

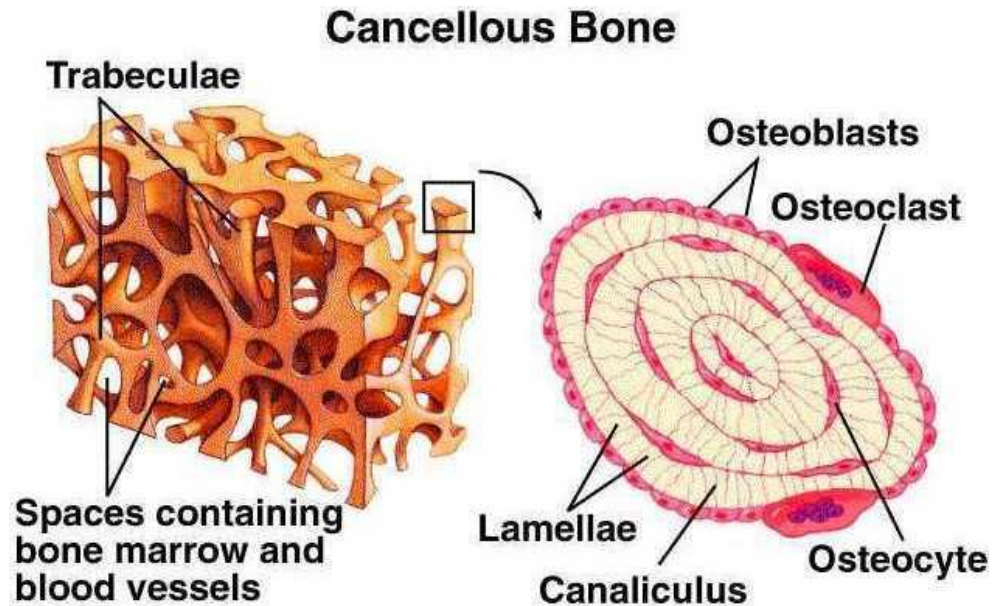
# American Society of Orthopedic Professionals

## Orthopedic Lecture Series<sup>©</sup>

*Bone/ Structures, Fracture Types and Skeletal Disorders/ Specialty Casts and Appliances/Surgical Procedures, Positioning and Devices*

**Lessons 1-5: Bones and Joints**

# Terminology



<http://fau.pearlashes.com/anatomy/Chapter%209/Chapter%209.htm>

Osteocytes - mature bone cells which develop from

Osteoblasts - a cell that manufactures

Osteoclasts - a bone cell which breaks down the bone matrix.

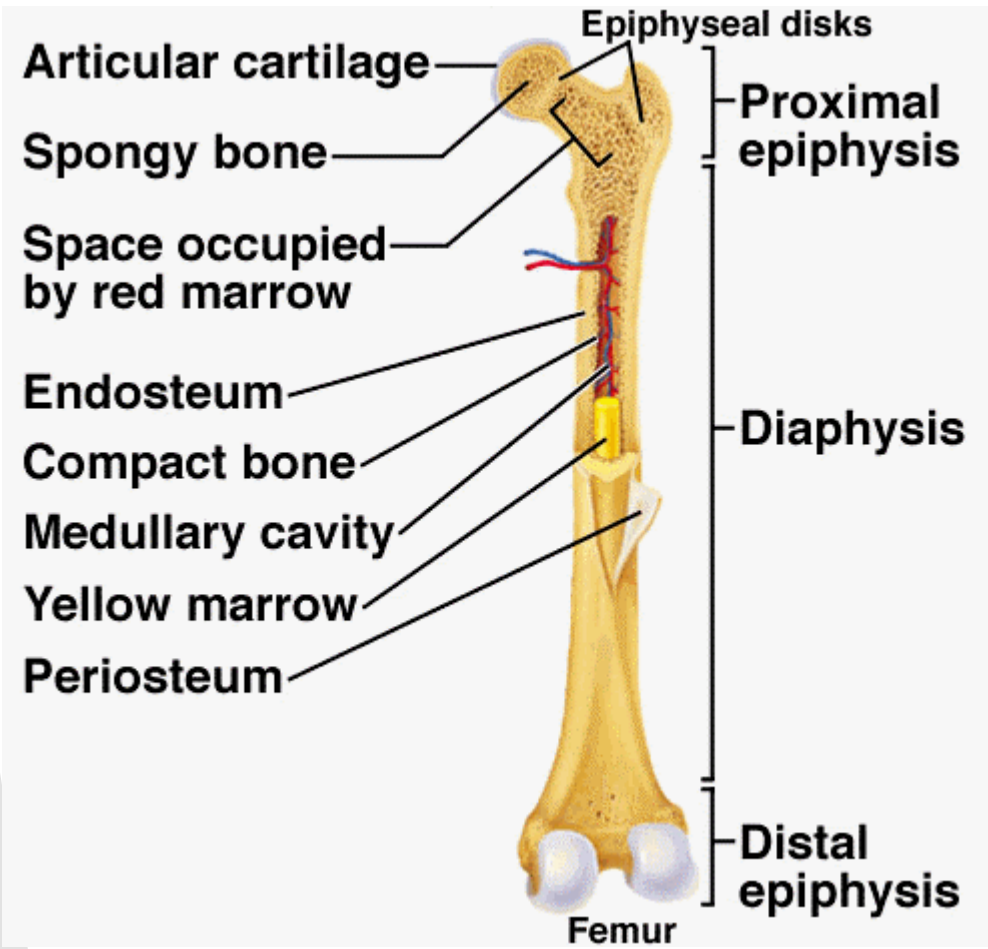
Trabecular (cancellous bone) - type of porous bone having large latticework and a spongy, honeycomb appearance; filled with marrow.

Example: the interior of a vertebra.

Matrix - the microscope substance of a tissue or cell.

Intercellular substance of cartilage, produced by cartilage cells.

# Bone Tissue Types



**Compact** (cortical) - dense hard layer of bone making up outer surface of long bones; surrounds spongy trabecular bone.

**Cancellous** (trabecular) - refers to the inner layer of bone that has a porous, lattice-like, spongy structure.

**Periosteum** - divided into 2 layers.

- New blood cells are produced in the inner layer of the periosteum.
- Nerve and blood vessels within the periosteum provide nourishment for the underlying bone, but not sufficient to provide all the nourishment needed by the bone cortex.
- Periosteum also helps protect the bone from infection.

The spaces in cancellous bone contain bone marrow

**Medullary Cavity** - refers to marrow or soft marrow-like material in the center of a bone (medulla)

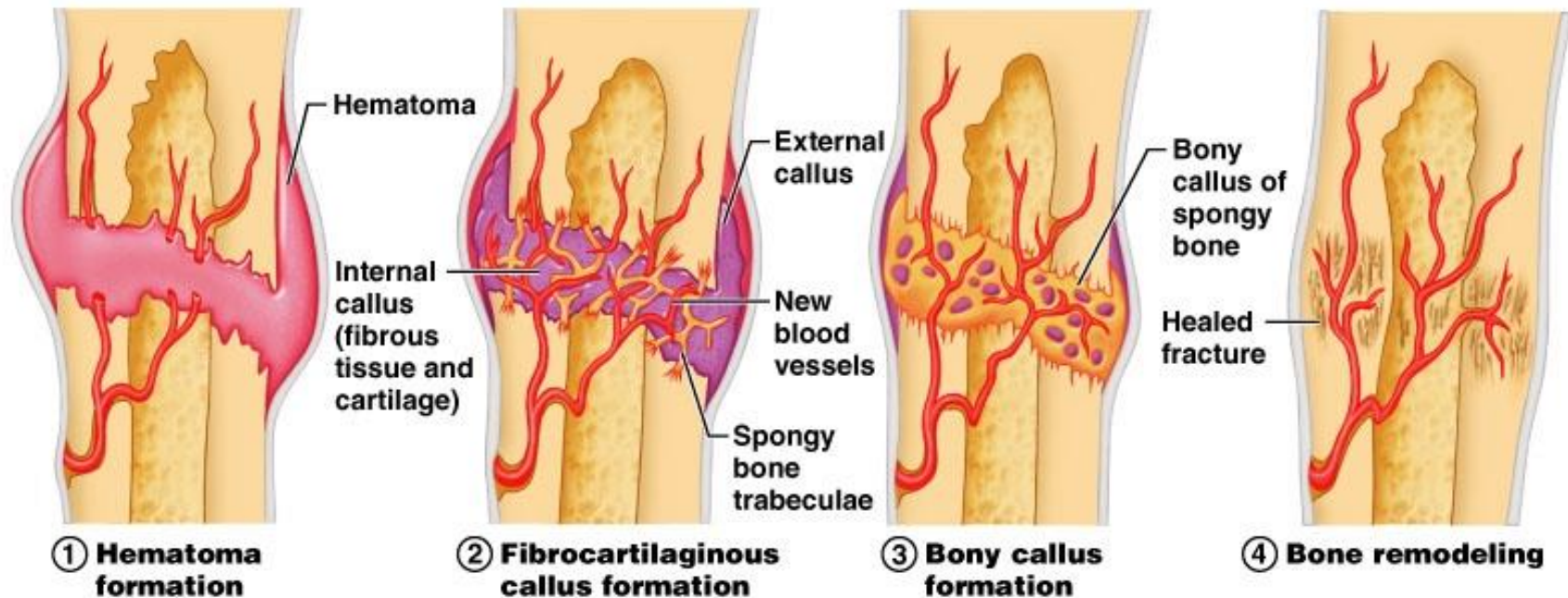
- Lined with a tissue called endosteum.
- Contains a blood supply for the bone.

