ANATOMY

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Any part of this workbook

Contents

Anatomical Terminology

Anterior: in front of; toward or at the front of the body

Posterior: behind; toward or at the back side of the body

Medial: toward or at the midline of the body; or on the inner side of a limb

Lateral: away from the midline of the body; on the outer side of the body or a limb

Superior: above: toward the head or the upper part of a structure or the body

Inferior: below; away from the head or towards the lower part of a structure or the body

Proximal: closer to the center of the body (the navel), or to the point of attachment of a limb to the torso

Distal: farther from the center of the body, or from the point of attachment of a limb to the torso

External: on the outside; or away from the center body

Internal: on the inside; or closer to the center of the body

Superficial: toward or at the body surface

Deep: further away from the body surface, more internal

Concave: hollowed or curving inwards, like the inside of a bowl

Convex: curving or bulging outward like the outside of a bowl

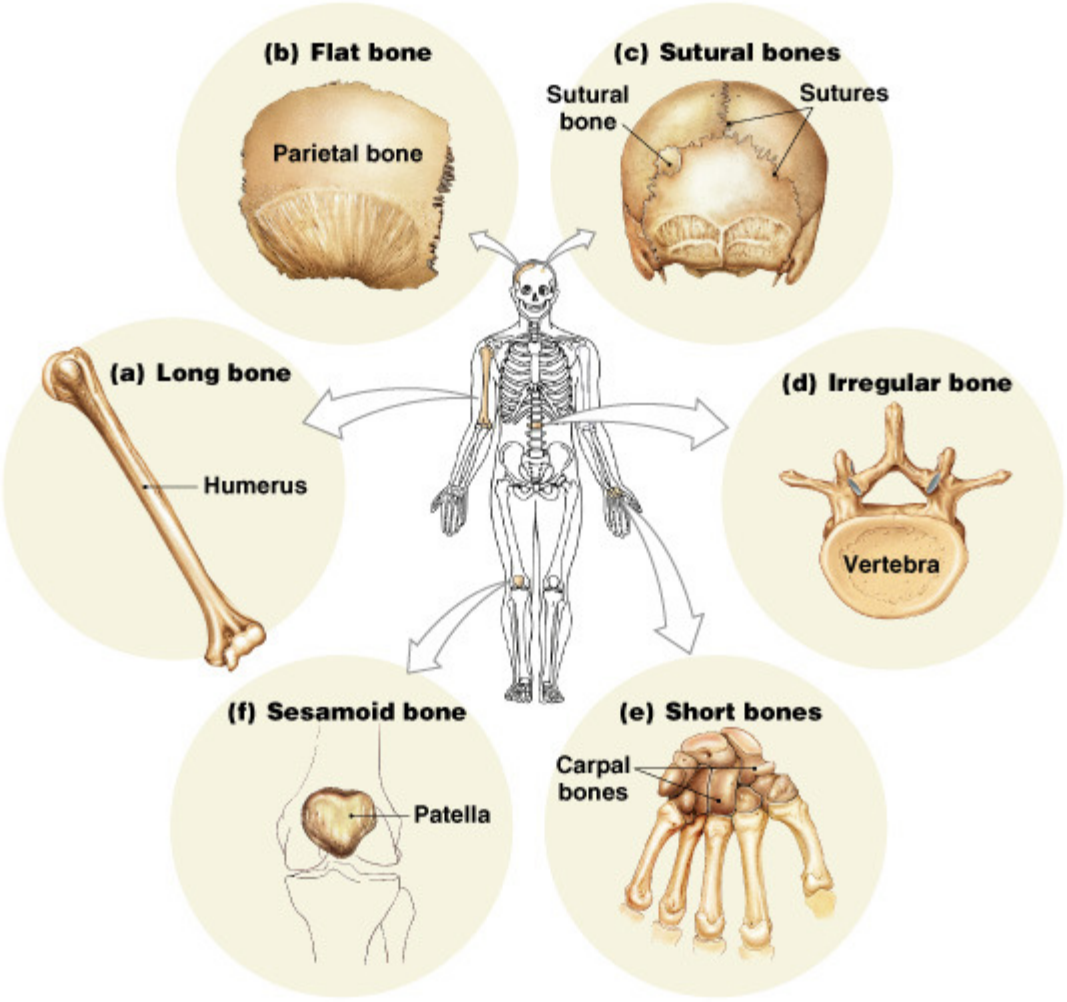
Bone Structure and Function

The 5 primary functions of the skeletal system are:

1. Support – provides a framework that holds the rest of the muscles, organs, nerves, blood vessels etc in place onto and holds the body up.
2. Storage of minerals (calcium)
3. Blood cell production (occurs in the bone marrow)
4. Protection of internal organs eg skull protects the brain, vertebrae the spinal cord, ribs the heart and lungs.
5. Leverage (force of motion) for the muscles to work off.

The 6 major bone shapes are:

1. **Long bones** are long and thin. They are found in arms, legs, hands, feet, fingers and toes.
2. **Flat bones** are thin with parallel surfaces. They are found in the skull, sternum, ribs and scapula.
3. **Sutural bones** are small, irregular bones between the flat bones of the skull.
4. **Irregular bones** are complex shapes such as spinal vertebrae and pelvic bones.
5. **Short bones** are small and thick, including ankle and wrist bones.
6. **Sesamoid bones** are small, flat bones that develop inside tendons near joints of knees, hands and feet.



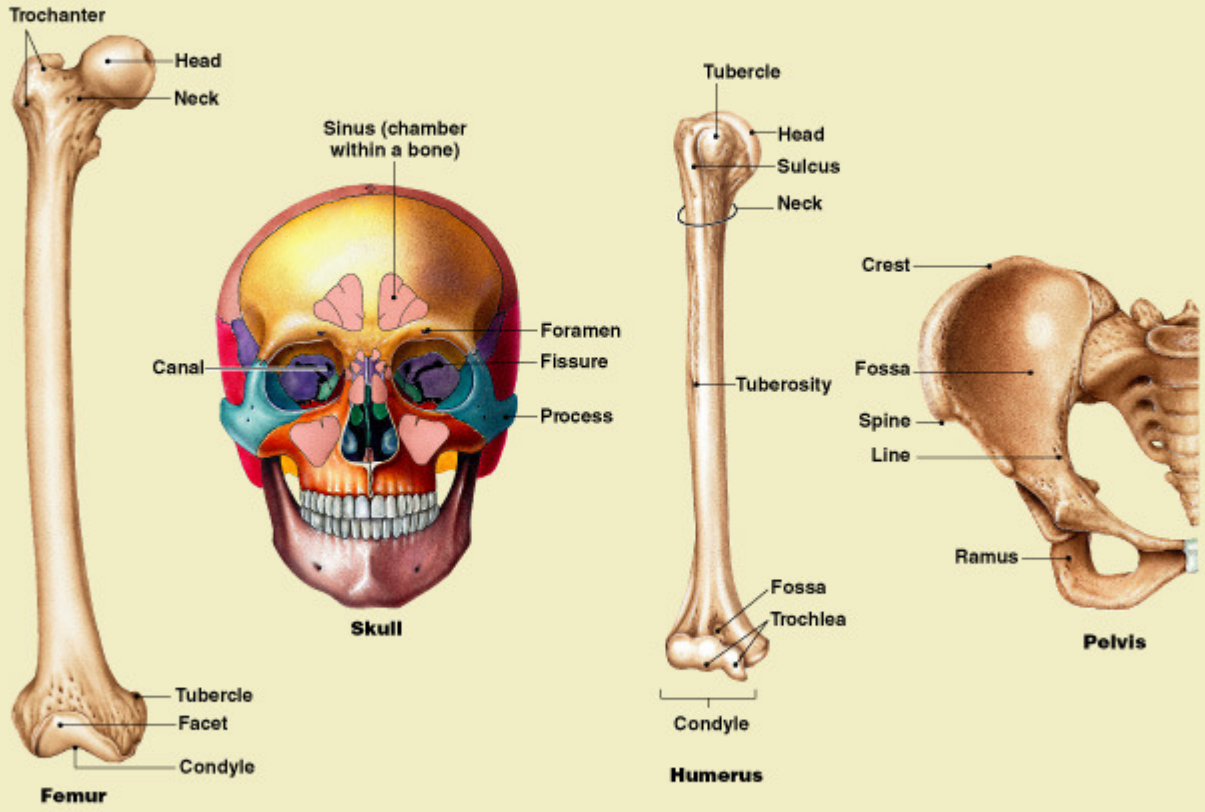
Bony Features/Terminology

The surface features of bones include depressions or grooves where tendons, ligaments and neighboring bones attach, and tunnels where blood and nerves enter the bone. It is not essential to memorize each and every one of these, but having an understanding of the terminology helps when reading the origin and insertions of the muscles.

TABLE 6–1 An Introduction to Bone Surface Features

General Description	Anatomical Term	Definition
Elevations and projections (general)	**Process**	Any projection or bump
	Ramus	An extension of a bone making an angle with the rest of the structure
Processes formed where tendons or ligaments attach	**Trochanter**	A large, rough projection
	Tuberosity	A smaller, rough projection
	Tubercle	A small, rounded projection
	Crest	A prominent ridge
	Line	A low ridge
	Spine	A pointed process
Processes formed for articulation with adjacent bones	**Head**	The expanded articular end of an epiphysis, separated from the shaft by a neck
	Neck	A narrow connection between the epiphysis and the diaphysis
	Condyle	A smooth, rounded articular process
	Trochlea	A smooth, grooved articular process shaped like a pulley
	Facet	A small, flat articular surface
Depressions	**Fossa**	A shallow depression
	Sulcus	A narrow groove
Openings	**Foramen**	A rounded passageway for blood vessels or nerves
	Canal	A passageway through the substance of a bone
	Fissure	An elongate cleft
	Sinus or **antrum**	A chamber within a bone, normally filled with air

TABLE 6–1 An Introduction to Bone Surface Features



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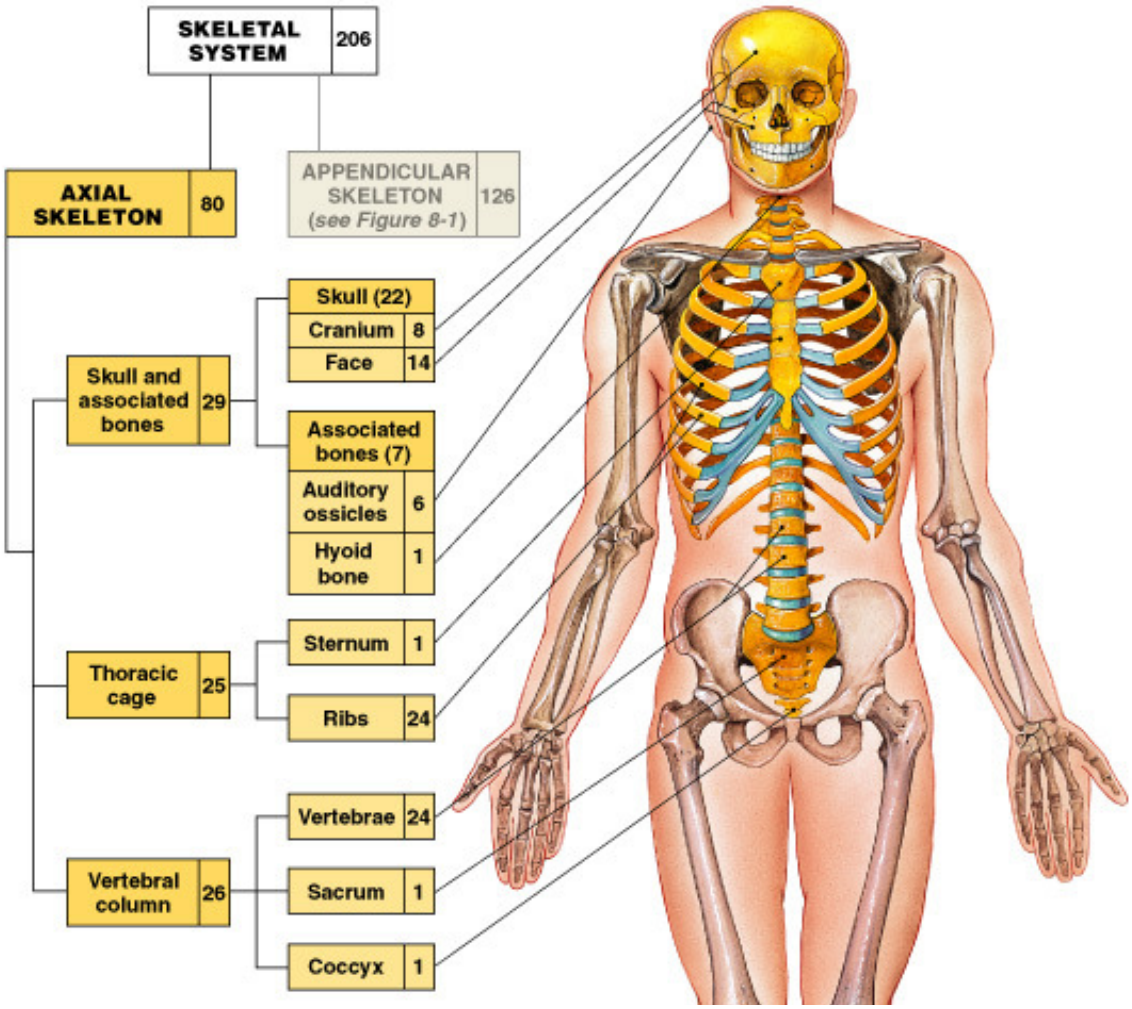
The Axial Skeleton

- The axial skeleton:
  - forms the longitudinal axis of the body
  - has 80 bones

- The axial skeleton includes:
  - the skull (8 cranial bones and 14 facial bones)
  - bones associated with the skull (7 bones)
  - the vertebral column (24 vertebrae, the sacrum and the coccyx)
  - the thoracic cage (24 ribs and the sternum)

- Functions of the axial skeleton include:
  - support and protect organs in the body cavities
  - attach to muscles that support head, neck and trunk
  - attach to breathing muscles
  - attach to muscles of the appendicular skeleton

- Axial bones are strong, with many ligaments, but are restricted in motion.



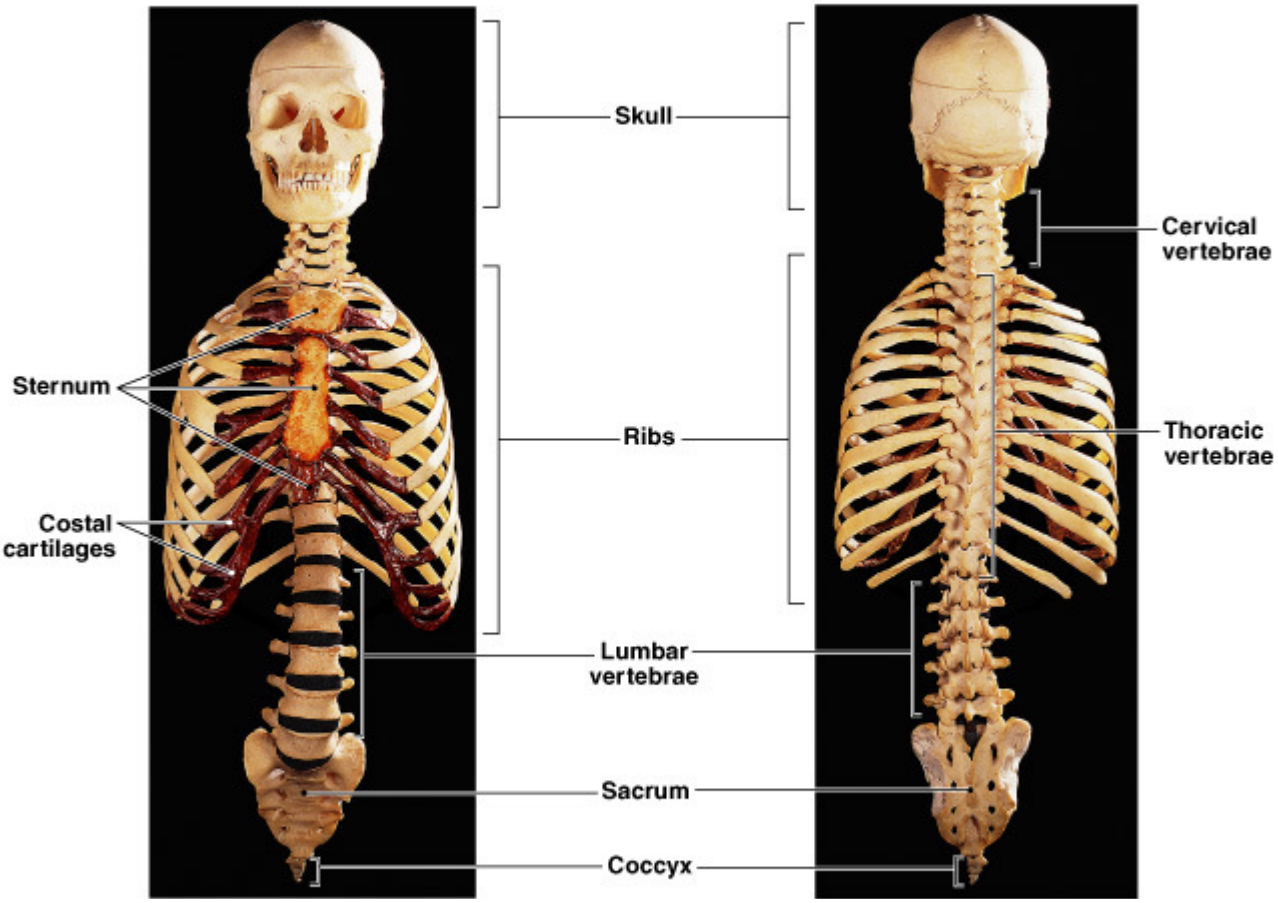
The Vertebral Column

- The spine or vertebral column protects the spinal cord and supports the head and body.

- The vertebral column consists of 26 bones (24 vertebrae, the sacrum and the coccyx).

- The vertebral column is divided into 5 regions:
  - cervical (C)
  - thoracic (T)
  - lumbar (L)
  - sacral
  - coccygeal

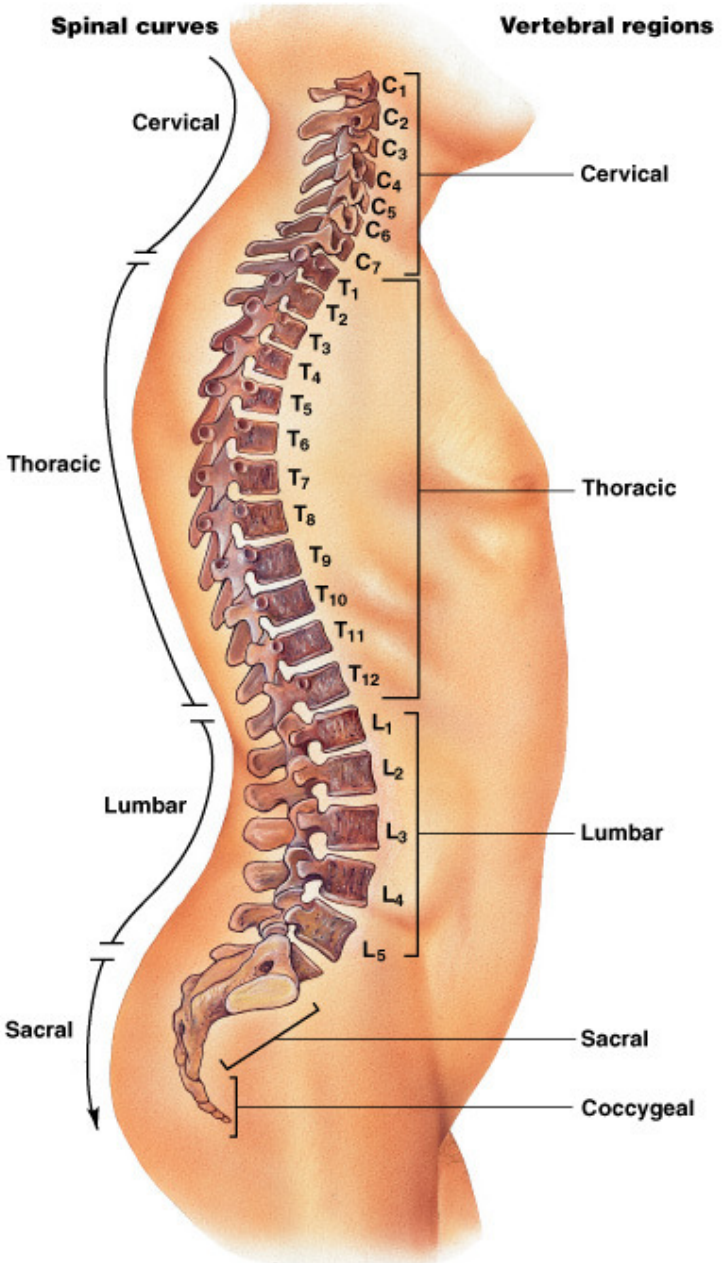
- The neck consists of 7 cervical vertebrae.
- The upper back has 12 thoracic vertebrae, each articulated with one or more pairs of ribs.
- The lower back consists of 5 lumbar vertebrae.
- The fifth lumbar vertebra articulates with the sacrum, which articulates with the coccyx.



- The spine is configured in 4 spinal curves:
  - cervical curve
  - thoracic curve
  - lumbar curve
  - sacral curve

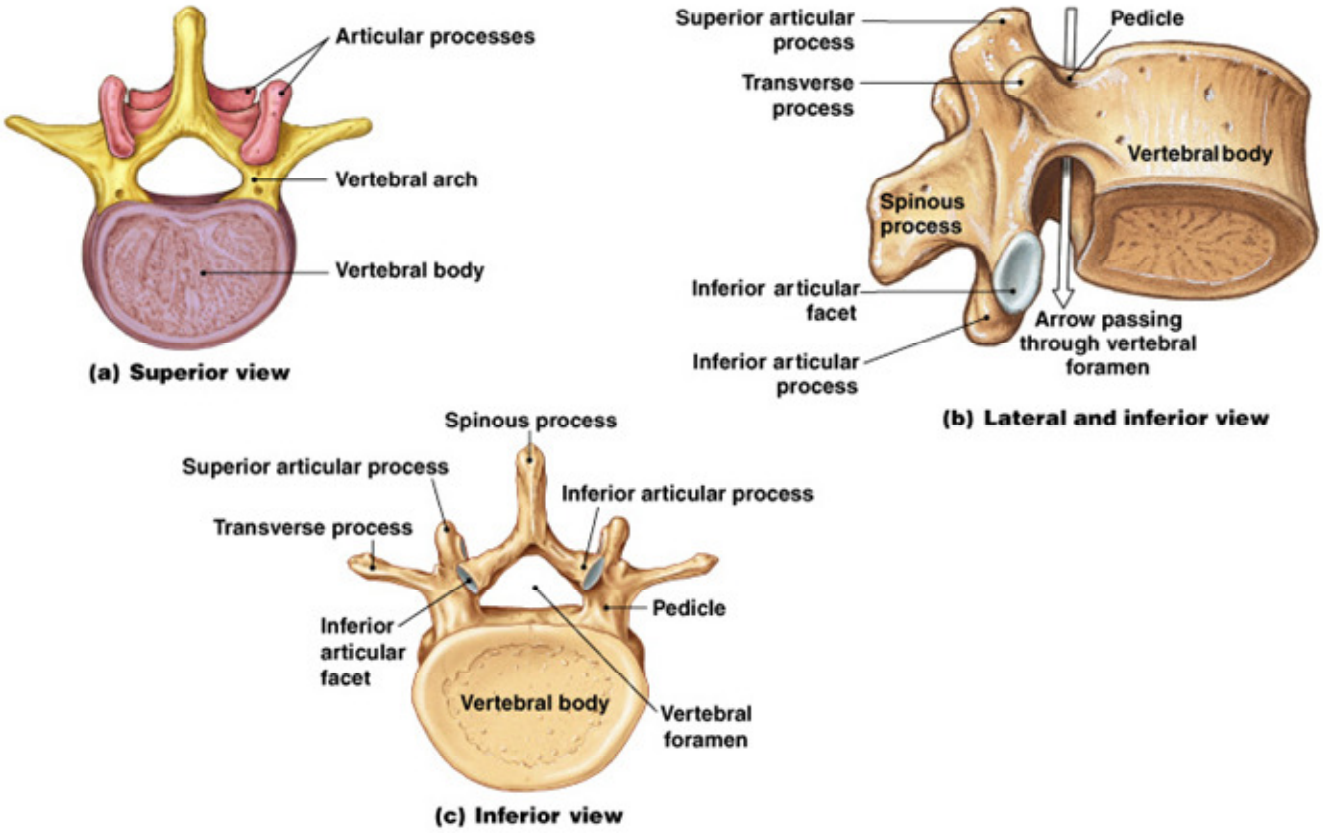
The cervical and lumbar spine curves are called a lordosis – it is curved so that there is a concave dip posteriorly.

The thoracic spine curve is called a kyphosis – it is curved in the opposite direction and is concave anteriorly.



Vertebral Anatomy

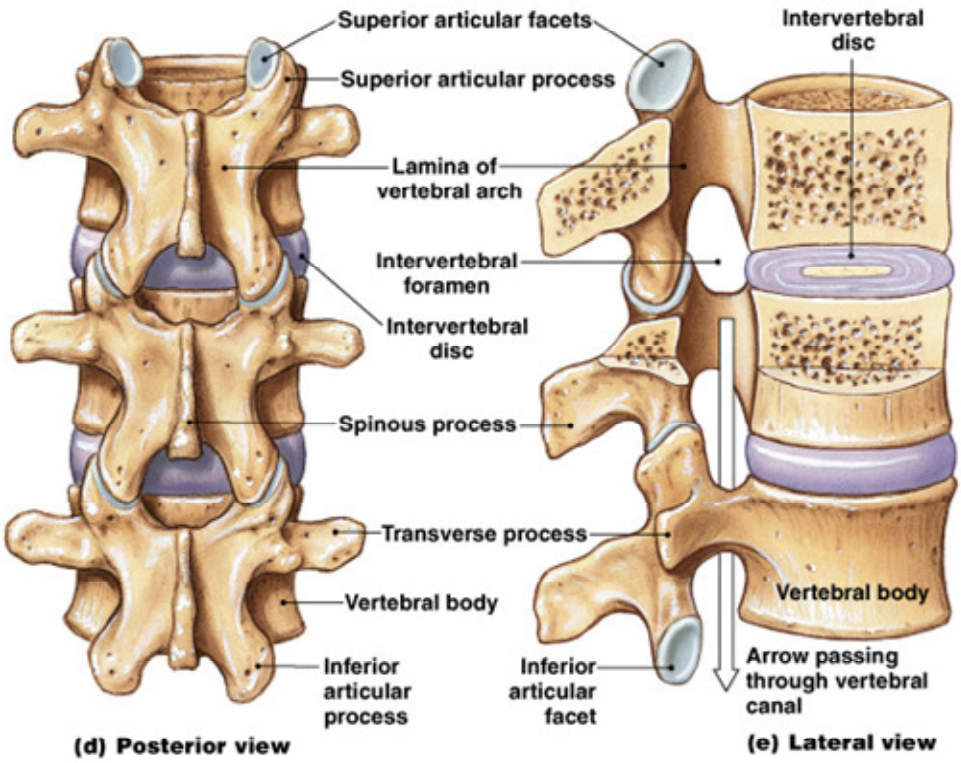
Each vertebra consists of 3 basic parts:
1. The vertebral body, which transfers weight along the spine.
2. The vertebral arch, which includes:
- pedicles (walls of the vertebral arch)
- laminae (roof of the vertebral arch)
- spinous process (muscles and ligaments attach to)
- transverse process (muscles and ligaments attach to)
3. The superior and inferior articular processes form the joints between each vertebra



- Together, the vertebral foramen forms the vertebral canal which encloses the spinal cord.

- Vertebral bodies are separated by pads called intervertebral discs.

- Gaps between the pedicles of adjacent vertebrae form intervertebral foramen which allow for nerves to run to and from the spinal cord to the rest of the body

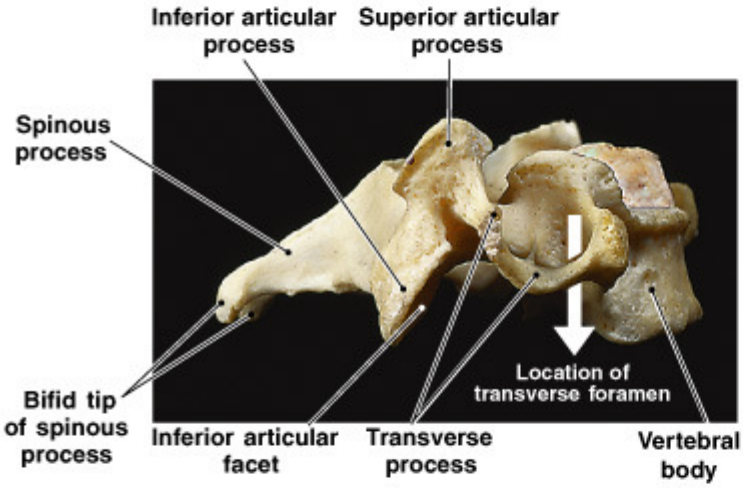


Vertebral Regions

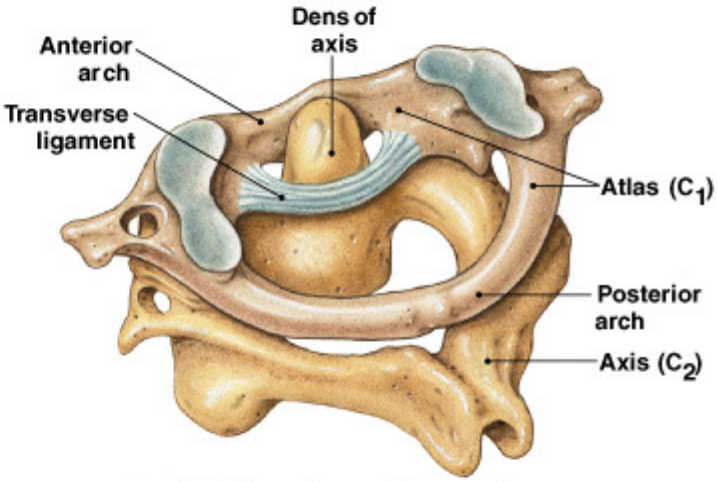
- Vertebrae are numbered by region, from top to bottom: C1 articulates with the skull, L5 with the sacrum. Vertebrae of each region have characteristics determined by their functions.

Cervical Vertebrae (C1-7):

- The body of a cervical vertebra is small compared to the vertebral foramen.
- The spinal cord within the vertebral foramen is largest near the brain, but the bodies of the vertebrae can be small because they only have to support the head.
- The Atlas (C1) articulates with the skull and has no body or spinous process.
- The Axis (C2) supports the atlas, and is the attachment point of many important neck muscles
- The C7 transitions to the thoracic vertebrae, and has a long, prominent spinous process which is easy to see and palpate.



(c) Typical cervical vertebra (lateral view)



(d) The atlas–axis complex

Thoracic Vertebrae (T1-12):
- The body is heart shaped, and larger than those of cervical vertebrae.
- The vertebral foramen is smaller.
- Spinous processes are long and slender.
- The lateral part of the vertebrae have transverse costal facets where the ribs articulate with the spine

Lumbar Vertebrae (L1-5):
- Are the largest vertebrae.
- The body is thicker than thoracic vertebrae, and oval-shaped.
- The spinous process is short and heavy, for attachment of lower back muscles.

