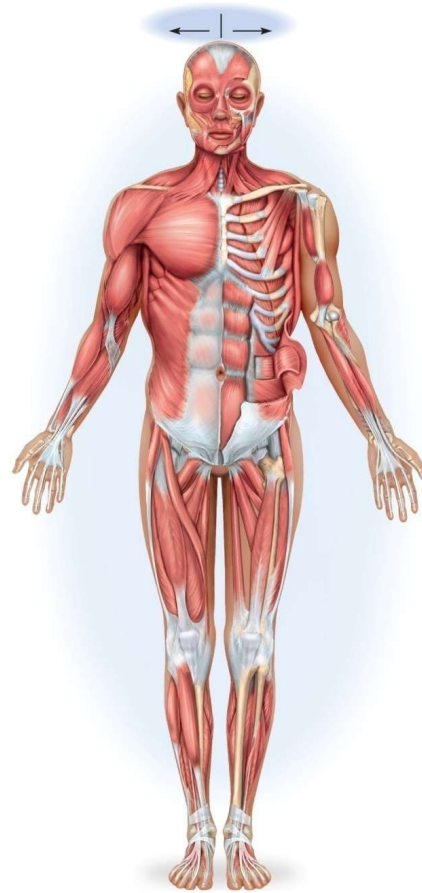
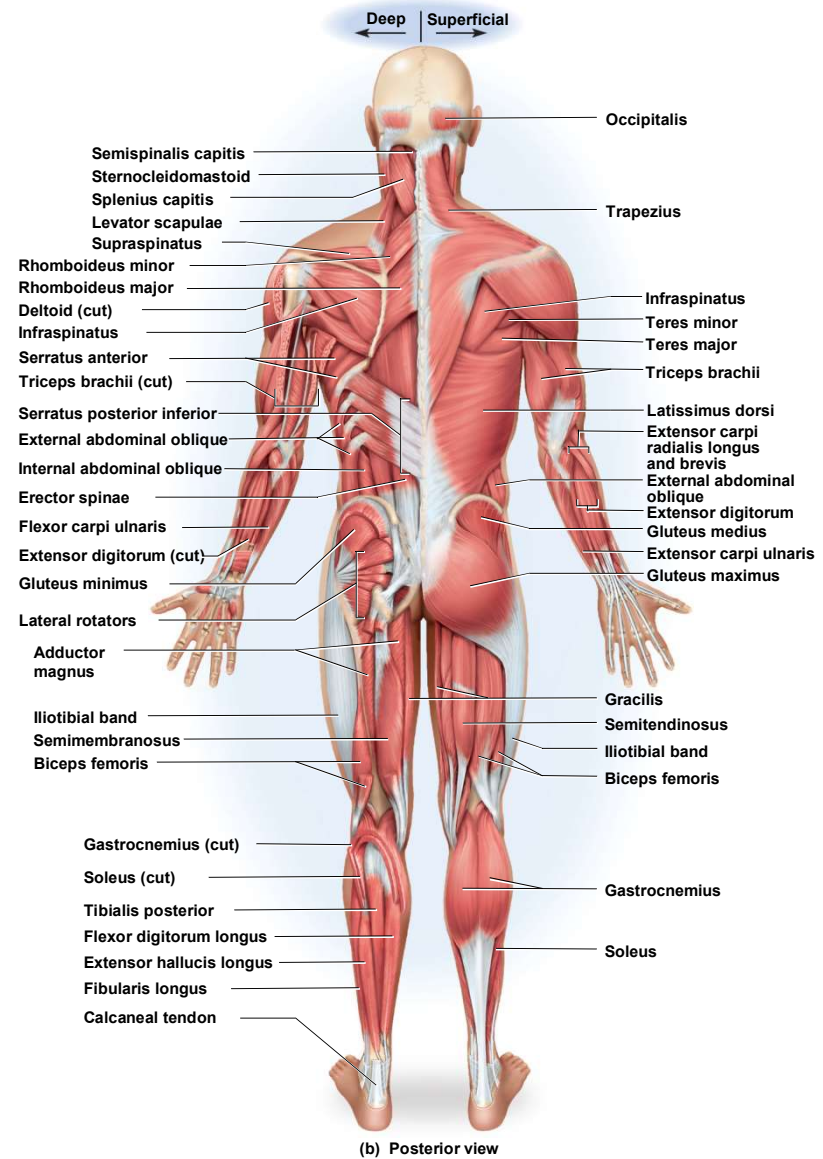
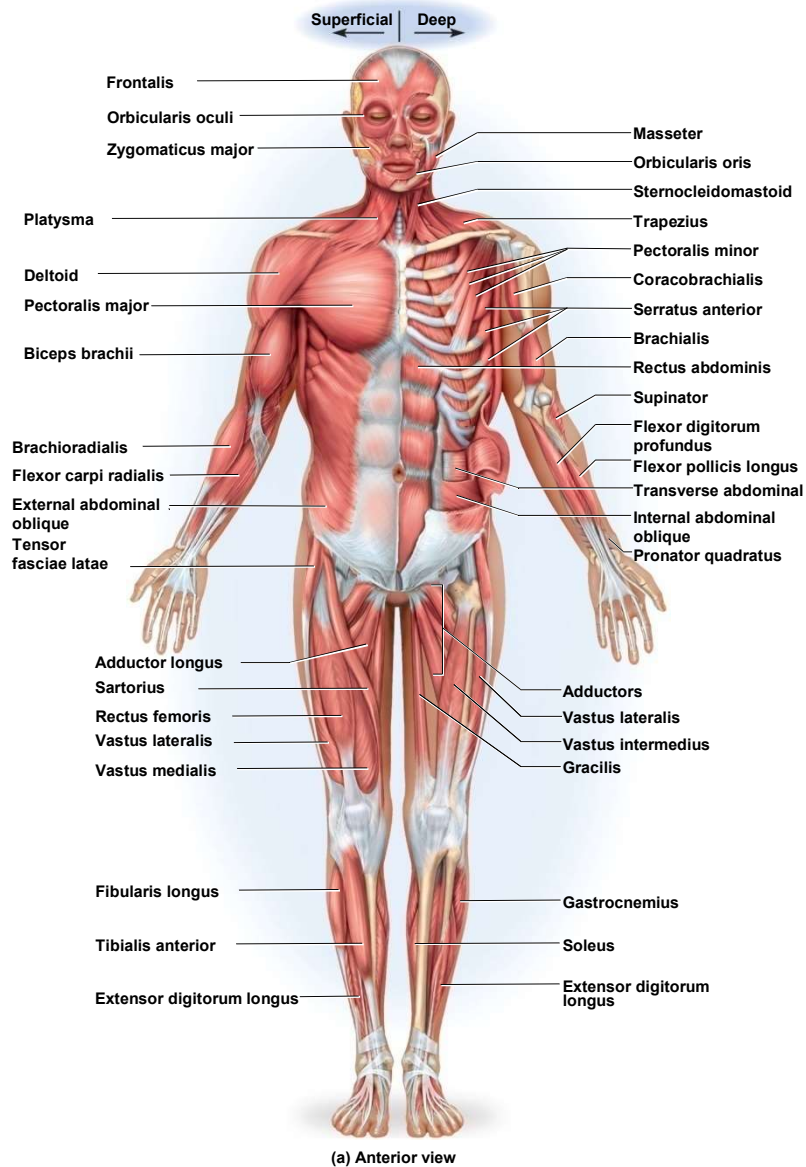


