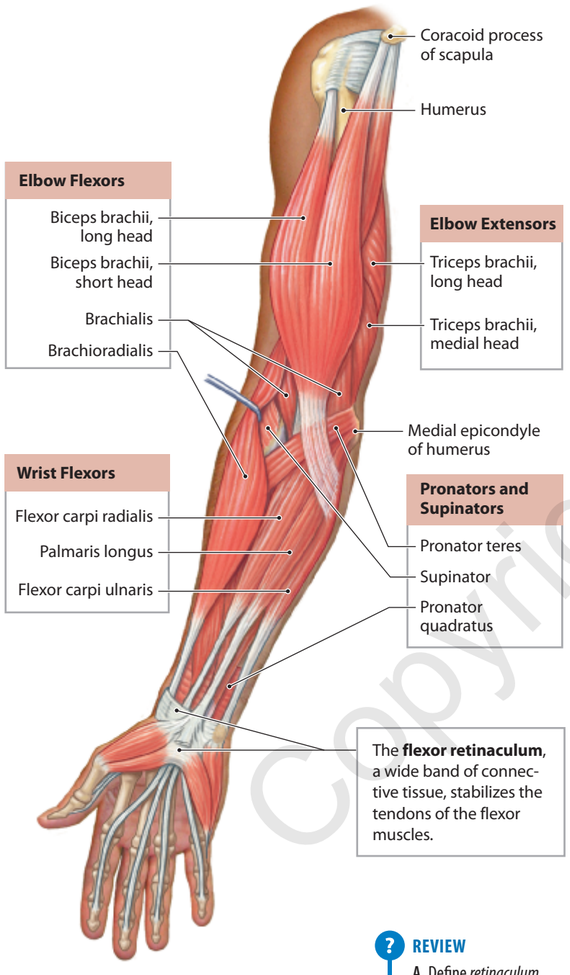
Muscles that move the forearm and hand originate on the scapula, humerus, radius, or ulna

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



Posterior view

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



Anterior view

? REVIEW

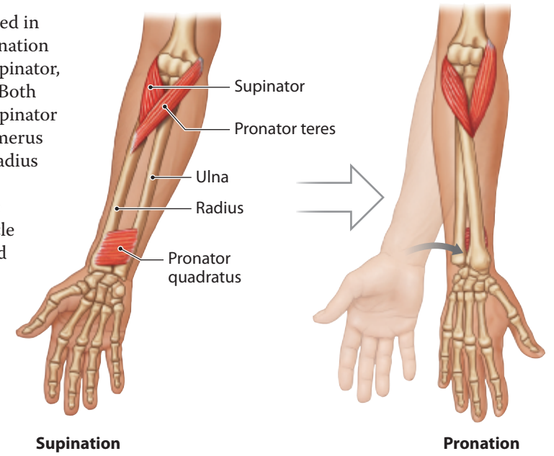
A. Define *retinaculum*.

B. Are the wrist extensors located on the anterior surface or the posterior surface of the forearm?

Muscles That Move the Forearm and Hand

Group and Muscle	Origin	Insertion	Action
Action at the Elbow			
FLEXORS — **Biceps brachii**	Short head from the coracoid process; long head from the supraglenoid tubercle (both on the scapula)	Tuberosity of radius	Flexion at elbow and shoulder; supination
FLEXORS — **Brachialis**	Anterior, distal surface of humerus	Tuberosity of ulna	Flexion at elbow
FLEXORS — **Brachioradialis**	Ridge superior to the lateral epicondyle of humerus	Lateral aspect of styloid process of radius	Flexion at elbow
EXTENSORS — **Anconeus**	Posterior, inferior surface of lateral epicondyle of humerus	Lateral margin of olecranon on ulna	Extension at elbow
EXTENSORS — **Triceps brachii**	Lateral head from the superior, lateral margin of humerus; long head from infraglenoid tubercle of scapula; and medial head from posterior surface of humerus inferior to radial groove	Olecranon of ulna	Extension at elbow, plus extension and adduction at the shoulder
PRONATORS / SUPINATORS — **Pronator quadratus**	Anterior and medial surfaces of distal portion of ulna	Anterolateral surface of distal portion of radius	Pronation
PRONATORS / SUPINATORS — **Pronator teres**	Medial epicondyle of humerus and coronoid process of ulna	Midlateral surface of radius	Pronation
PRONATORS / SUPINATORS — **Supinator**	Lateral epicondyle of humerus, annular ligament, and ridge near radial notch of ulna	Anterolateral surface of radius distal to the radial tuberosity	Supination
Action at the Hand			
FLEXORS — **Flexor carpi radialis**	Medial epicondyle of humerus	Bases of second and third metacarpal bones	Flexion and abduction at wrist
FLEXORS — **Flexor carpi ulnaris**	Medial epicondyle of humerus; adjacent medial surface of olecranon and anteromedial portion of ulna	Pisiform bone, hamate bone, and base of fifth metacarpal bone	Flexion and adduction at wrist
FLEXORS — **Palmaris longus**	Medial epicondyle of humerus	Palmar aponeurosis and flexor retinaculum	Flexion at wrist
EXTENSORS — **Extensor carpi radialis longus**	Lateral supracondylar ridge of humerus	Base of second metacarpal bone	Extension and abduction at wrist
EXTENSORS — **Extensor carpi radialis brevis**	Lateral epicondyle of humerus	Base of third metacarpal bone	Extension and abduction at wrist
EXTENSORS — **Extensor carpi ulnaris**	Lateral epicondyle of humerus; adjacent dorsal surface of ulna	Base of fifth metacarpal bone	Extension and adduction at 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).



Supination

Pronation

? INTEGRATION

C. Which muscles are involved in turning a doorknob?

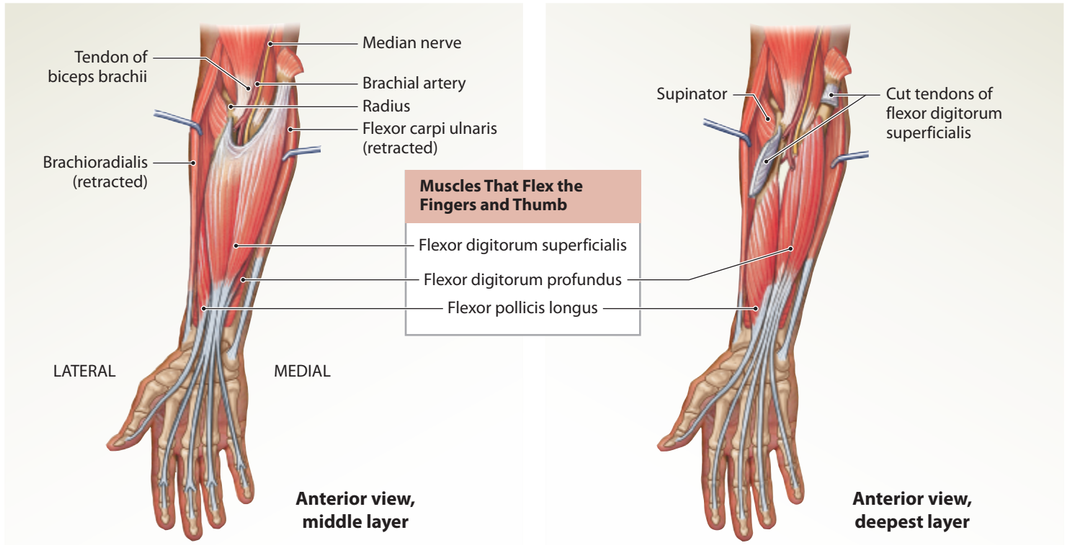
LO LEARNING OUTCOME

Identify the forearm 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

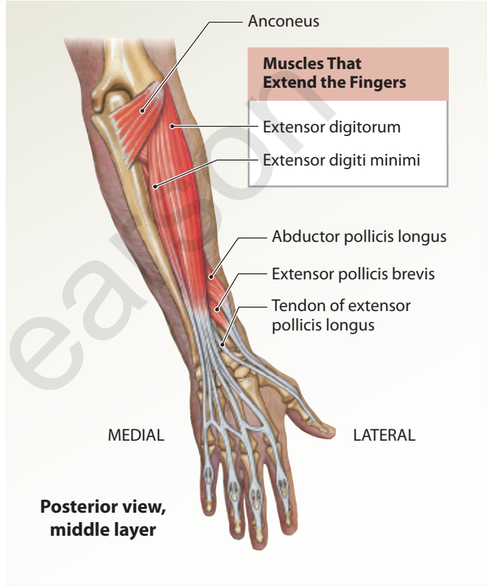
1 In anterior view, the large flexor digitorum superficialis covers the smaller digital flexors.