# Normal Bone Healing

A fractured bone should normally heal within 8 -12 weeks.

To ensure good healing, the fracture should be:

- a. Properly aligned
- b. Immobilized by internal or external fixation



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# 5 Stages to Normal Bone Healing

## 1. Inflammation

- a. The inflammatory stage of healing lasts about 2 days.
- b. A blood clot, called the hematoma is formed.

## 2. Cellular Proliferation

- a. The cellular proliferation stage begins on the second day post-injury.
- b. Macrophages debride the injured area.
- c. A fibrin mesh is produced which seals the edges of the fractured bones.
- d. The fibrin mesh allows capillary and fibroblastic ingrowth.
- e. Fibroblasts and osteoblasts form a periosteal callus

## 3. Callus Formation

- a. The callus formation stage continues for 3 -4 weeks.
- b. During this stage, the bone fragments grow together.

## 4. Ossification

- a. The ossification stage lasts 3 - 4 months.
- b. The new tissue calcifies

## 5. Remodeling

- a. The remodeling stage is normal bone maintenance

# Pathological Bone Healing

Bone healing can be disrupted at any stage.

- ▶ Inadequate immobilization of the injury
  - If the bone is poorly immobilized, the formation of the hematoma can be disturbed.
- ▶ Distraction of the bone fragments
  - Distracted fragments of bone are separated and do not come into contact.
- ▶ Inadequate blood supply
- ▶ Infection
- ▶ Interposition of soft tissues can interfere with proper healing

Granular tissue may fill the space between the bone fragments, and interfere with healing.

Distraction may decrease the blood supply to the site of injury.

In case of distraction, soft tissue may fill the gap, and cover the ends of the fracture interfering with hematoma and callus formation.

Vascular necrosis of the bone may occur when the blood supply is not reestablished.

Advancing age, poor nutrition, and hormone imbalances can affect healing

# Fibrosis, Erysipelas, Cornification, Keratosis, and Edema

The conditions can occur with lymphedema

**Fibrosis** - the hardening of tissue

- ▶ Pathologic process: Formation of fibrous tissue as a reaction to injury or disease.

**Erysipelas** - which means red skin in Greek, is the result of an acute streptococcal infection of the skin.

- ▶ The infection causes inflammation, and involves the fat underlying the affected skin.



# Fibrosis, Erysipelas, Cornification, Keratosis, and Edema

Cornification - involves the change of normal skin cells into a hard material such as

Keratosis - involves the growth of thick scaly bumps on the skin.

Edema - the accumulation of interstitial fluid in any soft tissue resulting in a swollen appearance.

- ▶ It results from the increased secretion of interstitial fluid, or a problem removing it from the tissue.
- ▶ Edema used to be called dropsy, or hydropsy.



<http://www.medindia.net/symptoms/ankle-edema.htm>



# Bones

The skeleton is composed of long bones, short bones, flat bones, irregular bones, and sesamoid (round) bones.

## Long bones

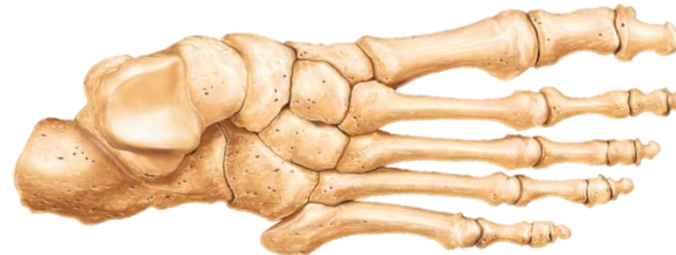
- ▶ **Diaphysis** - the shaft of a long bone
  - ▶ Made up of compact bone
- ▶ **Epiphysis** - the ends of a long bone
  - ▶ Made up of cancellous bone
  - ▶ The epiphysis are the sites of bone growth
- ▶ Examples of long bones: humerus and the femur

## Short

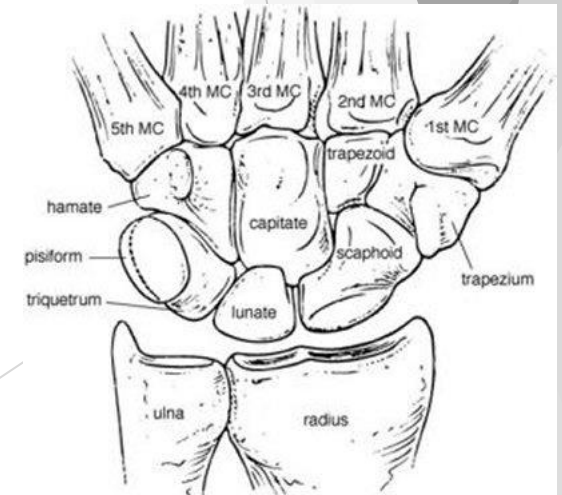
- ▶ Found in groups
- ▶ Aid in movement
- ▶ Found in the wrist and ankle



<http://www.kidport.com/reflib/science/humanbody/skeletalsystem/HumanSkeleton.htm>



<http://classconnection.s3.amazonaws.com/42/flashcards/1178042/png/foot1329095099695.png>

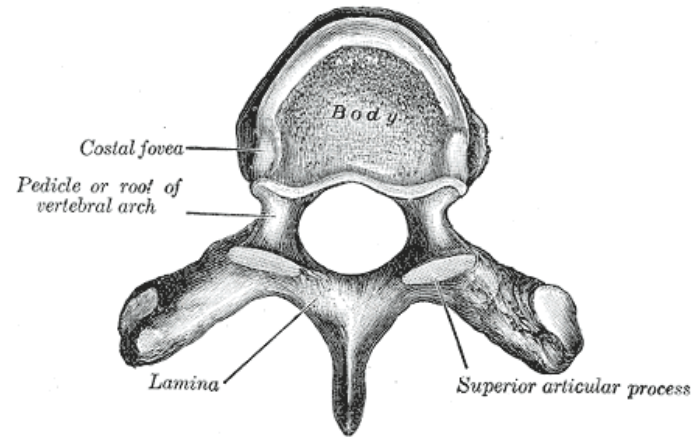


<http://www.daviddarling.info/encyclopedia/C/carpal.html>

# Bones

## Flat

- ▶ Ribs
- ▶ Scapula
- ▶ Sternum
- ▶ Cranial bones



<https://www.boundless.com/physiology/textbooks/boundless-anatomy-and-physiology-textbook/the-skeletal-system-7/vertebral-column-81/regional-vertebral-characteristics-469-7740/>

## Irregular

- ▶ Vertebrae
- ▶ Facial bones
- ▶ Skull bones

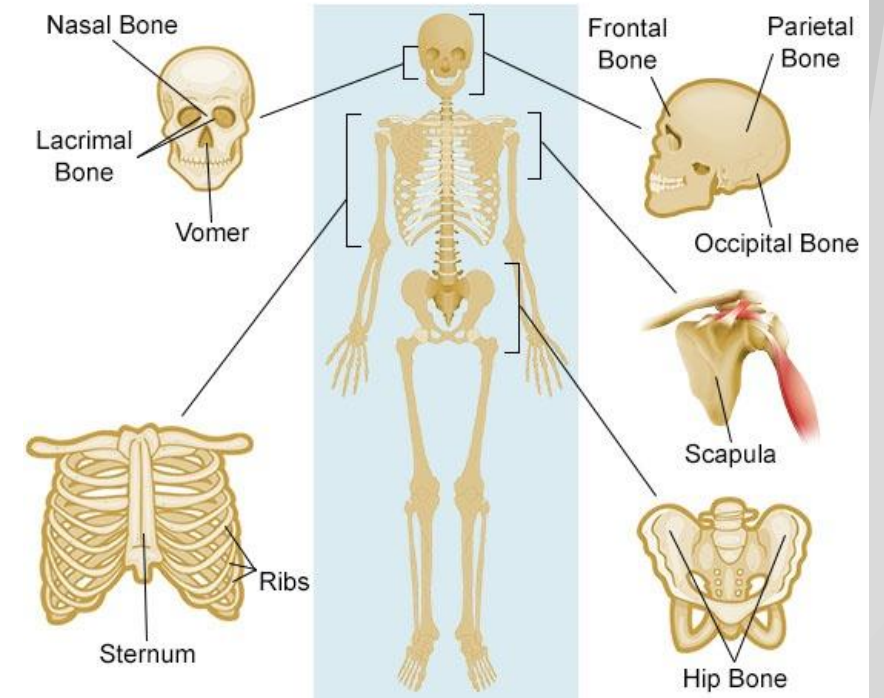
## Sesamoid

- ▶ Located within a tendon
- ▶ Example: patella



<http://uvahealth.com/services/rehabilitation/conditions-treatments/100267>

## Flat Bones in the Human Body



<http://www.buzzle.com/articles/list-of-all-the-flat-bones-in-the-human-body.html>



