MUSCLES LAB

"No knowledge can be more satisfactory to a man than that of his own frame, its parts, their functions and actions." -Thomas Jefferson.

Objectives

1. Identify the muscles of the body on a model or image.
2. Identify a muscle on the body in anatomical position as being anterior, posterior, medial, lateral, superficial and/or deep.
3. Identify the major actions of each muscle listed using terms like flexor, extensor, adductor, abductor, rotator etc.
4. Identify the origin and insertion points of selected muscles (with an asterisk *) using terms from your axial and appendicular lab.
5. Define, identify, and label a tendon, ligament, and aponeurosis.
6. Given the origin and insertion of selected muscles (with an asterisk *), predict the action of a muscle.

Terminology Checklist

Muscles of Facial Expression
- ❑ epicranius (occipitofrontalis)
  - o frontalis
  - o occipitalis
- ❑ nasalis
- ❑ orbicularis oculi
- ❑ orbicularis oris
- ❑ platysma
- ❑ zygomaticus

Muscles of Chewing
- ❑ buccinator
- ❑ lateral pterygoid
- ❑ masseter*
- ❑ temporalis

Muscles of the Head, Neck, and Vertebral Column
- ❑ erector spinae
  - o spinalis (medial)
  - o longissiumus (intermediate)
  - o iliocostalis
- ❑ sternocleidomastoid*

Muscles of Respiration
- ❑ diaphragm*
- ❑ external intercostals
- ❑ internal intercostals

Muscles of the Abdominal Wall
- ❑ external oblique
- ❑ internal oblique
- ❑ rectus abdominis*
- ❑ transverse abdominis

Muscles of the Pectoral Girdle and Arm (Humerus)
- ❑ deltoid*
- ❑ latissimus dorsi*
- ❑ pectoralis major*
- ❑ rhomboid
- ❑ rotator cuff muscles
  - o infraspinatus*
  - o subscapularis*
  - o supraspinatus*
- ❑ serratus anterior
- ❑ teres major
- ❑ trapezius (superior section)*

Muscles of the Forearm (Radius & Ulna)
- ❑ biceps brachii*
- ❑ brachialis*
- ❑ brachioradialis
- ❑ pronator teres
- ❑ supinator
- ❑ triceps brachii*

Muscles of the Carpus and Hand
- ❑ extensor carpi radialis longus
- ❑ extensor digitorum
- ❑ flexor carpi radialis
- ❑ flexor carpi ulnaris
- ❑ flexor digitorum superficialis

Muscles of the Hip and Thigh (Femur)
- ❑ adductor muscles
  - adductor longus
  - adductor magnus
- ❑ gluteus maximus
- ❑ gluteus medius*
- ❑ gracilis
- ❑ iliopsoas
  - iliacus
  - psoas major
- ❑ sartorius

Muscles of the Tibia and Fibula
- ❑ hamstring group
  - biceps femoris*
  - semitendinosus
  - semimembranosus
- ❑ quadriceps femoris
  - rectus femoris*
  - vastus lateralis
  - vastus medialis
  - vastus intermedius

Muscles of the Ankle and Foot
- ❑ extensor digitorum longus
- ❑ fibularis longus (peroneus longus)
- ❑ gastrocnemius *
  - calcaneal tendon (Achilles' tendon)
- ❑ soleus
- ❑ tibialis anterior *

Outline of Lab

Case Study: "Too Tired to Stand"
Activity 1: Muscle Actions
Activity 2: Muscles of the Axial Skeleton
Activity 3: Muscles of the Appendicular Skeleton
Putting it all Together

Case Study: "Too Tired to Stand"

You are working as a nurse's assistant in a pediatrician's office. As you bring the next patient, a 5-year-old boy named Jose, back to the exam room, he trips, and you catch him. His parents comment that he falls frequently. You observe how he moves and notice that he walks on his toes and uses his arms for balance. You notice that his calves appear larger than the average child of his age. When you get to the exam room, he is mildly out of breath. After questioning his parents, you learn that Jose has trouble

in school and suspect he has a learning disability. The parents are concerned that Jose has trouble running and jumping. He also frequently complains of muscle pain. When you question Jose about the pain, he comments that today his shoulder is sore. You ask him to show you how he ties his shoes. After he is done, he places his hands on his ankles and "walks" them up to his shin, knee and then thigh to stand upright. (This method of standing up is called "Gower's sign".) The pediatrician will want to see that you include all the muscles that might be affected in your notes. It might be wise to review the major muscles of the body!

Activity 1: Muscle Actions

Materials:
- none

Background:
There are over 600 muscles in the human body. Learning their names, locations and actions can be intimidating. In this lab we will focus on a select subset of muscles that contribute to major body movements. Skeletal muscle usually attaches to two different bones, one called the origin and the other at the insertion, and typically spans a joint. Muscles connect to the bone by a cord of dense connective tissue, called a tendon. When the muscle contracts, it gets shorter as it pulls one bone (insertion) toward the other bone (origin). Thus, in most cases the origin is stationary while the insertion moves toward the origin.

Exceptions to the rule
Some muscles insert not on bone, but on fascia, tendons, or even collagen fibers of the dermis. An aponeurosis is a broad sheet of dense connective tissue (tendon) that can serve as a site for muscle attachment. Instead of using the terms origin and insertion, anatomy books may refer to the proximal and distal sites or superior and inferior attachment sites for a muscle.

<u>Muscle Actions</u>
While we may think of each muscle as having a singular function, many muscles have multiple actions. Moreover, many muscles act together to carry out the same function. The actions of muscles can be grouped into four categories: prime mover (agonist), synergist, antagonist, and fixator. The prime mover (agonist) is a muscle that produces the most force during a particular movement. A synergist is a muscle that assists the prime mover (agonist) during the movement. One or more synergistic muscles allow for stronger contractions than can be produced by a single muscle on its own. Many synergistic muscles do not simply perform the same action as the prime mover but allow for a slightly different movement. For example, a synergist might assist the prime mover with flexion, creating greater flexion, but also contribute to rotation of that joint.

Every movement must have an opposing action; that is the job of the antagonist. Just like a villain or antagonist in a movie opposing a hero character, the antagonist opposes

the action of the prime mover (agonist). For example: when the prime mover of the elbow flexes, the antagonist is relaxed. Similarly, when the prime mover of the elbow contracts to extend the elbow, the flexor must relax.

Lastly, a fixator, “fixes”’ a bone in a position; a fixator prevents a bone from moving and instead holds it in a static position. Fixator muscles maintain posture, as in the muscles of the back, abdomen, and neck.

A joint is formed where two bones meet. As a muscle contracts, it pulls on the bone to which it is attached and causes the joint to move. Specific movements occur at the articulating surface of all synovial joints. The type of movement allowed at each synovial joint depends on the shape of the articulating bones and the direction of the muscle fibers causing contraction. Actions are classified as angular, gliding, and special movements. For this lab we will focus on the angular and special movements. These actions come in opposing pairs. Angular movements are the most common actions. Such movements increase or decrease the angle between two bones and include flexion, extension, adduction, abduction, medial and lateral rotation. Special movements include supination, pronation, dorsiflexion, plantarflexion, inversion, eversion, protraction retraction, and elevation and depression. (Joints will be explored in more depth in a separate lab.) (**Table 1**)

Table 1: Classification of muscle actions and their description.

Angular or Special	Movement	Description	Opposing movement
A	Flexion	Decreases the angle between bones; brings bones closer together. Movement in an anterior-posterior plane	Extension
A	Lateral flexion to the right	The vertebral column moves in the lateral direction along the coronal plane	Lateral flexion to the left
A	Abduction	Lateral movement of the body part away from midline	Adduction
S	Pronation	Rotation of the forearm where the palm is turned posteriorly (radius rotates over ulna)	Supination
A	Dorsiflexion	Ankle joint bends so that the dorsum (superior surface of the foot) moves toward the leg	Plantar flexion
A	Inversion	Movement at the ankle joint that turns the sole of the foot medially or inward	Eversion

A	Medial or internal rotation	Moving the anterior surface of the limb toward the midline of the body	Lateral or external rotation
S	Protraction	Movement of the scapula or mandible in the anterior (forward) direction.	Retraction
S	Elevation	Movement of the scapula or mandible in the superior (upward) direction.	Depression

Interpreting muscle names

While the names of skeletal muscle names might seem complicated, there are clues and patterns to their names that you can learn. Some muscles are named for their location in the body. For example, the intercostal muscles are found between the costal spaces of the ribs. The intermedius muscles are located between two other muscles. Some muscles are named for their unique shapes and sizes. For example, the trapezius muscle has a trapezoidal shape. Names such as maximus (largest), minimus (smallest), longus (long), and brevis (short) give a hint as to the relative size of the muscle. Muscle fibers run in different directions; some names indicate the direction of the fibers. For example, the term rectus means straight, transversus means horizontal., and oblique indicate fibers running at an angle. Some muscles use the origin and/or insertion in their name. The sternocleidomastoid muscle is named for both its origins (sternum and clavicle) and insertion (mastoid process). In addition, the number of “heads” or origins can be used in a name as in the quadriceps muscle which has four heads or the two-headed biceps muscle of the arm. Muscle actions may also be used as part of the name. The extensor digitorum, for example, extends the digits of the hand while the flexor digitorum superficialis flexes the digits of the hand.

Key for muscle names

Location
- Pectoral - chest
- Oris - mouth
- Oculi - eye
- Internal- deep
- Femoris - femur
- External - superficial
- Dorsi - back or dorsal
- Digitorum - digits (fingers or toes)
- Brachii - arm
- Abdominis - abdomen

Shape
- Trapezius - trapezoid
- Serratus - serrated or saw
- Rhomboideus - rhomboid
- Orb - circular
- Deltoid - triangular (delta)

Direction of fibers
- Transverse - straight across or horizontal
- Rectus - parallel or straight
- Oblique - at an angle

Number of heads
- Bi - 2 origins
- Tri - 3 origins
- Quadri - 4 origins

Size of the muscle
- Vastus - great or huge
- Maximus - largest
- Minimus - smallest
- Longus - long
- Brevis- -short

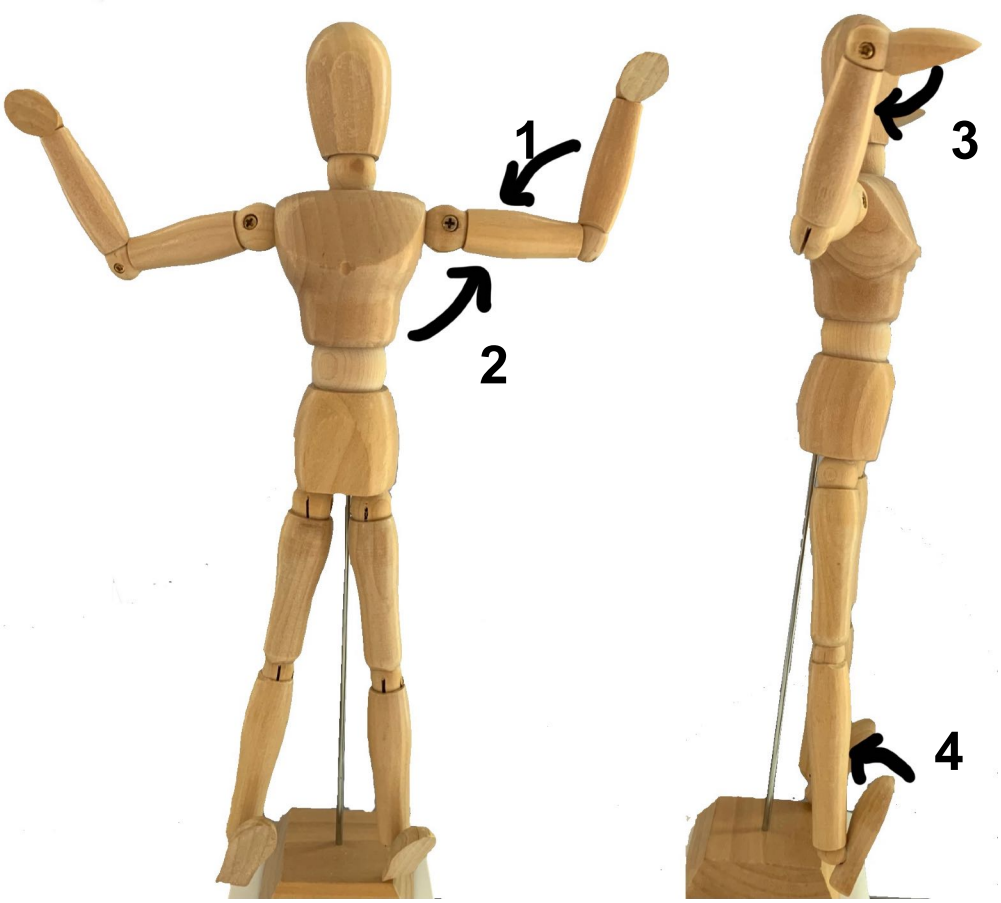
Learning muscles

1) Look at the name of the muscle
   - Many muscles are named based on their shape, location, action, fiber direction, or muscle attachment sites.
   - Think about what hints the muscle name might give you.
2) When possible, palpate the muscle on yourself. Contract the muscle to feel it bulge and see what bones move.
3) Look at an articulated skeleton to examine how the origin and insertion dictate the movement.
4) Group muscles together based on action. Typically, muscles with similar actions are located close to each other.

Procedure:

1. Use the images of angular movements below and identify the movement (use **Table 1** as a guide).

Arrow	Movement
1	
2	
3	
4	



Joint Movements

2. Look at the images below and draw an arrow for the direction of muscle contraction and name the angular movement using the terms from **Table 1**.

