Interactions of Skeletal Muscles

- Skeletal muscles work together or in opposition
- Muscles only pull (never push)
- As muscles shorten, the insertion generally moves toward the origin
- Whatever a muscle (or group of muscles) does, another muscle (or group) "undoes"

Muscle Classification: Functional Groups

- Prime movers – provide the major force for producing a specific movement
- Antagonists – oppose or reverse a particular movement
- Synergists
  - Add force to a movement
  - Reduce undesirable or unnecessary movement
- Fixators – synergists that immobilize a bone or muscle's origin

Naming Skeletal Muscles

- Location of muscle – bone or body region associated with the muscle
- Shape of muscle – e.g., the deltoid muscle (deltoid = triangle)
- Relative size – e.g., maximus (largest), minimus (smallest), longus (long)
- Direction of fibers – e.g., rectus (fibers run straight), transversus, and oblique (fibers run at angles to an imaginary defined axis)

Naming Skeletal Muscles

- Number of origins – e.g., biceps (two origins) and triceps (three origins)
- Location of attachments – named according to point of origin or insertion
- Action – e.g., flexor or extensor, as in the names of muscles that flex or extend, respectively

Arrangement of Fascicles

- Parallel – fascicles run parallel to the long axis of the muscle (e.g., sartorius)
- Fusiform – spindle-shaped muscles (e.g., biceps brachii)

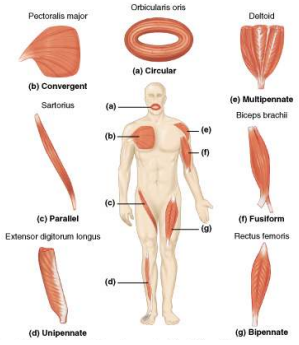


Figure 10.1

Arrangement of Fascicles

- Pennate – short fascicles that attach obliquely to a central tendon running the length of the muscle (e.g., rectus femoris)
- Convergent – fascicles converge from a broad origin to a single tendon insertion (e.g., pectoralis major)

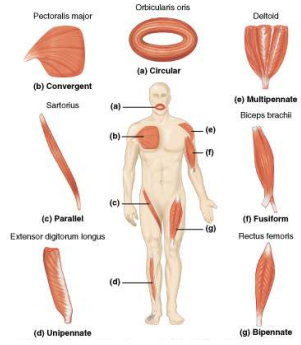


Figure 10.1

Arrangement of Fascicles

- Circular – fascicles are arranged in concentric rings (e.g., orbicularis oris)

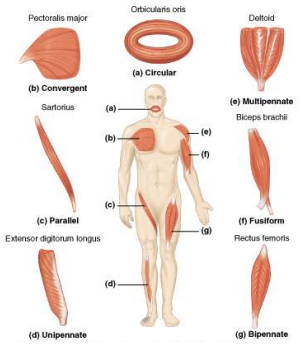


Figure 10.1

Bone-Muscle Relationships: Lever Systems

- Lever – a rigid bar that moves on a fulcrum, or fixed point
- Effort – force applied to a lever
- Load – resistance moved by the effort

Bone-Muscle Relationships: Lever Systems

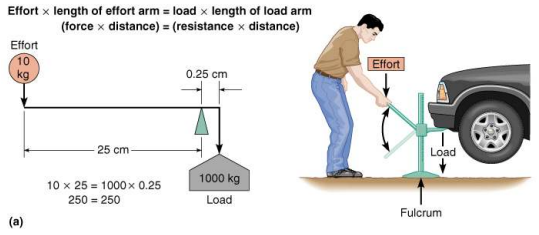


Figure 10.2a

Bone-Muscle Relationships: Lever Systems

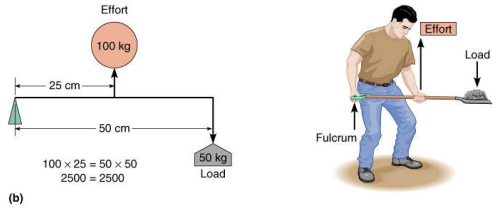


Figure 10.2b

Lever Systems: Classes

- First class – the fulcrum is between the load and the effort
- Second class – the load is between the fulcrum and the effort
- Third class – the effort is applied between the fulcrum and the load

Lever Systems: Classes

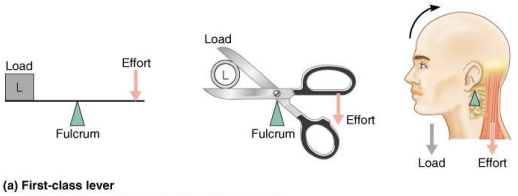
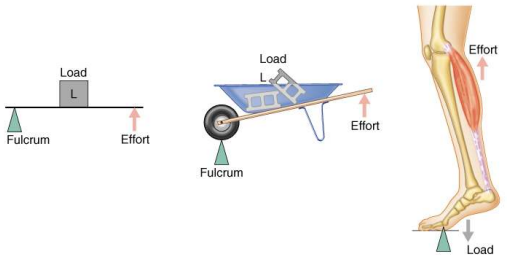