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<http://sesamoiditis.net/>

# Facial Bones

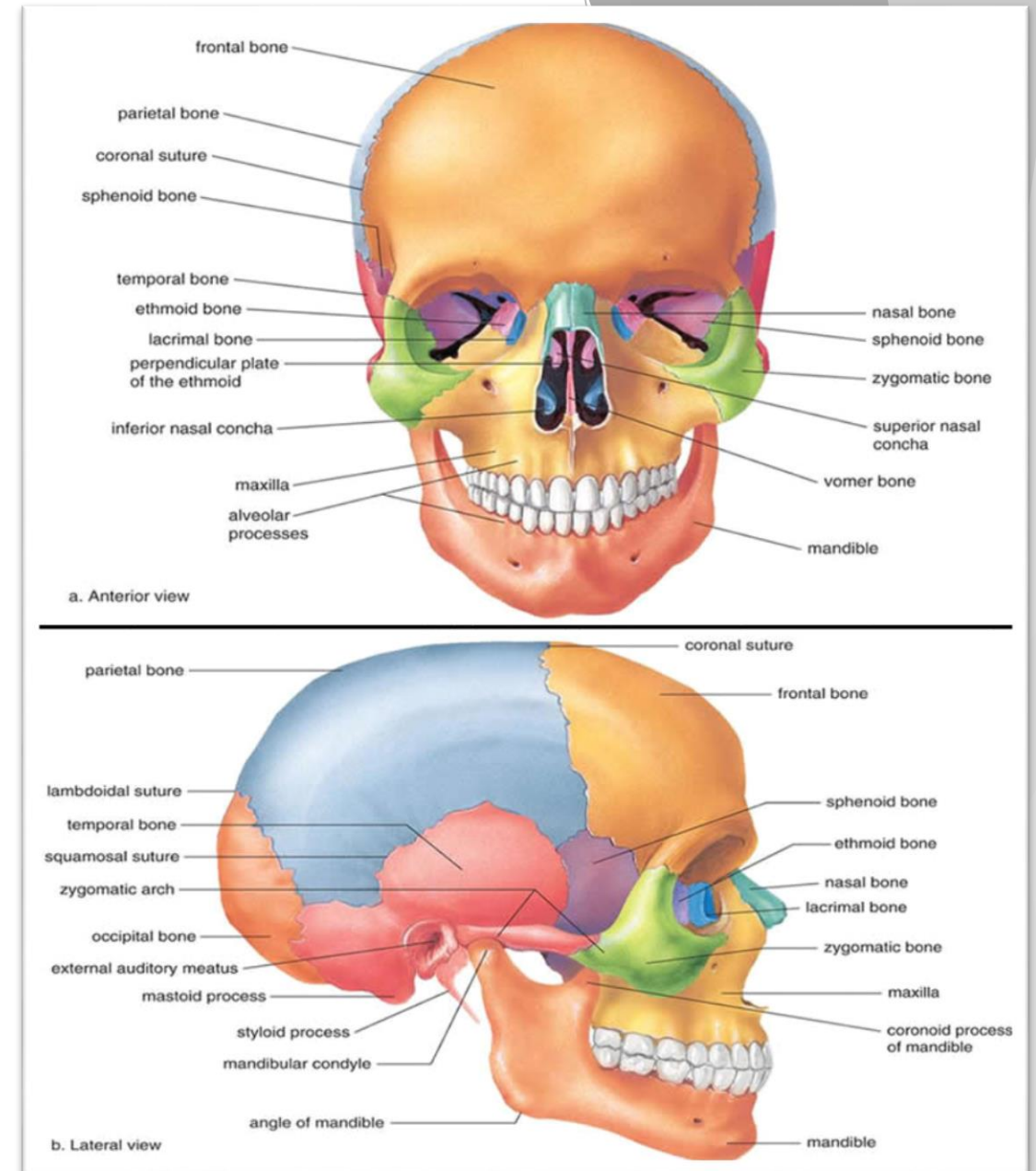
14 facial bones

Responsible for face shape

- ▶ Have sites of attachment for the jaw muscles, and the muscles of facial expression

Facial bones include:

- ▶ Maxillae (2)
- ▶ Palatine bones (2)
- ▶ Zygomatic bones (2)
- ▶ Lacrimal bones (2)
- ▶ Nasal bones (2)
- ▶ Mandible (1)
- ▶ Inferior nasal conchae (2)



# Facial Bones - Locations

## Maxillae

- ▶ Form the upper jaw and hold the upper teeth

## Palatine bones

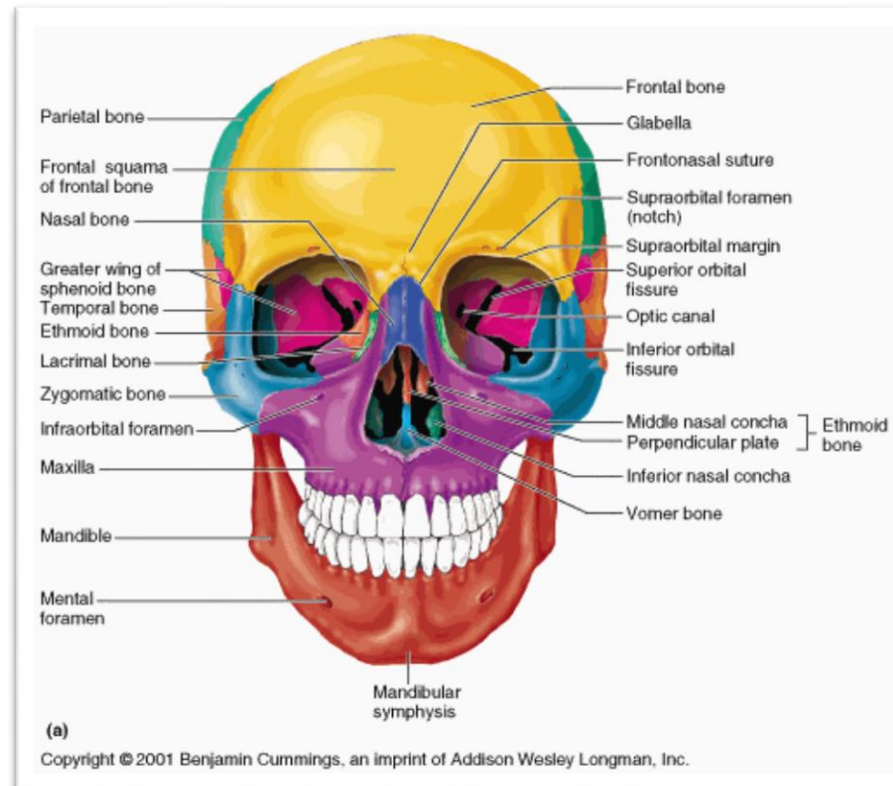
- ▶ Found behind the maxillae
- ▶ Form part of the nasal cavity
- ▶ Form part of the hard palate