## Chapter 10.1

# Intro to the Muscle System

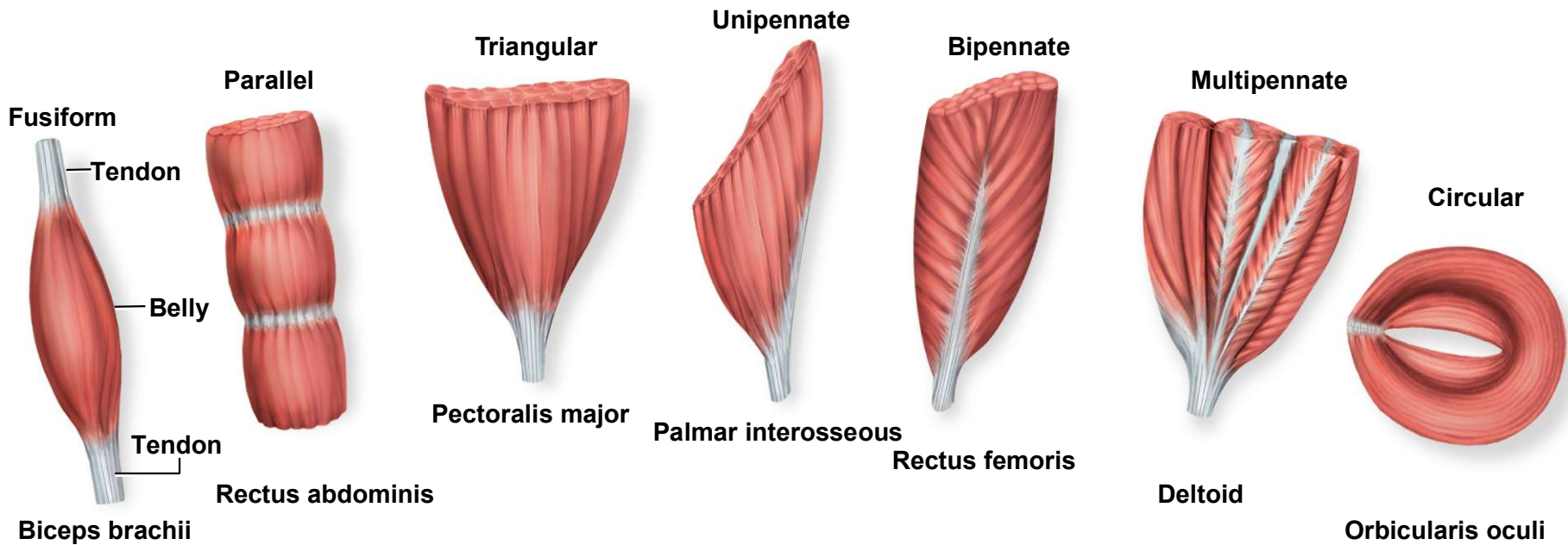


# The Muscular System



# Fascicle Orientation of Muscles

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strength of a muscle and the direction of its pull are determined partly by the orientation of its fascicles

# Classification of Muscles According to Fascicle Orientation (not a learning objective)

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- **fusiform muscles**
  - thick in middle and tapered at ends
  - *biceps brachii* , *gastrocnemius*
- **parallel muscles**
  - have uniform width and parallel fascicles
  - can span longer distances than other shapes
  - *rectus abdominis*, *zygomaticus major*
- **triangular (convergent) muscles**
  - fan-shaped, broad at origin and tapering to a narrower insertion
  - *pectoralis major*, *temporalis*
- **pennate muscles**
  - fascicles insert obliquely on a tendon (feather shaped)
  - unipennate, bipennate or multipennate
  - *palmar interosseus*, *rectus femoris* and *deltoid*
- **circular muscles (sphincters)**
  - ring around body opening
  - *orbicularis oculi*, *urethral* and *anal sphincters*

# Characteristics of Muscle Tissue

---

- **responsiveness (excitability)**
  - to chemical signals, stretch and electrical changes across the plasma membrane
- **conductivity**
  - local electrical change triggers a wave of excitation that travels along the muscle fiber
- **contractility**
  - shortens when stimulated
- **extensibility**
  - capable of being stretched between contractions
- **elasticity**
  - returns to its original resting length after being stretched

# The Functions of Muscles

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- **Movement** // move from place to place, movement of body parts and body contents in breathing, circulation, feeding and digestion, defecation, urination, and childbirth // role in communication – speech, writing, and nonverbal communications
- **Stability** // maintain posture by preventing unwanted movements // antigravity muscles – resist the pull of gravity and prevent us from falling or slumping over // stabilize joints
- **Control openings and passageways** // sphincter muscles = internal muscular rings that control the movement of food, bile, blood, and other materials through tubular structures
- **Heat production** by skeletal muscles // 85% of our body heat created by skeletal muscles

# Organization of Muscles

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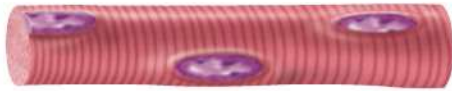


