

# Muscular System



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# Types & Function of Muscles

## ■ Skeletal Muscle:

- Generally attached to bone
- Produces movement, maintain posture & stabilize joints
- Produce heat therefore help maintain body temperature
- Muscle cells long, cylinder shaped & are **striated**
- Controlled by choice so considered **Voluntary Muscles**



# Muscular System

- Smooth Muscle:
  - Found in walls of the organs, breathing passages & blood vessels
  - Functions automatically so considered **involuntary muscle**
  - Not striped in appearance so called **non-striated** muscle
  - Contraction of smooth muscle enables viscera to perform

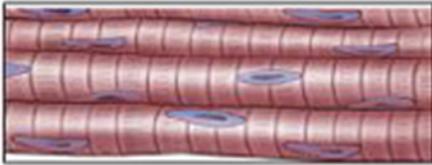


# Muscular System

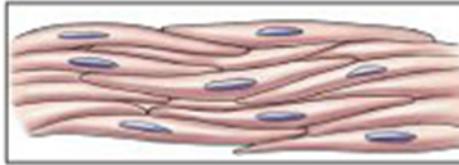
## ■ Cardiac Muscles:

- Found only in the heart
- Pumps blood to body
- Cells are long branching & fit together at junction called intercalated discs
- Junctions create electrical impulses
- **Striated & Involuntary muscle**

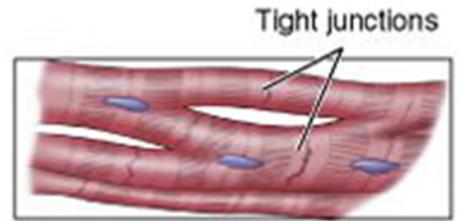
**Cellular appearance:**



**Skeletal muscle**

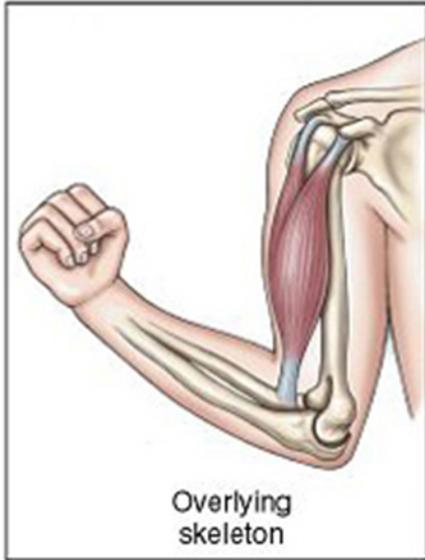


**Smooth muscle**

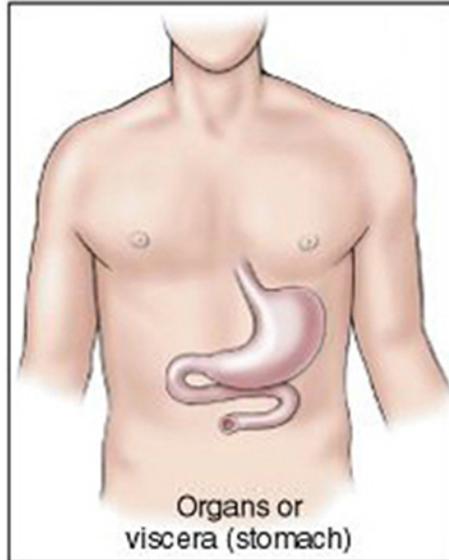


**Cardiac muscle**

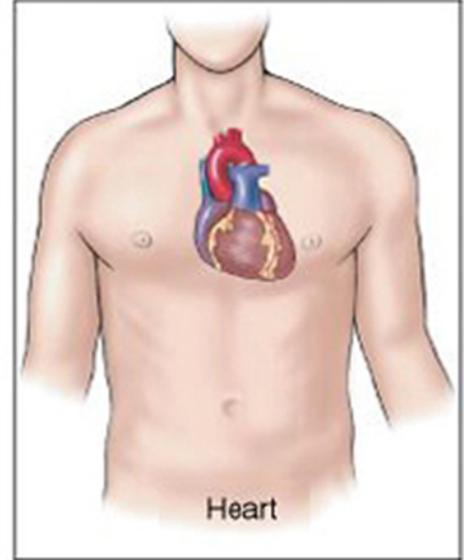
**Location:**



**Overlying  
skeleton**



**Organs or  
viscera (stomach)**



**Heart**

**Description:**

**Striated  
voluntary**

**Nonstriated  
involuntary**

**Striated  
involuntary**



# Muscular System

- Structure of a Single Muscle Fiber:
  - A muscle consists of elongated, multinucleated & surrounded by cell membrane **sarcolemma**
  - Cell membrane penetrates deep into interior of muscle fiber creating **transverse tubules**
  - Specialized endoplasmic reticulum are located within the muscle fiber called **sarcoplasmic reticulum** which stores  $\text{Ca}^+$