TABLE 7–2 Regional Differences in Vertebral Structure and Function

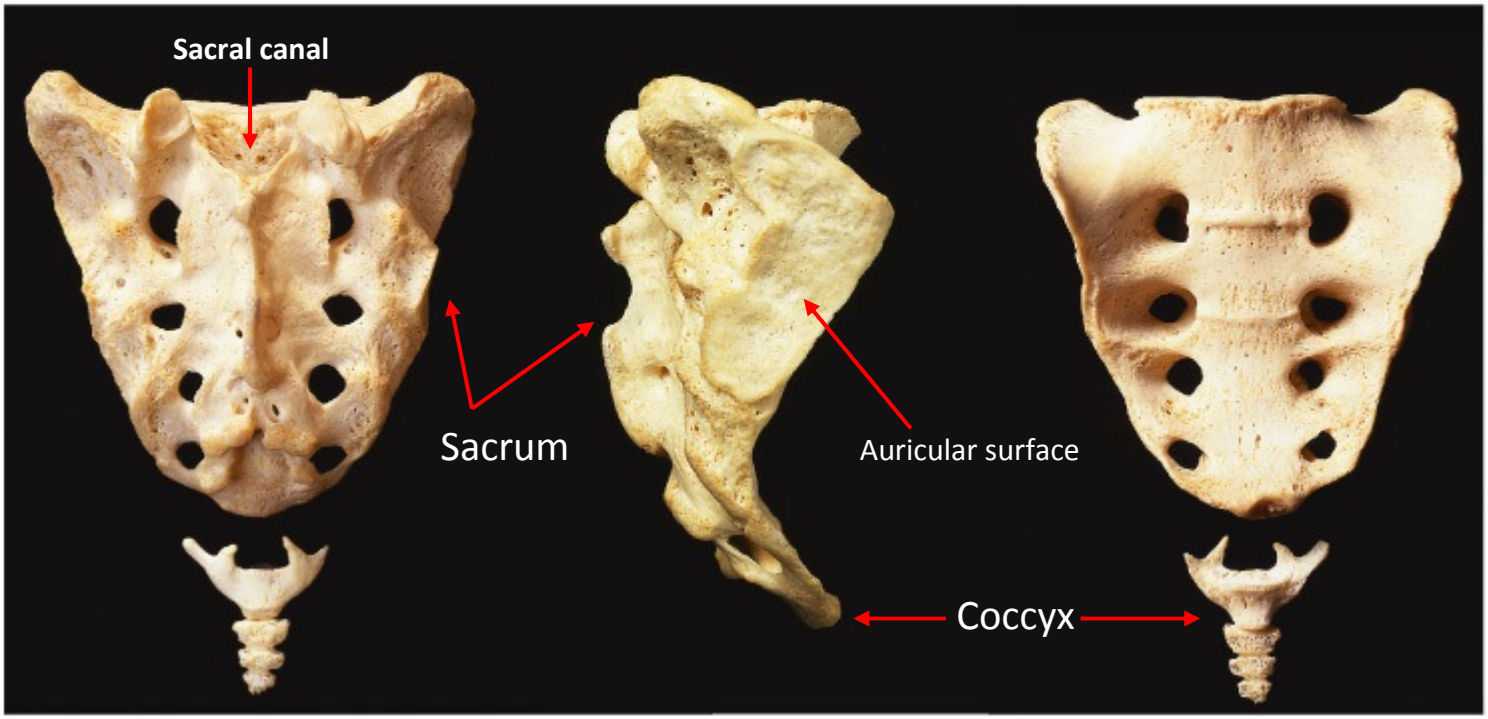
	Type (Number)		
Feature	**Cervical Vertebrae (7)**	**Thoracic Vertebrae (12)**	**Lumbar Vertebrae (5)**
Location	Neck	Chest	Inferior portion of back
Body	Small, oval, curved faces	Medium, heart-shaped, flat faces; facets for rib articulations	Massive, oval, flat faces
Vertebral foramen	Large	Smaller	Smallest
Spinous process	Long; split tip; points inferiorly	Long, slender; not split; points inferiorly	Blunt, broad; points posteriorly
Transverse processes	Have transverse foramina	All but two (T_{11}, T_{12}) have facets for rib articulations	Short; no articular facets or transverse foramina
Functions	Support skull, stabilize relative positions of brain and spinal cord, and allow controlled head movement	Support weight of head, neck, upper limbs, and chest; articulate with ribs to allow changes in volume of thoracic cage	Support weight of head, neck, upper limbs, and trunk
Typical appearance (superior view)			

Sacrum

- The adult sacrum consists of 5 fused sacral vertebrae
- Is the connection between the spine and pelvis
- Attaches many large muscles that move the thigh.
- The sacral canal replaces the vertebral canal.
- The thick, flattened auricular surface articulates with the pelvic girdle (*sacroiliac joint*).

Coccyx

- The mature coccyx (otherwise known as tailbone) consists of 3 to 5 fused coccygeal vertebrae.
- The coccyx attaches ligaments and a constricting muscle of the anus (one of the pelvic floor muscles).



Posterior view Lateral view Anterior view

Thoracic Cage

The thoracic cage is the skeleton of the chest, supporting the thoracic cavity. It consists of the thoracic vertebrae, ribs and sternum (breastbone). The ribs and sternum form the *rib cage*.

The thoracic cage has two main functions:

1. To protect the organs of the thoracic cavity, including the heart, lungs and thymus.
2. To attach muscles for respiration, the vertebral column, and shoulder girdle and upper limbs.

Sternum

The sternum, a flat bone in the midline of the thoracic wall, has 3 parts:

1. The manubrium:
   - the superior portion of the sternum, is broad and triangular
   - articulates with the collarbones (*clavicles*) and the first ribs
   - has a jugular notch, a shallow indentation on the manubrium, between the clavicle articulations
2. The sternal body:
   - is tongue-shaped
   - attaches to the manubrium
   - attaches to ribs 2-7
3. The xiphoid process:
   - is the smallest part of the sternum
   - attaches to the sternal body
   - attaches to the diaphragm and rectus abdominus muscles

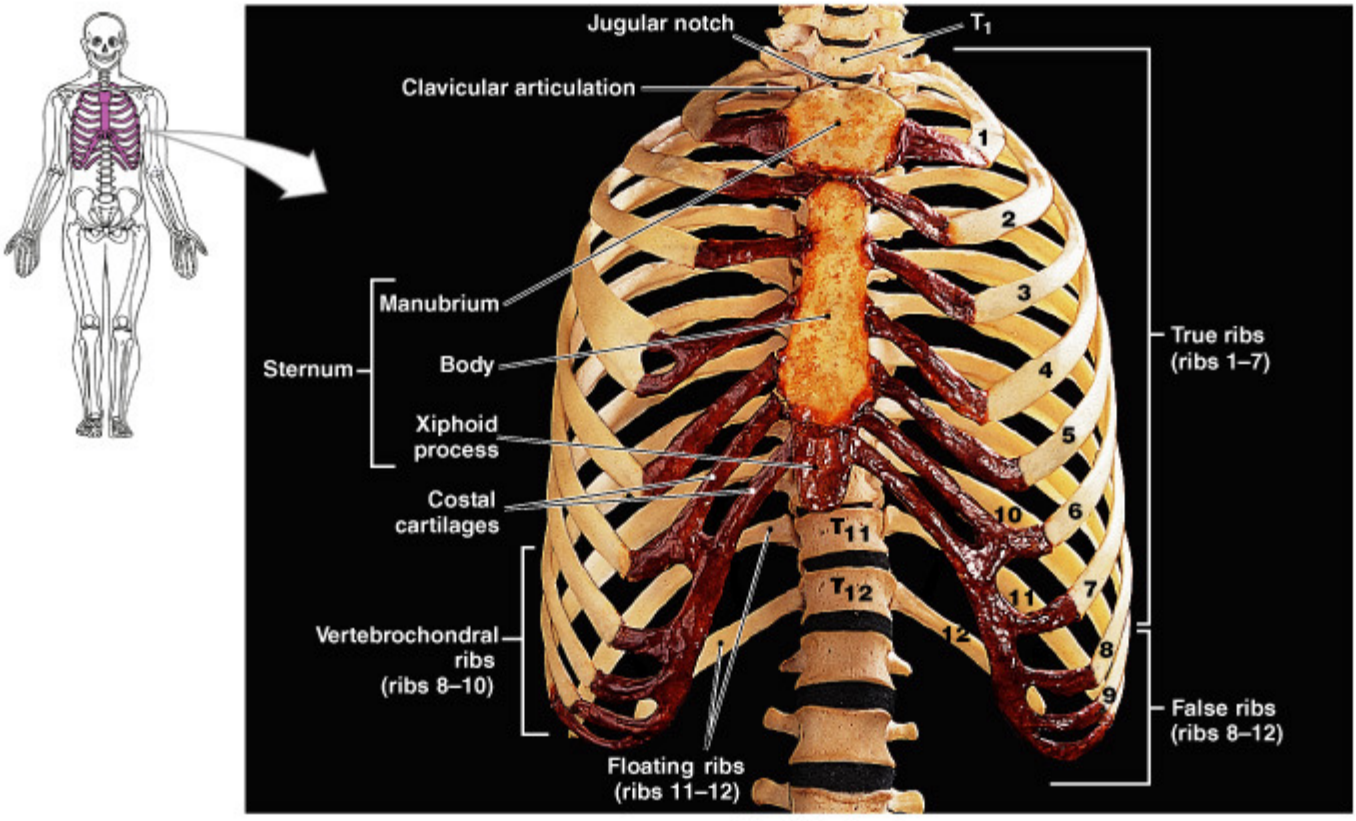
Ribs

- Ribs (*costae*) are 12 pairs of long, curved, flat bones extending from the thoracic vertebrae. They are divided into 2 types, true ribs and false ribs.

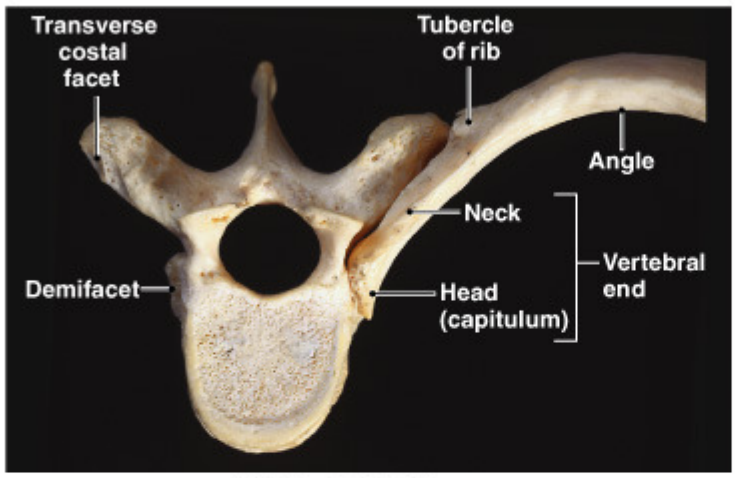
- Ribs 1-7 are called true ribs connected to the sternum by costal cartilages.

- Ribs 8-12 are called false ribs, because they do not attach directly to the sternum.

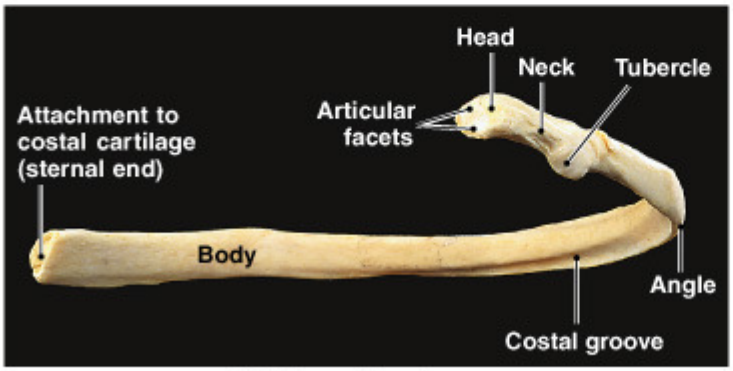
- Ribs are flexible, mobile, and can absorb shock. Rib movements (breathing) affect the width and depth of the thoracic cage, changing its volume.



(a) Anterior view



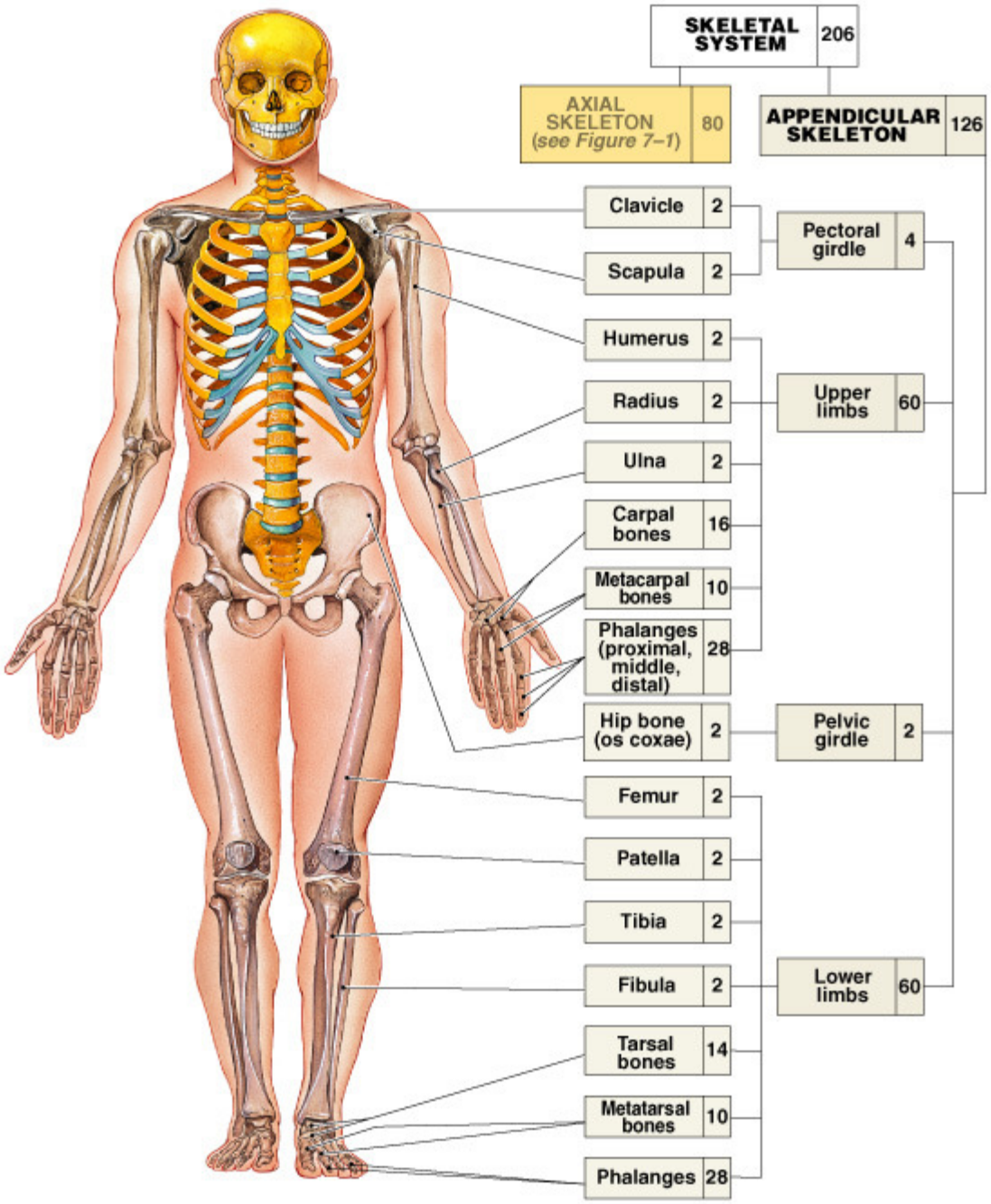
(a) Superior view



(b) Posterior view

The Appendicular Skeleton

The appendicular skeleton is made up of all bones (126 of them) other than the axial skeleton, including the bones of the limbs and their supporting elements, the girdles. The appendicular skeleton allows us to move and manipulate objects.

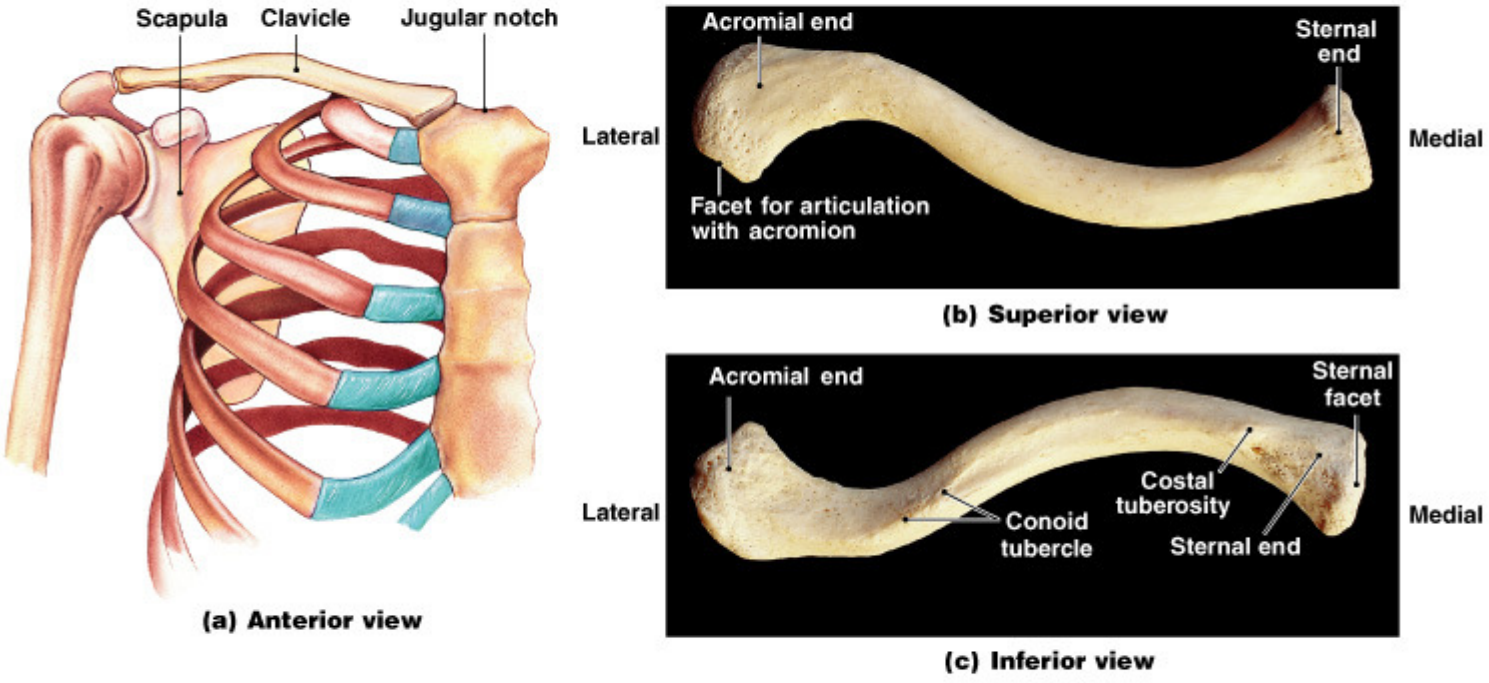


Shoulder Girdle

- The arms connect to the body at the shoulder girdle.
- The shoulder girdle consists of: 2 clavicles and 2 scapulae, which position the shoulders and provide a base for arm movement
- The shoulder girdle has no connection with the axial skeleton, except at the manubrium of the sternum.

Clavicle

The **clavicles** (collarbones) are long, s-shaped bones that originate at the manubrium of the sternum (at one end and articulate with the acromion of the scapulae at the other end.

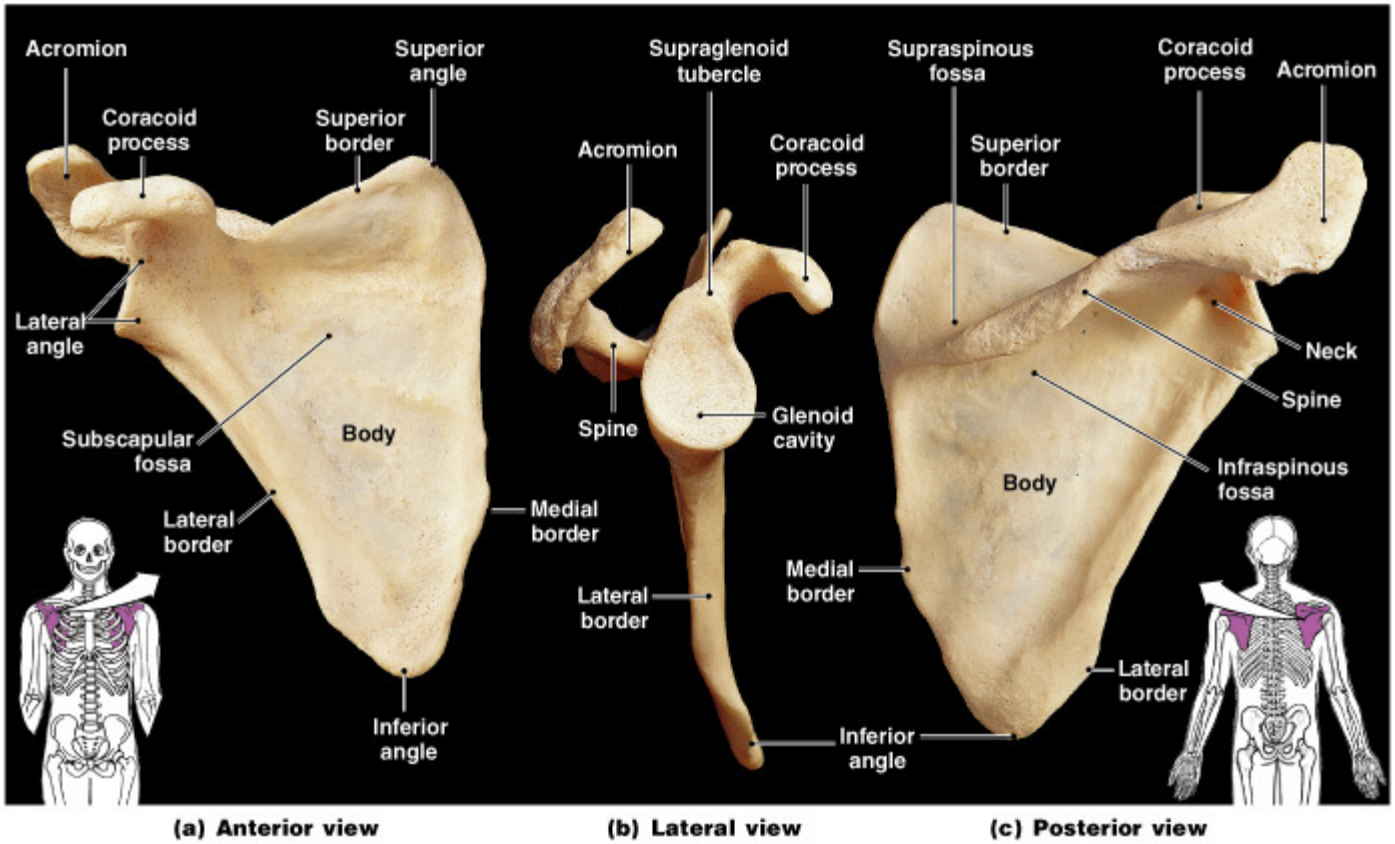


Scapula

The scapulae (shoulder blades) are broad, flat triangles that articulate with the arm and collarbone.

The body of the scapula has 3 edges: medial border, lateral border and superior border, and 3 corners: superior angle, inferior angle and lateral angle.

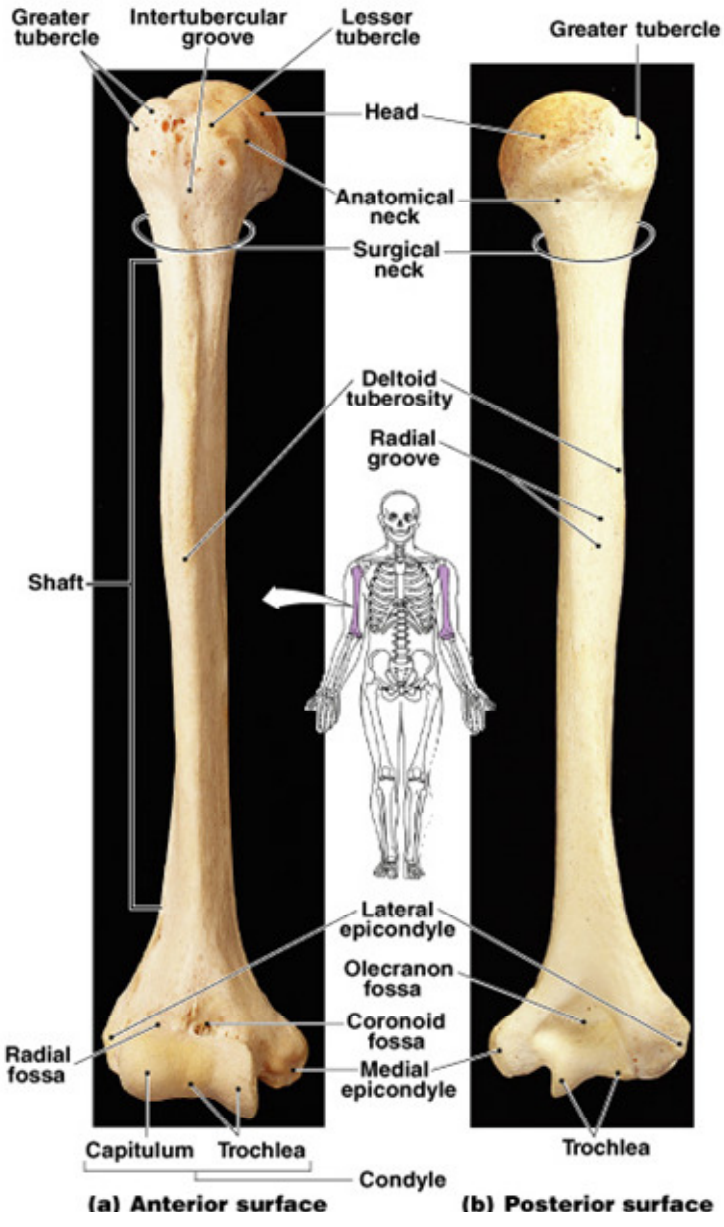
- The concave anterior surface of the scapula is called the subscapular fossa.
- The lateral angle of the scapula holds the glenoid cavity, which articulates with the humerus to form the shoulder joint.
- The 2 processes that extend around the glenoid cavity are the anterior coracoid process (smaller) and the posterior acromion (larger). The acromion articulates with the clavicle at the acromioclavicular joint.
- The scapular spine is a ridge that crosses the posterior surface of the body, dividing it into 2 regions: the supraspinous fossa and the infraspinous fossa.



The Upper Limbs

Upper arm - Humerus

- The humerus is the longest arm bone and it articulates with the shoulder girdle.
- The head of the humerus is the rounded part of the proximal end of the humerus that articulates with the glenoid fossa of the scapula to form the glenohumeral (shoulder) joint.
- The proximal end also has 2 projections (the lateral greater tubercle, forming the tip of the shoulder, and the anterior, medial lesser tubercle)
- The bulge halfway along the shaft is the deltoid tuberosity, where the deltoid muscle attaches.
- At the distal end, the medial and lateral epicondyles provide additional surface area for muscle attachment.
- The trochlea articulates with the ulna, the capitulum articulate with the radius

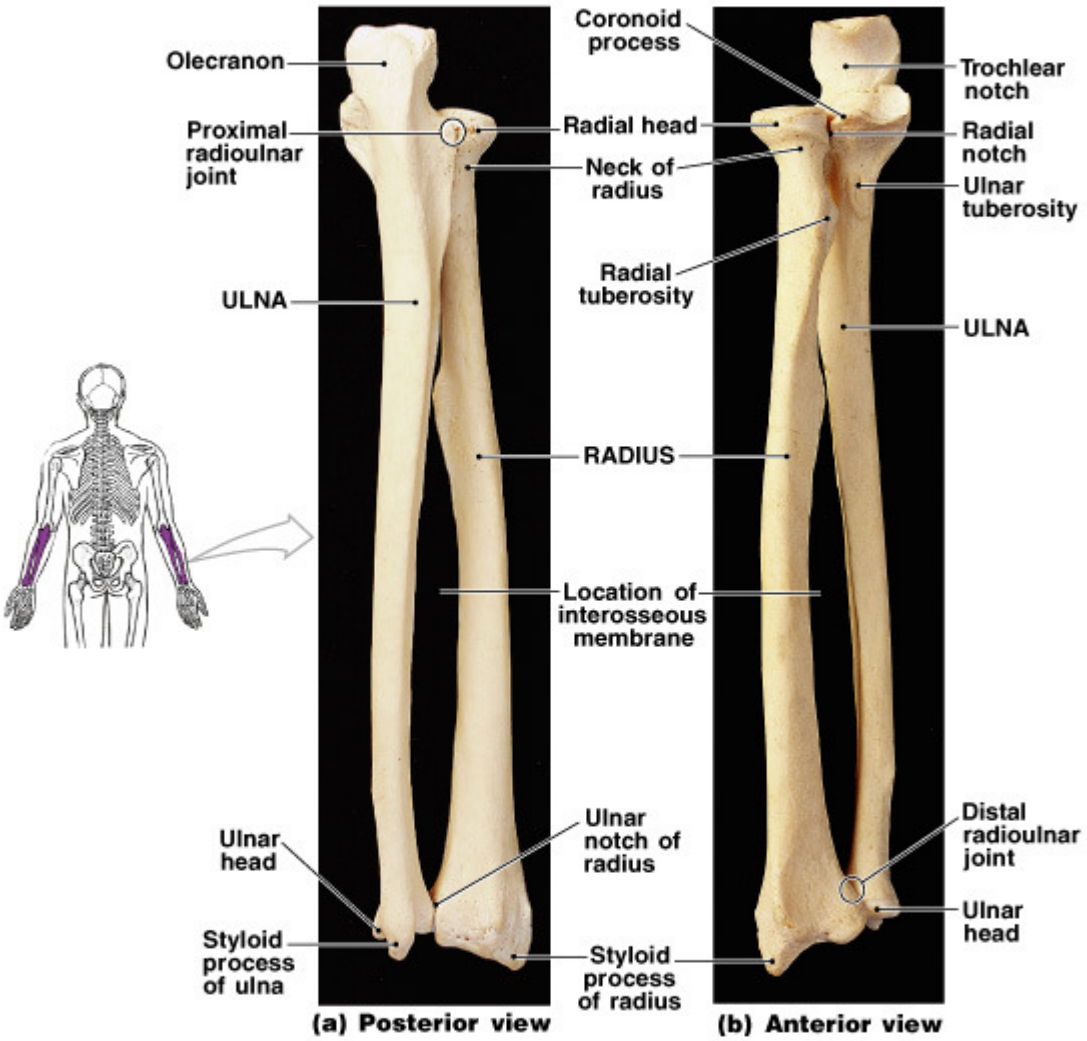


Forearm

The forearm consists of 2 long bones, the ulna (medial) and the radius (lateral).

Ulna

- The superior end of the ulna (the olecranon) is the point of the elbow, and the superior lip of the trochlear notch articulates with the trochlea of the humerus.
- The inferior lip of the trochlear notch is the coronoid process.
- When the forearm is extended, the olecranon fits into the olecranon fossa of the humerus.
- When the forearm is fully flexed, the coronoid process fits into the coronoid fossa of the humerus.
- The head of the radius fits into the radial notch, forming the proximal radio-ulnar joint.
- At its distal end, the ulna narrows into a small ulnar head with a prominent styloid process, which attaches to the cartilage (articular disc) that separates the forearm from the wrist.



Radius

- The lateral bone of the forearm, the radius, has a disk-shaped radial head above the neck, and a radial tuberosity below the neck, where the biceps attach.

- At its distal end, the radius articulates with the ulna at the ulnar notch, and also articulates with the wrist. A fibrous sheet called the interosseus membrane connects the ulna to the radius.

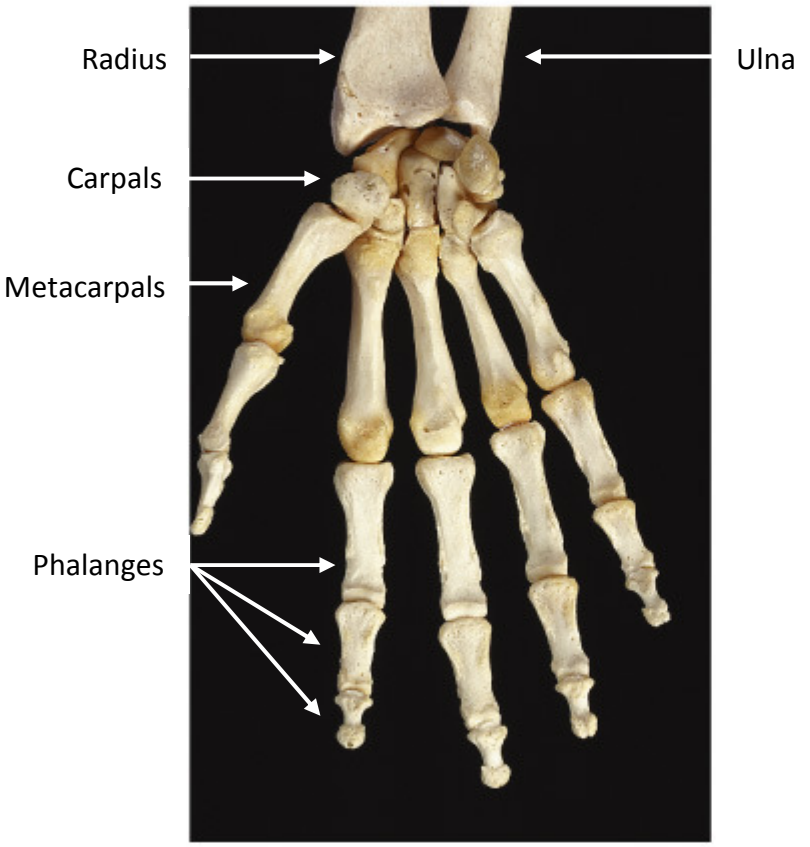
Wrist – Carpal Bones

- The wrist is made up of 8 carpal bones: 4 proximal carpal bones and 4 distal carpal bones. The articulations of the carpal bones allow the wrist to bend and twist.

Hand – Metacarpals and Phalanges

- The long bones of the hand are the 5 metacarpal bones, numbered I-V from lateral (thumb) to medial (little finger).

- The proximal finger bones, or phalanges, articulate with the metacarpals.
  - The thumb has 2 phalanges (proximal and distal).
  - The fingers each have 3 phalanges (proximal, middle and distal).



(R) Hand (palm of hand view)

(R) Hand (back of hand view)

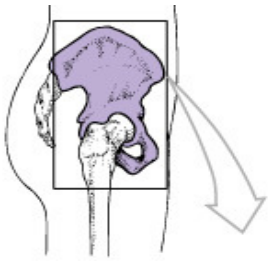
Pelvic Girdle

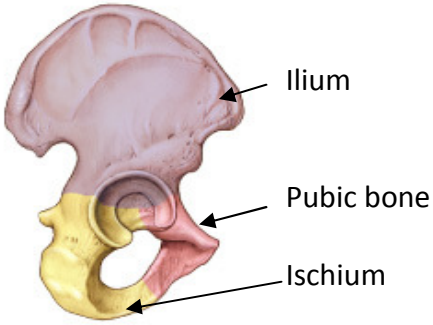
- The pelvic girdle (which is made up of the 2 hipbones or **os coxae**) is heavy because it bears the weight of the body and stress of movement.