Figure 10.3a

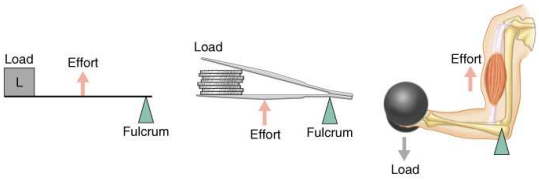
Lever Systems: Classes



(b) Second-class lever

Figure 10.3b

Lever Systems: Classes



(c) Third-class lever

Figure 10.3c

Major Skeletal Muscles: Anterior View

- The 40 superficial muscles here are divided into 12 regional areas of the body

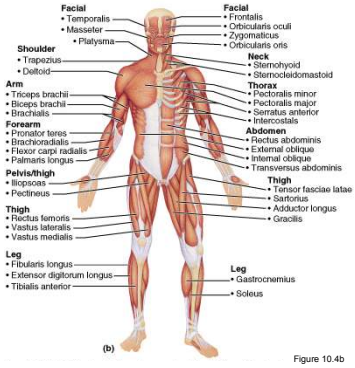


Figure 10.4b

Major Skeletal Muscles: Posterior View

- The 27 superficial muscles here are divided into seven regional areas of the body

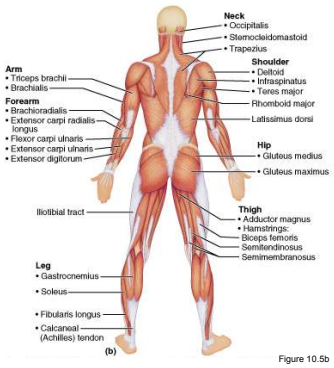


Figure 10.5b

Muscles: Name, Action, and Innervation

- Name and description of the muscle – be alert to information given in the name
- Origin and insertion – there is always a joint between the origin and insertion
- Action – best learned by acting out a muscle's movement on one's own body
- Nerve supply – name of major nerve that innervates the muscle

Muscles of the Scalp

- Epicranius (occipitofrontalis) – bipartite muscle consisting of the:
  - Frontalis
  - Occipitalis
  - Galea aponeurotica – cranial aponeurosis connecting above muscles
- These two muscles have alternate actions of pulling the scalp forward and backward

Muscles of the Face

- 11 muscles are involved in lifting the eyebrows, flaring the nostrils, opening and closing the eyes and mouth, and smiling
- All are innervated by cranial nerve VII (facial nerve)
- Usually insert in skin (rather than bone), and adjacent muscles often fuse

Muscles of the Face

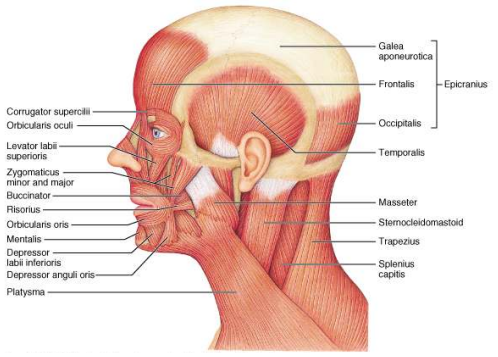


Figure 10.6

Muscles of Mastication

- There are four pairs of muscles involved in mastication:
  - Prime movers – temporalis and masseter
  - Grinding movements – pterygoids and buccinators
- All are innervated by cranial nerve V (trigeminal nerve)

Muscles of Mastication

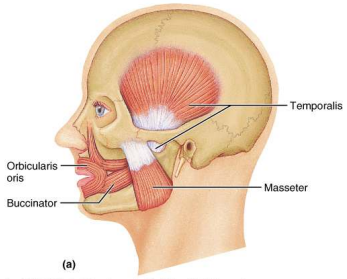


Figure 10.7a

Muscles of Mastication

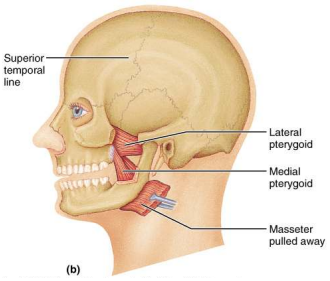


Figure 10.7b

Extrinsic Tongue Muscles

- Three major muscles that anchor and move the tongue
- All are innervated by cranial nerve XII (hypoglossal nerve)

Extrinsic Tongue Muscles

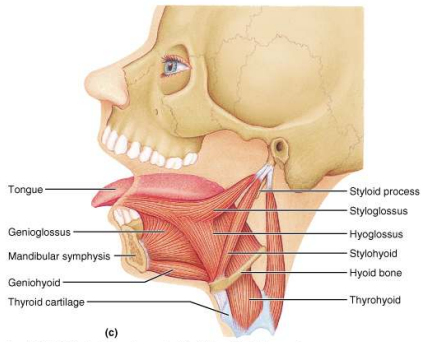


Figure 10.7c

Muscles of the Anterior Neck and Throat: Suprahyoid

- These four deep throat muscles form the floor of the oral cavity, anchor the tongue, elevate the hyoid, and move the larynx superiorly during swallowing

Muscles of the Anterior Neck and Throat: Suprahyoid

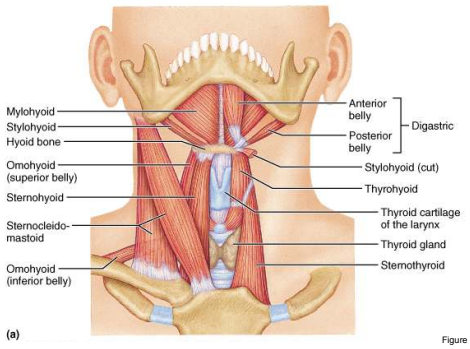


Figure 10.8a

Muscles of the Anterior Neck and Throat: Infrahyoid

- Straplike muscles that depress the hyoid and larynx during swallowing and speaking