# Muscular System

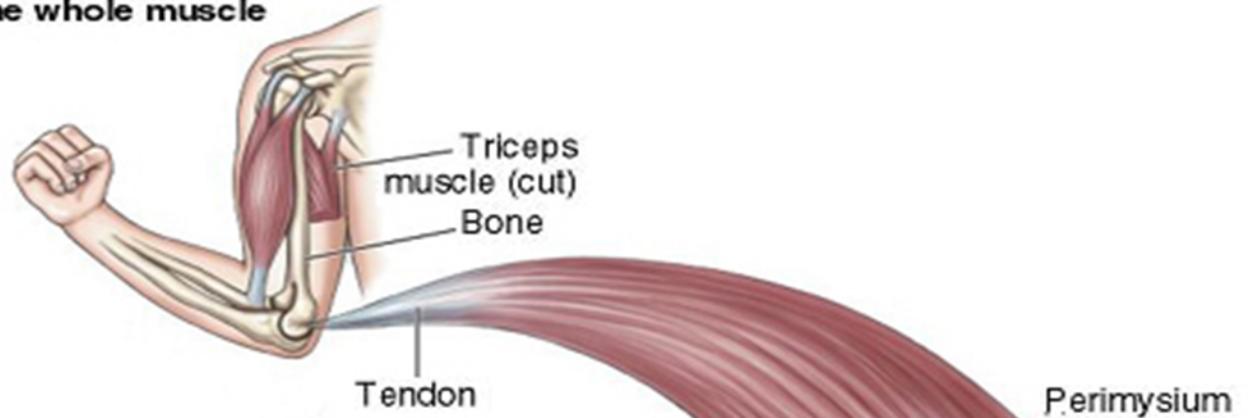
- Structure of Single Muscle Fiber:
  - Composed of long cylinder structures called ***myofibrils*** which bundle together to form a muscle cell
  - Myofibrils are made up of contractile units called ***sarcomeres***
  - Each sarcomere is formed by arrangement of two contractile proteins, ***actin & myosin***
  - ***Myosin heads*** extend from myosin filament
  - When myosin & actin make contact a crossbridge is formed



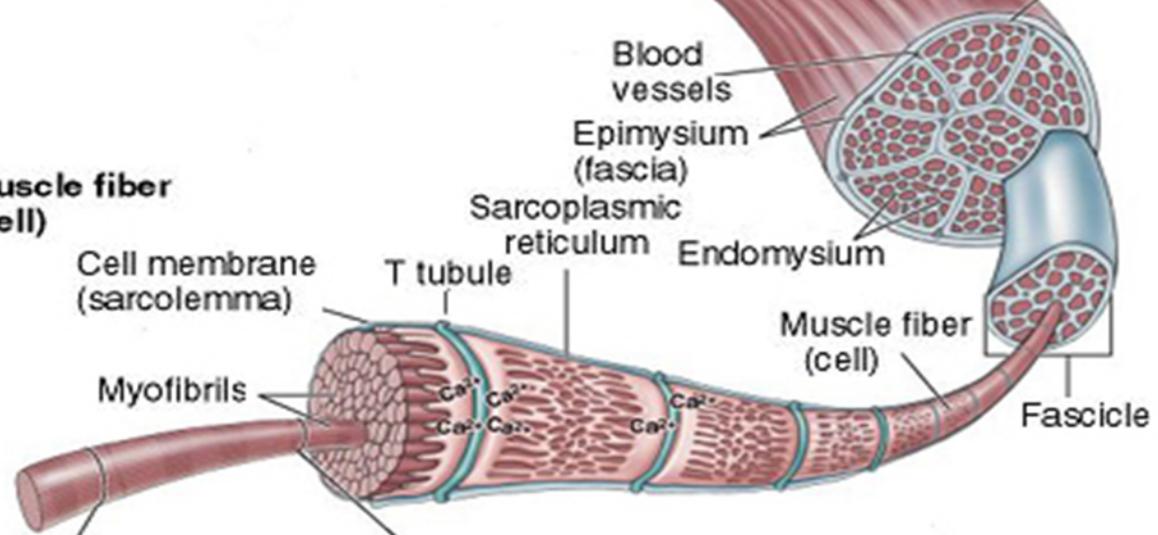
# Muscular System

- Structure of a **Whole** Muscle:
  - a *muscle fiber* is surrounded by the connective tissue ***endomysium***
  - when individual muscle fibers form bundles ***fascicles*** are created which are surrounded by another connective tissue ***perimysium***
  - These fascicles bundle together to form ***fascia*** that are covered by ***epimysium***

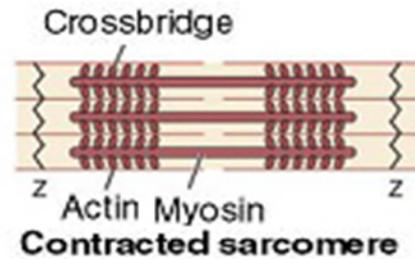
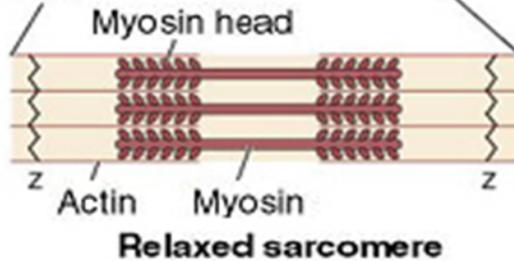
## The whole muscle



## Muscle fiber (cell)



## Sarcomere





# Muscular System

- Muscles form attachment in 3 ways:
  1. Tendons attach muscle to bone
  2. Muscles directly attach to bone
  3. Aponeurosis: flat sheet like fascia, connects muscle to muscle or muscle to bone



# Muscular System

## ■ Muscle Contraction:

- When actin & myosin filaments slide past each other the sarcomeres shorten causing muscle to shorten
- Sarcomere shorten because myosin heads make contact with actin forming temporary connections called crossbridges
- Myosin heads rotate pulling the actin toward the center of the sarcomere
- Relaxation occurs when crossbridges are broken & actin & myosin return to normal position