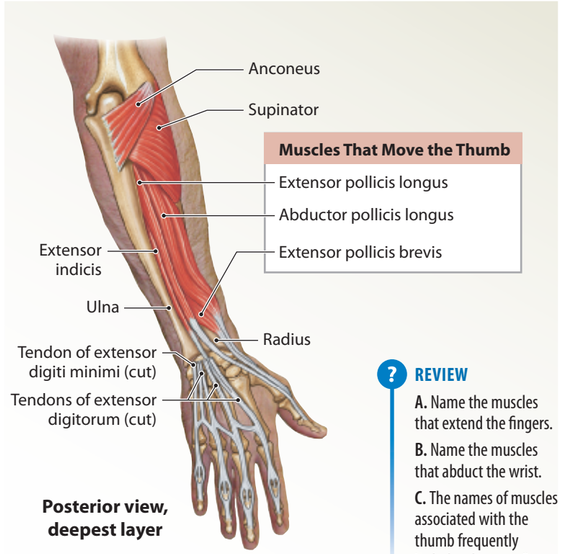


Muscles That Move the Hand and Fingers

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

2 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.





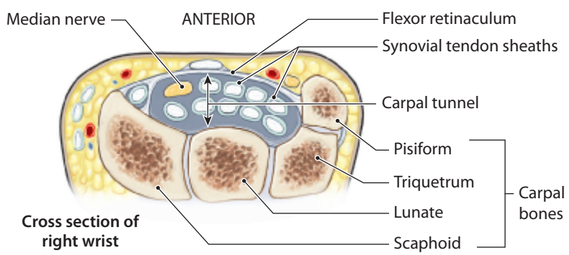
REVIEW

A. Name the muscles that extend the fingers.

B. Name the muscles that abduct the wrist.

C. The names of muscles associated with the thumb frequently include what term?

3 **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.

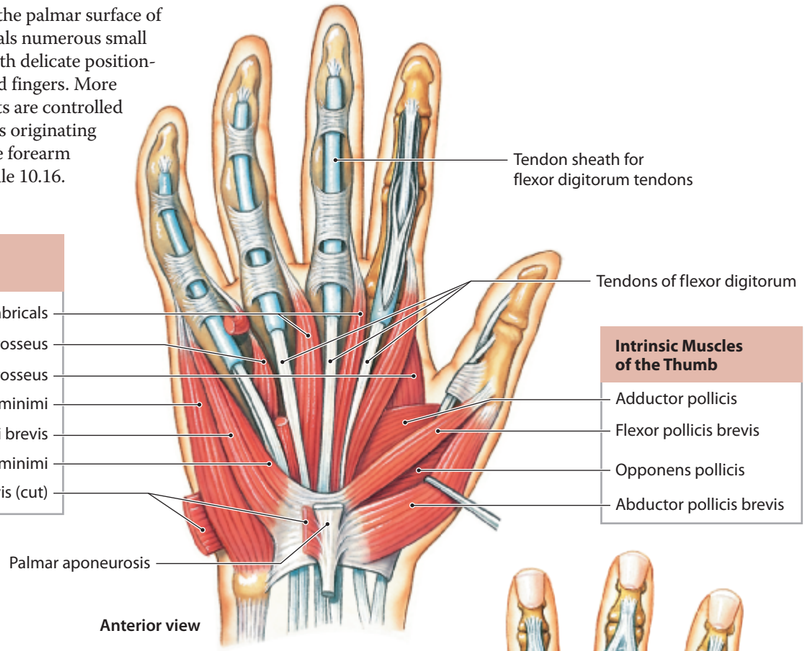
LEARNING OUTCOME

Identify the muscles of the hand and fingers, and cite their origins, insertions, and actions.

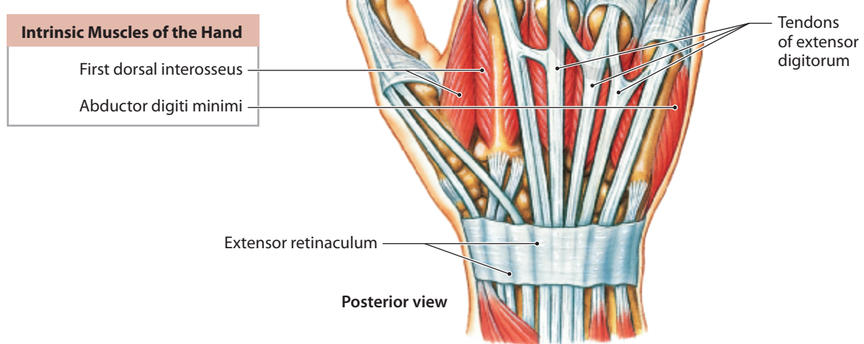
Module 10.18

The intrinsic muscles of the hand originate on the carpal and metacarpal bones and associated tendons and ligaments

1 Dissection of the palmar surface of the hand reveals numerous small muscles involved with delicate positioning of the thumb and fingers. More powerful movements are controlled by the many tendons originating at the muscles of the forearm considered in Module 10.16.



2 Extensor tendons from muscles originating on the forearm dominate the posterior surface of the hand.



REVIEW

A. Name the intrinsic muscles of the thumb.

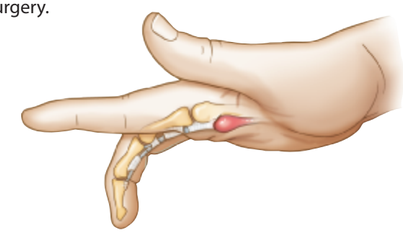
Intrinsic Muscles of the Hand

Muscle		Origin	Insertion	Action
Palmaris brevis		Palmar aponeurosis	Skin of medial border of hand	Moves skin on medial border toward midline of palm
ADDUCTION / ABDUCTION	**Adductor pollicis**	Metacarpal and carpal bones	Proximal phalanx of thumb	Adduction of thumb
	Palmar interosseus (3–4)	Sides of metacarpal bones II, IV, and V	Bases of proximal phalanges of fingers 2, 4, and 5	Adduction at metacarpophalangeal joints of fingers 2, 4, and 5; flexion at metacarpophalangeal joints; extension at interphalangeal joints
	Abductor pollicis brevis	Transverse carpal ligament, scaphoid bone, and trapezium	Radial side of base of proximal phalanx of thumb	Abduction of thumb
	Dorsal interosseus (4)	Each originates from opposing faces of two metacarpal bones (I and II, II and III, III and IV, IV and V)	Bases of proximal phalanges of fingers 2–4	Abduction at metacarpophalangeal joints of fingers 2 and 4; flexion at metacarpophalangeal joints; extension at interphalangeal joints
	Abductor digiti minimi	Pisiform bone	Proximal phalanx of little finger	Abduction of little finger and flexion at its metacarpophalangeal joint
FLEXION	**Flexor pollicis brevis**	Flexor retinaculum, trapezium, capitate bone, and ulnar side of first metacarpal bone	Radial and ulnar sides of proximal phalanx of thumb	Flexion and adduction of thumb
	Lumbrical (4)	Tendons of flexor digitorum profundus	Tendons of extensor digitorum to digits 2–5	Flexion at metacarpophalangeal joints 2–5; extension at proximal and distal interphalangeal joints, digits 2–5
	Flexor digiti minimi brevis	Hamate bone	Proximal phalanx of little finger	Flexion at joints of little finger
Opponens pollicis		Trapezium and flexor retinaculum	First metacarpal bone	Opposition of thumb
Opponens digiti minimi		Trapezium and flexor retinaculum	Fifth metacarpal bone	Opposition of fifth metacarpal bone

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.