Muscles of the Anterior Neck and Throat: Infrahyoid

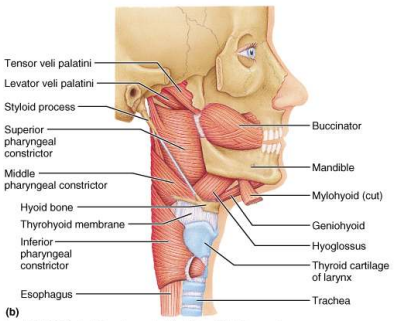


Figure 10.8b

Muscles of the Neck: Head Movements

- Major head flexor is the sternocleidomastoid
- Synergists to head flexion are the suprahyoid and infrahyoid
- Lateral head movements are accomplished by the sternocleidomastoid and the scalene muscles
- Head extension is accomplished by the deep splenius muscles and aided by the superficial trapezius

Muscles of the Neck: Head Movements

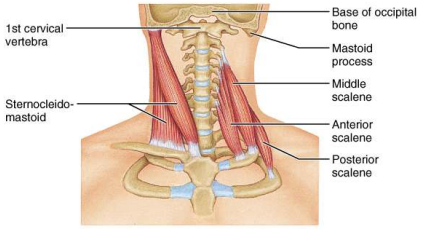


Figure 10.9a

Muscles of the Neck: Head Movements

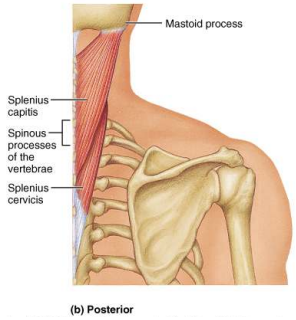


Figure 10.9b

Trunk Movements: Deep Back Muscles

- The prime mover of back extension is the erector spinae
- Erector spinae, or sacrospinalis, muscles consist of three columns on each side of the vertebrae – iliocostalis, longissimus, and spinalis
- Lateral bending of the back is accomplished by unilateral contraction of these muscles
- Other deep back extensors include the semispinalis muscles and the quadratus lumborum

Trunk Movements: Deep Back Muscles

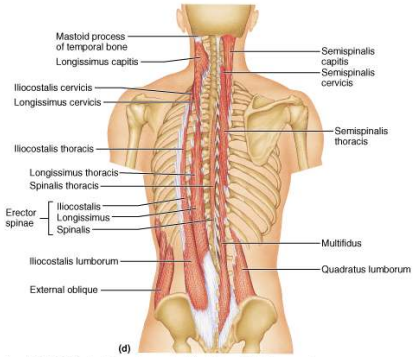


Figure 10.9d

Trunk Movements: Short Muscles

- Four short muscles extend from one vertebra to another
- These muscles are synergists in extension and rotation of the spine

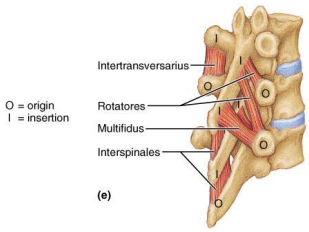


Figure 10.9e

Muscles of the Thorax: Breathing

- The primary function of deep thoracic muscles is to promote movement for breathing
- External intercostals – more superficial layer that lifts the rib cage and increases thoracic volume to allow inspiration

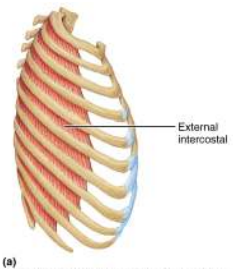


Figure 10.10a

Muscles of the Thorax: Breathing

- Internal intercostals – deeper layer that aids in forced expiration
- Diaphragm – most important muscle in inspiration

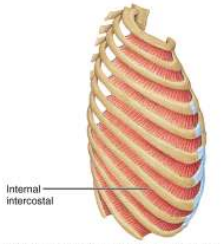


Figure 10.10a

Muscles of the Thorax: Breathing

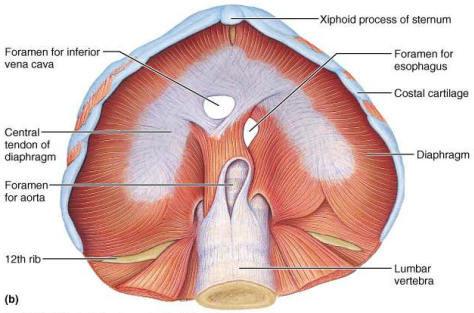


Figure 10.10b

Muscles of the Abdominal Wall

- The abdominal wall is composed of four paired muscles (internal and external obliques, transversus abdominis, and rectus abdominis), their fasciae, and their aponeuroses
- Fascicles of these muscles run at right and oblique angles to one another, giving the abdominal wall added strength

Muscles of the Abdominal Wall

- In addition to forming the abdominal wall, these muscles:
  - Are involved with lateral flexion and rotation of the trunk
  - Help promote urination, defecation, childbirth, vomiting, coughing, and screaming