# Muscular System

## ■ Contraction & Relaxation

- Adenosine triphosphate & calcium play key role
- ATP helps myosin heads form & break crossbridges with actin
- Calcium is stored in sarcoplasmic reticulum & is needed for ATP to function
- When muscle is stimulated, calcium is released from SR causing ATP, actin & myosin to interact creating muscle contraction
- When calcium is pumped back in SR, away from actin, myosin & ATP crossbridges break & muscles relax

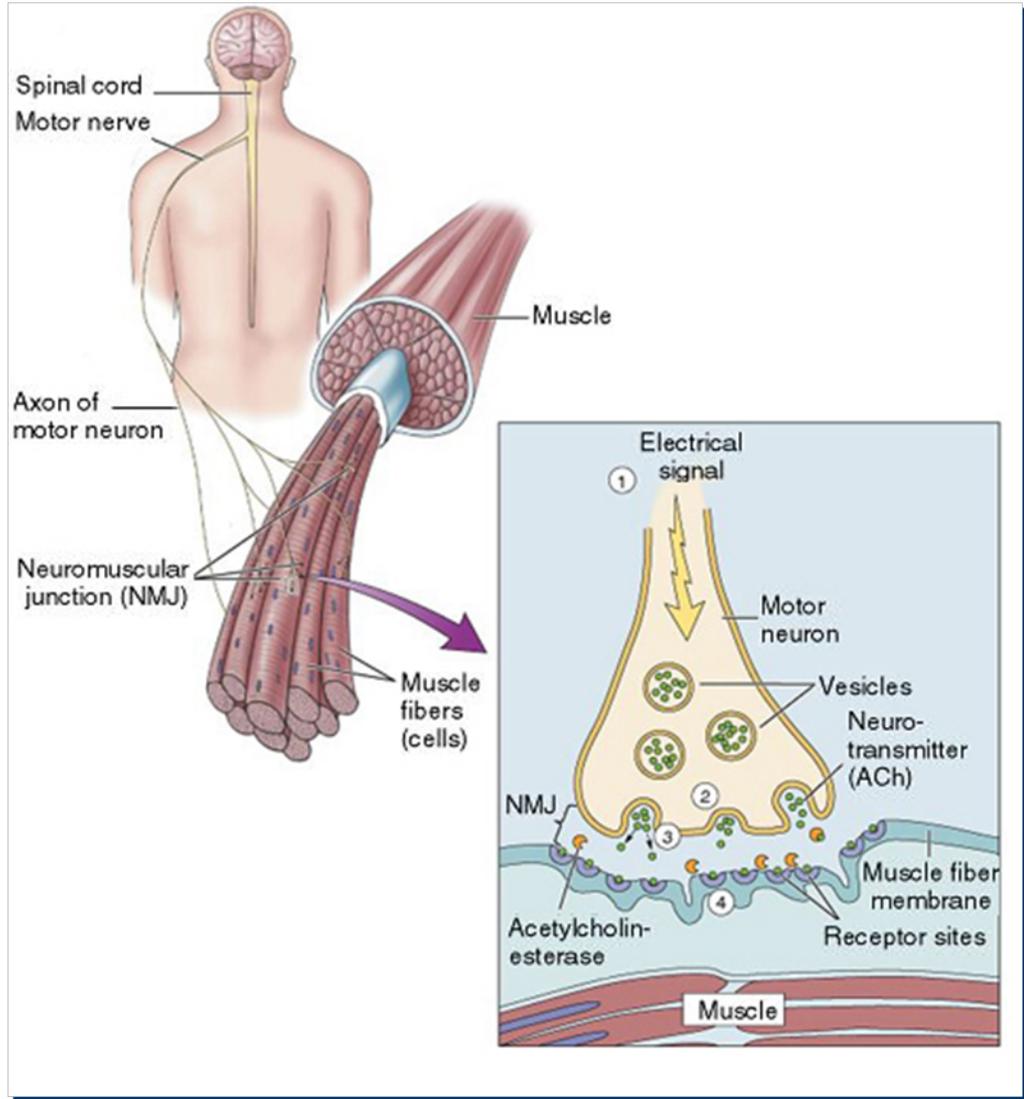




# Muscular System

## ■ Skeletal Muscles & Nerves

- Skeletal muscles only contract when stimulated by a motor nerve
- This motor nerve causes a release of neurotransmitter acetylcholine from the nerve into the neuromuscular junction
- The neurotransmitter then binds with the muscle membrane, travels along & triggers the release of calcium from sarcoplasmic reticulum which comes in contact with actin, myosin & ATP causing muscle contraction





# Types of Muscle Contraction

- Single muscle fibers contract in all or nothing manner; never partially.
- All whole muscle is capable of contracting partially, either weakly or very strong depending on need.
- Contracting of whole muscle may require several hundred fibers to several thousand.
- Recruitment is the process of using more muscle fibers for greater muscle force.