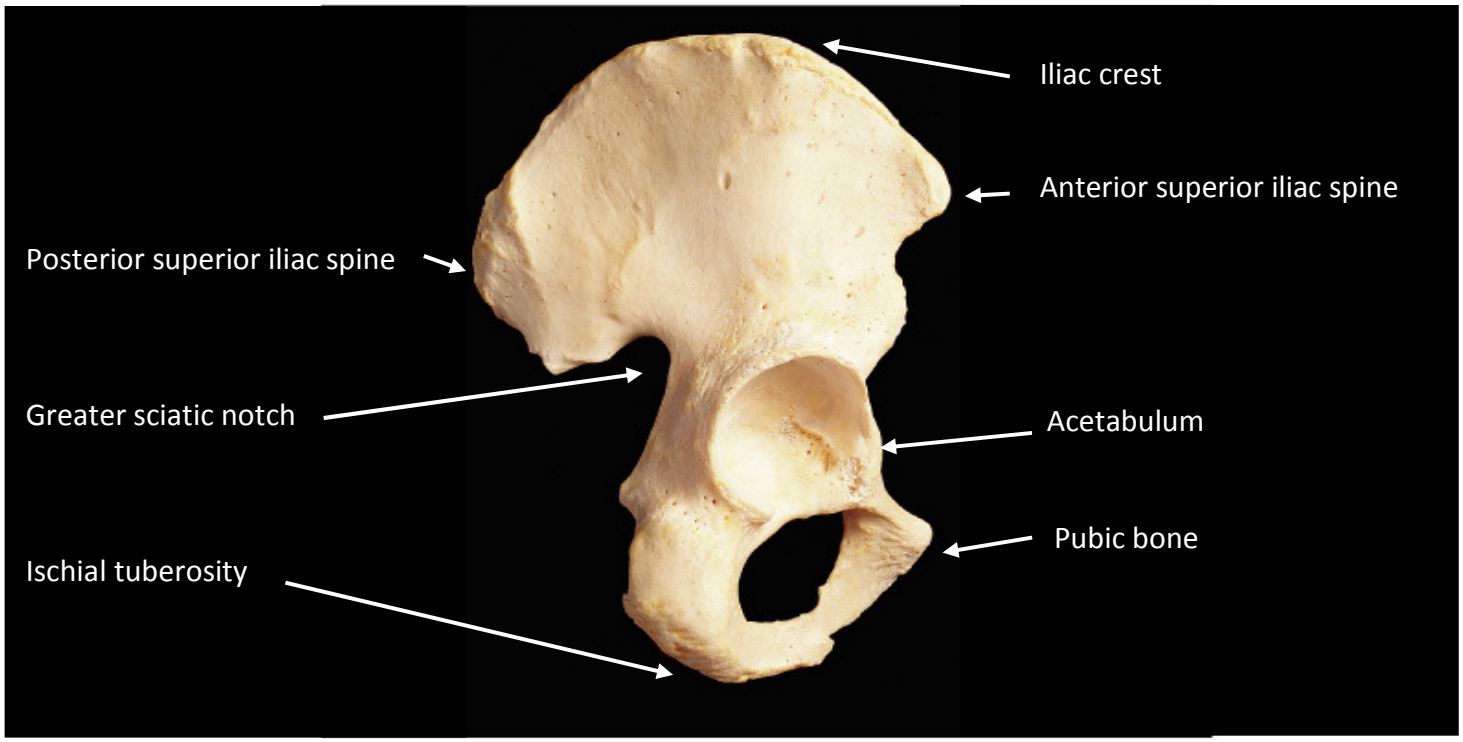
- Each os coxae is made up of 3 fused bones:
  1. Ilium (articulates with the sacrum)
  2. Ischium
  3. Pubic bone

- The ilium, ischium and pubis meet at the acetabulum (hip socket) on the lateral surface of the os coxae.
  - The acetabulum articulates with the head of the femur to from the hip joint
- On the ilium, the anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS) are the bony are the bony protuberances that can be felt at the front and back of the pelvis.

Os coxae (lateral view)







- The main landmark of the ilium is the greater sciatic notch, which the sciatic nerve runs past.

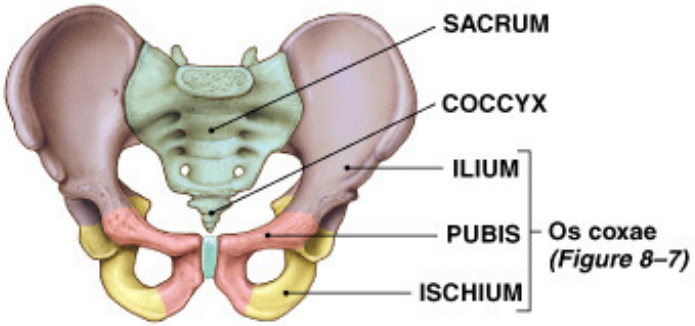
- The ischium has the ischial tuberosities which are the bones we sit on.

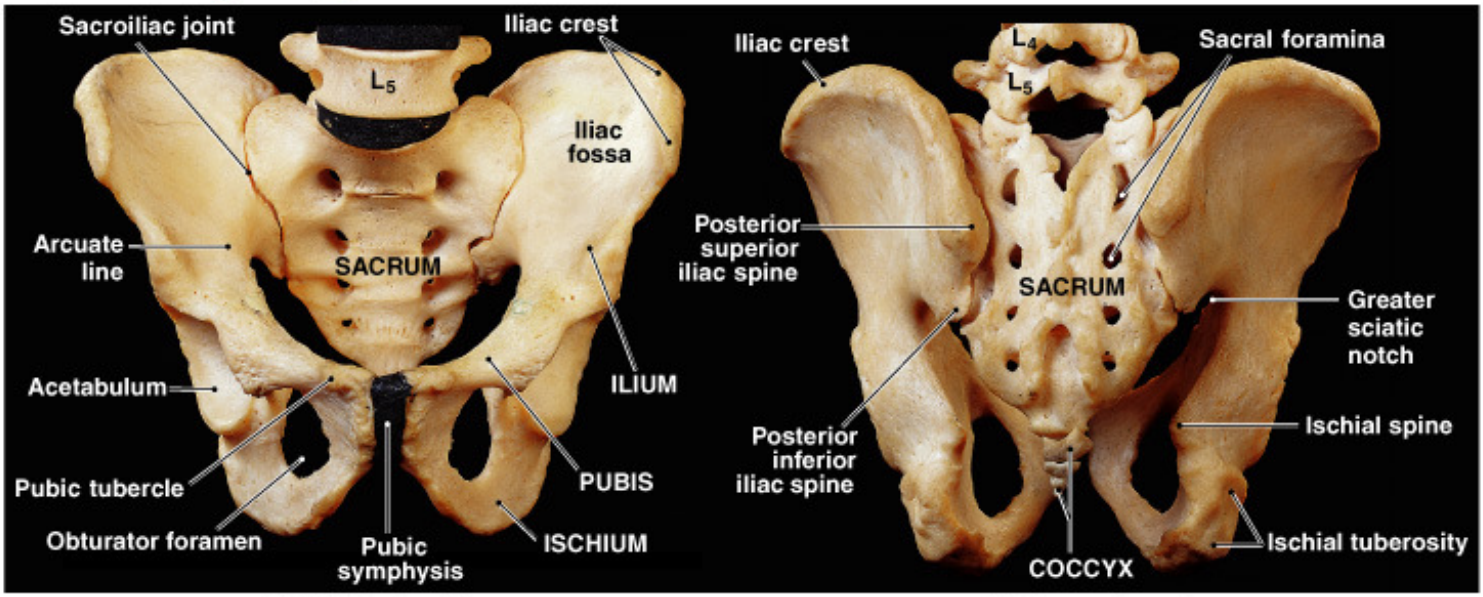
- The pubic bones are joined together in the midline at the front of the pelvis by a fibrocartilage pad to form the pubic symphysis joint.

- The posterior auricular surface of the ilium articulates with the sacrum to form the sacroiliac joint.

- The pelvis consists of the 2 os coxae (the pelvic girdle), the sacrum and coccyx. The pelvis is stabilized by ligament attachments between the pelvic girdle, the sacrum and the lumbar vertebrae.

- The inferior rim of the pelvis is where the pelvic floor/perineum muscles attach to support the organs of the pelvic cavity.





(a) Anterior view (b) Posterior view

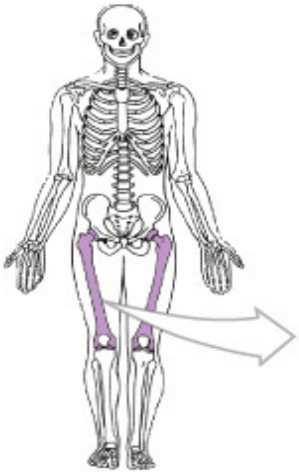
The Lower Limbs

- The lower limbs consist of a femur (thigh), patella (kneecap), tibia and fibula (lower leg) and the bones of the ankle and foot. The main functions of the lower limbs are weight bearing and motion.

Thigh - Femur

- The femur is the longest, heaviest bone in the body.
- At its proximal end, the femoral head articulates with the pelvis at the acetabulum to form the hip joint.
- The narrow neck joins the shaft at an angle formed by the greater and lesser trochanters, where a lot of the hip muscles and ligaments attach to.
- At the distal end, the medial and lateral condyles articulate with the tibia and fibula, and the patella surface articulates with the patella to collectively form the knee joint complex.

(R) Femur (front view)



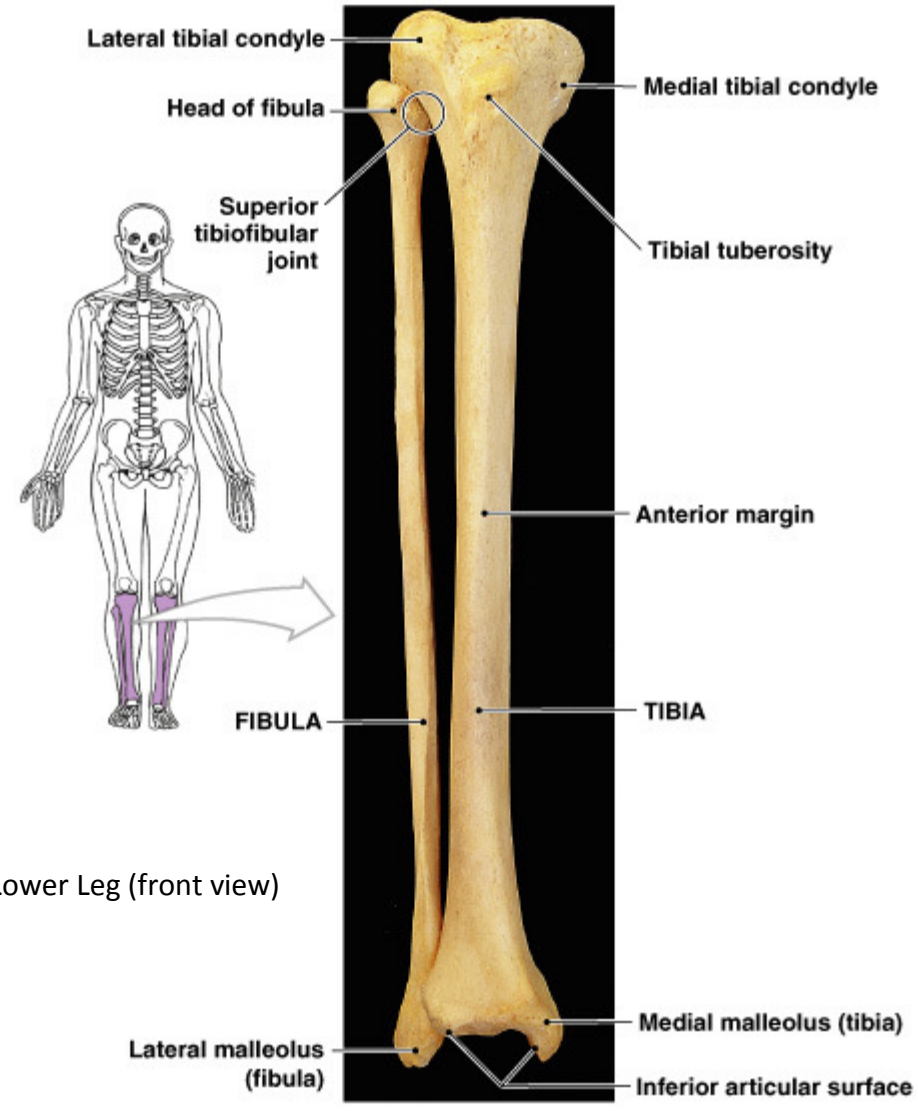
Lower Leg

Tibia

- The tibia (shinbone) supports the body weight. It is larger than and medial to the fibula.
    - The medial and lateral tibial condyles articulate with the medial and lateral condyles of the femur.
    - The patella bone attaches to the tibial tuberosity via the patella ligament.
    - The medial projection at the ankle is the medial malleolus.

Fibula

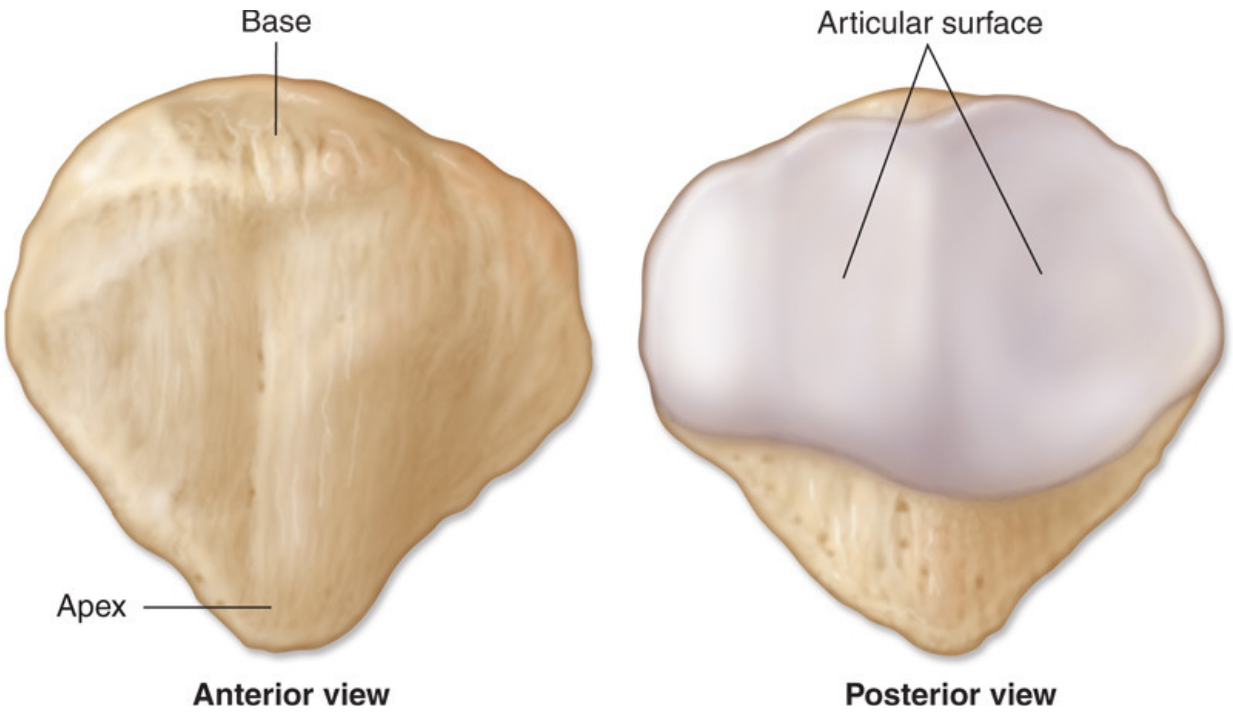
- The fibula attaches to muscles that move the feet and toes. It is smaller than and lateral to the tibia.
    - The fibula articulates with the tibia at the superior and inferior ends of the bones to form the superior and inferior tibiofibular joints.
    - The lateral projection at the ankle is the lateral malleolus – the bony protuberance that is easily seen and palpated.



(R) Lower Leg (front view)

Patella

The patella (kneecap) is a sesamoid bone formed within the tendon of the quadriceps femoris, which attaches to the base (superior end) of the patella. The patella ligament attaches at the apex (inferior end) of the patella and joins onto the tibia. The underneath side of the patella contains articular cartilage which articulates with the femur.



Ankle – Tarsal Bones

The ankle (tarsus) consists of 7 tarsal bones.

1. **Talus**: carries body weight from the tibia across an articular process called the trochlea

2**. Calcaneus** (heel bone): transfers weight from the talus to the ground and attaches to the Achilles tendon

3. Cuboid bone: articulates with the calcaneus

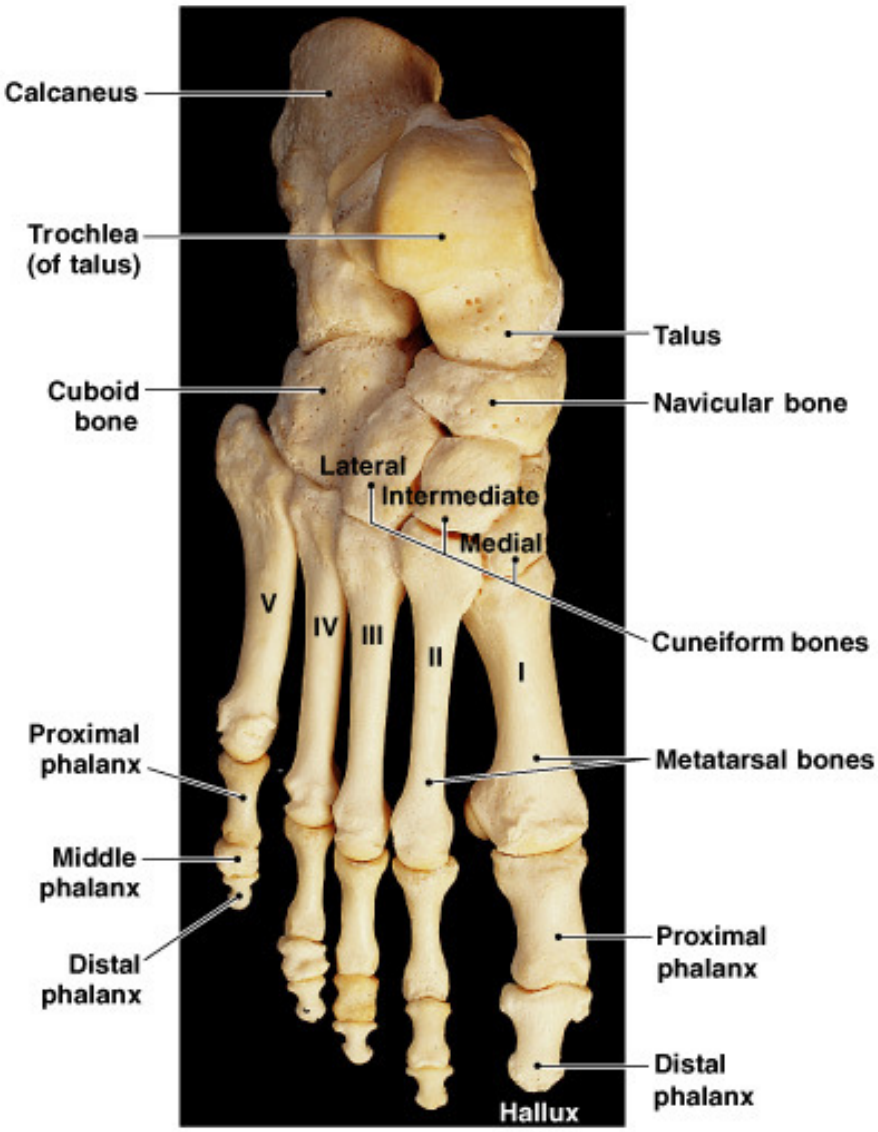
4. Navicular bone: articulates with the talus and 3 cuneiform bones

5, 6, 7. Cuneiforms – lateral, intermediate and medial cuneiform bones

Foot – Metatarsals and Phalanges

- The 5 long bones of the foot are the metatarsal bones, numbered I-V from medial to lateral.
    - The metatarsal bones articulate with the toes

- The bones of the toes are phalanges, organized in the same way as the phalanges of the fingers.
    - The big toe has 2 phalanges (distal and proximal)
    - The other 4 toes have 3 phalanges (distal, medial and proximal)



(a) Superior view, right foot

Joints

Movement of the skeletal system occurs only at joints where 2 bones connect (articulations). Joints have different structures that determine the direction and distance they can move.

Functional Classification of Joints

The distance and direction a joint can move is called *range of motion*. Joints can move a lot (diarthrosis), a little (amphiarthrosis), or not at all (synarthrosis).

In learning anatomy for Pilates, the joints of most interest are the joints that move a lot (diarthroses or synovial joints). There are joints that are important though that are not synovial joints eg rib articulations with the sternum, vertebrae and pubic symphysis)

Synovial Joints *(Moveable Joints)*

- Diarthroses (synovial joints) are found at the ends of long bones, within articular capsules lined with synovial membrane.

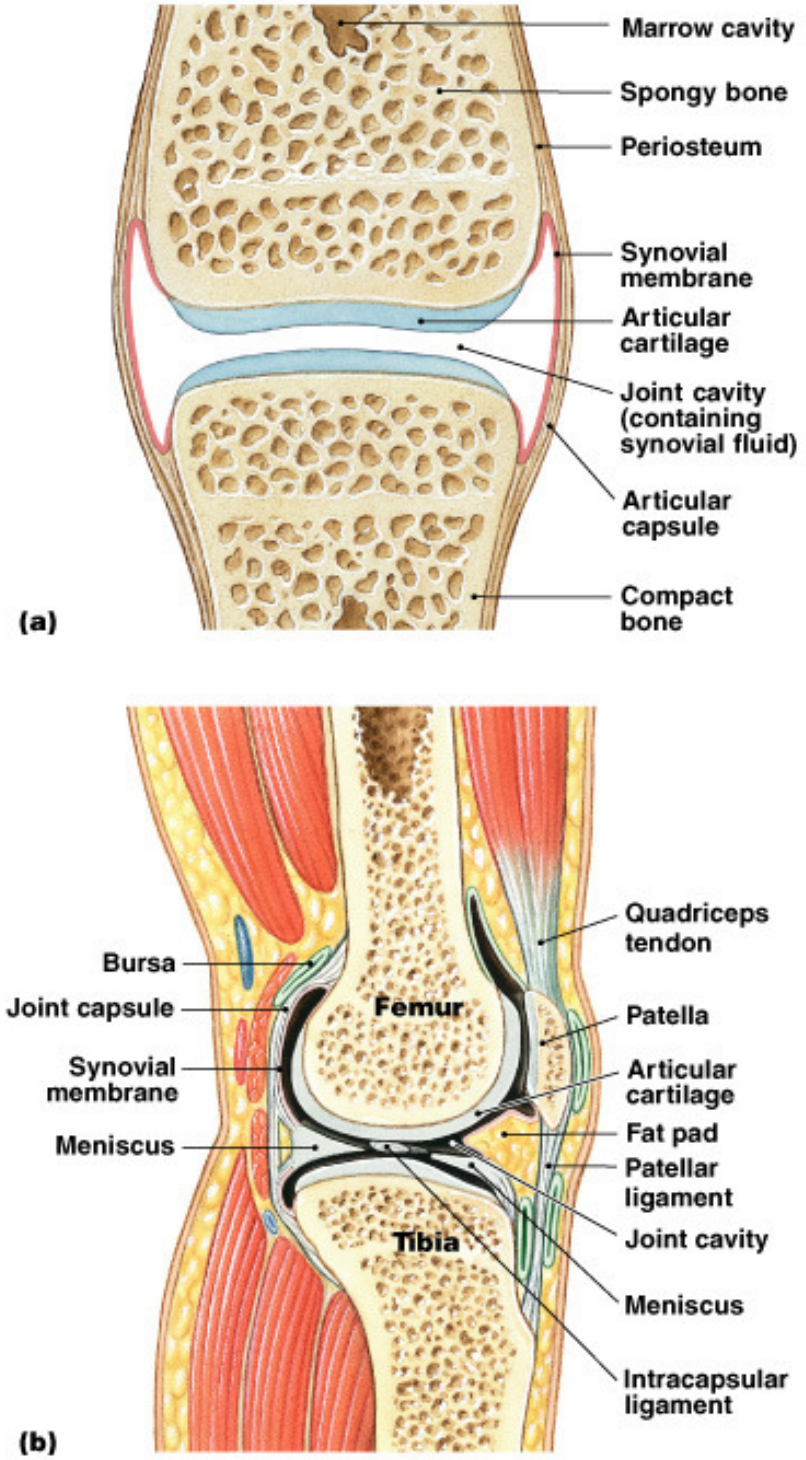
- The articulating surfaces of the bones within the articular capsules are padded with articular cartilages, which prevent the bones from touching. The smooth surfaces are lubricated by synovial fluid to reduce friction.

- Synovial joints have several kinds of accessory structures:
  1. Cartilages and fat pads cushion the joint.
     - a fibrocartilage meniscus or *articular disc* lies between bones and protects them from rubbing against each other
     - fat pads lie superficial to the joint capsule to protect articular cartilages
  2. Various kinds of ligaments support and strengthen joints.
     - an injury which tears collagen fibres in a ligament is a sprain
  3. Tendons attach muscles to bone and around a joint can help support the joint.
  4. Bursae are pockets of synovial fluid that cushion areas where tendons or ligaments rub.

- Several factors stabilize joints and prevent injury by limiting range of motion:
  1. collagen fibres of the joint capsule and associated ligaments
  2. the shapes of articulating surfaces and menisci
  3. other bones, muscles, or fat pads around the joint
  4. tendons of opposing (articulating) bones may help control or limit movement

- An injury to a joint in which articulating surfaces are forced out of position is called a dislocation (A partial dislocation is a subluxation). These can damage

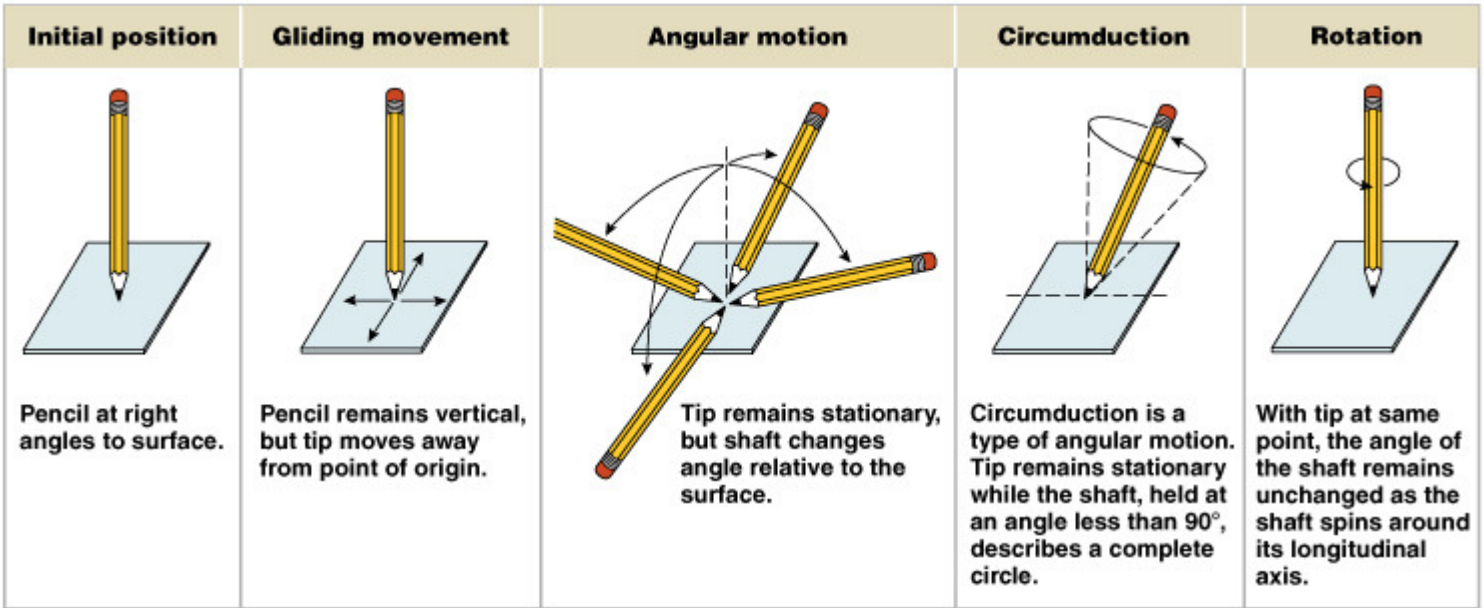
articular cartilage, tear ligaments, or distort the joint capsule.



An example of the structure of a synovial joint (the knee)

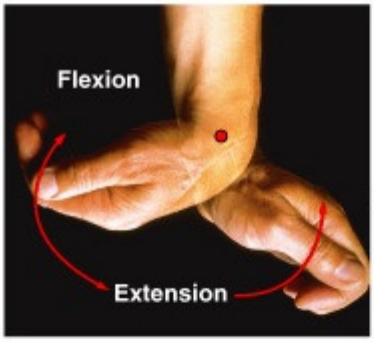
Movements at Synovial Joints

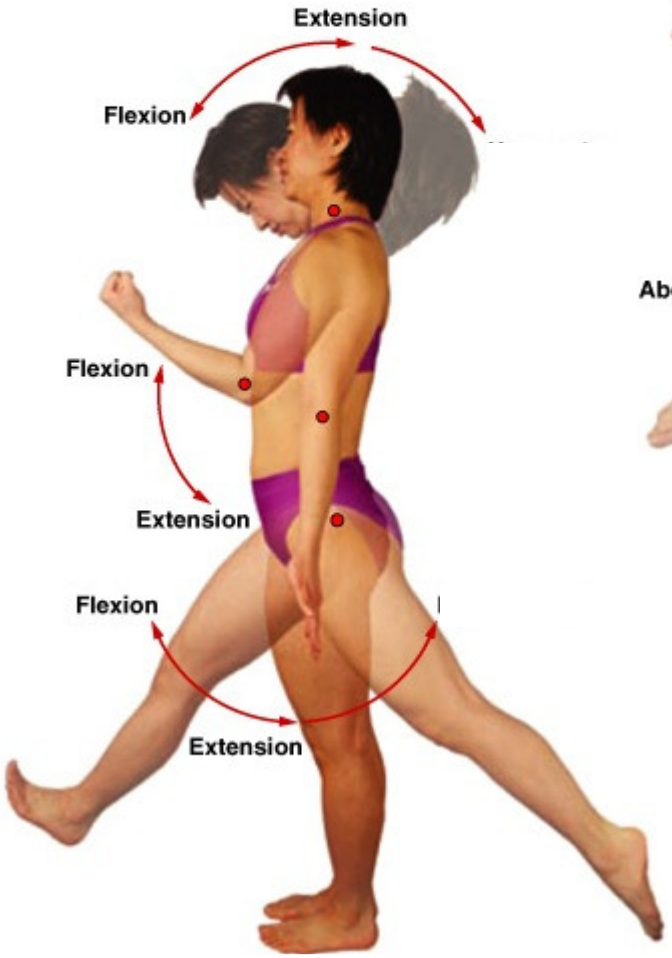
Accurate terms must be used to describe movement, including the plane or direction of motion, and the change in relationship between the elements or structures involved.