Muscles of the Abdominal Wall

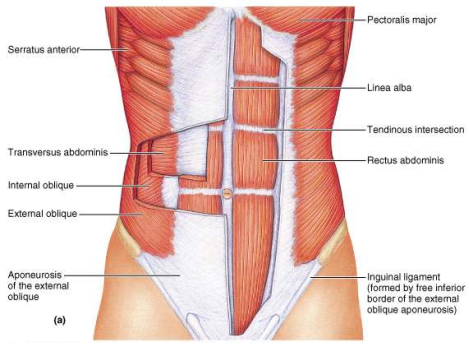


Figure 10.11a

Muscles of the Abdominal Wall

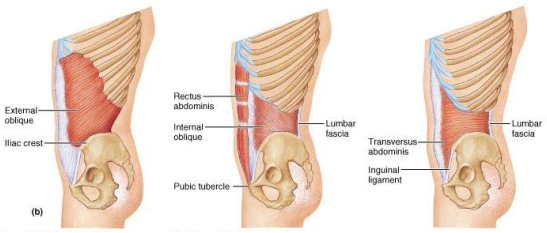


Figure 10.11b

Muscles of the Abdominal Wall

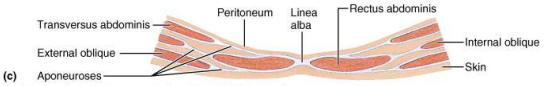


Figure 10.11c

Muscles of the Pelvic Floor (Pelvic Diaphragm)

- The pelvic diaphragm is composed of two paired muscles – levator ani and coccygeus
- These muscles:
  - Close the inferior outlet of the pelvis
  - Support the pelvic floor
  - Elevate the pelvic floor to help release feces
  - Resist increased intra-abdominal pressure

Muscles of the Pelvic Floor (Pelvic Diaphragm)

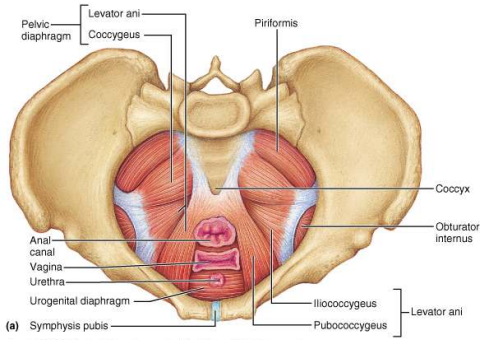


Figure 10.12a

Muscles Inferior to the Pelvic Floor

- Two sphincter muscles allow voluntary control of urination (sphincter urethrae) and defecation (external anal sphincter)
- The ischiocavernosus and bulbospongiosus assist in erection of the penis and clitoris

Muscles Inferior to the Pelvic Floor

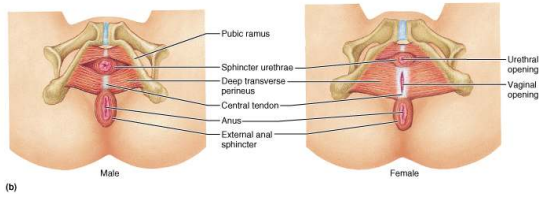


Figure 10.12b

Muscles Inferior to the Pelvic Floor

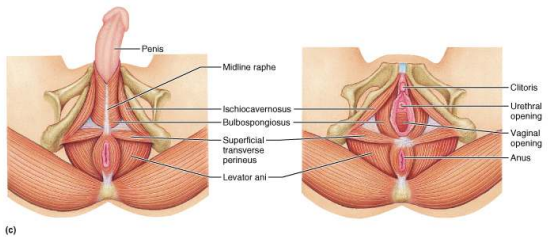


Figure 10.12c

Extrinsic Shoulder Muscles

- Muscles of the thorax
  - Anterior: pectoralis major, pectoralis minor, serratus anterior, and subclavius
  - Posterior: latissimus dorsi, trapezius muscles, levator scapulae, and rhomboids
  - These muscles are involved with the movements of the scapula including elevation, depression, rotation, and lateral and medial movements
- Prime movers of shoulder elevation are the trapezius and levator scapulae

Extrinsic Shoulder Muscles

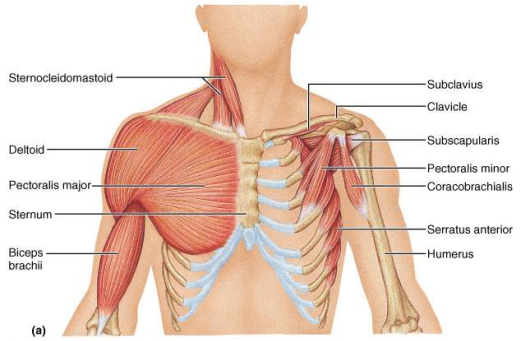


Figure 10.13a

Extrinsic Shoulder Muscles

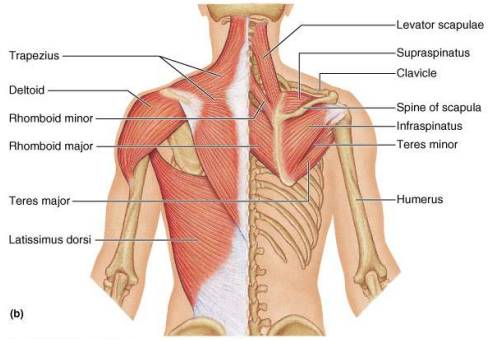


Figure 10.13b

Chapter 10

The Muscular System

Part F

Muscles Crossing the Shoulder

- Nine muscles cross the shoulder joint and insert into the humerus
- Prime movers include:
  - Pectoralis major – arm flexion
  - Latissimus dorsi and posterior fibers of the deltoid – arm extension
  - Middle fibers of the deltoid – arm abduction