- about 600 human skeletal muscles
- constitute about half of our body weight
- three kinds of muscle tissue
  - skeletal
  - cardiac
  - smooth
- muscle converts the chemical energy of ATP into the mechanical energy of motion



# How to Identify the Three Different Types of Muscle

Skeletal muscle

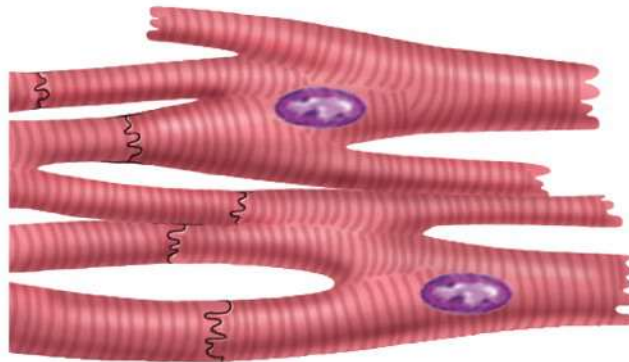


Striated

Voluntary

Somatic NS

Cardiac muscle



Striated

Involuntary

Internal pacemaker and  
modified by ANS

Smooth muscle



No striation

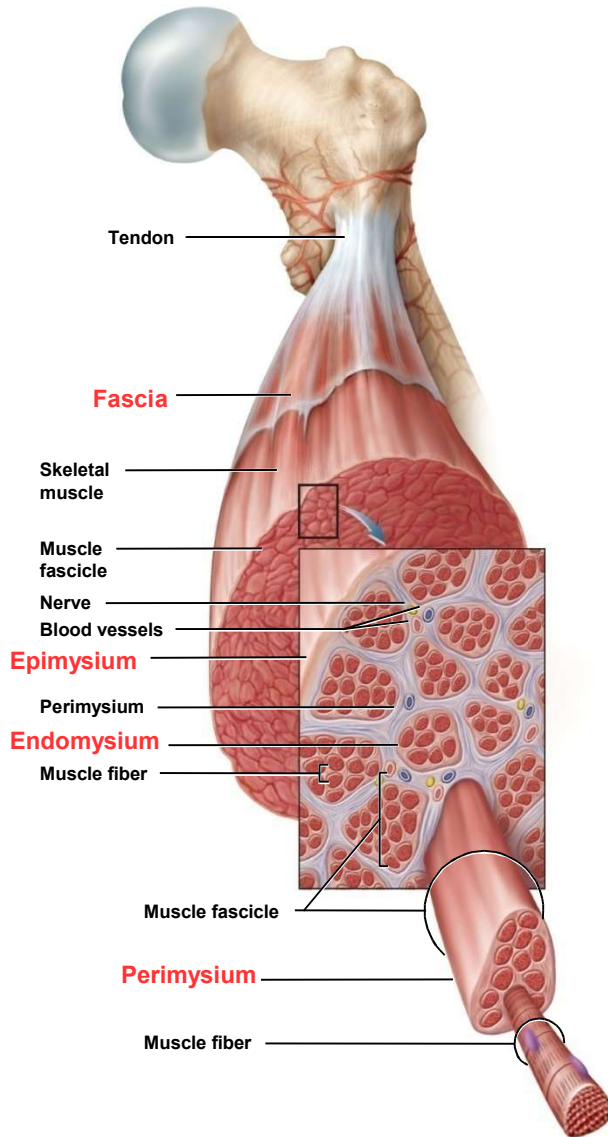
Involuntary

ANS

Note: This lecture will primarily cover “skeletal muscle”.



# Connective Tissues of a Skeletal Muscle Organ



What is the structural relationship between the endomysium, perimysium, and epimysium?

How does the connective tissue's fibers (i.e. collagen fibers) change their orientation between the tendon and the epimysium-perimysium-endomysium?

How do the collagen fibers in the tendon interact with the bone tissue?

# Four Connective Tissues of a Skeletal Muscle

---

- **1) Endomysium**
  - thin sleeve of loose connective tissue surrounding each **muscle fiber**
  - allows room for capillaries and nerve fibers to reach each muscle fiber
- **2) Perimysium**
  - slightly thicker layer of connective tissue
  - **fascicles** – bundles of muscle fibers wrapped in perimysium
  - carry larger nerves and blood vessels, and stretch receptors

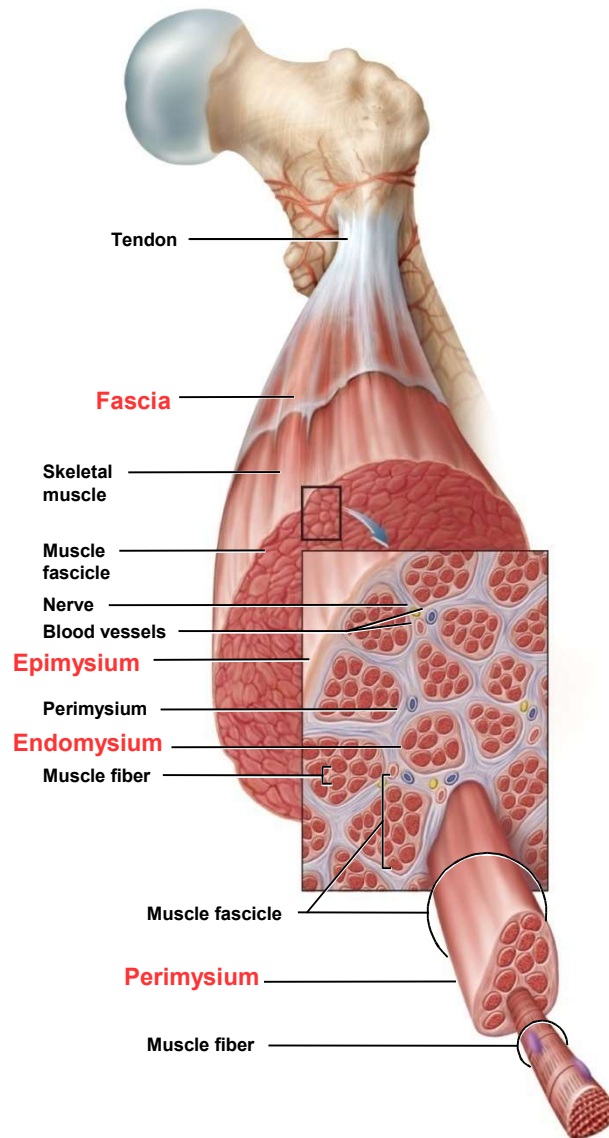
# Four Connective Tissues of a Skeletal Muscle

---

- **3) Epimysium**
    - fibrous sheath surrounding the entire muscle
    - outer surface grades into the fascia
    - inner surface sends projections between fascicles to form perimysium
  - **4) Fascia** = sheet of connective tissue that may separate and/or connect neighboring muscles from each other /// also between all other organ systems throughout body
- 
- **Compartment Syndrome** /// CNN science reporter, Miles O'Brien had his arm amputated 12 hours after a heavy case "bruised his arm". Why?