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.

REVIEW

B. Which muscles originate on the phalanges?

INTEGRATION

C. If there are no muscles in the fingers, how are we able to move them?

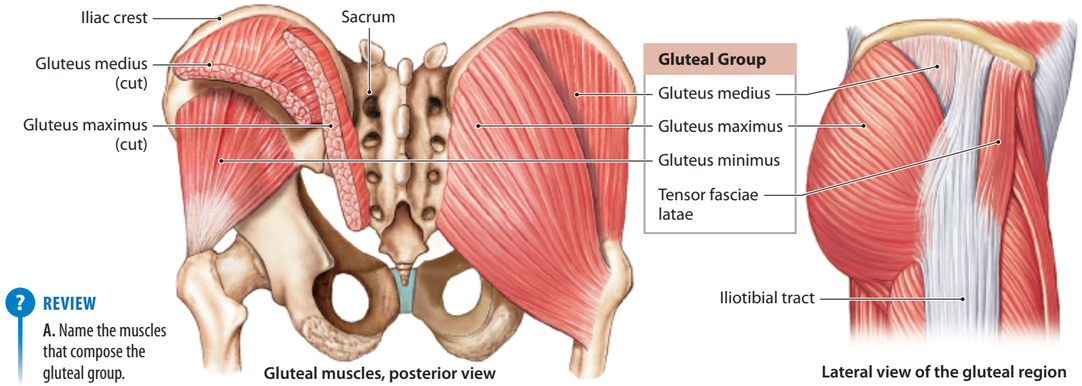
LEARNING OUTCOME

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.



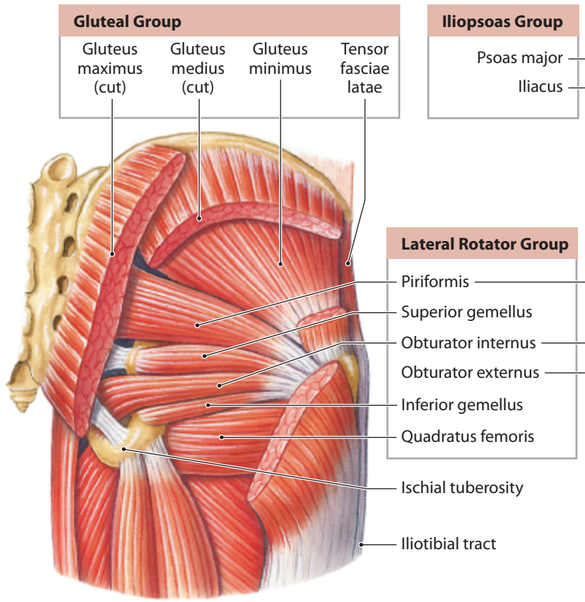
Gluteal muscles, posterior view

Lateral view of the gluteal region

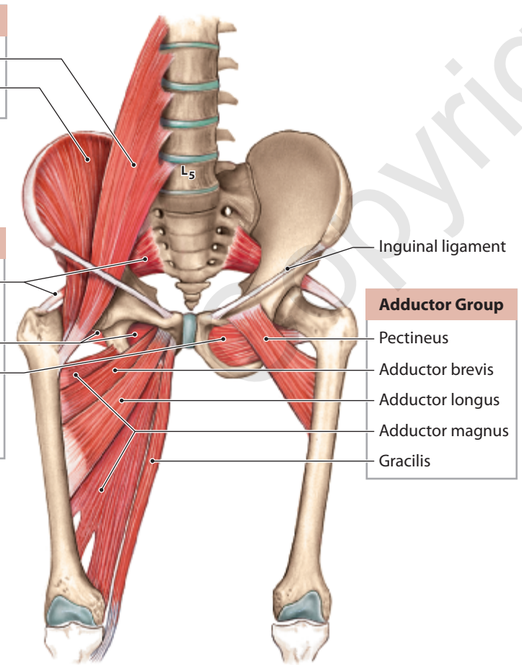
REVIEW

A. Name the muscles that compose the gluteal group.

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

Group and Muscle	Origin	Insertion	Action
Gluteal Group			
Gluteus maximus	Iliac crest, posterior gluteal line, and lateral surface of ilium; sacrum, coccyx, and thoracolumbar fascia	Iliotibial tract and gluteal tuberosity of femur	Extension and lateral rotation at hip
Gluteus medius	Anterior iliac crest of ilium, lateral surface between posterior and anterior gluteal lines	Greater trochanter of femur	Abduction and medial rotation at hip
Gluteus minimus	Lateral surface of ilium between inferior and anterior gluteal lines	Greater trochanter of femur	Abduction and medial rotation at hip
Tensor fasciae latae	Iliac crest and lateral surface of anterior superior iliac spine	Iliotibial tract	Extension of the knee and lateral rotation of the leg acting through the iliotibial tract; abduction** and medial rotation of the thigh
Lateral Rotator Group			
Obturator (externus and **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 and **inferior)**	Ischial spine and tuberosity	Medial surface of greater trochanter with tendon of obturator internus	Lateral rotation at hip
Quadratus femoris	Lateral border of ischial tuberosity	Intertrochanteric crest of femur	Lateral rotation at hip
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	Femur distal to lesser trochanter; tendon fused with that of psoas major	Flexion at hip
Psoas major	Anterior surfaces and transverse processes of vertebrae (T_{12}–L_5)	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 what portion of the muscle is activated; when the entire muscle contracts, it produces a combination of flexion, extension, and adduction at the hip.

REVIEW

B. Which leg movement would be impaired by injury to the obturator muscles?

LEARNING OUTCOME

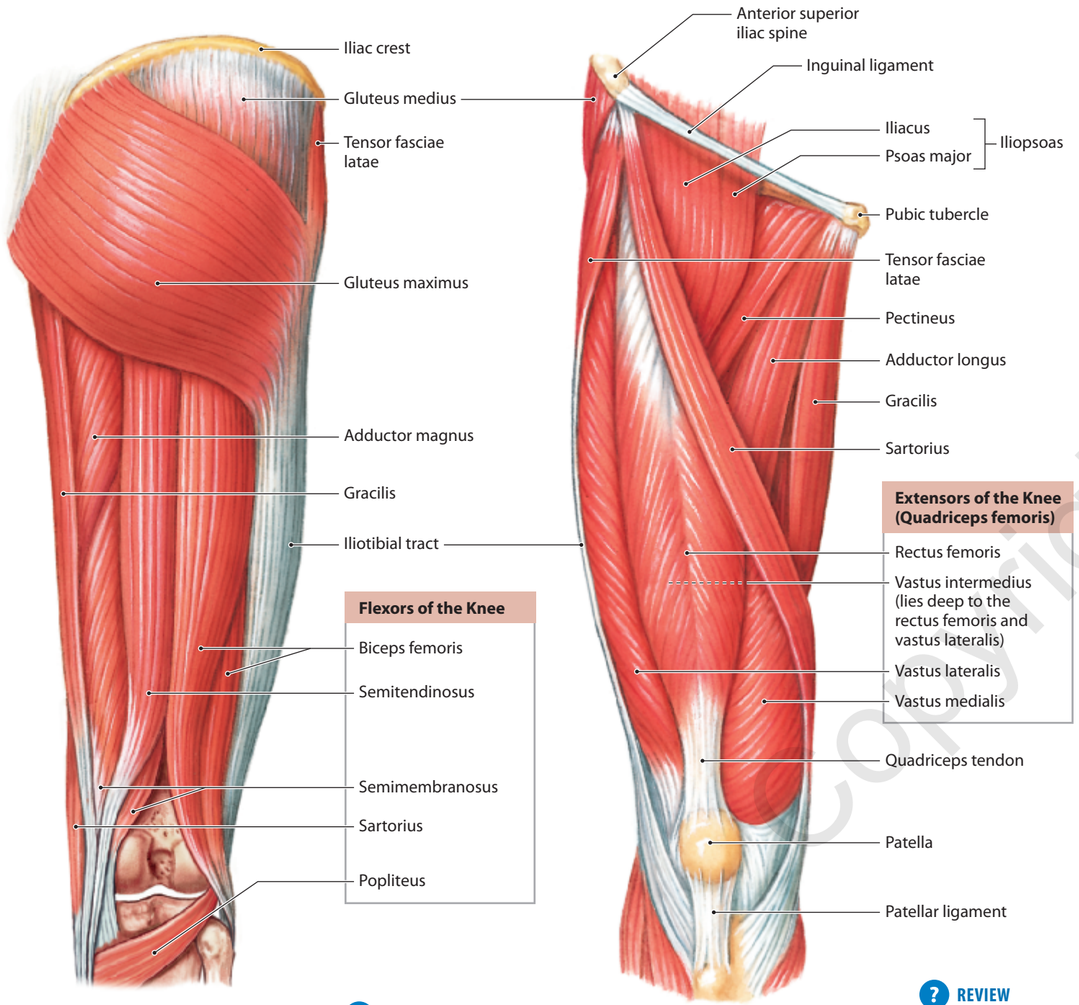
Identify the muscles that move the thigh, and cite their origins, insertions, and actions.