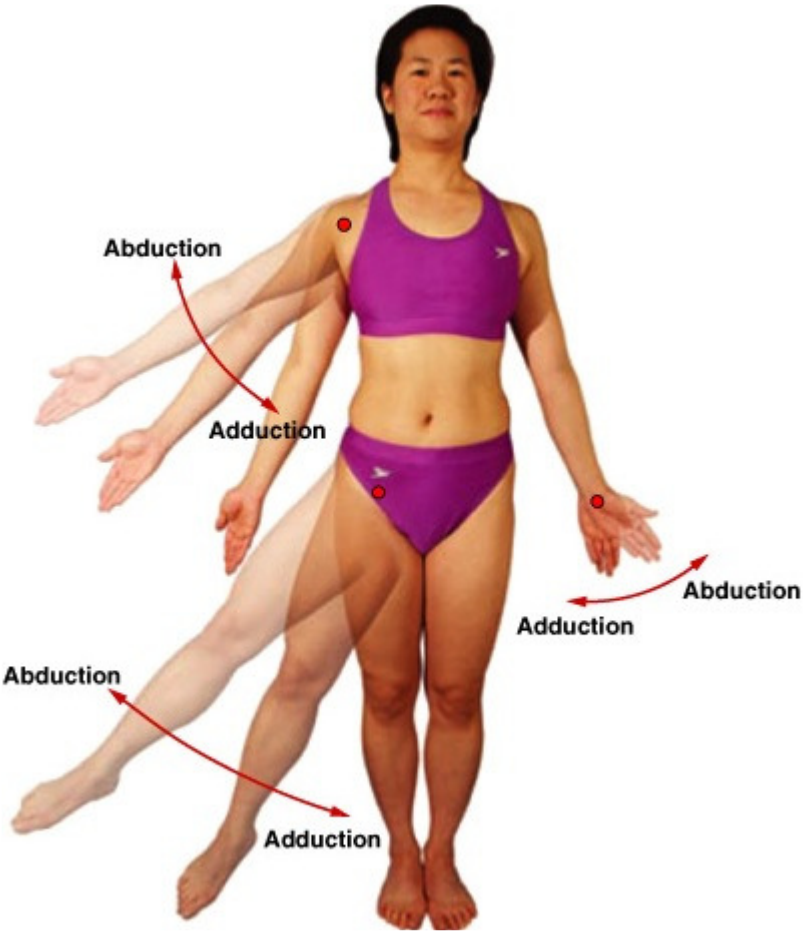


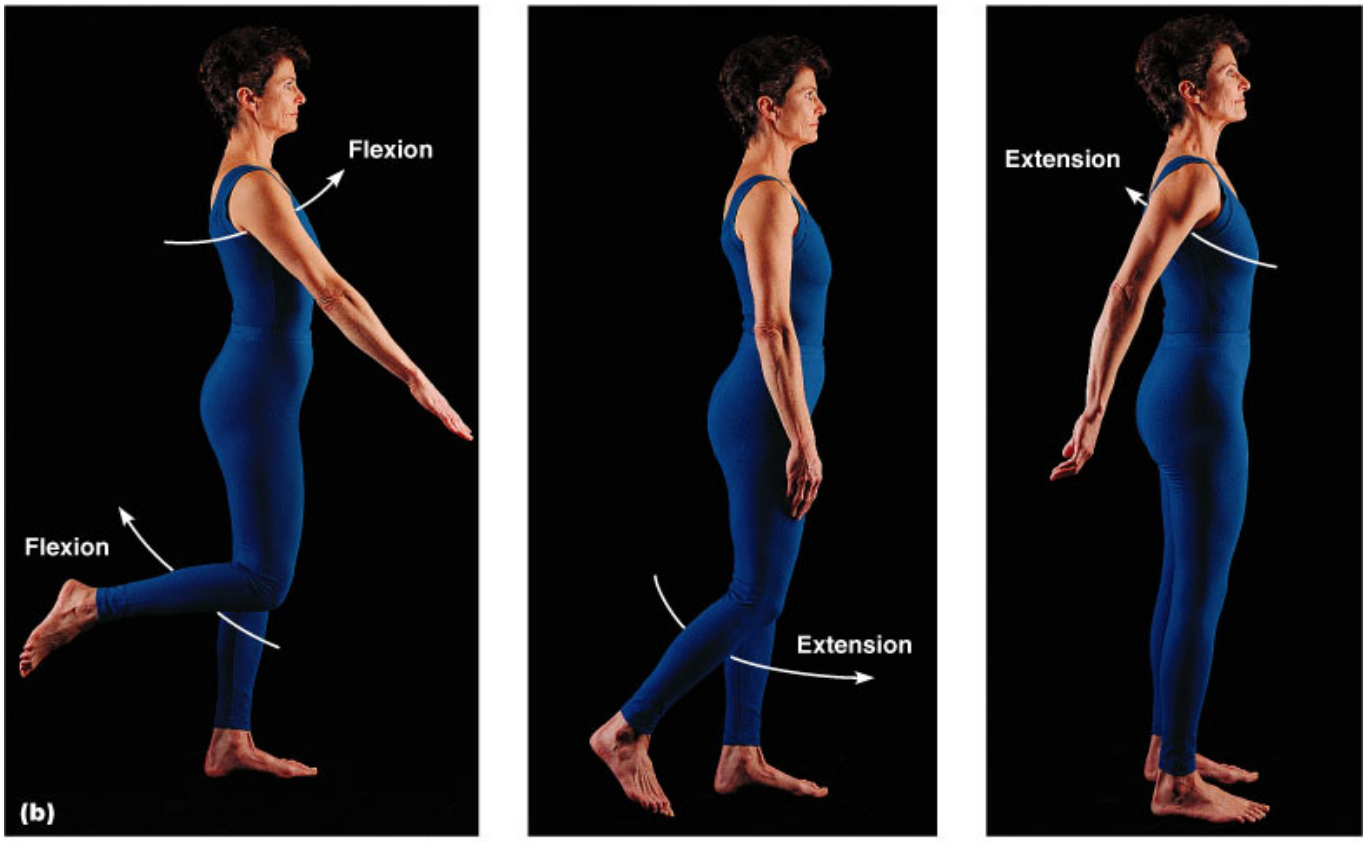
- 1. Linear Motion (gliding):
  - 2 surfaces slide past each other
  - *e.g.* between carpal or tarsal bones

- 2. Angular Motions
  - flexion:
    - in the anterior-posterior plane
    - *reduces* the angle between elements
  - extension:
    - in the anterior-posterior plane
    - *increases* the angle between elements
  - abduction:
    - in the frontal plane
    - moves out away from the longitudinal axis of the body
  - adduction:
    - in the frontal plane
    - moves in toward the longitudinal axis of the body
  - circumduction:
    - a circular motion without rotation









- 3. Rotational Motions
  Rotation: the direction of a rotation from anatomical position, relative to the longitudinal axis of the body.

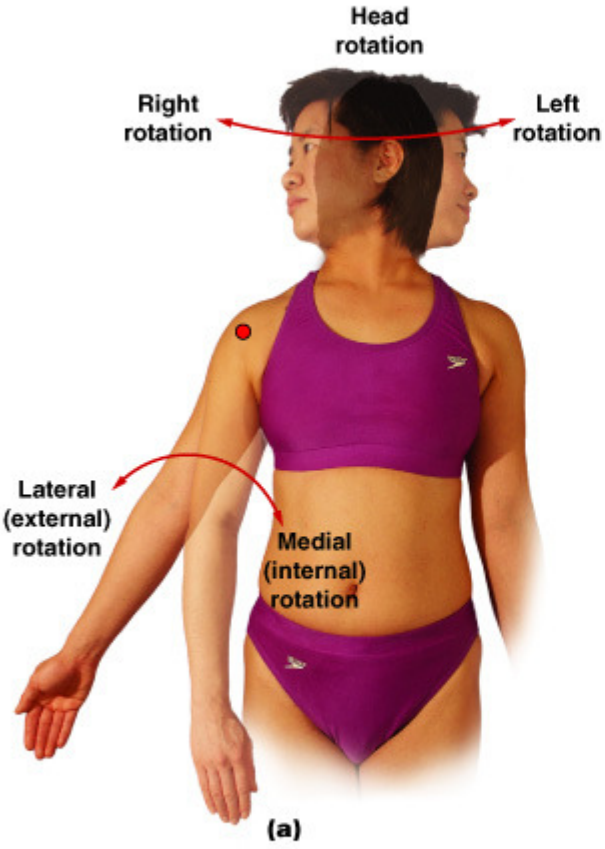
  - left or right rotation

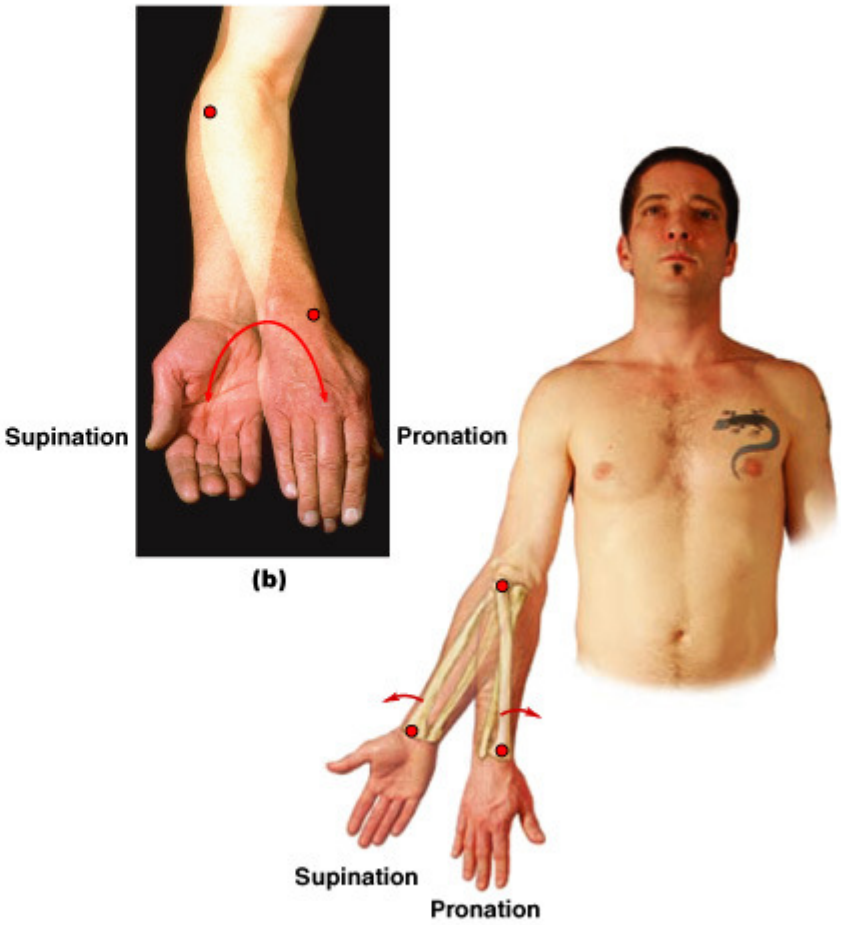
  - medial rotation (*internal rotation*): rotates toward the midline of body

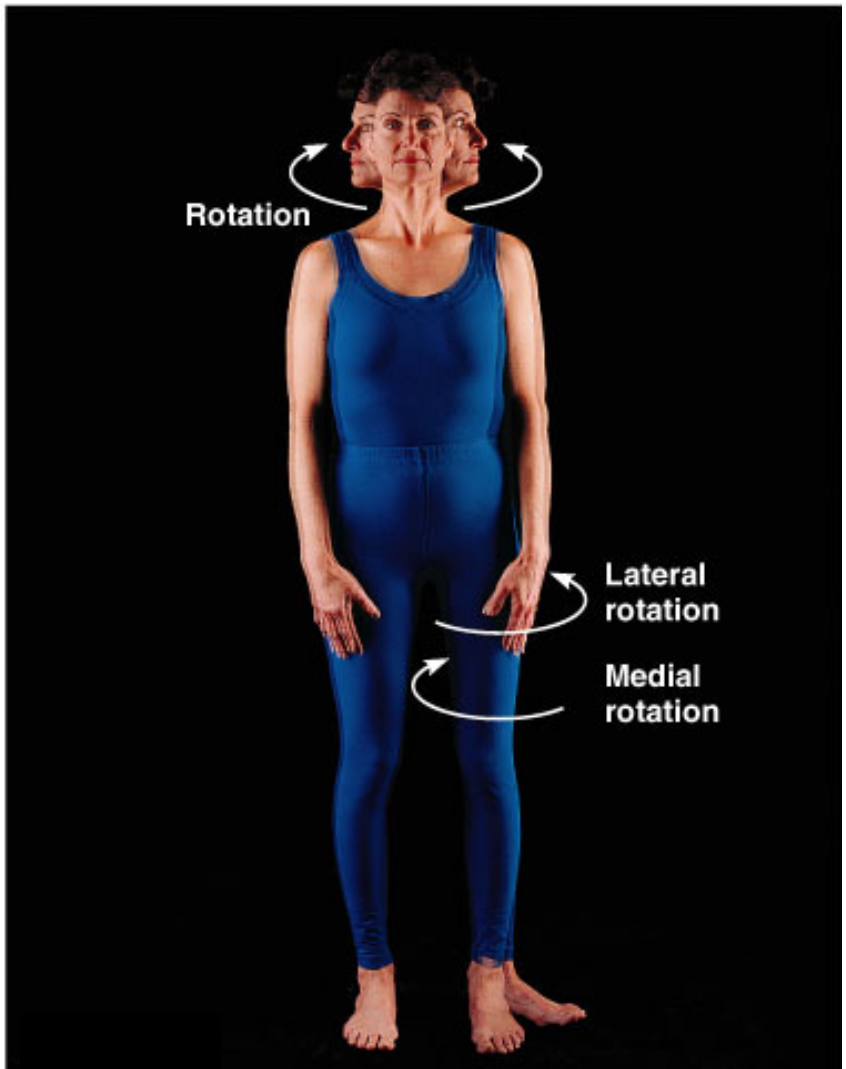
  - lateral rotation (*external rotation*): rotates away from midline of body

  - pronation: rotates the forearm, radius over ulna, thumb moving towards the body

  - supination: the forearm in anatomical position, thumb moving away from the body


Head rotation
Right rotation
Left rotation
Lateral (external) rotation
Medial (internal) rotation
(a)


Supination
Pronation
(b)
Supination
Pronation


Rotation
Lateral rotation
Medial rotation

- 4. Special movements of specific articulations:

  inversion: twists the sole of the foot medially

  eversion: twists the sole of the foot laterally

  dorsiflexion: flexion at the ankle (lifting toes)

  plantar flexion: extension at the ankle (pointing toes)

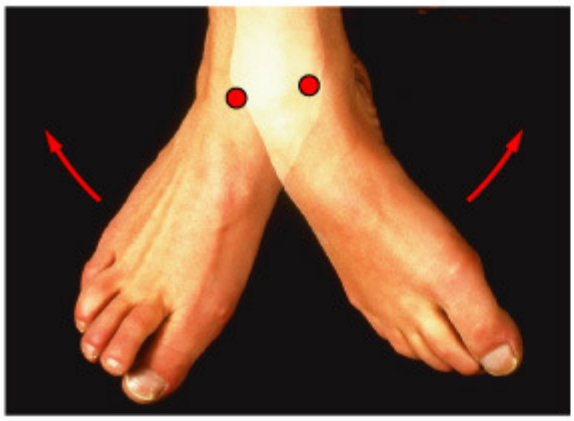
  protraction: moves a body part anteriorly, in the horizontal plane (pushing forward)

  retraction: the opposite of protraction, moving anteriorly (pulling back)

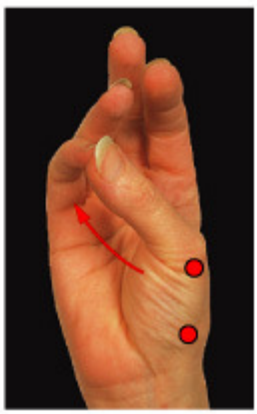
  elevation: moves in a superior direction (up)

  depression: moves in an inferior direction (down)

  lateral flexion: bends the vertebral column from side to side.

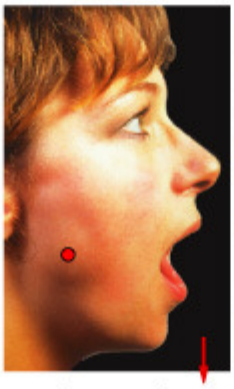


Eversion Inversion



Opposition

Retraction Protraction



Depression

Elevation

Lateral flexion

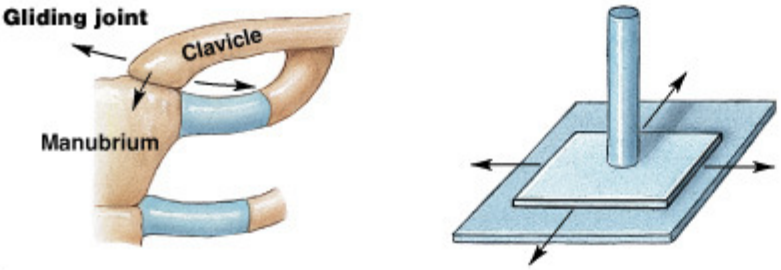
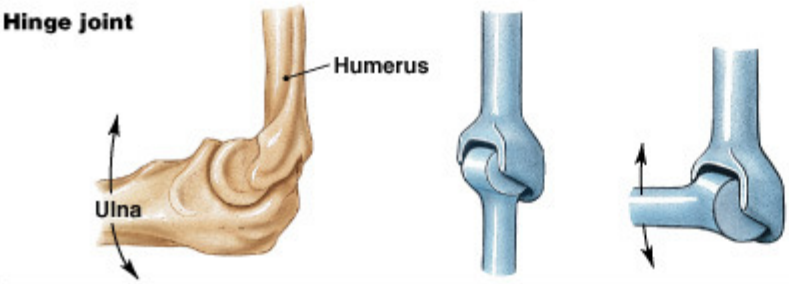
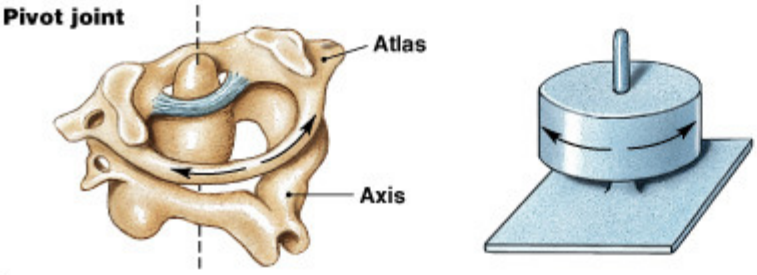
Types of Synovial Joints

- Synovial joints may be classified by the shapes of their articulating surfaces, as follows:

1. gliding joints:
   - flattened or slightly curved faces
   - limited motion

2. hinge joints:
   - angular motion in a single plane

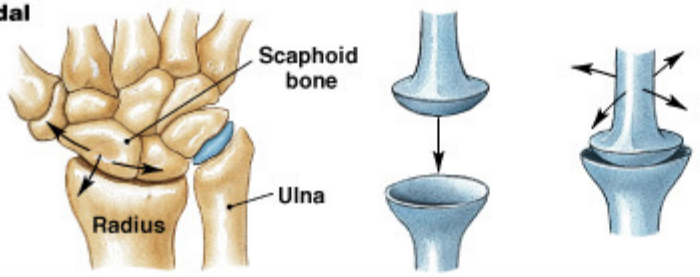
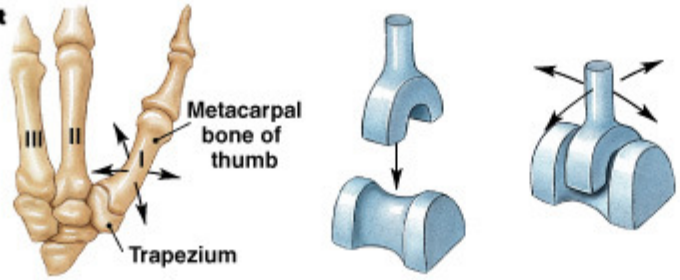
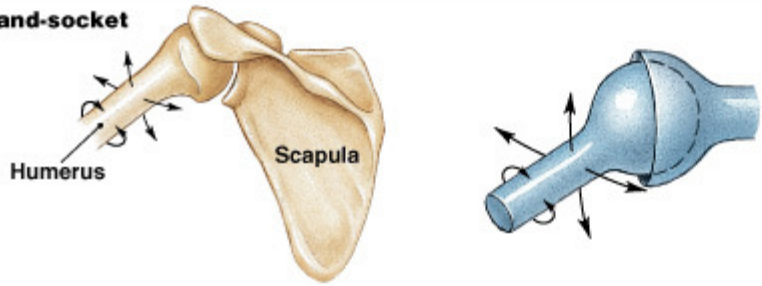
3. pivot joints:
   - rotation only

Types of Synovial Joints	Movement	Examples
Gliding joint 	Slight nonaxial or multiaxial	• Acromioclavicular and claviculosternal joints • Intercarpal and intertarsal joints • Vertebrocostal joints • Sacroiliac joints
Hinge joint 	Monaxial	• Elbow joint • Knee joint • Ankle joint • Interphalangeal joint
Pivot joint 	Monaxial (rotation)	• Atlas/axis • Proximal radioulnar joint

4. ellipsoidal joints:
   - an oval articular face within a depression
   - motion in 2 planes

5. saddle joints:
   - two concave faces, straddled

6. ball-and-socket joints:
   - a round articular face in a depression

Types of Synovial Joints	Movement	Examples
Ellipsoidal joint 	Biaxial	• Radiocarpal joint • Metacarpophalangeal joints 2–5 • Metatarsophalangeal joints
Saddle joint 	Biaxial	• First carpometacarpal joint
Ball-and-socket joint 	Triaxial	• Shoulder joint • Hip joint

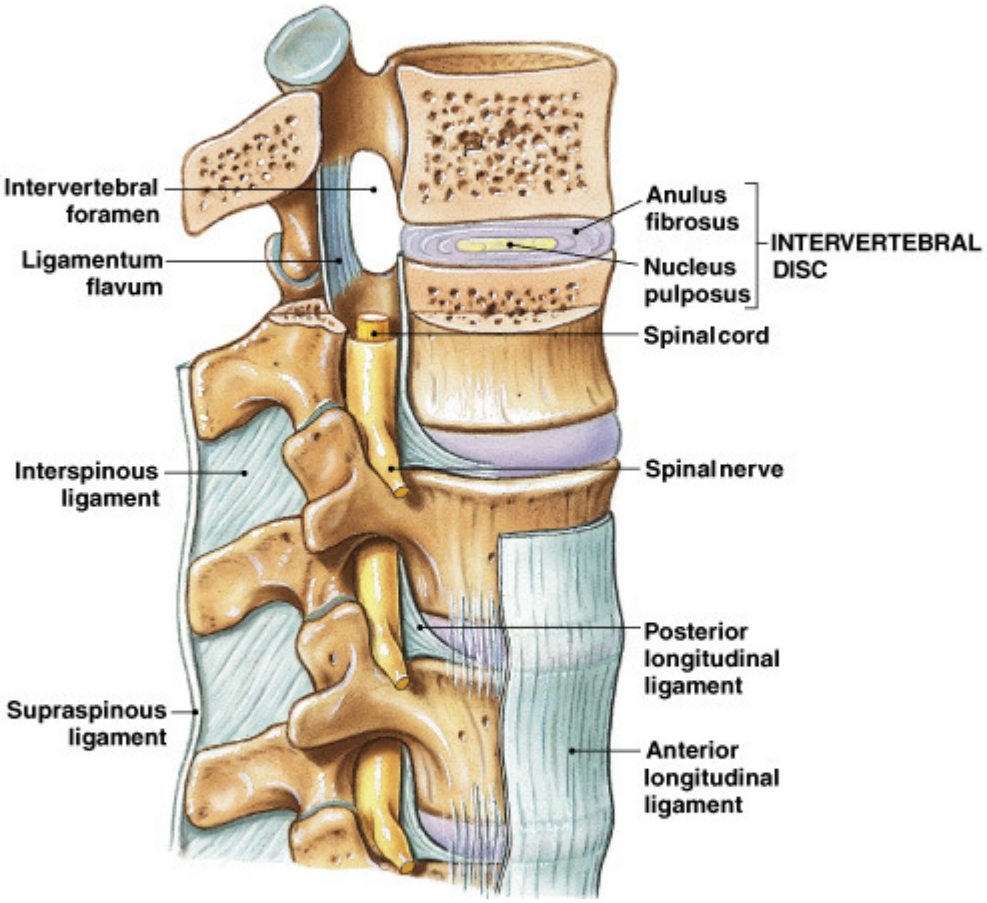
A joint can't be both highly mobile and very strong. The greater the mobility, the weaker the joint, because mobile joints rely on muscular and ligamentous support rather than solid bone-to-bone connections.

Intervertebral Joints

- From the second cervical vertebra to the last lumbar vertebra, the spinal vertebrae articulate at their inferior and superior articular processes and between adjacent vertebral bodies through the intervertebral discs.

- Pads of fibrocartilage (intervertebral discs) separate the vertebral bodies. The tough outer layer (anulus fibrosus) attaches the disc to adjacent vertebrae. The elastic, gelatinous core (nucleus pulposus) absorbs shocks. As the vertebral column moves, the nucleus pulposus shifts, allowing the intervertebral disc to conform to the motion.

- Intervertebral ligaments bind vertebrae together and stabilize the vertebral column



- The vertebral column can move in 4 ways:
  1. flexion (bending anteriorly)
  2. extension (bending posteriorly)
  3. lateral flexion (bending laterally)
  4. rotation (right and left)

  (see pages 33, 35, 36)

Shoulder Complex

Glenohumeral Joint (shoulder joint)

- The shoulder joint (*glenohumeral joint*) allows more motion than any other joint. Therefore, it is also the least stable.

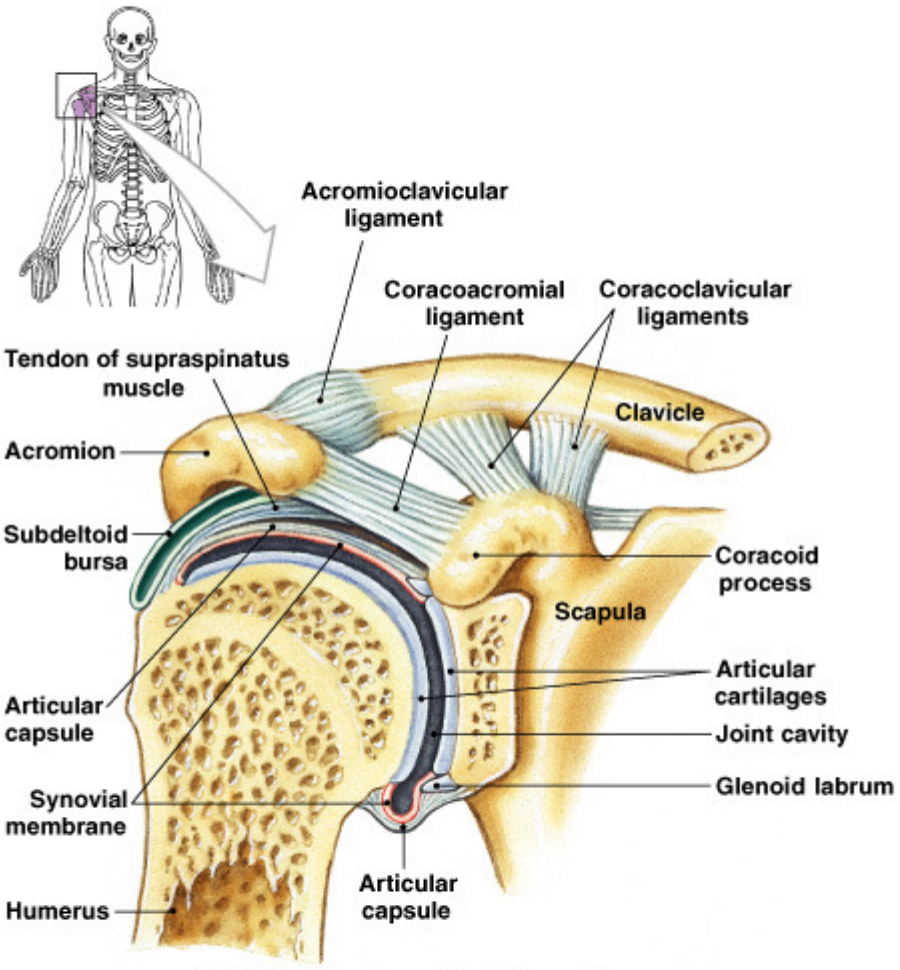
- The shoulder joint is a ball-and-socket joint between the head of the humerus and the glenoid cavity of the scapula. The socket of the glenoid cavity is deepened by a lining of fibrocartilage (the glenoid labrum) that extends past the bone.

- The acromion of the clavicle and the coracoid process of the scapula project laterally, superior to the humerus, and help stabilize the joint, but position is maintained mainly by skeletal muscles, tendons and ligaments.

- A common injury is partial or complete dislocation of the shoulder joint.

- The main support for the shoulder joint is a muscle group called the rotator cuff.

- The shoulder has several important bursae that reduce friction across the joint.



(a) Anterior view, frontal section

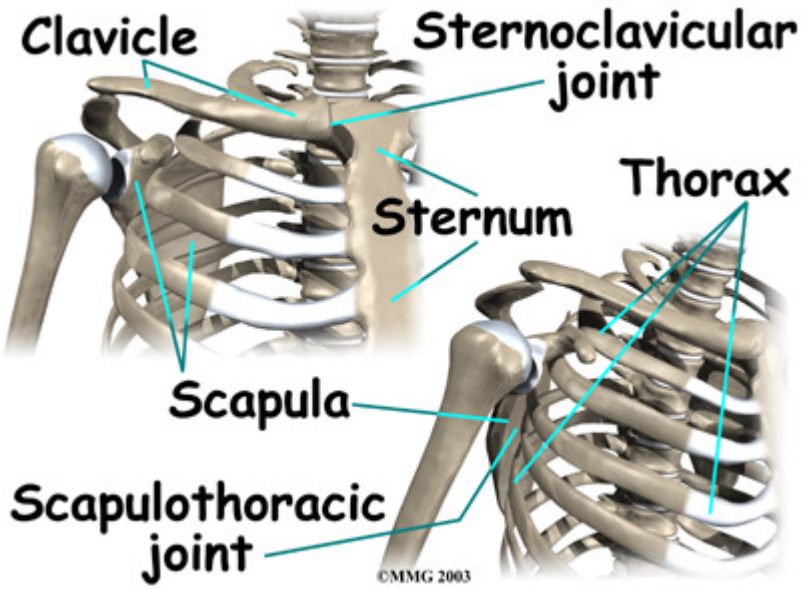
- The shoulder joint can move in many ways:
  1. flexion (taking the arm anteriorly (forwards) then overhead
  2. extension: drawing the arm posteriorly (backwards) behind the body
  3. abduction: taking the arm out to the side then overhead
  4. adduction: drawing the arm towards the body/closer to the midline
  5. medial rotation/internal rotation: rotating the humerus towards the body
  6. lateral rotation/external rotation: rotating the humerus away from the body
  (*see pages 33, 34, 35)*

- the shoulder can also move in:
  7. circumduction: making a large circle with the arm
  8, horizontal abduction: when the shoulder is flexed to 90 degrees, the arm is at shoulder height then the arm is moved away from the midline
  9. horizontal adduction: when the shoulder is flexed to 90 degrees, the arm is at shoulder height then the arm is moved towards the midline

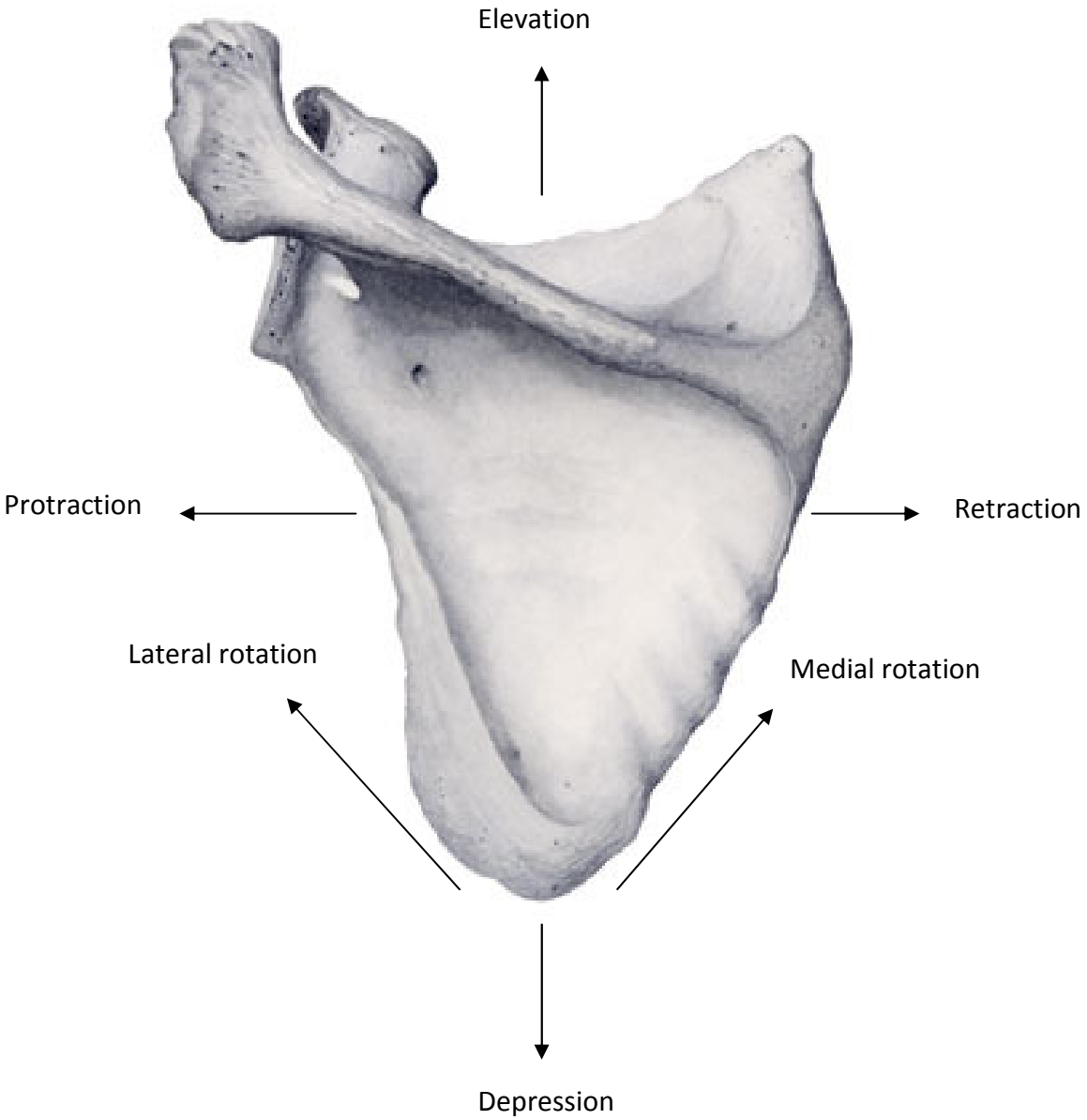
Scapulo-thoracic

- The scapula is a very mobile bone as it connects to axial skeleton only by the clavicle. It lies very close to the posterior ribcage (at the level of ribs 2-7) but does not articulate with it. Rather it floats behind it, suspended in a network of muscles and ligaments. This is called the scapula-thoracic complex.

- The scapula can move in many directions:
  1. elevation: raising the scapula superiorly
  2. depression: lowering the scapula inferiorly
  3. protraction: gliding laterally and forwards around the ribcage, scapula separate from each other
  4. retraction: gliding medially and backwards, scapula move towards each other
  5. medial rotation: inferior angle moves towards the midline
  6. lateral rotation: inferior angle moves away from the midline



Lateral side/shoulder *Medial side/spine*



Posterior view (L) scapula

Elbow Joint Complex

- The elbow joint is a stable hinge joint with articulations between the humerus and radius/ulna.