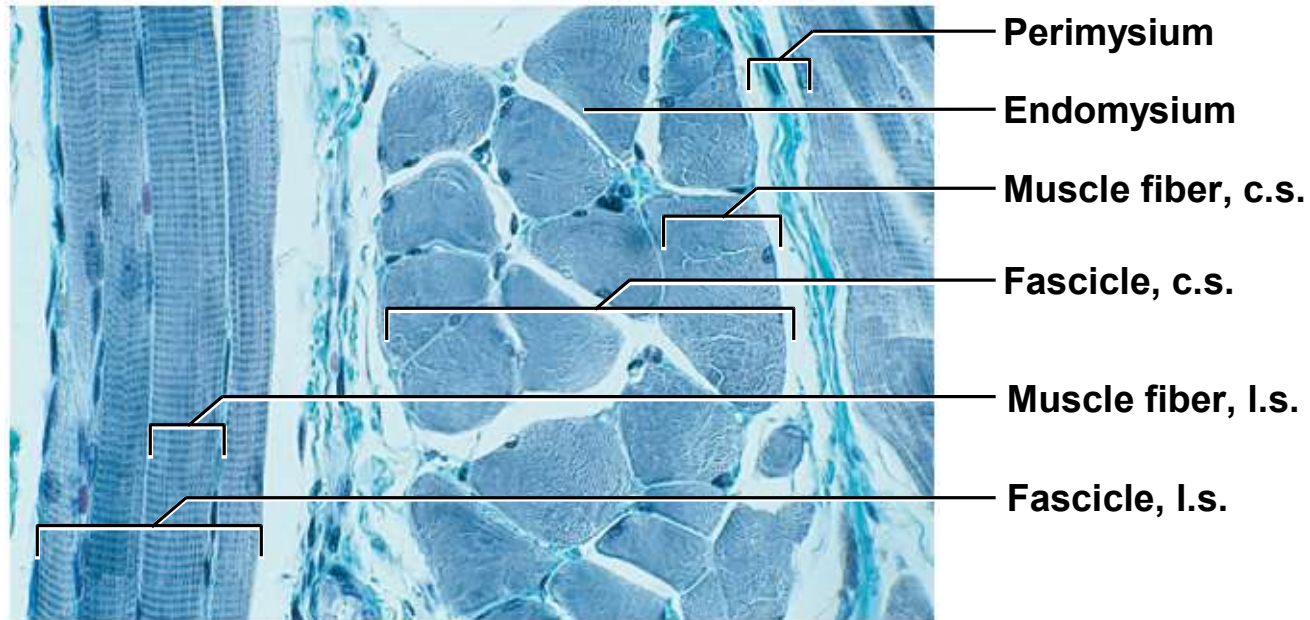


# Connective Tissues of a Muscle



# Connective Tissue in a Muscle

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(c)

Victor Eroschenko

# Muscle Attachments

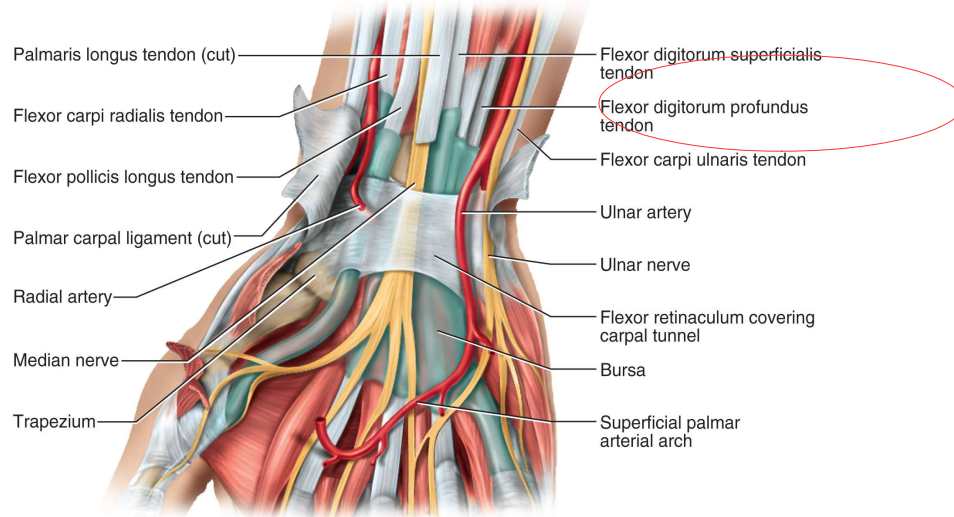
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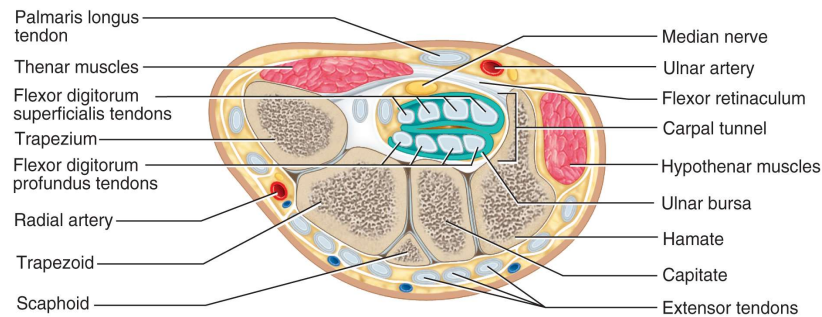
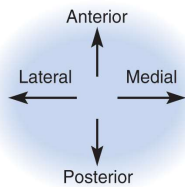
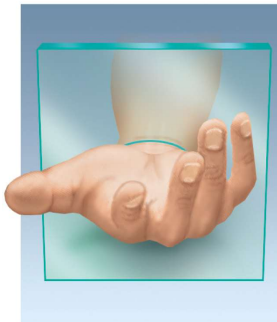
- **Indirect attachment to bone**
  - **tendons** bridge the gap between muscle fiber's ends and bony attachment
    - the collagen fibers of the endomysium, perimysium, and epimysium continue into the tendon /// these fibers weave themselves into the periosteum and penetrate beyond periosteum into the matrix of bone (weaving into the collagen fibers of the bone matrix)
    - very strong structural continuity from muscle into bone /// e.g. *biceps brachii*, *Achilles tendon*
    - **aponeurosis** – tendon is a broad, flat sheet (*palmar aponeurosis*)
    - **retinaculum** – connective tissue band which tendons from separate muscles pass through