## Zygomatic bones

- ▶ Cheek bones

## Lacrimal bones

- ▶ Located in the inner corner of the eye orbit



## Nasal bones

- Are seen as the bridge of the nose

## Vomer

- Located in the nasal cavity
- Forms the nasal septum

## Mandible

- Lower jaw

## Nasal conchae

- Located in the nasal cavity

# Cranium Bones

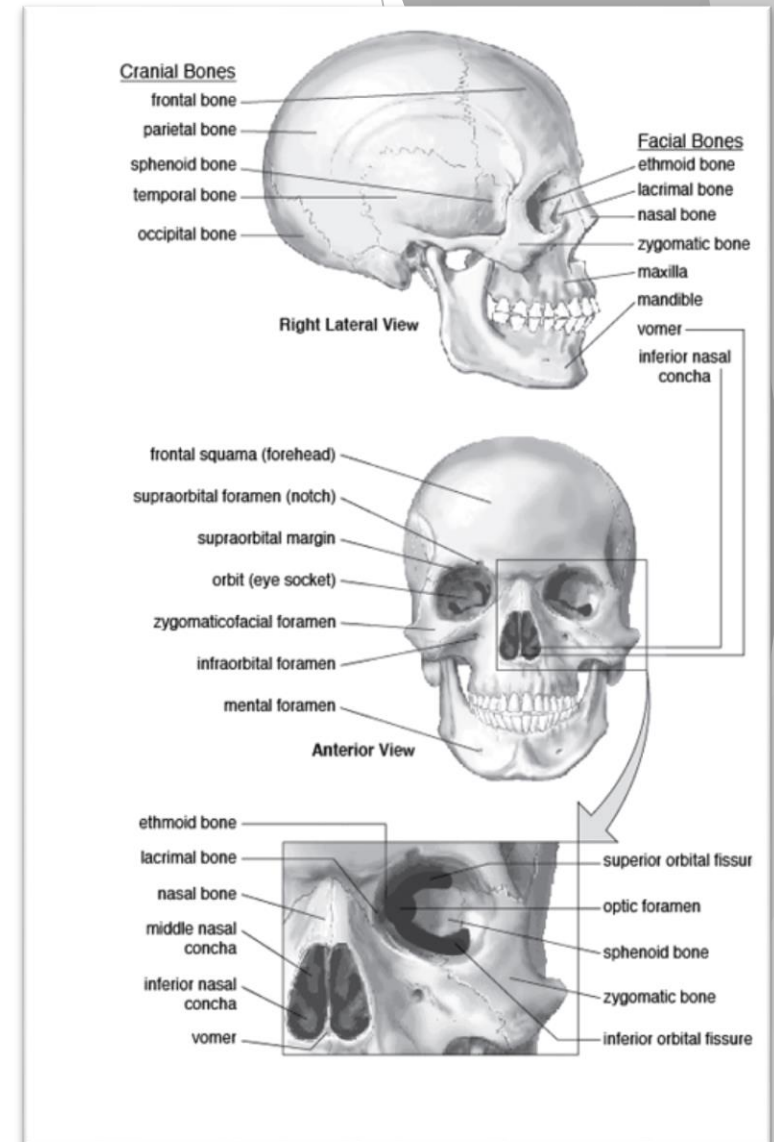
## Cranium

- ▶ Encloses and protects the brain
- ▶ Has attachment points for the muscles that allow chewing
- ▶ Has attachment points of the muscles that allow movement of the head

## Eight cranium bones

- ▶ Frontal bone (1)
- ▶ Parietal bones (2)
- ▶ Occipital bone (1)
- ▶ Temporal bones (2)
- ▶ Sphenoid bone (1)
- ▶ Ethmoid bone (1)

These bones are attached by immovable joints called sutures



# Cranium Bones - Locations

## Frontal bone

- ▶ Located on the anterior part of the cranium

## Parietal bones

- ▶ Make up the top and sides of the cranium

## Occipital bone

- ▶ Found at the base of the cranium

## Temporal bones

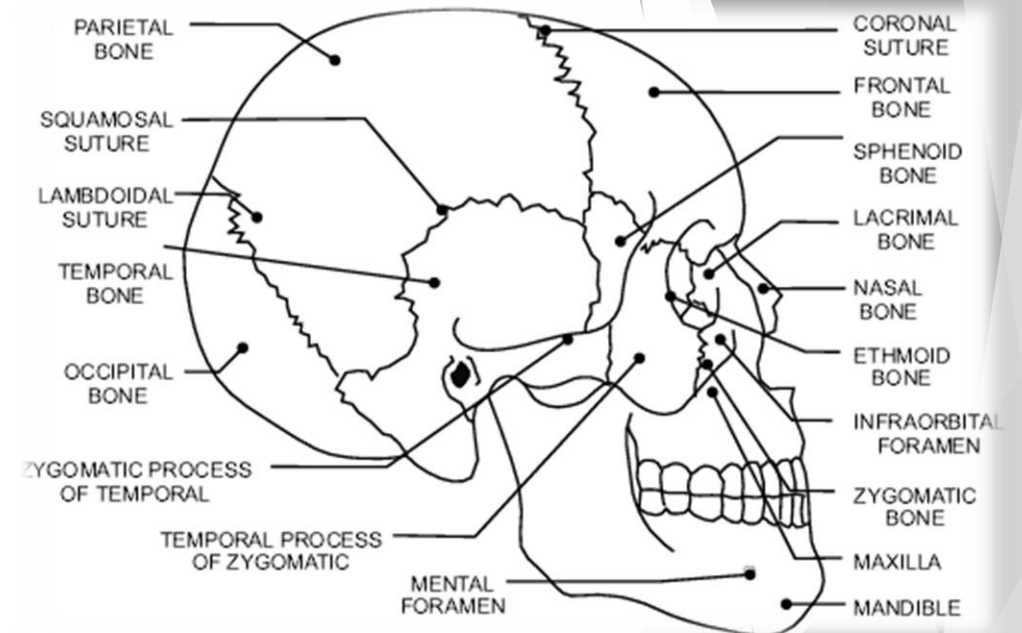
- ▶ Found at the sides of the cranium

## Sphenoid bone

- ▶ Forms part of the base and sides of the cranium

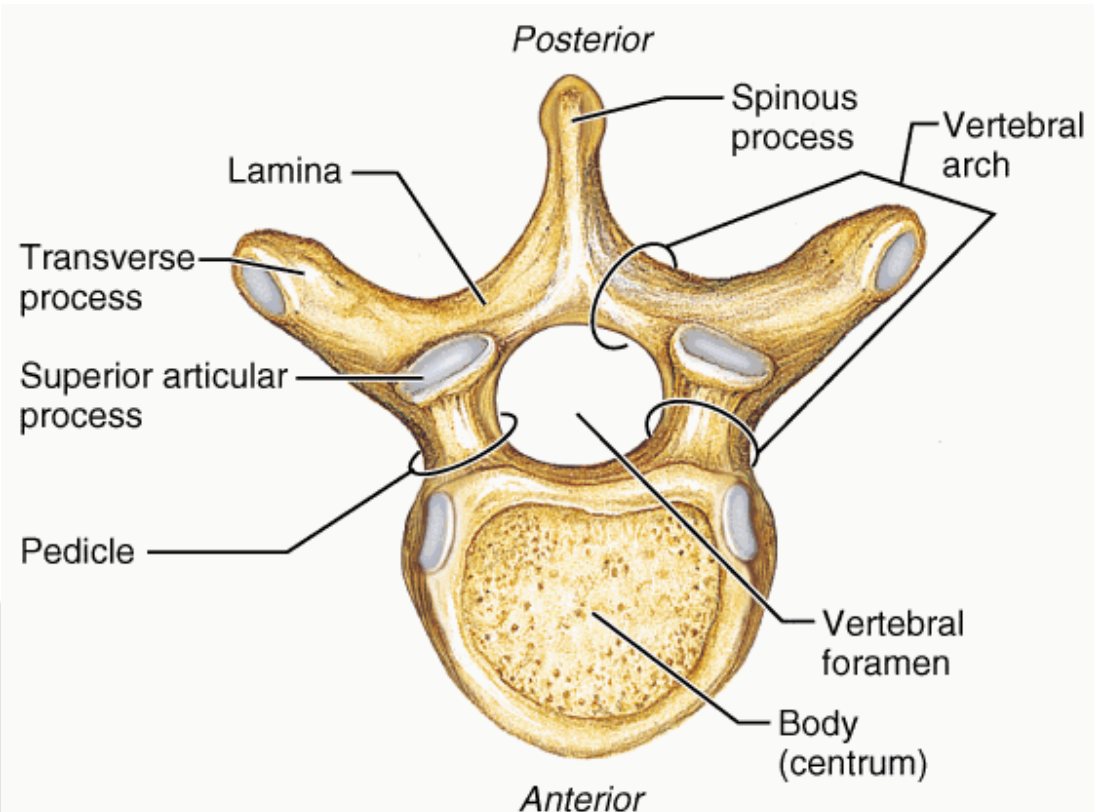
## Ethmoid bone

- ▶ Divided into 2 part, one on each side of the nasal cavity



# Vertebra

The vertebrae have different shapes, but they all have characteristics in common.



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The body of the vertebra

- ▶ The anterior part that is thick and round
- ▶ Vertebral bodies are separated by the intervertebral disks.

