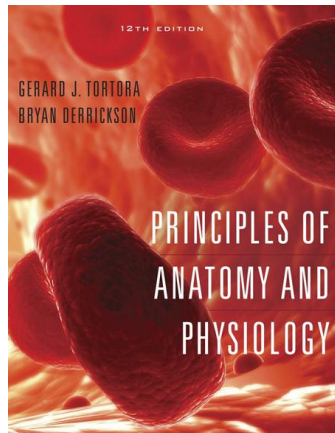

Chapter 11

The Muscular System



Muscle Attachment Sites: Origin & Insertion

- Skeletal muscles cause movements by exerting force on tendons, which pulls on bones or other structures.
- Articulating bones usually do not move equally in response to contraction.
 - the attachment of a tendon to the stationary bone is called the **origin**.
 - the attachment of the muscle's other tendon to the movable bone is called the **insertion**.
 - the **action/s** of a muscle are the main movements that occur during contraction (e.g., flexion or extension).

Relationship of skeletal muscles to bones

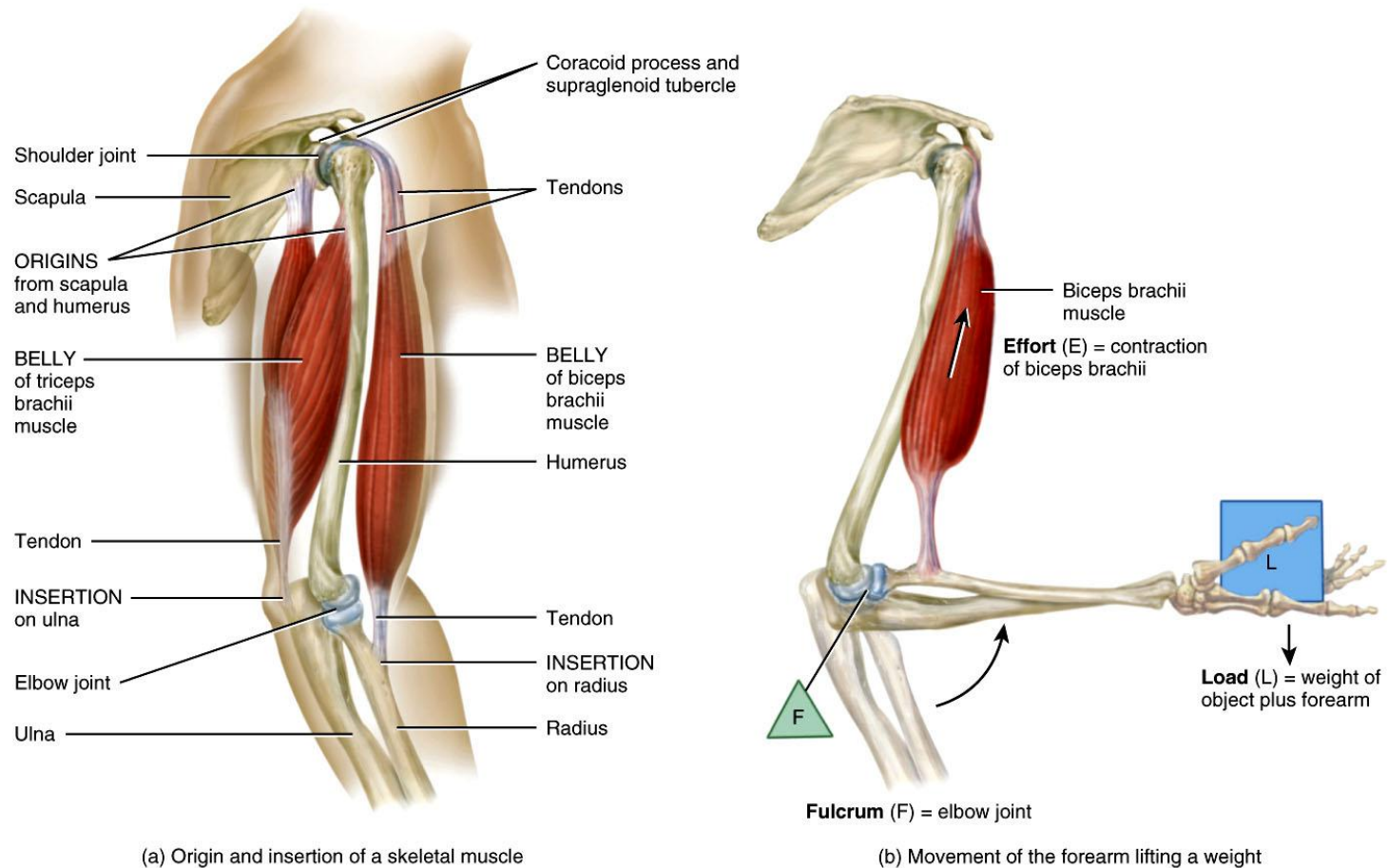


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Lever Systems

- A **lever** is a rigid structure that can move around a fixed point called a **fulcrum**.
- A lever is acted on at two different points by two different forces:
 - the **effort**, which causes movement, and
 - the **load** or **resistance**, which opposes movement.
- The **effort** is the force due to muscular contraction; the **load** is the weight that is moved or some **resistance** an object to being moved (e.g., weight of a book to be overcome before you can pick it up).
- Motion occurs when the effort applied to the bone at the insertion exceeds the load.

Types of levers

- There are 3 types of levers that differ on the positions of the fulcrum, effort, and load.
 - **First-class levers** are not common: the fulcrum is between the effort and the load.
 - **Second-class levers** are uncommon: the load is between the fulcrum and the effort.
 - **Third-class levers** are common: the effort is between the fulcrum and the load.

Types of levers

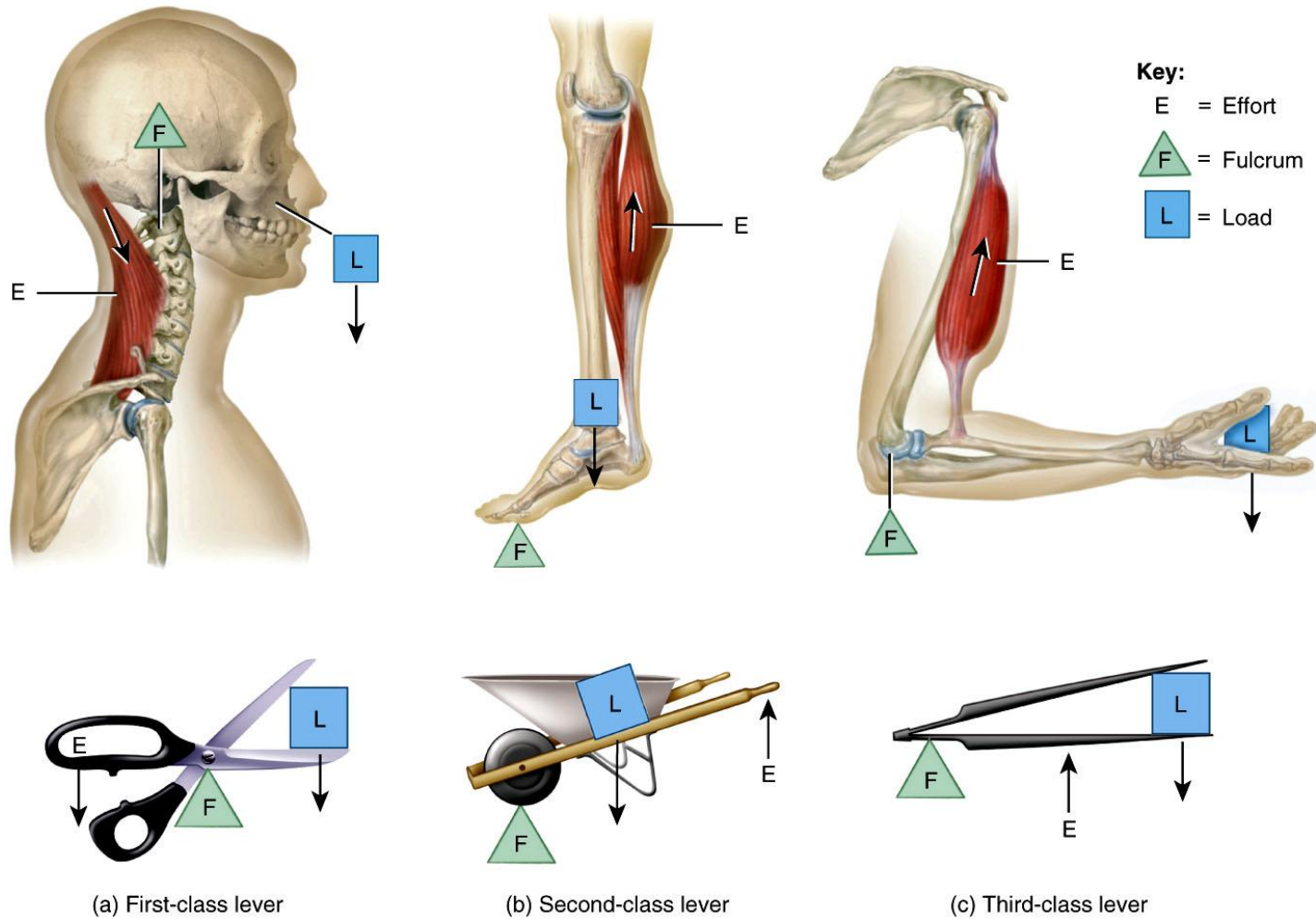


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Effects of muscle fascicle arrangement

- All muscle fibers are parallel to one another within a single fascicle.
- Fascicles, however, form patterns with respect to the tendons.
 - Parallel
 - Fusiform
 - Circular
 - Triangular
 - Pennate

Effects of muscle fascicle arrangement

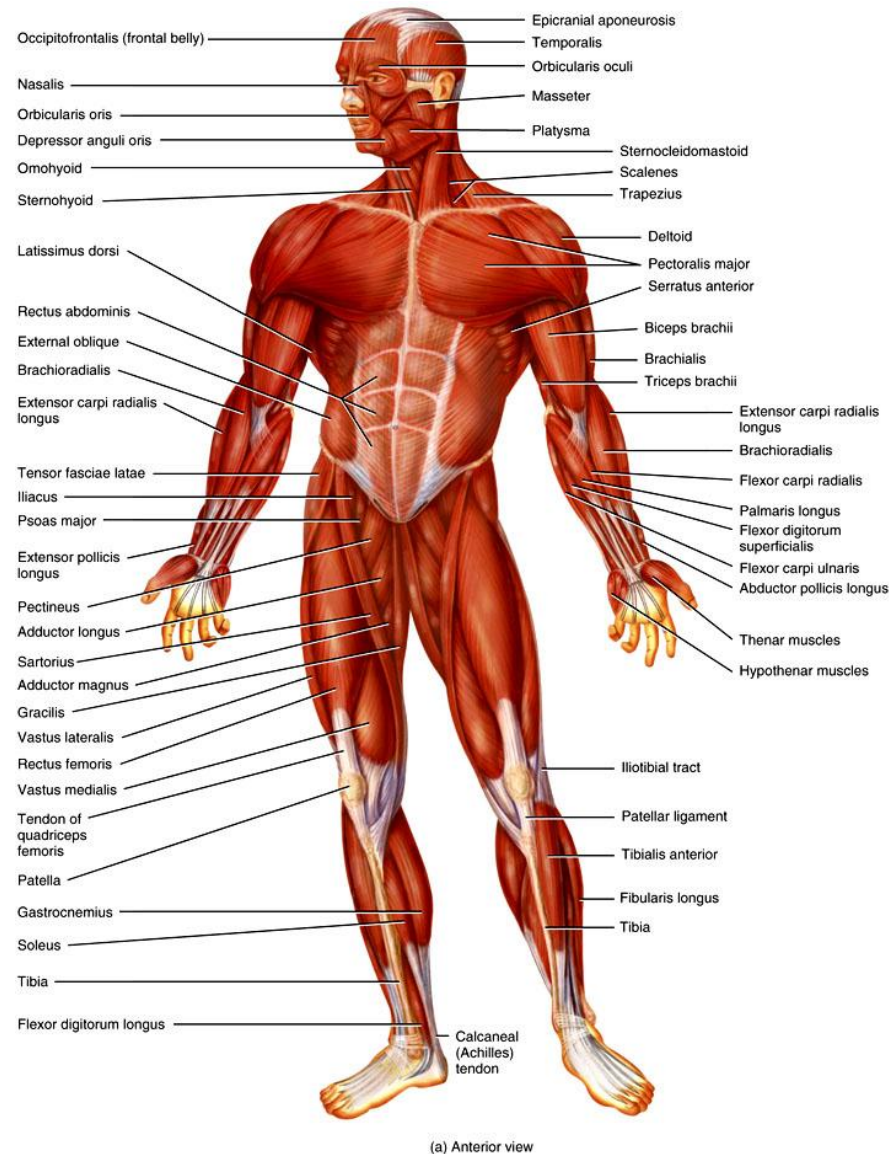
- Muscle fascicles have a compromise that they must make. They must compromise between power and range of motion.
 - The longer the fibers in a muscle, the greater the range of motion it can produce.
 - The power of a muscle depends not on length but on its total cross-sectional area.