**What is a retinaculum? Clinical significance?** – connective tissue band ///  
 tendons from separate muscles may pass through the retinaculum ///  
 inflammation swells tissue but retinaculum unable to expand which results in  
 pain (carpal tunnel syndrome)

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(a) Anterior view

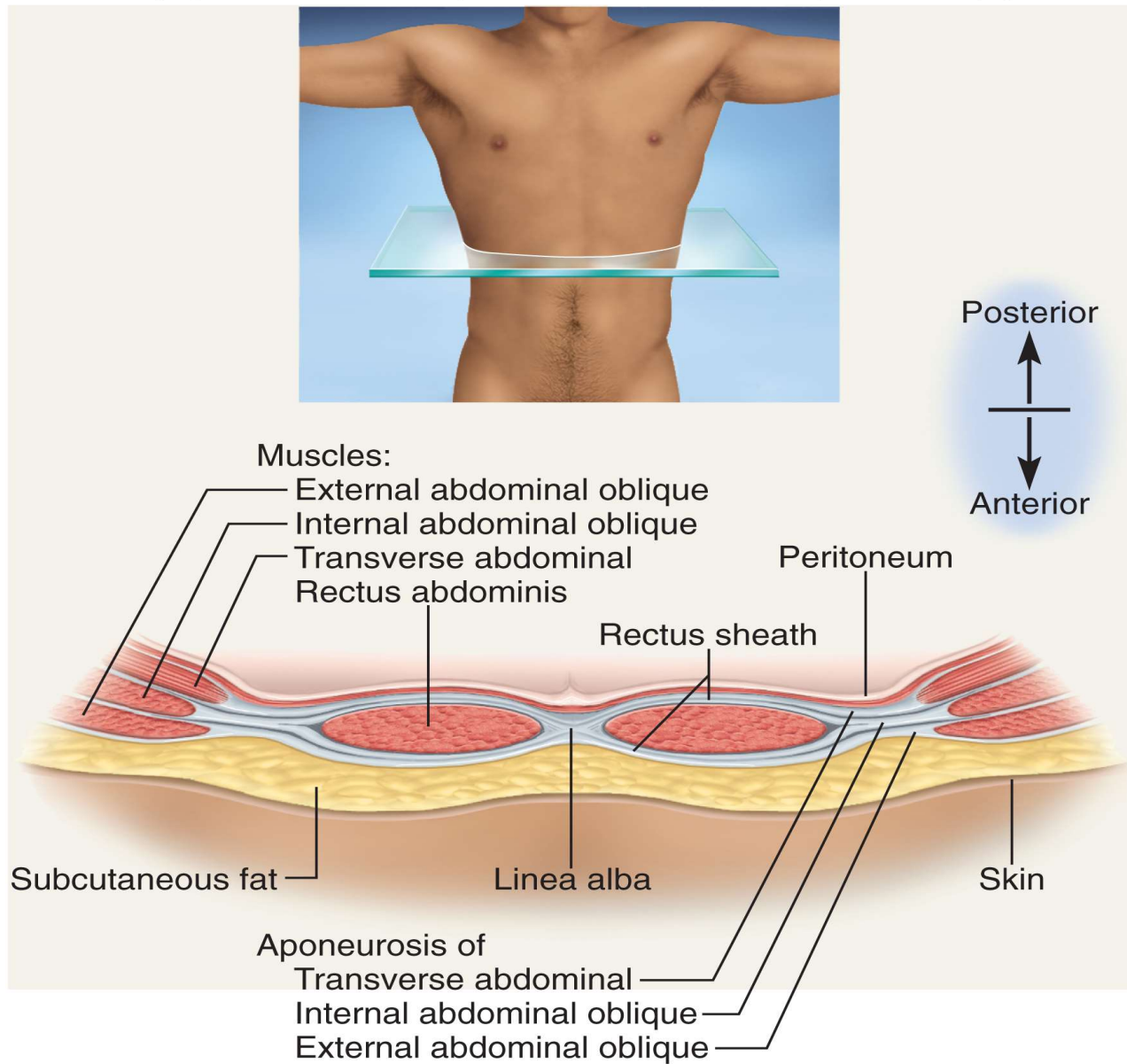


(b) Cross section



# Muscles May Also Be Arranged in Layers

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# Muscle Attachments

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- Some muscles have a more direct (fleshy looking) attachment to bone
  - little separation between muscle and bone
  - muscle seems to immerge (but tendon does exist) directly from bone
  - margins of *brachialis*, lateral head of *triceps brachii*
- Some skeletal muscles do not insert onto the periosteum of the bone but attach to the dermis of the skin or to the tendons of another muscle (best example are muscles of facial expression // see next slide)

Frontalis  
Levator palpebrae superioris  
Zygomaticus major and minor  
Levator anguli oris  
Levator labii superioris  
Depressor labii inferioris