Movement: _____ _____ _____ _____

Muscle Action Predictions

Activity 2: Muscles of the Axial Skeleton

Materials:
- laminated numbers 1-5
- laminated terminology labels with sticky tack
- model of body muscles
- model of head muscles

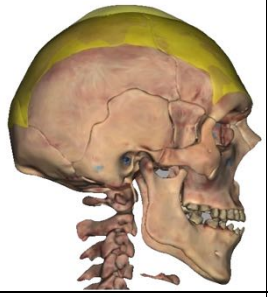
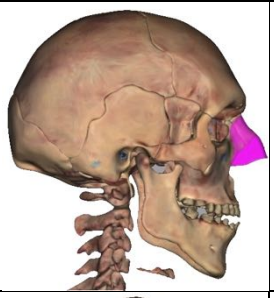
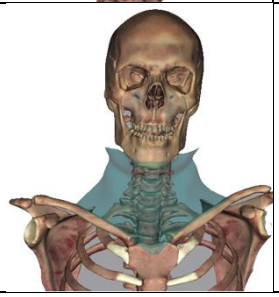
Background:
In the patient's notes, you see new results from a recently performed genetic test. Jose has the gene for a genetic disease called Duchenne type muscular dystrophy. It is a progressive disease caused by a defective gene for dystrophin (a protein in muscle). The condition is more common in boys than girls, as it is carried on the X chromosome. As the disease progresses, patients develop severe muscle weakness, including the diaphragm muscle and the intercostal muscles which makes it difficult to breathe. You notice that Jose has a protruding belly despite not being overweight. He is slumped in the chair, and has difficulty catching his breath. Silently, you review the muscles that are important for breathing, supporting the abdomen, and holding up the frame of the body.

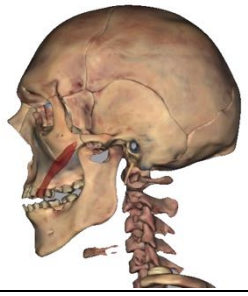
Muscles of facial expression (**Table 2, Figure 1**)
Humans are social animals that communicate not only verbally, but also through facial expressions. Every facial expression is governed by numerous muscles contracting simultaneously. Most of the muscles of the face are innervated by cranial nerve 7, the facial nerve. This nerve controls many facial expressions. Indeed, when this nerve is injured, facial paralysis often occurs, causing distinctive facial sag on the affected side. To create facial expression many muscles of the face insert into the connective fibers of the dermis. This allows the skin to move as the muscles contract.

The **occipitofrontalis** (**epicranius**) is frequently divided into two parts, the **frontalis** and **occipitalis**, connected by an aponeurosis, a large band of connective tissue. The frontalis is superficial to the frontal bone and the occipitalis is superficial to the occipital bone.

Muscle names like the **orbicularis oris** and **orbicularis oculi** give you hints of shape and location in their name. Orb means circle. Oculi and oris refer to eye and mouth respectively. Look for round muscles surrounding the mouth and the eye respectively The **nasalis** is the muscle of the nose. The **zygomaticus** muscle originates on the zygomatic bone. The **platysma** is a large, sheetlike muscle that can be seen in the anterior neck area. It is responsible for the "jaw-dropping" expression and tightening the neck.

Table 2: Muscles of facial expression with their origin(s), insertion(s), action(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Epicranius (occipitofrontalis) Frontalis & Occipitalis		frontalis: raises eyebrows occipitalis: pulls scalp posteriorly	frontalis: epicranial aponeurosis occipitalis: line of occipital bone	frontalis: skin of eyebrows occipitalis: epicranial aponeurosis	Facial nerve
Nasalis		elevates corners of nostrils (flares the nose)	maxilla and cartilage of nose	dorsal side of nose	Facial nerve
Orbicularis oculi		closes eye (blinking and squinting)	orbital portions of the frontal bone and maxilla	skin of orbital area and eyelids	Facial nerve
Orbiularis oris		compresses and purses lips	maxilla and mandible	connective tissue of the lips	Facial nerve
Platysma		depresses the lower lip, depresses the mandible	connective tissue of deltoid and pectoralis muscles	mandible	Facial nerve

Muscle	Image	Action	Origin	Insertion	Innervation
Zygomaticus major		pulls the corners of the mouth laterally and superiorly (for smiling)	zygomatic bone	corner of mouth	Facial nerve

Muscles of chewing (**Figures 1, 2,** and **Table 3**)
The fibers of the **buccinator** run transversely, and when contracted, compresses the cheek (**Figure 1**). Buccinator means trumpeter. A trumpeter must compress the cheeks to expel air from the mouth. The **masseter** muscle also hints at its action -mastication (chewing). The **lateral pterygoid** is deep to the buccinator and masseter, it also aids in chewing. The **temporalis** muscle is located superficial to the temporal bone (**Figure 3**).

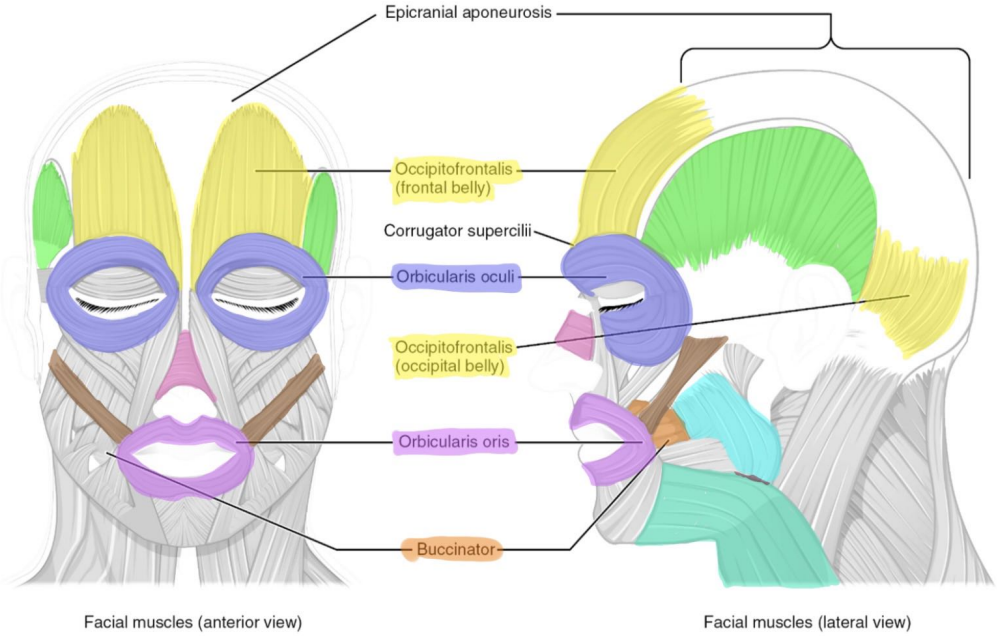


Figure 1: Muscles of the head and face involved in facial expression and chewing.

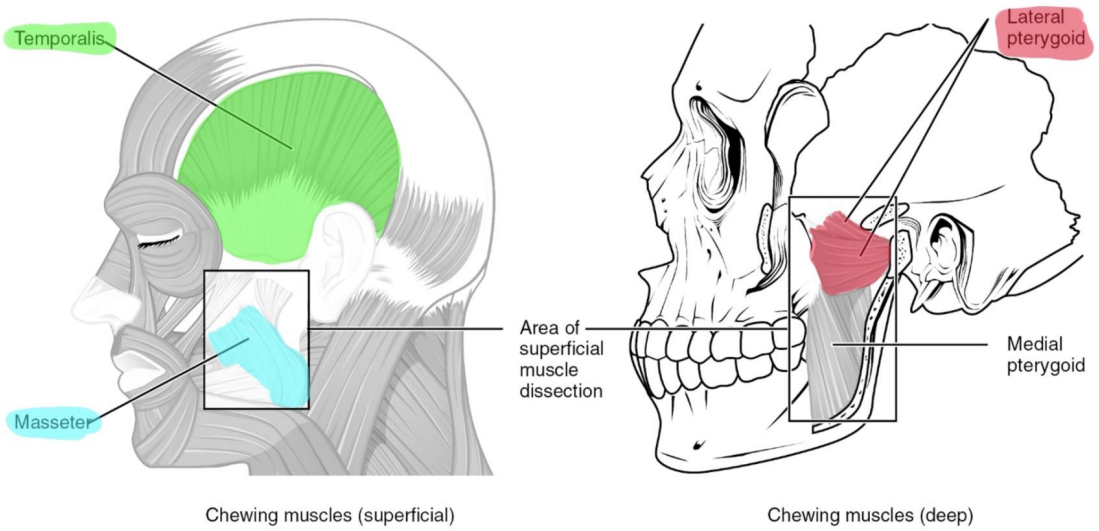


Figure 2: The superficial (left) and deep (right) muscles involved in chewing.

Table 3: The action(s), origin(s), insertion(s) and innervation of the muscles involved in chewing.

Muscle	Image	Action	Origin	Insertion	Innervation
Buccinator		compresses cheek, pulls checks in (sucking movement)	maxilla and mandible	connective tissue of cheeks and obicularis oris	Facial nerve
Lateral pterygoid		protracts and depresses the mandible	greater wing of the sphenoid	mandible	Mandibular nerve
Masseter		closes (elevates) the jaw	zygomatic arch	angle and ramus of mandible	Mandibular nerve

Muscle	Image	Action	Origin	Insertion	Innervation
Temporalis		elevates and retracts the mandible (closes the jaw)	lateral surface of skull	coronoid process of the mandible	Mandibular nerve

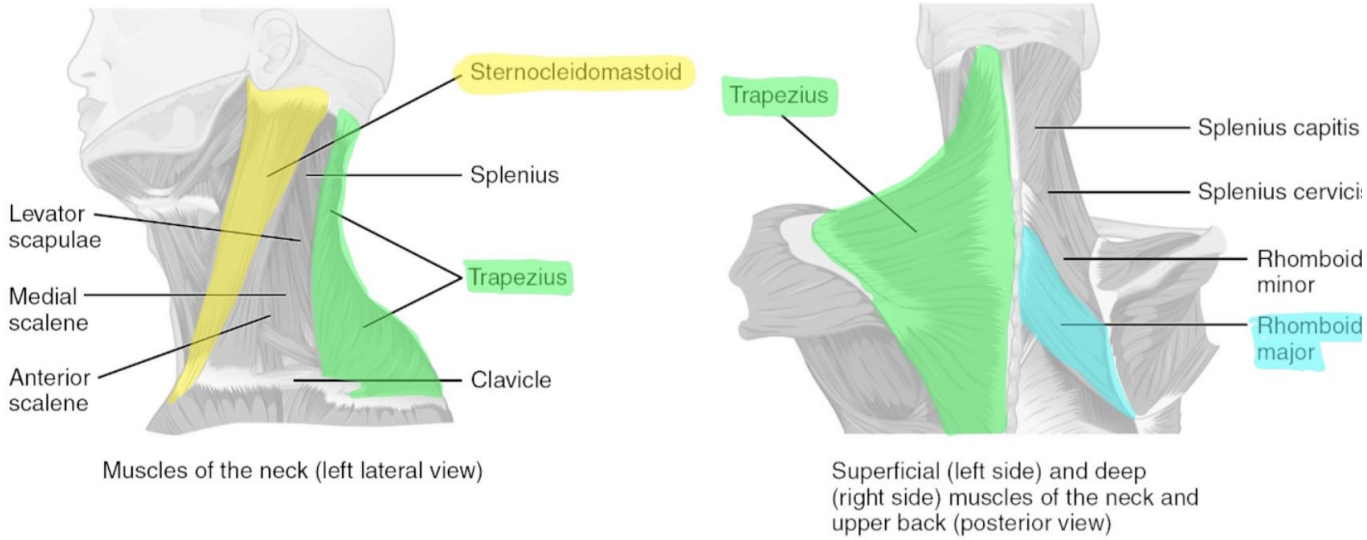


Figure 3: Muscles of the neck and back.

Muscles of the head, neck, and vertebral column (**Figures 3, 4** and **Table 4,**)
The **sternocleidomastoid** muscle tells you the origin and insertion in the name. The sternum and clavicle are the origins, and the insertion is the mastoid process of the temporal bone. Since the muscle starts medially and ends laterally, this muscle causes a twisting (rotational) movement of the head.

The **erector spinae** group is group of muscles responsible for extension of the vertebral column. They help in flexion, lateral flexion, and rotation of the vertebral column. The three main muscles are the iliocostalis (lateral), the longissimus (middle), and spinalis (medial) (**Figure 4**). Other back muscles will be discussed when shoulder and arm movements are discussed (See pectoral girdle and scapula).

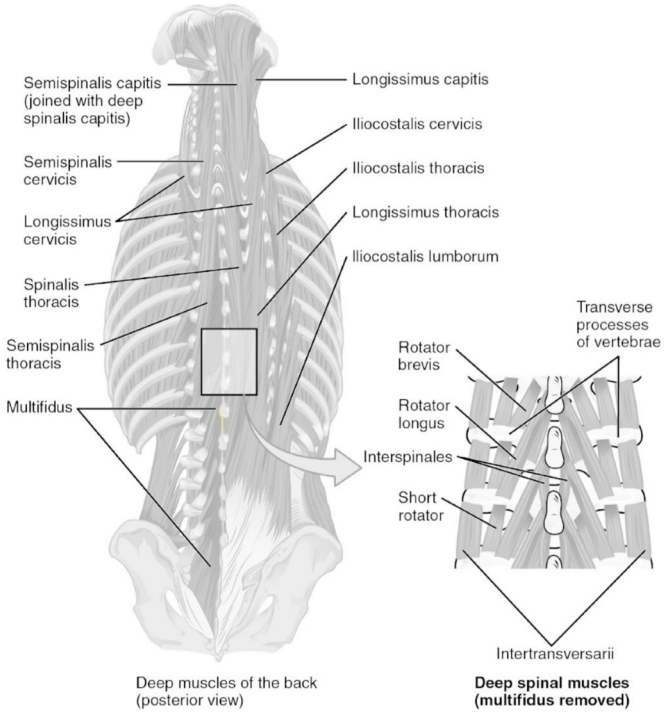


Figure 4: The erector spinae muscle group.