Coordination among muscles

- It is common to attribute a specific action at a joint to a single muscle bundle, but remember that muscles do not work in isolation.
- Movements usually result from several skeletal muscles acting as a group. Most skeletal muscles are arranged in opposing (antagonistic) pairs at joints (e.g., flexors vs. extensors).
- In an opposing muscle pair, one is called the **prime mover** or **agonist** and is responsible for the action, while the other muscle called the **antagonist** stretches and yields to the effects of the agonist.

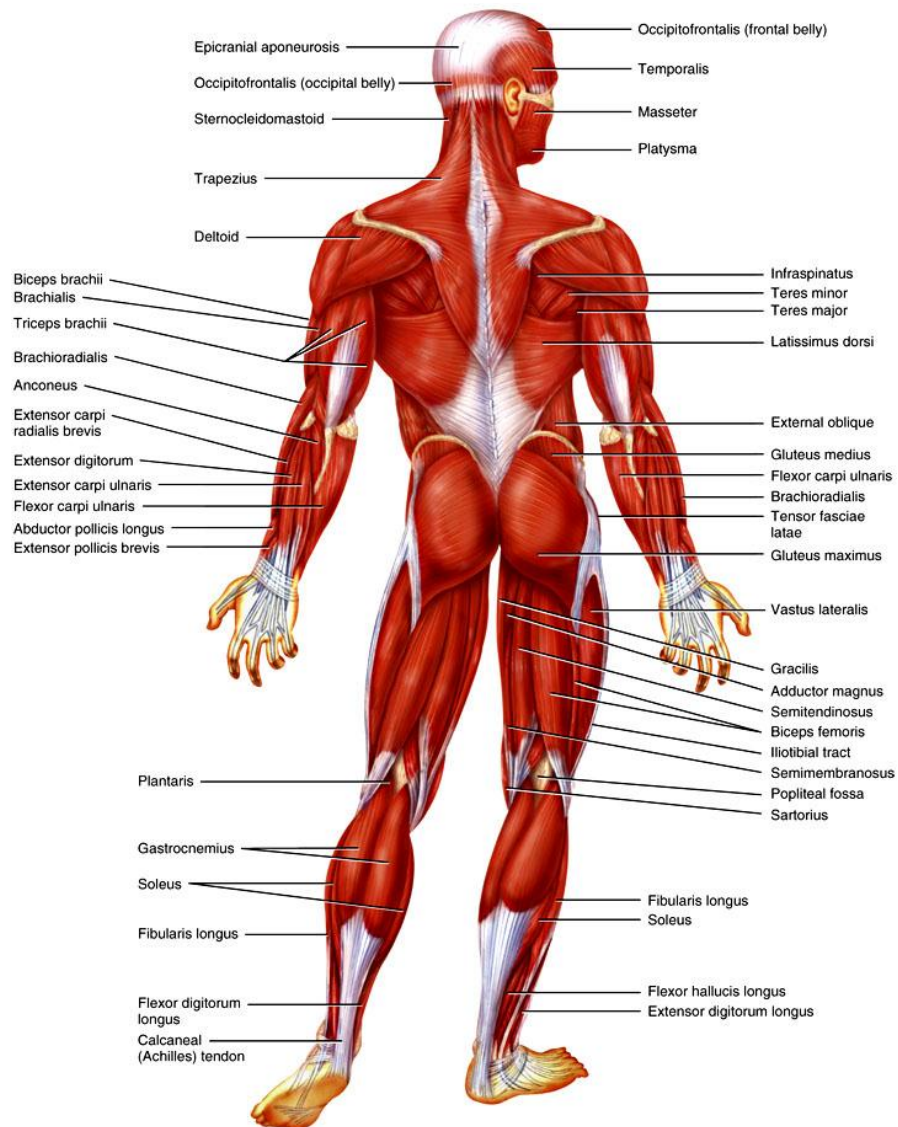
Coordination among muscles

- To prevent unwanted movements at other joints or to otherwise aid the movement of the agonist, muscles called **synergists** contract and stabilize the intermediate joints.
- Other muscles act as **fixators**, stabilizing the origin of the agonist so that the agonist is more efficiently.
- Depending upon the movement required, many muscles may act as prime movers, antagonists, synergists, or fixators.



(a) Anterior view

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(b) Posterior view

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Muscles of facial expression

- Muscles of facial expression
 - lie within the subcutaneous layer
 - usually originate in the fascia or skull bones & insert into the skin.
- Because of their insertions, the muscles of facial expression move the skin rather than a joint when they contract.

Muscles of Facial Expression

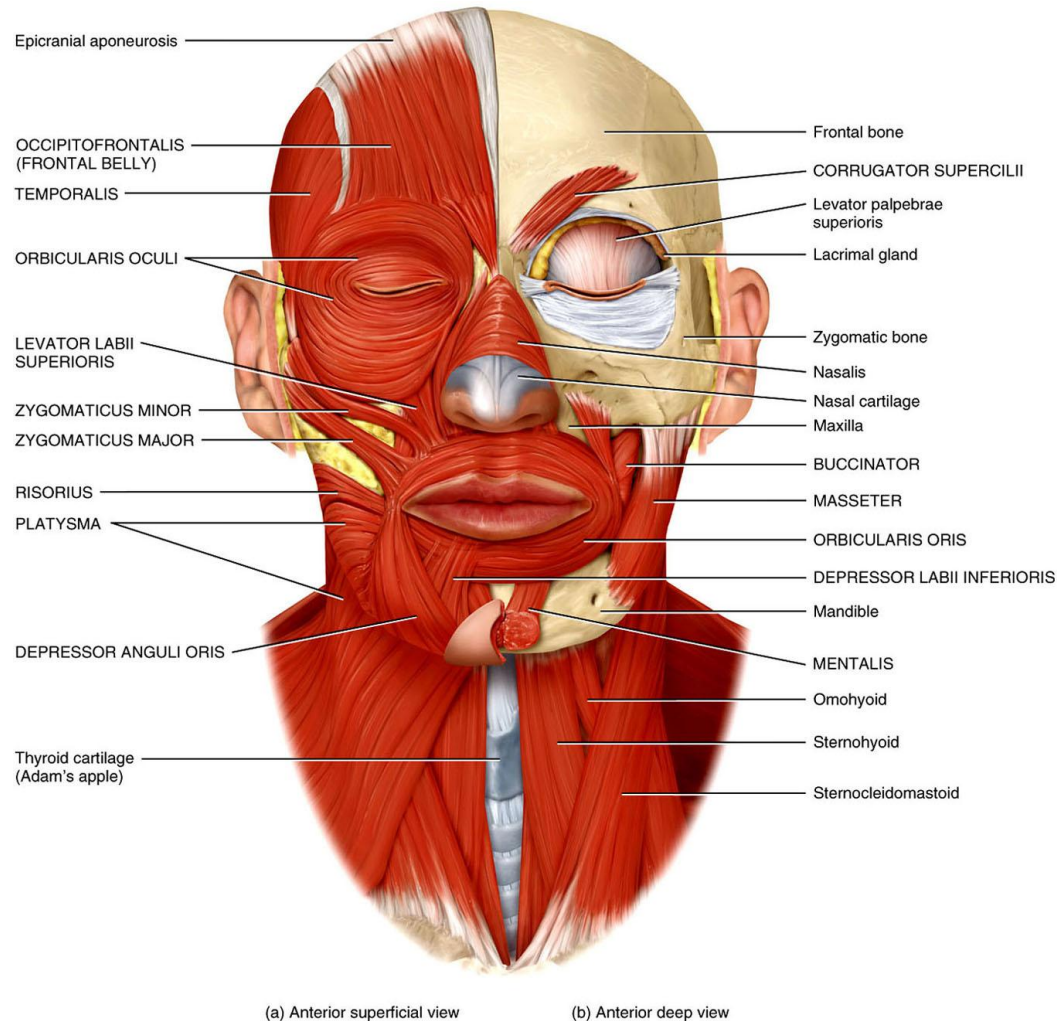
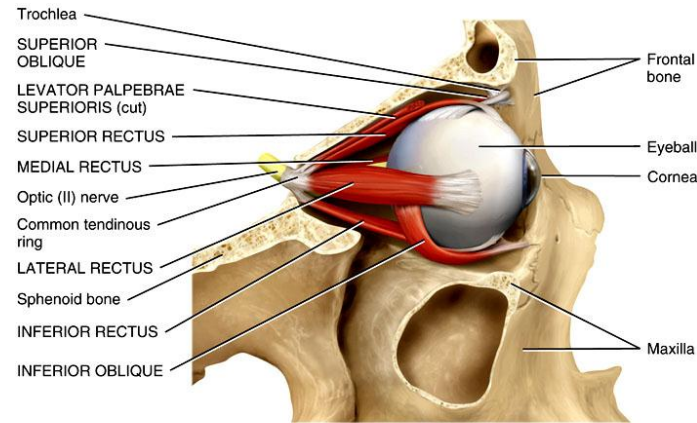


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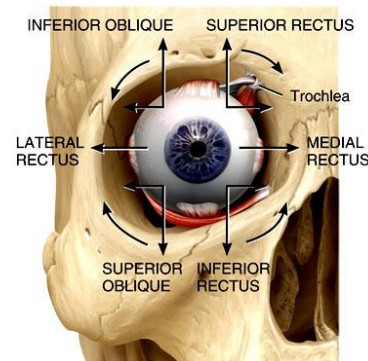
Extrinsic Eye Muscles

- Six **extrinsic** eye muscles control movements of each eyeball. They are called extrinsic because they originate on the outside of the eyeballs in the bony orbit and insert on the outer surface of the sclera.
- Those muscles with the word “rectus” in their name have obvious actions (the inferior rectus muscle moves the eye inferiorly so that you would be looking downward).
- The actions of the two oblique muscles cannot be deduced from their names. To understand how they move the eye, you must know the origin, insertion, and the unusual ‘path’ that each follows (see 11.5b).