Muscles Crossing the Shoulder

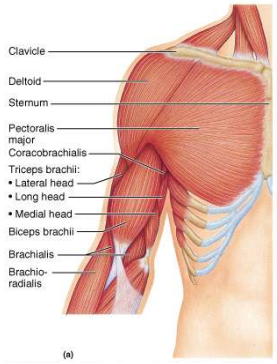


Figure 10.14a

Muscles Crossing the Shoulder

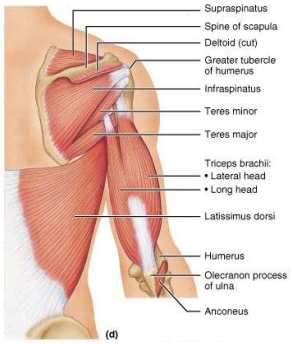


Figure 10.14d

Muscles Crossing the Shoulder

- Rotator cuff muscles – supraspinatus, infraspinatus, teres minor, and subscapularis
  - Function mainly to reinforce the capsule of the shoulder
  - Secondarily act as synergists and fixators
- The coracobrachialis and teres major:
  - Act as synergists
  - Do *not* contribute to reinforcement of the shoulder joint

Muscles Crossing the Shoulder

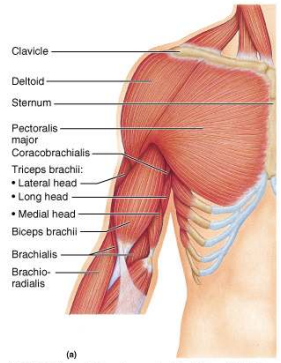


Figure 10.14a

Muscles Crossing the Shoulder

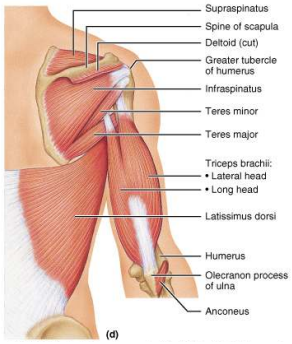


Figure 10.14d

Muscles Crossing the Shoulder

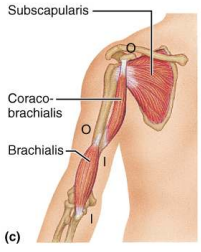


Figure 10.14c

Muscles Crossing the Elbow

- Forearm extension
  - The triceps brachii is the prime mover of forearm extension
  - The anconeus is a weak synergist
- Forearm flexion
  - Brachialis and biceps brachii are the chief forearm flexion
  - The brachioradialis acts as a synergist and helps stabilize the elbow

Muscles of the Forearm

- Two functional groups: those that cause wrist movement, and those that move the fingers and the thumb
- These muscles insert via strong ligaments called *flexor* and *extensor retinacula*
- Most anterior muscles are flexors, and posterior muscles are extensors
- The pronator teres and pronator quadratus are not flexors, but pronate the forearm
- The supinator muscle is a synergist with the biceps brachii in supinating the forearm