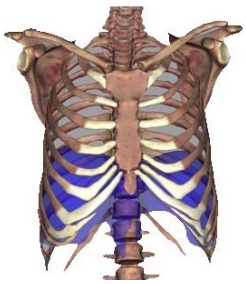
Table 4: Muscles of the neck and vertebral column.

Muscle	Image	Action	Origin	Insertion	Innervation
Erector spinae *Spinalis (medial) *Longissiumus (intermediate) *Iliocostalis (lateral)		extend and laterally flex the vertebral column	vertebrae	vertebrae	Posterior rami of spinal nerves
Sternocleidomastoid		flexes head, laterally rotates head	manubrium of sternum and medial portion of clavicle	mastoid process of temporal bone	Accessory nerve

Muscles of Respiration (**Figure 5, Table 5**)

Most thoracic muscles assist in breathing, inhalation, and exhalation. The **diaphragm** is a large muscle that separates the thoracic and abdominal cavities. The muscle is dome-shaped at rest and flattens during contraction pulling the ribs and increasing the size of the thoracic cavity for inhalation. Relaxation of the diaphragm assists in exhalation. The **external intercostal** muscles are located outside of each rib and assist in inhalation while the **internal intercostals** are located deep to each rib and contract the rib cage during forced exhalation. The fibers of the external and internal intercostals run opposite to each other. When looking at the patient's right side, the external fibers run like a forward slash (\)-and the external intercostals run like a backwards slash (/). Together the fibers create an "X" pattern.

Table 5: Muscles of respiration, their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
External Intercostals		elevates the rib cage, assists in inspiration	inferior edge of superior rib	superior edge of inferior rib	Intercostal nerves
Internal Intercostals		depresses the rib cage, assists in forced expiration	lateral edge of costal groove of inferior rib	superior rib, deep to the external intercostal attachment	Intercostal nerves
Diaphragm		flattens the thoracic cavity for inspiration (inhalation)	xyphoid process of sternum, lower ribs, costal cartilages, and upper lumbar vertebrae	central tendon of diaphragm	Phrenic nerve

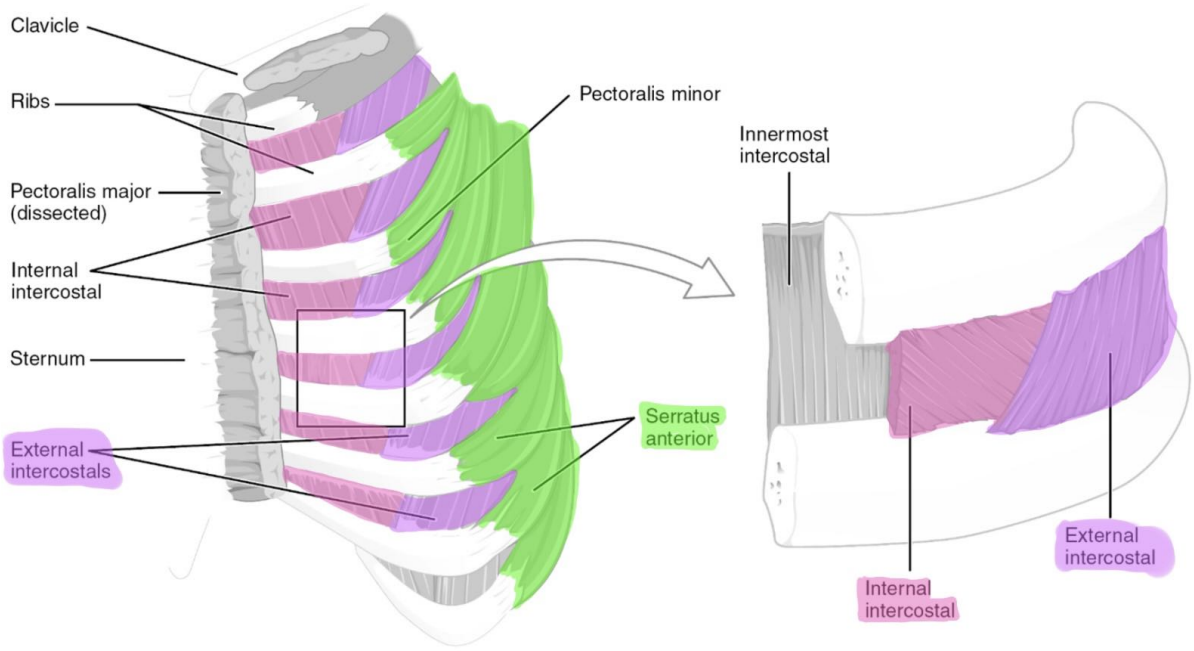
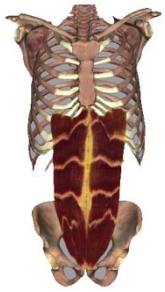


Figure 5: Muscles involved in breathing (ventilation).

Muscles of the abdominal wall (**Figure 6, Table 6**)

There are four pairs of muscles that make up the main abdominal muscles. Three of the muscles are located anterolaterally and are layered on top of each other. The **external oblique** is the most superficial and can be identified based on the direction of the fibers. Place your hands in your pockets and the direction of your fingers represents the fibers of the external oblique. If you cross your arms with your fingers on your shoulders this would represent the direction of fibers of the **internal oblique**. The deepest muscle is the **transversus abdominis** and as the name implies the fibers run transversely (horizontally) across the abdomen. The last muscle is the **rectus abdominis**. The term rectus means straight. The fibers of the rectus abdominis run straight up and down the abdomen and create the “6-pack” look with three transverse bands of collagen fibers between each section of muscle. The linea alba (white line) runs down the midsagittal plane of the abdomen. It forms the rectus sheath, the attachment site for some abdominal muscles.

Table 6: Muscles of the abdominal wall and their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
External oblique		flexes and laterally flexes the trunk; compresses abdomen	outer surface of Inferior eight ribs	lateral iliac crest, pubic tubercle, and linea alba	Thoracic nerves
Internal oblique		flexes and laterally flexes the trunk; compresses abdomen	iliac crest	inferior border of lower four ribs, linea alba, and pubic bone	Thoracic nerves
Rectus abdominis		flexes trunk; compresses abdominal cavity	superior part of pubic bone	costal cartilages of lower rib bones and xiphoid process	Thoracic nerves
Transverse abdominis		compresses abdominal cavity	inferior costal cartilage of lower 6 ribs, medial iliac crest, and fascia	linea alba and pubic crest	Thoracic nerves

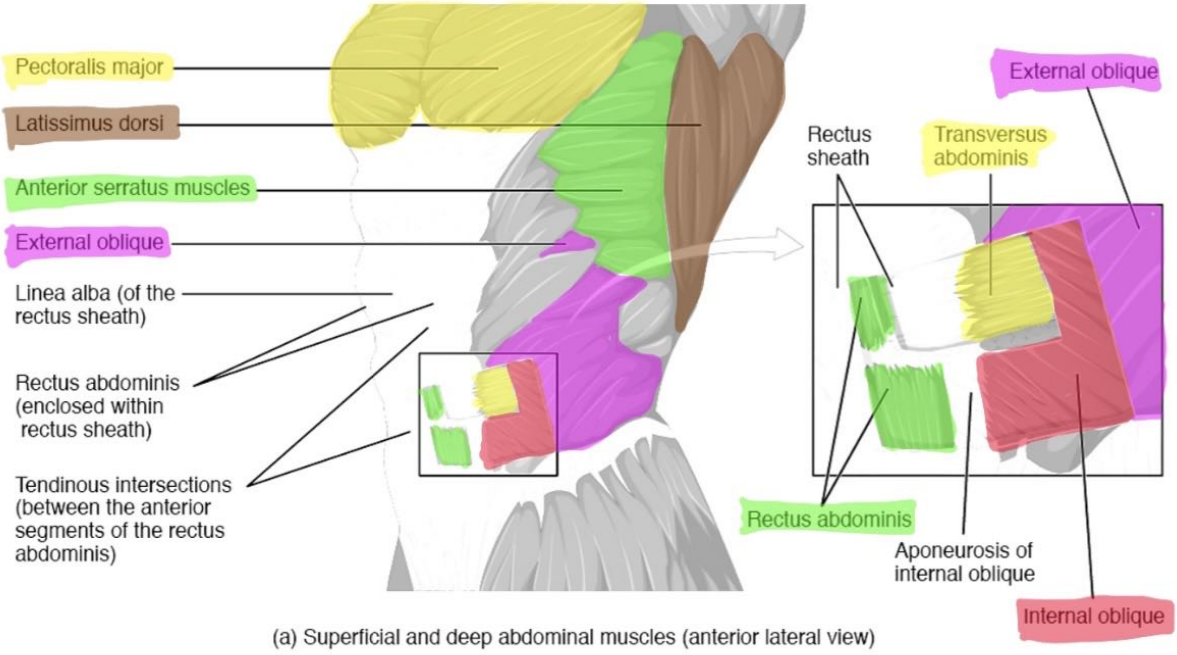


Figure 6: Muscle of the abdominal wall.

Procedure:

1. Divide into pairs. One group label the muscles on the head model while the other labels the muscles of the abdomen and back. As you identify the muscles, label them with the laminated muscle stickers.
2. As you identify the muscles, label them with the laminated muscles terms and label the corresponding images by drawing a line between the muscle name and the muscle.

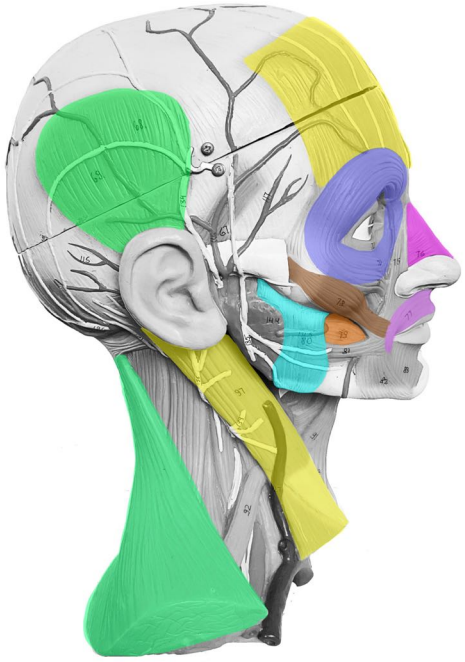
Temporalis

Orbicularis oculi

Masseter

Sternocleidomastoid

Trapezius



Frontalis

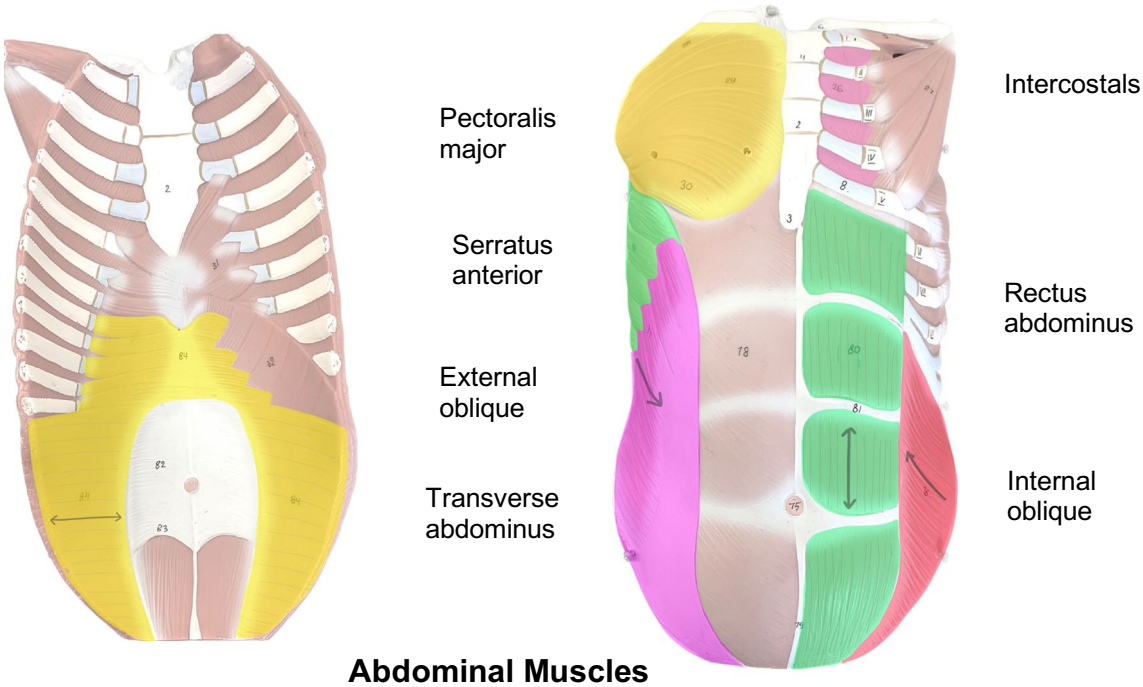
Nasalis

Zygomaticus

Orbicularis oris

Buccinator

Head Muscles to Label



Abdominal Muscles

Activity 3: Muscles of the Appendicular Skeleton

Materials:
- laminated terminology labels with sticky tack
- model of full body muscles
- model of muscle arm
- model of muscle leg

Background:
Today the doctor will perform a muscle biopsy from the rectus femoris of Jose's leg to confirm the diagnosis. Children affected with Duchenne muscular dystrophy often are in a wheelchair by age 12-15. Their skeletal muscles are too weak to move the arms and are not strong enough to support the body to walk. You grab the supplies to prep for the muscle biopsy and review in your head precisely where the rectus femoris is located. The femoris must mean it is over the femur and rectus means straight. You hope it is the straight muscle over the femur....