Muscles that move the eyeballs and the upper eyelid



(a) Lateral view of right eyeball



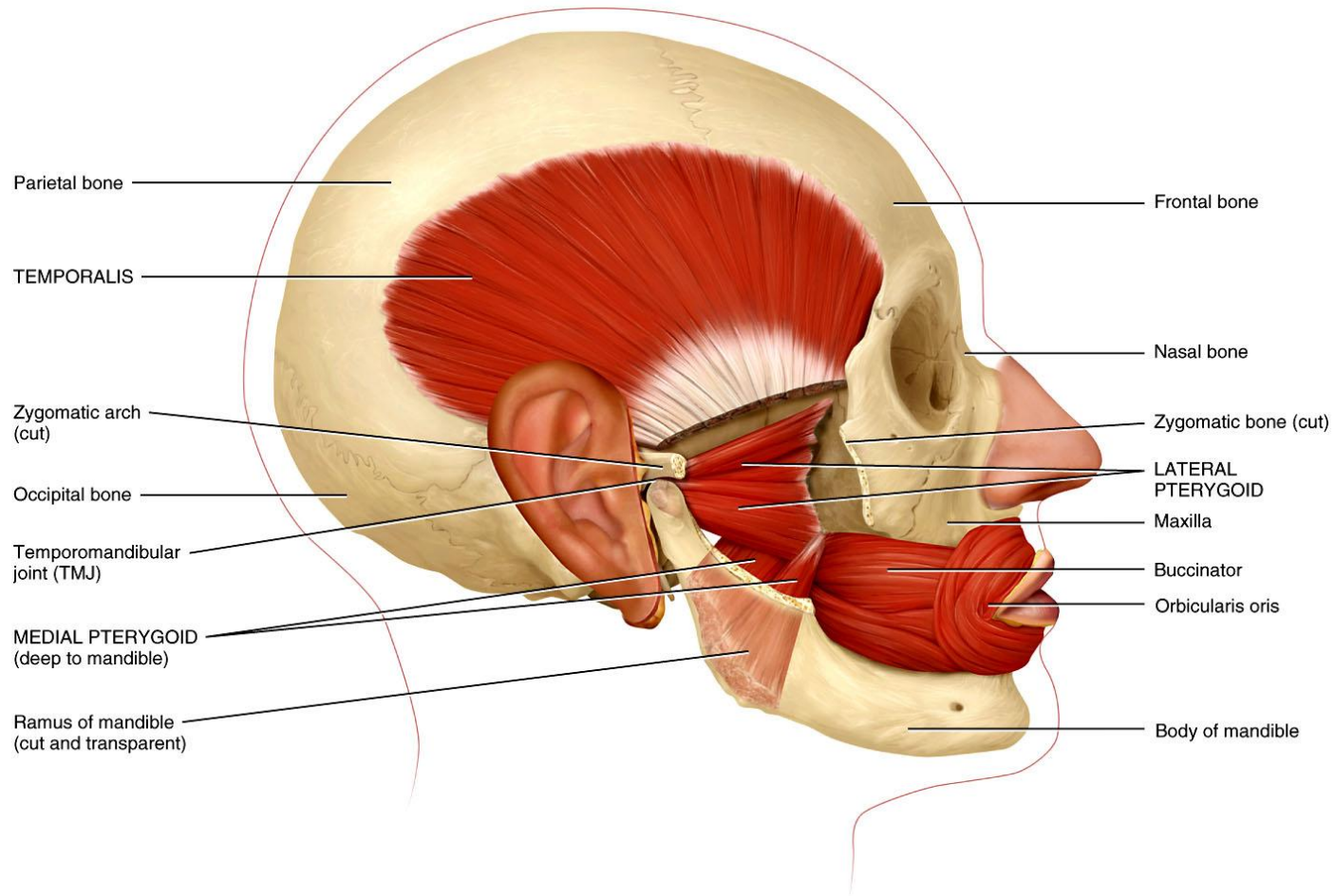
(b) Movements of right eyeball in response to contraction of extrinsic muscles

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Muscles that move the mandible

- Four pairs of muscles move the mandible, and are known as 'muscles of mastication'.
- The **masseter**, **temporalis**, and **medial pterygoid** account for the strength of the bite.
- The medial and **lateral pterygoid** muscles help to chew by moving the mandible from side to side. Additionally, these muscles protract (protrude) the mandible.

Muscles that move the mandible



Right lateral superficial view

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Muscles of the anterior neck that help in swallowing and speech

- There are two main muscle groups in the anterior neck:
 - **suprahyoid muscles**, are superior to the hyoid
 - **infrahyoid muscles**, are inferior to the hyoid.
- Both groups of muscles stabilize the hyoid bone, allowing it to serve as a firm base on which the tongue can move.

Muscles of the anterior neck that help in swallowing and speech

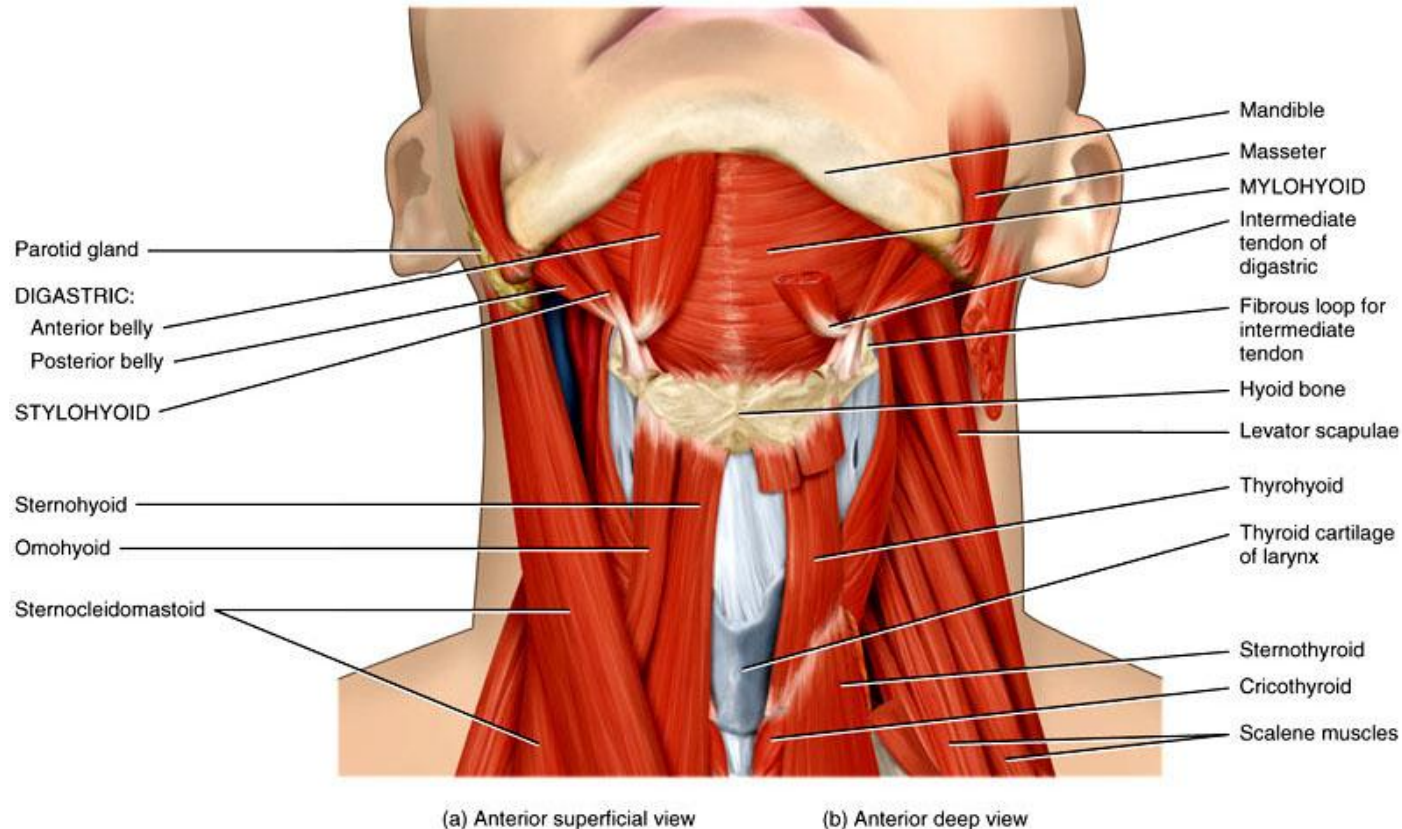
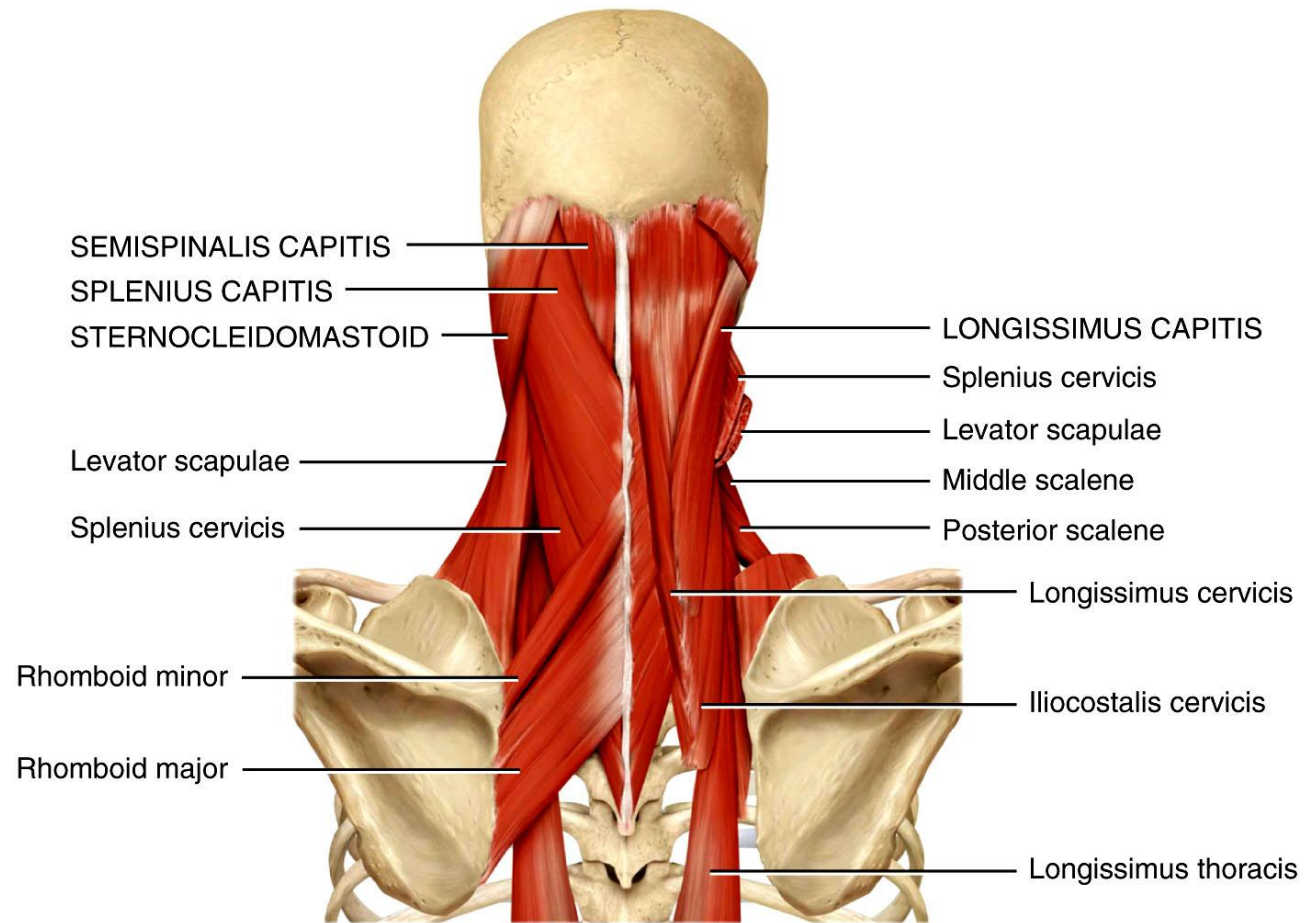


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Muscles of the neck that move the head

- The head articulates with the vertebral column at joints formed by the atlas & occipital bone.
- Balance and movement of the head involves several neck muscles.
- An important landmark (the sternocleidomastoid muscle) divides the sides of the neck into two major triangles: anterior and posterior.
 - The triangles are important anatomically and surgically because of the structures that lie within their boundaries.

