
بسم الله الرحمن الرحيم
السلام عليكم ورحمة الله وبركاته

بسم الله الرحمن الرحيم

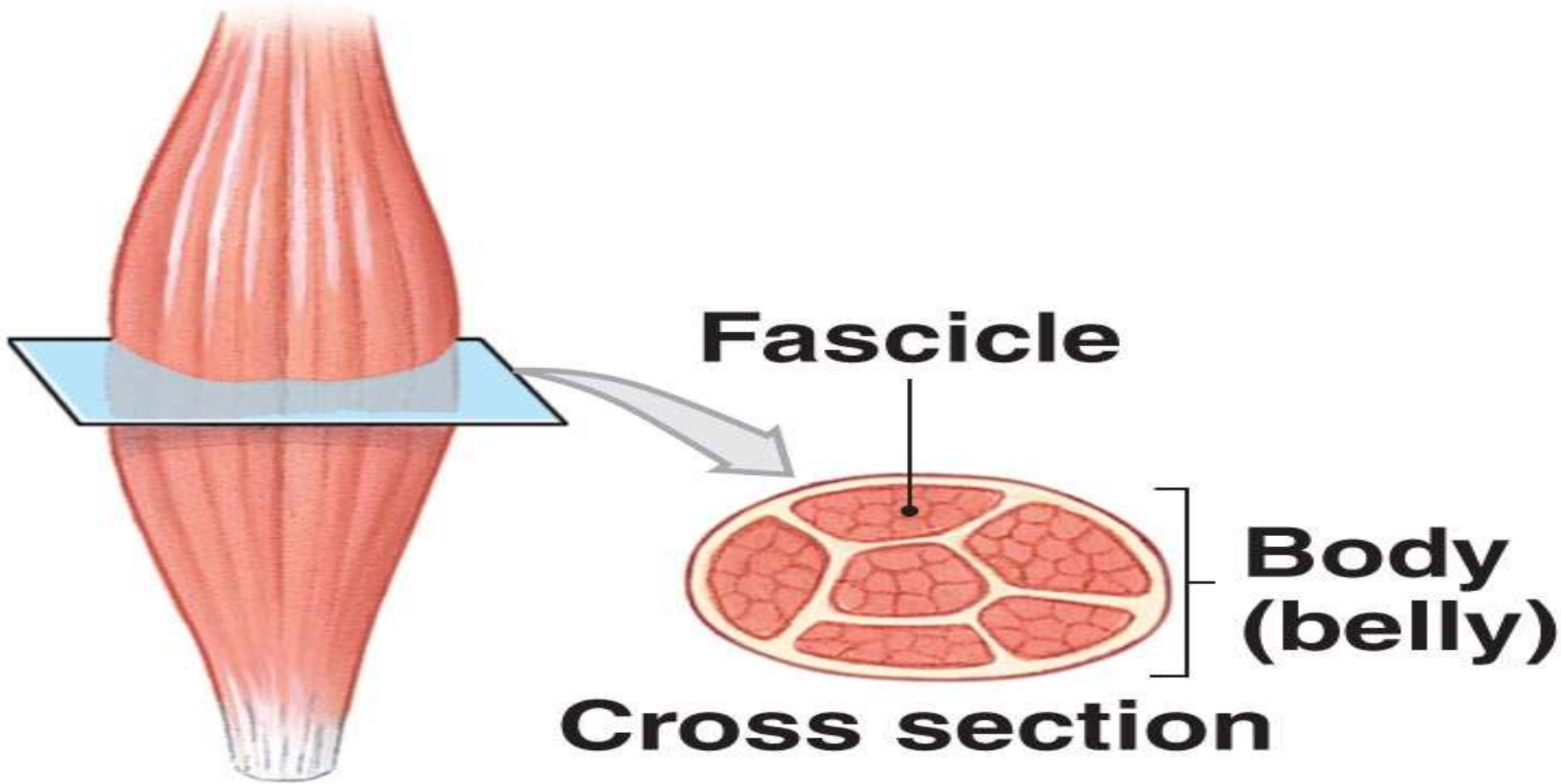
DR. NAMMER
PhD ANATOMY, HISTOLOGY
AND EMBRYOLOGY

# Parts of the skeletal system

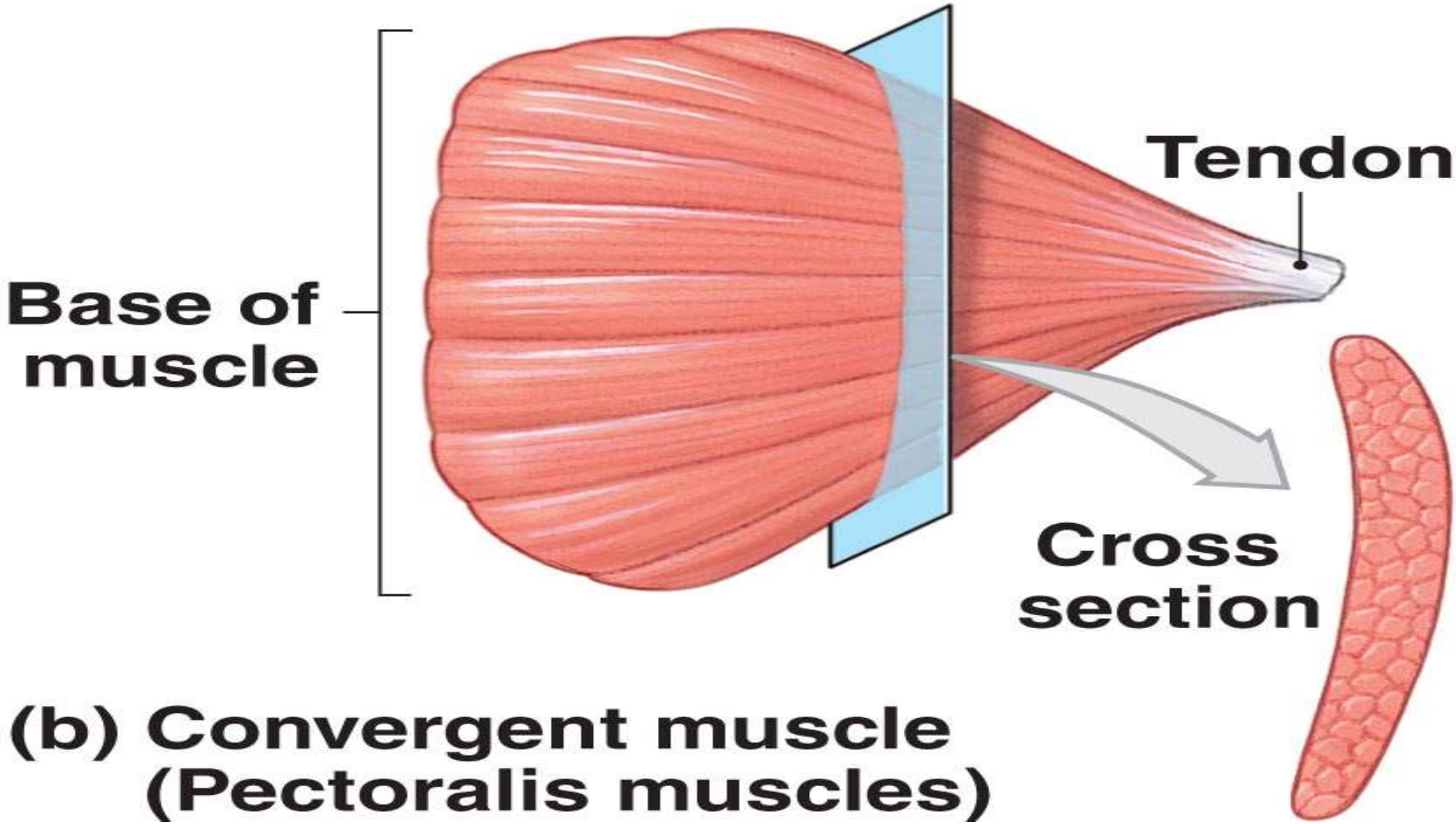
- Bones (skeleton)
- Cartilage
- Joints: hold bones together & mobility
- Ligaments & Tendons

# Fascicle Arrangement

- **Organization of Skeletal Muscle Fibers**
  - **Four patterns of fascicle organization**
    - **Parallel**
    - **Convergent**
    - **Pennate**
    - **Circular**



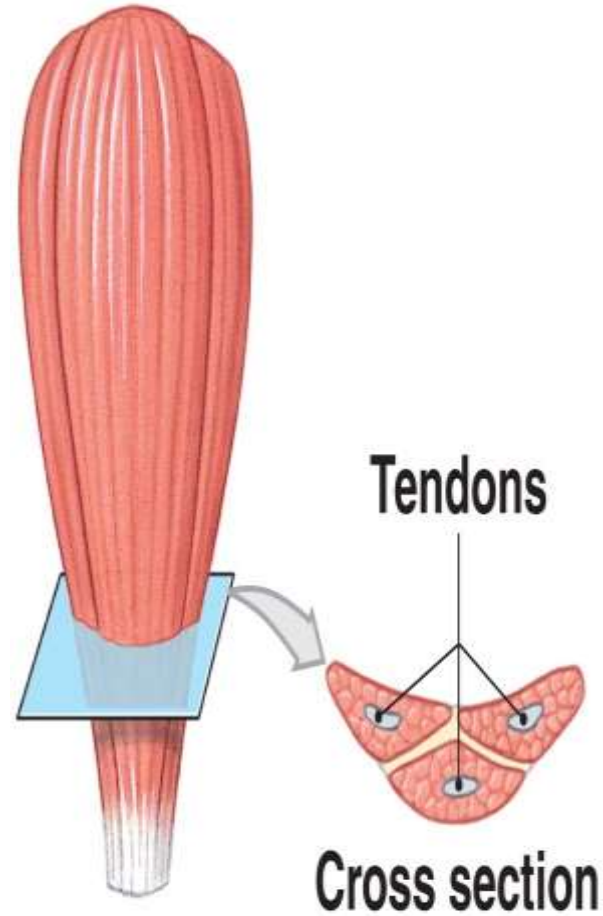

(a) Parallel muscle
(Biceps brachii muscle)




(b) Convergent muscle (Pectoralis muscles)

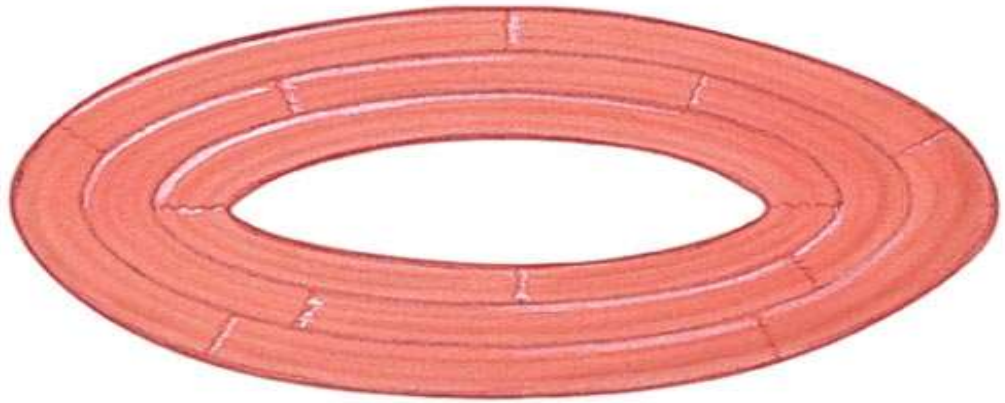

(c) Unipennate muscle
(Extensor digitorum muscle)

(d) Bipennate muscle
(Rectus femoris
muscle)




(e) Multipennate muscle
(Deltoid muscle)

Contracted



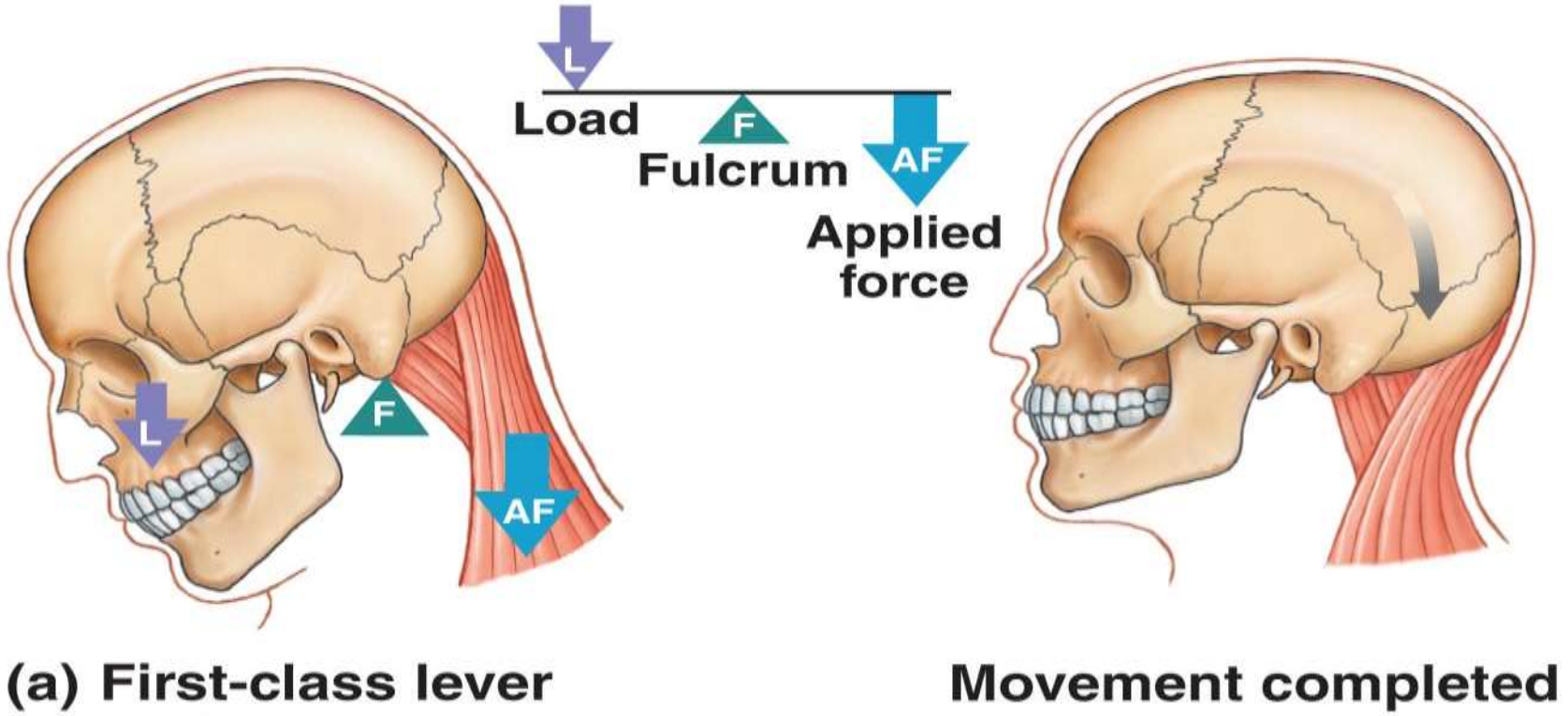
Relaxed

(f) Circular muscle (Orbicularis oris muscle)