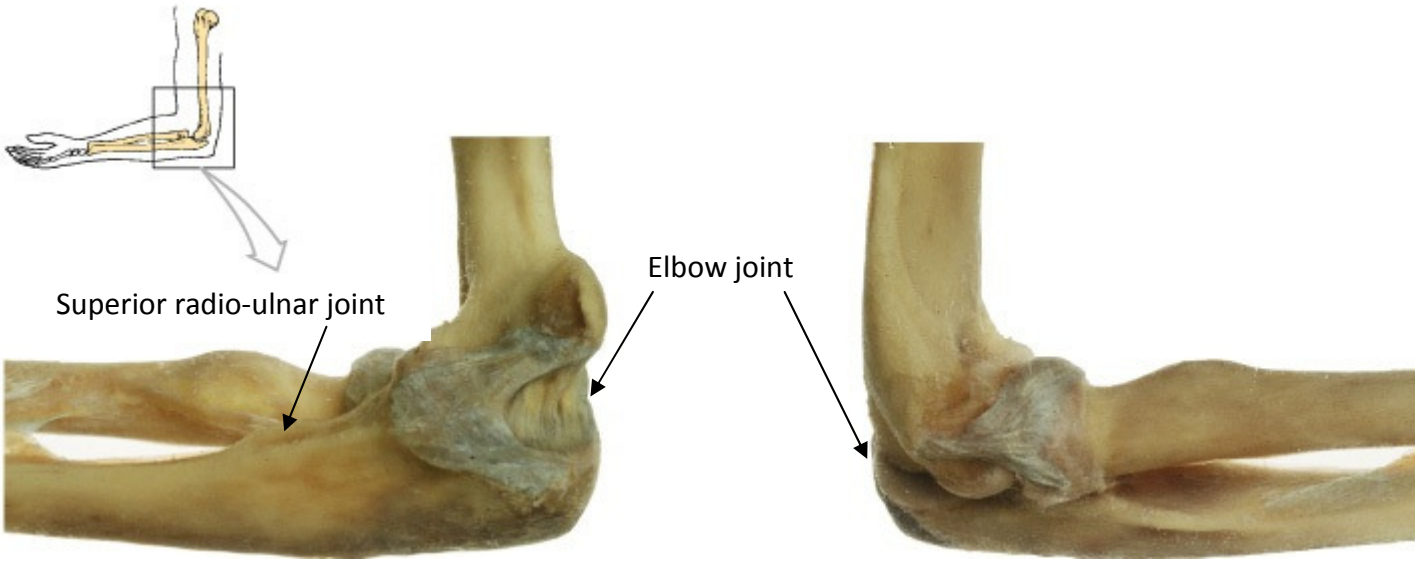
- Also in the elbow joint complex is the superior radio-ulna joint, where the radius and ulna articulate with each other.

- Elbow motion is stabilized by several ligaments.

- The elbow joint (articulation between the humerus and radius/ulna) can move in 2 ways:
  1. flexion: the elbow bend and the angle between the forearm and upper arm closes in
  2. extension: the elbow straightens and the angle between the forearm and upper arm opens out

- The superior radio-ulna joint can also move in 2 ways:
  1. pronation: the radius moves over the ulna to turn the thumb towards the body
  2. supination: the ulna moves over the radius to turn the thumb away from the body

  (*see pages 33 and 35)*



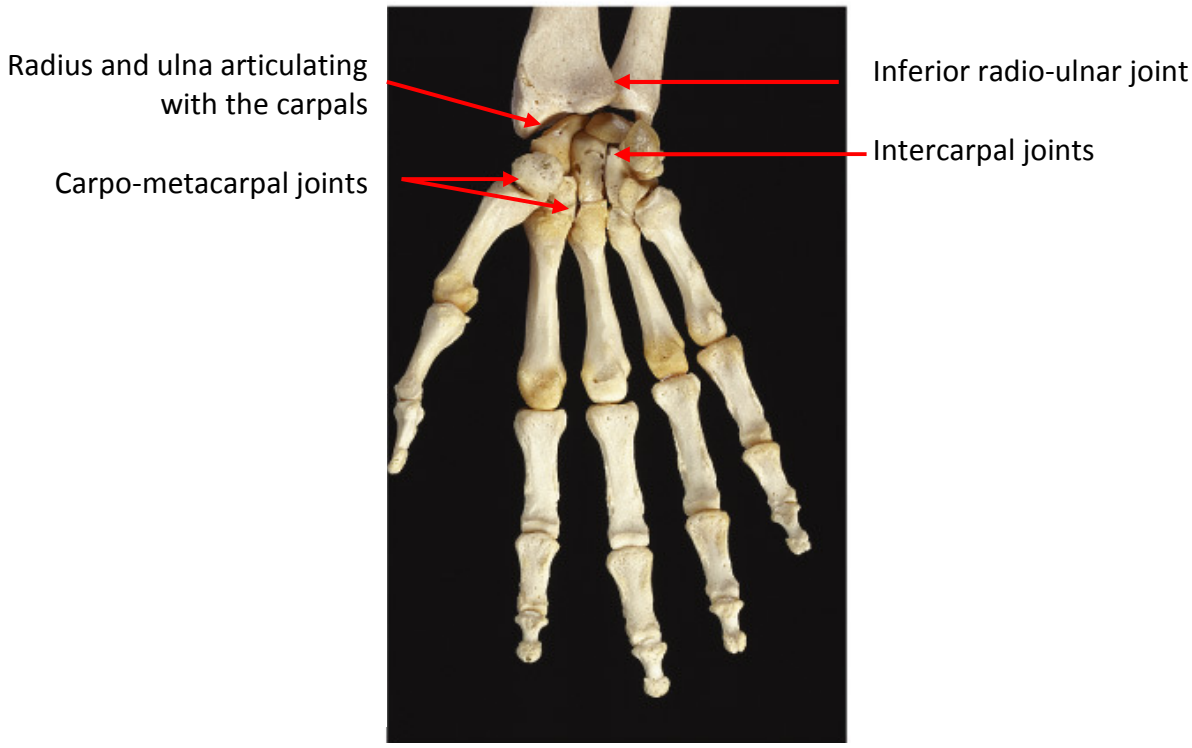
Wrist Joint complex

- The wrist is made up of many bones and complex articulations.
  1. inferior radio-ulnar joint: between the radius and ulnar
  2. the radius and ulna articulating with the carpal bones
  3. the carpal bones articulating with each other and the metacarpal bones.

- Movements produced at the wrist are:
  1. flexion: bending the wrist so that the palm of the hand moves towards the forearm
  2. extension: extending the wrist so that the back of the hand moves closer to the back of the forearm
  3. radial deviation: lateral movement of the hand so that the thumb side of the hand moves towards the radius
  4. ulnar deviation: medial movement of the hand so that the little finger moves towards the ulna

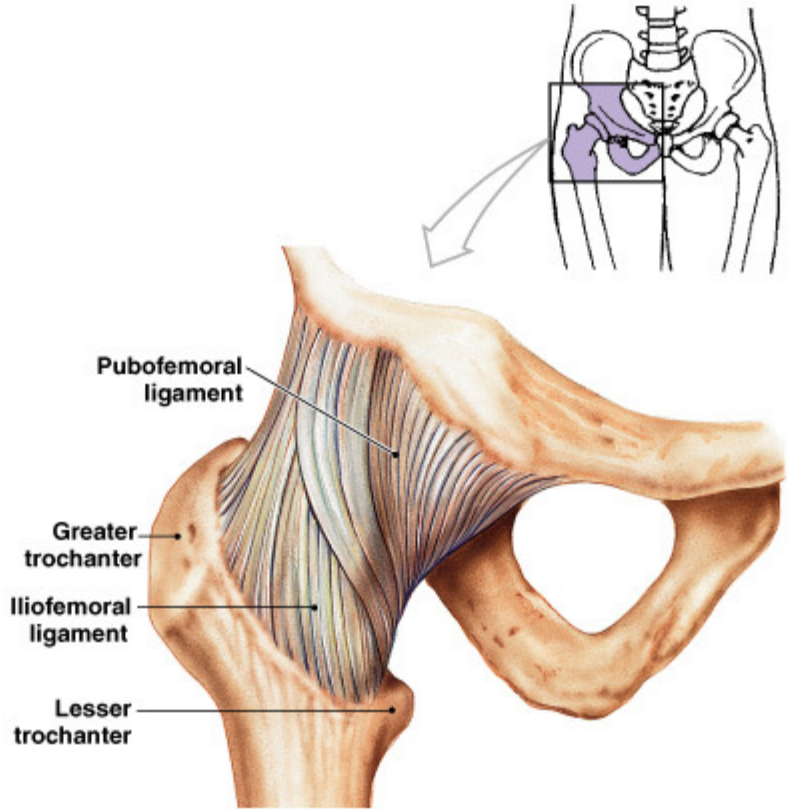
- Movements produced at the inferior radio-ulnar joint are:
  1. pronation: the radius moves over the ulna to turn the thumb towards the body
  2. supination: the ulna moves over the radius to turn the thumb away from the body

(see pages 33, 35)



Hip Joint

- The hip joint is a strong ball-and-socket joint with a wide range of motion.
- The head of the femur fits into the socket of the acetabulum, which is extended by a fibrocartilage rim
- The strong articular capsule is reinforced by several ligaments
- The hip joint is very stable. Stress on the angle of the neck tends to cause fractures rather than dislocations.



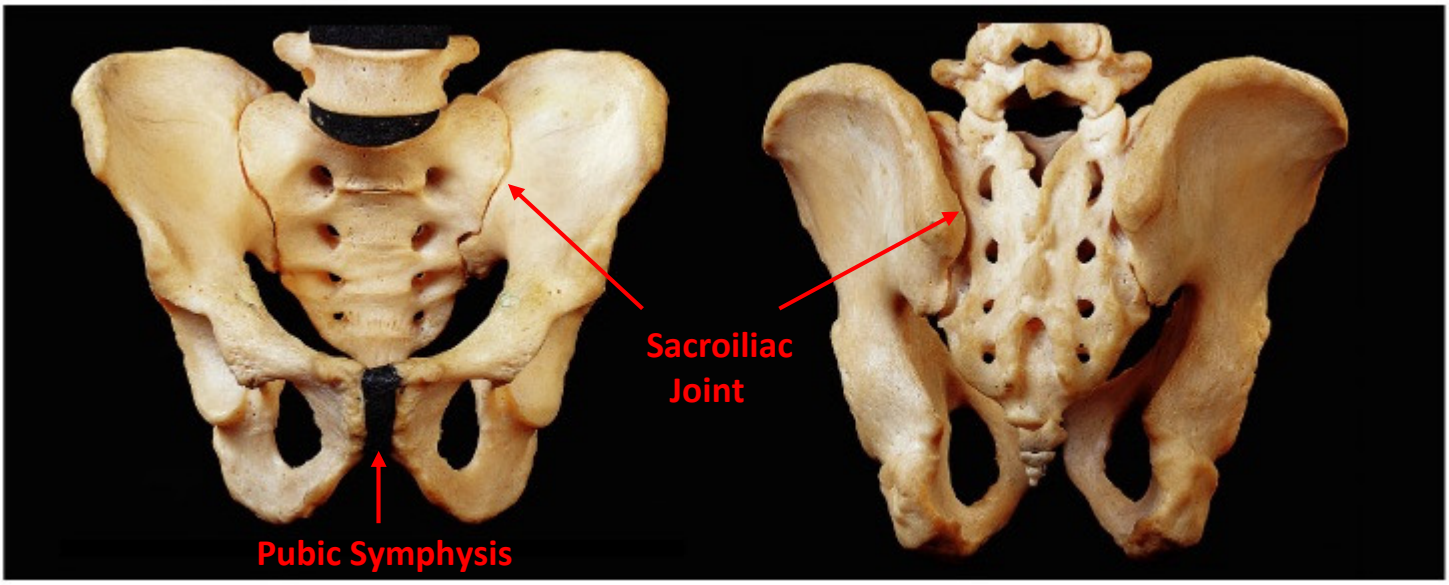
(b) Anterior view

- The hip joint can move in many ways, very similar to the shoulder except less range of movement:
  1. flexion: bending the hip so that the thigh moves forwards and up towards the body, decreasing the angle between the thigh and the front of the body
  2. extension: straightening the hip so the leg moves backwards or behind the body, increasing the angle between the thigh and front of the body
  3. abduction: moving laterally away from the midline of the body
  4. adduction: moving medially towards the midline of the body
  5. medial (internal rotation: rotating towards the midline of the body
  6. lateral rotation: rotating away from the midline of the body
  7. circumduction: taking the leg in a circle type motion

  (see pages 33 and 35)

Sacro-iliac Joint

- The sacroiliac joint is the articulation between the auricular surfaces of the sacrum and ilium.
- The ilium is slightly convex and the sacrum slightly concave, so the surfaces sit on top of each other and allow slight movement. This movement increases in those with hypermobility or throughout pregnancy for childbirth.
- The joint is designed more for stability than mobility and transfers load and weight from the lower limb through the pelvis to the spine.
- Each sacro-iliac joint is reinforced by a strong network of ligaments.



Pubic symphysis

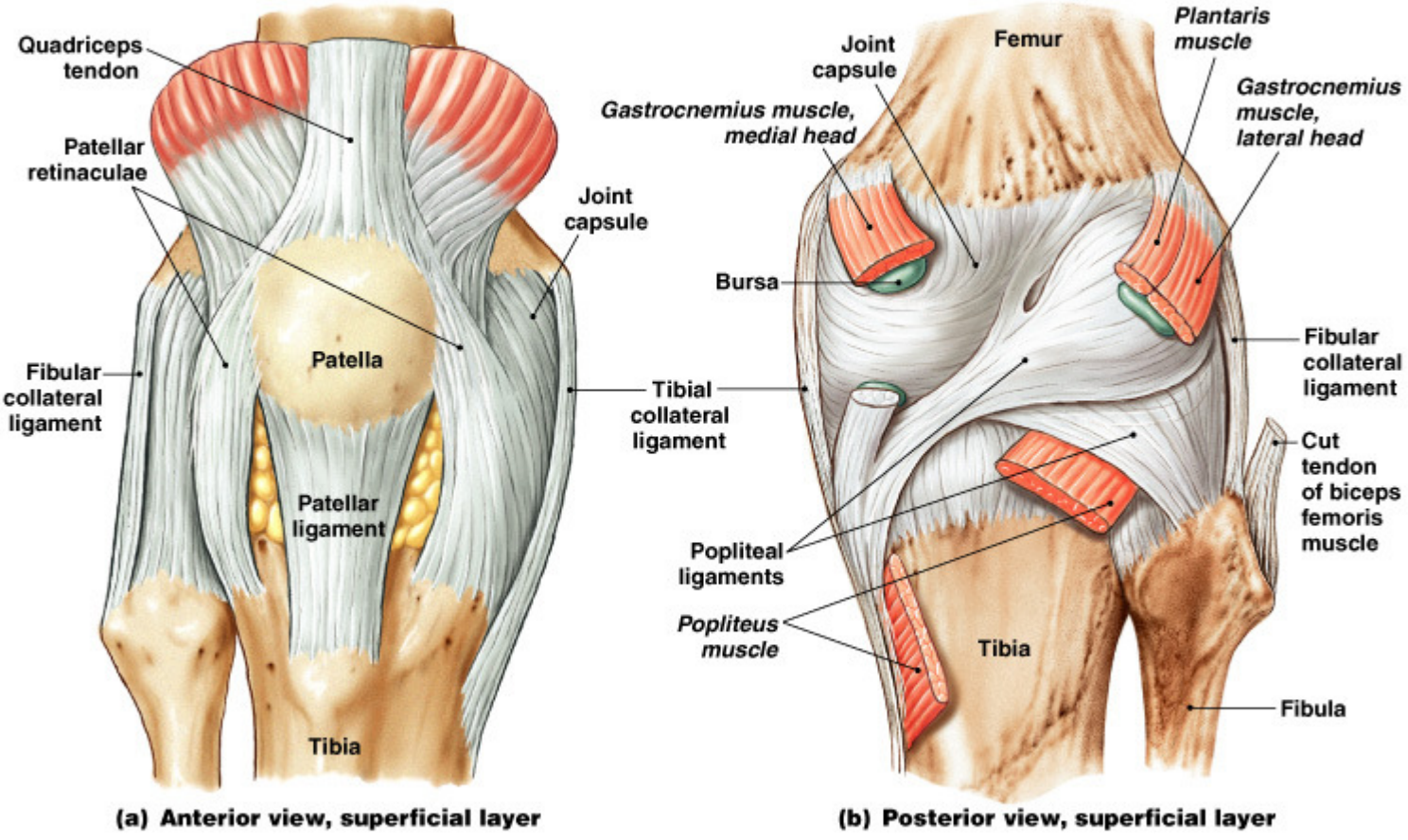
- The pubic bones are joined together in the midline at the front of the pelvis by a fibrocartilage pad to form the pubic symphysis joint.
- There is little to no movement in this joint, however in cases of instability or during pregnancy it can move slightly out of alignment, become unstable or separated.

Knee Joint

- The knee joint is a complicated hinge joint, transferring weight from the femur to the tibia. It has 2 femur-tibia articulations (at the medial and lateral condyles) and 1 between the patella and the patellar surface of the femur **(patello-femoral joint)**

- The 2 femur-tibia articulations are cushioned by fibrocartilage pads (the medial and lateral menisci), which stabilize the joint and give lateral support. Fat pads and bursae also protect the joint.

- 7 major ligaments support the knee joint:
  - *patellar ligament* (anterior, contains the patella)
  - *anterior* and *posterior cruciate ligaments* (inside the joint capsule)
  - *medial collateral ligament* (tibial)
  - *lateral collateral ligament* (fibular)
  - 2 *popliteal ligaments* (posterior)



- The knee moves in 2 ways:
  1. flexion: bending the knee
  2. extension: straightening the knee

  (see page 34)

- Just inferior to the knee joint complex lies the superior tibiofibular joint, where the tibia and fibula articulate with each other.
- There is only a small amount of movement at this joint, similar to the radio-ulnar joint of the elbow, but much smaller ranges of movement. The movements are:
  1. medial rotation: the lower leg rotates slightly towards the midline
  2. lateral rotation: the lower leg rotates away from the midline

Ankle Joint Complex

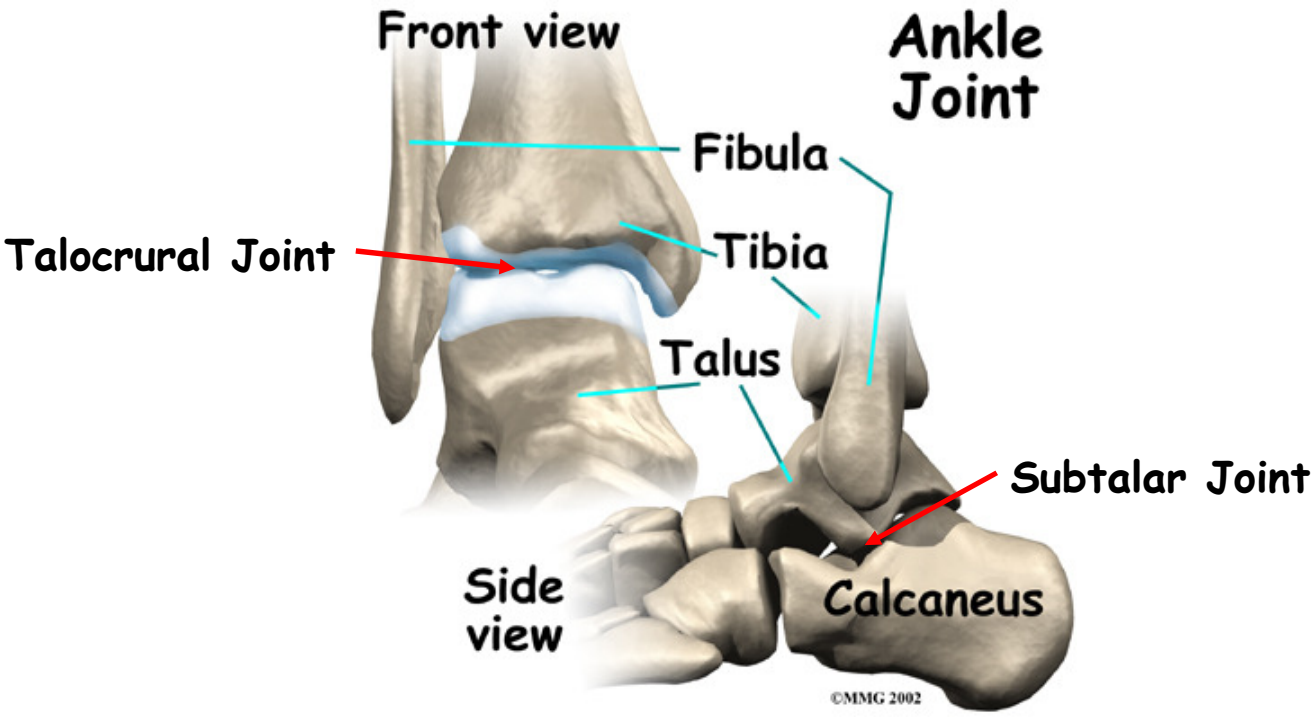
- The ankle is made up of many bones and complex articulations.
  1. Inferior tibiofibular joint – the tibia and fibula are joined by fibrous tissue and ligaments
  2. Talocrural joint – this is the hinge joint of the ankle formed between the talus and the tibia and fibula
  3. Subtalar joint – the articulation between the talus and calcaneus
  4. Articulations between all of the other tarsal bones

Talocrural Joint

- The medial and lateral malleolus of the tibia and fibula provide stability of the joint, along with the medial and lateral ligaments. The lateral ligaments in particular are the ones that are damaged in the typical ankle sprain.
- Movement at this joint is the largest range of movement out of any of the ankle joints and consists of :
  1. dorsiflexion: bending the top of the foot up towards the front of the shin
  2. plantarflexion: pointing the foot, or moving the top of the foot away from the shin *(see page 36)*

Subtalar Joint

- Allows for much smaller ranges of motion in the following movements:
  1. inversion: the heel moves medially or movement of the sole of the foot towards the midline of the body
  2. eversion: the heel moves laterally or sole of the foot moves away from the midline of the body



Foot

Similar to the wrist and hand, the tarsal bones articulate with the metatarsals, the metatarsals with the phalanges.

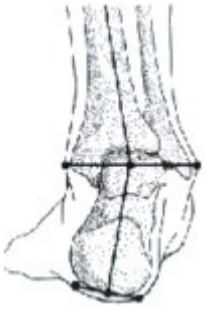
Muscles and ligaments run underneath the foot to support the arch of the foot.

During standing, walking and running, the foot and ankle positions are described as pronation and supination. These movements involve not only the ankle joints but also the joints of the foot.

Pronation

Pronation refers to the inward roll of the foot during normal motion and occurs as the outer edge of the heel strikes the ground and the foot rolls inward and flattens out. A moderate amount of pronation is required for the foot to function properly, however damage and injury can occur during excessive pronation. When excessive pronation does occur the foot arch flattens out and stretches the muscles, tendons and ligaments underneath the foot.

Supination



Supination is the opposite of pronation and refers to the outward roll of the foot during normal motion. A natural amount of supination occurs during walking as the heel lifts off the ground and the weight transfers onto the toes. However, excessive supination (outward rolling) places a large strain on the muscles and tendons that stabilize the ankle, and can lead to the ankle rolling completely over, resulting in an ankle sprain or total ligament rupture.

Skeletal Muscle Tissue

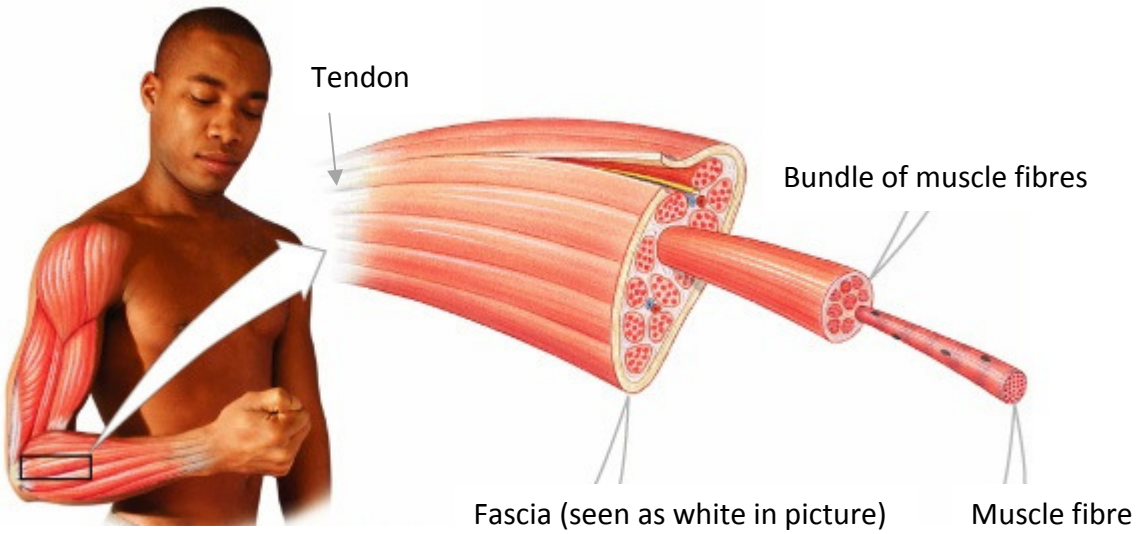
- Skeletal muscles are the muscles attached to the skeletal system, which allow us to move.

- Skeletal muscles are made up of muscle tissue (composed of muscle cells or fibres), connective tissues, nerves and blood vessels.

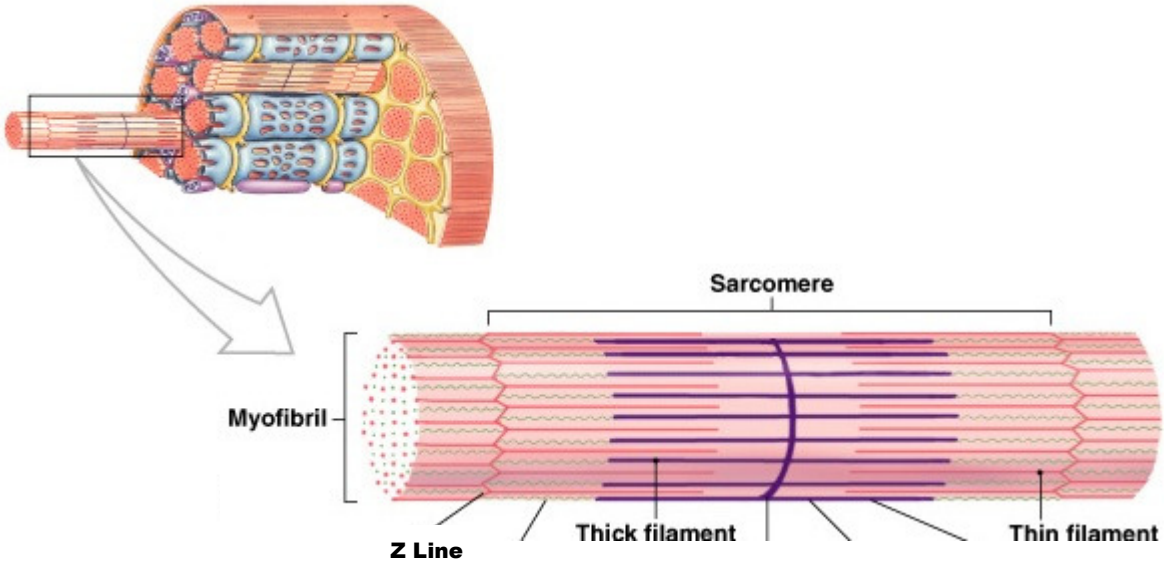
- The 5 functions of skeletal muscles are:
    1. To produce skeletal movement.
    2. To maintain posture and body position.
    3. To support soft tissues.
    4. To guard the entrances and exits of the body.
    5. To maintain body temperature.

Structure of Skeletal Muscle

- In a microscopic cross section of a muscle, we see that it is composed of bundles of individual muscle fibres held together and compartmentalized by fibrous sheaths called fascia.
- These connective tissue partitions allow easy movement of one muscle of muscle group relative to another. They can extend beyond the muscle to form a strong fibrous cord called a tendon which attaches the muscle to a bone.



- Each Individual muscle fibre contains units called <u>sarcomeres</u>. Each sarcomere contains proteins called <u>thick and thin filaments</u>. Separated by a z line.



Blood Vessels and Nerves

- Skeletal muscles are voluntary muscles, controlled by nerves from the brain and spinal cord. A <u>motor neuron</u> is the name for the nerve that supplies electrical impulses to tell the muscle to contract. A single motor neuron can control hundreds of muscle fibres (a <u>motor unit</u>) that contract at the same time.

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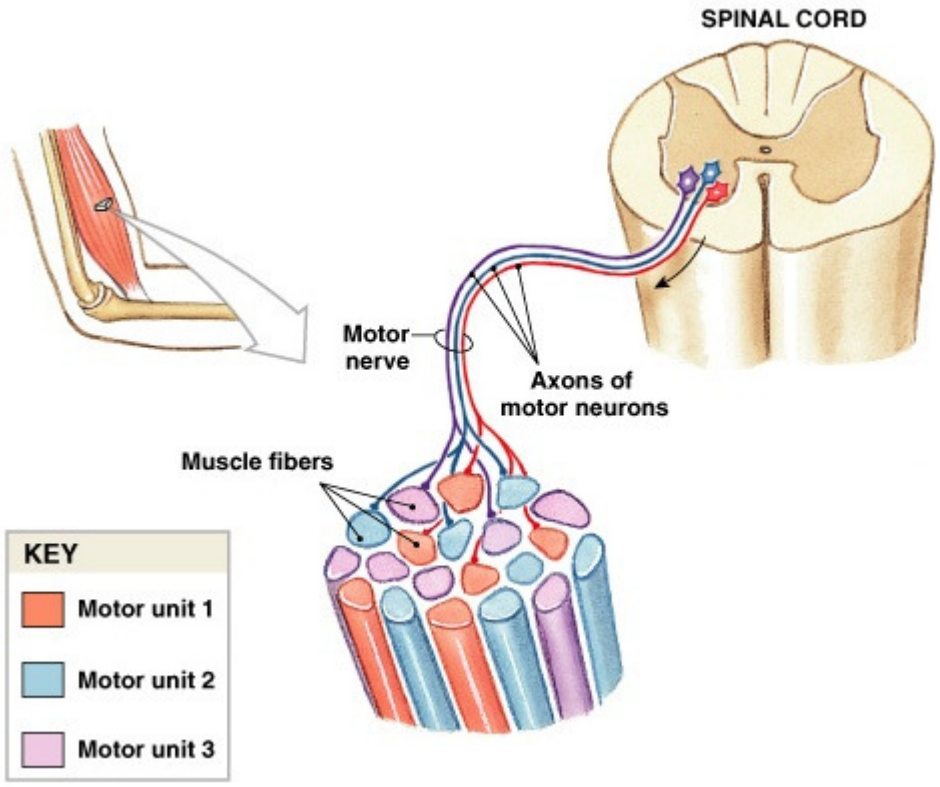


- An extensive system of blood vessels supply large amounts of oxygen and minerals to the muscles to allow them to contract, and carries away wastes like lactic acid.

Muscle contractions

- When a muscle fibre is stimulated be the motor neuron, a series of chemical reactions take place, causing the thin filaments to slide along the thick filaments. As a result the z lines draw closer towards each other and the individual sarcomere (and then the whole muscle) becomes shorter. This is the basis of a contraction.

- Skeletal muscle contraction results from the coordinated action of many fibres in a muscle.

- The amount of tension a whole muscle can produce depends on:
    1. The internal tension produced by the each of the muscle fibres
    2. The total number of muscle fibres stimulated

- In a whole muscle or group of muscles, smooth motion is produced by slowly increasing the size or number of motor units stimulated. This is called muscle recruitment.

- The normal tension and firmness of a muscle at rest is called muscle tone. Though not producing motion, some muscle units are always actively maintaining body position and posture. Increasing muscle tone leads to more active muscle fibres, which increases the body's metabolism, even at rest. This is how improving muscle tone helps weight loss.

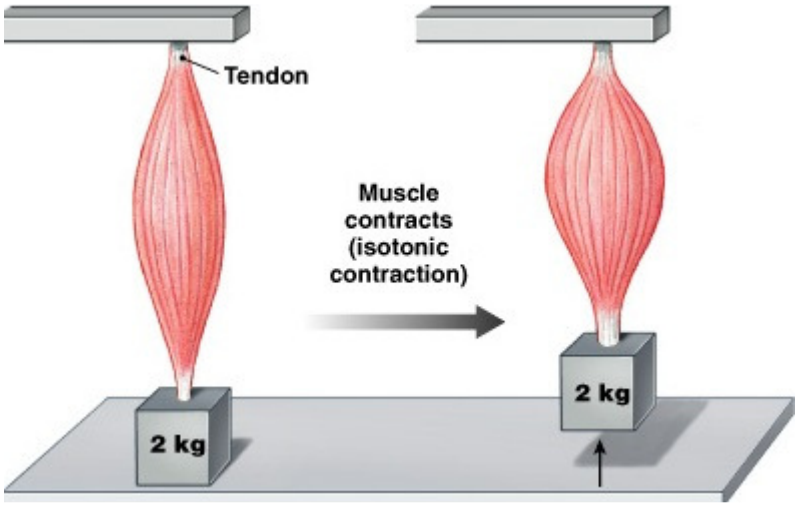
- There are 2 basic patterns of muscle contractions: isotonic contraction and isometric contraction.