Module 10.20

The muscles that move the leg originate on the pelvis and femur

1 **Flexors of the knee** originate on the pelvic girdle and extend along the posterior and medial surfaces of the thigh.

2 Most of the **extensors of the knee** originate on the femoral surface and extend along the anterior and lateral surfaces of the thigh. Collectively, the four knee extensor muscles are called the **quadriceps femoris**.



Posterior view **Anterior view**

REVIEW
A. Which muscles flex the knee?

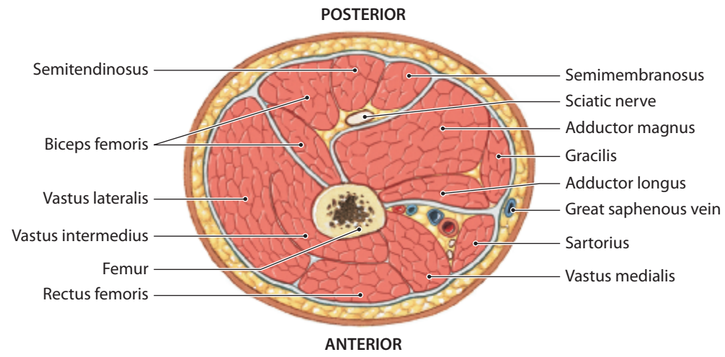
REVIEW
B. Name the muscles of the quadriceps femoris.

Muscles That Move the Leg

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

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

3 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.



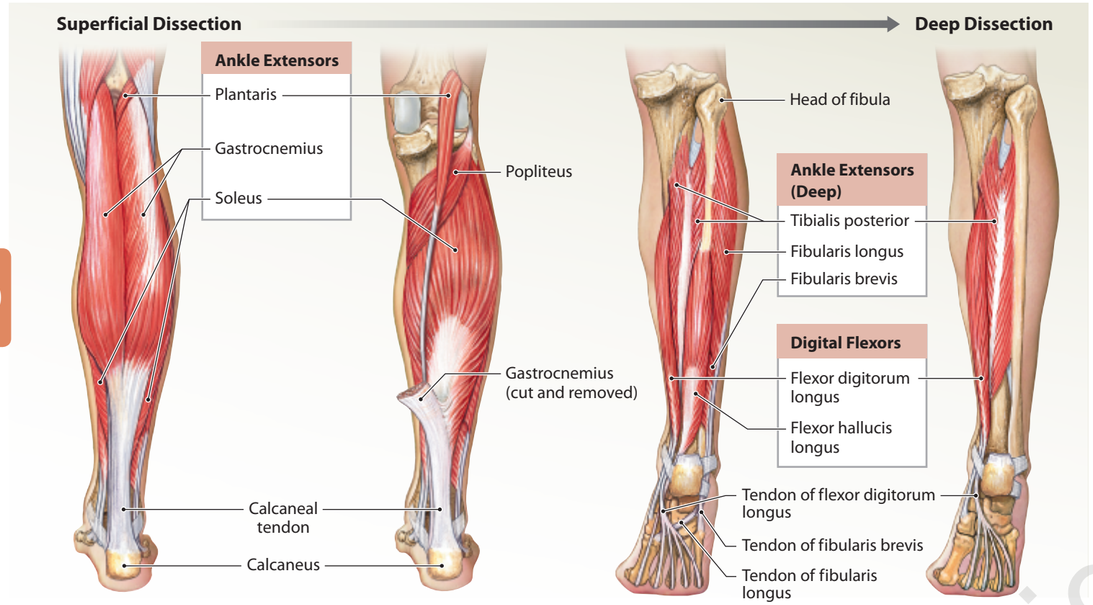
INTEGRATION
D. Which muscle of the leg crosses and produces actions at two joints?

LEARNING OUTCOME
Identify the muscles that move the leg, and cite their origins, insertions, and actions.