- **Levers**
  - **Mechanically, each bone is a lever (a rigid, moving structure)**
    - **And each joint a fulcrum (a fixed point)**
  - **Muscles provide applied force (AF)**
    - **Required to overcome resistance (R)**

- Function of a lever is to change
  - Direction of an AF
  - Distance and speed of movement produced by an AF
  - Effective strength of an AF
- The Three Classes of Levers
  - Depend on the relationship between applied force, fulcrum, and resistance
    - First class, second class, and third class

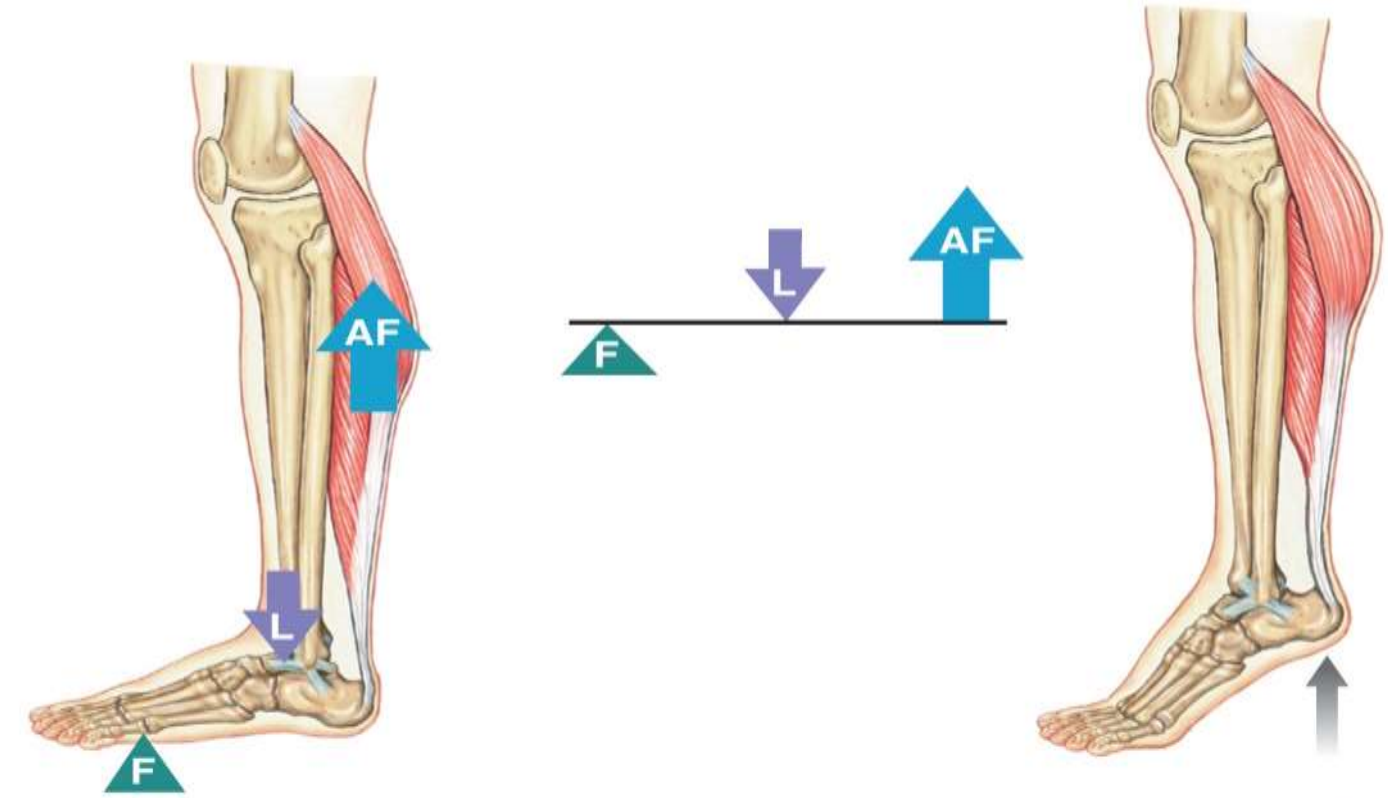
# First Class Lever




(a) First-class lever

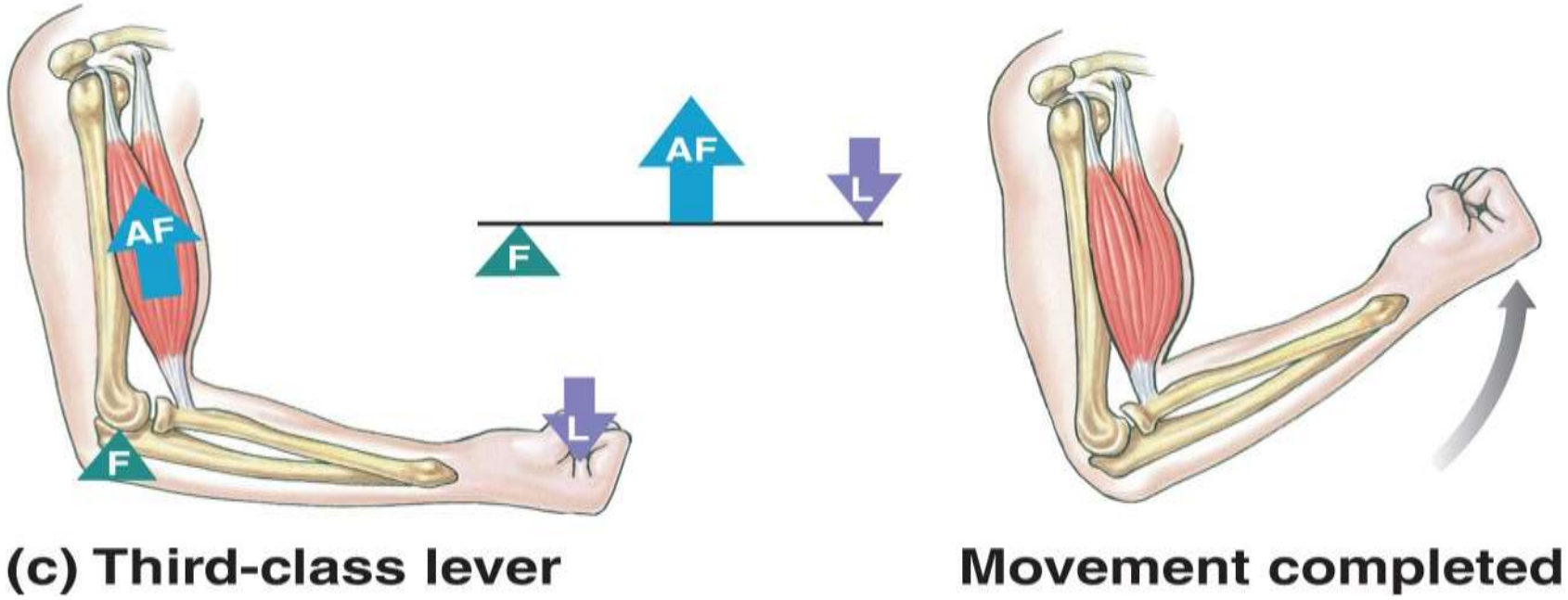
Movement completed

# Second Class Lever




(b) Second-class lever

# Third Class Lever



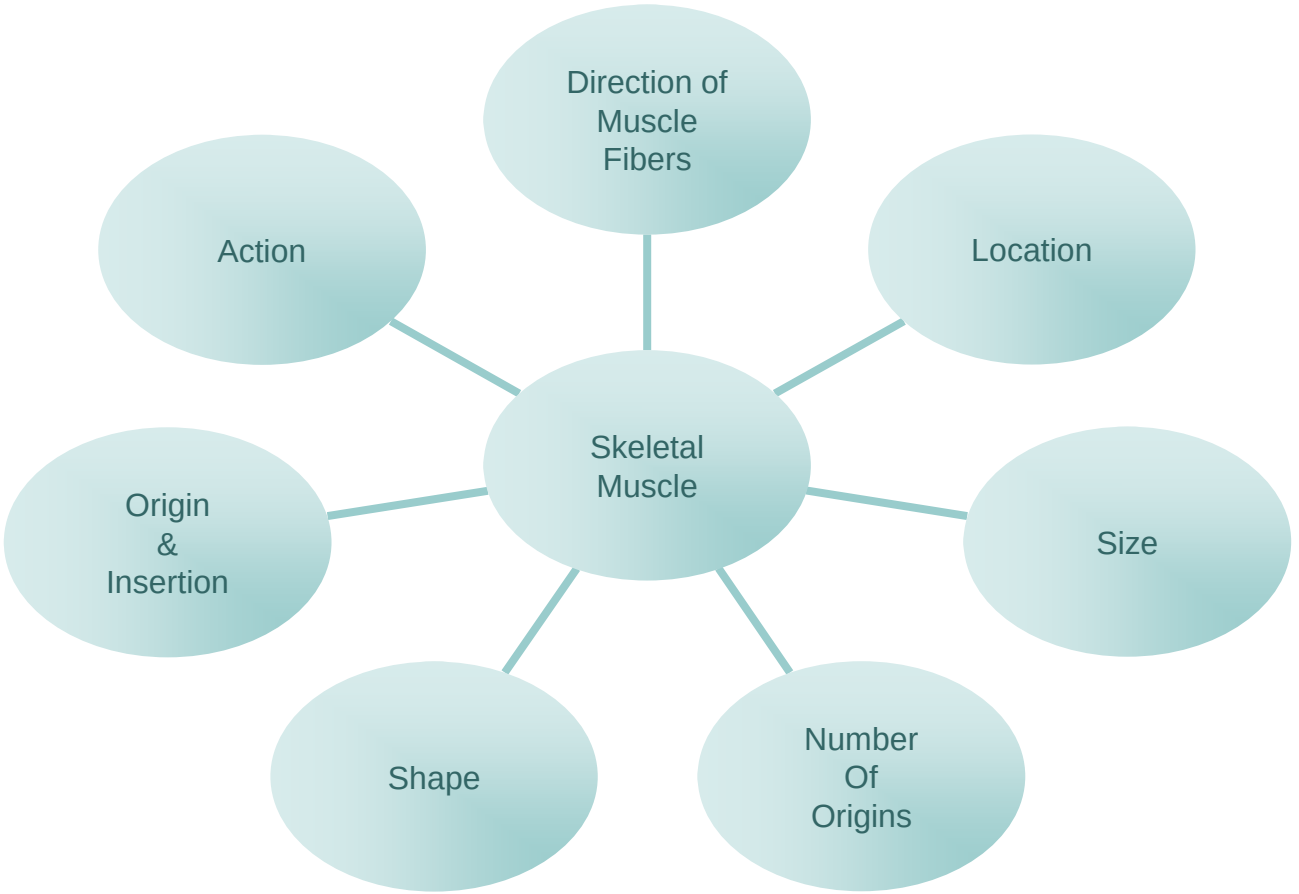

(c) Third-class lever

Movement completed

# Types of Muscle--Actions

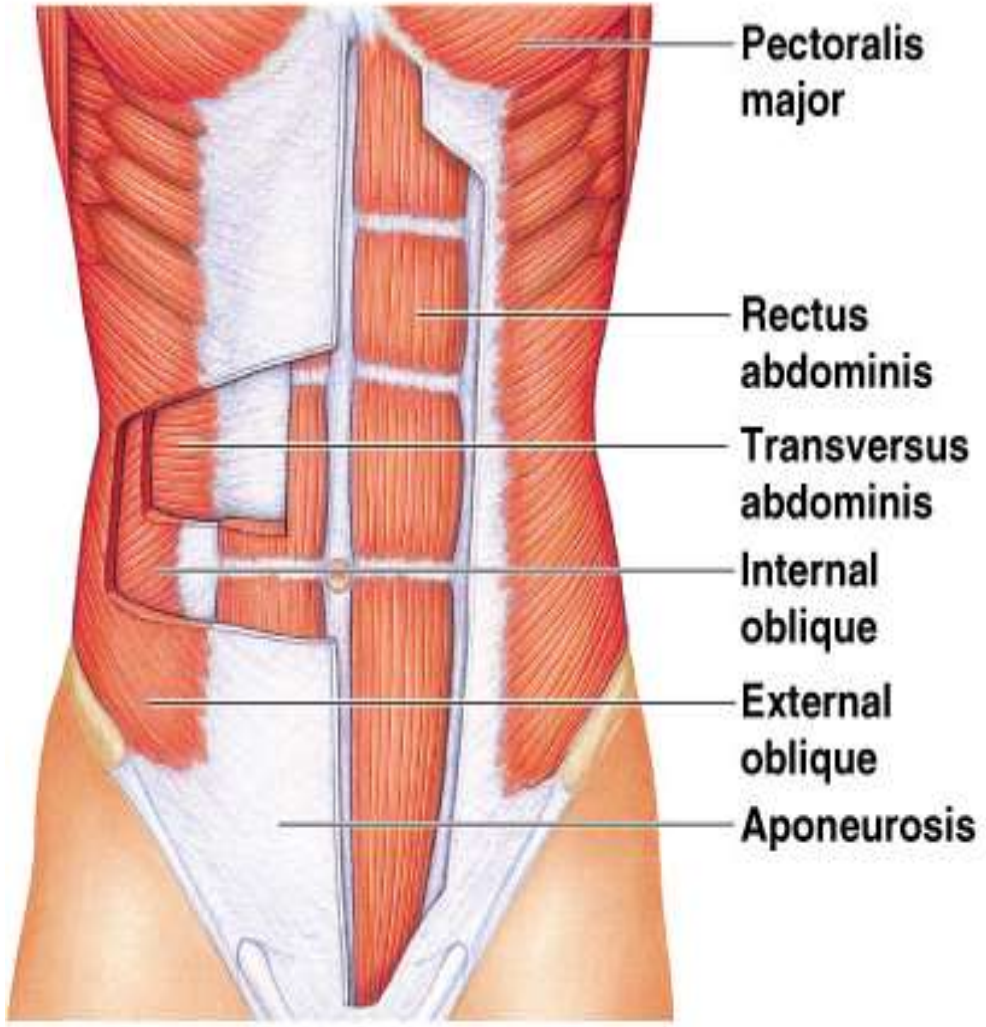
- **Prime mover (Agonist) – muscle with the major responsibility for a certain movement**
- **Antagonist – muscle that opposes or reverses a prime mover**
- **Synergist – muscle that aids a prime mover in a movement and helps prevent rotation**
- **Fixator – stabilizes the origin of a prime mover**