Peduncles

- ▶ Two projections that extend posteriorly from each vertebra
- ▶ Attached to each peduncle is a lamina

Vertebral arch

- ▶ Formed by the peduncles, laminae, and spinous process
  - ▶ Spinal cord passes through this arch
  - ▶ The superior and inferior articulating processes extend from each vertebral arch

Spinous process

- ▶ Formed when the 2 laminae fuse in the back

Transverse process

- ▶ Located between the peduncles and laminae
- ▶ Projects laterally and inferiorly
- ▶ Point of attachment for ligaments and muscles

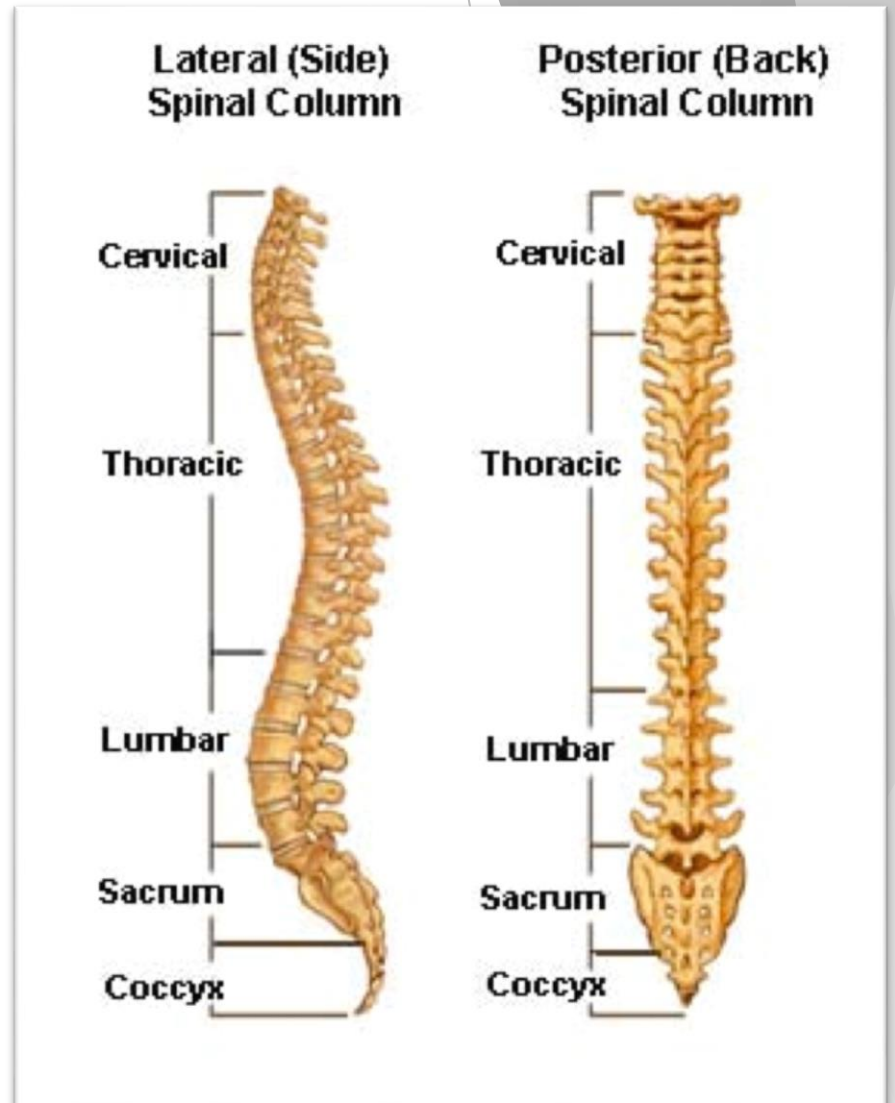
The latter two processes serve as attachments for the ligaments that connect adjacent vertebrae

# Vertebral Column

- ▶ Extends from the skull to the pelvis
- ▶ Comprised of bony vertebrae separated by intervertebral disks of cartilage
- ▶ Vertebrae are tied together by ligaments
- ▶ Protects the spinal cord

## Locations and Number

- ▶ Consist of 33 vertebrae
- ▶ Divided into regions of differing numbers
  - ▶ Vertebrae are referred to by their location in the column
- ▶ The first cervical vertebra (the atlas) is referred to as C1
- ▶ The second cervical vertebra (the axis) is referred to as C2
- ▶ From superior to inferior:
  - ▶ Cervical (7)
  - ▶ Thoracic (12)
  - ▶ Lumbar (5)
  - ▶ Sacral (5 fused together when adulthood is reached)
  - ▶ Coccygeal (4 fused)





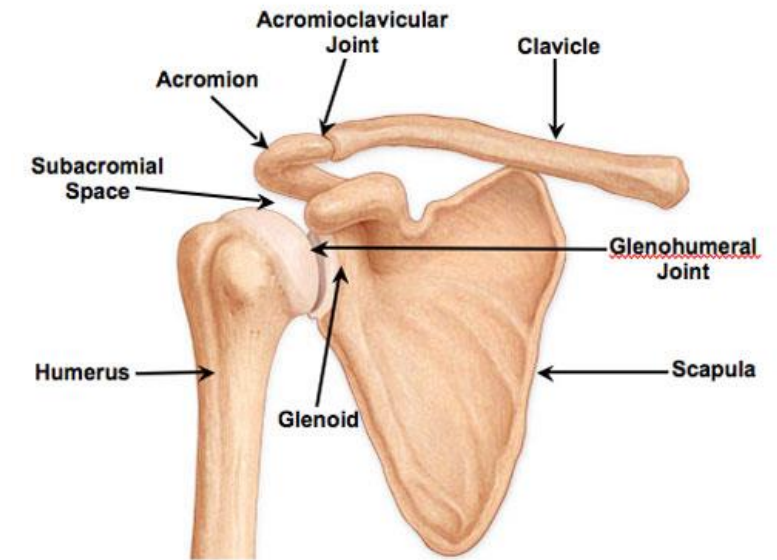
# Pectoral Girdle Bones

There is one of each bone on each side of the body

- ▶ Clavicle (collarbone)
- ▶ Scapula

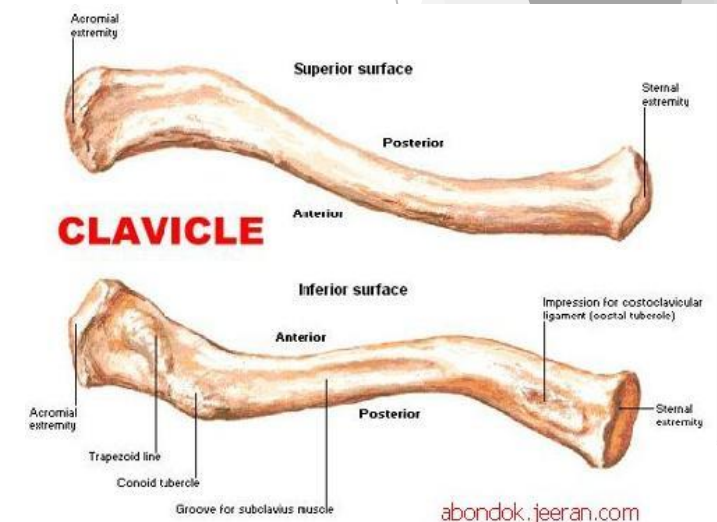
## Clavicle

- ▶ A long thin bone with 2 curves
- ▶ Keeps the shoulder in place
- ▶ One end of the bone attaches laterally to the acromion process of the scapula
- ▶ The other end of the bone attaches medially to the manubrium of the sternum
  - ▶ Easily breaks



Bony anatomy of the shoulder

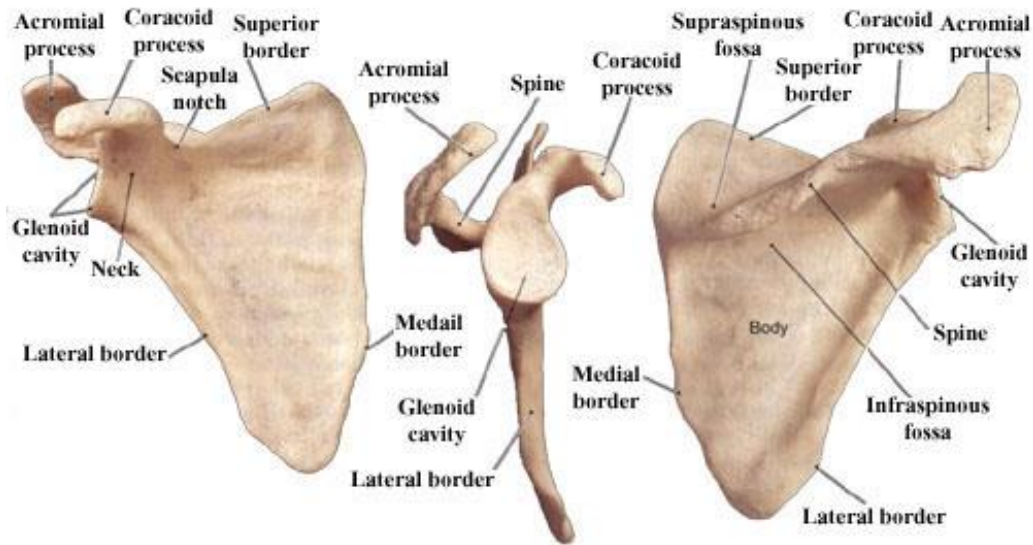
<http://www.cityedgephysio.com.au/how-your-shoulder-works.html>



abondok.jeeran.com

<http://www.123tagged.com/Picture/55241/Clavicle.html>

# Pectoral Girdle Bones



<https://theverticalworkshop.files.wordpress.com/2012/01/shoulder-girdle-bones.jpg>

## Scapula

- ▶ Commonly called the shoulder blade
- ▶ Is a broad, triangular shaped flat bone
- ▶ Has three surfaces called fossae which serve as attachment points for muscle
- ▶ Important sites on the scapula
  - ▶ Acromion process - Finger-like projection from the shoulder blade (scapula); forms the roof (bony ceiling) of the shoulder
  - ▶ Coracoid process - A beaklike projection on the front of the scapula (shoulder blade) to which is attached to the short head of the biceps, pectoralis minor and coracobrachialis muscles, and the coracoacromial, coracohumeral, and coracoclavicular ligaments.
  - ▶ Glenoid fossa - Shallow curved surface on the upper, outer scapula (shoulder blade) and its cartilaginous and fibrous rim, where the humerus articulates with the shoulder girdle.