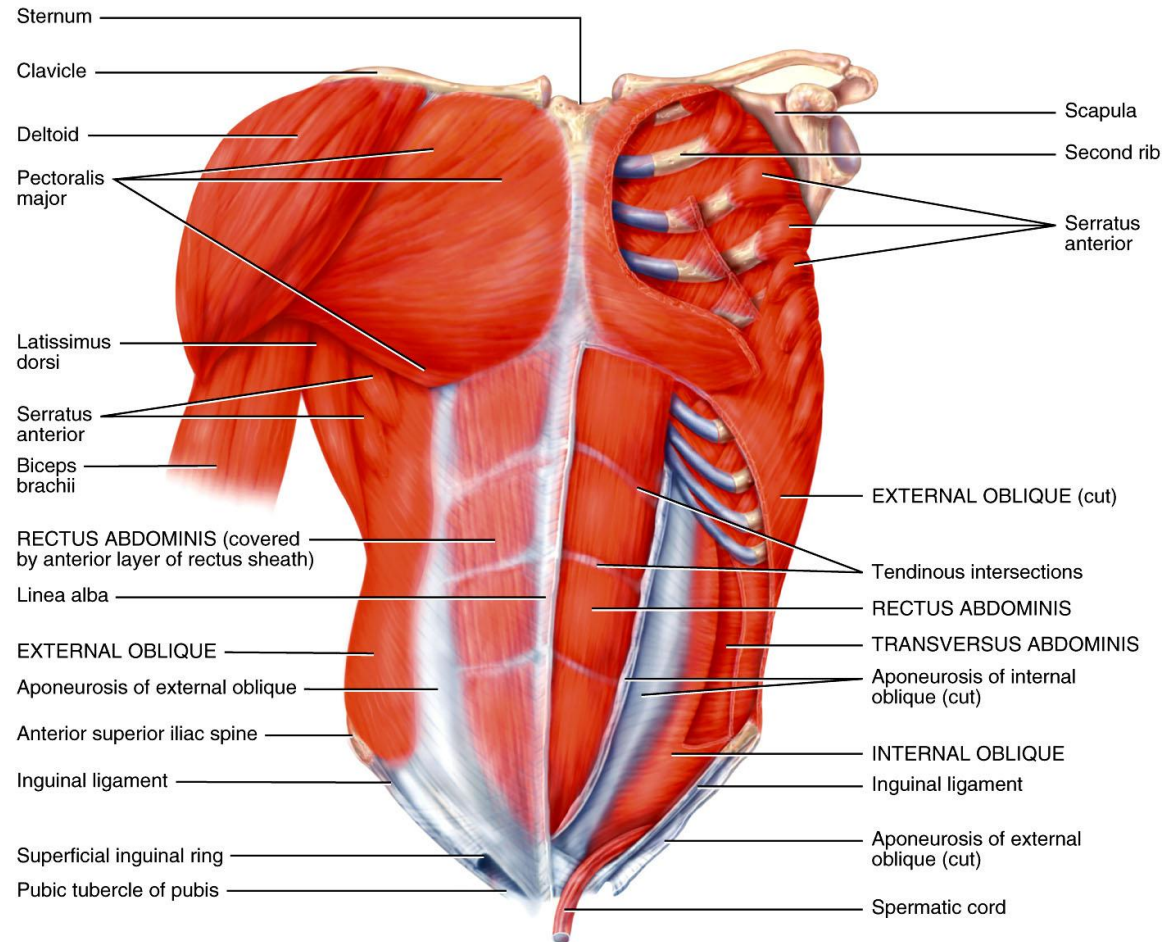
Muscles of the neck that move the head



(a) Posterior superficial view (left) and deep view (right)

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Muscles of the Abdomen



(a) Anterior superficial view

(b) Anterior deep view

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Muscles of the abdomen that protect the viscera and move the vertebral column

- The anterolateral abdominal wall includes the external oblique, internal oblique, and transversus abdominis muscles which form three protective layers around the abdomen.
- The muscle fascicles of each layer extend in a different direction, conferring considerable protection to the abdominal viscera.
- The aponeuroses of these 3 muscles form the **rectus sheaths** which enclose the **rectus abdominis muscles**.
 - The sheaths form the **linea alba**, a connective tissue band extending from the xiphoid process to the pubic symphysis.

Muscles of the Thorax that Assist in Breathing

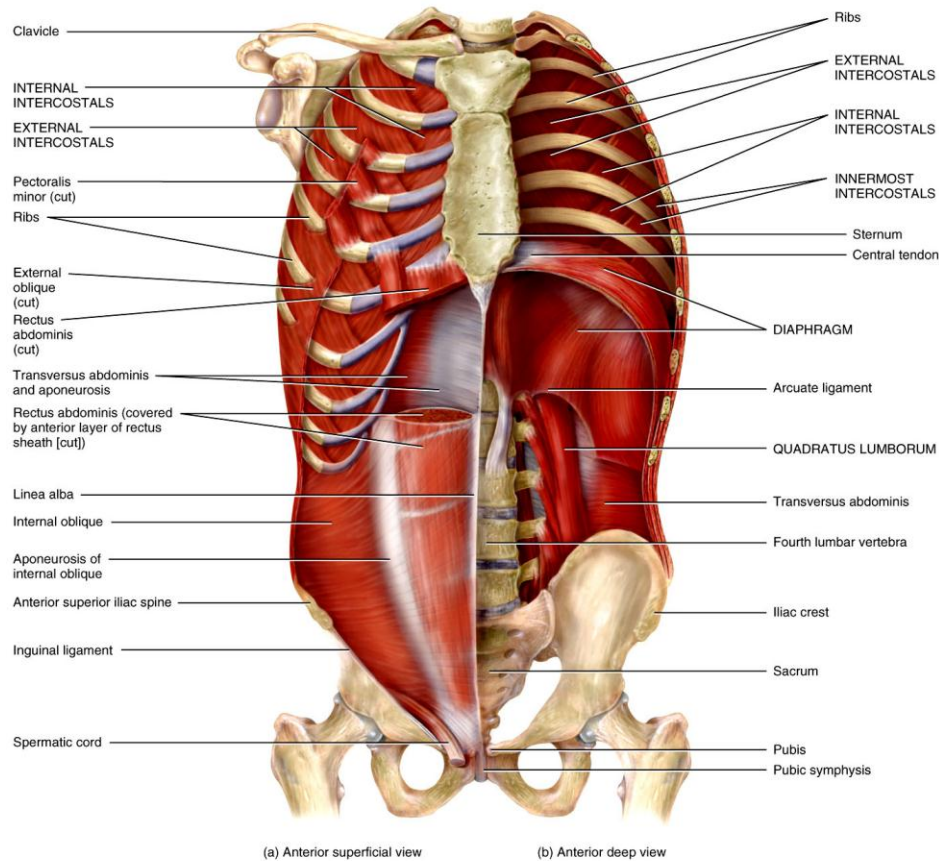


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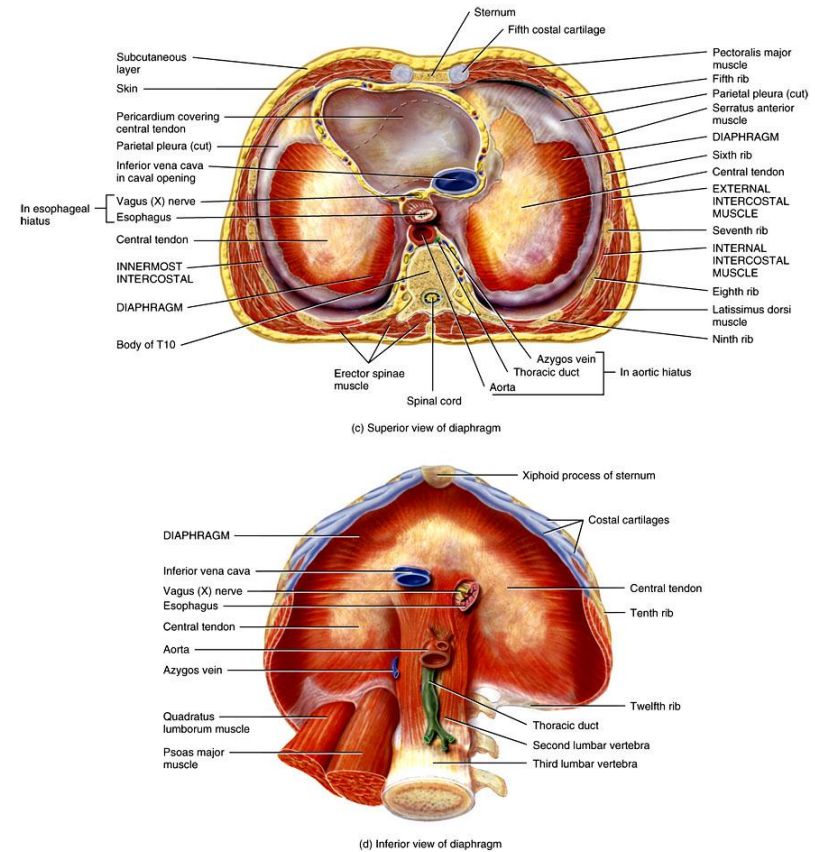


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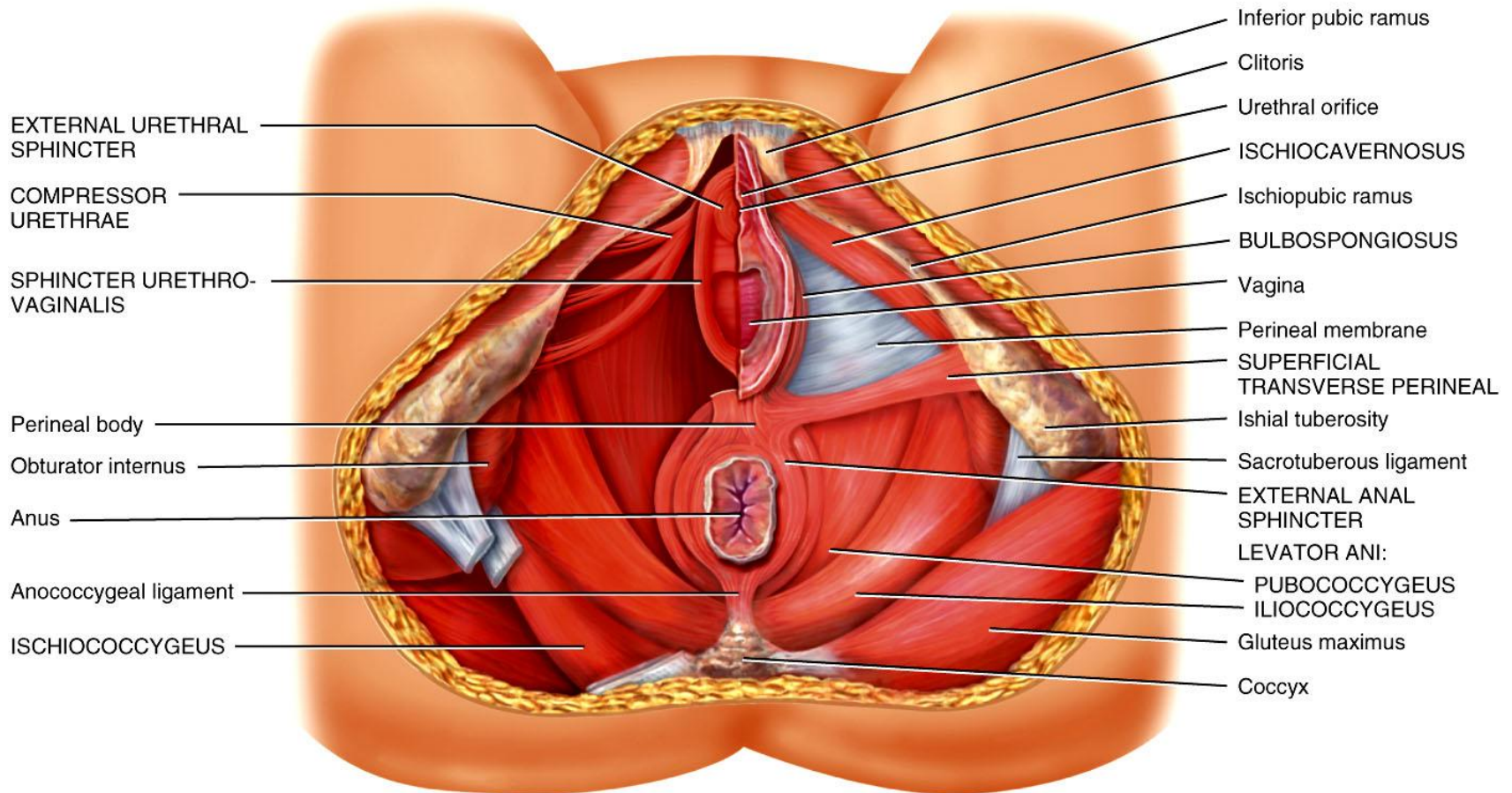
Muscles of the Thorax that Assist in Breathing

- Respiratory muscles alter the size of the thoracic cavity which affects the pressure in the lungs, and that determines whether we inhale or exhale.
- The **diaphragm** is the most important respiratory muscle.
- Other important respiratory muscles include the **external** and **internal intercostal muscles**.
- There are also a number of accessory muscles useful in forced breathing.