# Naming Skeletal Muscles

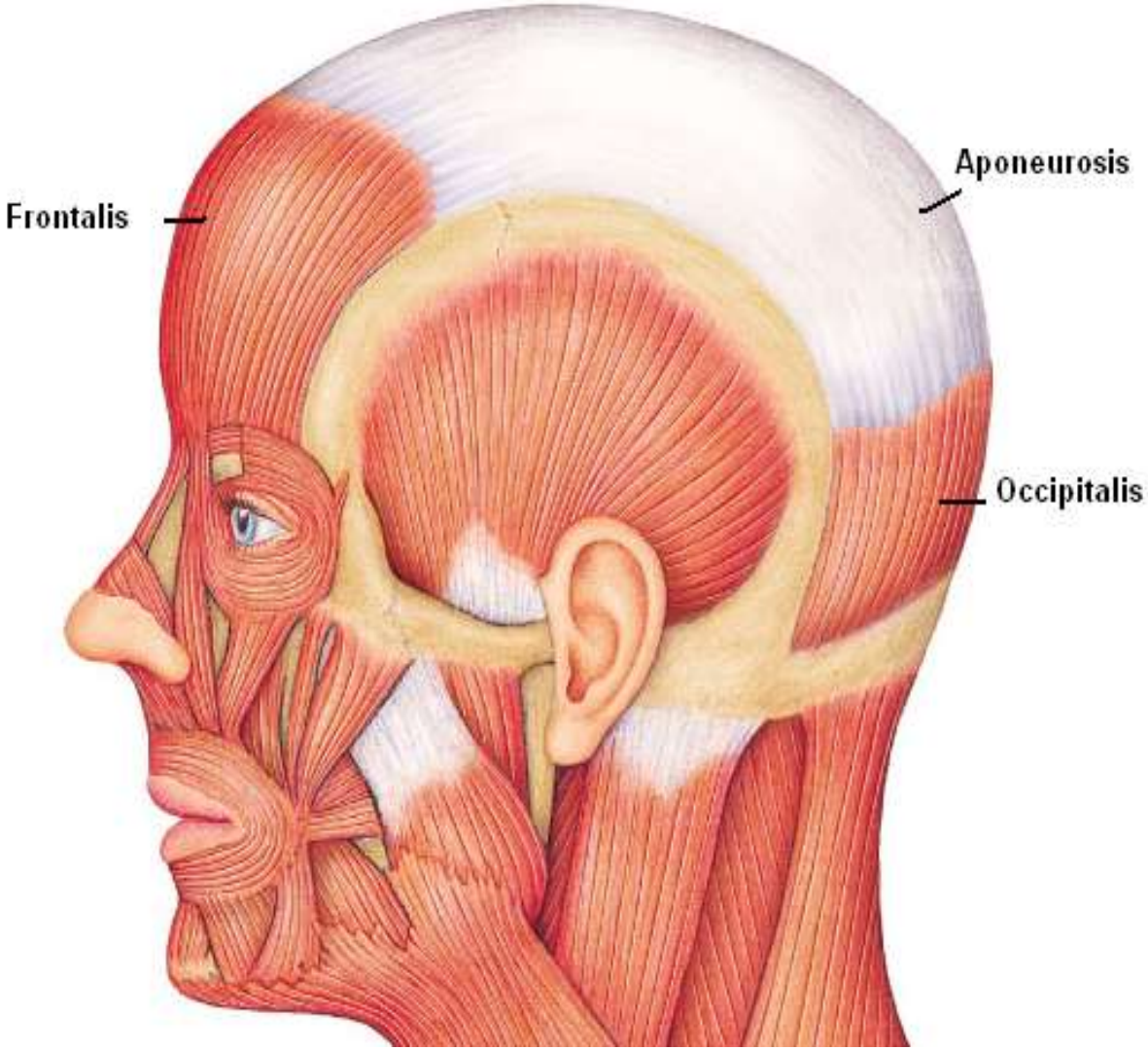


# Direction of Muscle Fibers

- Relative to the Midline
- **RECTUS** = parallel to the midline
  - ***Rectus*** *Abdominus*
- **TRANSVERSE** = perpendicular to midline
  - ***Transverse*** *Abdominus*
- **OBLIQUE** = diagonal to midline
  - *External* ***Oblique***



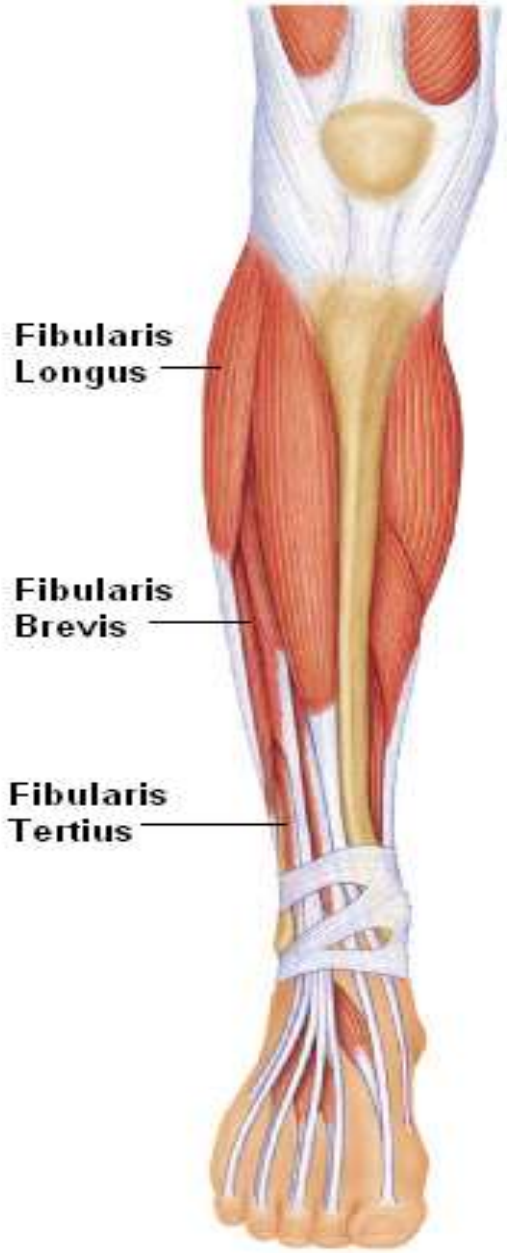
# Location

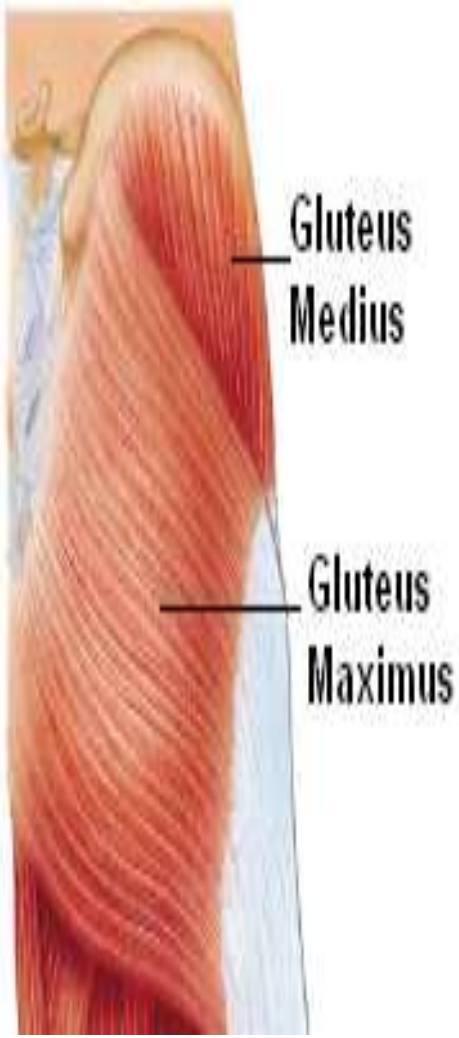



- Structure near which muscle is found
  - ***FRONTALIS*** = near FRONTAL bone
  - ***OCCIPITALIS*** = near OCCIPITAL bone

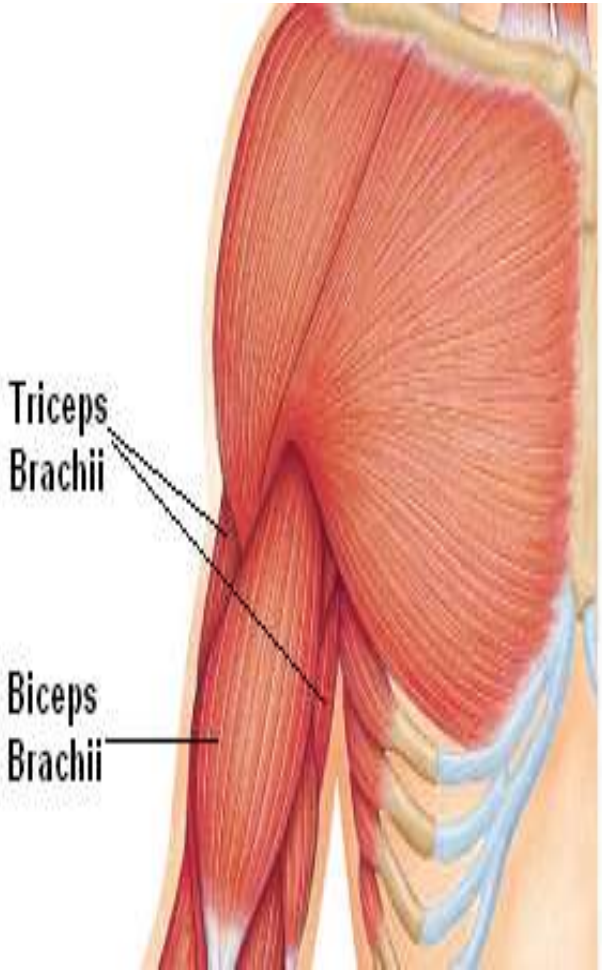
# Size

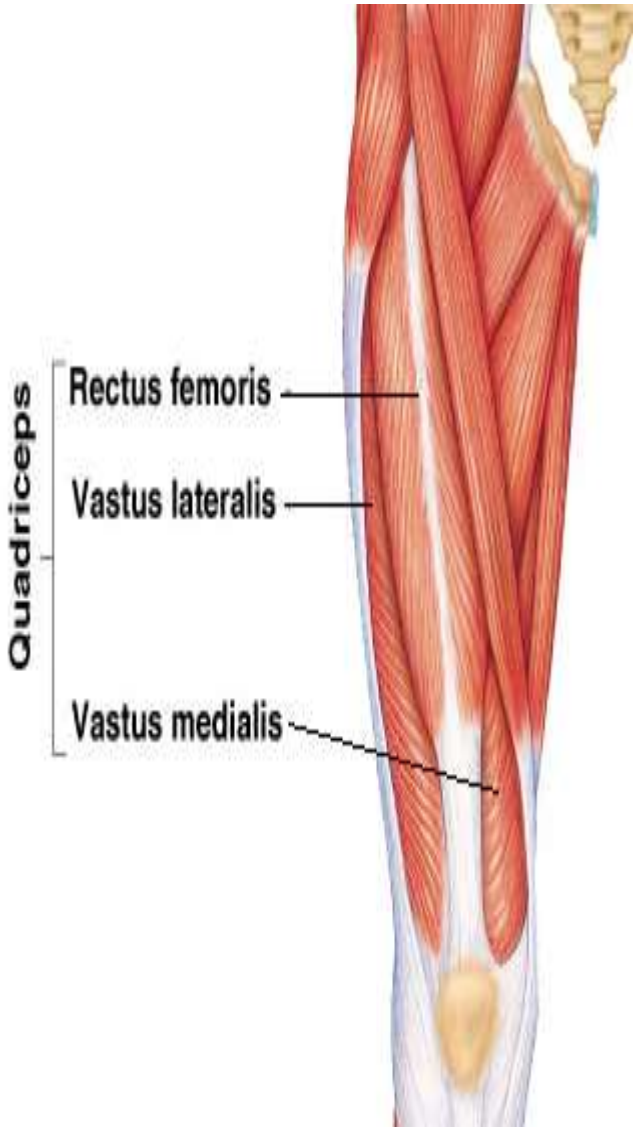
- Relative Size of Muscle
- **MAXIMUS** = largest
  - *Gluteus **Maximus***
- **MEDIUS** = middle
  - *Gluteus **Medius***
- **MINIMUS** = smallest
  - *Gluteus **Minimus***
- **LONGUS** = longest
  - *Fibularis **Longus***
- **BREVIS** = short
  - *Fibularis **Brevis***
- **TERTIUS** = shortest
  - *Fibularis **Tertius***