Muscles of the pectoral girdle and arm (humerus)**(Figures 7, 8, Tables 7** and **8)**
The muscles of the scapular region perform several movements such as elevation (superior movement of scapula), depression (inferior movement of scapula), protraction or abduction (lateral and anterior movement of scapula), retraction or adduction (medial and posterior movement of scapula), and rotation (upward and downward rotation of the

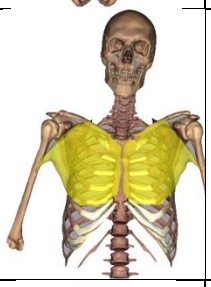
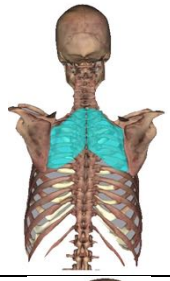
scapula). These muscles include the pectoralis major, the serratus anterior, and the muscles of the rotator cuff.

The **trapezius** muscle is a diamond or trapezoid shaped muscle found on the posterior head and neck. The **Rhomboid** (major) is found in the middle of the trapezius muscle on the dorsal surface. It is responsible for pulling or retracting the scapula. The **pectoralis major** is a thick, fan shaped muscle that covers the superior portion of the superficial thorax. Muscles that originate posterior to the shoulder tend to extend the arm like the latissimus dorsi and teres major. The **latissimus dorsi** is a large, triangular muscle found on the dorsal surface. The **teres major** can be found originating on the posteroinferior scapula inserting into the humerus. The **serratus anterior** looks like a serrated knife blade and can be found on the lateral anterior surface of the thorax.

The **deltoid** sits on the shoulder like a shoulder pad and is triangular shaped. The point of the triangle inserts onto the humerus between the biceps brachii and brachialis. The tendons of four muscles circle the shoulder joint forming the rotator cuff. The rotator cuff muscles include the **subscapularis**, located on the anterior surface of the scapula, the **supraspinatus** found superior to the spine of the posterior surface of the scapula, and the **infraspinatus** which is located inferior to the spine of the scapula. The teres minor is the fourth muscle of the rotator cuff group.

Table 7: Muscles of the pectoral girdle and arm and their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Deltoid		arm abduction, secondarily flexes and extends arm	acromion and spine of scapula; acromial end of clavicle	deltoid tuberosity of humerus	Axillary nerve
Infraspinatus		adducts and rotate arm laterally	infraspinous fossa of scapula	greater tubercle of humerus	Subscapular nerve

Muscle	Image	Action	Origin	Insertion	Innervation
Latissimus dorsi		adducts, extends, and medially rotates the arm	iliac crest, spinous process of thoracic and lumbar vertebrae	humerus	Thoracodorsal nerve
Pectoralis Major		flexes, adducts, and medially rotates humerus	medial scapula and lateral sternum	lateral part of humerus	Medial and lateral pectoral nerve
Rhomboid major		retracts scapula	spinous process of T2-T5	medial border of scapula	Dorsal scapular nerve
Serratus anterior		primary for protraction of scapula, and assists in rotation of scapula	ribs 1-9	medial border of scapula	Thoracic nerves
Subscapularis		rotates arm medially	subscapular fossa of scapula	lesser tubercle of humerus	Subscapular nerve

Muscle	Image	Action	Origin	Insertion	Innervation
Supraspinatus		arm abduction	supraspinous fossa of scapula	greater tubercle of humerus	Subscapular nerve
Teres major		adducts, extends, and rotates arm medially	posterior, inferior portion of scapula	lesser tubercle and intertubercular groove of humerus	Lower subscapular nerve
Trapezius (superior section)		elevates the scapula; rotates scapula superiorly	external occipital protuberance and cervical vertebrae	lateral clavicle	Accessory nerve

Table 8: Muscle actions of the shoulder (arm).

Actions at the Shoulder (Arm)	Flexion	Extension	Abduction	Adduction	Medial Rotation	Lateral Rotation
Biceps brachii	X (weak)					
Deltoid	X (PM) (anterior fibers)	X (PM) (posterior fibers)	X (PM) (middle fibers)		X (anterior fibers)	X (posterior fibers)
Pectoralis major	X (PM)			X (PM)	X	
Latissimus dorsi		X (PM)		X (PM)	X	
Triceps brachii		X (long head)		X		
Teres Major		X		X	X	
Supraspinatus			X			
Subscapularis					X (PM)	
Rhomboid major					X	

Actions at the Shoulder (Arm)	Flexion	Extension	Abduction	Adduction	Medial Rotation	Lateral Rotation
Infraspinatus						X (PM)
Serratus anterior						X
Trapezius (superior part)						X

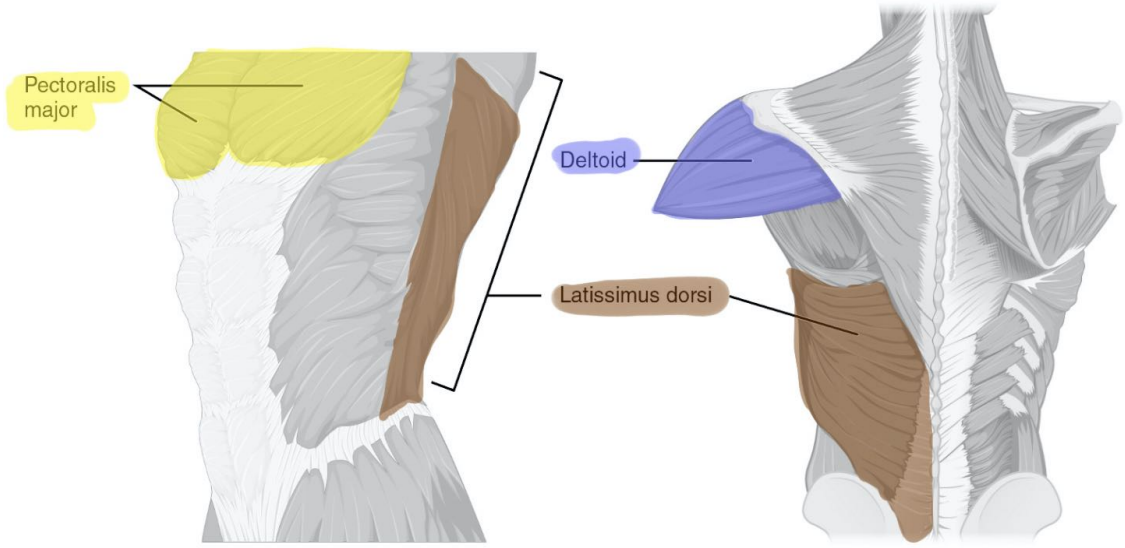


Figure 7: Superficial muscles of the shoulder anterior, lateral view (a) and posterior view (b).

Muscles of the forearm (radius and ulna) **(Figures 8, 9, Tables 9,** and **10)**
Note that, when in anatomical position, most of the muscles that act as flexors are found on the anterior surface or the arm and conversely, the muscles that act as extensors are typically found on the posterior surface of the arm. The forearm flexors are the biceps brachii, brachialis, and brachioradialis. As the name implies, the **biceps brachii** has two heads. The **brachialis** is deep to the biceps brachii and is an agonist of elbow flexion. The main extensor is the **triceps brachii** which has three heads. Another assisting extensor muscle is the anconeus. The forearm can also pronate (when the forearm faces posteriorly) and supinate (when the forearm faces anteriorly). The prime pronator muscle is the **pronator teres** and the **supinator** muscle controls supination. These two muscles can be found crisscrossing over the radius and ulna to create the pivoting action.

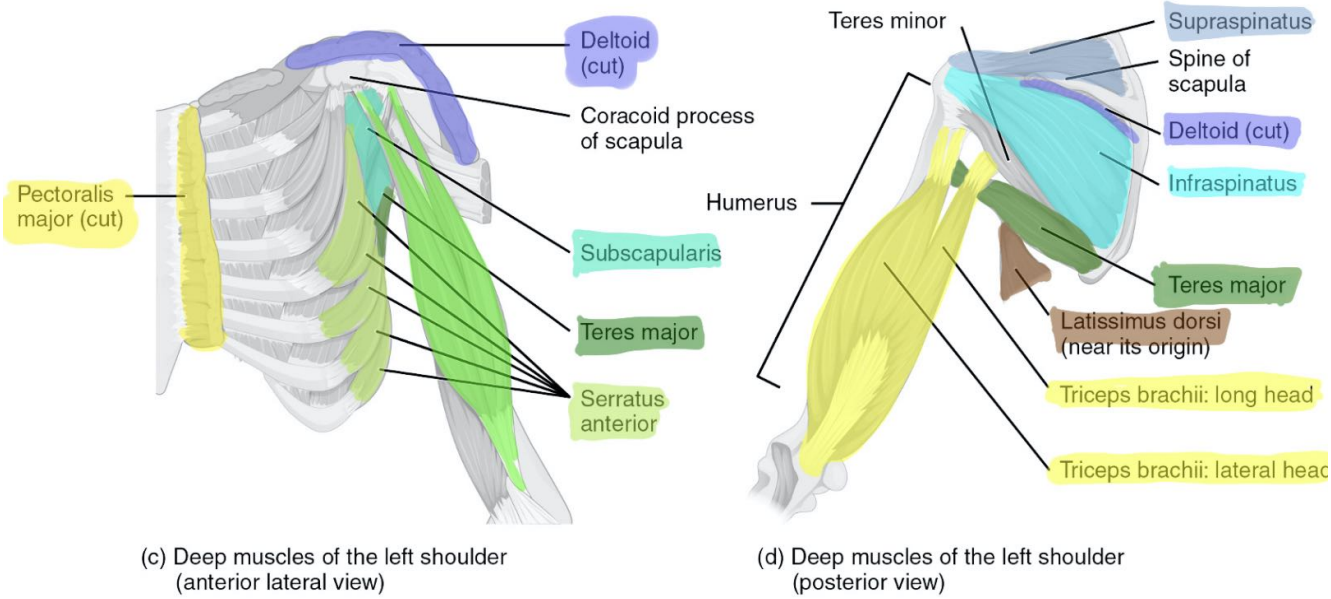


Figure 8: Deep muscles of the shoulder from anterior lateral view (c) and posterior view (d).

Table 9: Muscles that move the forearm and their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Biceps brachii		supinates and flexes forearm	long head: supraglenoid tubercle, short head: coracoid process	radial tuberosity	Musculocutaneous nerve
Brachialis		flexes forearm	distal anterior diaphysis of the humerus	tuberosity and coronoid process of ulna	Musculocutaneous nerve

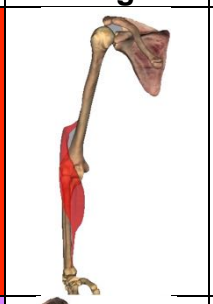
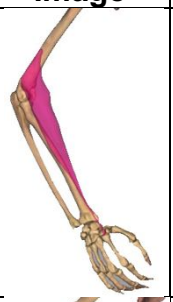
Muscle	Image	Action	Origin	Insertion	Innervation
Brachioradialis		flexes forearm	ridge proximal to the lateral condyle of the distal humerus	styloid process of radius	Radial nerve
Pronator teres		pronates forearm	medial epicondyle of humerus, coronoid process of ulna	lateral surface of radius	Median nerve
Supinator		supinates forearm	lateral epicondyle of humerus, area of the radial notch of ulna	anterolateral area of proximal third of radius, distal to tuberosity	Radial nerve
Triceps brachii		extends and adducts arm	long head: infraglenoid tubercle of scapula; lateral and medial head: diaphysis of humerus	olecranon process of ulna	Radial nerve

Table 10: Muscle actions of the forearm.

Actions of the Forearm	Flexion	Extension	Pronation	Supination
Biceps brachii	X (PM)			X (PM)
Brachialis	X (PM)			
Brachioradialis	X			
Pronator teres	X (weak)		X	
Triceps brachii		X (PM)		
Supinator				X

Muscles of the wrist (carpus) and hand **(Figure 9, Tables 11** and **12)**
The muscles of the forearm overlie the ulna and radius and serve to move the wrist, hand, and fingers. The wrist, hand, and fingers are capable of many complicated movements. Typically, the forearm muscles are the most difficult to find and learn because these muscles are in different layers and directions to assist in these numerous complex movements. When viewing the anterior forearm look for the most lateral, flat muscle called the **brachioradialis**. Medial to the brachioradialis are the **flexor carpi radialis**, palmaris longus, and the **flexor carpi ulnaris** muscles, in order. Deep to the palmaris longis is the **flexor digitorum superficialis**. In the posterior view, the **extensor digitorum** is an easy landmark as it had tendons running to digits 2-5. Medially from the extensor digitorum is the **extensor carpi radialis longus** and then back to the brachioradialis.