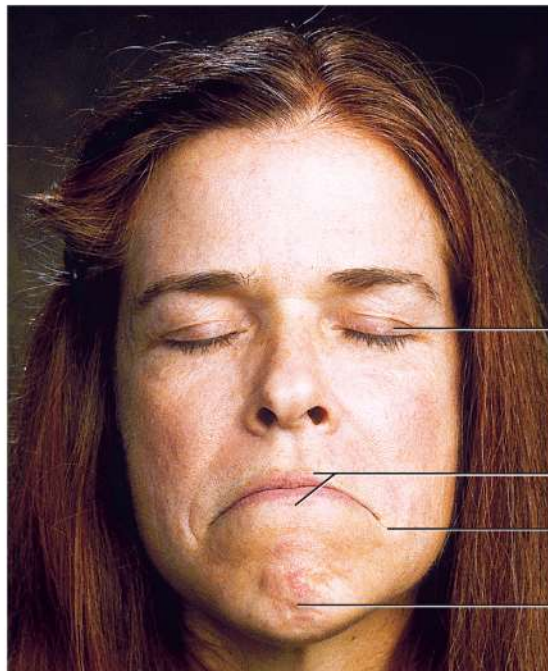
Frontalis  
Levator palpebrae superioris  
Nasalis  
Risorius  
Depressor labii inferioris  
Platysma



Frontalis  
Levator palpebrae superioris  
Corrugator supercilii  
Orbicularis oris  
Depressor anguli oris  
Mentalis



Orbicularis oculi  
Orbicularis oris  
Depressor anguli oris  
Mentalis



# Muscle Origins and Insertions

- **Origin**

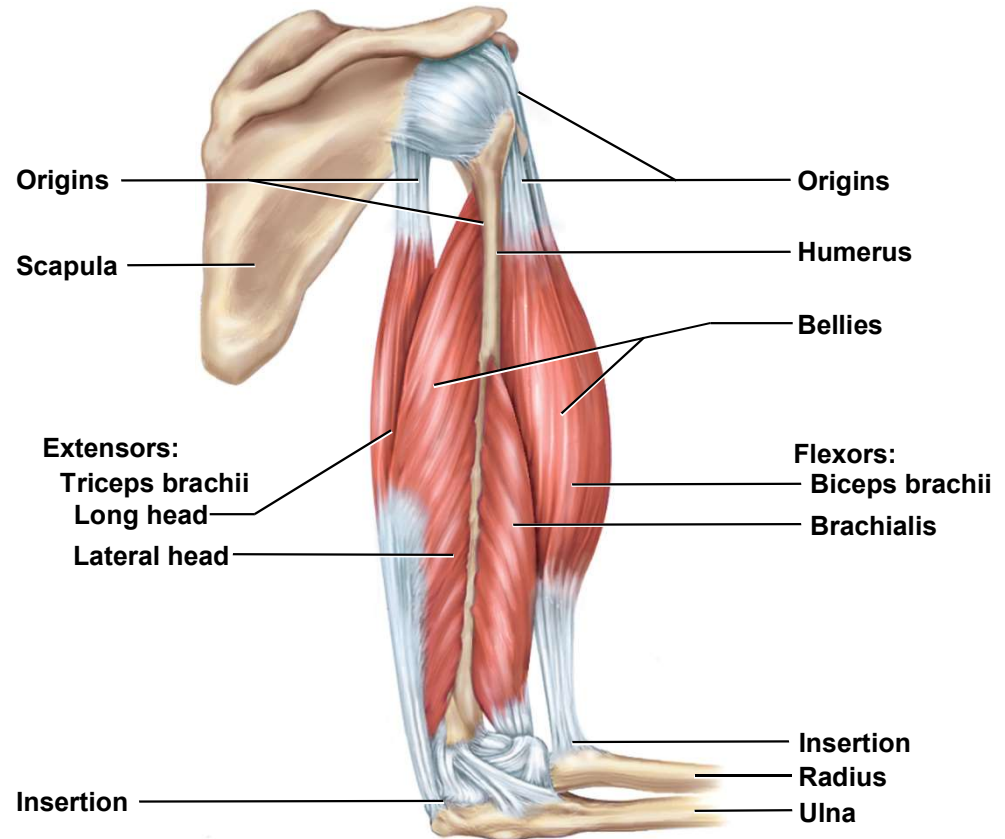
- bony attachment at stationary end of muscle

- **Belly**

- thicker, middle region of muscle between origin and insertion

- **Insertion**

- bony attachment to mobile end of muscle



# Classify Muscles by Their Function

---



- **Action**
  - the effects produced by a muscle
  - to produce or prevent movement
- **Prime mover (agonist)**
  - muscle that produces most of force during a joint action
- **Synergist**
  - muscle that aids the prime mover
  - stabilizes the nearby joint
  - modifies the direction of movement

# Classify Muscles by Their Function

---



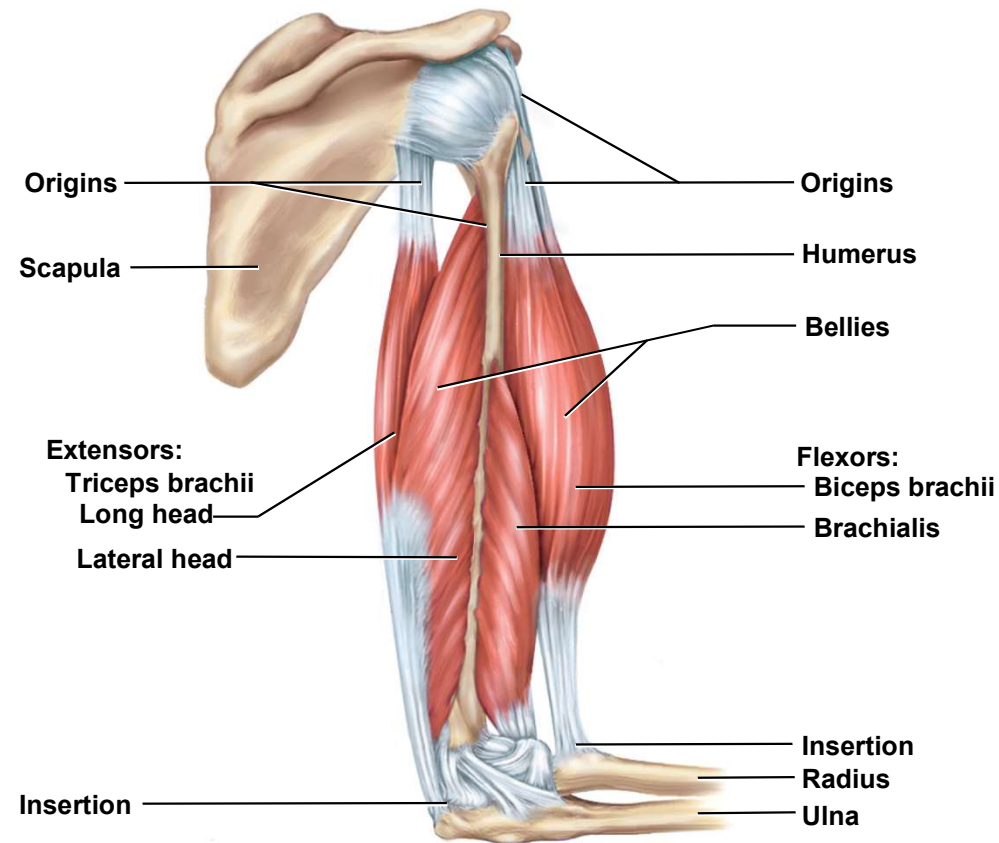
- **Antagonist**

- opposes the prime mover
- relaxes to give prime mover control over an action
- preventing excessive movement and injury
- **antagonistic pairs** – muscles that act on opposite sides of a joint