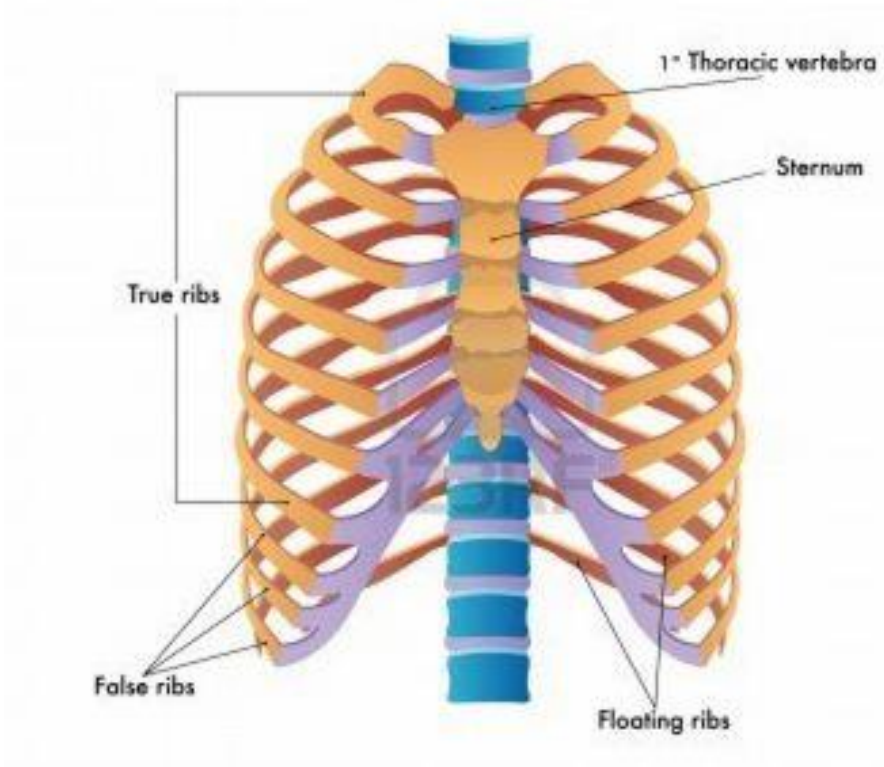
# Thorax Bones

## Bones in the thorax

- Ribs
- Sternum

## Anatomy of Thorax Bones

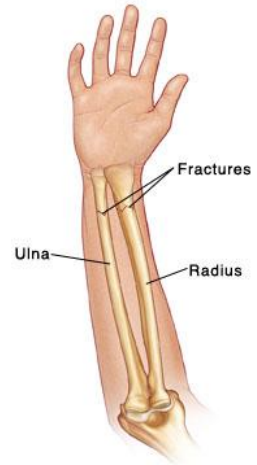
- ▶ Human body contains 12 ribs attached to the 12 thoracic vertebrae
- ▶ Bones are curved and slightly flattened
- ▶ True ribs
  - ▶ First 7 ribs
  - ▶ They are connected directly to the sternum by the costal cartilage
- ▶ False ribs
  - ▶ Next 3 ribs
  - ▶ Referred to as the false ribs because they are not connected directly to the sternum
  - ▶ The cartilages of these ribs join together, and attach to the seventh costal cartilage
- ▶ Floating ribs
  - ▶ Last two ribs
  - ▶ Not attached to the sternum
- ▶ Sternum (breastbone)
  - ▶ Flat
  - ▶ Divided into 3 parts:
    - ▶ Upper manubrium
    - ▶ Middle body
    - ▶ Xiphoid process
- ▶ The sternal notch can be felt at the top of the sternum at the bottom of the throat.



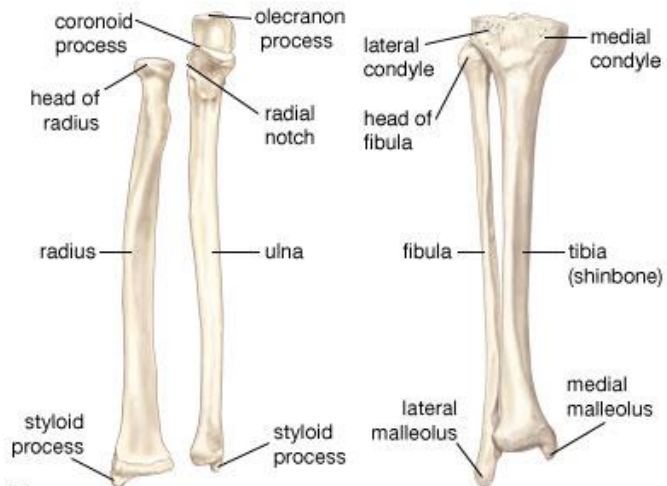
# Lower Arm Bones

## Bones in the lower arm

- Radius
- Ulna



<http://www.uofmmedicalcenter.org/healthlibrary/Article/116468EN>



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## Radius

- ▶ The larger of the 2 bones in the lower arm
- ▶ Extends from the elbow to the wrist
- ▶ Lies on the same side of the limb as the thumb
- ▶ The proximal end of the radius is disk shaped
- ▶ Articulates with the capitulum of the humerus
- ▶ Also attaches at the proximal end to the radial notch of the ulna
- ▶ The arrangement permits the radius to rotate around the ulna
- ▶ Distal end of the radius articulates with the wrist via the articular facets

## Ulna

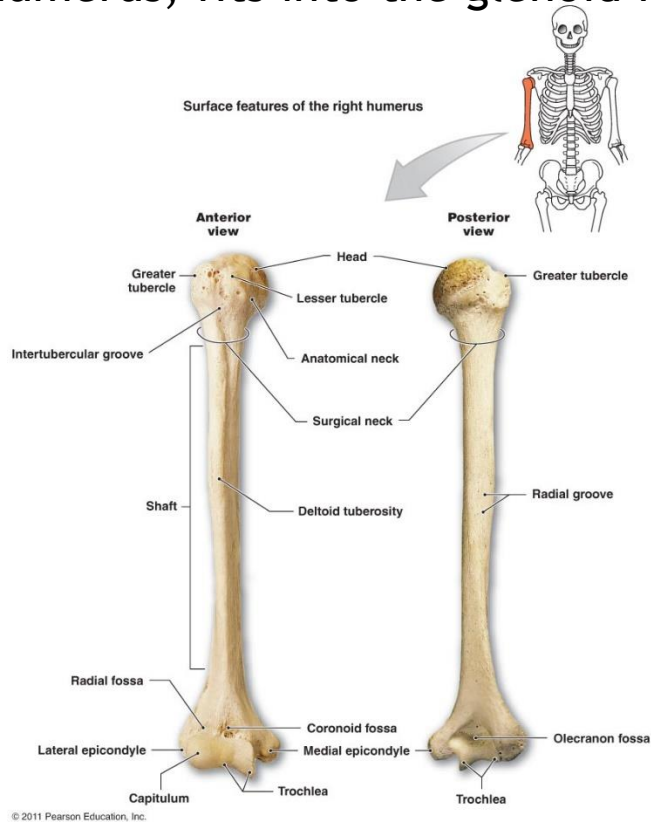
- ▶ Attached to the humerus at the trochlear notch
- ▶ On the distal end, the ulna articulates with the radius at the ulnar notch
- ▶ Connects to the wrist at the styloid process.

The radius and ulna are connected by the interosseous membrane.