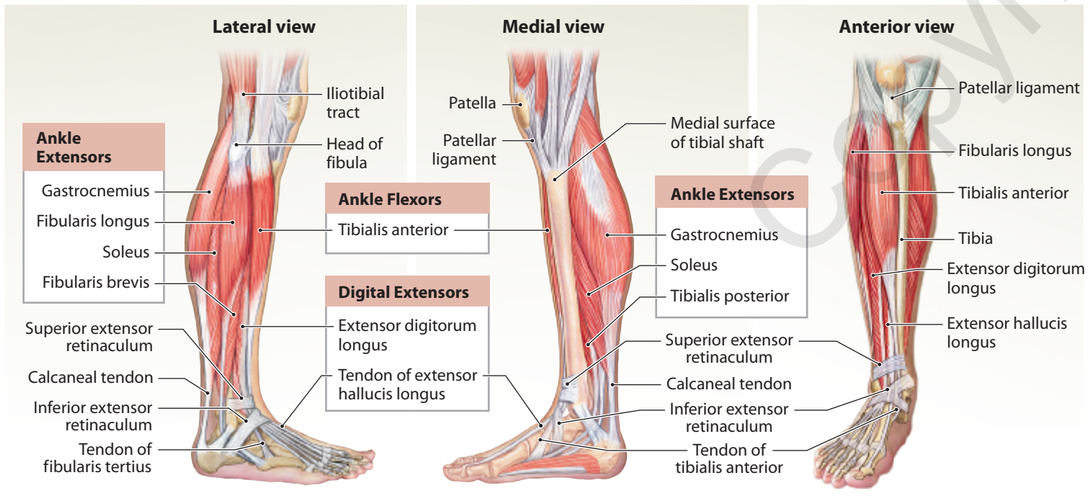
Module 10.21

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

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



2 These lateral, medial, and anterior views show the arrangement of the major superficial muscles.



Extrinsic Muscles That Move the Foot and Toes

	Group and Muscle	Origin	Insertion	Action
	Action at the Ankle			
FLEXORS (Dorsiflexors)	**Tibialis anterior**	Lateral condyle and proximal shaft of tibia	Base of first metatarsal bone and medial cuneiform bone	Flexion (dorsiflexion) at ankle; inversion of foot
FLEXORS (Dorsiflexors)	**Fibularis tertius**	Distal anterior surface of fibula and interosseous membrane	Dorsal surface of fifth metatarsal bone	Flexion (dorsiflexion); eversion of foot
EXTENSORS (Plantar flexors)	**Gastrocnemius**	Femoral condyles	Calcaneus by calcaneal tendon	Extension (plantar flexion) at ankle; inversion of foot; flexion at knee
EXTENSORS (Plantar flexors)	**Fibularis brevis**	Midlateral margin of fibula	Base of fifth metatarsal bone	Eversion of foot and extension (plantar flexion) at ankle
EXTENSORS (Plantar flexors)	**Fibularis longus**	Lateral condyle of tibia, head and proximal shaft of fibula	Base of first metatarsal bone and medial cuneiform bone	Eversion of foot and extension (plantar flexion) at ankle; supports longitudinal arch
EXTENSORS (Plantar flexors)	**Plantaris**	Lateral supracondylar ridge	Posterior portion of calcaneus	Extension (plantar flexion) at ankle; flexion at knee
EXTENSORS (Plantar flexors)	**Soleus**	Head and proximal shaft of fibula and adjacent posteromedial shaft of tibia	Calcaneus by calcaneal tendon (with gastrocnemius)	Extension (plantar flexion) at ankle
EXTENSORS (Plantar flexors)	**Tibialis posterior**	Interosseous membrane and adjacent shafts of tibia and fibula	Tarsal and metatarsal bones	Adduction and inversion of foot; extension (plantar flexion) at ankle
	Action at the Toes			
DIGITAL FLEXORS	**Flexor digitorum longus**	Posteromedial surface of tibia	Inferior surfaces of distal phalanges, toes 2–5	Flexion at joints of toes 2–5
DIGITAL FLEXORS	**Flexor hallucis longus**	Posterior surface of fibula	Inferior surface, distal phalanx of great toe	Flexion at joints of great toe
DIGITAL EXTENSORS	**Extensor digitorum longus**	Lateral condyle of tibia, anterior surface of fibula	Superior surfaces of phalanges, toes 2–5	Extension at joints of toes 2–5
DIGITAL EXTENSORS	**Extensor hallucis longus**	Anterior surface of fibula	Superior surface, distal phalanx of great toe	Extension at joints of great toe

REVIEW

A. Name the muscles involved in extending the ankle.

B. Name the muscles involved in flexing the toes.

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.

INTEGRATION

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

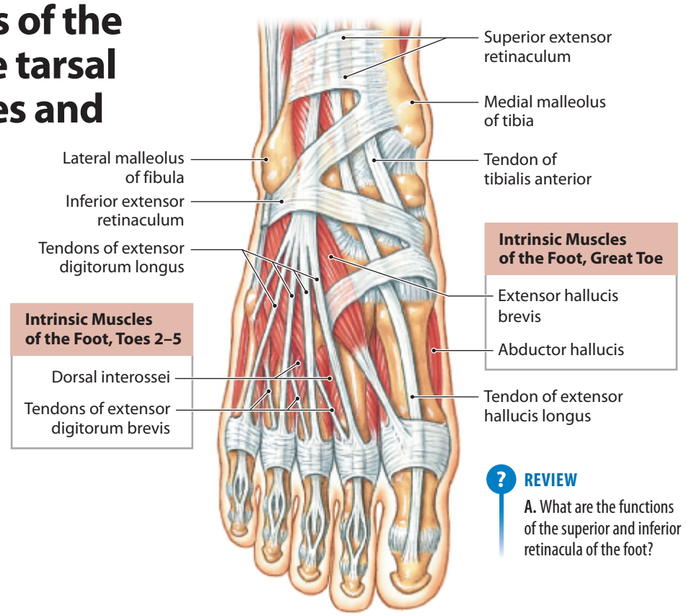
LEARNING OUTCOME

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

Module 10.22

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

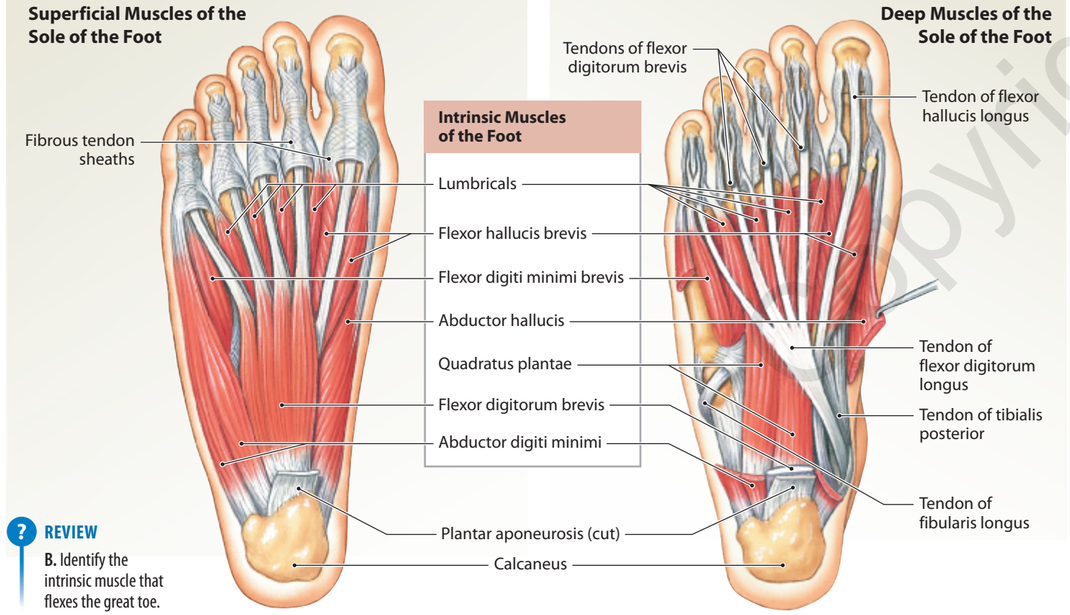
1 This superior view introduces some of the **intrinsic muscles of the foot**. It also reveals the importance of the retinacula in stabilizing the positions of the tendons descending from the leg.



REVIEW

A. What are the functions of the superior and inferior retinacula of the foot?

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

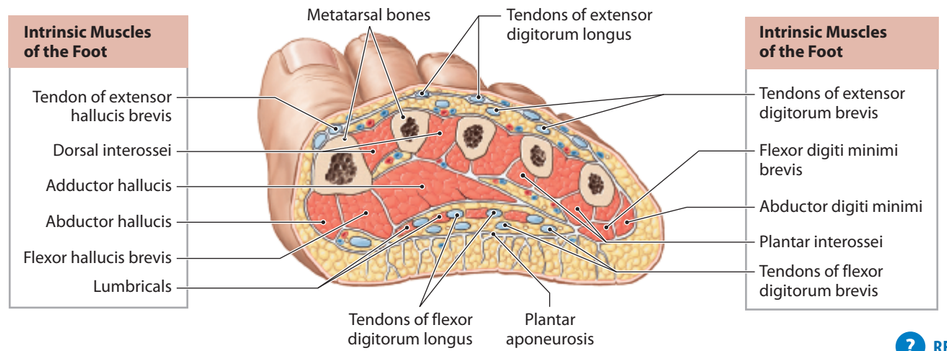


REVIEW

B. Identify the intrinsic muscle that flexes the great toe.

Intrinsic Muscles of the Foot

	Muscle	Origin	Insertion	Action
FLEXION / EXTENSION	**Flexor hallucis brevis**	Cuboid and lateral cuneiform bones	Proximal phalanx of great toe	Flexion at metatarsophalangeal joint of great toe
	Flexor digitorum brevis	Calcaneus (tuberosity on inferior surfaces)	Sides of middle phalanges, toes 2–5	Flexion at proximal interphalangeal joints of toes 2–5
	Quadratus plantae	Calcaneus (medial, inferior surfaces)	Tendon of flexor digitorum longus	Flexion at joints of toes 2–5
	Lumbrical (4)	Tendons of flexor digitorum longus	Tendons of extensor digitorum longus, toes 2 to 5	Flexion at metatarsophalangeal joints; extension at proximal interphalangeal joints of toes 2–5
	Flexor digiti minimi brevis	Base of metatarsal bone V	Lateral side of proximal phalanx of toe 5	Flexion at metatarsophalangeal joint of toe 5
	Extensor digitorum brevis	Calcaneus (superior and lateral surfaces)	Dorsal surfaces of toes 1–4	Extension at metatarsophalangeal joints of toes 1–4
	Extensor hallucis brevis	Superior surface of anterior calcaneus	Dorsal surface of the base of proximal phalanx of great toe	Extension of great toe
ADDUCTION / ABDUCTION	**Adductor hallucis**	Bases of metatarsal bones II–IV and plantar ligaments	Proximal phalanx of great toe	Adduction at metatarsophalangeal joint of great toe
	Abductor hallucis	Calcaneus (tuberosity on inferior surface)	Medial side of proximal phalanx of great toe	Abduction at metatarsophalangeal joint of great toe
	Plantar interosseus (3)	Bases and medial sides of metatarsal bones	Medial sides of toes 3–5	Adduction at metatarsophalangeal joints of toes 3–5
	Dorsal interosseus (4)	Sides of metatarsal bones	Medial and lateral sides of toe 2; lateral sides of toes 3 and 4	Abduction at metatarsophalangeal joints of toes 3 and 4
	Abductor digiti minimi	Inferior surface of calcaneus	Lateral side of proximal phalanx, toe 5	Abduction at metatarsophalangeal joint of toe 5