# Number of Origins

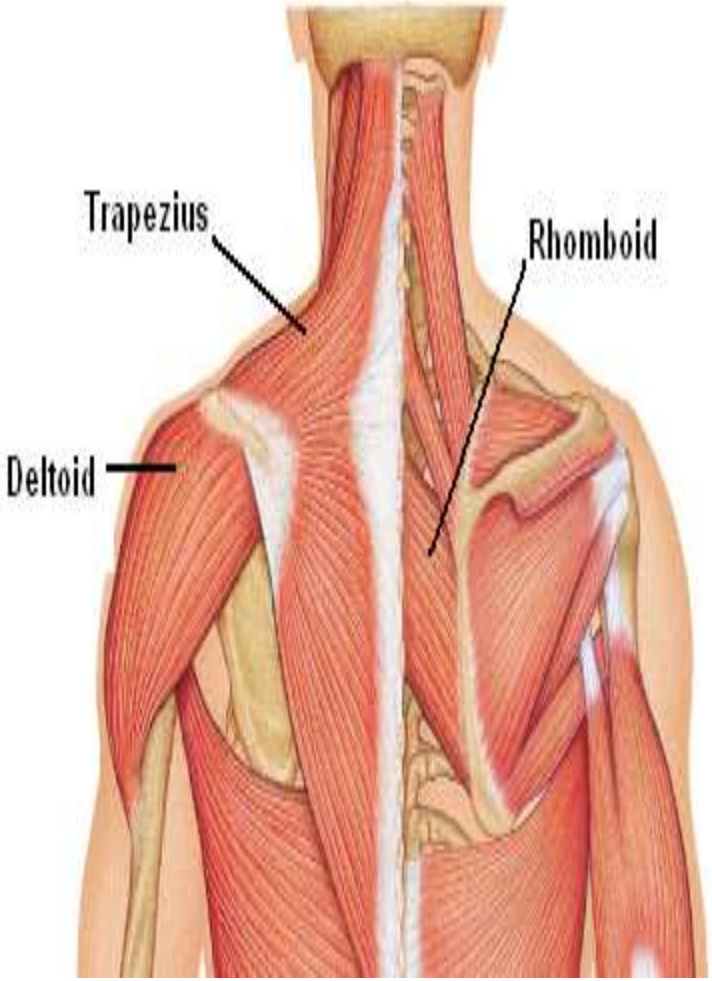


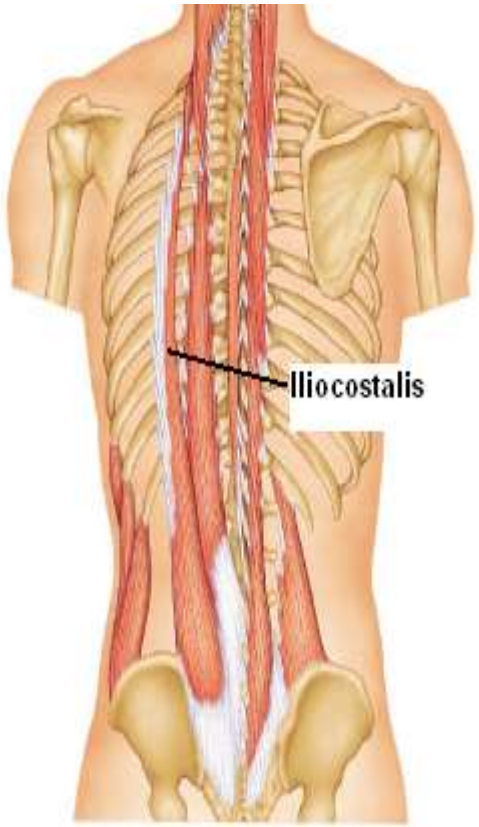

- Number of tendons of origin
- **BICEPS** = Two
  - ***Biceps*** *Brachii*
  - ***Biceps*** *Femoris*
- **TRICEPS** = Three
  - ***Triceps*** *Brachii*
- **QUADRICEPS** = Four
  - ***Quadriceps*** *Femoris*

# Shape

- Relative Shape of the Muscle
- **DELTOID** = triangular shape Δ
- **TRAPEZIUS** = trapezoid shape ◊
  **SERRATUS** = saw-toothed ≈
- **RHOMBOIDEUS** = rhomboid shape ▱
- **TERES** = round ○



# Origin & Insertion




- Origin – attachment to an immoveable bone
- Insertion – attachment to a movable bone
- **ILIO COSTALIS**= attaches to the ilium & ribs (costal = ribs)

# Action

| NAME | ACTION | EXAMPLE |
|---|---|---|
| FLEXOR | Decrease angle at a joint | ***Flexor*** *Carpi Radialis* |
| EXTENSOR | Increase angle at a joint | ***Extensor*** *Carpi Ulnaris* |
| ABDUCTOR | Move bone away from midline | ***Abductor*** *Pollicis Longus* |
| ADDUCTOR | Move bone toward midline | ***Adductor*** *Longus* |
| LEVATOR | Produce upward movement | ***Levator*** *Scapulae* |
| DEPRESSOR | Produce downward movement | ***Depressor*** *Labii Inferioris* |
| SUPINATOR | Turn palm upward/anterior | ***Supinator*** |
| PRONATOR | Turn palm downward/posterior | ***Pronator*** *Teres* |

# MUSCLES CAN WORK AS:

- Flexors – contracting to bend our joints.
- Extensors – contracting to straighten joints.
- Prime movers (agonists) – contracting to start a movement.
- Antagonists – relaxing to allow movement to take place.
- Fixators – contracting to give the working muscles a firm base.
- Synergists – stabilising the area around the prime mover and fine tuning our movement.

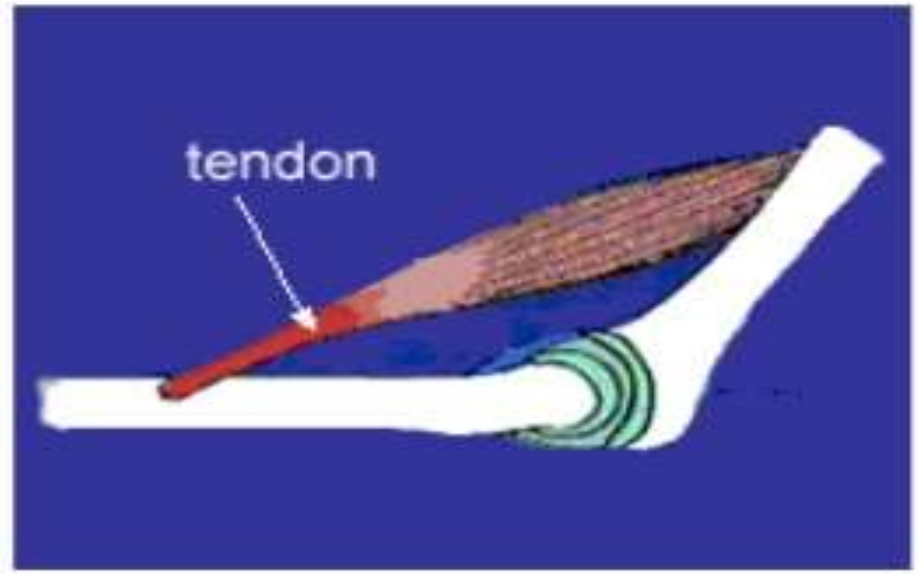
# HOW ARE MUSCLES ATTACHED TO BONES?

Muscles are usually attached to 2 or more different bones.

The muscle fibres end in a strong, white flexible cord, called a TENDON. At the bone, the fibres of the tendon are embedded in the PERIOSTIUM of the bone. This anchors the tendon strongly and spreads the force of the Contraction

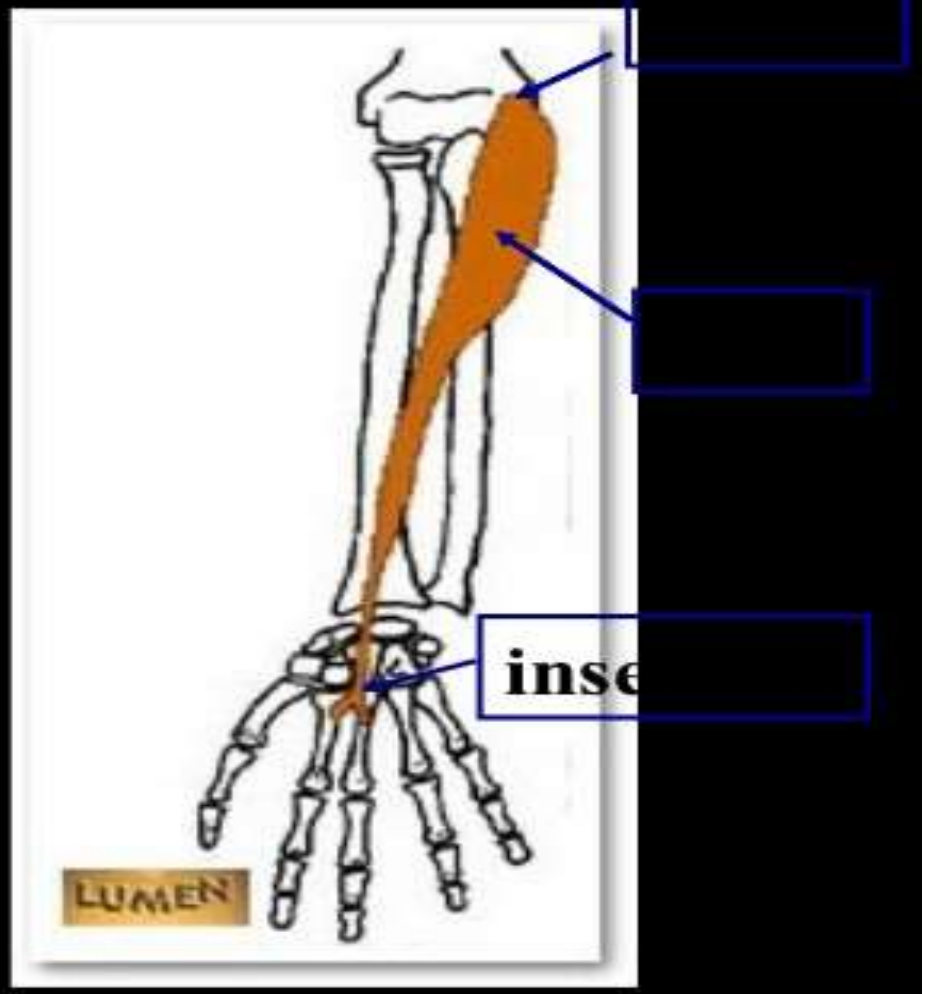
**REMEMBER:**

Tendons join muscle to bone.
Ligaments join bone to bone.



# Movement of Muscles

- **Origin:** the attachment of the muscle to the bone that remains stationary
- **Insertion:** the attachment of the muscle to the bone that moves
- **Belly:** the fleshy part of the muscle between the tendons of origin and/or insertion



# Movement of skeletal muscle

- These muscles move when the brain sends messages to the muscle
- Always work in pairs
- 2 movements of skeletal muscle
  - Contraction (shorten)
  - Extension (lengthen)

# Categories of skeletal muscle actions

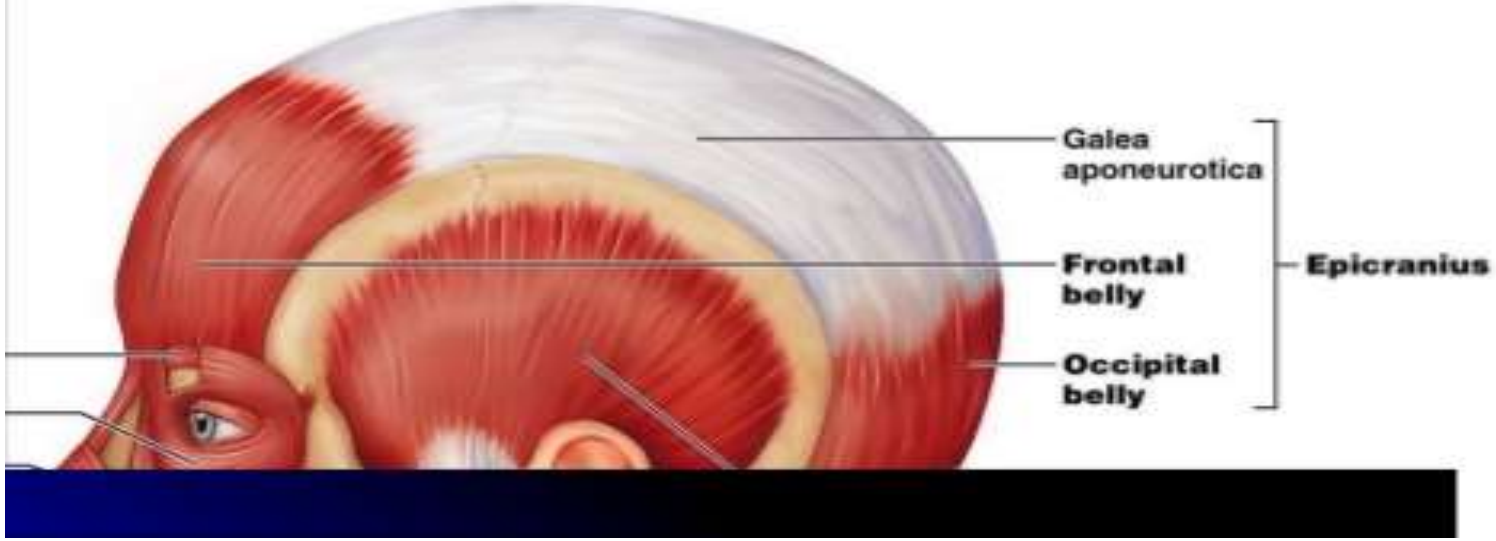
| Categories | Actions |
| --- | --- |
| **Extensor** | Increases the angle at a joint |
| **Flexor** | Decreases the angle at a joint |
| **Abductor** | Moves limb away from midline of body |
| **Adductor** | Moves limb toward midline of body |
| **Levator** | Moves insertion upward |
| **Depressor** | Moves insertion downward |
| **Rotator** | Rotates a bone along its axis |
| **Sphincter** | Constricts an opening |

# Naming Skeletal Muscles

- Location of the muscle
- Shape of the muscle
- Relative Size of the muscle
- Direction/Orientation of the muscle fibers/ cells
- Number of Origins
- Location of the Attachments
- Action of the muscle