Muscles of the Pelvic Floor

- The levator ani and ischiococcygeus muscles, along with the fascia which covers them, form the **pelvic diaphragm**.
- The pelvic diaphragm separates the pelvic cavity above from the perineum below.

Muscles of the Pelvic Floor



Inferior superficial view

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Muscles of the Perineum

- The **perineum** is a diamond-shaped area inferior to the pelvic diaphragm that extends from the pubic symphysis anteriorly, to the coccyx posteriorly, and to the ischial tuberosities laterally.
- Perineal muscles are arranged in two layers; **superficial** and **deep**.
- The deep muscles of the perineum assist in urination and ejaculation in males and urination and compression of the vagina in females.

Muscles of the Perineum

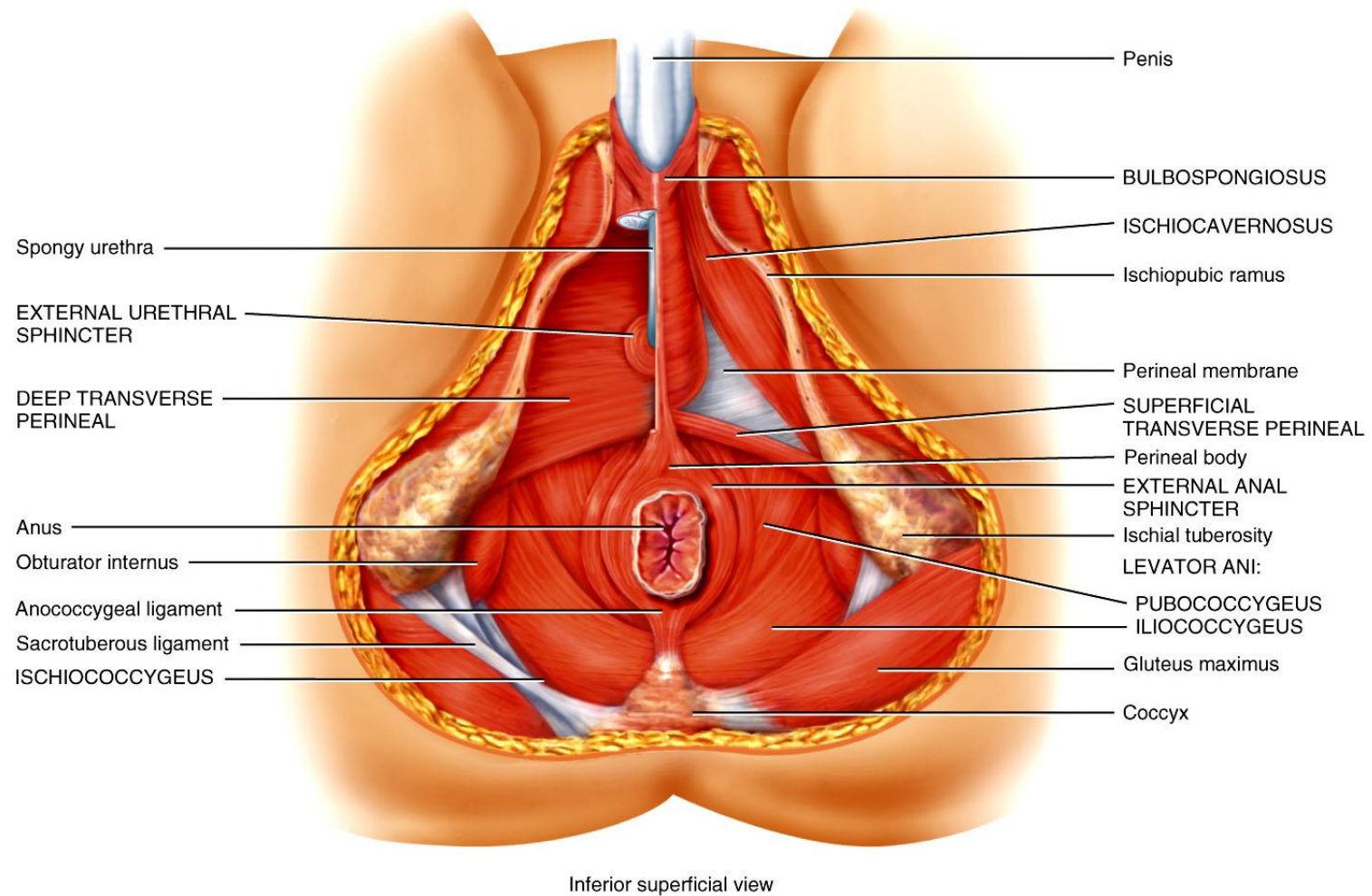


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Muscles of the Thorax that Move the Pect

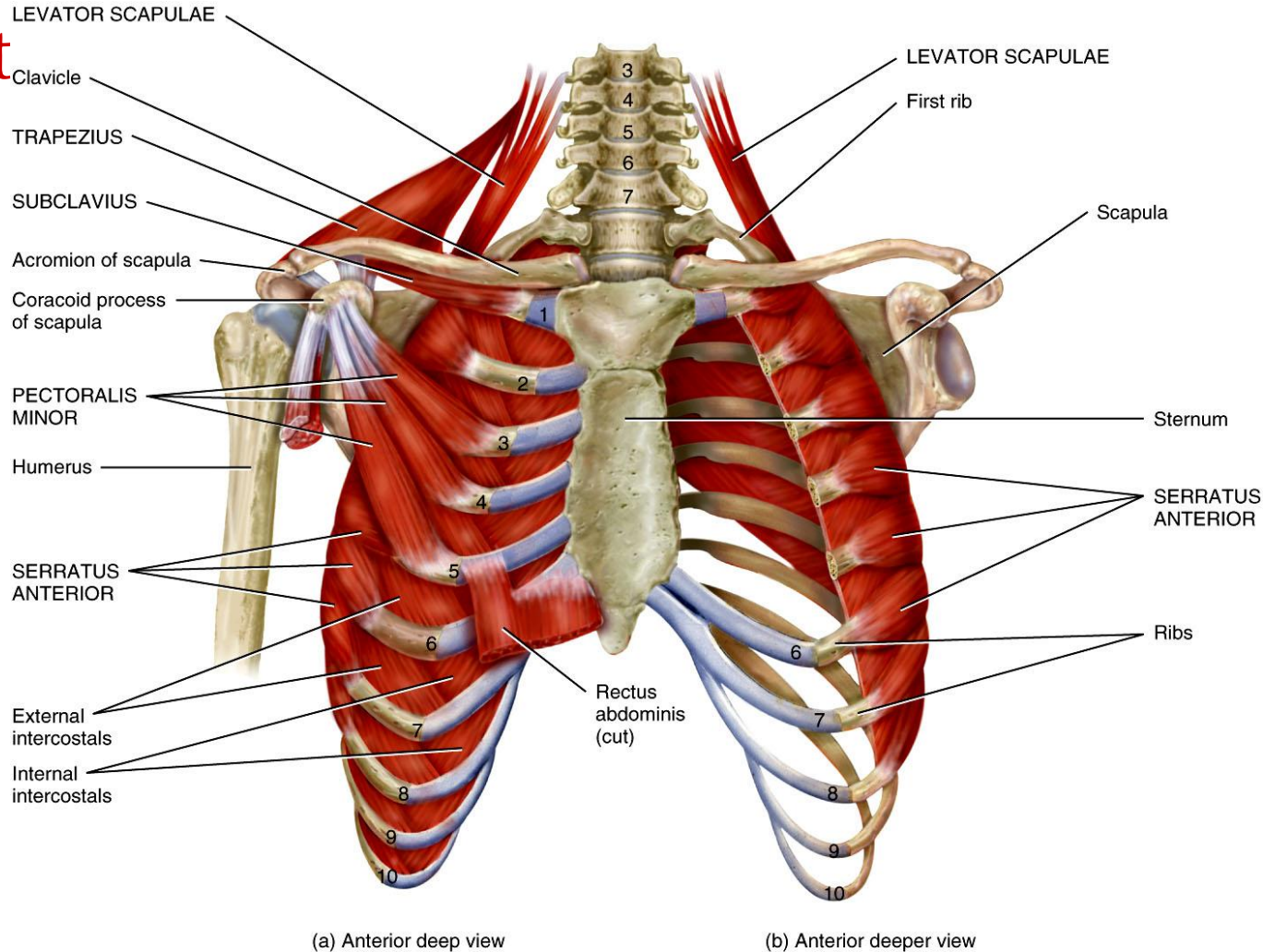


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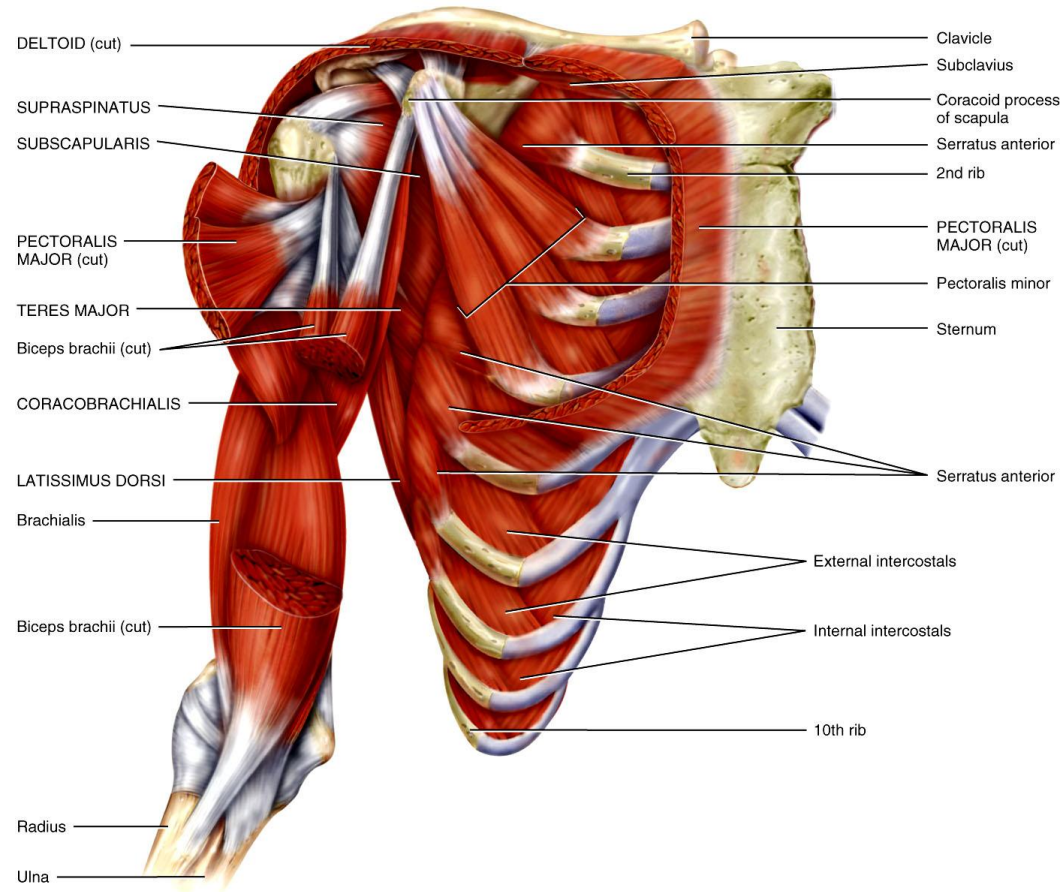
Muscles of the Thorax that Move the Pectoral Girdle

- Muscles that move the pectoral girdle must do so by stabilizing the scapula so it can function as a stable origin for the muscles that move the humerus.
- Scapular movements increase the range of motion of the humerus.
- Many humeral movements would not be possible without scapular movements accompanying those of the humerus (e.g., raising your arm above the head).

Muscles of the Thorax and Shoulder that move the Humerus

- Seven of nine muscles that cross the shoulder joint originate on the scapula, except the pectoralis major and latissimus dorsi.
- It is for this reason that the pectoralis major and latissimus dorsi are considered axial muscles.
- Four deep shoulder muscles strengthen and stabilize the shallow shoulder joint, and act to join the scapula to the humerus. They form the **rotator cuff**, a nearly complete circle of tendons around the shoulder joint, like the cuff on a shirtsleeve.