# Muscular System

- Types of muscle contraction:
  - Twitch: single stimulus delivered to muscle, muscle contracts & then fully relaxes
  - Tetanus: muscle is stimulated repeatedly without giving the muscle time to relax with sustained muscle contraction
- Muscle tonus: normal continuous state of partial muscle contraction



# Muscular System

- ATP is required for contraction
- ATP is replaced in three ways:
  1. Aerobic metabolism: glycogen, glucose & fats are broken down for energy
  2. Anaerobic metabolism: not a complete breakdown of fuels without O<sub>2</sub> lactic acid is produced
  3. Metabolism of creatine phosphate



# Muscular System

- Terms related to muscle movement:
  - Origin: where muscle attaches to stationary bone
  - Insertion: where muscle attaches to movable bone
  - Prime mover: the chief muscle responsible for most movement of the muscle group
  - Synergist: helper muscles of prime mover
  - Antagonist: muscles that oppose the action of another muscle
  - Hypertrophy: increase in muscle size
  - Atrophy: decrease in muscle size
  - Contracture: abnormal formation of fibrous tissue



# Muscular System

- Naming skeletal Muscles according to the following characteristics:
  - Size
  - Shape
  - Direction of fibers
  - Location
  - Number of origins
  - Origin & Insertion
  - Muscle Action



# Muscular system

## ■ Size:

- vastus: huge
- maximus: large
- langus: long
- minimus: small
- brevis: short

## ■ Shape:

- deltoid: triangular
- latissimus: wide
- teres: round



# Muscular System

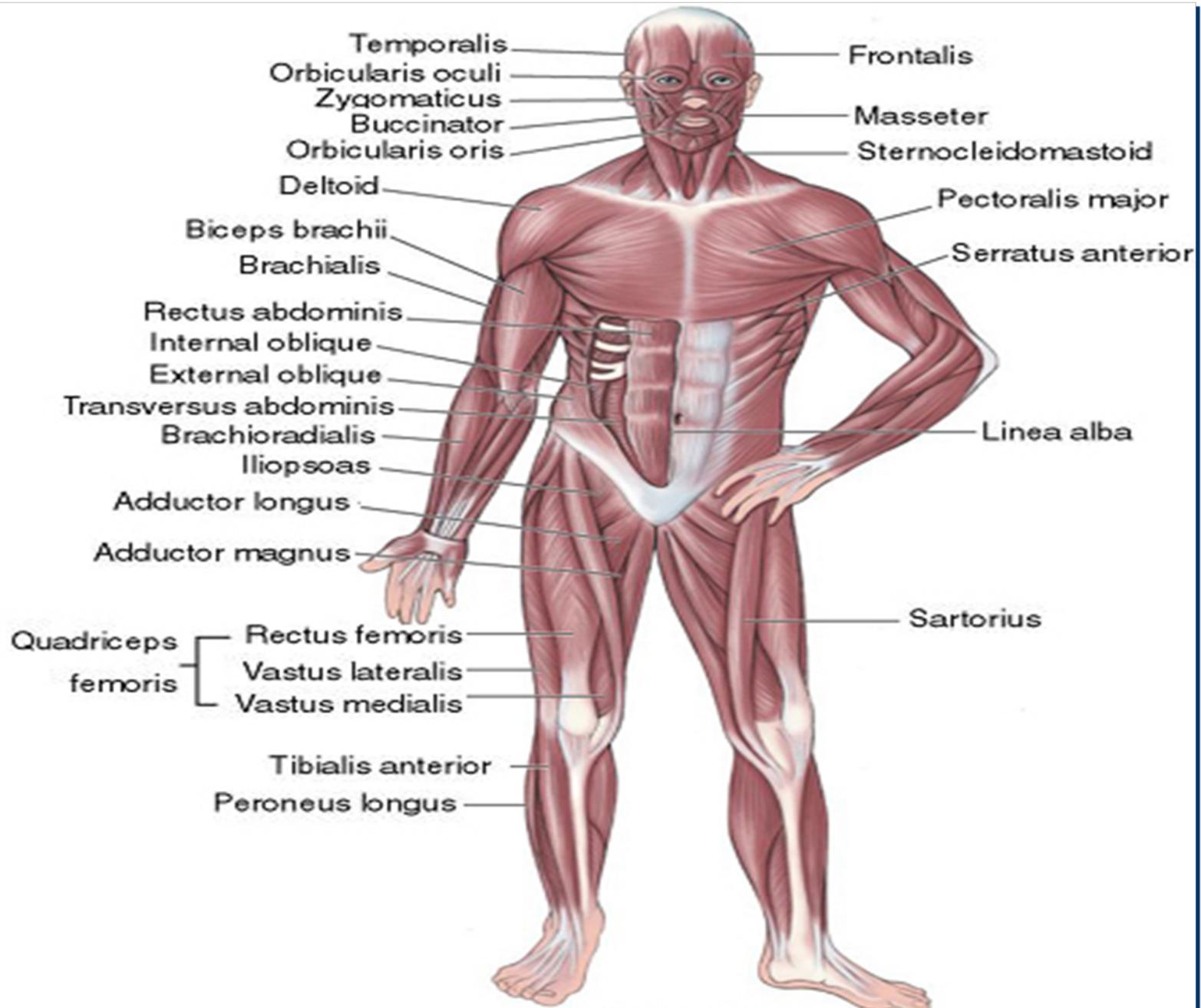
## ■ Location:

- pectoralis: chest
- gluteus: buttock
- brachii: arm
- supra: above
- infra: below
- lateralis: lateral
- sub: underneath



# Muscular System

- Number of Origins:
  - Biceps (2)
  - Triceps (3)
  - Quadriceps (4)
- Origin & Insertion:
  - Sternoideomastoid
- Direction of fibers:
  - Oblique: diagonal
  - Rectus: straight
  - Transverse: across
- Muscle Action



Temporalis  
Orbicularis oculi  
Zygomaticus  
Buccinator  
Orbicularis oris

Frontalis  
Masseter  
Sternocleidomastoid

Deltoid  
Biceps brachii  
Brachialis  
Rectus abdominis  
Internal oblique  
External oblique  
Transversus abdominis  
Brachioradialis  
Iliopsoas  
Adductor longus  
Adductor magnus