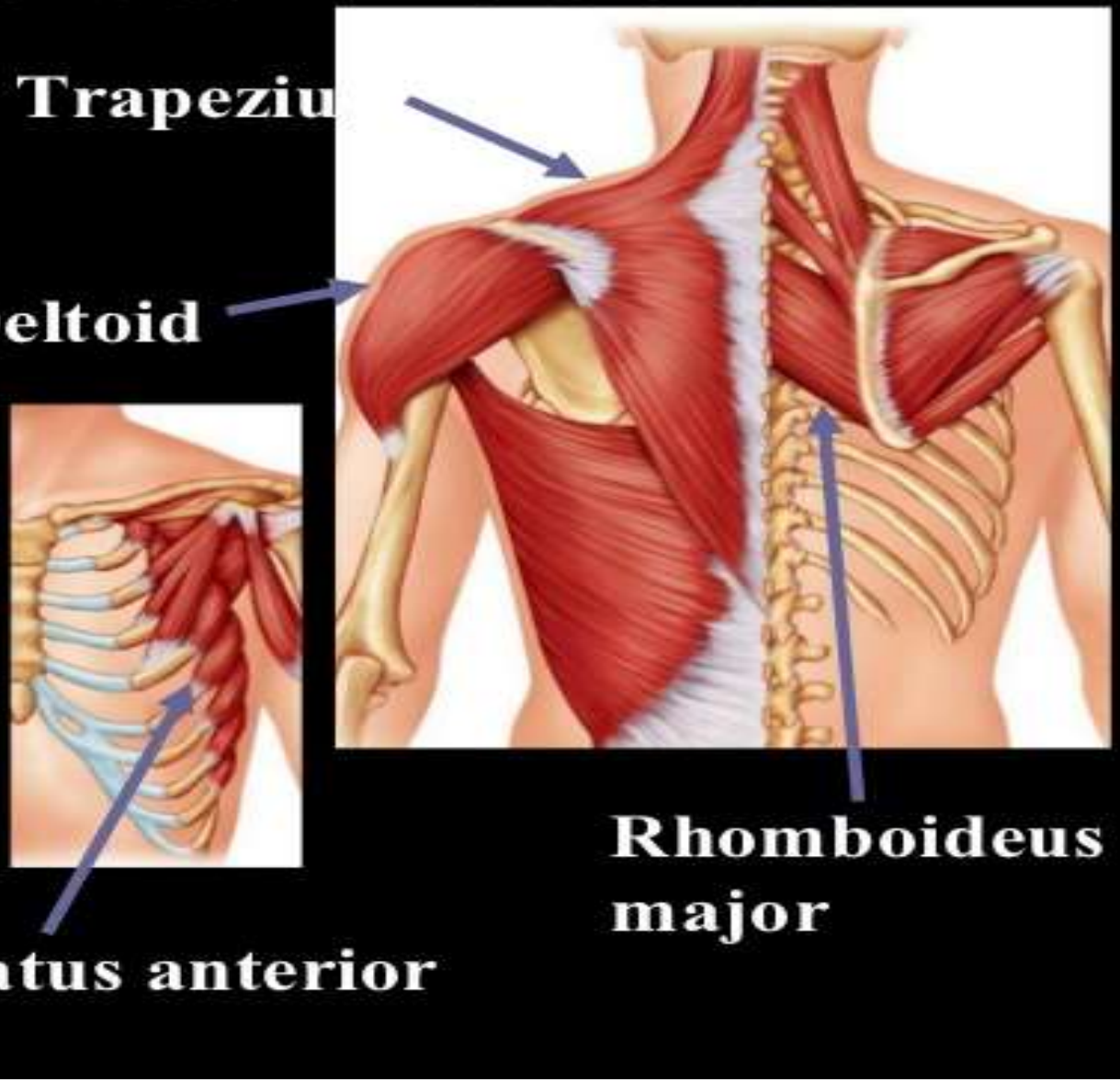
# Muscles Named by Location

- **Epicranius**
  (around cranium)
- **Tibialis anterior**
  (front of tibia)



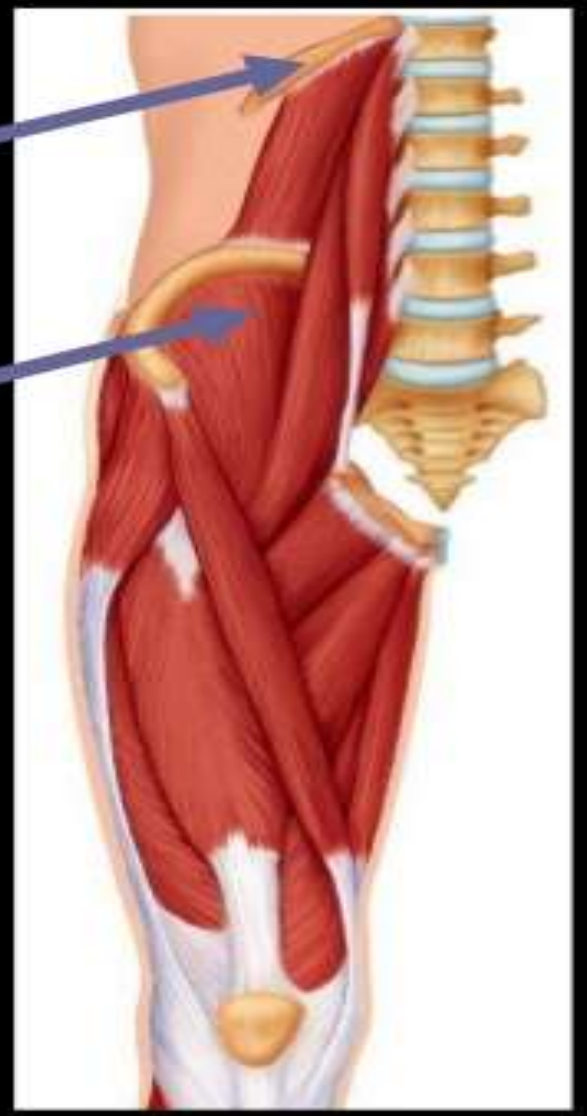

# Naming Skeletal Muscles

- **Shape:**
  - deltoid (triangle)
  - trapezius (trapezoid, 2 parallel sides)
  - serratus (saw-toothed)
  - rhomboideus (rhomboid, 4 parallel sides)
  - orbicularis and sphincters (circular)



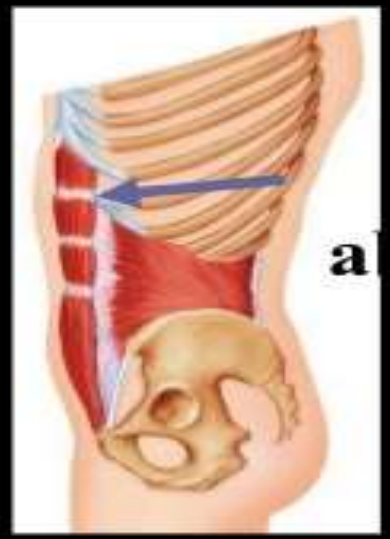
# Muscles Named by Size

- maximus (largest)
- minimis (smallest)
- longus (longest)
- brevis (short)
- major (large)
- minor (small)



# Muscles Named by Direction of Fibers

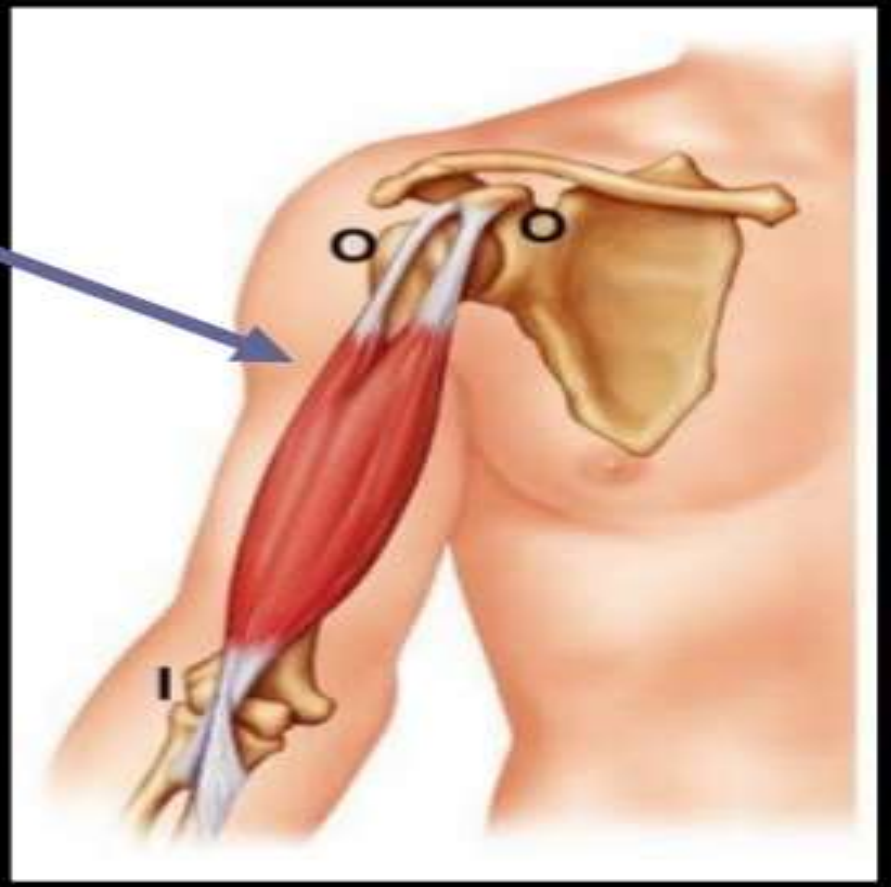
- Rectus (straight) –parallel to long axis
- Transverse
- Oblique



External oblique

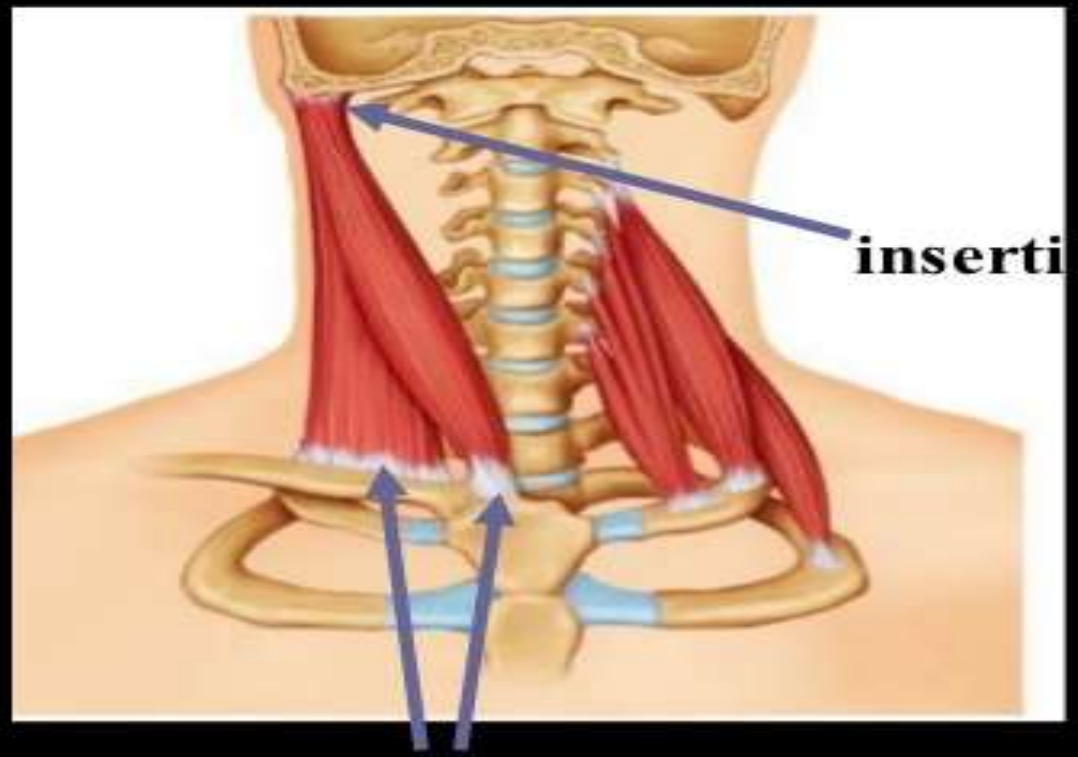
# Muscles Named for Number of Origins

- Biceps (2)
- Triceps (3)
- Quadriceps (4)



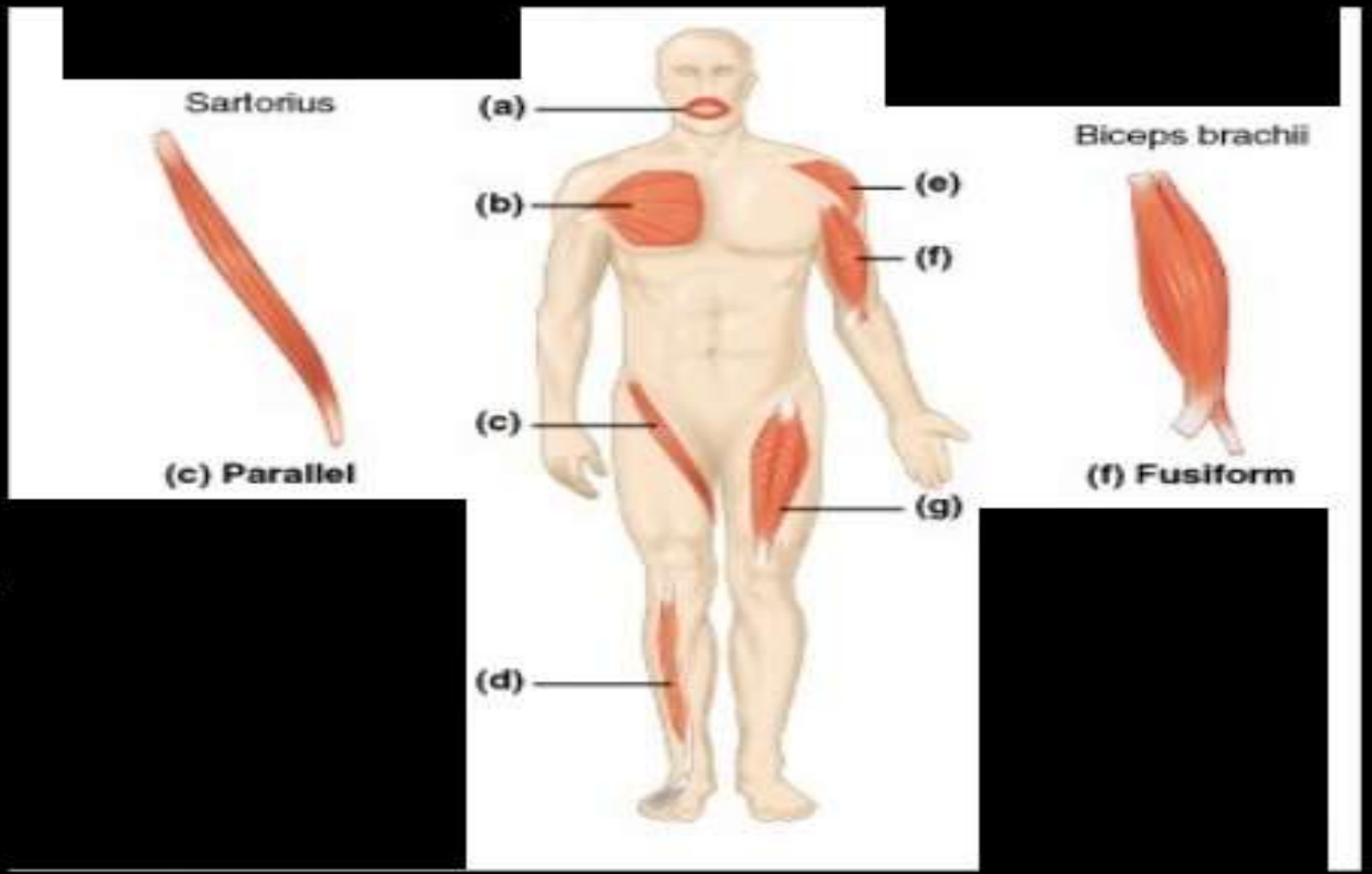
# Muscles Named for Origin and Insertion