Muscles of the Thorax and Shoulder that move the Humerus



(a) Anterior deep view (the intact pectoralis major muscle is shown in figure 11.12a)

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Muscles of the Thorax that Move the Humerus

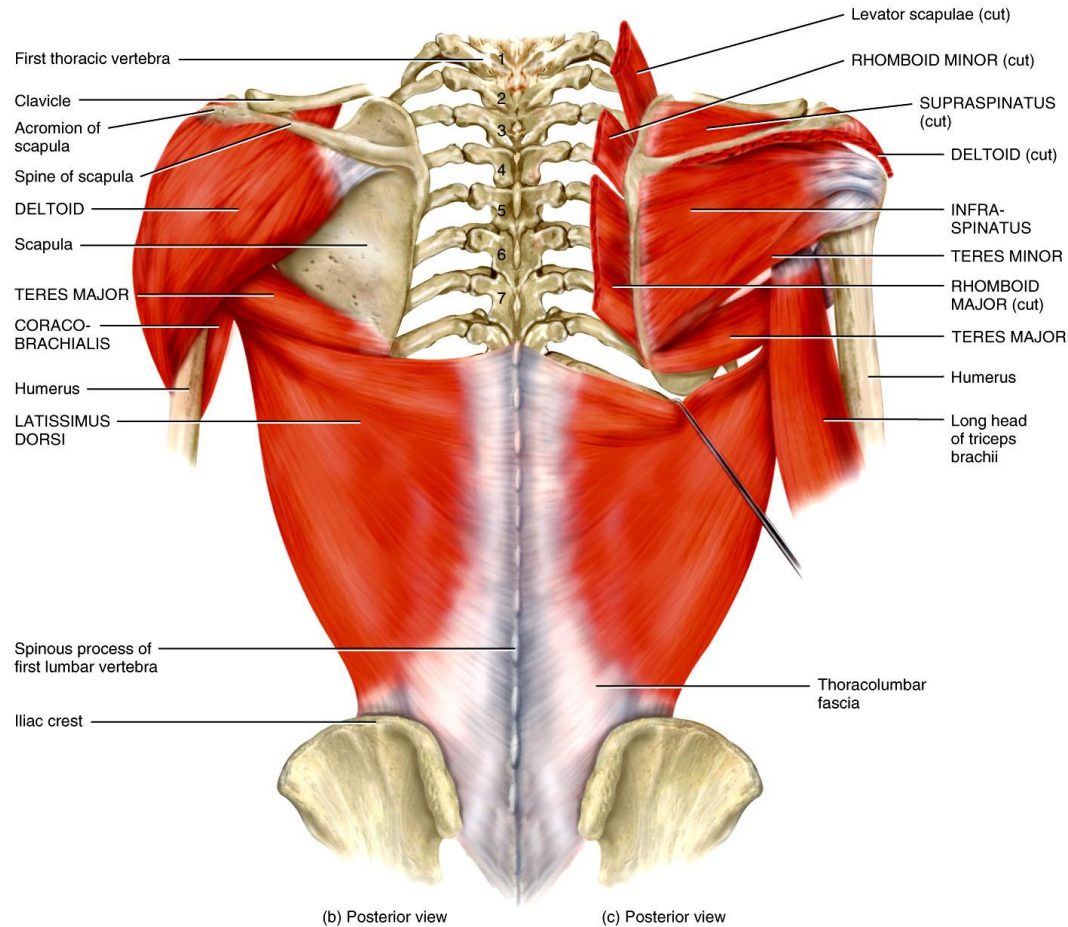


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Muscles of the Arm that Move the Radius and Ulna

- Most muscles that move the forearm cause flexion and extension at the elbow.
- The biceps brachii, brachialis, and brachioradialis are flexors. The extensors are the triceps brachii and the anconeus.
- Some muscles that move the forearm are involved in pronation and supination. The pronators are the **pronator teres** and **pronator quadratus**. Only the **supinator** can supinate. You use the powerful action of the supinator when you twist a corkscrew or turn a screw with a screwdriver.

Muscles of the Arm that Move the Radius and Ulna

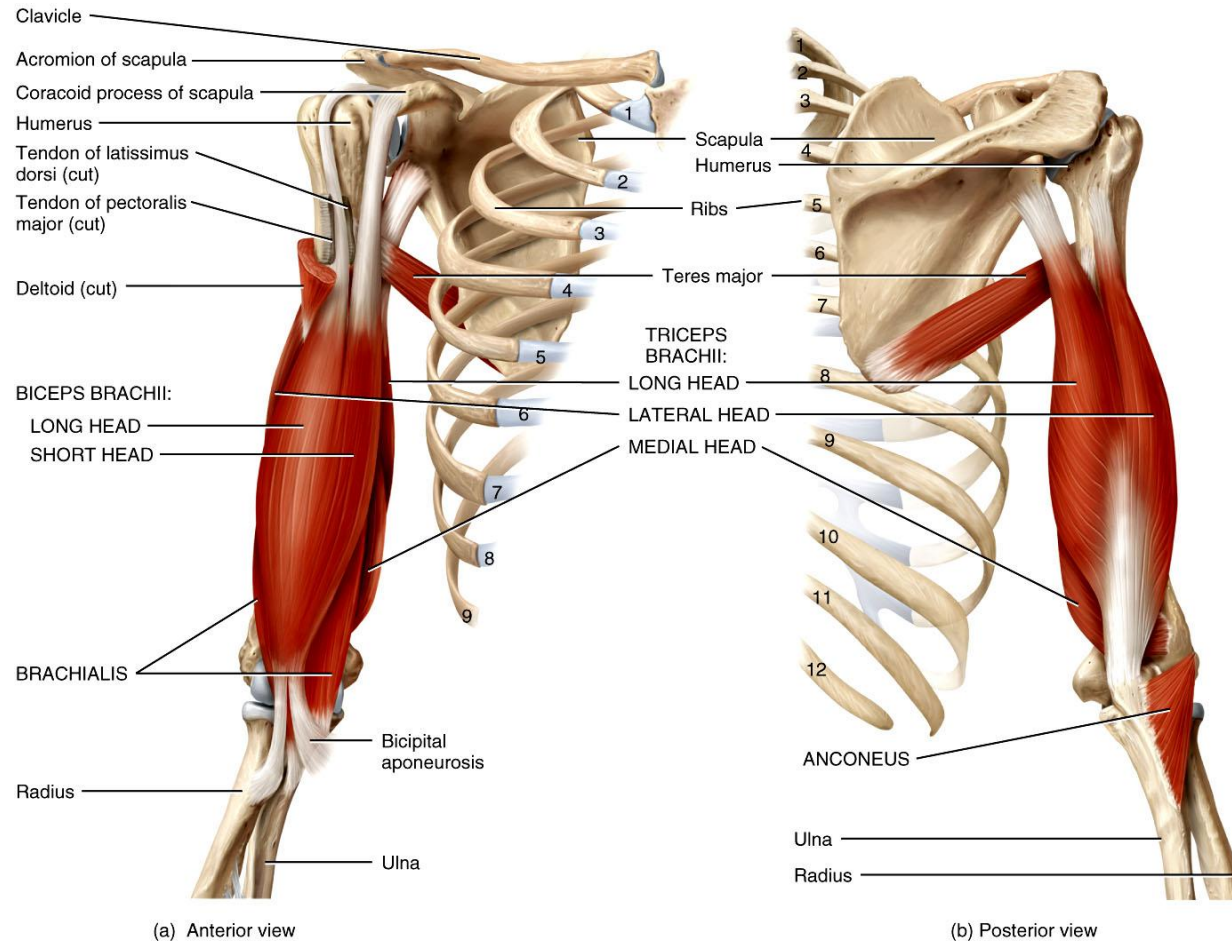


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Muscles of the Forearm that Move the Wrist, Hand, Thumb and Fingers

- Muscles in this group are known as **extrinsic muscles of the hand** because they originate *outside* the hand and *insert* within it.
- Based on location and function, these muscles are divided into an **anterior**, and a **posterior compartment** group.
- The tendons of these muscles that continue into the hand are held close to the bones by strong fascial bands called **retinacula**.

Muscles of the Forearm that Move the Wrist, Hand, Thumb and Fingers

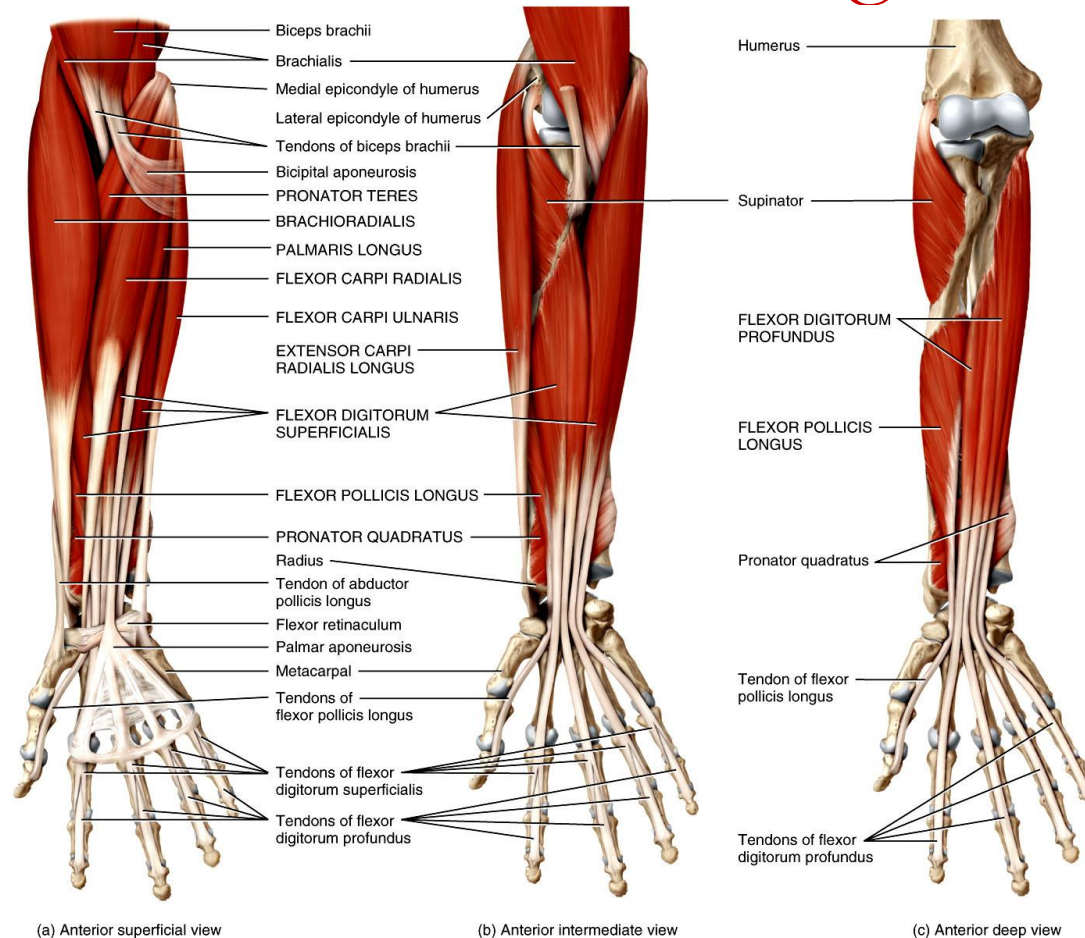


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Muscles of the Palm that Move the Digits: Intrinsic Muscles of the Hand