Table 11: Muscles that move the carpus (wrist) and hand and their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Extensor carpi radialis longus		extends and abducts hand	lateral lower diaphysis of humerus	second metacarpal	Radial nerve
Extensor digitorum		extends carpus and hand	lateral epicondyle of humerus	posterior phalanges of fingers 2-5	Radial nerve
Flexor carpi radialis		flexes carpus and abducts hand	medial epicondyle of humerus	second and third metacarpals	Median nerve

Muscle	Image	Action	Origin	Insertion	Innervation
Flexor carpi ulnaris		flexes hand; adducts hand	medial epicondyle of humerus, coronoid process of ulna, anterior proximal radius	carpal bones, 5th metacarpal	Ulnar nerve
Flexor digitorum superficialis		flexes wrist and flexes phalanges 2-5	medial epicondyle of humerus, coronoid process of ulna, anterior proximal radius	middle phalanges of fingers 2-5	Median nerve

Table 12: Muscle actions of the wrist (carpus).

Actions on the wrist	Flexion	Extension	Abduction	Adduction
Flexor carpi radialis	X (PM)		X	
Flexor carpi ulnaris	X (PM)			X
Flexor digitorum superficialis	X (PM)			
Extensor digitorum		X (PM)		
Extensor carpi radialis longus		X	X	

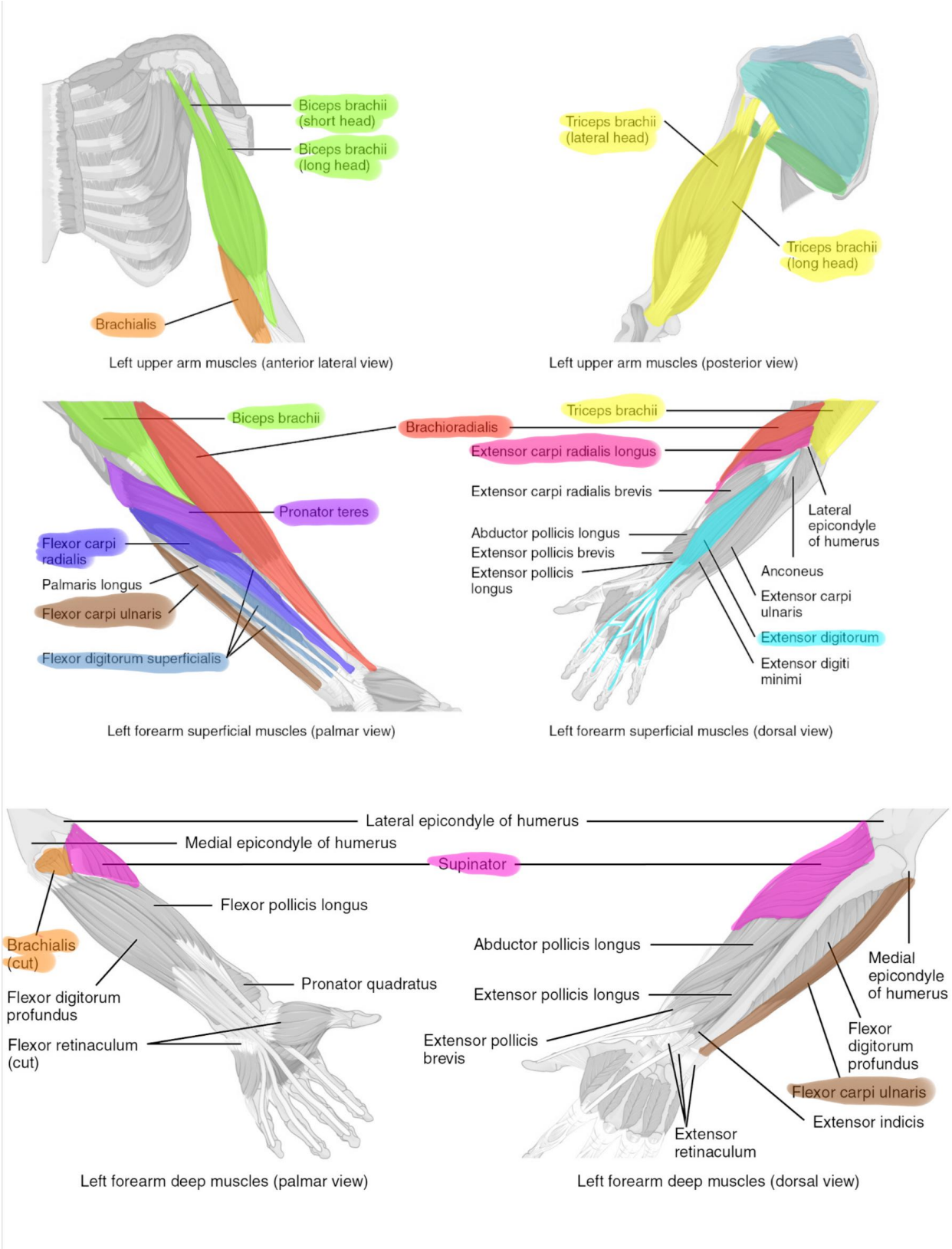


Figure 9: Muscles of the forearm, wrist and hand.

Muscles of the hip and thigh (femur) (**Figures 10, 11, Tables 13,** and **14**)

The anterior muscles of the hip and thigh flex the femur at the hip and extend the knee. This is an important action for the fore-swing phase during walking and for flexing the hip for sitting. The posterior muscles of the hip and thigh extend the thigh and flex the knee. This is the movement necessary for the backswing phase of walking and for standing. Muscles that flex the thigh originate from the vertebral column and pelvis and pass anteriorly to the hip joint. These muscles include the iliopsoas and rectus femoris. The **iliopsoas** muscle is formed from two muscles, the **iliacus** and **psoas** major. The posterior thigh muscles that extend the hip include the gluteus maximus and hamstring group, which itself consists of three muscles. As the name suggests, the **gluteus maximus** is a large muscle, located superficially on the posterior of the thigh.

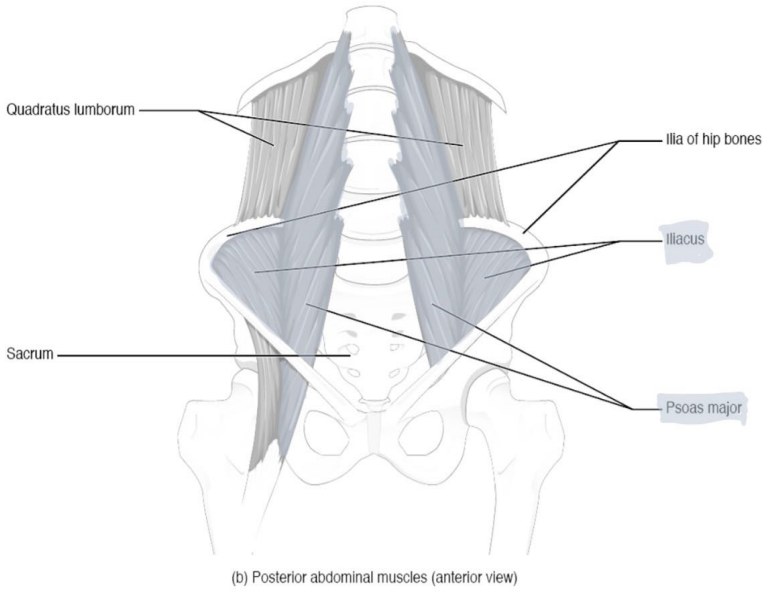
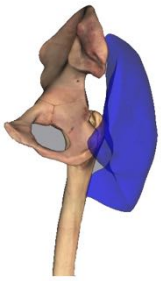


Figure 10: Muscles of the hip, anterior view.

The lateral muscles of the thigh, like the middle-sized **gluteus medius**, control abduction (away from midline) of the hip. The medial muscles of the thigh cause adduction of the leg (bringing in toward midline). The three adductor muscles are the longus, brevis, and magnus. Their names suggest their shapes: the **adductor longus** is long and skinny, the brevis is the shortest (briefest), and the **adductor magnus** is the largest. The **sartorius** muscle runs obliquely across the upper thigh and its action is rotational. It makes a great landmark when examining the anterior thigh as it wraps laterally to medially and looks like a sash. The sartorius is the longest muscle in the body! The **gracilis** is a flat, strap-like muscle that can be seen on the medial thigh.

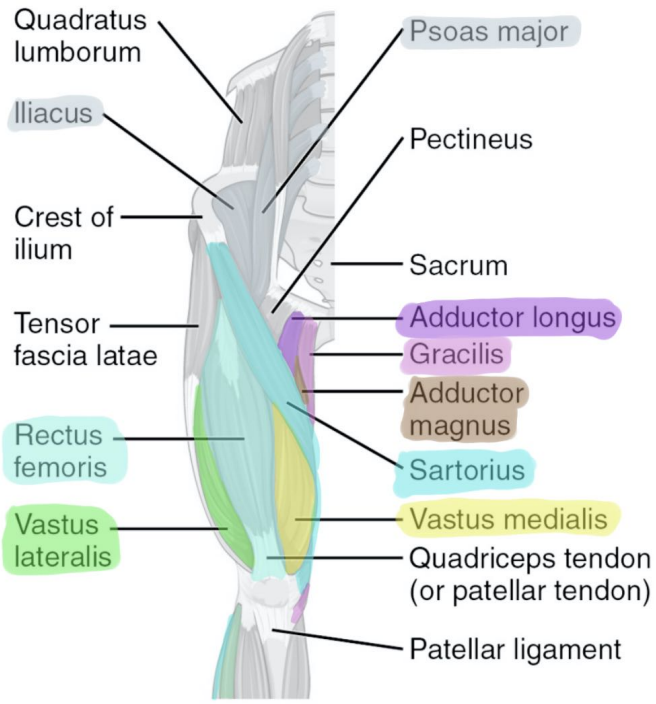
Table 13: Muscles of the hip and thigh and their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Adductor longus		adducts and flexes the thigh; rotates the thigh medially	body of pubis	linea aspera of femur	Obturator nerve
Adductor magnus		adducts and medially rotates the thigh	Ischial tuberosity, ischial ramus, inferior ramus of pubis	linea aspera and adductor tubercle of femur	Obturator and Sciatic nerves
Gluteus maximus		extends and abducts the thigh; laterally rotates the thigh	posterior and lateral parts of the ilium, sacrum, and coccyx	gluteal tuberosity of femur	Inferior gluteal nerve
Gluteus medius		abducts and medially rotates thigh	Outer surface of Ilium	greater trochanter of femur	Superior gluteal nerve
Gracilis		adducts and flexes the thigh, medially rotates thigh	body and inferior ramus of pubis	medial, proximal tibia	Obturator nerve

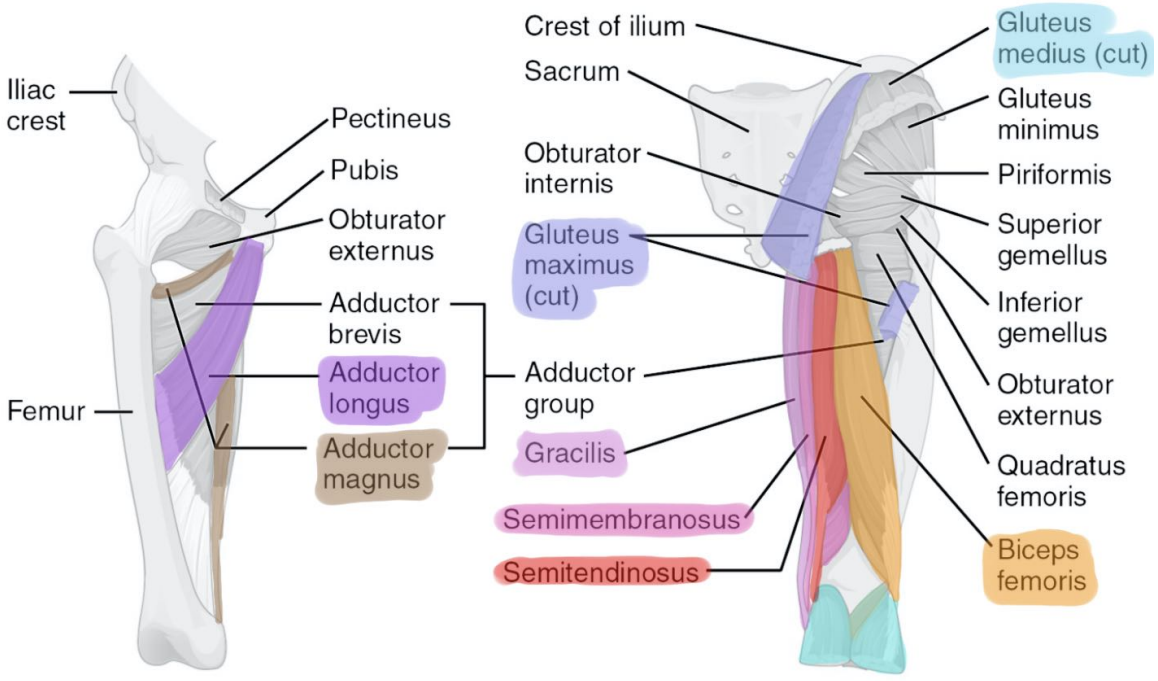
Muscle	Image	Action	Origin	Insertion	Innervation
Iliopsoas: Iliacus & Psoas major		flexes thigh	Iliacus: iliac fossa Psoas major: lateral side and transverse processes of T12 and lumbar vertebrae	lesser trochanter of femur	Femoral nerve
Sartorius		flexes the thigh and leg (knee); abducts and laterally rotates the thigh	Anterior superior iliac spine	proximal, medial condyle of the tibia	Femoral nerve

Table 14: Muscle actions of the hip and thigh.