**Sternocleidomastoid** originates from sternum and clavicle and inserts on mastoid process of temporal bone



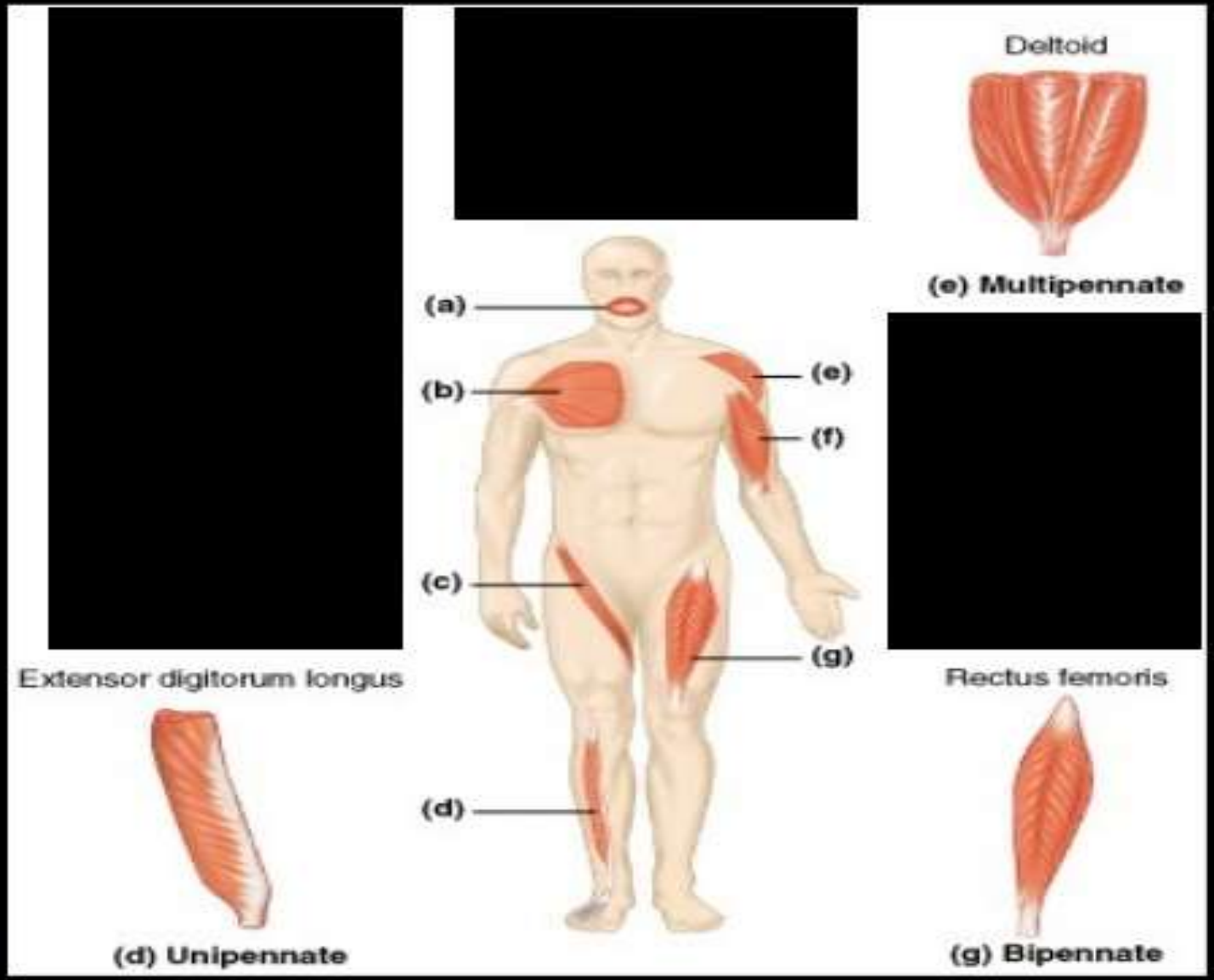
# Arrangement of Fascicles

- **Parallel**
  - strap-like
  - ex: sartorius
- **Fusiform**
  - spindle shaped
  - ex: biceps femor



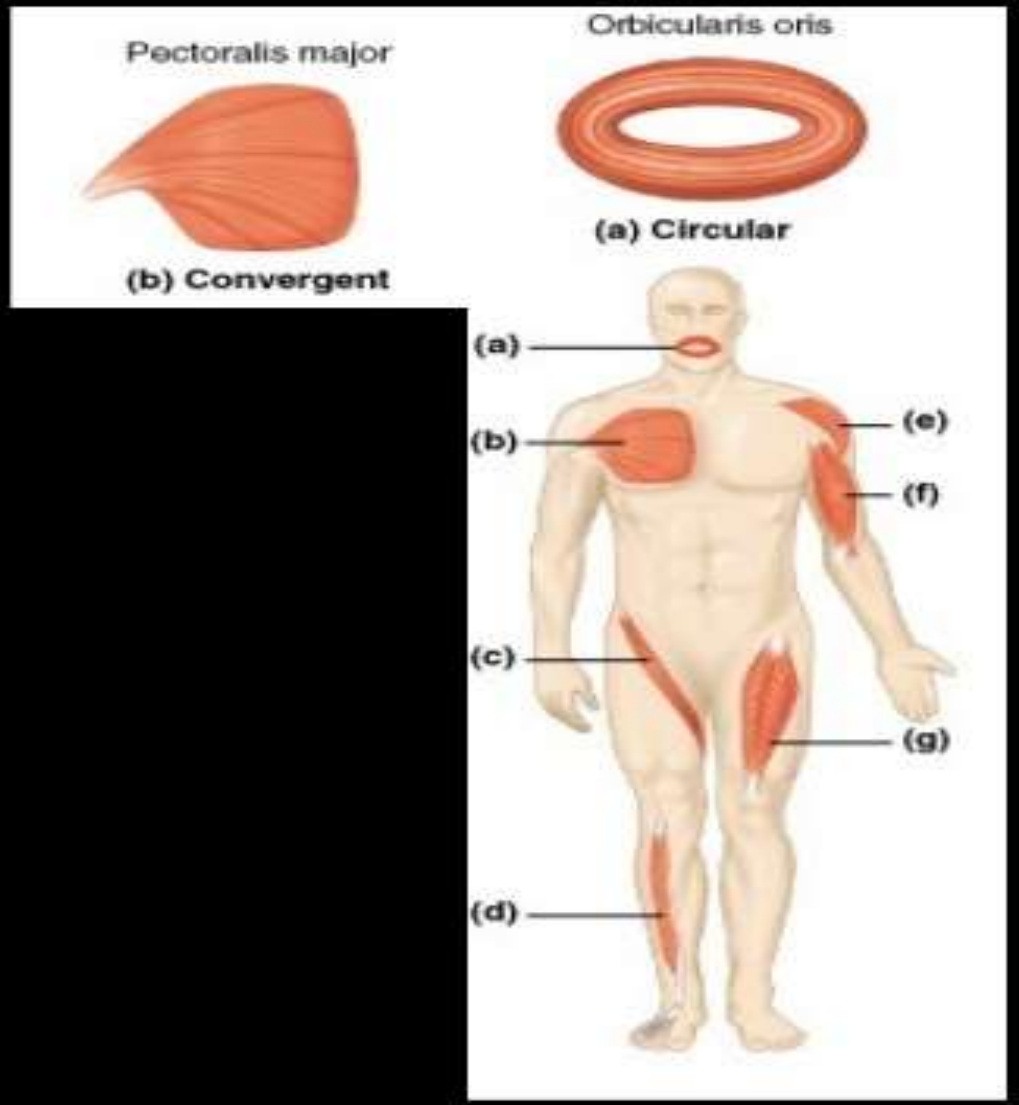
# Arrangement of Fascicles

- **Pennate**
  - "feather shaped"
- **Unipennate**
  - ex: extensor digitorum longus
- **Bipennate**
  - ex: rectus femoris
- **Multipennate**
  - ex: deltoid



# Arrangement of Fascicles

- **Convergent**
  - ex: pectoralis major
- **Circular**
  - sphincters
  - ex: orbicularis oris



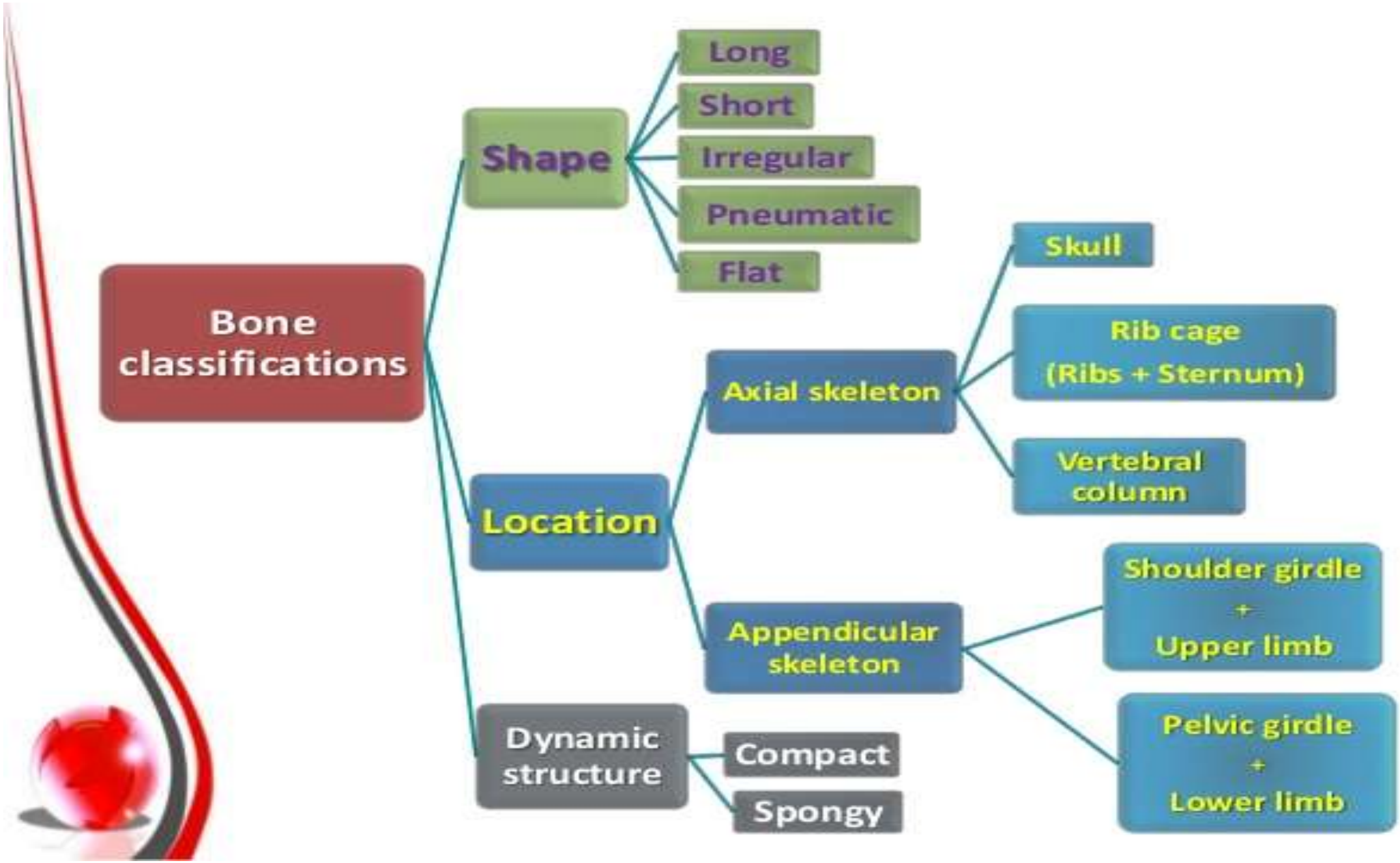

BONE

# Introduction

- Bone is mineralized dense connective tissue
- Made up of few cells in mineralized matrix
- Consists of 30-40 % of our body weight.
- Dynamic in nature

# Parts of bones

- **Epiphysis** – secondary centers
  - Pressure epiphysis
  - Traction epiphysis
  - Atavistic epiphysis
- **Diaphysis** – primary center
  - Strongest part of bone


Bone classifications
Shape
Long
Short
Irregular
Pneumatic
Flat
Location
Axial skeleton
Skull
Rib cage (Ribs + Sternum)
Vertebral column
Appendicular skeleton
Shoulder girdle + Upper limb
Pelvic girdle + Lower limb
Dynamic structure
Compact
Spongy