# Upper Arm Bone

The bone of the upper arm is the humerus

- Largest bone in the arm
- Extends from the scapula to the elbow
- The proximal end, which is called the head of humerus, fits into the glenoid fossa



## Humerus

- ▶ Two processes, called the greater and lesser tuberosities, are located below the head of the humerus.
- ▶ Common site for fractures
- ▶ An area just below the tubercles called the surgical neck
- ▶ Distal end of humerus has two condyles

## Condyles

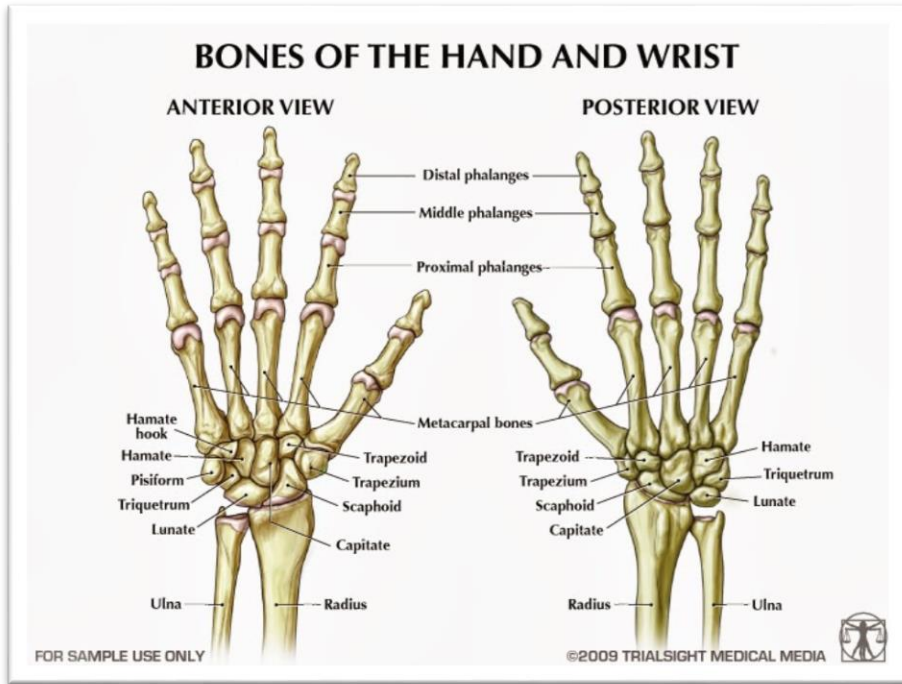
### Capitulum

- ▶ The lateral of the two condyles
- ▶ It articulates with the head of the radius

### Trochlea

- ▶ The medial condyle
- ▶ It articulates with the ulna
- ▶ Above the condyles, the humerus flares out forming 2 epicondyles
  - ▶ Medial epicondyle
  - ▶ Commonly referred to as the funny bone, as the ulnar nerve is located at this site

# Phalangeal Bones



<http://clutchstatus.blogspot.com/>

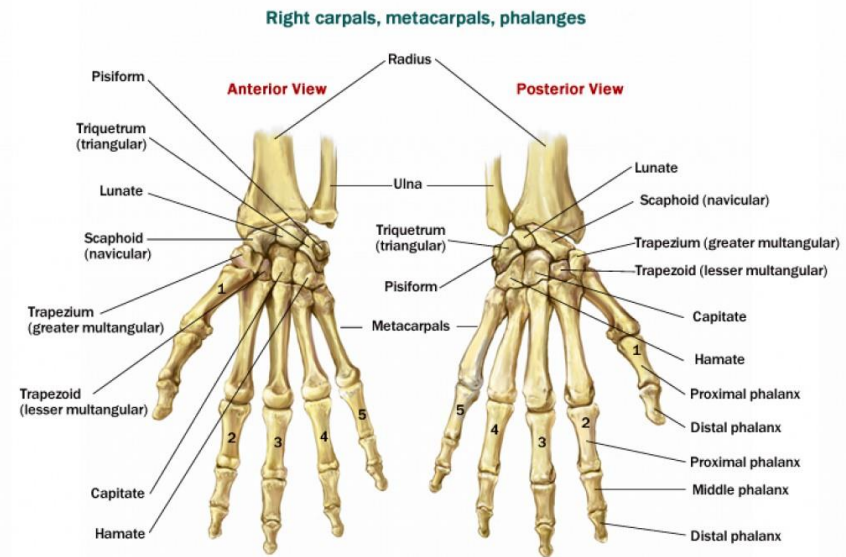
## Phalangeal bones

- ▶ 14 bones forming the fingers and thumbs
- ▶ The phalangeal bones articulate with the metacarpals
- ▶ There are 3 bones in each finger
  - ▶ Proximal
  - ▶ Middle
  - ▶ Distal
- ▶ Two bones in the thumb
  - ▶ Proximal
  - ▶ Distal
- ▶ Each bone is called a phalanx
- ▶ Starting from the thumb, the phalanges are named according to their relative position to the metacarpals
  - ▶ The phalanx in the thumb closest to the metacarpal is phalanx I proximal
  - ▶ The other phalanx of the thumb is phalanx distal I
  - ▶ The phalanges of the little finger are called phalanx V proximal, phalanx V middle, and phalanx V distal
- ▶ Like the metacarpals, the phalanges are long bones, and are cylindrical

# Carpal and Metacarpal Bones

## Metacarpals

- 5 metacarpal bones in the palm
- Roman numerals are used to identify the five metacarpals
- The metacarpals are long bones and are cylindrical
- They number from I - V beginning with the thumb



## Carpals

- ▶ 8 carpal bones in the wrist arranged in 2 rows of 4
- ▶ Distal Row
  - ▶ Bones are arranged from the lateral side to the medial side:
    - ▶ Trapezium
    - ▶ Trapezoid
    - ▶ Capitate
    - ▶ Hamate
      - ▶ A small bony projection on the distal end of the hamate is used in identification of this bone
      - ▶ The projection is called the hamulus

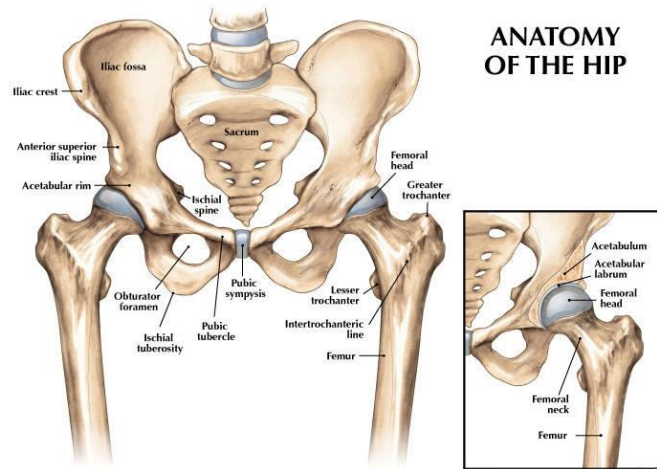
## Proximal Row

- ▶ Bones contained:
  - ▶ Scaphoid (navicular)
  - ▶ Lunate
  - ▶ Triquetrum
  - ▶ Pisiform
- ▶ All of the carpal bones are short bones, except the pisiform, which is a sesamoid bone.
- ▶ The most commonly fractured carpal bone is the scaphoid.

# Hip, Femur, Patella Bones

## Hip

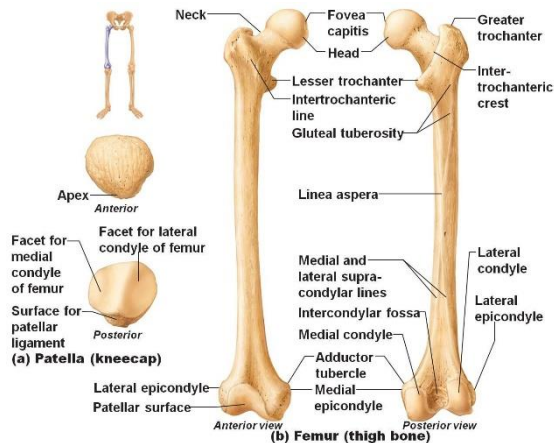
- ▶ The ball-and-socket of the hip is formed by the articulation of the acetabulum of the innominate bone, and the head of the femur.
- ▶ The acetabulum is found at the junction of the ilium, ischium, and pubis.



<http://unitedhipspecialists.com/hip-anatomy.htm>

## Femur

- ▶ Largest bone in the human body
- ▶ Reaches from hip to knee
- ▶ The greater and lesser trochanters, and the femoral head and neck make up the proximal end of the femur.
- ▶ The distal part of the femur ends in the lateral and medial condyles
- ▶ These 2 condyles articulate with the condyles of the proximal end of the tibia and form the knee joint

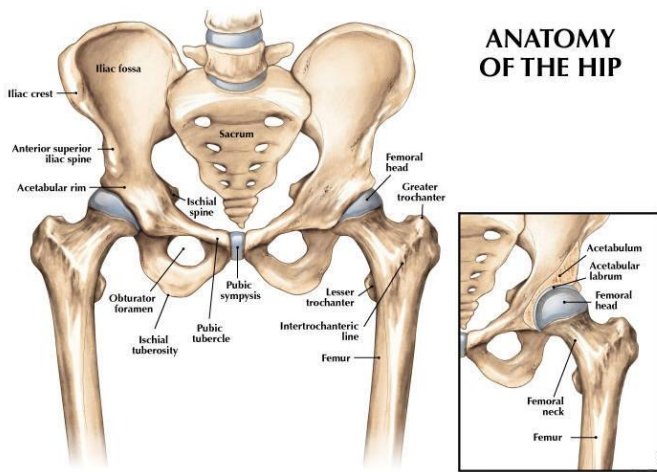


## Patella

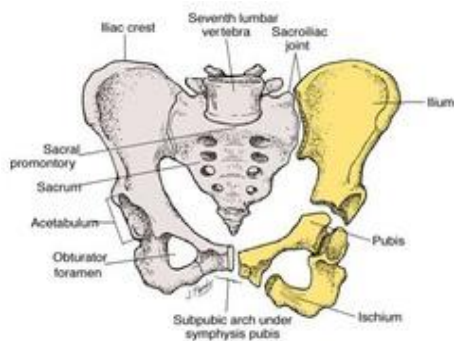
- ▶ The lateral and medial condyles are separated by a depression, called the patellar surface or groove, which provides an articular surface for the patella.
- ▶ The patella is a triangular shaped sesamoid bone which protects and strengthens the knee.