Actions at the hip and thigh	Flexion	Extension	Abduction	Adduction	Medial Rotation	Lateral Rotation
Iliacus	X (PM)					
Psoas major	X (PM)					
Adductor longus	X			X	X	
Rectus femoris	X					
Sartorius	X		X			X
Biceps femoris		X (PM)				X (weak)
Gluteus maximus		X (PM)	X			X
Adductor magnus		X		X	X	
Semimembranosus		X				
Semitendinosus		X				
Gluteus medius			X (PM)		X	
Gracilis				X	X	



Superficial pelvic and thigh muscles of right leg (anterior view)



Deep pelvic and thigh muscles of right leg (anterior view)

Pelvic and thigh muscles of right leg (posterior view)

Figure 11: Muscles of the hip and thigh showing the superficial anterior (top), deep pelvic, anterior view (bottom, left) and posterior (bottom, right) views.

Muscles of the leg (tibia and fibula) **(Figures 11, 12, Tables 15,** and **16)**
The muscles of the thigh extend and flex the lower leg at the knee. The quadriceps femoris is a group of four muscles on the anterior thigh and are the prime movers for knee extension. The **rectus femoris** is the middle muscle that is in the femoral region and connects to the patella. Lateral to the rectus femoris is the **vastus lateralis**. Medial to the rectus femoris is the **vastus medialis**, and deep to the rectus femoris is the **vastus intermedius**. On the posterior surface of the upper leg (femur) you can find the hamstring group. The hamstrings are a group of three muscles that are prime movers for knee flexion. The most lateral of the three muscles is the **biceps femoris** with two heads. The **semimembranosus** is the most medial muscle and on top of semimembranosus is the **semitendinosus** with the longest tendon.

Hint: Semimembranosus is medial and Semitendinosus is on top and has a long tendon.

Table 15: Muscles of the leg and their action(s), origin(s), insertion(s) and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Biceps femoris		flexes the leg (knee); laterally rotates and extends the thigh	ischial tuberosity (long head); linea aspera, and distal posterior femur (short head)	head of fibula and lateral condyle of tibia	Sciatic nerve
Rectus femoris		extends leg (knee), flexes thigh	anterior inferior iliac spine and acetabulum	patella and tibial tuberosity via quadriceps femoris tendon	Femoral nerve
Semimembranosus		flexes the leg (knee); extends and medial rotates the thigh	ischial tuberosity	posterior surface of medial condyle of tibia	Sciatic nerve
Semitendinosus		flexes the leg (knee); extends the thigh; medially rotates the leg	ischial tuberosity	proximal, medial surface of the tibia	Sciatic nerve

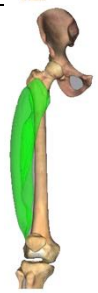
Muscle	Image	Action	Origin	Insertion	Innervation
Vastus intermedius		extends leg (knee)	anterior and lateral part of the proximal diaphysis of the femur	quadriceps femoris tendon; lateral patella; lateral condyle of tibia	Femoral nerve
Vastus lateralis		extends leg (knee)	greater trochanter, proximal linea aspera of femur	quadriceps femoris tendon; lateral patella	Femoral nerve
Vastus medias		extends leg (knee)	linea aspera of femur	medial border of patella	Femoral nerve

Table 16: Muscle actions on the lower leg.

Actions on the leg (knee)	Flexion	Extension
Rectus femoris		X (PM)
Vastus intermedius		X (PM)
Vastus lateralis		X (PM)
Vastus medialis		X (PM)
Biceps femoris	X (PM)	
Semimembranosus	X (PM)	
Semitendinosus	X (PM)	
Gastrocnemius	X	
Gracilis	X	
Sartorius	X	

Muscles of the ankle and foot **(Figure 12, Tables 17, and 18)**
Muscles acting on the ankle joint cause dorsiflexion or plantarflexion. Muscles acting on the intertarsal joints allow for eversion and inversion. The muscles are found overlying the tibia and fibula of the lower leg. The anterior tibia is an excellent landmark for the lower leg muscles. Just lateral to the anterior surface of the tibia is the **tibialis anterior**,

literally “front of the tibia”. Moving laterally from the tibialis anterior is the **extensor digitorum longus** and the most lateral muscle on the fibula is the **fibularis longus (peroneus longus)**. Muscles on the anterior aspect of the tibia are responsible for extending the toes and dorsiflexing the foot. Muscles on the lateral aspect of the leg (fibula) are responsible for eversion and plantarflexing the foot. The **gastrocnemius** is the large calf muscle found on the posterior leg with the soleus deep to it. The gastrocnemius forms the **calcaneal tendon** (**Achilles’ heel**) that inserts onto the tarsal bone, the calcaneus. This posterior muscle performs one of the most powerful actions, plantar flexion. Plantar flexion allows humans to walk and run by providing forward thrust. The **Soleus** is a flat muscle deep to gastrocnemius; it assists in plantar flexion.

Table 17: Muscles of the ankle and foot and their action(s), origin(s), insertion(s), and innervation.

Muscle	Image	Action	Origin	Insertion	Innervation
Extensor digitorum longus		dorsiflexion of the foot and extends the toes	lateral condyle of tibial and proximal fibula	2-5 middle phalanges	Deep fibular nerve
Fibularis longus (peroneus longus)		eversion and plantarflexion of the foot	proximal lateral fibula	medial cuneiform bone and first metatarsal	Superficial fibular nerve
Gastrocnemius		flexes the knee and plantarflexes the foot	medial and lateral condyles of femur	posterior calcaneus via calcaneal tendon	Tibial nerve
Soleus		plantarflexes the foot	head of fibula, proximal tibia	posterior calcaneus	Tibial nerve

Muscle	Image	Action	Origin	Insertion	Innervation
Tibalis anterior		dorsiflexion and inverts the foot	lateral condyle and proximal 2/3 of tibial diaphysis	medial tarsal bone (cuneiform) and first metatarsal bone	Deep fibular nerve

Table 18: Muscle actions on the ankle.

Actions on the foot (ankle)	Plantar Flexion	Dorsiflexion	Inversion	Eversion
Gastrocnemius	X (PM)			
Soleus	X (PM)			
Fibularis longus (Peroneus longus)	X			X
Tibialis anterior		X (PM)	X	
Extensor digitorum longus		X		

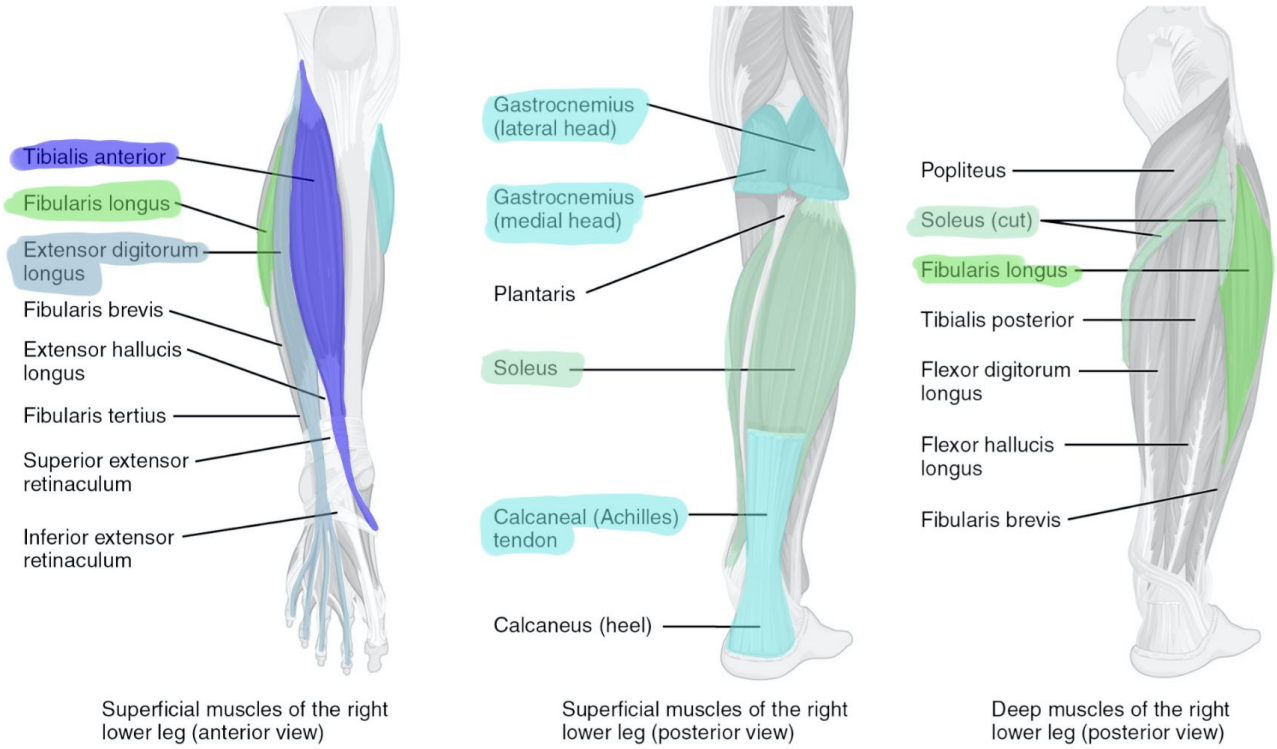


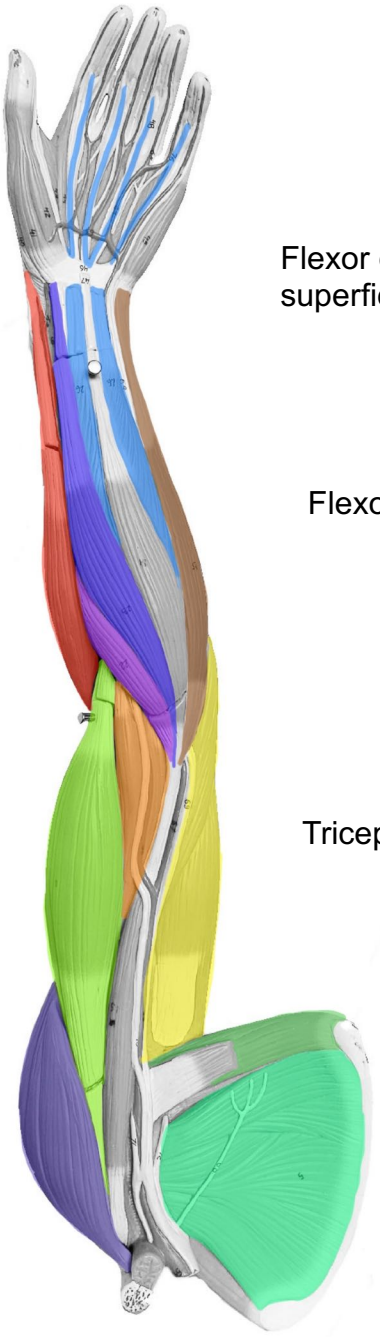
Figure 12: Muscles of the lower leg. Superior muscles, anterior view (left), superior muscles, posterior view (middle) and deep muscles, posterior view (right).

Procedure:

1. Divide into pairs. One pair will label and answer the questions on the arm muscle model while the other pair works on the leg muscle model. As you identify the muscles, label them with the laminated muscle stickers. Fill in the charts with the muscle name that matches the number on the model and draw a line between the muscle name and the muscle on the images.
2. Switch models and repeat step 1.

Number	Muscles of the Arm
5	
6	
7	
9	
10	
11, 12 & 13	
14	
16, 17 & 18	
19	
20	
22	
23	
25	
26	
30	
34	

Word Bank: Biceps brachii, Brachialis, Brachioradialis, Deltoid, Extensor carpi radialis longus, Extensor digitorum, Flexor carpi radialis, Flexor carpi ulnaris, Flexor digitorum superficialis, Infraspinatus, Pronator teres, Subscapularis, Supinator, Supraspinatus, Teres major, Triceps brachii