Muscles of the Forearm: Anterior Compartment

- These muscles are primarily flexors of the wrist and fingers

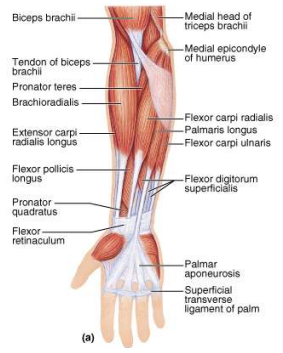


Figure 10.15a

Muscles of the Forearm: Anterior Compartment

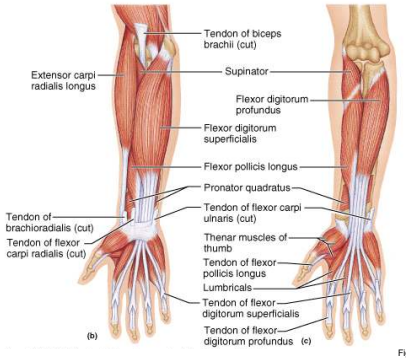


Figure 10.15 b, c

Muscles of the Forearm: Posterior Compartment

- These muscles are primarily extensors of the wrist and fingers

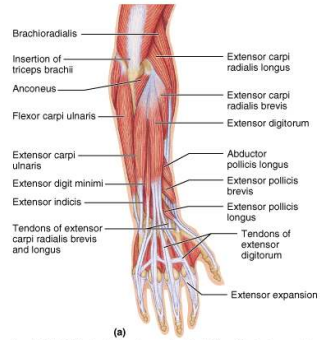


Figure 10.16a

Muscles of the Forearm: Posterior Compartment

- These muscles are primarily extensors of the wrist and fingers

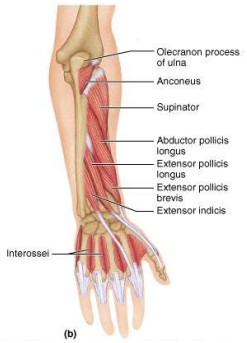


Figure 10.16b

Muscle Action of the Brachium: Summary

- The posterior extensor and anterior flexor muscles are shown

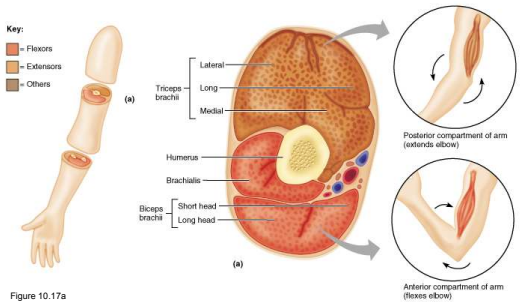


Figure 10.17a

Muscle Action of the Forearm: Summary

- Posterior extensors of the wrist and fingers, and anterior flexor muscles are shown

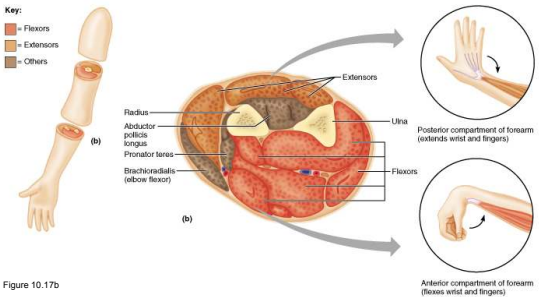


Figure 10.17b

Intrinsic Muscles of the Hand

- These small muscles:
  - Lie in the palm of the hand (none on the dorsal side)
  - Move the metacarpals and fingers
  - Control precise movements (e.g., threading a needle)
  - Are the main abductors and adductors of the fingers
  - Produce opposition – move the thumb toward the little finger

Intrinsic Muscles of the Hand

Figure 10.18a

Intrinsic Muscles of the Hand

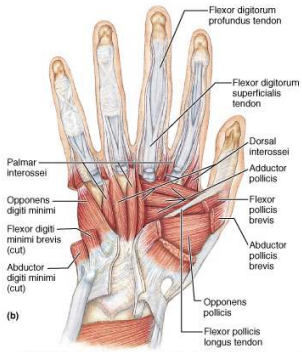


Figure 10.18b

Finger and Thumb Movements

- Flexion
  - Thumb – bends medially along the palm
  - Fingers – bend anteriorly
- Extension
  - Thumb – points laterally
  - Fingers – move posteriorly

Intrinsic Muscles of the Hand: Groups

- There are three groups of intrinsic hand muscles
- The thenar eminence (ball of the thumb) and hypothenar eminence (ball of the little finger) – each have a flexor, an abductor, and an opponens muscle
- The midpalm muscles, the lumbricals and interossei, extend the fingers
- The interossei also abduct and adduct the fingers

Intrinsic Muscles of the Hand: Groups

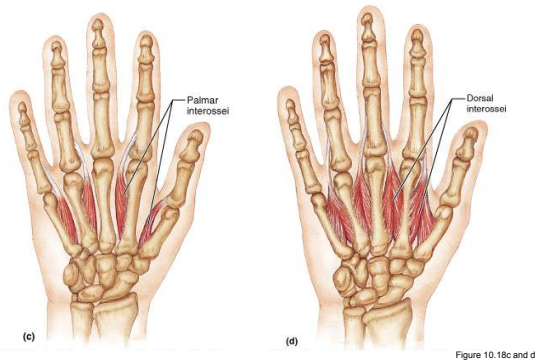


Figure 10.18c and d

Muscles Crossing Hip and Knee Joints

- Most anterior compartment muscles of the hip and thigh flex the femur at the hip and extend the leg at the knee
- Posterior compartment muscles of the hip and thigh extend the thigh and flex the leg
- The medial compartment muscles all adduct the thigh
- These three groups are enclosed by the fascia lata

Movements of the Thigh at the Hip: Flexion and Extension

- The ball-and-socket hip joint permits flexion, extension, abduction, adduction, circumduction, and rotation
- The most important thigh flexors are the iliopsoas (prime mover), tensor fasciae latae, and rectus femoris
- The medially located adductor muscles and sartorius assist in thigh flexion
- Thigh extension is primarily effected by the hamstring muscles (biceps femoris, semitendinosus, and semimembranosus)
- Forceful extension is aided by the gluteus maximus

Movements of the Thigh at the Hip: Flexion and Extension

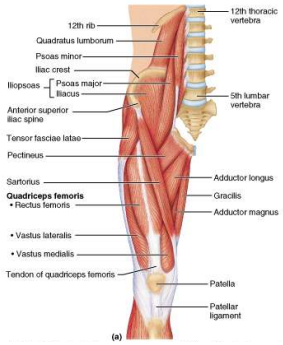


Figure 10.19a

Movements of the Thigh at the Hip: Flexion and Extension

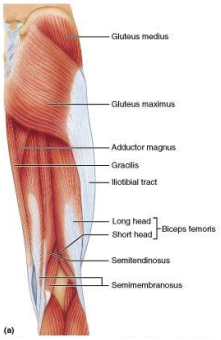


Figure 10.20a

Movements of the Thigh at the Hip: Other Movements

- Abduction and rotation are effected by the gluteus medius and minimus, and are antagonized by the lateral rotators
- Thigh adduction is the role of five adductor muscles (adductor magnus, longus, and brevis; the pectineus, and the gracilis)