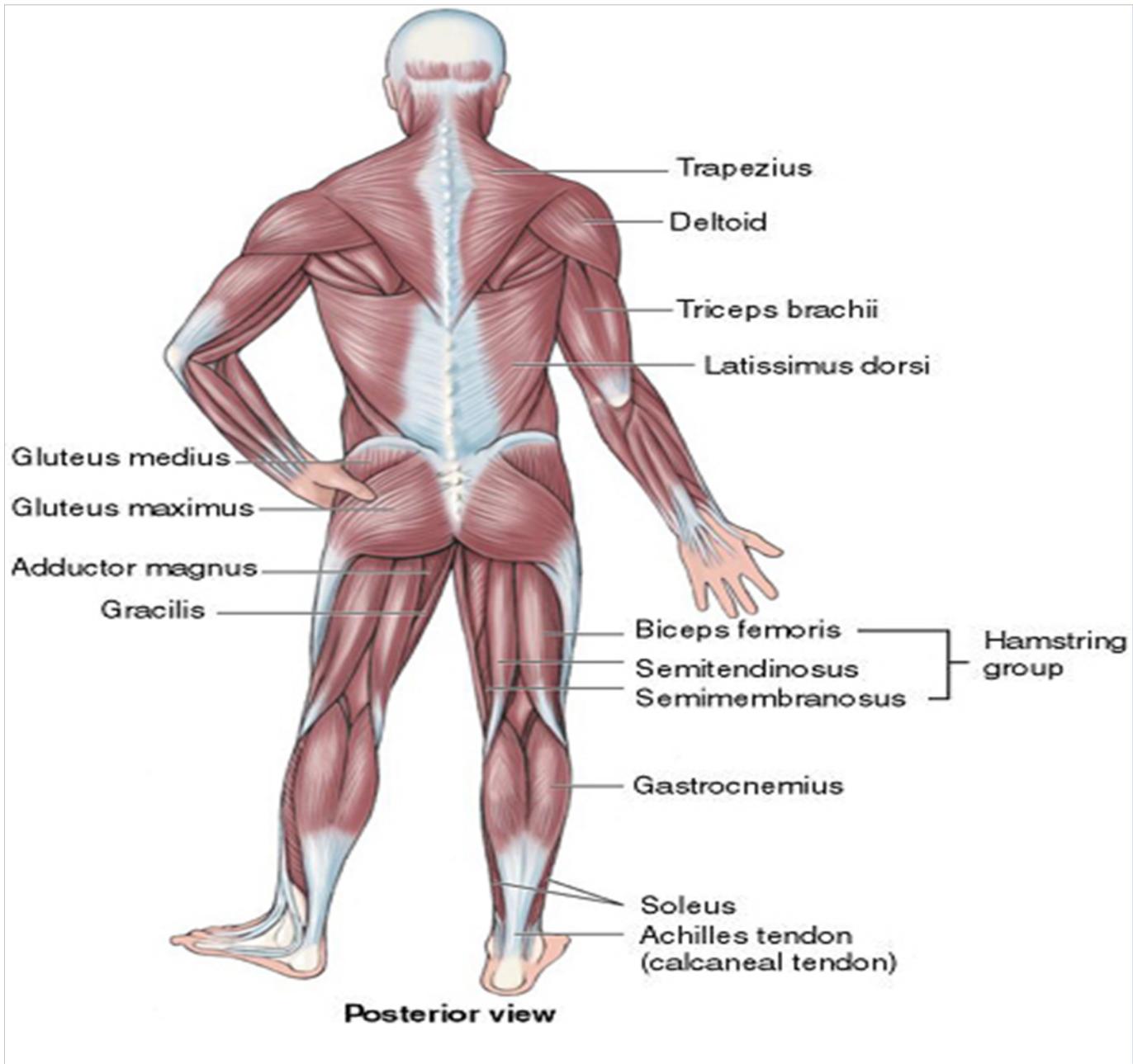
Pectoralis major  
Serratus anterior

Quadriceps femoris  
Rectus femoris  
Vastus lateralis  
Vastus medialis

Linea alba  
Sartorius

Tibialis anterior  
Peroneus longus

**Anterior view**





# Muscular System

- Major Muscles:

- Facial:

- Frontalis: covers frontal bone; contraction raises eyebrows
- Orbicularis oculi: sphincter muscle that encircles the eye; contraction closes eye, assists with winking, blinking & squinting
- Orbicularis oris: sphincter muscle that encircles the mouth; contraction assists in closing the mouth, forming words & pursing lips