Flexor digitorum superficialis

Brachioradialis

Flexor carpi radialis

Flexor carpi ulnaris

Pronator teres

Brachialis

Triceps brachii

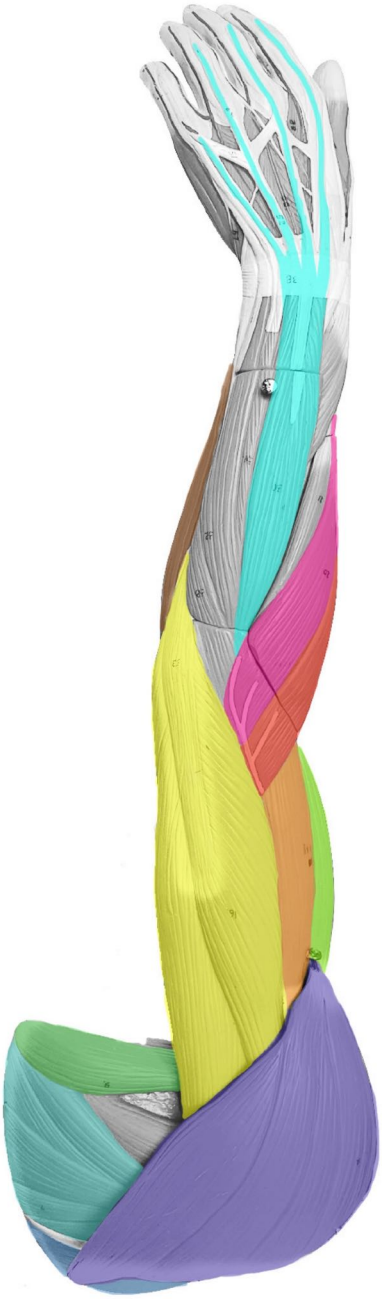
Biceps brachii

Teres major

Deltoid

Subscapularis

Anterior Arm Muscles to Label



Extensor digitorum

Flexor carpi ulnaris

Triceps brachii

Teres major

Infraspinatus

Supraspinatus

Extensor carpi radialis longus

Brachioradialis

Biceps brachii

Brachialis

Deltoid

Posterior Arm Muscles to Label

Brachioradialis
&
Extensor carpi radialis
longus
partially removed

Flexor carpi radialis

Supinator

Pronator teres

Brachialis

Biceps brachii

Teres major

Triceps brachii

Subscapularis

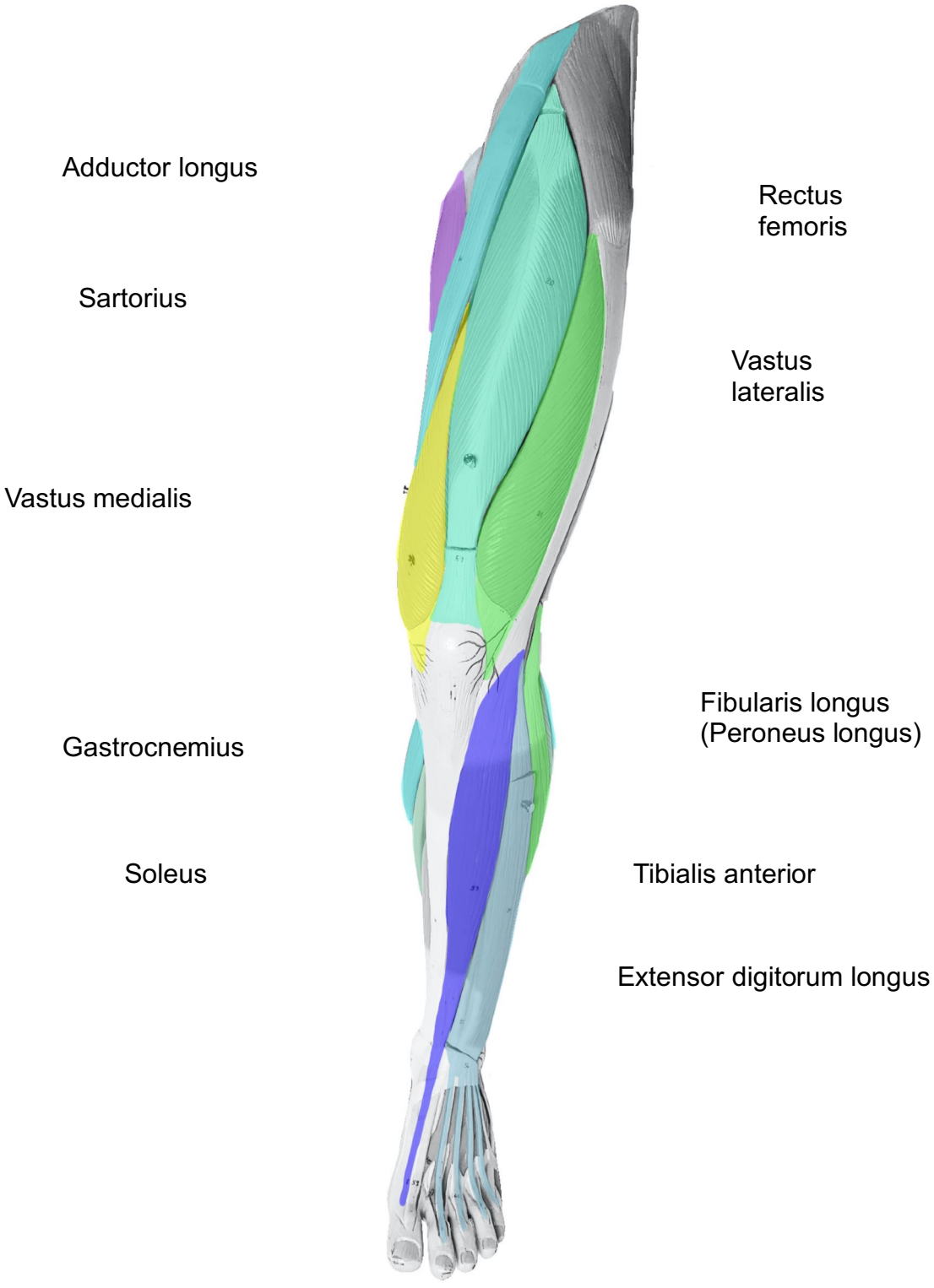
Deltoid is removed

Lateral Arm Muscles to Label

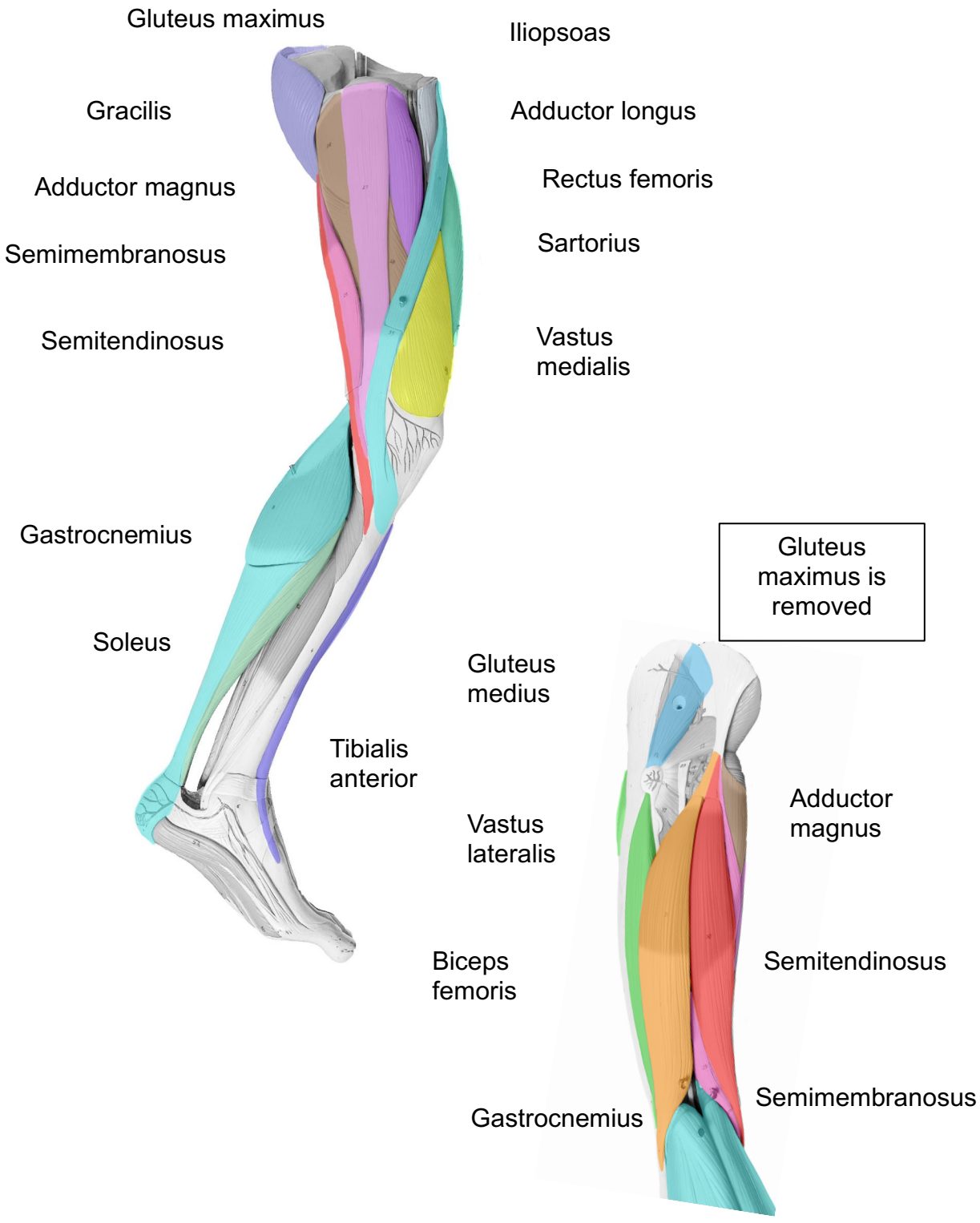
3. As you work on the leg model fill in the key using the numbers of the model and matching them to the numbers of your leg chart. Label the images of the leg model using the same key.

Number	Muscles of the Leg
11	
12	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31 & 32	
33	
34	
35	
37 & 38	
39	

Word Bank: Adductor longus, Adductor magnus, Biceps femoris, Extensor digitorum longus, Fibularis longus (Peroneus), Gastrocnemius, Gluteus maximus, Gluteus medias, Gracilis, Iliopsoas, Rectus femoris, Semimembranosus, Semitendinosus, Soleus, Tibialis anterior Vastus lateralis, Vastus intermedius, Vastus medialis, Sartorius

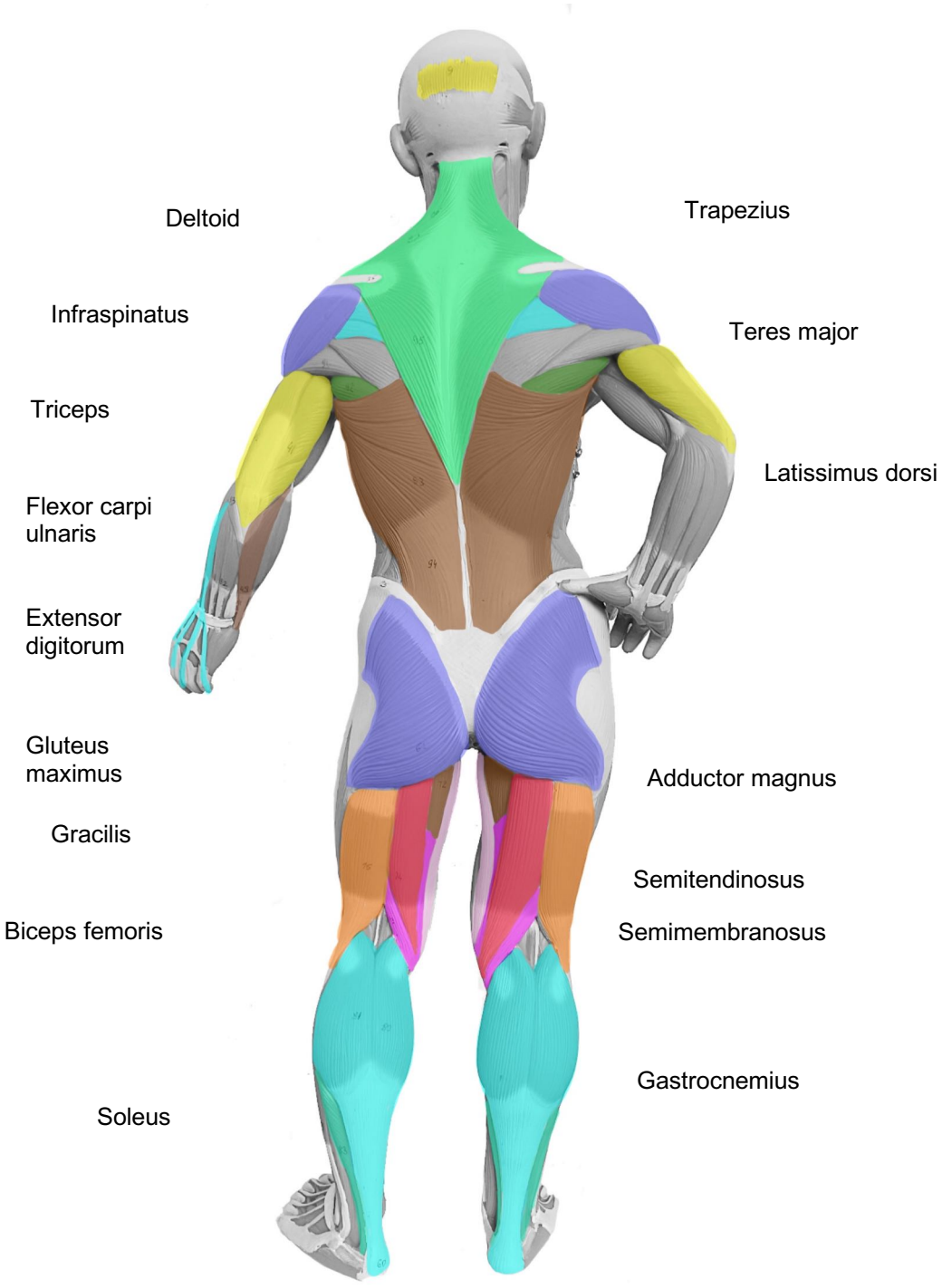


Anterior Leg Muscles to Label



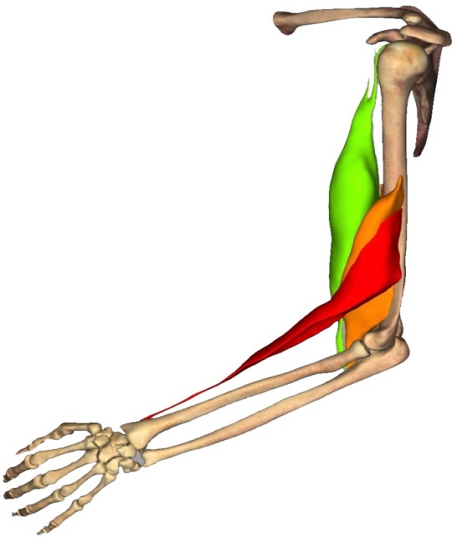
Posterior and Medial Leg Muscles to Label

4. Identify the muscles of the axial and appendicular on the full body muscle model. Draw a line from the muscle name to the muscle on the image.