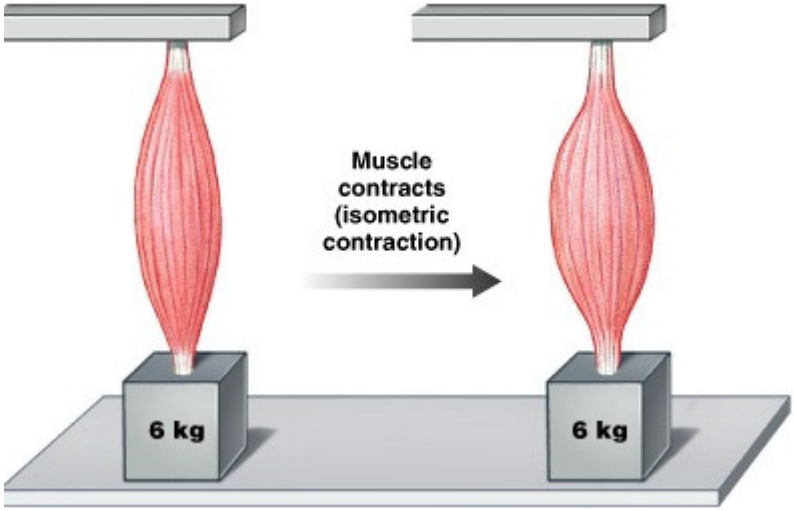
  1. In an **isotonic contraction**, the muscle changes length, resulting in motion. If the muscle is shortening as it contracts it is called a concentric contraction. If the muscle is lengthening as it contracts it is called an eccentric contraction.

  An example of this is the bicep muscle contraction involved in having a drink. The bicep shortens and performs a concentric contraction to bend the elbow and take the cup to the mouth. The bicep then lengthens but still maintains a contraction to control the straightening of the elbow to place the cup back on the table.

  2. In an isometric contraction, the muscle contracts but doesn't change length at all. An example of this is holding a squat like position – the quadriceps and

buttocks are working to hold the position, but they are neither shortening nor lengthening whilst they are holding the position.





The Recovery Period

- After high levels of exertion, it can take hours or days for muscles to return to their normal condition.

- During the recovery period, oxygen is made available to the cells, lactic acid is carried by the blood stream to the liver then eliminated and glucose is released to recharge the muscles reserves.

- To process excess lactic acid and normalize metabolic activities after exercise, the body uses more oxygen than usual. This elevated need for oxygen is responsible for heavy breathing after exercise.

- *Heat Production and Loss*: The more active muscles are, the more heat they produce. During strenuous exercise, up to 70 percent of the energy produced can be lost as heat, raising body temperature.

Muscle Performance

- Muscle performance is measured by the maximum amount of tension produced (power) and the amount of time the activity can be sustained (endurance). Power and endurance depend on the types of muscle fibres and physical conditioning.

Types of Skeletal Muscle Fibres

- There are 3 major types of skeletal muscle fibres:
    1. Fast Fibres:
        - contract very quickly
        - have strong contractions, fatigue quickly
    2. Slow Fibres:
        - are slow to contract, slow to fatigue
        - have high oxygen supply
    3. Intermediate Fibres:
        - are mid-sized
        - have better oxygen supply than fast fibres, are slower to fatigue

- Different muscles have different percentages of fast, slow and intermediate fibres. The deeper, stabilizing muscles contain more slow twitch fibres as they need to be activated for long periods of time. Larger more superficial muscles contain more fast twitch muscles as they are usually needed for short, strong bursts of activity.

- Different people have different percentages of fast, slow and intermediate fibres and this makes them suited to specific sports. Fast twitch fibres are needed for sprinting and short bursts of effort, slow twitch fibres are needed for endurance events such as running a marathon.

Muscle Hypertrophy and Atrophy

- Hypertrophy: Extensive training can cause muscles to grow by increasing the diameter of the muscle fibres.

- Atrophy: Lack of muscle activity causes reduction in muscle size, tone and power. *W*hen inactive for days or weeks, muscles become flaccid. The muscle fibres break down and become smaller and weaker. If inactive for long periods of time, muscle fibres may be replaced by fibrous tissue.

Muscle Organization and Function

- Muscle organization affects the power, range and speed of muscle movement.

- Muscle fibres are organized in bundles called fascicles.

- Skeletal muscles are classified according to the way fascicles are organized, and their relationships to tendons.

Organization of Skeletal Muscle Fibres

- The 4 patterns of fascicle organization are:
    1. parallel
    2. convergent
    3. pennate
    4. circular

- Most skeletal muscles are parallel muscles. Their fibres parallel the long axis of the muscle. (e.g. biceps brachii)

- When a parallel muscle contracts, the center or body of the muscle thickens. Parallel muscles contract about 30% in length.

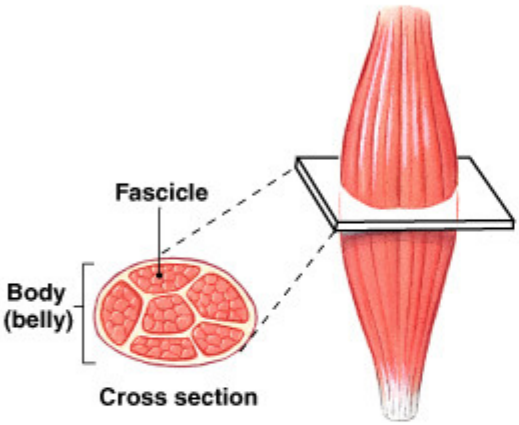
- Tension in parallel muscle depends on the total number of muscle fibres. Therefore, the cross section of the muscle is directly related to tension.

- Convergent muscles have a broad area that converges on an attachment site such as a tendon, or aponeurosis (bands of collagen fibres). Convergent muscle fibres pull in several different directions, depending on which portion of the muscle is stimulated. (e.g. pectoralis muscles)

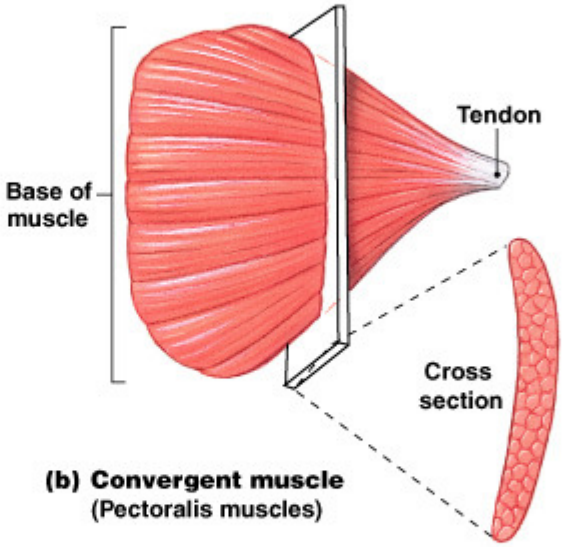
- Pennate muscles form an angle with the tendon, so they do not move as far as parallel muscles. But, pennate muscles contain more muscle fibres than parallel muscles, and develop more tension.

- Pennate muscles can be subdivided into:
    1. unipennate: all muscle fibres on 1 side of the tendon (e.g. extensor digitorum)
    2. bipennate: muscle fibres on both sides of the tendon (e.g. rectus femoris)
    3. multipennate: tendon branches within the muscle (e.g. deltoid)

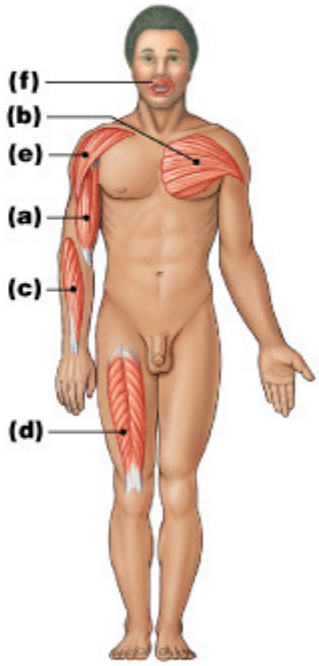
- Circular muscles or sphincters open and close to guard entrances of the body (e.g. mouth and pelvic floor muscles)

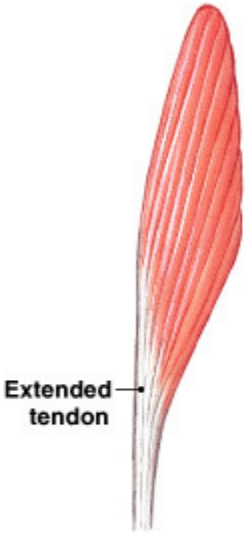


(a) Parallel muscle
(Biceps brachii muscle)



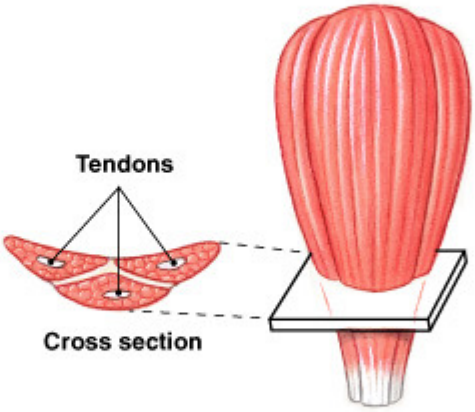
(b) Convergent muscle
(Pectoralis muscles)





(c) Unipennate muscle (Extensor digitorum muscle)

(d) Bipennate muscle (Rectus femoris muscle)



(e) Multipennate muscle
(Deltoid muscle)

(f) Circular muscle
(Orbicularis oris muscle)

Levers

- To produce motion, skeletal muscles are attached to the skeleton. Like muscle organization, the type of muscle attachment affects the power, range and speed of muscle movement.

- Mechanically, each bone is a lever (a rigid, moving structure) and each joint is a fulcrum (a fixed point). The muscles provide the applied force (AF) required to overcome resistance (R).

- The function of a lever is to change:
    1. the direction of an applied force
    2. the distance and speed of movement produced by an applied force
    3. the effective strength of an applied force

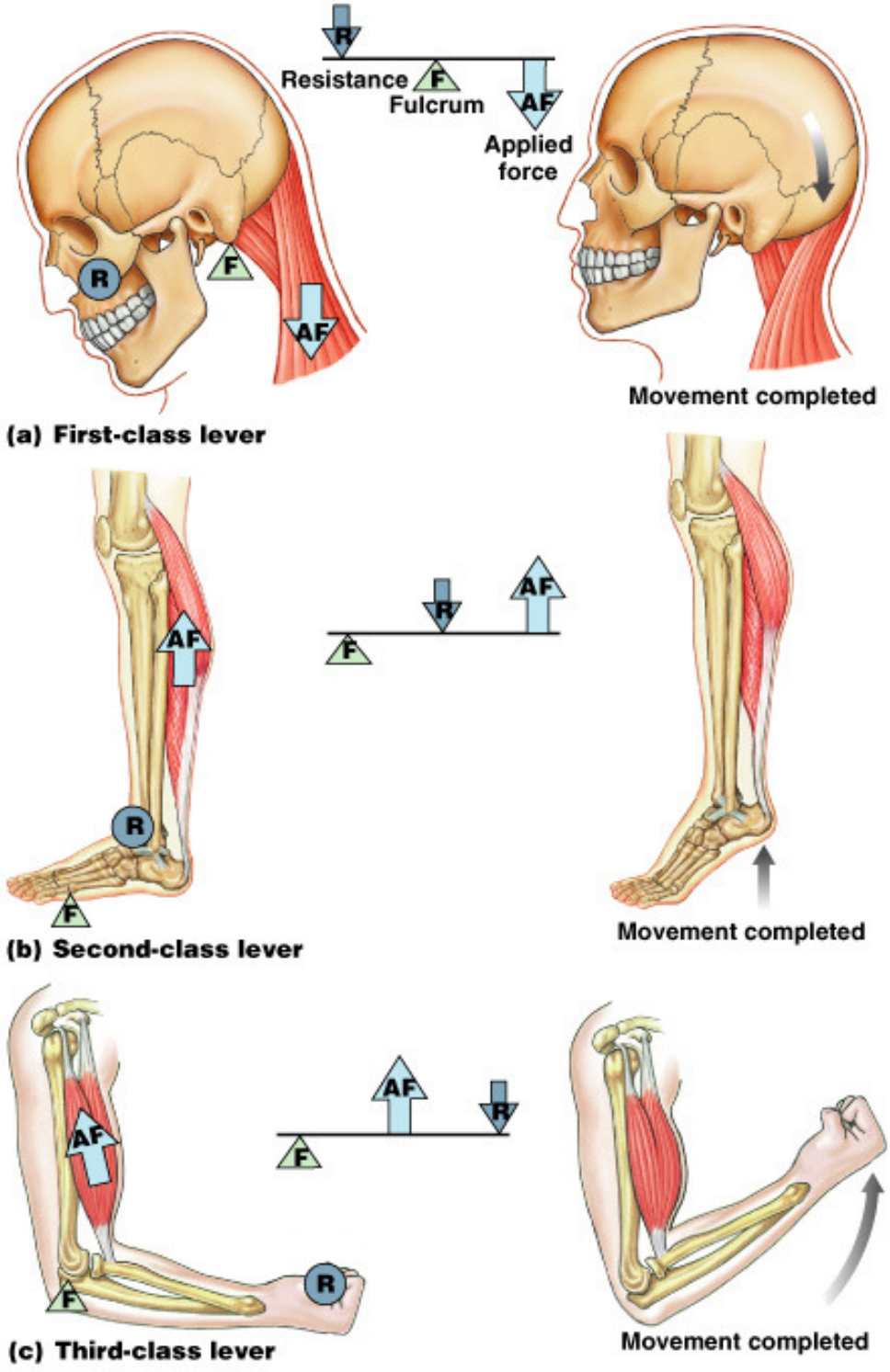
- There are 3 classes of levers, depending on the relationship between the applied force, the fulcrum, and the resistance:

First-class lever:
- e.g. seesaw
- the fulcrum is in the center, between the applied force and the resistance
- force and resistance are balanced

Second-class lever:
- e.g. wheelbarrow
- the resistance is in the center, between the applied force and the fulcrum
- a small force can move a large weight

Third-class lever:
- the most common levers in the body
- the applied force is in the center, between the resistance and the fulcrum
- requires a greater force to move a smaller resistance, but maximizes speed and distance traveled

- Most skeletal muscles can shorten to roughly 70% of their ideal resting length.
- The versatility in terms of power, speed and range of body movements results from differences in the positions of muscle attachments relative to the joints involved.



Muscle Terminology

Origins and Insertions

- Most muscles have one end that is fixed and another end that moves toward the fixed end during a contraction. The point of attachment at the fixed end is called the origin. The point of attachment to the structure that moves is the insertion. The origin is usually proximal to the insertion.

- The movement a muscle contraction produces is called its action. Actions are body movements such as flexion, extension, adduction, etc.

Actions

- Most muscles either originate or insert on the skeleton. Actions are described in terms of the bone, joint or region affected.

- Muscles usually work in groups to maximize efficiency. The smaller muscles reach maximum tension first, followed by the larger, primary muscles.

- Muscles are described based on their functions:
    1. An agonist (prime mover) is a muscle that produces a particular movement.
    2. An antagonist opposes the movement of a particular agonist.
        - agonists and antagonists work in pairs (flexors-extensors, abductors-adductors, etc.) When one contracts, the other stretches.
    3. A synergist is a smaller muscle that assists a larger agonist. They may help start a motion or stabilize the origin of the agonist (fixators).

Names of Skeletal Muscles

- The correct names of all muscles include the word "muscle." We may use the descriptive term alone, but the word "muscle" is always implied.

- The names of skeletal muscles include descriptive information about:
    1. Location in the body:
        - identified by body regions
        - e.g. rectus abdominus (abdomen)
    2. Origin and insertion
        - the first part of the name indicates the origin
        - the second part of the name indicates the insertion
        - e.g. brachioradialis muscle
    3. Fascicle organization
        - describes the fascicle orientation within the muscle
        - i.e. rectus (straight), transversus, and oblique
    4. Relative position
        - externus (superficialis) are visible at the body surface
        - internus (profundus) are deep muscles
        - intrinsic muscles are inside an organ
        - superior and inferior, medial and lateral are also used
    5. structural characteristics
        - such as number of tendons (bi = 2, tri = 3)
        - shape (trapezius, deltoid or rhomboid)
        - or size
            longus (long)
            longissimus (longest)
            teres (long and round)
            brevis (short)
            magnus (large)
            major (larger)
            maximus (largest)
            minor (small)
            minimus (smallest)
    6. Action
        - muscles may be named after movements
        (flexor, extensor, rotators, etc.)

Please see tables for specific names and meanings. These are not necessary to learn but it does help you to remember the names of muscles and origin/insertion etc if you can understand these terms.

TABLE 11–1 Muscle Terminology

Terms Indicating Specific Regions of the Body*	Terms Indicating Position, Direction, or Fascicle Organization	Terms Indicating Structural Characteristics of the Muscle	Terms Indicating Actions
Abdominis (abdomen)	Anterior (front)	**Nature of Origin**	**General**
Anconeus (elbow)	Externus (superficial)	Biceps (two heads)	Abductor
Auricularis (auricle of ear)	Extrinsic (outside)	Triceps (three heads)	Adductor
Brachialis (brachium)	Inferioris (inferior)	Quadriceps (four heads)	Depressor
Capitis (head)	Internus (deep, internal)		Extensor
Carpi (wrist)	Intrinsic (inside)	**Shape**	Flexor
Cervicis (neck)	Lateralis (lateral)	Deltoid (triangle)	Levator
Cleido-/-clavius (clavicle)	Medialis/medius (medial, middle)	Orbicularis (circle)	Pronator
Coccygeus (coccyx)	Oblique	Pectinate (comblike)	Rotator
Costalis (ribs)	Posterior (back)	Piriformis (pear-shaped)	Supinator
Cutaneous (skin)	Profundus (deep)	Platy- (flat)	Tensor
Femoris (femur)	Rectus (straight, parallel)	Pyramidal (pyramid)	
Genio- (chin)	Superficialis (superficial)	Rhomboid	**Specific**
Glosso-/-glossal (tongue)	Superioris (superior)	Serratus (serrated)	Buccinator (trumpeter)
Hallucis (great toe)	Transversus (transverse)	Splenius (bandage)	Risorius (laugher)
Ilio- (ilium)		Teres (long and round)	Sartorius (like a tailor)
Inguinal (groin)		Trapezius (trapezoid)	
Lumborum (lumbar region)			

TABLE 11–1 Muscle Terminology

Terms Indicating Specific Regions of the Body*	Terms Indicating Position, Direction, or Fascicle Organization	Terms Indicating Structural Characteristics of the Muscle
Nasalis (nose)		**Other Striking Features**
Nuchal (back of neck)		Alba (white)
Oculo- (eye)		Brevis (short)
Oris (mouth)		Gracilis (slender)
Palpebrae (eyelid)		Lata (wide)
Pollicis (thumb)		Latissimus (widest)
Popliteus (posterior to knee)		Longissimus (longest)
Psoas (loin)		Longus (long)
Radialis (radius)		Magnus (large)
Scapularis (scapula)		Major (larger)
Temporalis (temples)		Maximus (largest)
Thoracis (thoracic region)		Minimus (smallest)
Tibialis (tibia)		Minor (smaller)
Ulnaris (ulna)		-tendinosus (tendinous)
Uro- (urinary)		Vastus (great)

Axial Muscles

Posterior Muscles that move the spine

Erector Spinae Muscles

There are many muscles which run along the spine and extend the spine – collectively they are called the erector spinae muscles. These spinal extensors are subdivided into superficial and deep spinal extensors, which run from the skull right down to the sacrum. You do not need to remember the names of these - just the muscle group name of erector spinae.

1. The superficial muscles include the:
   a. spinalis group
   b. longissimus group
   c. iliocostalis group

Origin and insertions: They traverse over the vertebrae and originate and insert on various different spinal and transverse processes.

Function: **extension** of the lumbar, thoracic and cervical spine

2. The smaller, deep muscles include the:
   a. semispinalis group
   b. multifidus muscle
   c. interspinalis muscles
   d. intertransversarii muscles
   e. rotatores muscles

Origin and insertions: They tend to be smaller and traverse only over 2-3 vertebrae each and also originate and insert on the spinous and transversus processes of the vertebrae.

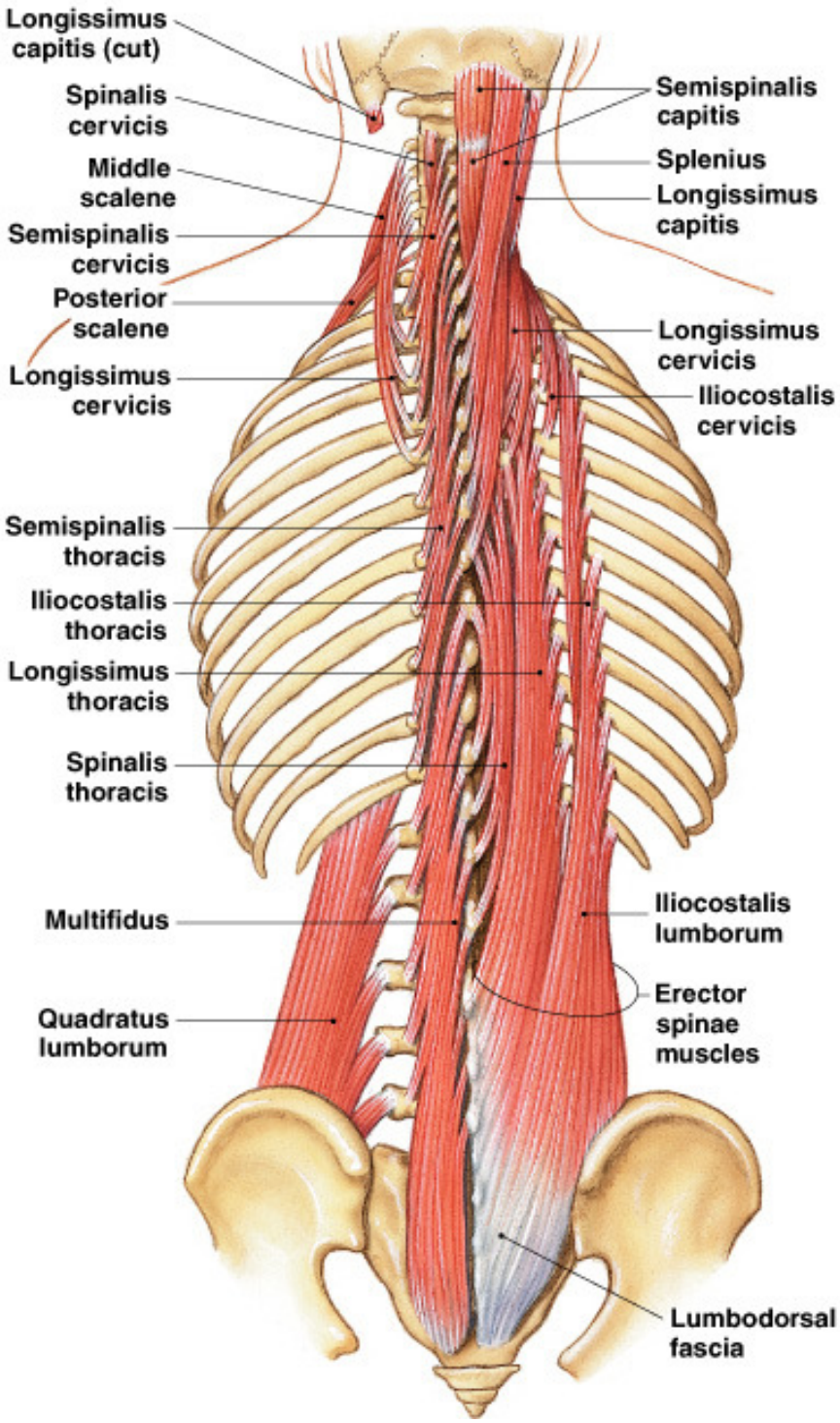
Function: These muscles are responsible for fine movements between each cervical, thoracic and lumbar vertebra in **rotation and extension**, and also controlling the stability of the spine.

Quadratus Lumborum

Origin: iliac crest

Insertion: last rib and transverse processes of lumbar vertebrae

Function: together, they depress the ribs; alone each side laterally flexes the spine or hitches the pelvis up towards toe ribs.



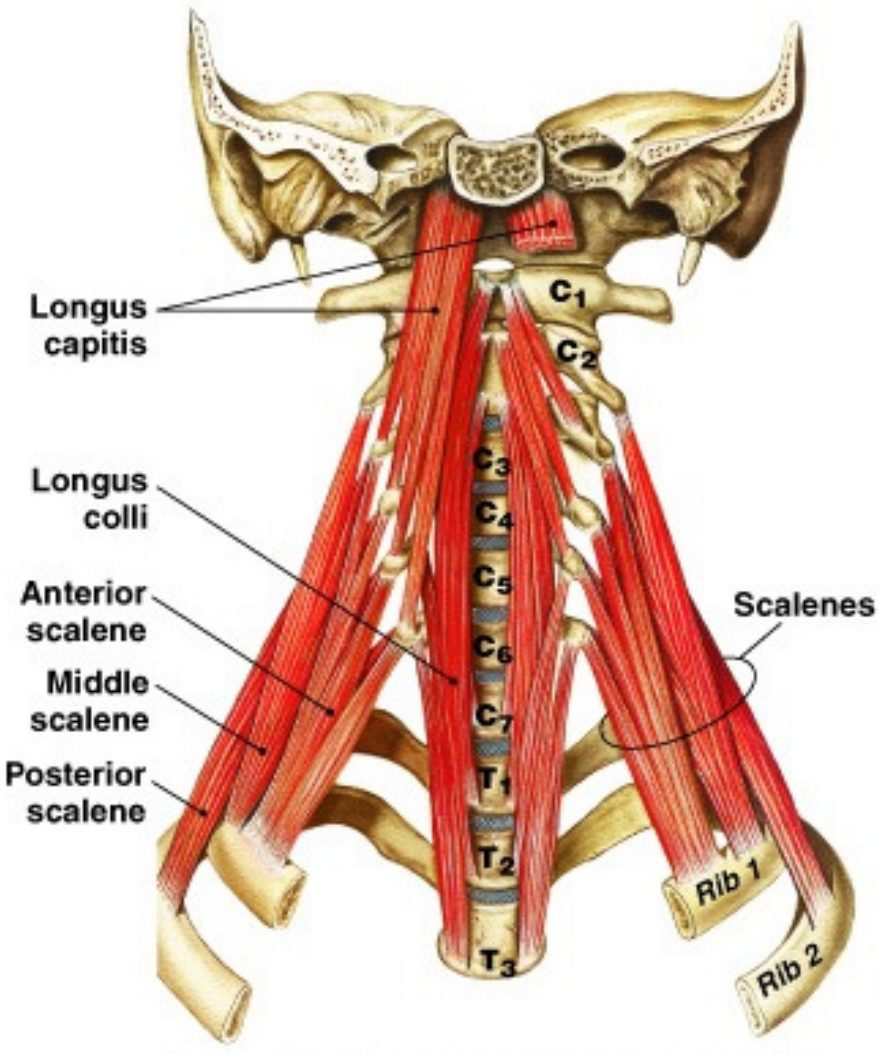
Anterior muscles that move the spine

Deep Neck Flexors

The deep neck flexor muscle group consists of the rectus capitis, longus capitis and longus coli muscles. You do not need to remember the names of all of these – just the muscle group name deep neck flexors.

Origin and insertions: these muscles run anteriorly over either side of the cervical spine with attachments from the skull to the upper cervical vertebrae, and from the cervical vertebrae to the upper thoracic vertebrae.

Function: contraction of both sides leads to neck flexion and flattening of the cervical lordotic curve and works to correct a forwards head posture in which the chin is poking out.
Contraction of one side leads to lateral flexion and rotation.



Scalenes

There are 3 portions- anterior, middle and posterior, running from the neck to the ribs

Origin: transverse processes of C2-7

Insertion: anterior and middle – 1st rib, posterior 2nd rib

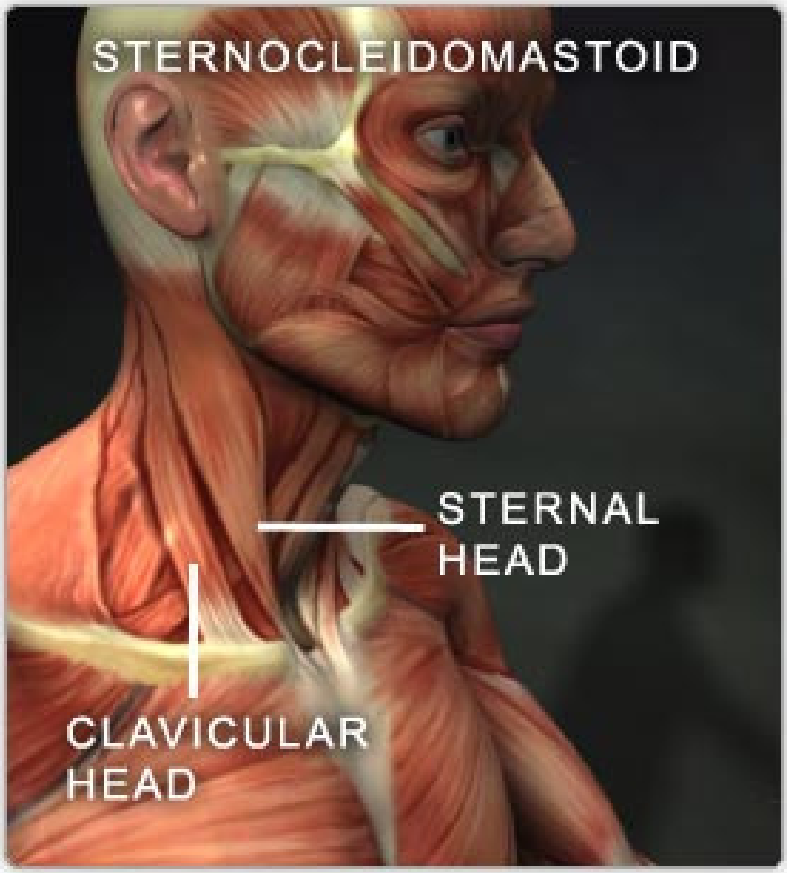
Function: together, they flex the neck and raise the 1st rib in breathing
: alone, they laterally flex and rotate the neck

Sternocleidomastoid

Origin: sternal head – sternum, clavicular head - clavicle

Insertion: mastoid process on the temporal bone, occipital bone skull.

Function: together, they flex the neck and draw the head forwards
: alone, lateral flexion of the neck to the same side, rotation of the neck to the other side



Intercostal muscles - External and Internal (*pictures also on page 74)*

Origin and insertion – originate and insert on the superior and inferior border of each rib

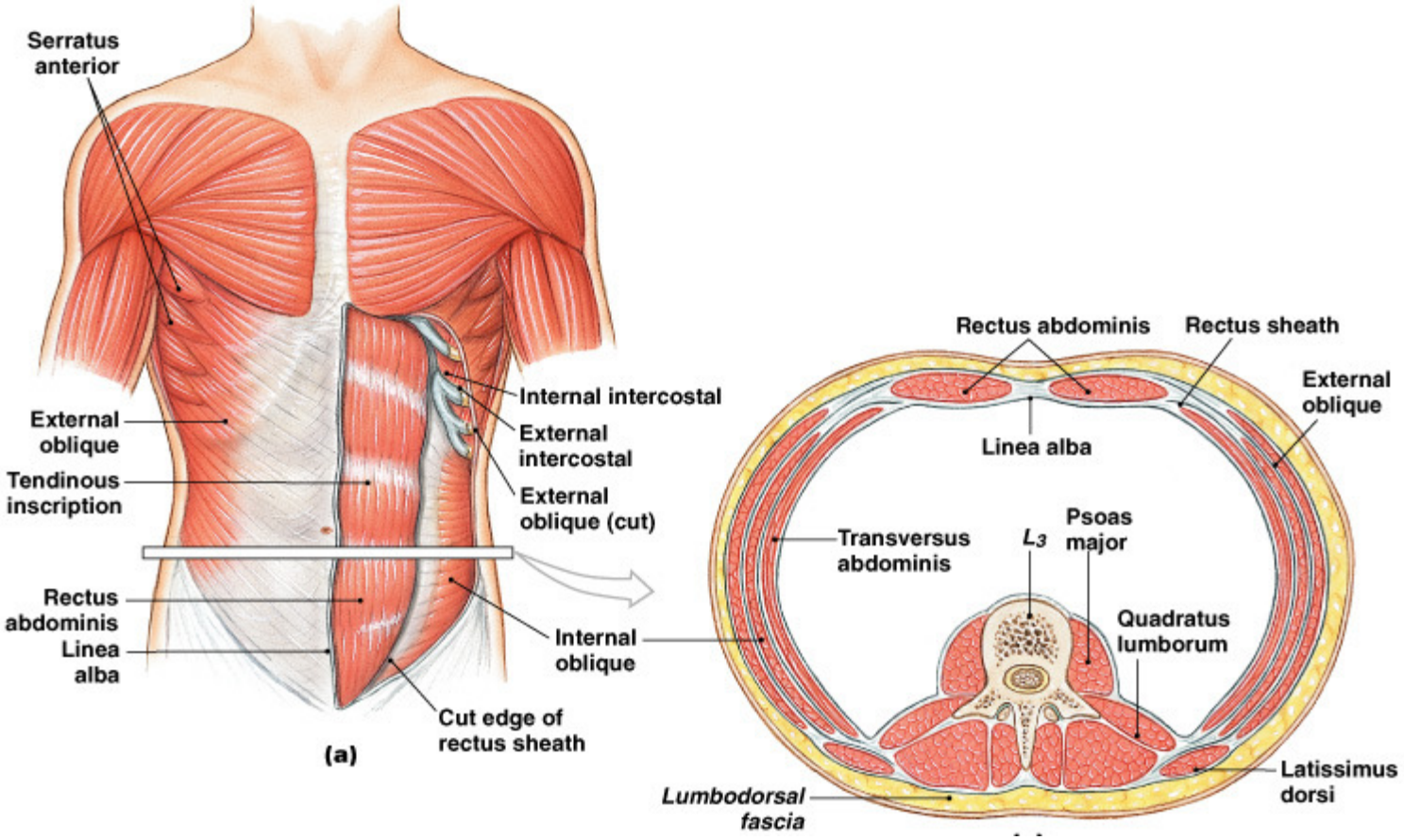
Function – elevates and depresses ribs for breathing

Rectus Abdominus

Origin – pubic bone

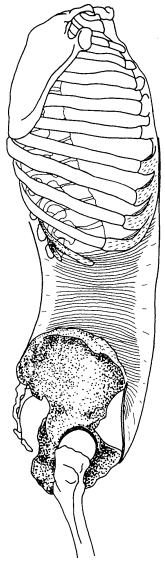
Insertion - xiphoid process of sternum, cartilage of ribs 5-7

Function - flexes the lumbar spine, depresses the ribcage



Anterior view of torso

Cross section of thorax at level of L2

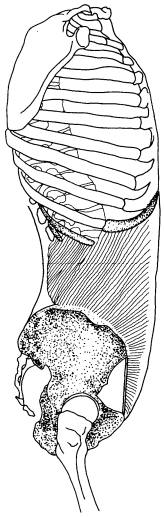


Transversus abdominus

Origin - the inguinal ligament, from the anterior portion of the iliac crest, the inside of the lower six ribs, connecting with the diaphragm, and from the lumbodorsal fascia.