# Muscular System

## ■ Facial Muscles:

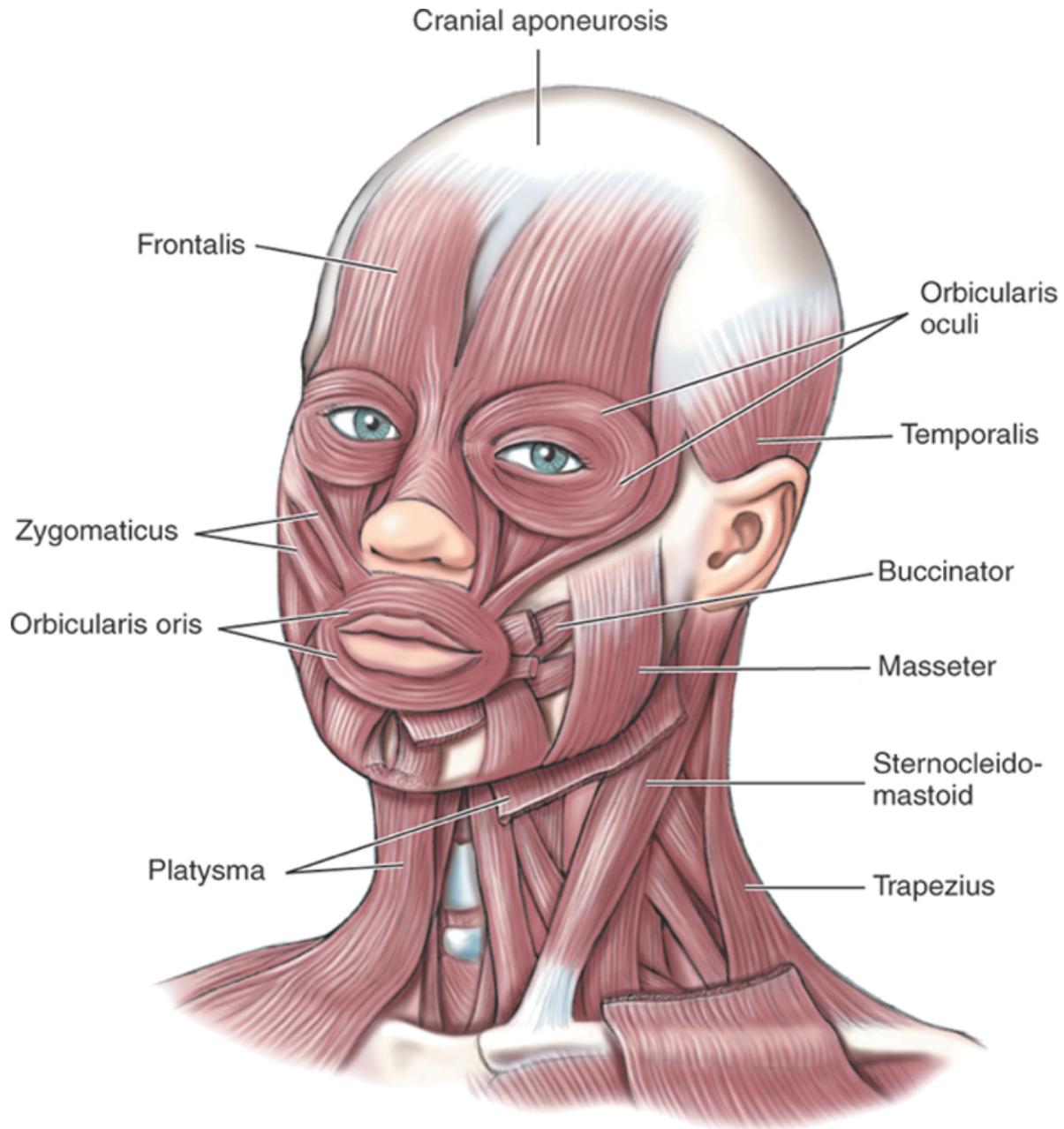
- Buccinator: muscle that inserts into the orbicularis oris & flattens the cheek when contracted; helps position food between teeth for chewing
- Zygomaticus: extends from the corners of the mouth to the cheekbone; smiling muscle



# Muscular System

## ■ Chewing Muscles:

- Masseter: extends from zygomatic process of temporal bone to mandible; contraction closes jaw; synergistically works with temporalis muscle
- Temporalis: fan-shaped muscle extending from the flat portion of the temporal bone to the mandible; works synergistically with other chewing muscles