- **Bone shapes**

➢ Long bones

➢ Short bones

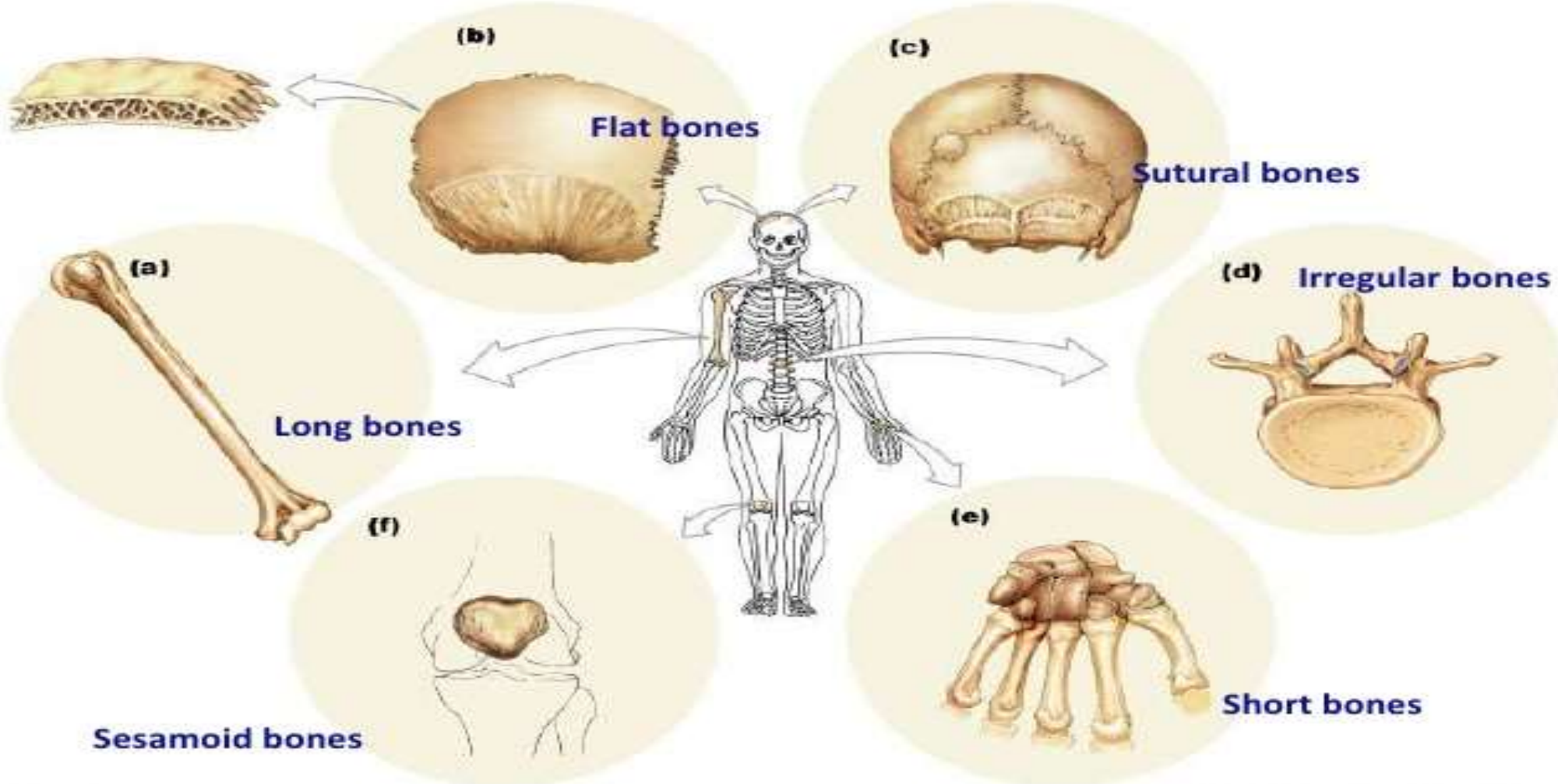
➢ Flat bones

➢ Irregular bones

➢ Sesamoid bones

➢ Pneumatic bones

➢ Accessory bones




*Human Anatomy*, 5e
by Frederic H. Martini/Michael J. Timmons/Robert B. Tallitsch

# Compact and Spongy Bone

- Compact bone located where stresses are limited in direction.
- Spongy bone located where stresses are weaker or multi-directional.

# Classification of Joints

- Function:
  - Synarthroses = no/little movement
  - Amphiarthroses =  slight movement
  - Diarthroses = great movement

# Joints by Functional Classification

| Type | Movement | Example | |
|---|---|---|---|
| Synarthrosis | None (minimal) | Sutures, Teeth, Epiphyseal plates, 1st rib and costal cart. | |
| Amphiarthrosis | Slight | Distal Tibia/fibula Intervertebral discs Pubic symphysis | |
| Diarthrosis | Great | Glenohumeral joint Knee joint TMJ | |

# Joint Classification

- Structure
  - Cartilagenous
    - Synchondrosis: connected by hyaline cartilage (synarthroses)
    - Symphysis: connected by fibrocartilage (amphiarthroses)
  - Fibrous
    - Sutures: connected by short strands of dense CT  (synarthroses)
    - Syndesmoses: connected by ligaments (varies)
    - Gomphosis: peg  in socket w/short ligament (synarthroses)
  - Synovial (diarthroses)

# Joints by Structural Classification

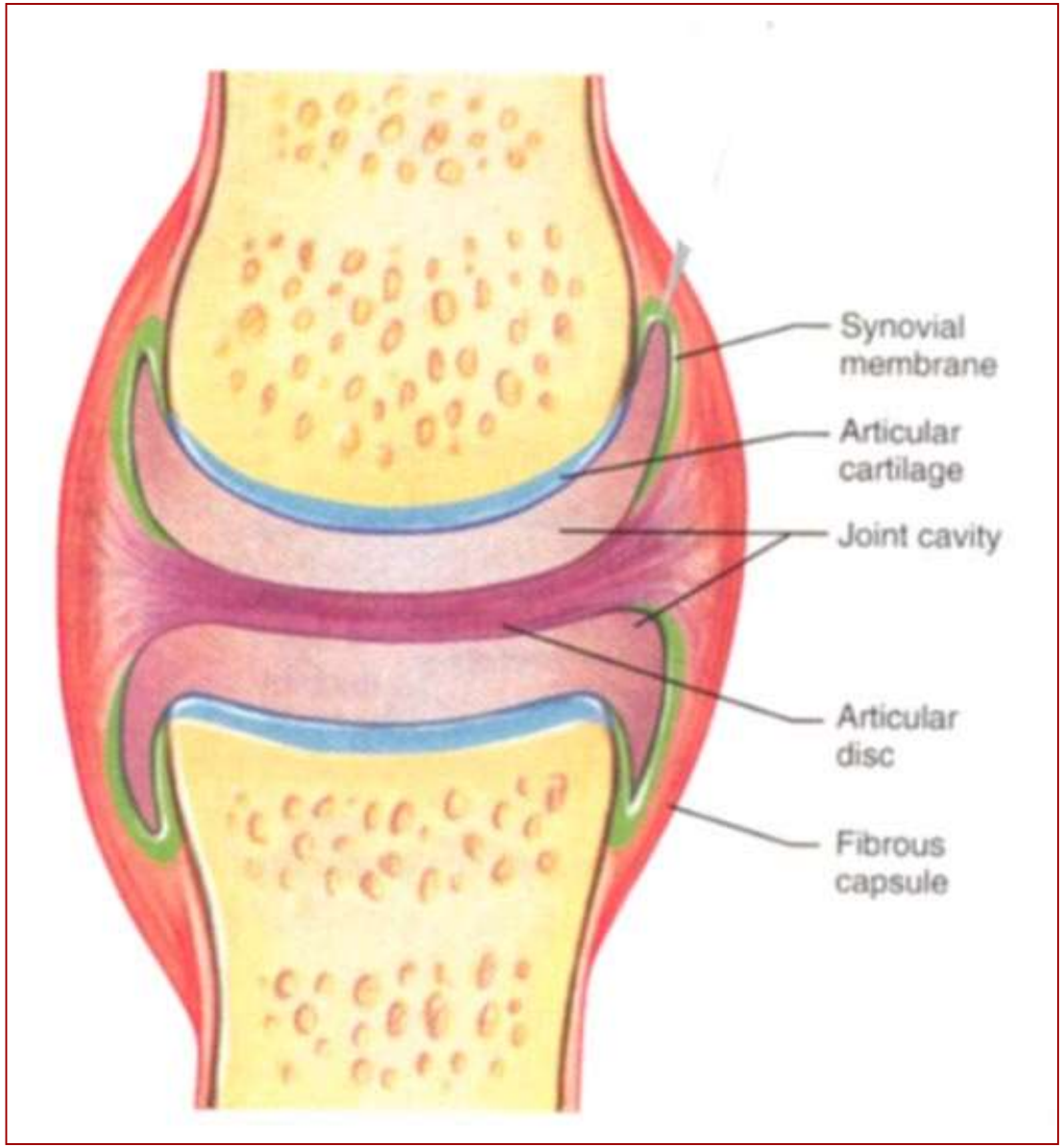
| Structure | Type | Example |
|---|---|---|
| Cartilagenous | Synchondrosis<br>Symphysis | Epiphyseal plates<br>Intervertebral discs |
| Fibrous | Sutures<br>Syndesmoses<br>Gomphosis | Skull<br>Distal Tibia/fibula<br>Teeth in sockets |
| Synovial | | Glenohumeral joint<br>Knee joint<br>TMJ |

# Components of SYNOVIAL JOINTS:

## (Structural Joint Classification continued)

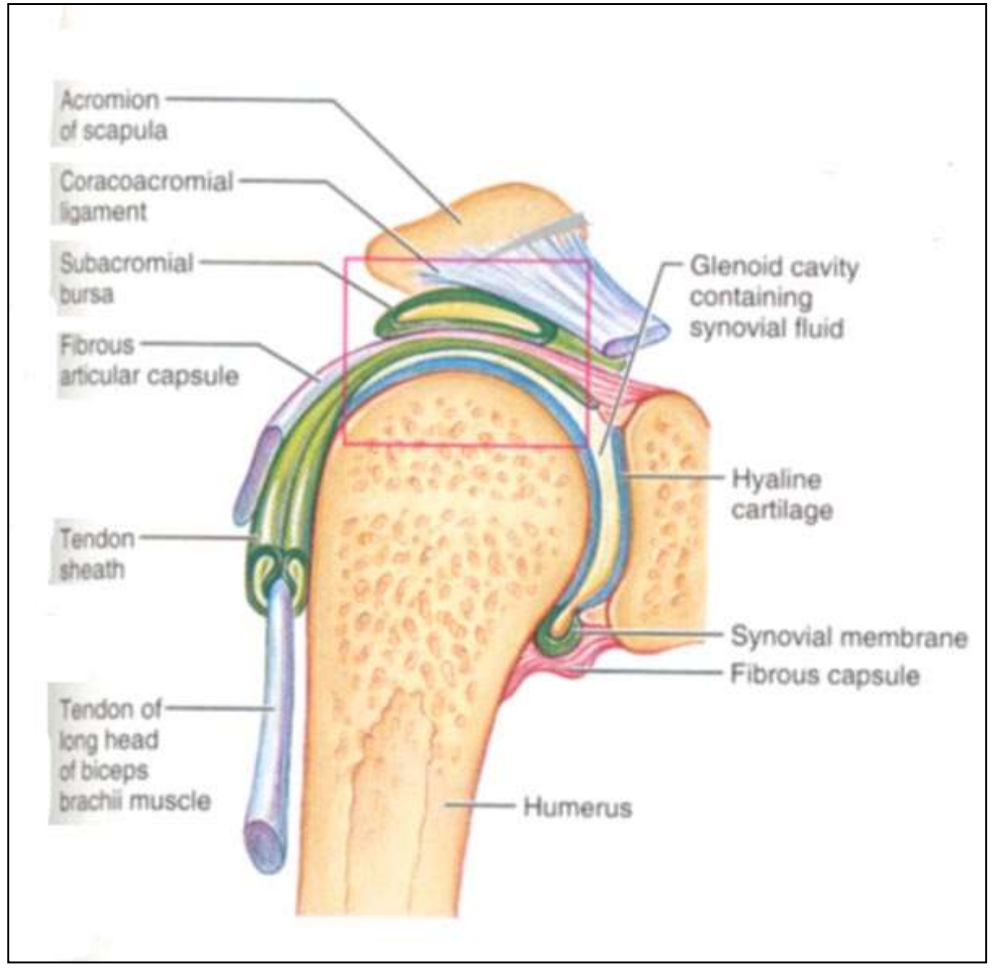
- **Articular cartilage**: hyaline; covers ends of both bones articulating
- **Synovial (joint) cavity**: space holding synovial fluid
- Articular capsule: Made of 2 layers
  - Fibrous: external, dense CT for strength
  - Synovial membrane: internal, produces synovial fluid
- **Synovial fluid**: viscous; lubricates and nourishes; contained in capsule and articular cartilages
- **Reinforcing ligaments:** extracapsular/intracapsular
- **Nerves + vessels**: Highly innervated, Highly vascular
- **Meniscus** (some): fibrocartilage; improves the fit of 2 bones to increase stability

# Synovial Joint



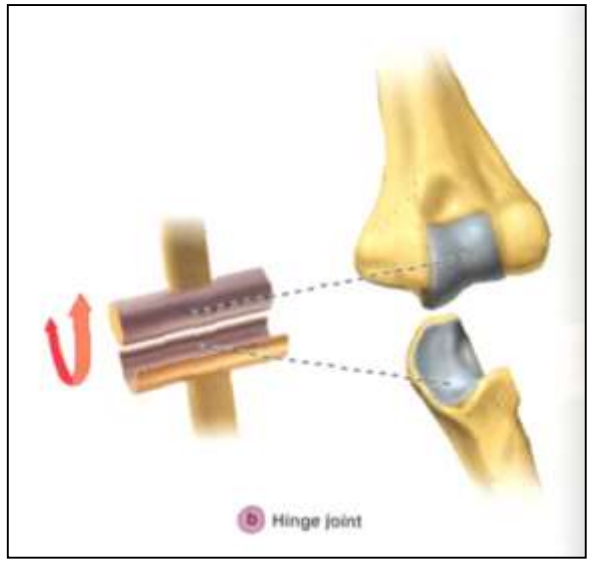

pg 215

# Bursae & Tendon Sheaths

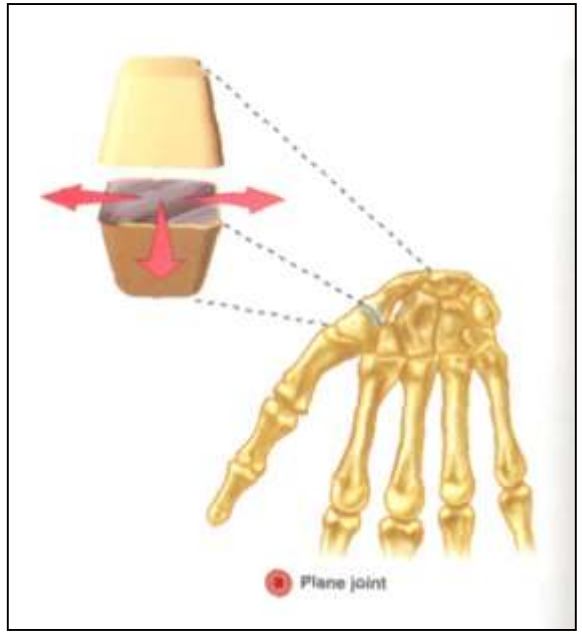



- **Bursae**: flat, fibrous sac w/synovial membrane lining
- **Tendon Sheaths:** elongated bursae that wraps around tendons
- 3 Factors in Joint Stability:
  - Muscle Tone
  - Ligaments
  - Fit of Articular Surface