Movements of the Thigh at the Hip: Other Movements

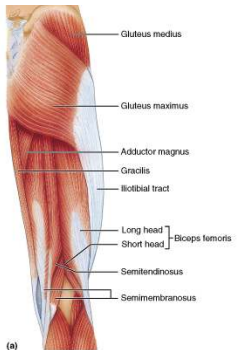


Figure 10.20a

Movements of the Thigh at the Hip: Other Movements

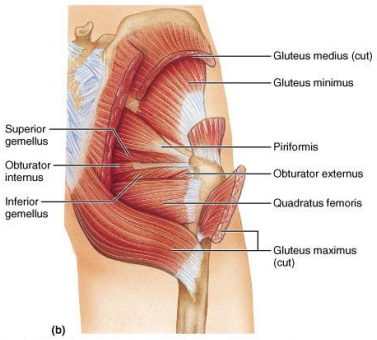


Figure 10.20b

Movements of the Knee Joint

- The sole extensor of the knee is the quadriceps femoris
- The hamstring muscles flex the knee, and are antagonists to the quadriceps femoris

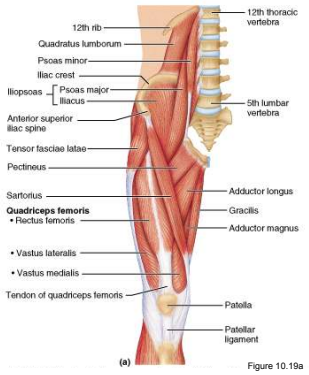


Figure 10.19a

Fascia of the Leg

- A deep fascia of the leg is continuous with the fascia lata
- This fascia segregates the leg into three compartments: anterior, lateral, and posterior
- Distally, the fascia thickens and forms the flexor, extensor, and fibular retinaculae

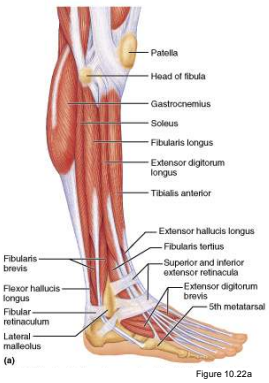


Figure 10.22a

Muscles of the Leg: Movements

- Various leg muscles produce the following movements at the:
  - Ankle – dorsiflexion and plantar flexion
  - Intertarsal joints – inversion and eversion of the foot
  - Toes – flexion and extension

Muscles of the Anterior Compartment

- These muscles are the primary toe extensors and ankle dorsiflexors
- They include the tibialis anterior, extensor digitorum longus, extensor hallucis longus, and fibularis tertius

Figure 10.21a

Muscles of the Anterior Compartment

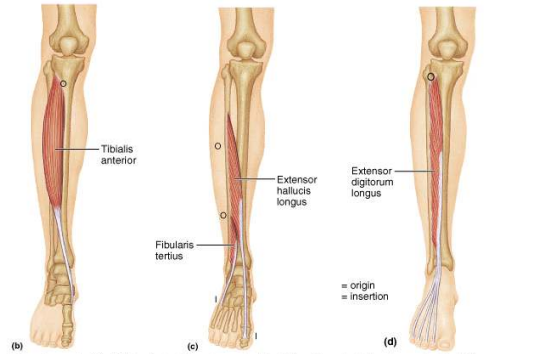


Figure 10.21b-d

Muscles of the Lateral Compartment

- These muscles plantar flex and evert the foot
- They include the fibularis longus and fibularis brevis muscles

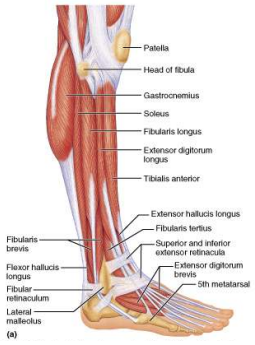


Figure 10.22a

Muscles of the Lateral Compartment

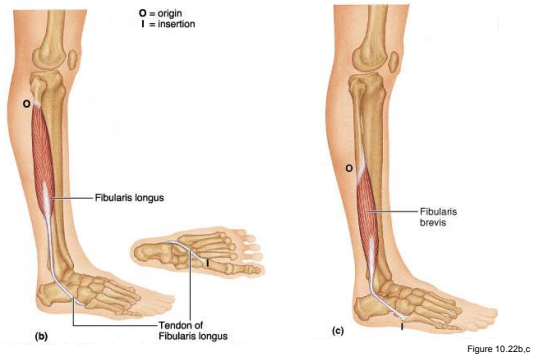


Figure 10.22b,c

Muscles of the Posterior Compartment

- These muscles primarily flex the foot and the toes
- They include the gastrocnemius, soleus, tibialis posterior, flexor digitorum longus, and flexor hallucis longus