- **Fixator**

- muscle that prevents movement of bone
- allows other muscles to exert force to produce movement.

# Muscle Actions Across Elbow

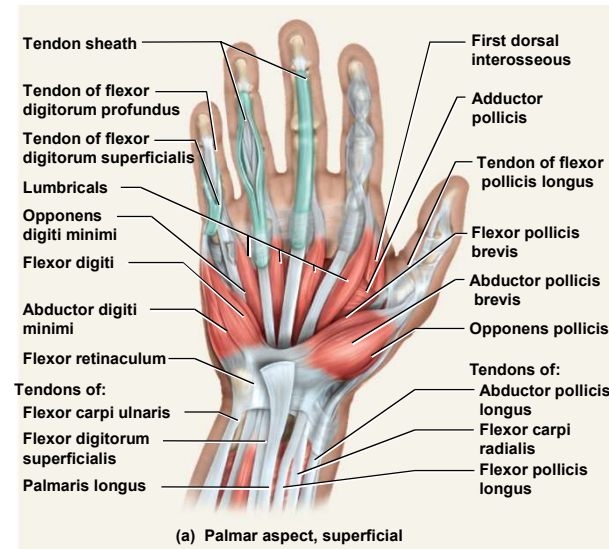


- **Prime mover**
  - brachialis
- **Synergist**
  - biceps brachii
- **Antagonist**
  - triceps brachii
- **Fixator**
  - *Rhomboids* (muscle that holds scapula firmly in place)

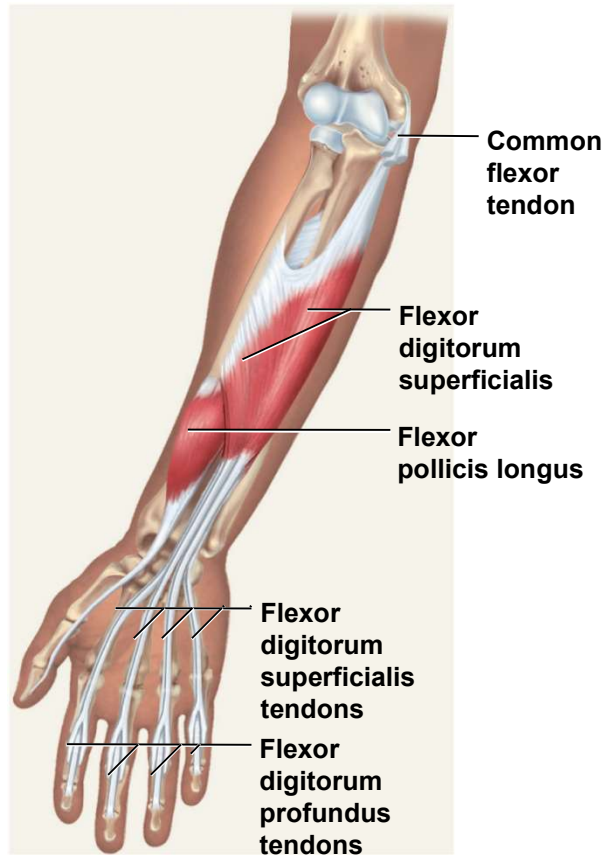


# Intrinsic vs Extrinsic Muscles

- A muscles maybe classified by the relationship between the location and action of the muscle.
- **Intrinsic muscles** // entirely contained within a region, such as the hand // both its origin and insertion are located in the hand.



# Intrinsic VS Extrinsic Muscles



(b) Intermediate flexor

- **Extrinsic muscles**
  - muscle act on a designated region, but has its origin elsewhere
  - e.g. fingers – extrinsic muscles in the forearm



# About Skeletal Muscle Contractions

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- **Key factoids about skeletal muscle innervation**
  - skeletal muscles are classified as “voluntary, striated, and multi-nucleated”
  - skeletal muscle contraction requires a conscious signal from brain
  - knowledge about “pathway” enables the diagnosis of nerve, spinal cord, and brainstem injuries that effects muscle function
  - **motor nerve pathways for voluntary skeletal muscle contraction**
    - **upper motor neuron (corticospinal and corticobulbar)**
    - **lower motor neuron (spinal nerves and cranial nerves)**
  - Important to note: skeletal muscles may also be induced to contract involuntarily either by a spinal cord reflexes or an indirect nerve pathways that originates in the brain stem. Reflexes and the indirect pathway are both not voluntary.

# Skeletal Muscle Innervation

---

- **Corticospinal tracts**
  - upper motor neuron
  - Originate in precentral gyrus
  - Transits into spinal cord and synapse on lower motor neuron in the anterior horn
  - Lower motor neurons are common pathway to skeletal muscle below head and neck
- **Corticobulbar**
  - lower motor neuron
  - Originate in precentral gyrus
  - Transits to brainstem and synapse on cranial nerves
  - Cranial are common pathway to skeletal muscles above head and neck

# Skeletal Muscle Innervation

---

- **Spinal nerves (i.e. lower motor neuron)**
  - arise from the spinal cord
  - emerge through intervertebral foramina
  - immediately branch into a posterior and anterior ramus
  - innervate muscles below the neck
  - **plexus** – weblike network of spinal nerves adjacent to the vertebral column
- **Cranial nerves (i.e. lower motor neuron)**
  - arise from the base of the brain
  - emerge through skull foramina
  - innervate the muscles of the head and neck
  - numbered I to XII