3 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

C. Which intrinsic foot muscles originate on and insert on tendons?

LEARNING OUTCOME

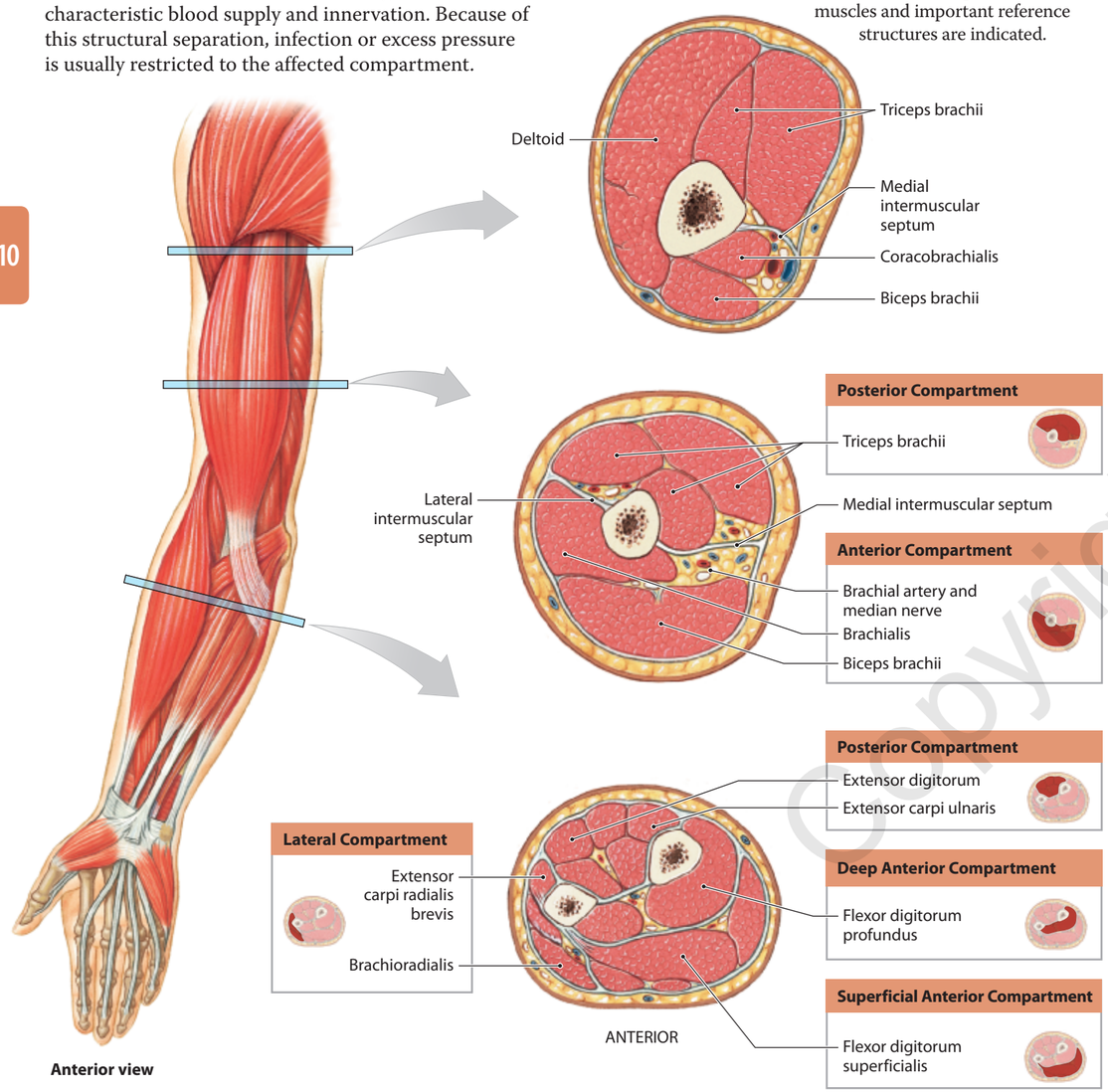
Identify the intrinsic foot muscles, and cite their origins, insertions, and actions.

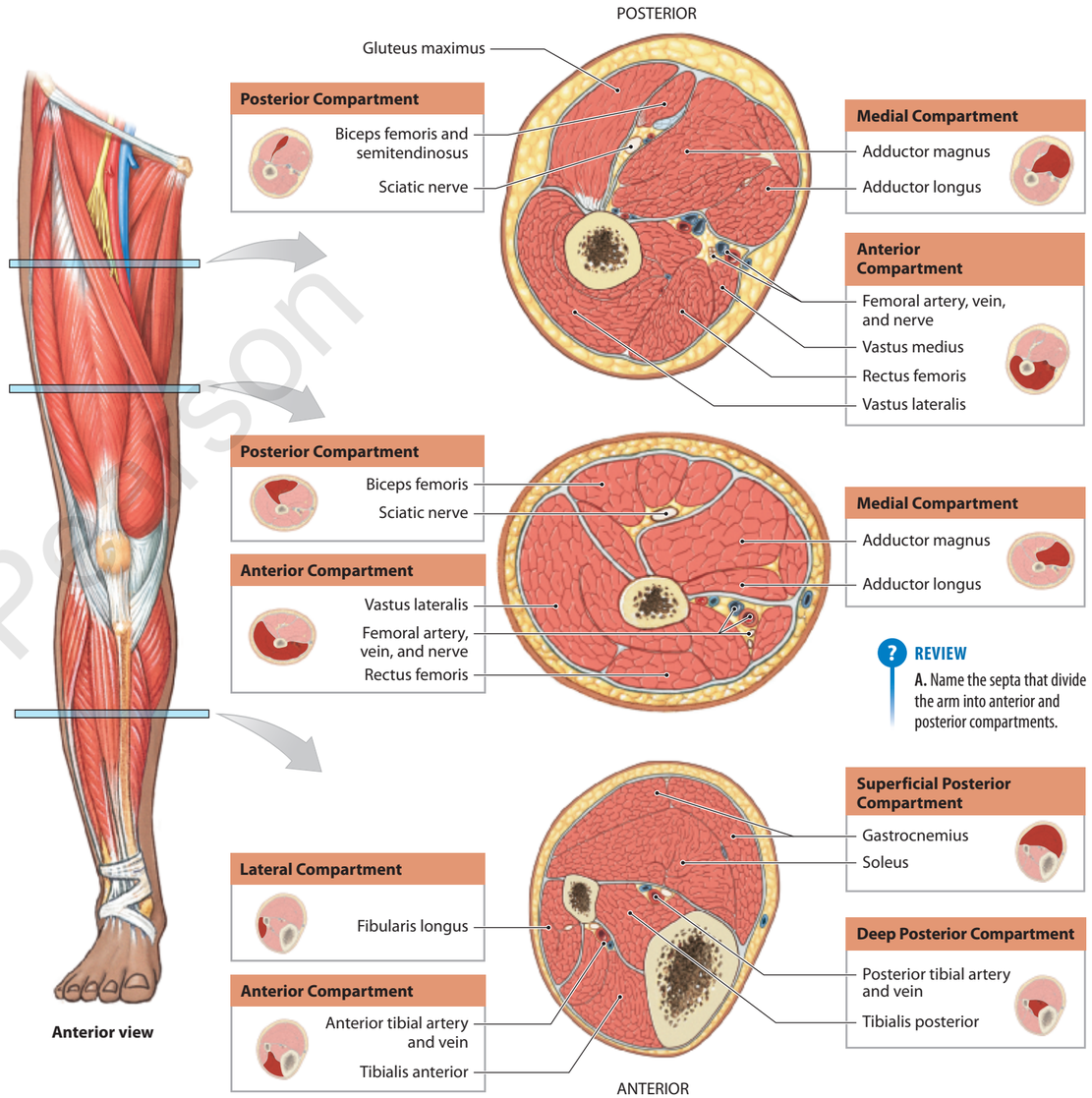
Module 10.23

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.