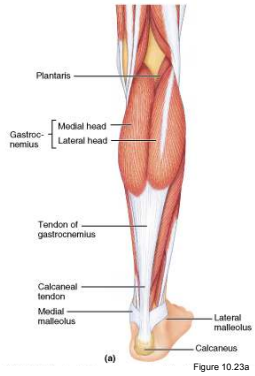


Figure 10.23a

Muscles of the Posterior Compartment

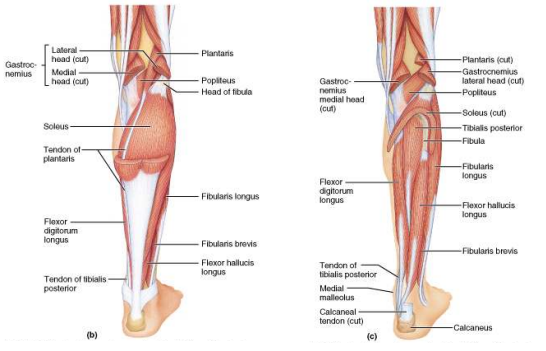


Figure 10.23b, c

Muscles of the Posterior Compartment

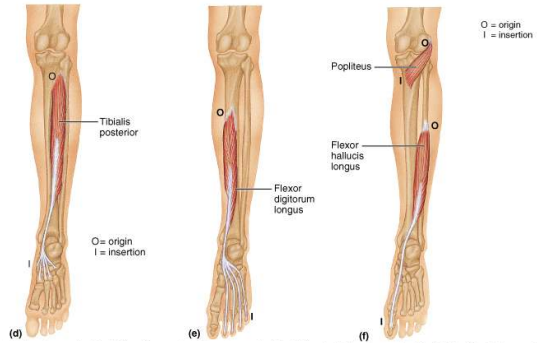


Figure 10.23d-f

Muscle Actions of the Thigh: Summary

- These muscles:
  - Flex and extend the thigh (posterior compartment)
  - Extend the leg (anterior compartment)
  - Adduct the thigh (medial compartment)

Muscle Actions of the Thigh: Summary

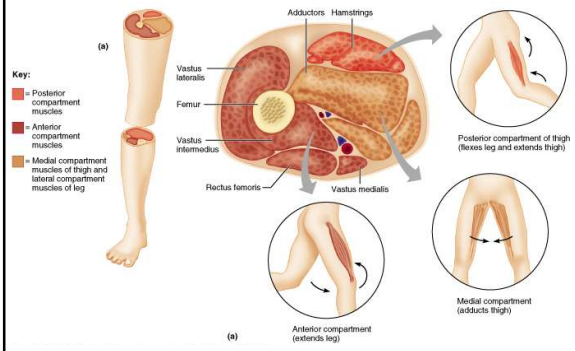


Figure 10.24a

Muscle Actions of the Leg: Summary

- These muscles:
  - Plantar flex and evert the foot (lateral compartment)
  - Plantar flex the foot and flex the toes (posterior compartment)
  - Dorsiflex the foot and extend the toes (anterior compartment)

Muscle Actions of the Leg: Summary

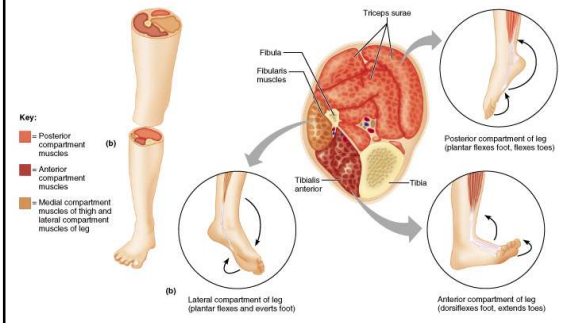


Figure 10.24b

Intrinsic Muscles of the Foot

- These muscles help flex, extend, abduct, and adduct the toes
- In addition, along with some leg tendons, they support the arch of the foot
- There is a single dorsal foot muscle, the extensor digitorum brevis, which extends the toes
- The plantar muscles occur in four layers

Plantar Muscles: First Layer (Superficial)

- Superficial muscles of the plantar aspect of the foot
- These muscles are similar to the corresponding muscles of the hand

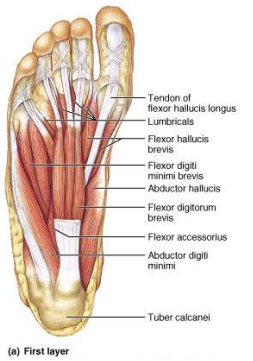
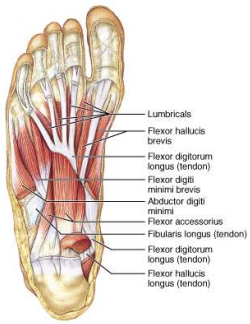


Figure 10.25a

Plantar Muscles: Second Layer



(b) Second layer

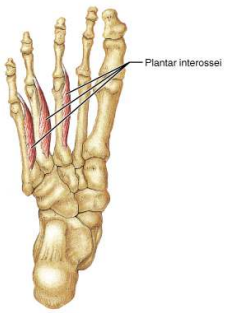
Figure 10.25b

Plantar Muscles: Third Layer

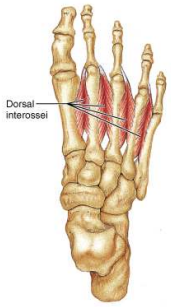
(d) Third layer

Figure 10.25d

Plantar Muscles: Fourth Layer (Deepest)



(e) Fourth layer: plantar interossei



(f) Fourth layer: dorsal interossei

Figure 10.25e, f