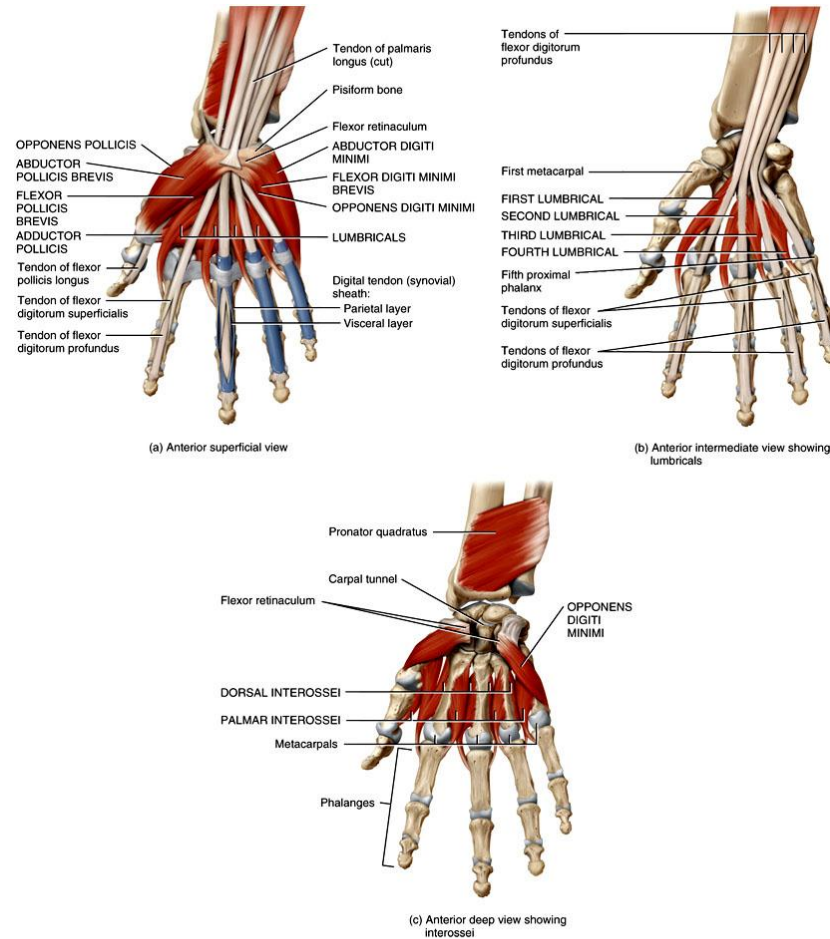


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Muscles of the Palm that Move the Digits: Intrinsic Muscles of the Hand

- **Intrinsic muscles of the hand** produce weak but precise movements.
- Intrinsic hand muscles are split into 3 groups: **thenar, hypothenar, & intermediate**.
 - The thenar muscles plus the adductor pollicis form the **thenar eminence**.
 - Hypothenar muscles act on the little finger and form the **hypothenar eminence**.
- Movements of the thumb are defined in different planes compared to other digits because the thumb is positioned at a right angle to the other digits.

Muscles of the Neck and Back that Move the Vertebral Column

- Muscles that move the backbone are quite complex having multiple origins/insertions with considerable overlap among them.
- One way to simplify this is to group muscles based on the general direction of the muscle bundles and their lengths.
- Many of these muscles are named for the position of the superior attachment site (e.g., splenius capitis is attached to the head).

Muscles of the Neck and Back that Move the Vertebral Column (continued)

- Splenius muscles extend the head, and laterally flex and rotate the head.
- **Erector spinae muscles** include iliocostalis, longissimus, and spinalis groups. They are mainly responsible for extension of the backbone, but also can effect flexion, lateral flexion, and rotation.
- The **transversospinales** are so named because their fibers run from the transverse processes to the spinous processes of the vertebrae.
 - The semispinalis muscles in this group are also named according to the region of the body with which they are associated.
 - These muscles extend the vertebral column and rotate the head.

Muscles of the Neck and Back that Move the Vertebral Column

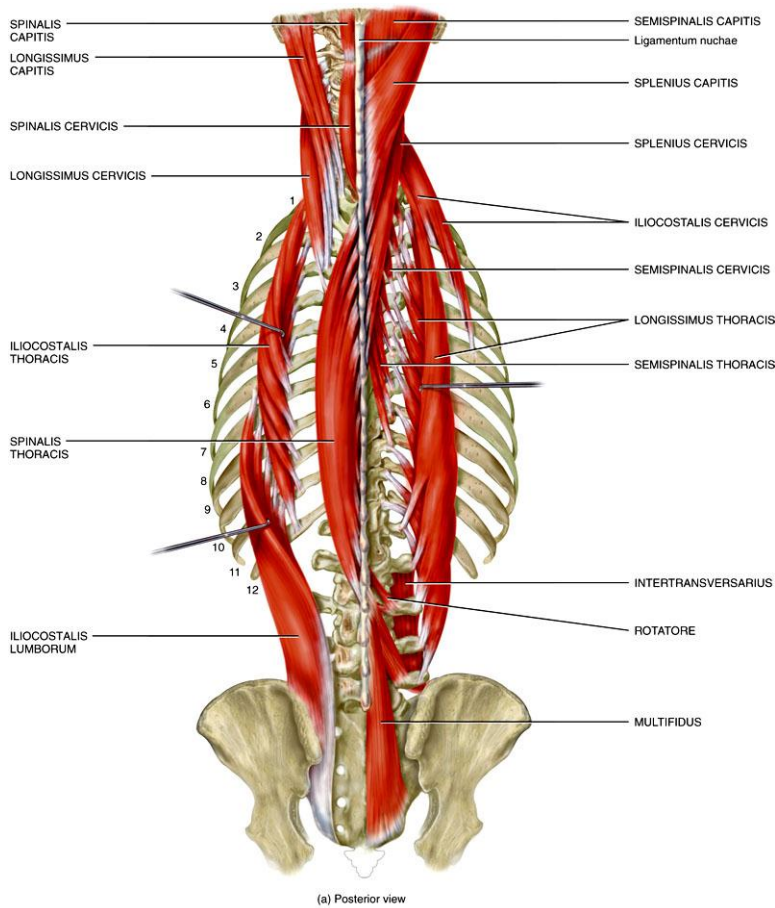


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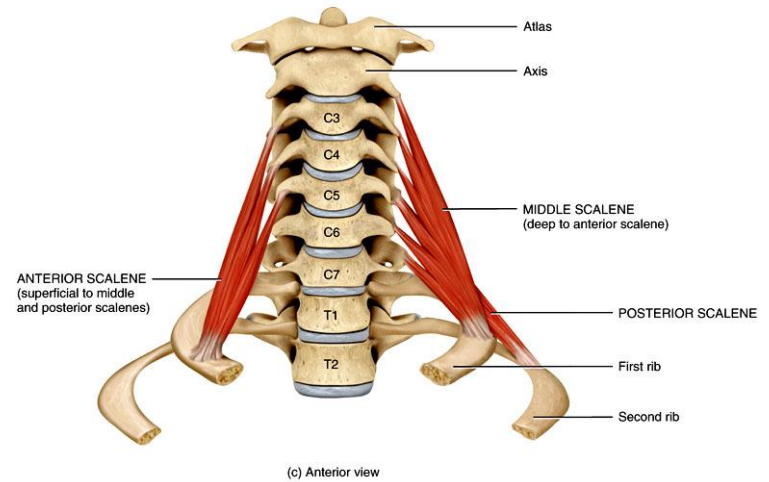
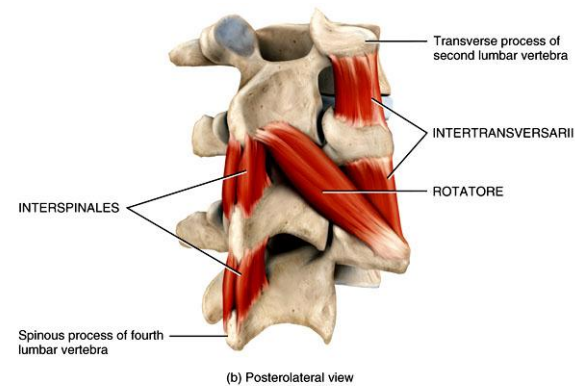
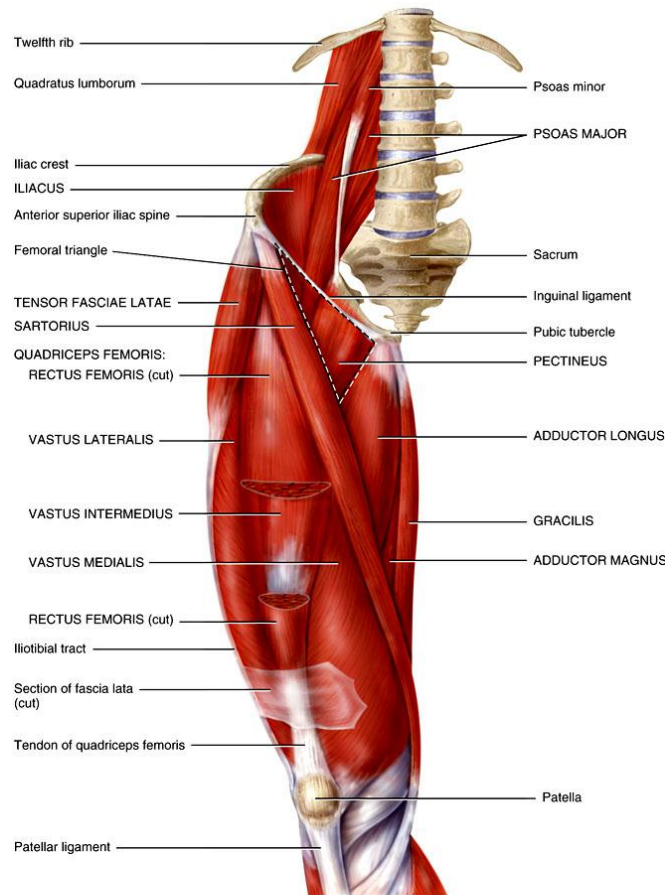


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Muscles of the Gluteal Region that Move the Femur

- Lower limb muscles function in stability, locomotion, and maintenance of posture. In contrast, upper limb muscles are characterized by versatility of movement.
- Muscles of the lower limbs often cross two joints and can act equally on both.
- Most muscles that move the femur originate on the pelvic girdle and insert on the femur.
- Major muscle groups that move the thigh include the gluteals, and adductor muscles.

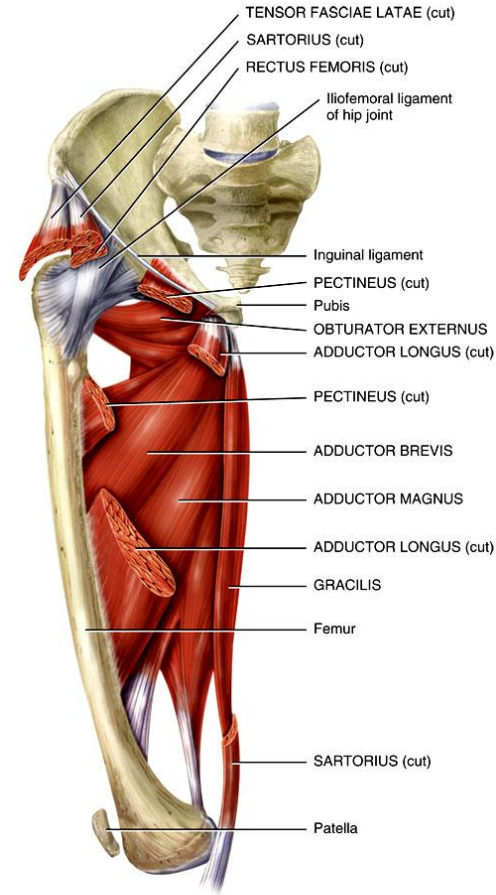
Muscles of the Gluteal Region that Move the Femur



(a) Anterior superficial view (the femoral triangle is indicated by a dashed line)

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(b) Anterior deep view (femur rotated laterally)

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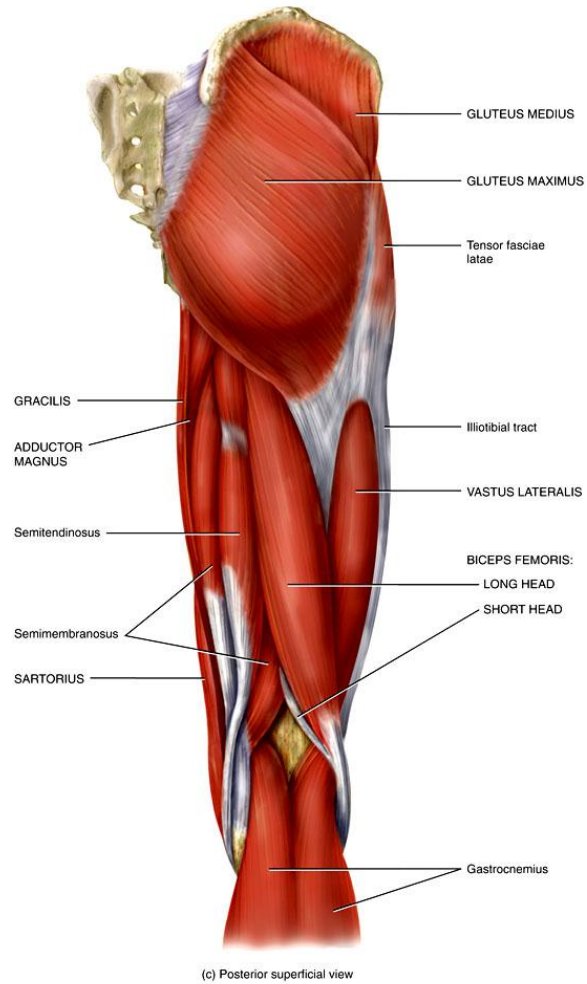