1 Here are sectional views at intervals along the length of an upper and lower limb. In each relevant section the compartments are labeled, and representative muscles and important reference structures are indicated.





REVIEW

A. Name the septa that divide the arm into anterior and posterior compartments.

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.

INTEGRATION

B. Propose a reason why compartment syndrome can be life threatening.

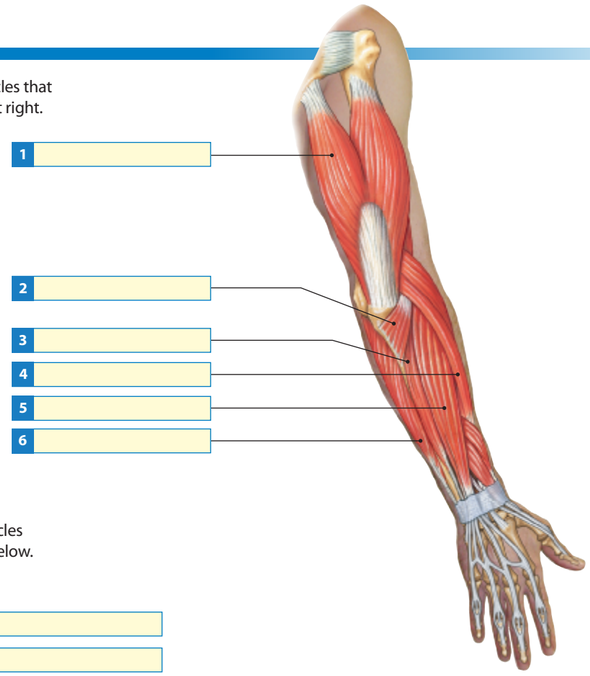
LEARNING OUTCOME

Describe the deep fascia and its relationship to the various limb muscle compartments.

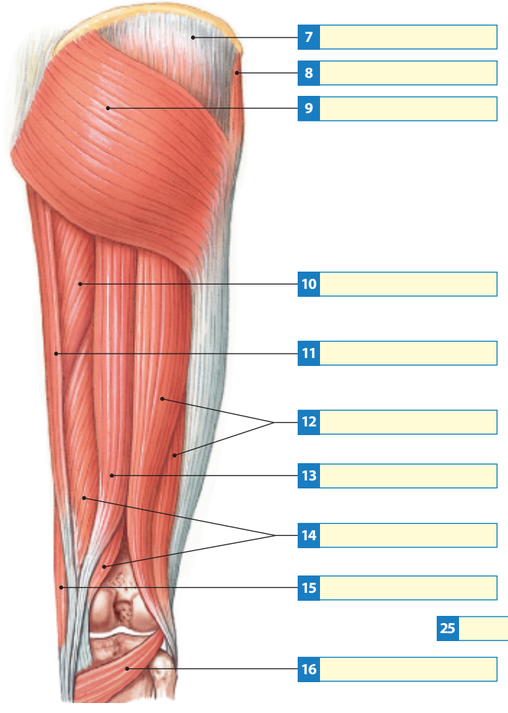
Section 3 Review

Appendicular Muscles

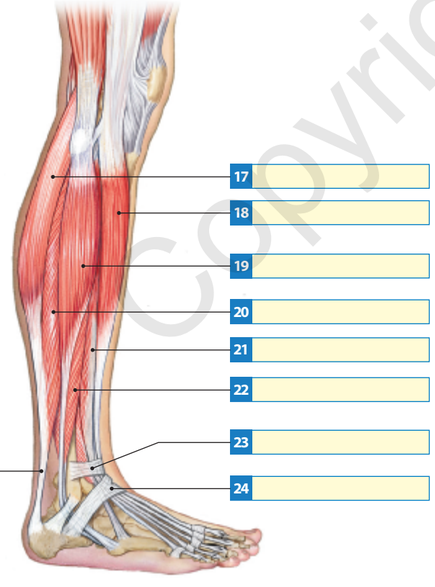
Labeling: Label each of the indicated muscles that move the forearm and hand in the diagram at right.



Label each of the indicated structures or muscles that move the thigh and leg in the diagram below.



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



Study Outline

SECTION 1 • Functional Organization of the Muscular System

Module 10.1

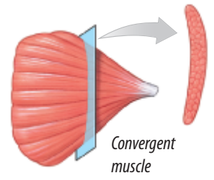
The axial and appendicular muscles have different functions p. 351

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 support 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 fulcrums.
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

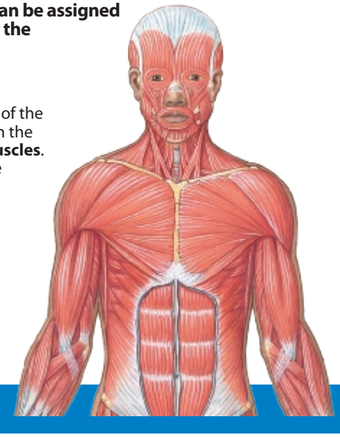
The origins and insertions of muscles determine their actions, while their names can provide clues to appearance and/or function p. 354

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 **agonist**, 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**, **geniohyoid**, **mylohyoid**, **omohyoid**, **sternohyoid**, **sternothyroid**, **stylohyoid**, **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**.

Module 10.11

The muscles of the pelvic floor support the organs of the abdominopelvic cavity p. 370

24. The muscles of the pelvic floor form the **perineum**, a muscular sheet that spans the pelvic outlet.
25. The muscles of the pelvic floor are divided into the muscles of the **urogenital triangle** and **anal triangle**.

SECTION 3 • Appendicular Muscles

Module 10.12

The appendicular muscles stabilize, position, and support the limbs p. 373

26. The upper limb muscles include muscles of the pectoral girdle, arm, forearm, hand, and fingers.
27. The lower limb muscles include muscles of the thigh, leg, foot, and toes.

Module 10.13

The largest appendicular muscles originate on the trunk p. 374

28. Gross movements of the limbs are controlled by muscles that originate on the trunk. Limb muscles get smaller, more numerous, and more precise as they are located more distally on the limb.

Module 10.14

Muscles that position each pectoral girdle originate on the occipital bone, superior vertebrae, and ribs p. 376

29. The muscles of the pectoral girdle are **trapezius**, **levator scapulae**, **subclavius**, **pectoralis minor**, **serratus anterior**, **rhomboid major**, and **rhomboid minor**.

Module 10.15

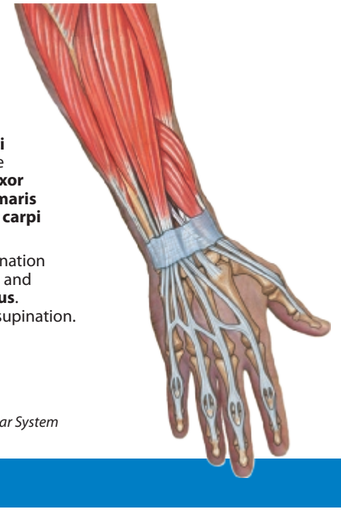
Muscles that move the arm originate on the clavicle, scapula, thoracic cage, and vertebral column p. 378

30. The muscles that move the arm are **deltoid**, **pectoralis major**, **coracobrachialis**, **teres major**, **latissimus dorsi**, and the four muscles of the **rotator cuff**: **supraspinatus**, **infraspinatus**, **teres minor**, and **subscapularis**.