# Learning Strategy

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- examine models, cadavers, dissected animals, or a photographic atlas to **get visual images of the muscle**
- when studying a particular muscle, **palpate it on yourself if possible**
- locate **origins and insertions** of muscles on an articulated skeleton
- study **derivation** of each muscle name // usually describes the muscle's location, appearance, origin, insertion or action
- **say the names aloud** to yourself or study partner, and spell them correctly

# Athletic Injuries

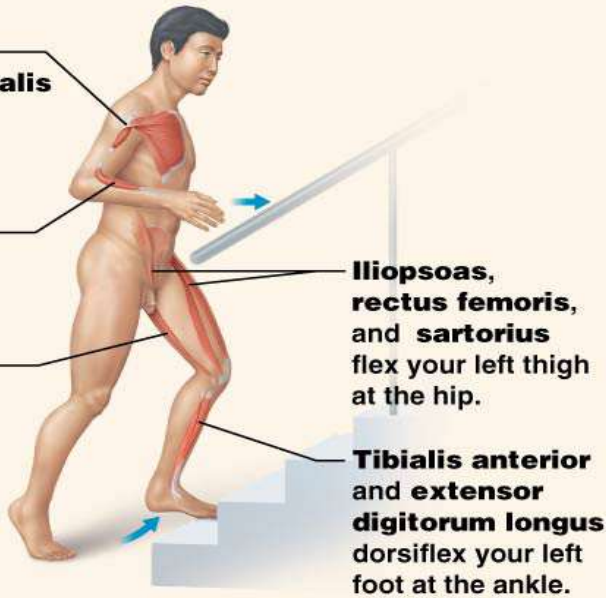
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- muscles and tendons are vulnerable to sudden and intense stress
- proper conditioning and warm-up needed
- common injuries;
  - compartment syndrome
  - shinsplints
  - pulled hamstrings
  - tennis elbow
  - pulled groin
  - rotator cuff injury
- treat with rest, ice, compression and elevation /// known as “RICE”
- “no pain, no gain” is a dangerous misconception

**Pectoralis major** and **coracobrachialis** flex your right arm.

**Brachioradialis** flexes your right forearm.

**Hamstrings** flex your left leg at the knee.



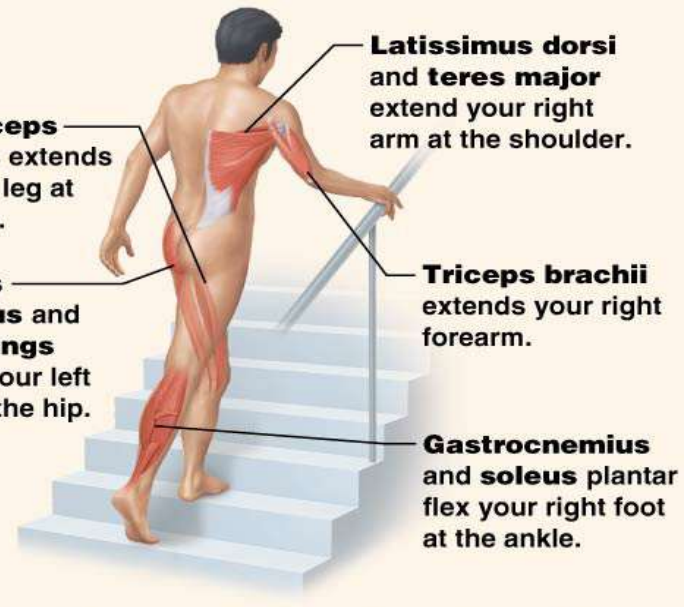
**Iliopsoas, rectus femoris, and sartorius** flex your left thigh at the hip.

**Tibialis anterior and extensor digitorum longus** dorsiflex your left foot at the ankle.

① Bring your left foot to the first step and flex your right arm to reach for the handrail.

**Quadriceps femoris** extends your left leg at the knee.

**Gluteus maximus and hamstrings** extend your left thigh at the hip.



**Latissimus dorsi and teres major** extend your right arm at the shoulder.

**Triceps brachii** extends your right forearm.

**Gastrocnemius and soleus plantar** flex your right foot at the ankle.

② Stand upright on your left leg and extend your right arm and forearm on the handrail.

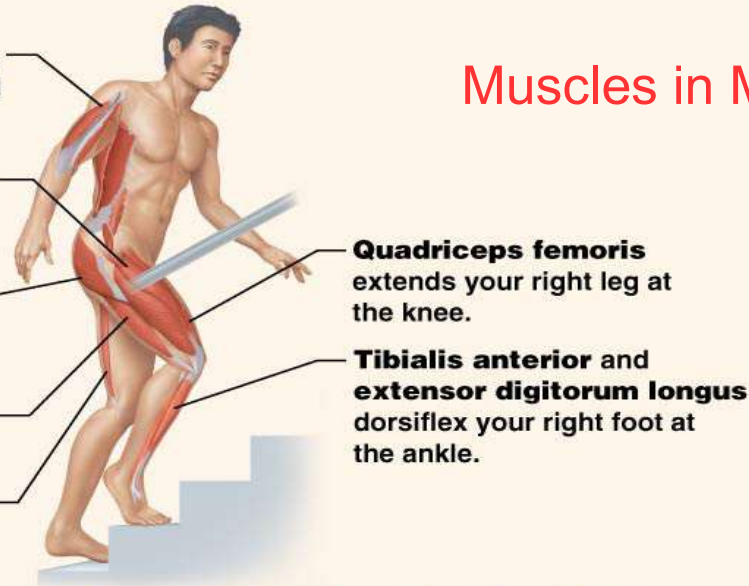
**Latissimus dorsi, teres major, and triceps brachii** hyperextend your right arm at the shoulder.

**Iliopsoas, rectus femoris, and sartorius** flex your right thigh at the hip.

**Gluteus maximus and hamstrings** extend your right thigh at the hip.

**Hamstrings** flex your right leg at the knee.

**Hamstrings** flex your left leg at the knee.



**Quadriceps femoris** extends your right leg at the knee.

**Tibialis anterior and extensor digitorum longus** dorsiflex your right foot at the ankle.

③ Bring your right leg to the next step and extend it. Take the weight off your left leg and hyperextend your right arm to swing it forward again, reaching for the handrail.

## Muscles in Motion