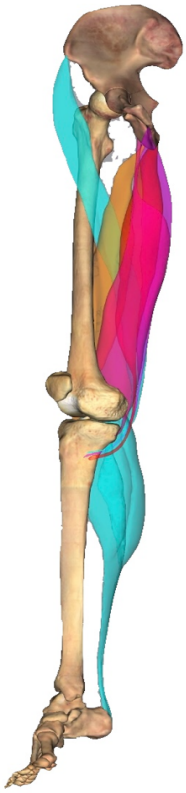


Posterior Body Muscles to Label

5. Look at the following two images. Draw with an arrow the direction of contraction of each muscle group. Name the angular movement indicated by each arrow.



Angular Movement



6. Once you have labelled all the images in the lab, ask your instructor to check and initial below.

Instructor's Initials for labeled muscle: _____

Putting it all Together

Your guess was correct, the rectus femoris was the muscle on the anterior thigh. You listen as the doctor talks to the family about the severity of the disease. As of today, there is no cure for Duchenne; it is an irreversible, progressive disease. Jose will undergo intense physical therapy to keep his muscles active and moving for as long as possible. Eventually, the muscles of respiration will weaken and cannot move air into the lungs. Jose will receive breathing support at this point. In addition to skeletal muscle weakness, Duchenne also affects the heart (cardiac) muscle. Thus, heart contractions cannot keep up with the demands of the body. This is a sad diagnosis for the family. This case highlights how the muscles in the body work together in synchrony to produce incredible movements that support the body and life itself.

Name: _____

Lab Checkout: When you finish the lab, please clean up your lab space and put away your materials and labels neatly. Once you have thoroughly cleaned your lab table, please get your instructor's initials to check-out of lab.

- ❑ Lab bench clean
- ❑ All labels removed and neatly returned to binder
- ❑ Materials put away properly and organized in trays

Lab completed (% completed = _____ %) **Instructor initials:** _____

Post-lab: Muscles Lab

Activity 1: Muscle Actions

1. How does one determine the action of a muscle, using knowledge of the origin and insertion?

2. Some muscles, like the flexor carpi ulnaris, are defined both as agonists and antagonists. Explain how this is possible using the flexor carpi ulnaris as an example.

Activity 2 & 3: Muscles of the Axial and Appendicular Skeleton

3. Name the muscle(s) that is/are true for each statement. Use muscles only from your terminology sheet.

_____ flexes the thigh

_____ extends the digits

_____ insertion on the mastoid process of the temporal bone

_____ insertion above the eyebrows, near frontal bone

_____ abducts the arm

_____ flexes the trunk

_____ Insertion is on humerus

_____ adduction of the leg

_____ plantarflexion of the foot

_____ origin is the vertebral column

_____ causes pursing of the lips

_____ pronates the arm

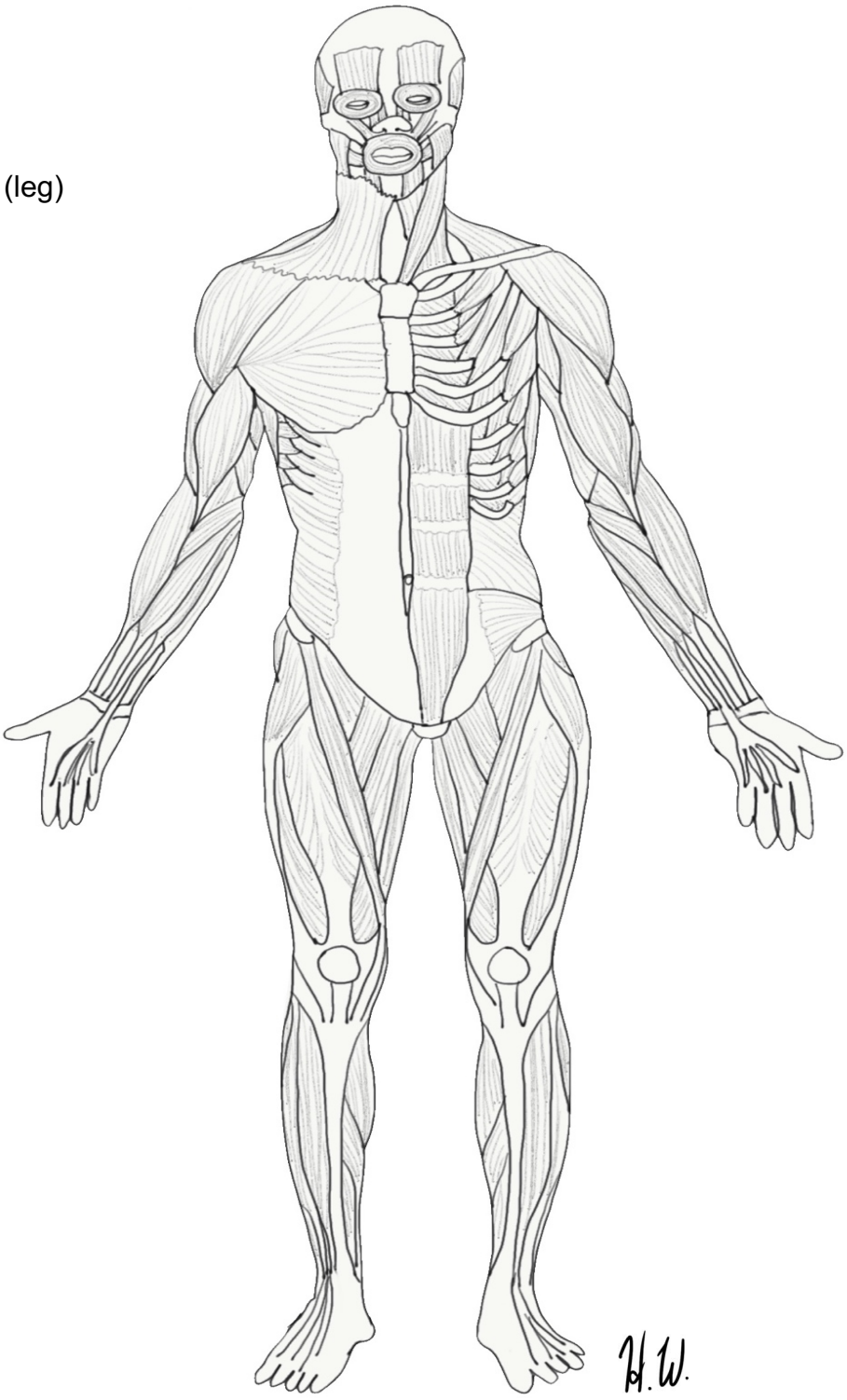
4. Name the four muscles that make up the quadriceps femoris.
   - _____
   - _____
   - _____
   - _____
5. Name the three muscles that make up the hamstring set.
   - _____
   - _____
   - _____
6. Name the three muscles of the rotator cuff.
   - _____
   - _____
   - _____
7. Below each image write the main action of the muscle group.




Movement: _____ _____ _____ _____

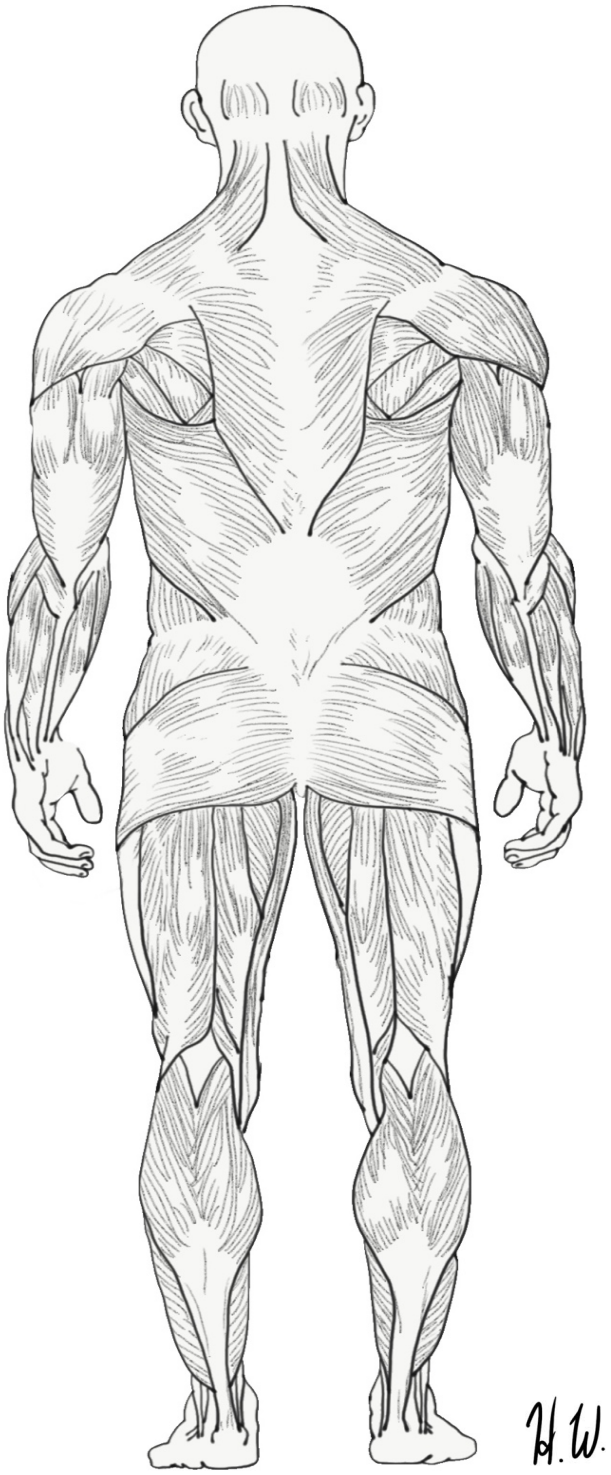
Muscle Actions

8. Color the bullet point (or term) and the corresponding muscle on the anterior view of the body muscles in the same color:
   - adductor longus
   - biceps brachii
   - brachioradialis
   - buccinator
   - deltoid
   - extensor digitorum longus (leg)
   - external oblique
   - fibularis longus
   - flexor carpi radialis
   - flexor carpi ulnaris
   - frontalis
   - gracilis
   - iliopsoas
   - internal oblique
   - masseter
   - orbicularis oculi
   - orbicularis oris
   - pectoralis major
   - platysma
   - pronator teres
   - rectus abdominis
   - rectus femoris
   - sartorius
   - serratus anterior
   - sternocleidomastoid
   - temporalis
   - tibialis anterior
   - transverse abdominis
   - vastus lateralis
   - vastus medialis
   - zygomaticus



Anterior Body Muscles

9. Color the bullet point (or term) and the corresponding muscle on the posterior view of the body muscles in the same color:
   - adductor magnus
   - biceps femoris
   - deltoid
   - gastrocnemius
   - gluteus maximus
   - gluteus medius
   - gracilis
   - latissimus dorsi
   - occipitalis
   - rhomboid
   - semimembranosus
   - semitendinosus
   - soleus
   - teres major
   - trapezius



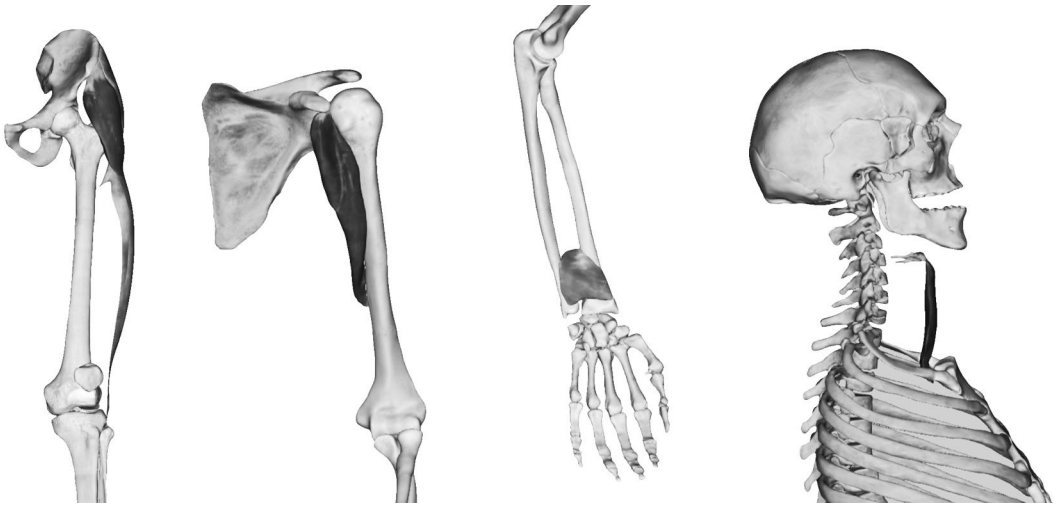
Posterior Body Muscles

The following questions are an application of what you have learned. The muscles are not muscles you need to know but are instead used to apply the skills you have learned in this lab.

10. Given the name and action of a muscle, draw the muscle's insertion and origin on the image of the lower limb to the right. Don't look up the muscle but think about what the name tells you about its location on the body. Think about where the muscle would have to start and end to generate the movement.
    a. Tibialis posterior, action: foot inversion and plantar flexes
    b. Adductor brevis, action: to adduct the hip joint

Posterior View of Leg

11. Apply it! View the images below and pay close attention to the attachment points of the muscle to the skeleton. These are not muscles that you need to know. Multiple answers will be accepted! Predict the action of each muscle.



Movement: _____ _____ _____ _____

Muscle Action Predictions