# Joint Shapes

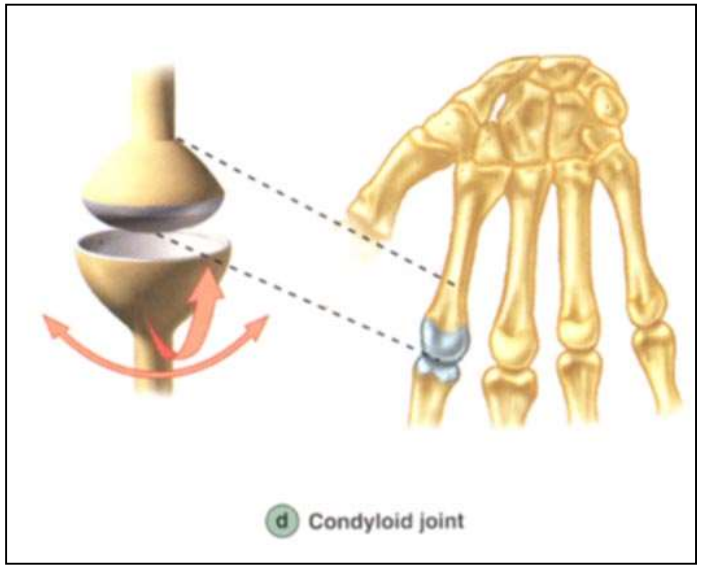



- **Hinge:** cylindrical end of 1 bone fits into trough shape of other
  - angular movement-1 plane (eg) elbow, ankle, interphalangal

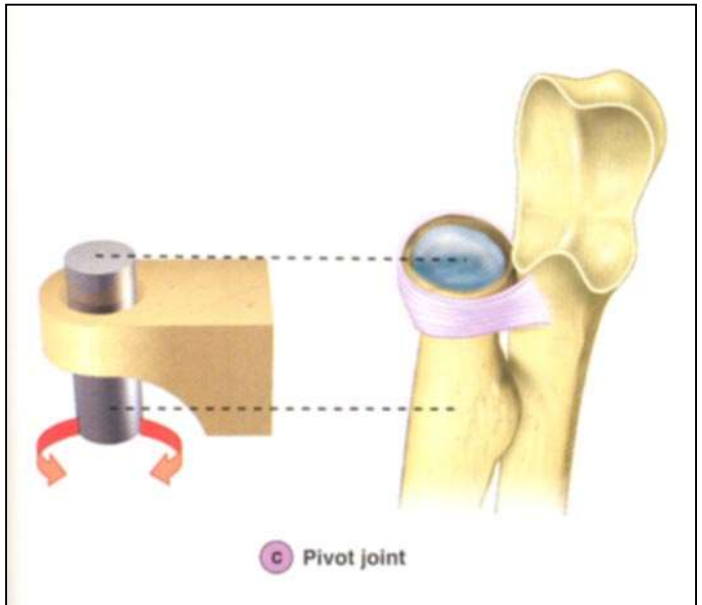



- **Plane**: articular surface in flat plane
  - Short gliding movement
  - (eg) intertarsal, articular processes of vertebrae

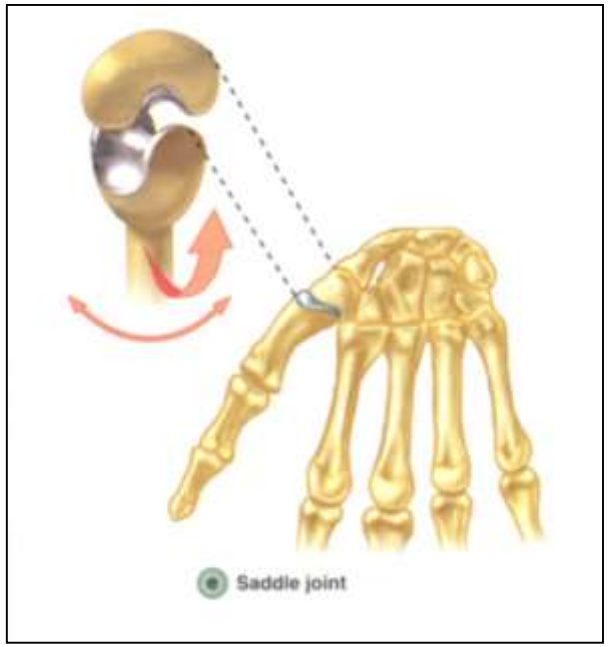
# Joint Shapes

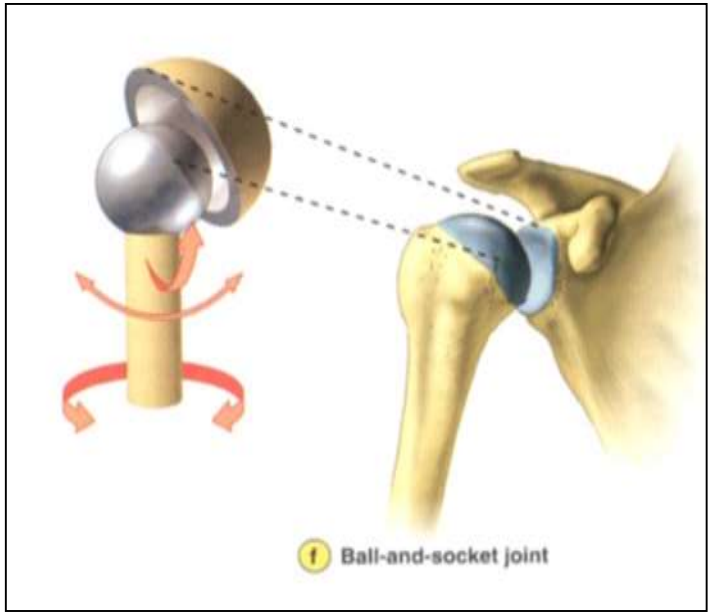



- **Condyloid**: egg-shape articular surface + oval concavity
  - side-to-side, back+forth movement
  - (eg) metacarpophalangeal (knuckle)




- **Pivot**: round end fits into ring of bone + ligament
  - rotation on long axis
  - (eg) prox. radius/ulna, atlas/dens




# Joint Shapes

- **Saddle**: articular surface both concave + convex
  - side-to-side, back-forth movement
  - (eg) carpometacarpal jt of thumb
  -
- **Ball + Socket**: spherical head + round socket
  - multiaxial movement
  - (eg) shoulder, femur

# !Muscles!

Function: 1) movement

2) maintain posture

3) joint stability

4) generate heat

# !Muscles!

# Special Features of Muscle

- **Contractibility** = cells generate pulling force
- **Excitibility** = nervous impulses travel through muscle plasma membrane to stimulate contraction
- **Extensibility** = after contraction muscle can be stretched back to original length by opposing muscle action
- **Elasticity** = after being stretched, muscle passively recoils to resume its resting length

# Muscle System: uses levers to move objects

- How it works: A rigid bar moves on fixed point when a force is applied to it, to move object
- Lever = rigid bar = bone
- Fulcrum = fixed point = joint
- Effort = force applied = muscle contraction
- Load = object being moved = bone

# Movements of Muscles

- Extension: increasing angle between body parts
- Flexion: decreasing angle between body parts
  - Dorsiflexion vs. Plantarflexion
  - **Inversion** vs. **Eversion**
- **Ab**duction: moving away from the median plane
- **Ad**duction: moving towards the median plane
- Rotation: moving around the long axis
- Circumduction: moving around in circles

# Movements of Muscles

- Elevation: lifting body part superiorly
- Depression: moving body part inferiorly
- Supination: rotating forearm laterally
- Pronation: rotating forearm medially
- Protraction: Anterior movement
- Retraction: Posterior movement

# Muscle Basics to Remember

- 3 Types: Skeletal, Cardiac, Smooth
- Origin vs. Insertion
- Direct vs. Indirect Attachments
  - direct = right onto bone
  - indirect = via tendon/aponeurosis
    - more common
    - leave bony markings = tubercle, crest, ridge, etc.
    - Sometimes attach to skin

# Functional Muscle Groups

- Agonist = primary mover of a muscle, major response produces particular movement
  - (eg) biceps brachii is main flexor of forearm

- Antagonists = oppose/reverse particular movement, prevent overshooting agonistic motion
  - (eg) triceps brachii is antagonist to biceps brachii

# Functional Muscle Groups

- Synergists = muscles work together, adds extra force to agonistic movement, reduce undesirable extra movement
  - (eg) muscles crossing 2 joints

- Fixators = a synergist that holds bone in place to provide stable base for movement
  - (eg) joint stablilizers

# Naming Muscles

- Location:  (eg) brachialis = arm
- Shape: (eg) deltoid = triangle
- Relative Size: (eg) minimus, maximus, longus
- Direction of Fascicles: (eg) oblique, rectus
- Location of Attachment: (eg) brachioradialis
- Number of Origins: (eg) biceps, quadriceps
- Action: (eg) flexor, adductor, extensor

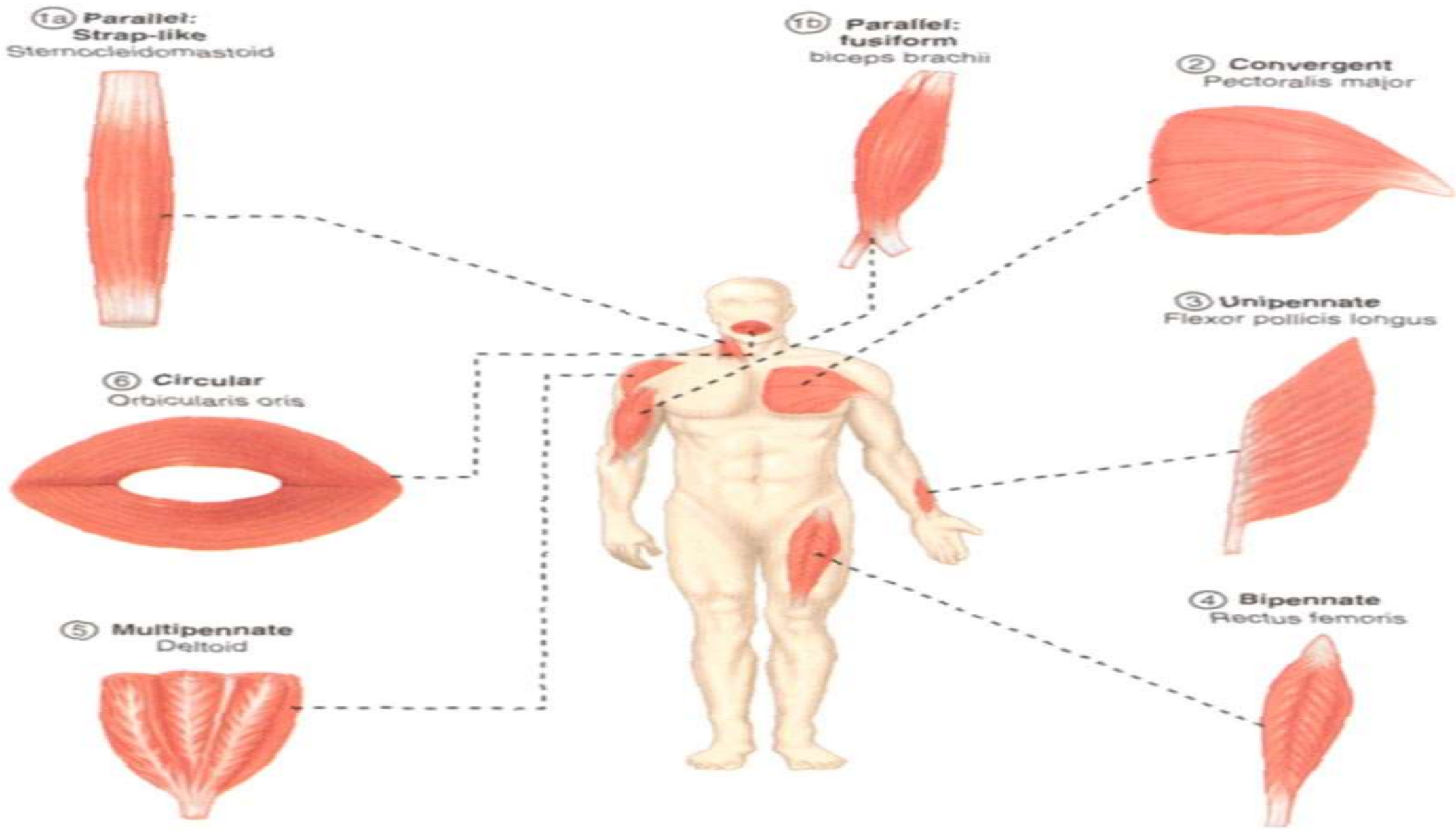
# Arrangement of Muscle Fibers

- Parallel: long axis of fascicles parallel to axis of muscle; straplike (eg) biceps, sternocleidomastoid
- Convergent: O = broad, I = narrow, via tendon; fan or triangle shaped (eg) pectoralis major
- Circular: fascicles arranged in concentric circles; sphincter (eg) around mouth

# Arrangement of Muscle Fibers

- Pennate: fascicles short + attached obliquely to tendon running length of muscle; featherlike
  - Unipennate = fascicles insert on only 1 side
    - (eg) flexor pollicis longus
  - Bipennate = fascicles insert both sides
    - (eg) rectus femoris
  - Multipennate = many bundles inserting together
    - (eg) deltoid

# Arrangements of Muscle Fascicles




Thank You