Insertion – the fibres are orientated horizontally, and act like a corset around the abdomen, inserting into the linea alba, in the middle of the abdomen and onto the pubic bone. The upper ¾ of the muscle lies behind the rectus abdominus, the lower ¼ lies in front of the rectus abdominus.

Function: draws abdomen in, stabilizes the spine

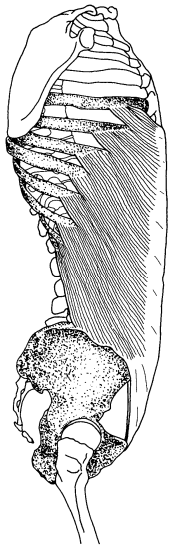


Internal obliques

Origin – iliac crest, inguinal ligament and lumbodorsal fascia

Insertion – the fibres are orientated obliquely and run upwards and medial, inserting on the linea alba, xiphoid process and inferior ribs

Function – unilateral contraction leads to lateral flexion and rotation to that side, bilateral contraction compresses the abdomen for stability and breathing.



External obliques

Origin –anterolateral ribs 5-12

Insertion – fibres run obliquely and run downwards medially to the iliac crest, inguinal ligament

Function – unilateral contraction leads rotation to the opposite side, bilateral contraction flexes the spine and draws the ribcage towards the hips, and compresses the abdomen.

Diaphragm

The diaphragm is an important structure as it separates the thoracic and abdominal cavities.

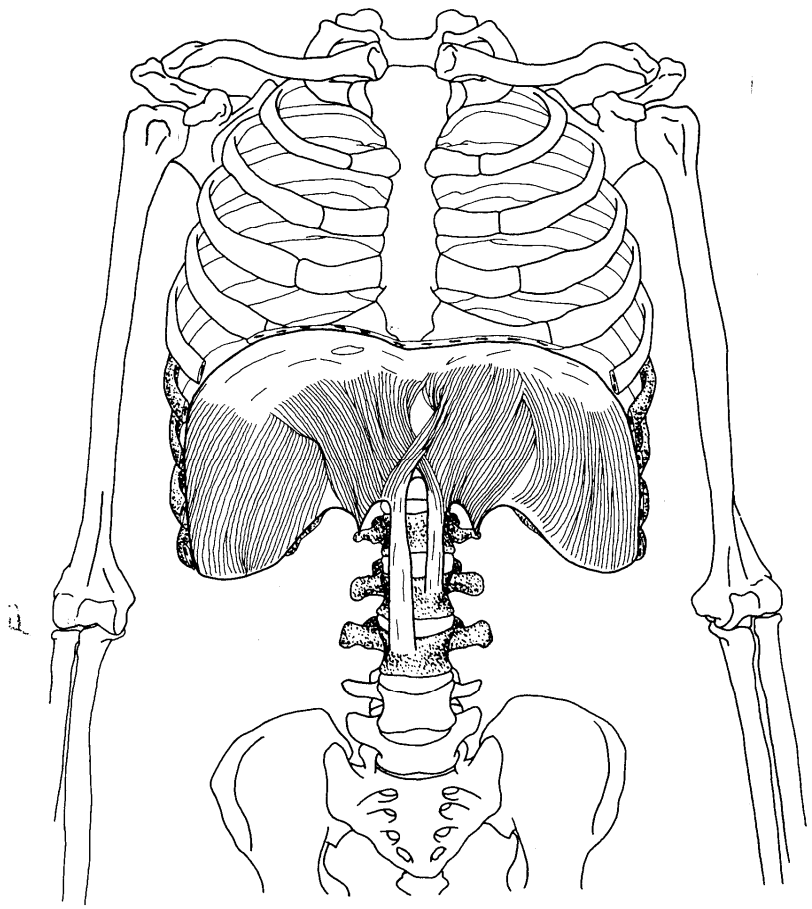
Origin: xiphoid process of sternum, inner surfaces of lower six ribs and their costal cartilages, upper lumbar vertebrae

Insertion: fibres converge on a central tendon

Function: the dome - shaped diaphragm is drawn inferiorly when it is contracted and is a principal muscle of ventilation or breathing.

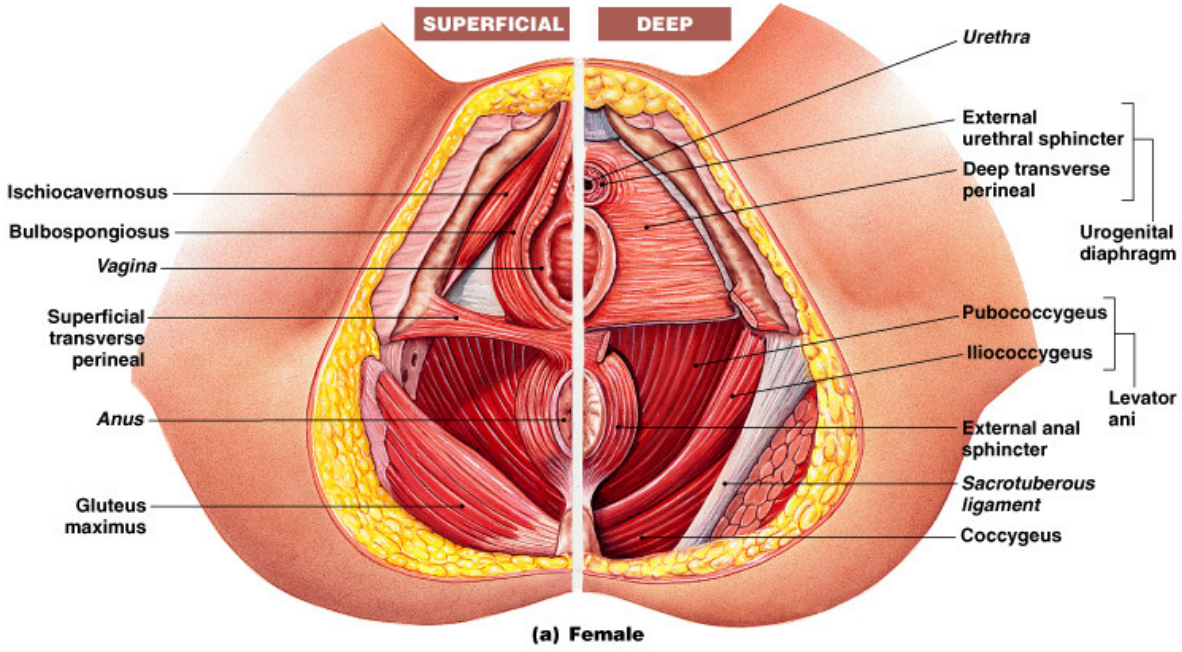
The diaphragm contracts to facilitate inhalation - air is breathed in, and the abdomen rises slightly. If a person uses mostly their diaphragm for breathing and not their intercostals and other muscles then the stomach will protrude greatly each time they inhale, rather than the ribcage expanding.

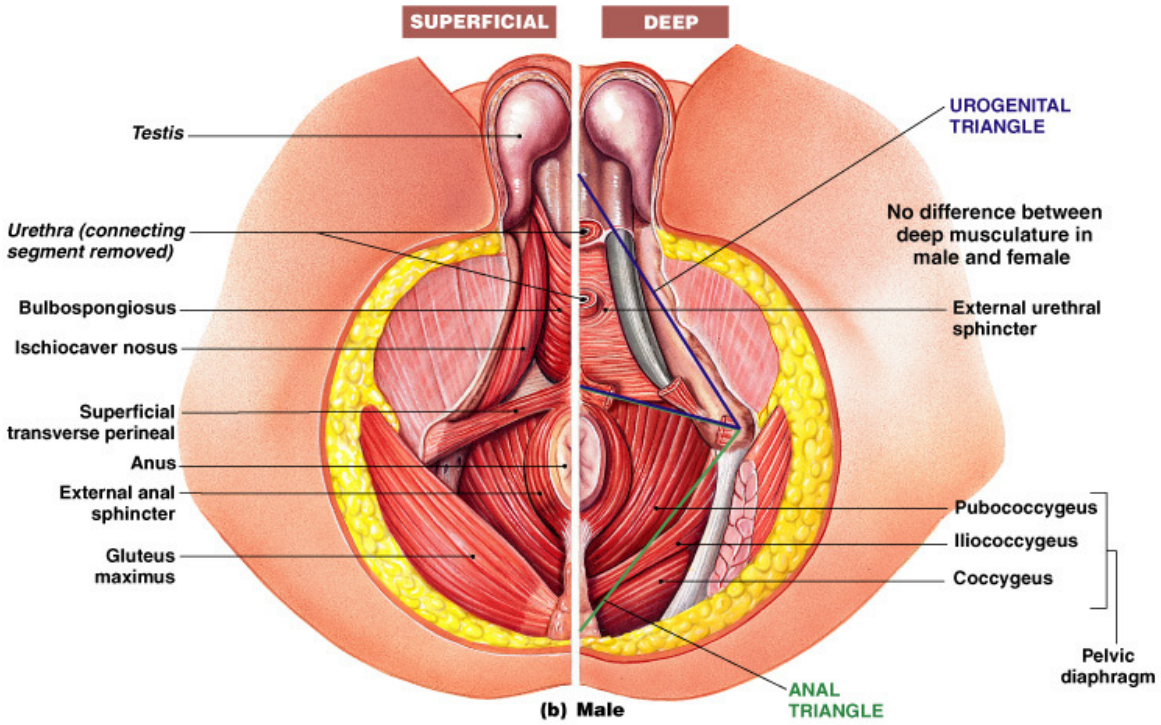
Apart from its role in breathing, movements of the diaphragm also increase the pressure within the abdomen (intra-abdominal pressure) and aid in return of blood to the heart, aids in defecation, urination and child birth responses.



Pelvic floor

The pelvic floor consists of a group of muscles which together form an internal sling which provides support to hold the pelvic and abdominal organs in place, and also allows bladder and bowel control. Both males and females have the same pelvic floor muscles, they are just positioned slightly differently around the genital organs.





Appendicular Muscles

- The appendicular muscles position and stabilize the shoulder and pelvic girdles, and move the upper and lower limbs.

Muscle that move/control the Scapula

Trapezius

Superficial muscle shaped like a trapezoid that covers the back and neck up to the base of the skull. Consists of upper, middle and lower sections.

Origin - base of the skull, vertebrae C1-T12

Insertion – clavicle, scapula (acromion process and spine of scapula)

Function - upper fibres elevate the shoulder girdle, and help prevent depression of the shoulder girdle
middle fibres retract the scapula
lower fibres depress the scapula,
upper and lower fibres together rotate the scapula laterally

Rhomboid

Consists of 2 parts – rhomboid minor is superior, rhomboid major is inferior

Origin – spinous processes C7-T1

Insertion - medial border of scapula

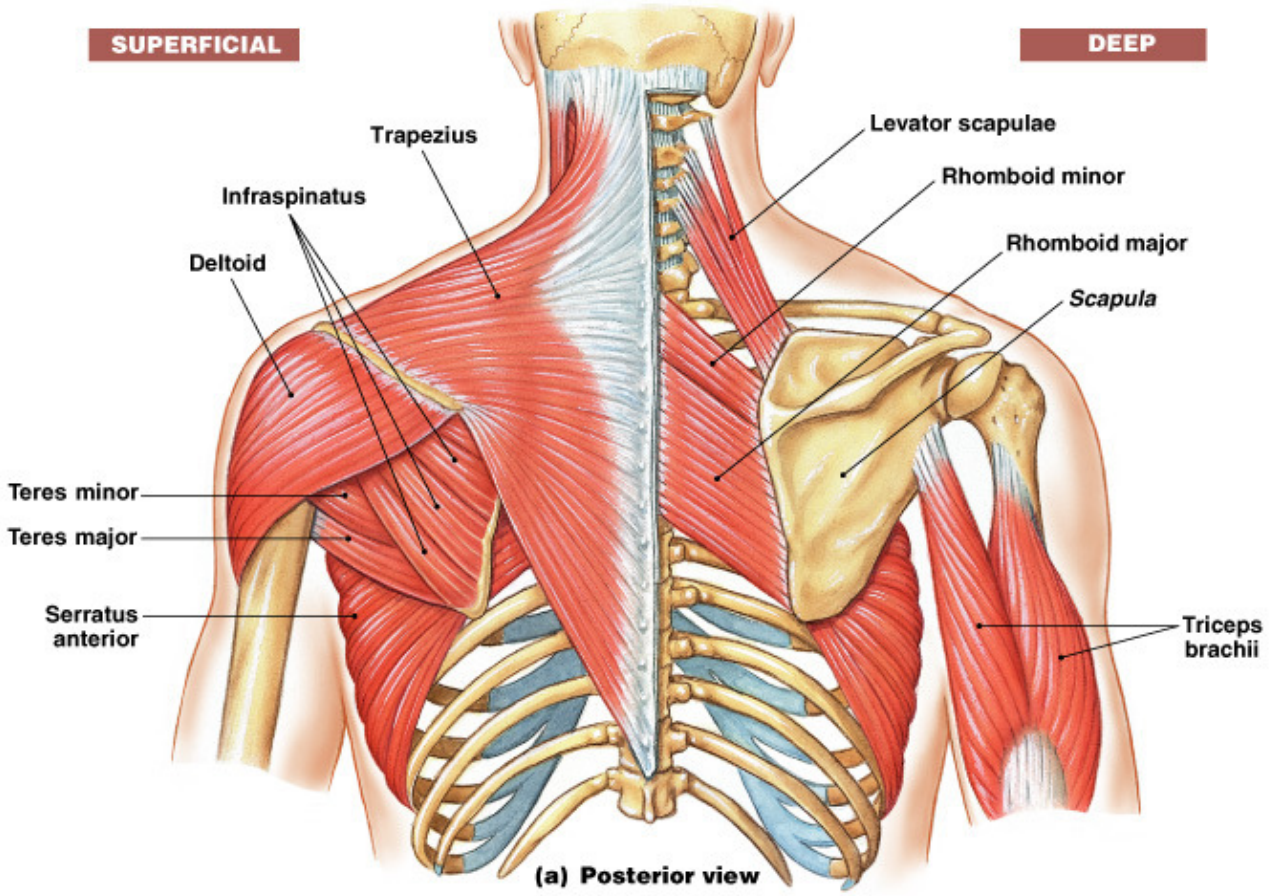
Function – retracts and stabilizes scapula

Levator scapulae

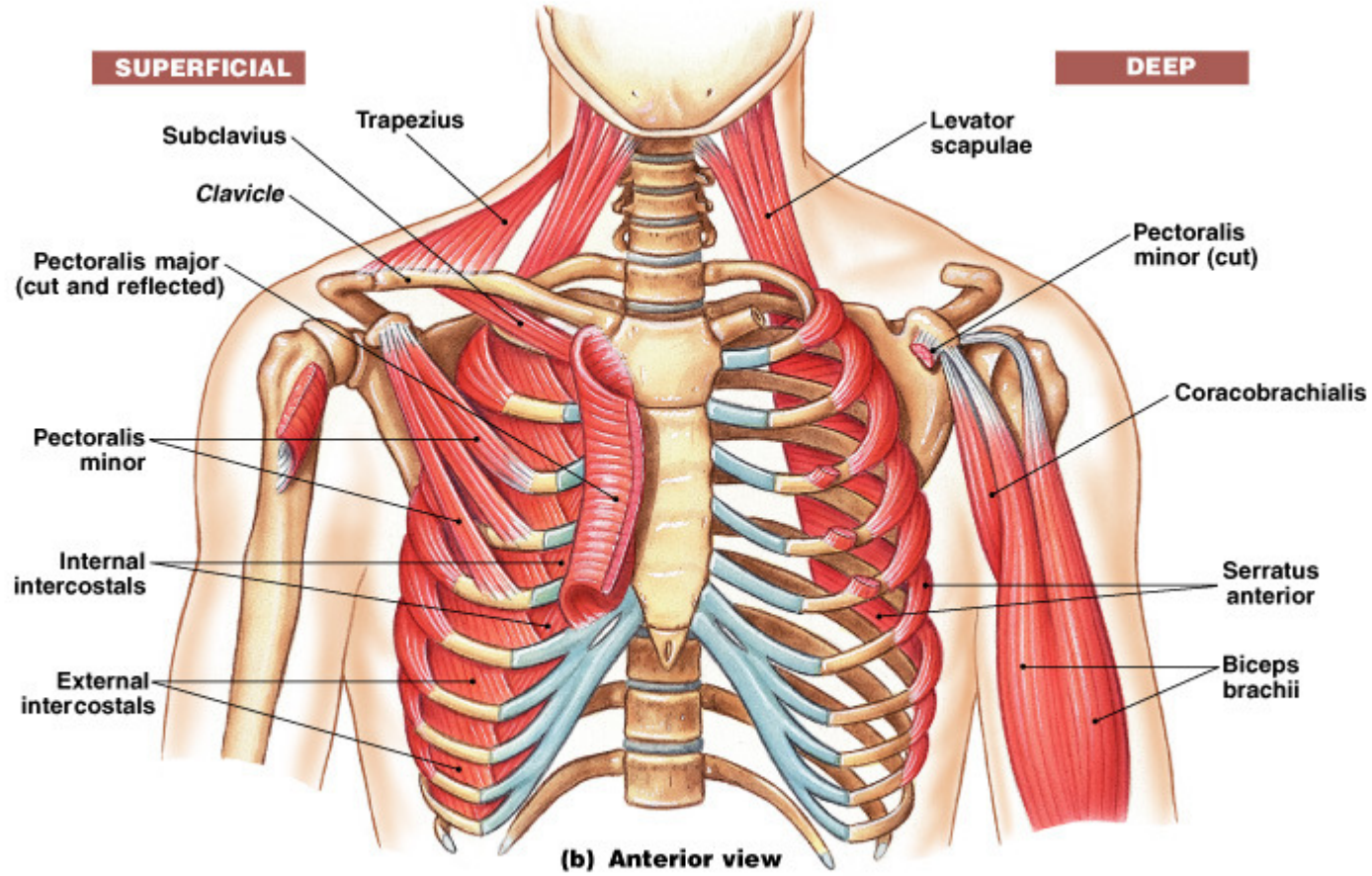
Origin - transverse processes C1-C4

Insertion - superior angle of scapula

Function - elevates the scapula, laterally flexes the neck



(a) Posterior view



(b) Anterior view

Serratus Anterior

An important scapula stabilizer, it runs from the ribs to the underneath side of the scapula.

Origin – outer lateral surfaces of ribs 1-9

Insertion – anterior surface of the scapula (between the scapula and ribcage) on the medial border and inferior angle

Function - protracts and stabilizes scapula, assists in scapula upward rotation through elevation, hold the scapula against the ribcage and prevents it from winging away from the ribcage

Pectoralis Minor

Situated underneath the pectoralis major.

Origin – anterior ribs 3-5

Insertion – corocoid process of the scapula

Function – draws scapula forwards and downwards, tightness in this muscle contributes to winging of the scapula

Muscles that move the Shoulder Joint

Pectoralis Major

There are 2 parts to the pec major – pectoral head and sternocostal head

Origin – Clavicular head: clavicle
Sternocostal head: sternum, upper 6 ribs (costal cartilages)

Insertion – upper humerus

Function – adducts and medially rotates shoulder
Clavicular portion – flexes and horizontally adducts humerus towards opposite shoulder
Sternocostal portion – obliquely adducts humerus towards opposite hip

Latissimus dorsi

Large muscle that covers most of the back of the body.

Origin – sacrum and iliac crest, thoracolumbar (or lumbodorsal) fascia, spinous processes of T7-12, posterior surface of lower ribs

Insertion – humerus bone (intertubercular groove)

Function - extends, adducts and medially rotates the shoulder

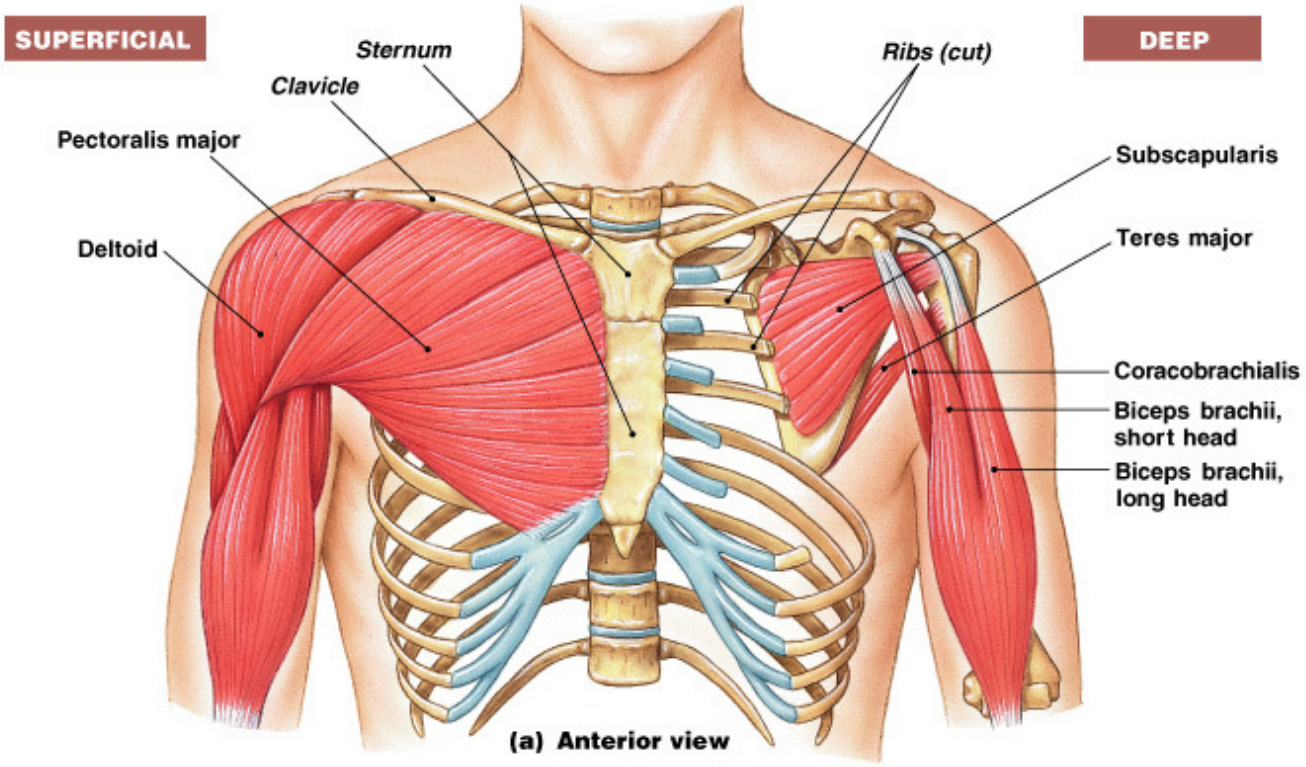
Deltoid

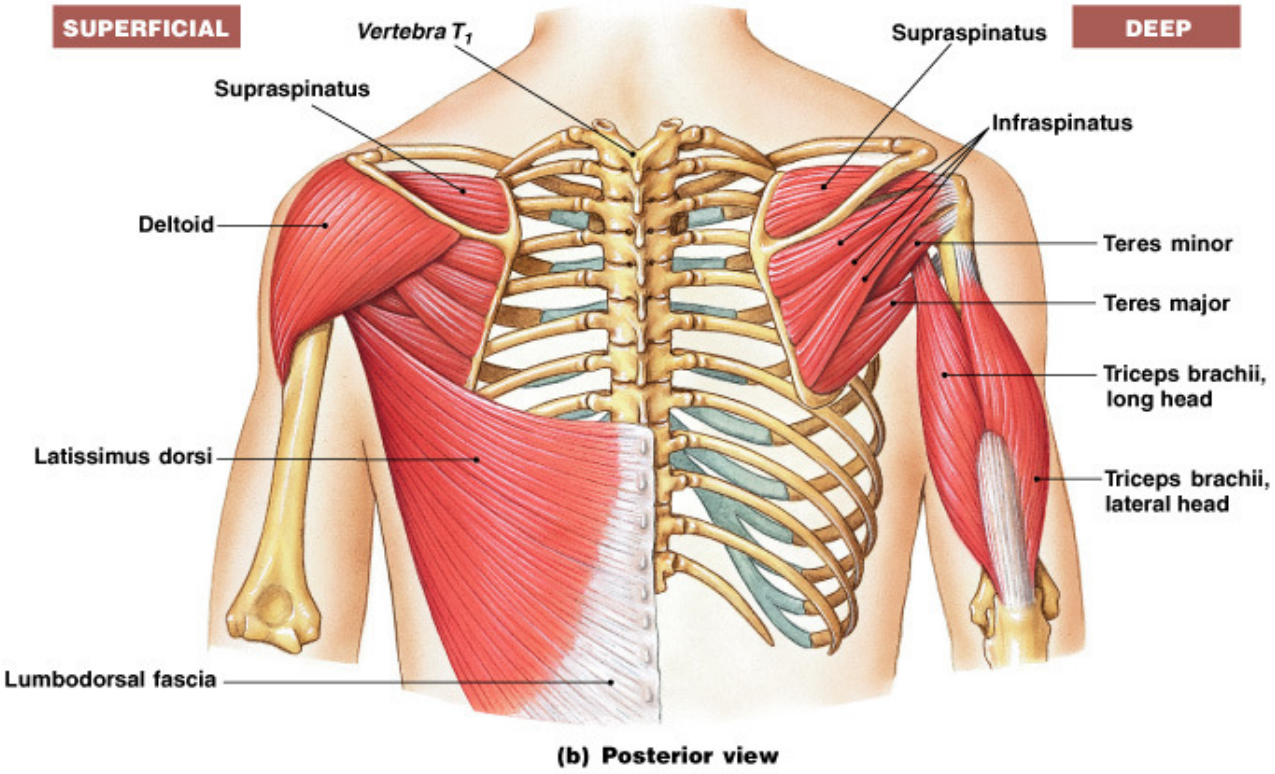
The major abductor of the shoulder, it has 3 parts – anterior, middle and posterior.

Origin – Anterior: clavicle
Middle: acromion process scapula
Posterior: spine of scapula

Insertion – humerus bone (deltoid tuberosity)

Function - Anterior: flex and medially rotate shoulder
Middle: abducts shoulder
Posterior: extends, horizontally abducts and laterally rotates shoulder





(b) Posterior view

Rotator Cuff Muscles

Muscle	Origin	Insertion	Function
Supraspinatus	Supraspinous fossa of scapula	Greater tubercle of humerus	Abduction and horizontal abduction shoulder
Infraspinatus	Infraspinous fossa of scapula	Greater tubercle of humerus	Lateral rotation shoulder
Teres Minor	Lateral border of scapula	Greater tubercle of humerus	Lateral rotation shoulder
Teres Major	Inferior angle of scapula	Anterior humerus	Extension, adduction and medial rotation shoulder
Subscapularis	Subscapular fossa (anterior side of scapula)	Lesser tubercle of humerus	Medial rotation shoulder

Muscles that move the Elbow joint

- The extensors lie mainly on the posterior and lateral surfaces of the arm, and flexors lie mainly on the anterior and medial surfaces.

Biceps Brachii

Biceps is the main elbow flexor, and has 2 parts: short head and long head.

Origin – Long head: above the glenoid of the scapula
Short head: corocoid process of scapula

Insertion – radius (radial tuberosity)

Function – flexes elbow, supinates elbow, weakly flexes shoulder joint

Triceps brachii

Triceps is the main elbow extensor, and has 3 parts: long head, lateral head, medial head

Origin – Long head: below the glenoid on the scapula
Lateral head: upper half of posterior humerus
Medial head: lower half of posterior humerus

Insertion – olecranon process of ulna

Function - extends elbow, longhead can adduct and extend shoulder joint from flexed position

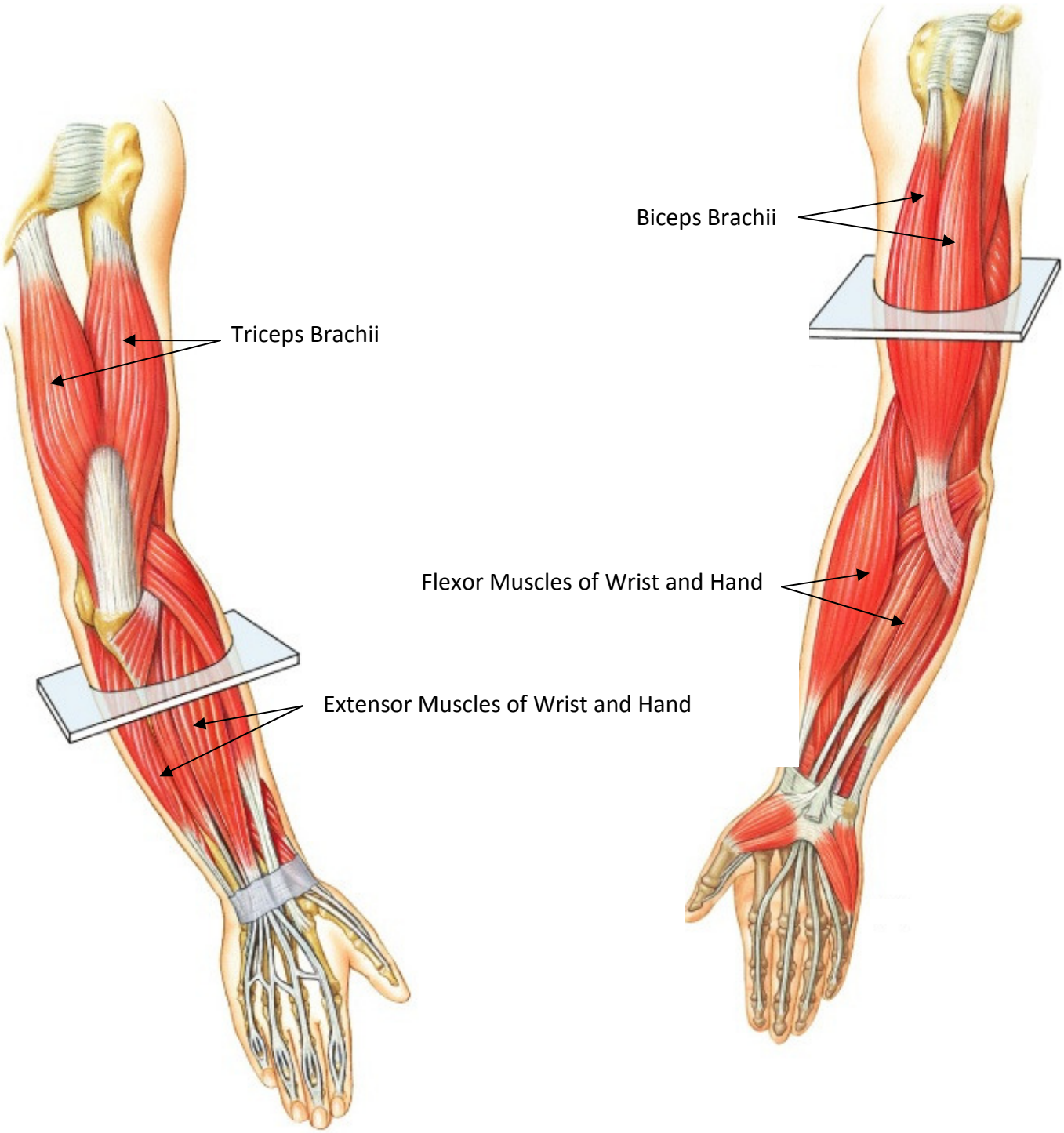
Muscles that move the Wrist and Hand

Wrist flexors

Several muscles make up the wrist flexor group. Most of these muscles all originate on the anterior/medial surfaces of the distal humerus and proximal ulna and radius, and insert in various places on the wrist and hand to produce a flexion movement.

Wrist extensors

Several muscles make up the wrist extensor group. Most of these muscles all originate on the posterior/lateral surfaces of the distal humerus and proximal ulna and radius, and insert in various places on the wrist and hand to produce an extension movement.