Module 10.16

Muscles that move the forearm and hand originate on the scapula, humerus, radius, or ulna p. 380

31. The elbow extensors are **triceps brachii** and **anconeus**. The elbow flexors are **biceps brachii**, **brachialis**, and **brachioradialis**.
32. The wrist extensors are **extensor carpi ulnaris**, **extensor carpi radialis longus**, and **extensor carpi radialis brevis**. The wrist flexors are **flexor carpi radialis**, **palmaris longus**, and **flexor carpi ulnaris**.
33. The muscles of pronation are **pronator teres** and **pronator quadratus**. **Supinator** causes supination.



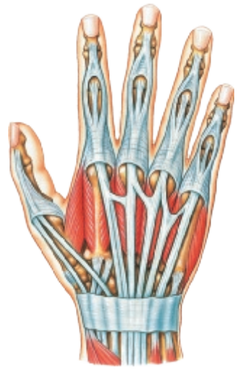
Module 10.17

Muscles that move the hand and fingers originate on the humerus, radius, ulna, and interosseous membrane p. 382

34. The muscles that flex the fingers and the thumb are **flexor digitorum superficialis**, **flexor digitorum profundus**, and **flexor pollicis longus**. Finger extension is caused by **extensor**, **digitorum extensor pollicis brevis**, **extensor pollicis longus**, **extensor indicis**, and **extensor digiti minimi**.
35. The muscles that move the thumb are **extensor pollicis longus**, **abductor pollicis longus**, and **extensor pollicis brevis**.
36. The tendons of the flexor muscles pass through **synovial tendon sheaths**. Inflammation of the flexor retinaculum and the synovial tendon sheaths can put pressure on the median nerve, causing the pain known as **carpal tunnel syndrome**.

Module 10.18

The intrinsic muscles of the hand originate on the carpal and metacarpal bones and associated tendons and ligaments p. 384



37. The intrinsic muscles of the hand perform flexion and extension of the fingers at the metacarpophalangeal joints; abduction and adduction of the fingers at the metacarpophalangeal joints; and opposition and reposition (relaxed position) of the thumb.

Module 10.19

The muscles that move the thigh originate on the pelvis and associated ligaments and fasciae p. 386

38. The muscles of the **gluteal group** are **gluteus maximus**, **gluteus medius**, **gluteus minimus**, and **tensor fasciae latae**.
39. The iliopsoas group includes **psoas major** and **iliacus**.
40. The lateral rotator group muscles are **piriformis**, **superior** and **inferior gemellus**, **obturator internus** and **externus**, and **quadratus femoris**.
41. The adductor group muscles are **pectineus**, **adductor brevis**, **adductor longus**, **adductor magnus**, and **gracilis**.

Module 10.20

The muscles that move the leg originate on the pelvis and femur p. 388

42. The **flexors of the knee** are **biceps femoris**, **semimembranosus**, **semitendinosus**, **sartorius**, and **popliteus**.
43. The **extensors of the knee** are **rectus femoris**, **vastus intermedius**, **vastus lateralis**, and **vastus medialis**.

Module 10.21

The extrinsic muscles that move the foot and toes originate on the tibia and fibula p. 390

44. Plantar flexion is performed by **gastrocnemius**, **soleus**, **fibularis brevis**, **fibularis longus**, **plantaris**, and **tibialis posterior**. The **tibialis anterior** and **fibularis tertius** cause dorsiflexion.
45. Flexion of the toes is caused by **flexor digitorum longus** and **flexor hallucis longus**. Toe extension is caused by **extensor digitorum longus** and **extensor hallucis longus**.

Module 10.22

The intrinsic muscles of the foot originate on the tarsal and metatarsal bones and associated tendons and ligaments p. 392

46. 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.
47. These intrinsic muscles are responsible for flexion and extension of the interphalangeal joints, as well as abduction and adduction of the metatarsophalangeal joints.

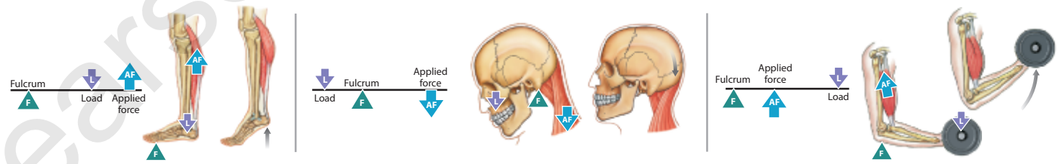
Module 10.23

The deep fascia divides the limb muscles into separate compartments p. 394

48. Fibrous partitions called **intermuscular septa** create **compartments** containing muscles with compatible functions as well as characteristic blood supply and innervation.
49. Trauma to a limb may cause bleeding into a compartment. This may elevate pressures and compress blood vessels and nerves within a compartment, a condition called **compartment syndrome**.

Chapter Review Questions

Labeling: Identify the lever system in each of the images below.



1 _____ 2 _____ 3 _____

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

4. The pectoralis major is an example of a convergent muscle.
5. A wheelbarrow is an example of a third-class lever.
6. A muscle agonist can also be referred to as a prime mover.
7. The inferior rectus and superior oblique are examples of extrinsic eye muscles.
8. The esophageal hiatus is an opening in the transversus abdominis.

4 _____
5 _____
6 _____
7 _____
8 _____

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

a. moves eye laterally
b. flexion at knee
c. extension at knee
d. abduction at shoulder
e. downward rotation of scapula
f. flexion at elbow
g. plantar flexion
h. mastication
i. medial rotation at shoulder
j. dorsiflexion

9. Tibialis anterior
10. Temporalis
11. Brachialis
12. Lateral rectus
13. Soleus
14. Biceps femoris
15. Rhomboid major
16. Vastus medialis
17. Deltoid
18. Subscapularis

9 _____
10 _____
11 _____
12 _____
13 _____
14 _____
15 _____
16 _____
17 _____
18 _____

Multiple choice: Select the correct answer from the list provided.

19 The site where the more movable end of a muscle attaches is the
- a) origin.
- b) insertion.
- c) belly.
- d) fascicle.

20 A muscle with a feather-shaped fascicle organization is called a
- a) parallel muscle.
- b) pennate muscle.
- c) convergent muscle.
- d) circular muscle.

21 The most common lever system in the body is
- a) first-class.
- b) second-class.
- c) third-class.
- d) fourth-class.

22 Which of the following muscles is an axial muscle?
- a) erector spinae
- b) trapezius
- c) deltoid
- d) flexor carpi radialis

23 The major extensor of the elbow is
- a) triceps brachii.
- b) biceps brachii.
- c) deltoid.
- d) subscapularis.

24 Inflammation of the retinaculum and synovial tendon sheaths resulting in pressure on the median nerve is called
- a) anterior compartment syndrome.
- b) rotator cuff syndrome.
- c) carpal tunnel syndrome.
- d) plantar fasciitis.

25 When a person is doing a pull-up exercise, which of the following muscles is responsible for adduction at the shoulder joint?
- a) levator scapulae
- b) deltoid
- c) supraspinatus
- d) latissimus dorsi

26 Which of the following muscles performs the hip and knee action required to kick a ball?
- a) rectus femoris
- b) pectineus
- c) gracilis
- d) biceps femoris

27 Which of the following locations is an attachment site for the short head of the biceps brachii?
- a) tuberosity of ulna
- b) coracoid process of scapula
- c) acromion process of scapula
- d) supraglenoid tubercle of scapula

28 Which of the following is *not* a muscle of mastication?
- a) masseter
- b) buccinator
- c) temporalis
- d) lateral pterygoid

Short answer

29 What are the functions of the muscles of the pelvic floor?

30 Identify the muscles of the rotator cuff.

31 List the muscles of the quadriceps femoris, and describe their actions.

Chapter Integration • Applying what you have learned

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?**