# Muscular System

## ■ Muscles of Neck:

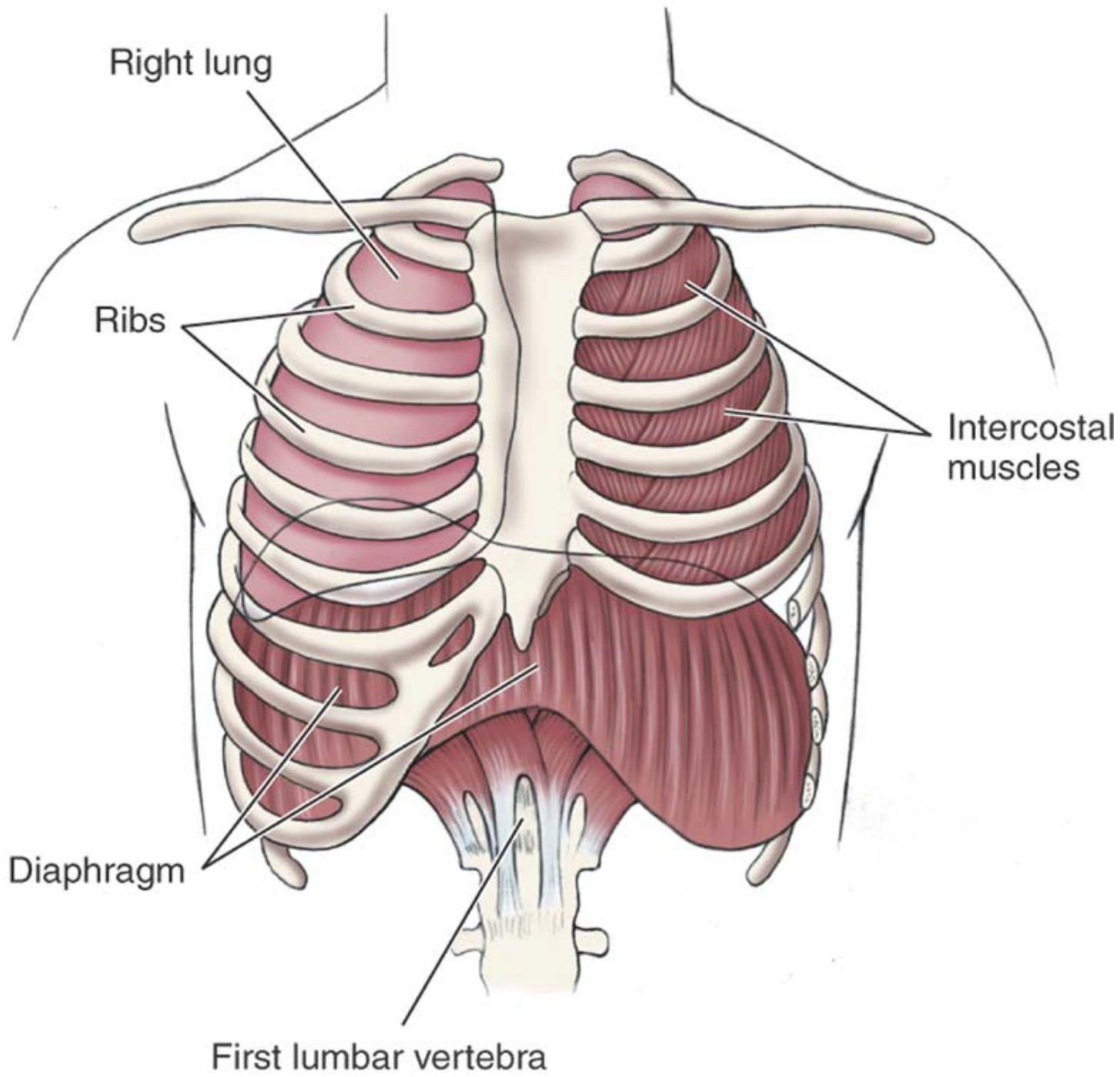
- Sternocleidomastoid (2): Muscle extends from sternum & clavicle to the mastoid process of temporal bone; contraction of one causes head to rotate; contraction of both causes flexion of the head (bows to pray)
- Trapezius: attaches to the base of the occipital bone, shoulder & upper vertebral column; contraction extends head (face to sky)
- These two muscles work antagonistically to one another



# Muscular System

## ■ Muscles of Trunk:

- Intercostal muscles: located between ribs; raise & lower rib cage during breathing
- Diaphragm: dome-shaped muscle that separates the thoracic cavity from the abdominal cavity; chief muscle of inhalation





# Muscular System

## ■ Muscles of Abdomen:

- Rectus abdominus: runs up & down; longitudinally from sternum to pubic bone; contraction flexes or bends vertebral column
- External Oblique: make up lateral walls of abdomen; run slanted



# Muscular System

## ■ Muscles of the abdomen:

- Internal oblique: part of the lateral walls of the abdomen; add strength of external oblique by creating a criss-cross pattern
- Transverse abdominus: form the innermost layer of abdominal muscles; run horizontally across abdomen
- Abdominal muscles are covered with fascia that forms a large aponeurosis. White line in center of these aponeuroses is linea alba & extends from sternum to pubic bone



# Muscular System

- Muscles of the Vertebral Column: group of muscles attached to vertebrae; assist with movement of vertebral column
- Muscles of the Pelvic Floor: two flat muscle sheets & surrounding fascia; support pelvic viscera & assist with urinary & bowel elimination



# Muscular System

## ■ Muscles of Shoulder & Upper Arm

- Trapezius: attaches to thoracic vertebrae & scapula; contraction shrugs shoulders & moves head
- Serratus anterior: located on sides of the chest & extends from the ribs to the scapula where it attaches; contraction lowers shoulders & moves upper arms forward
- Deltoid: rounded portion of shoulder; extends from the clavicle & scapula to humerus; contraction abducts the arm, raising it to a horizontal position