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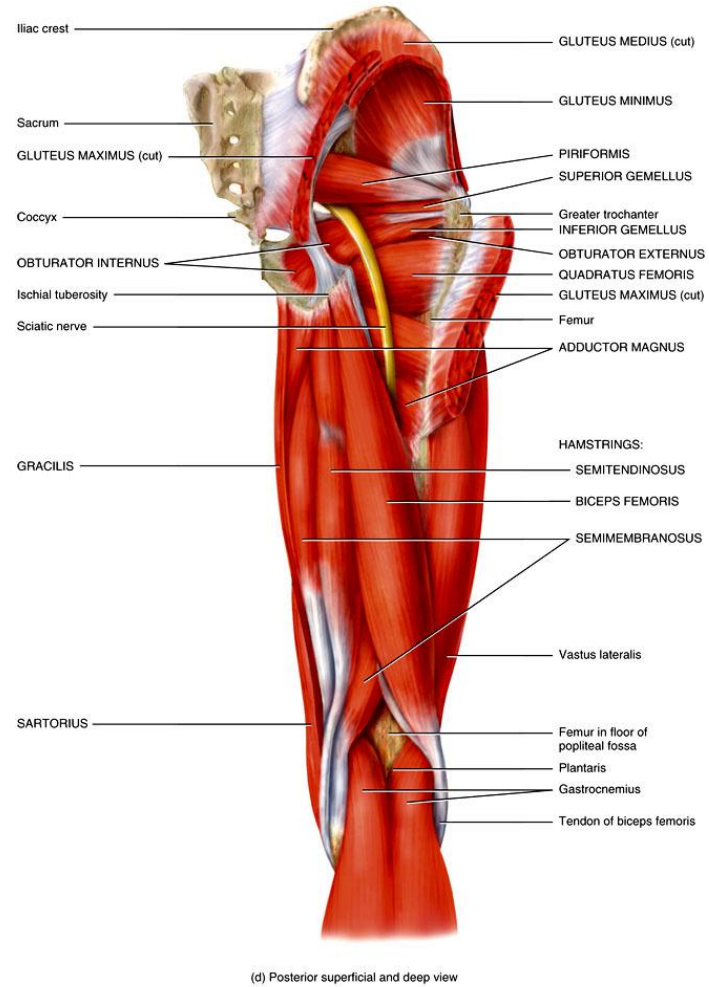


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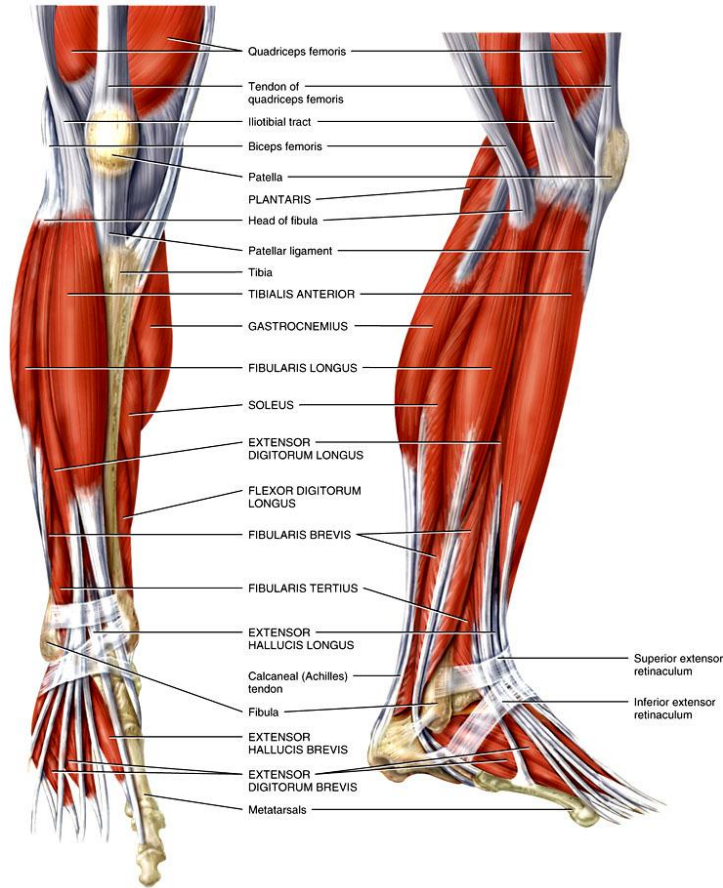
Muscles of the Thigh

- Deep fascia separate muscles that act on the femur, and tibia and fibula into medial, anterior, and posterior compartments.
 - **medial (adductor) compartment** of the thigh adduct the femur at the hip joint.
 - **anterior (extensor) compartment** of the thigh extend the leg (and flex the thigh).
 - **posterior (flexor) compartment** of the thigh flex the leg (and extend the thigh).

Muscles of the Leg that Move the Foot and Toes

- Leg muscles, like those of the thigh, are divided by deep fascia into three compartments: anterior, lateral, and posterior.
 - **Anterior compartment** muscles dorsiflex the foot.
 - **Lateral compartment** muscles plantar flex & evert the foot.
 - **Posterior compartment** muscles are split between superficial (e.g., gastrocnemius) and deep (e.g., tibialis posterior) groups. Superficial muscles share a common tendon of insertion, the **calcaneal tendon**.

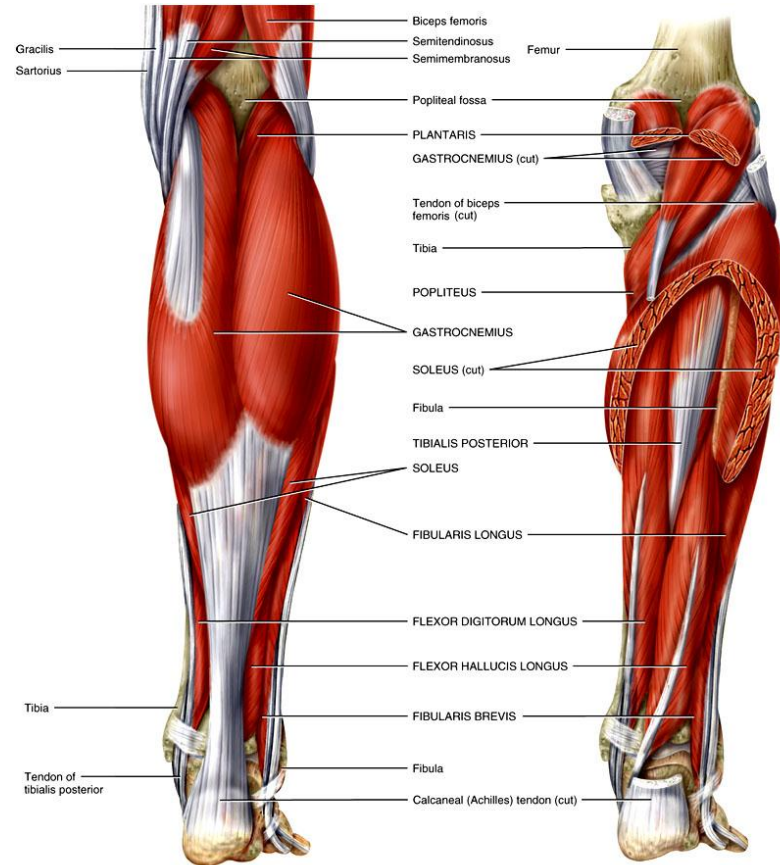
Muscles of the Leg that Move the Foot and Toes (Fig. 11.24)



(a) Anterior superficial view

(b) Right lateral superficial view

Figure 11.22ab Tortora - PAP 12/e
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(c) Posterior superficial view

(d) Posterior deep view

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Intrinsic Muscles of the Foot that Move the Toes

- These muscles are termed **intrinsic** because they originate & insert *within* the foot.
- These muscles are limited designed for support and locomotion, and are split into **dorsal** and **plantar groups**.
- There is only one dorsal muscle which extends toes 2–5 at the MTP joints.
- Plantar muscles are arranged in four layers with the most superficial of these called the first layer, etc.

Intrinsic Muscles of the Foot that Move the Toes (Fig. 11.25)

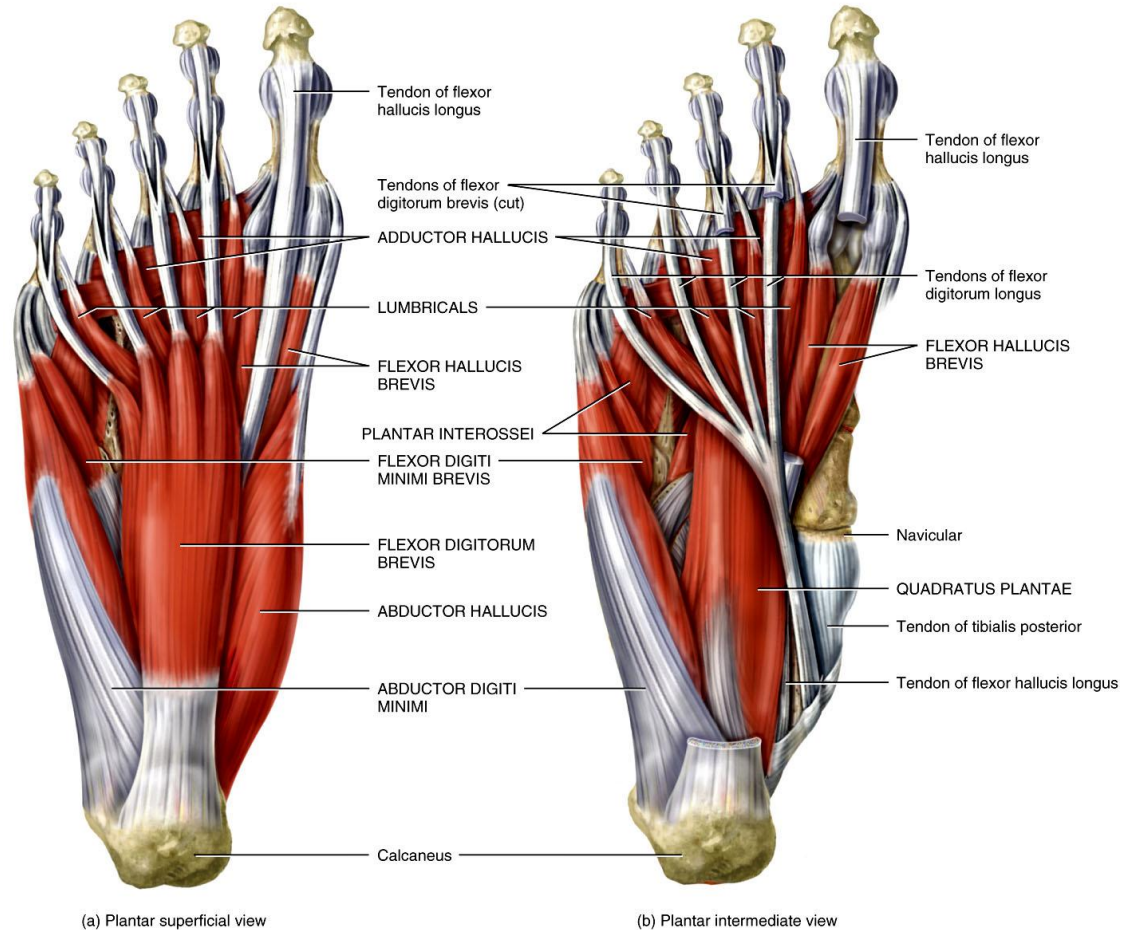


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End of Chapter 11

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