Muscles that move the Hip joint

Gluteus maximus

Gluteus maximus is the largest, most posterior gluteal muscle.

Origin - ilium, lumbar fascia, sacrum

Insertion – gluteal tuberosity of the femur, iliotibial band (ITB)

Function – upper glut max abducts and laterally rotates the hip; lower glut max extends the hip

Gluteus medius

More lateral than the gluteus maximus, the gluteus medius is a stabilizing muscle of the hip and pelvis.

Origin – gluteal surface of the ilium, under gluteus maximus

Insertion – greater trochanter

Function - Stabilizes the hip and pelvis, especially when standing on one leg
Anterior portion – internal rotation, works with the TFL
Middle portion – abduction
Posterior/deep portion – externally rotates and abducts the hip

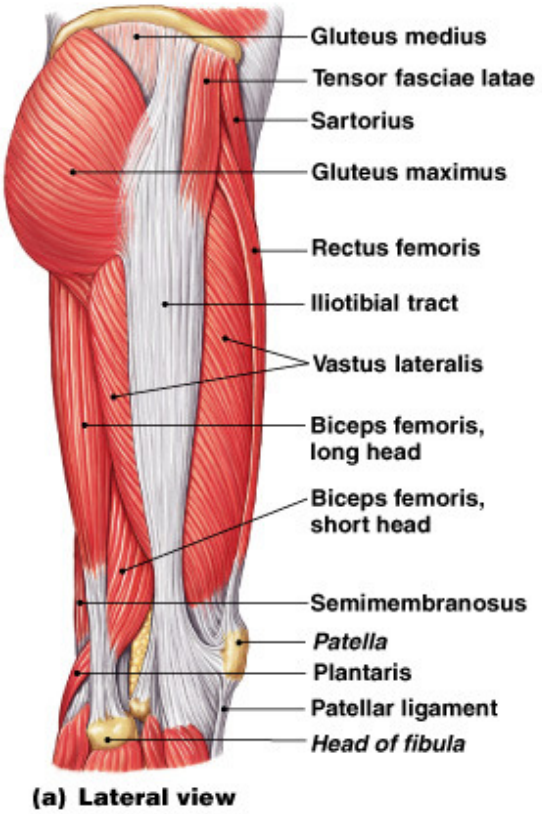
Gluteus minimus

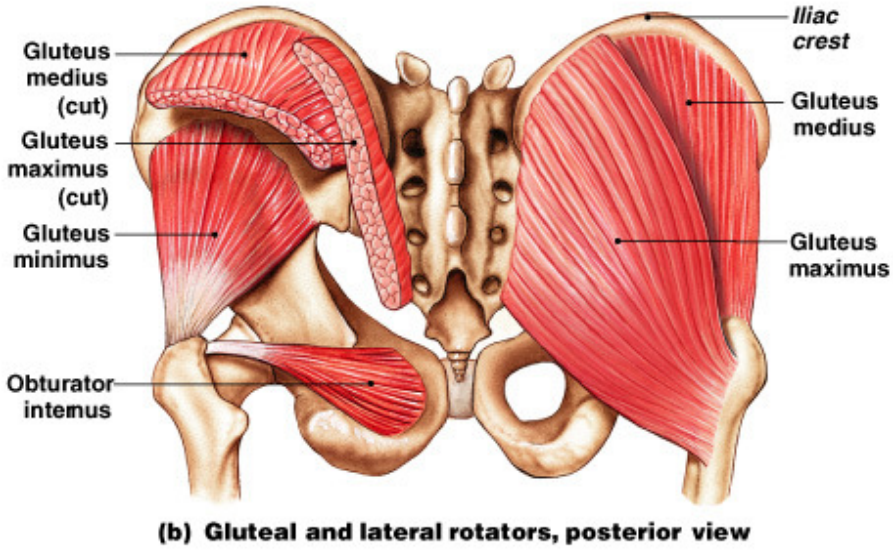
Gluteus minimus is smaller and deeper than gluteus medius.

Origin – gluteal surface of the ilium, under the gluteus medius

Insertion – greater trochanter

Function – deepest hip abductor, internally rotates the hip, stabilizes the hip and pelvis





Tensor Fascia Latae (TLF)

Origin - Iliac crest and anterior superior iliac spine (ASIS)

Insertion - Iliotibial band (ITB)

Function – flexion and medial rotation hip

Iliotibial band (ITB)

The Iliotibial band or ITB (sometimes called iliotibial tract) isn't a muscle – it is a long, flat wide fascia the both the gluteus maximus and tensor fascia latae insert into. The ITB then inserts into the lateral side of the knee.

It can help with the lateral stability of the hip and knee.

Piriformis

Origin – sacrum

Insertion – greater trochanter of femur

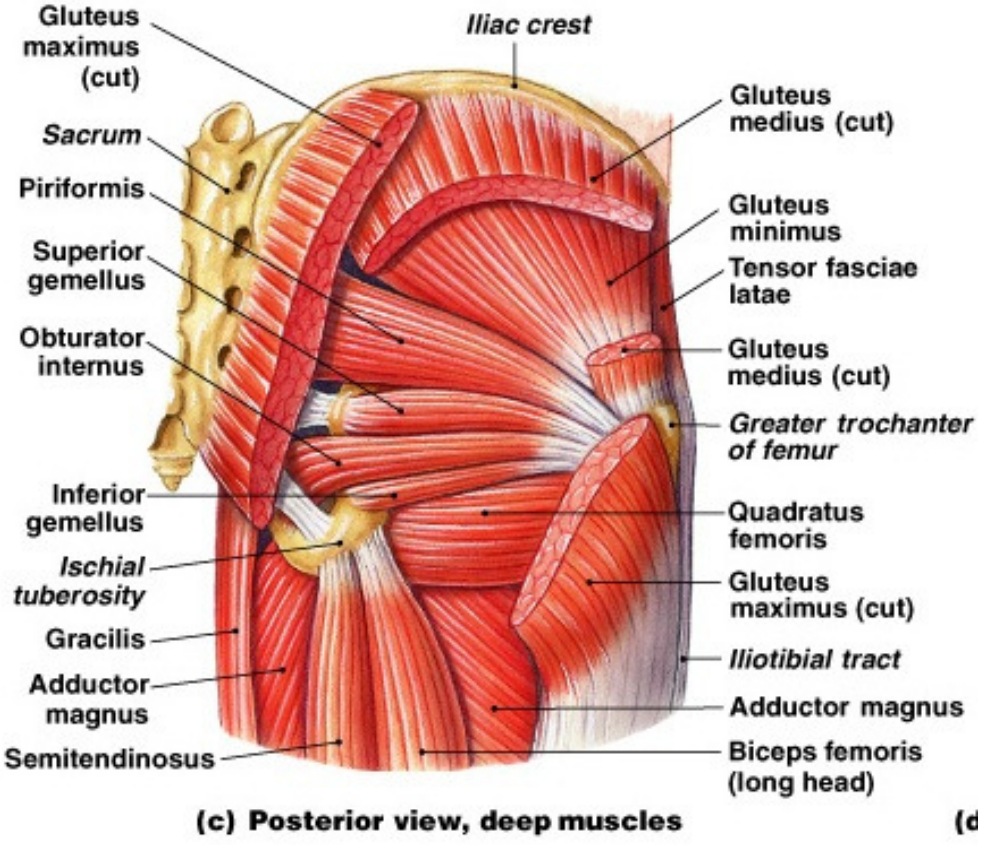
Function – lateral rotation and abduction of hip

Deep Hip rotators

These 5 muscles which laterally rotate the hips are similar to the rotator cuff of the shoulder – they not only rotate the hip, they act as stabilizers to the hip joint and control movement of the femoral head within the hip socket.

1. Quadratus femoris
2. Superior gemellus
3. Inferior gemellus
4. Obturator internus
5. Obturator externus

They all originate on the ischium and insert on or near the greater trochanter of the femur.



Adductors

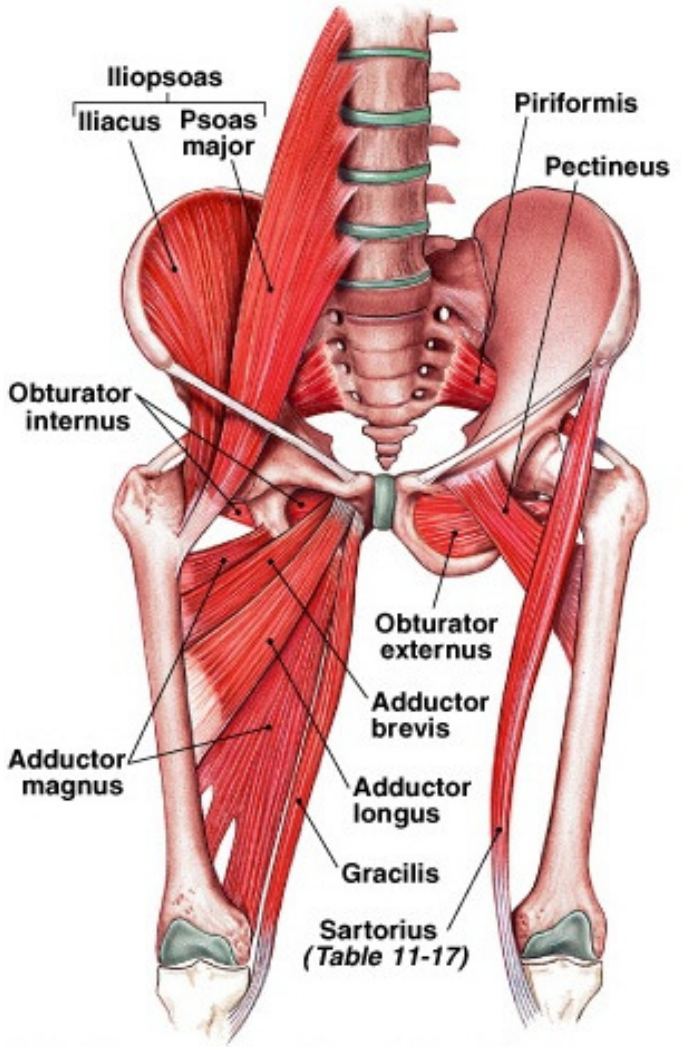
The adductors comprises of 5 muscles - you do not need to remember each of these names – just that there are short and longer adductors.

1. Adductor brevis
2. Adductor longus
3. Adductor magnus
4. Pectineus
5. Gracilis

Origin – all from the pubic bone

Insertion – they all insert on the medial aspect of the femur at varying levels, except gracilis which crosses over the knee joint to insert on the medial tibia

Function – hip adduction.
May also assist with hip flexion or extension



The iliopsoas muscle and the adductor group

Iliacus

Origin – iliac fossa

Insertion – lesser trochanter femur

Function – flexes the hip, stabilizes the hip in the socket

Psoas Major

Origin – anterior transverse processes of T12-L5

Insertion - the tendon of psoas fuses with the tendon of iliacus and inserts on the femur

Function - primary function is to flex the hip
Controversy still exists regarding its action on the lumbar spine - it has been show to flex the lumbar spine when the spine or hips are already in flexion eg in sitting, and extends the lumbar spine when the spine and hips are extended eg in standing.

Muscles that move the Knee

Quadriceps

The quadriceps is a group of muscles which extend (straighten) the knee. It consists of 4 muscles whose tendons all insert into the patella, then the patella tendon inserts onto the tibia on the tibial tuberosity.

1. Rectus Femoris

Origin - ASIS on ilium
(crosses the hip and knee joints)

Function – extends the knee
flexes the hip

2. Vastus Medialis

Origin – shaft of femur

Function – extends and stabilizes the knee, draws the patella medially

3. Vastus Intermedius

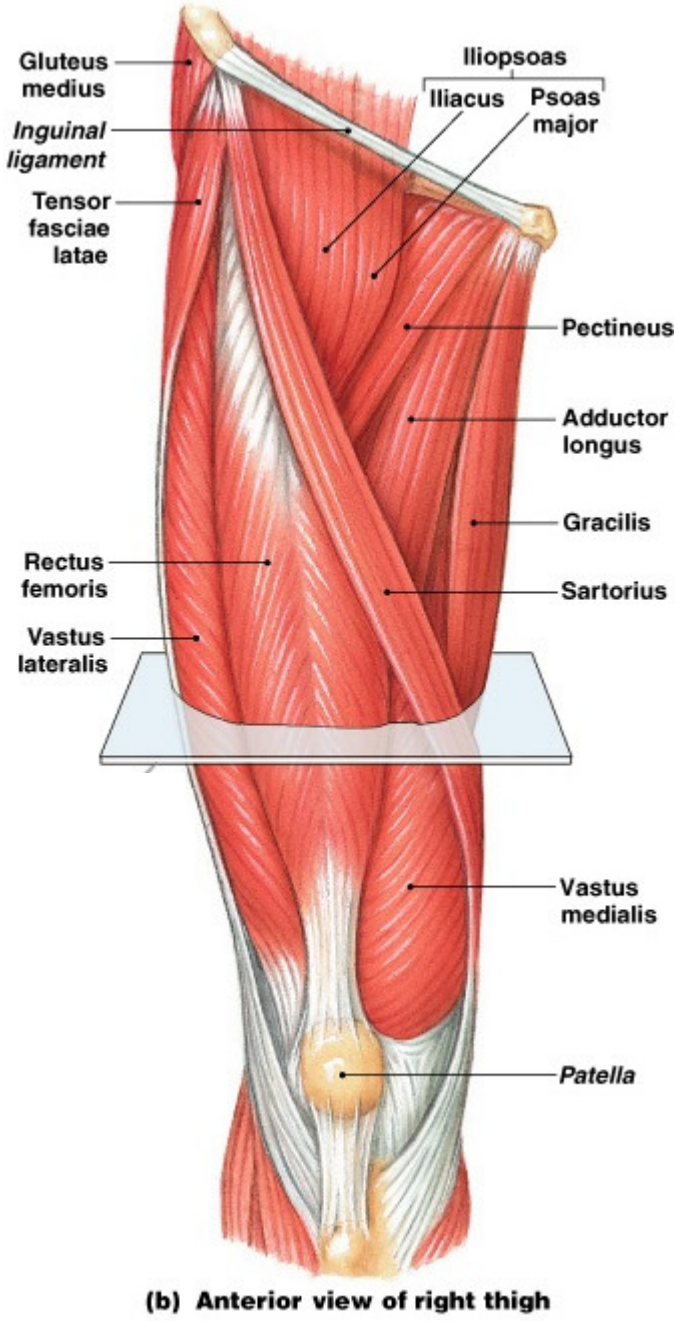
Origin – shaft of femur

Function – knee extension

4. Vastus Lateralis

Origin – shaft of femur

Function – knee extension, draws the patella laterally



(b) Anterior view of right thigh

Hamstrings

The hamstrings are the muscle group which flex (bend) the knee. It consists of 3 muscles:

1. Biceps femoris

Origin – ischial tuberosity and posterior femur

Insertion – head of fibula, lateral condyle of tibia

Function – knee flexion
hip lateral rotation

2. Semimembranosus

Origin – ischial tuberosity

Insertion – posterior surface of medial condyle of tibia

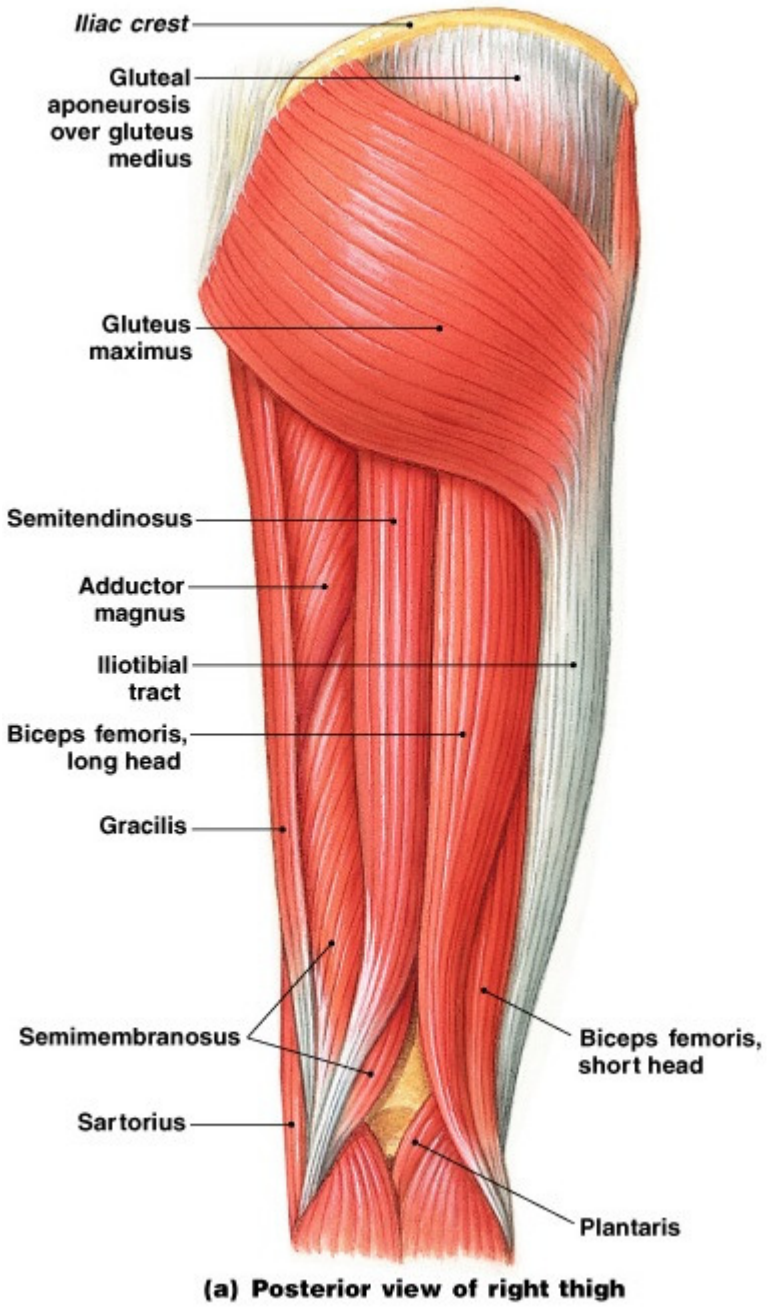
Function – knee flexion
hip extension and medial rotation

3. Semitendinosus

Origin – ischial tuberosity

Insertion – proximal medial surface of tibia, near gracilis insertion

Function – knee flexion
hip extension and medial rotation



(a) Posterior view of right thigh

Sartorius

Origin – ASIS on ilium

Insertion – medial surface of tibia

Function – knee flexion, hip flexion and lateral rotation

Muscle that move the Ankle and Foot

Gastrocnemius

The gastrocnemius or "calf muscle" is the largest muscle in the lower leg. It travels over both the knee and ankle and has 2 heads – lateral and medial.

Origin – femoral condyles (distal femur)

Insertion – calcaneus via Achilles tendon (sometimes called calcaneal tendon)

Function – ankle plantarflexion and inversion, knee flexion

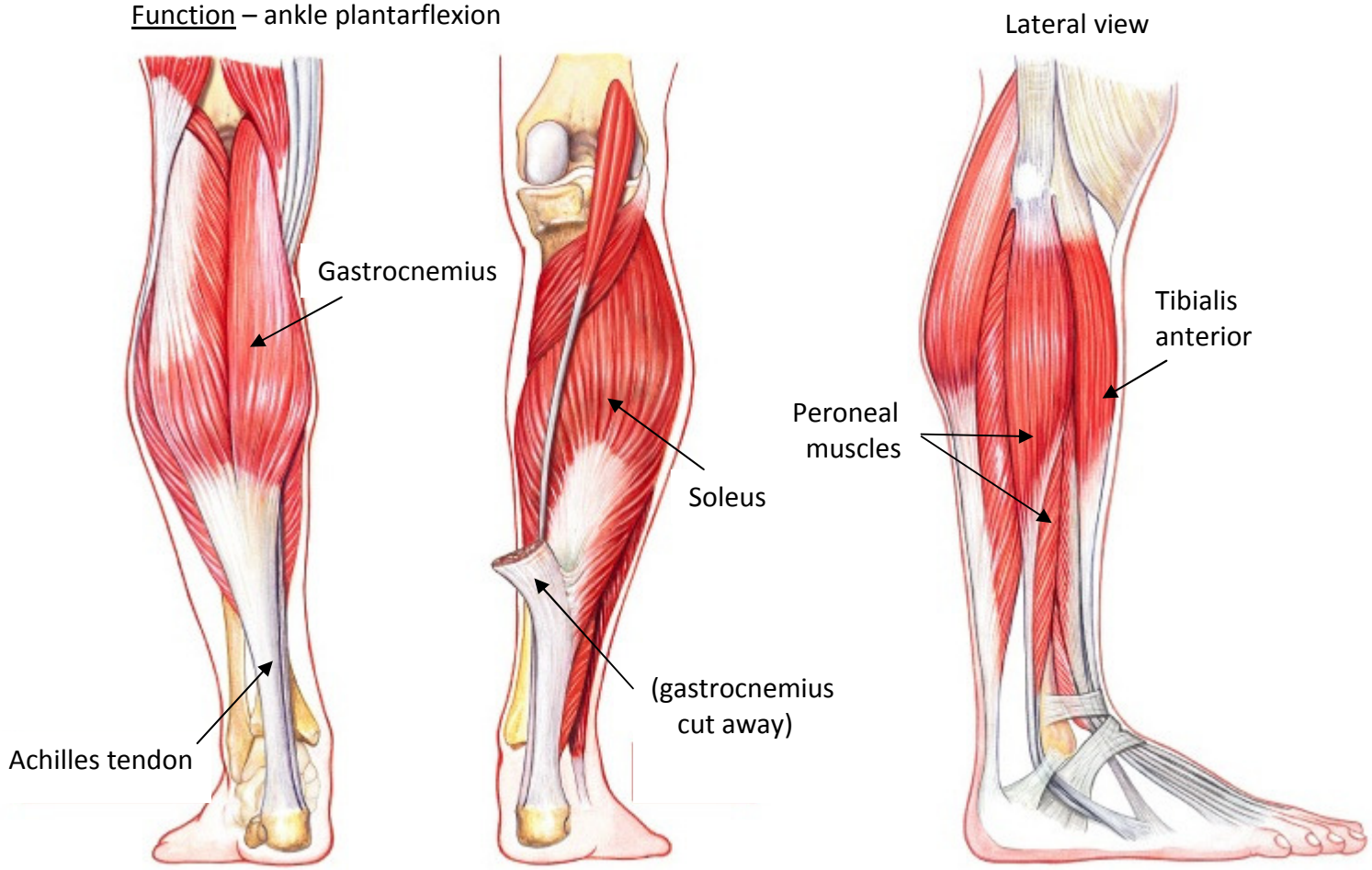
Soleus

Lies deeper to the gastrocnemius

Origin – head of fibula and shaft of tibia

Insertion – calcaneus via Achilles tendon (with gastrocnemius)

Function – ankle plantarflexion



Peroneal muscles

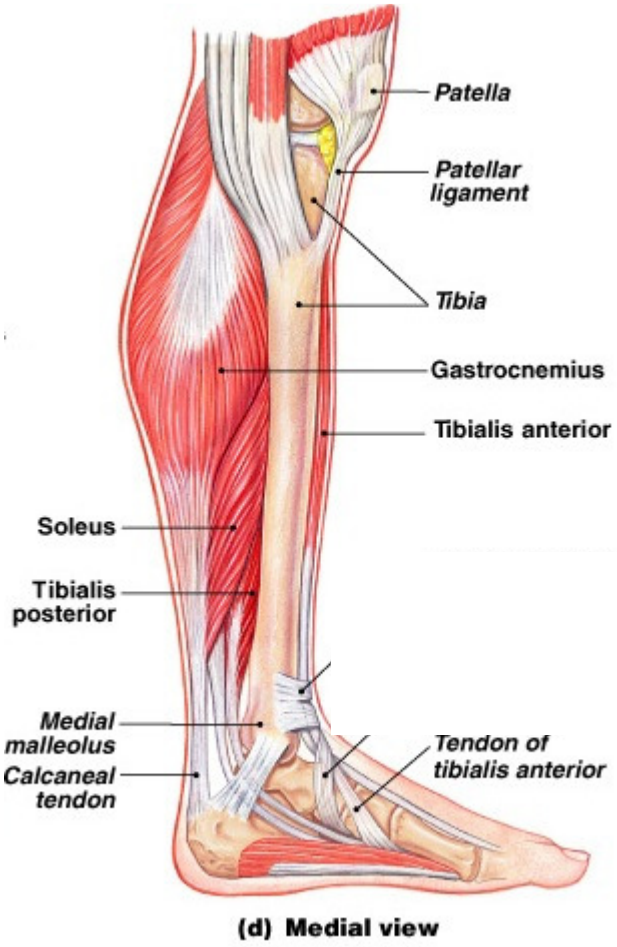
These muscles are on the lateral side of the lower leg. There are 2 muscles:

Peroneus longus and Peroneus brevis

Origin – fibula and tibia

Insertion – base of the 5th metatarsal bone and medial cuneiform bone

Function – ankle eversion,
can also plantarflex the ankle



(d) Medial view

Tibialis anterior

The tibialis anterior runs along the anterolateral shin.

Origin – lateral surface of the tibia and interosseus membrane

Insertion – medial tarsal and metatarsals

Function – dorsiflexion and inversion of the ankle

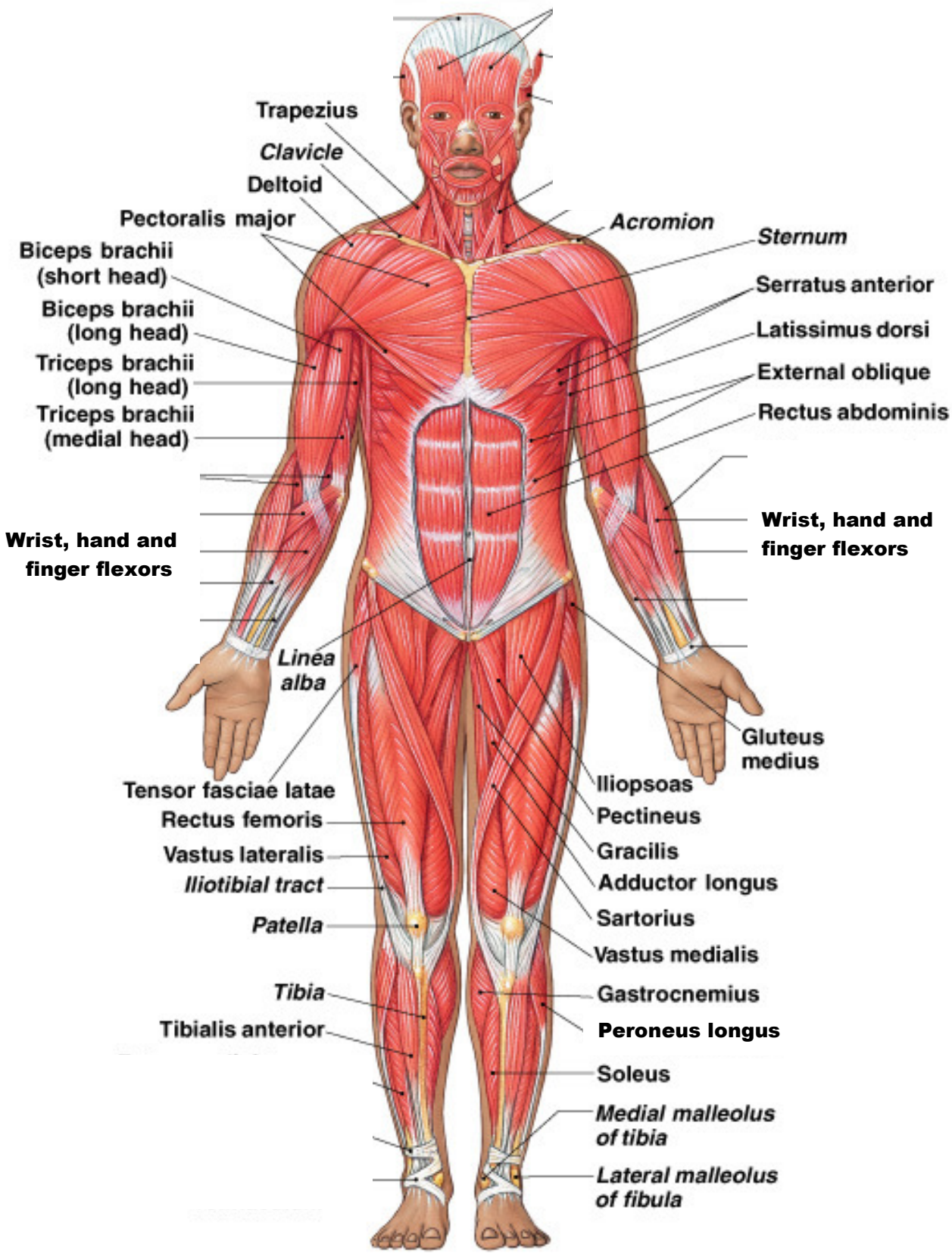
Tibialis Posterior

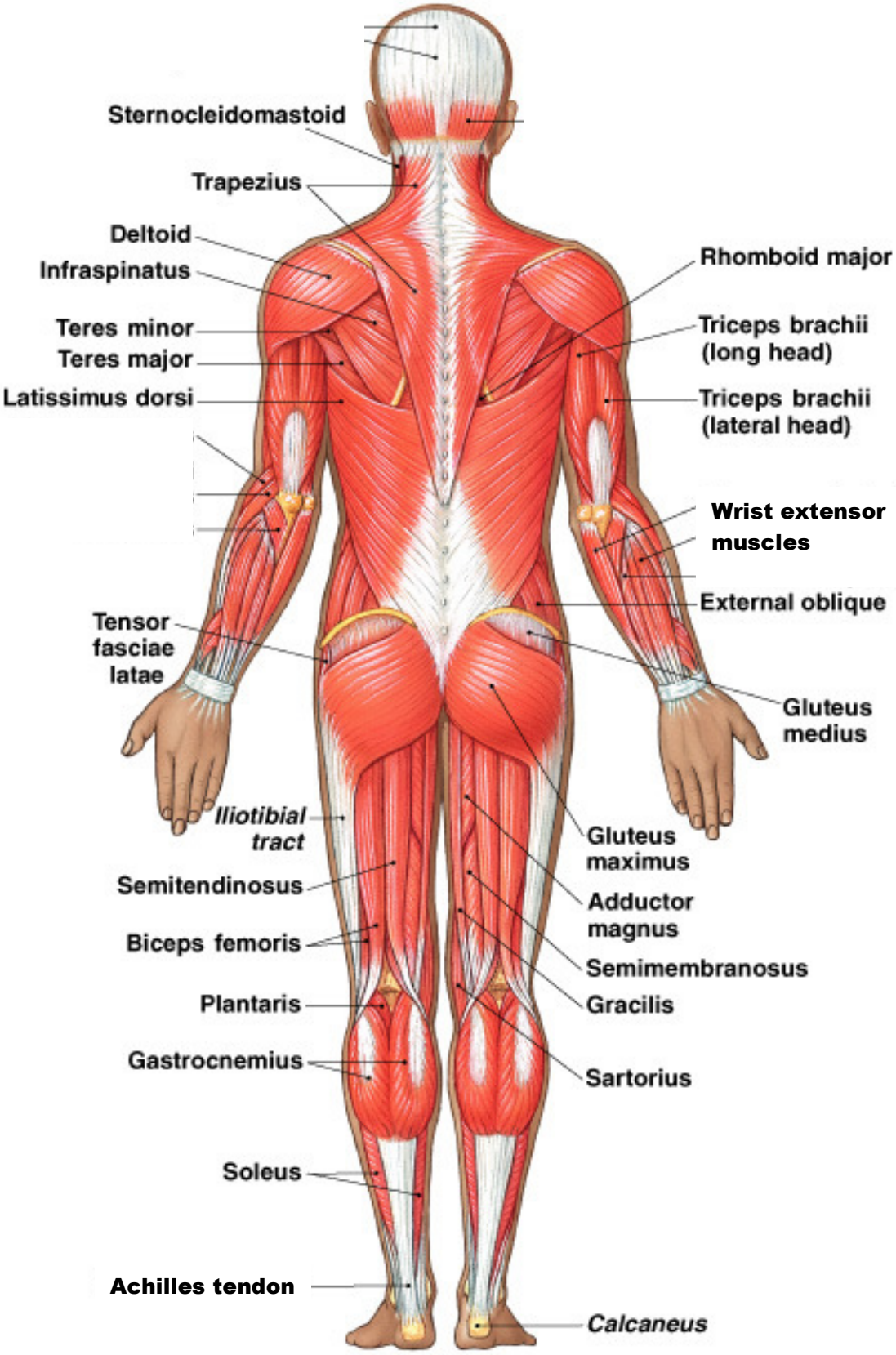
Deep muscle running along the back of the lower leg.

Origin – posterior surface of tibia, fibula and interosseus membrane

Insertion – tarsal and metatarsal bones

Function – inversion and adduction of the ankle/foot, plantarflexion, helps maintain the arch underneath the foot.




Sternocleidomastoid
Trapezius
Deltoid
Infraspinatus
Teres minor
Teres major
Latissimus dorsi
Rhomboid major
Triceps brachii (long head)
Triceps brachii (lateral head)
Wrist extensor muscles
External oblique
Tensor fasciae latae
Gluteus medius
Iliotibial tract
Gluteus maximus
Semitendinosus
Adductor magnus
Biceps femoris
Semimembranosus
Plantaris
Gracilis
Gastrocnemius
Sartorius
Soleus
Achilles tendon
Calcaneus

References

All pictures/photographs are from:

Fundamentals of Anatomy and Physiology, 7th Edition, Frederick H Martini PhD, Pearson Education 2006.