# Muscular System

## ■ Muscles of shoulder & Upper Arm

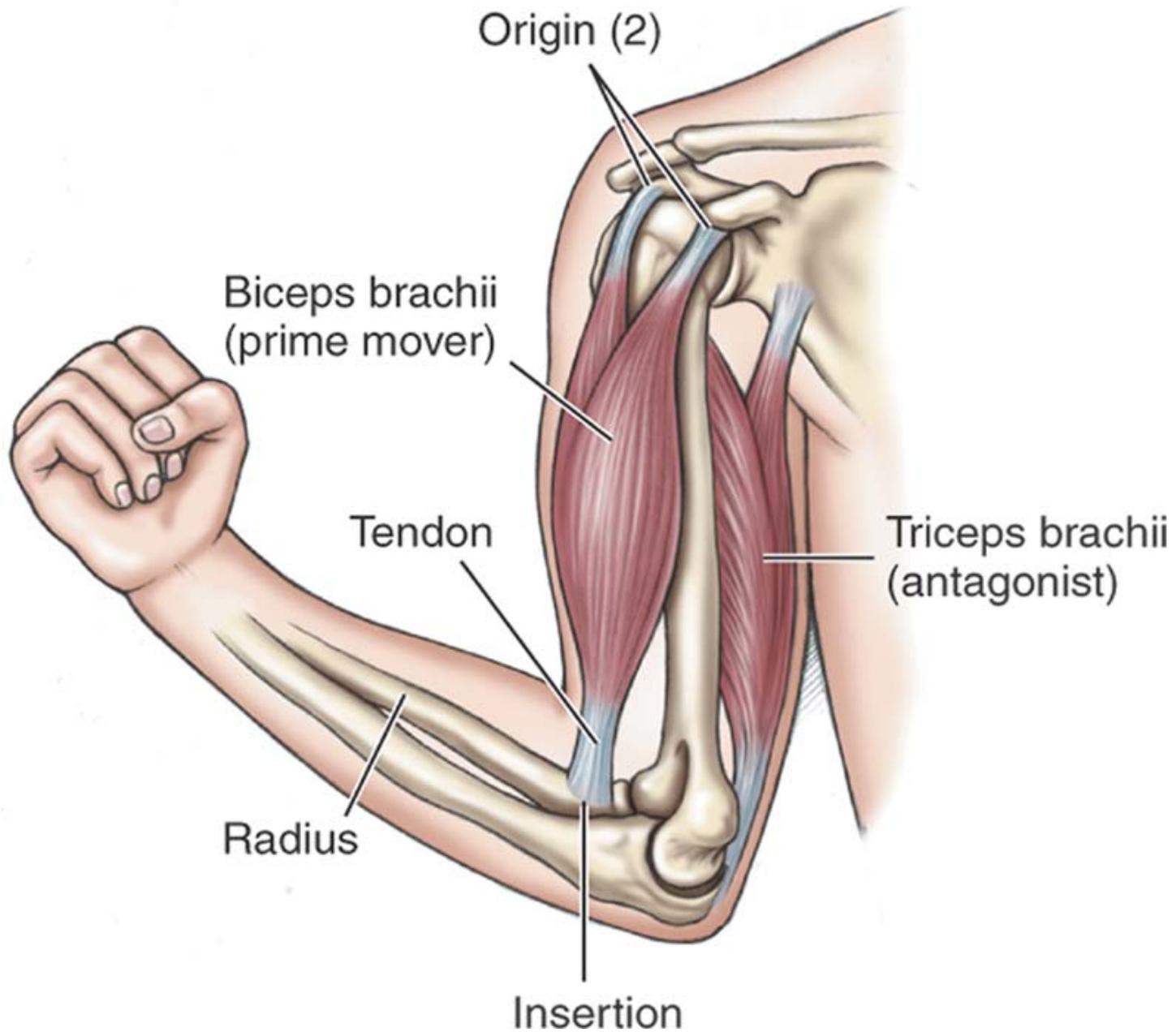
- Pectoralis major: large broad muscle that forms anterior chest wall; connects with humerus & clavicle; contraction moves upper arm across front of chest
- Latissimus dorsi: large broad muscle located in the middle & lower back region; extends from back to humerus; contraction lowers shoulders & brings arms back as in rowing
- Rotator cuff muscles: group of 4 muscles that attach the humerus to scapula; form cuff over proximal humerus; helps rotate arm at shoulder



# Muscular System

## ■ Muscles that move Lower Arm

- Triceps brachii: lies at posterior surface of the humerus; contraction extends forearm
- Biceps brachii: located on the anterior surface of the humerus; contraction extends the forearm; works synergistically with brachialis & brachioradialis





# Muscular System

- Muscles that move the Hands & Fingers
  - Flexors & extensors are 20 muscles move hand & fingers; allow delicate movements
  - Flexors are located anteriorly
  - Extensors are located posteriorly
  - Flexors are slightly stronger which attributes to the slight flexed position of the hand at rest



# Muscular System

## ■ Muscles that move the Thigh, Leg & Foot

- Gluteal Muscles: located on posterior surface of body & include:
  - Gluteus maximus: largest muscle of body & forms buttocks; muscle we sit on
  - Gluteus medius
  - Gluteus minimus
- The gluteal muscles abduct the thigh; raise thigh sideways to a horizontal position



# Muscular System

## ■ Muscles that move the Thigh

- Iliopsoas: anterior surface of groin; contraction flexes the thigh; antagonist to the gluteus maximus
- Adductor muscles: located on medial surface of the thigh; adduct the thighs pressing them together & include:
  - Adductor longus
  - Adductor brevis
  - Adductor magnus
  - Adductor gracilis



# Muscular System

## ■ Muscles that move the Leg

- Quadriceps Femoris: group of four muscles located on anterior & lateral surface of the thigh; insert into tibial tuberosity by patellar tendon; contraction extends or straightens the leg at the knee; kicking a football
- 4 muscles that make Quadriceps Femoris:
  - Vastus lateralis
  - Vastus intermedius
  - Vastus medialis
  - Rectus femoris



# Muscular System

## ■ Muscles that move the Leg

- Sartorius: longest muscle in the body; strap-like muscle located on the anterior surface thigh; passes over quadriceps in an oblique direction; allows legs to rotate; cross legs
- Hamstrings: group of muscles located on posterior surface of thigh; extend from ischium to tibia; contraction flex leg at knee
- Includes:
  - biceps femoris
  - Semimembranosus
  - semitendinosus



# Muscular System

## ■ Muscles that Move the Foot

- Tibialis anterior: located on anterior surface; contraction causes dorsiflexion
- Peroneus longus: muscles on lateral surface; contraction causes eversion; supports arch of foot; assist plantar flexion
- Gastrocnemius & Soleus: major muscles of the posterior leg that form calf; attach to the calcaneus by calcaneal tendon or Achilles tendon; contraction causes plantar flexion; tiptoe