# Pelvic Bones



<http://unitedhipspecialists.com/hip-anatomy.htm>



<http://quizlet.com/4017500/ob-reproduction-and-fetal-development-flash-cards/>

## Pelvic Girdle

- The midline of the pelvic girdle is formed by the sacrum and the coccyx

## Ox Coxae

- ▶ Is found on either side of the midline complex
- ▶ Also referred to as the innominate bone
- ▶ The ox coxae is the result of the fusion of 3 bones, which are separate in children.
- ▶ These bones are the ilium, ischium, and pubis

## Ilium

- ▶ The largest of these bones
- ▶ Forms the superior part of the pelvis
- ▶ Has a ridge which is called the iliac crest
- ▶ Bone is often harvested from this area for bone grafts.

## Ischium

- ▶ Makes up the inferior part of the pelvic girdle

## Pubis

- ▶ The pubis is the anterior part of the pelvic girdle
- ▶ Pubic bones are joined at the midline by a disk of cartilage to form the pubic symphysis
- ▶ Women have wider and shallower pelvic girdles than do men

## Tarsal bones

- ▶ 7 tarsal bones which are arranged in 2 rows
  - ▶ Proximal
  - ▶ Distal

## Proximal Row

- ▶ Calcaneus
- ▶ Talus
- ▶ Navicular

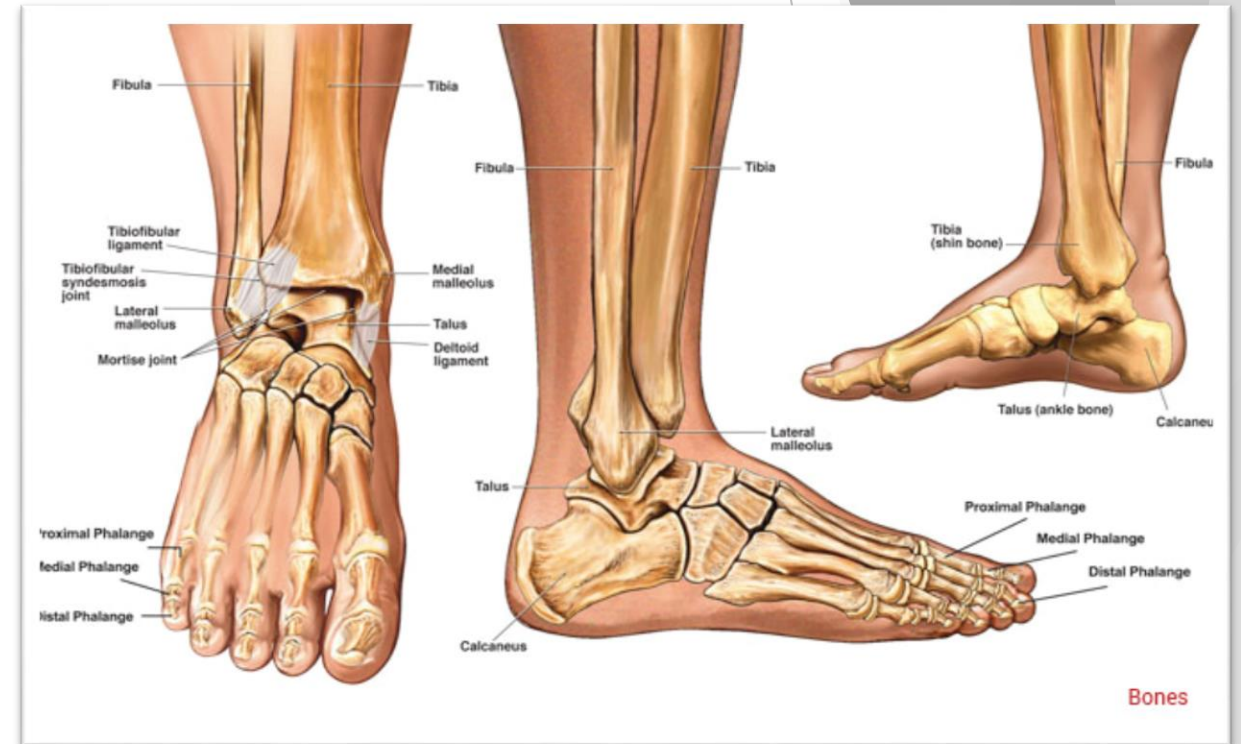
## Distal Row

- ▶ There are 4 bones (from lateral to medial)
- ▶ Cuboid
- ▶ Medial cuneiform
- ▶ Intermediate cuneiform
- ▶ Lateral cuneiform

These bones vary widely in shape and size.

- ▶ The largest of these bones is the calcaneus, or heel bone.

# Ankle and Foot Bones



<http://www.myankle.com/Patient-Education/Anatomy-of-the-Foot-Ankle>

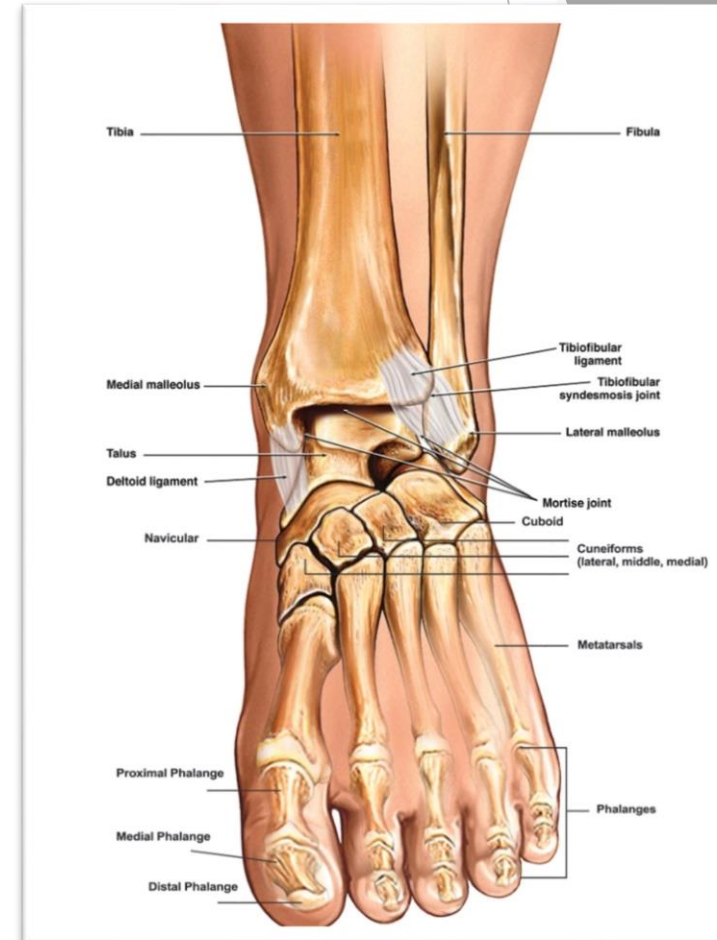
The 5 metatarsals are the equivalent of the metacarpals.

- The metatarsals are numbered with Roman numerals beginning with the big toe
- Metatarsals I, II, and III articulate with the medial, intermediate, and lateral cuneiforms respectively
- Metatarsals IV and V articulate with the cuboid

There are 14 phalanges in the feet.

- The big toe, known as the hallux, consists of 2 phalanges.
- The other toes have 3 phalanges each
- They are numbered as the fingers, beginning with the big toe.

## Ankle and Foot Bones



<http://www.myankle.com/Patient-Education/Anatomy-of-the-Foot-Ankle>

## Tibia

- Commonly called the shinbone
- Larger of the 2 bones in the lower leg
- The weight bearing bone
- Located on the medial side
- On the proximal end of the tibia are the medial and lateral condyles which articulate with the condyles of the femur and form the knee joint
- The knee joint is cushioned by the crescent shaped lateral and medial menisci located on the tibia
- The medial malleolus, on the distal part of the tibia, articulates with the talus bone contributing to the ankle joint

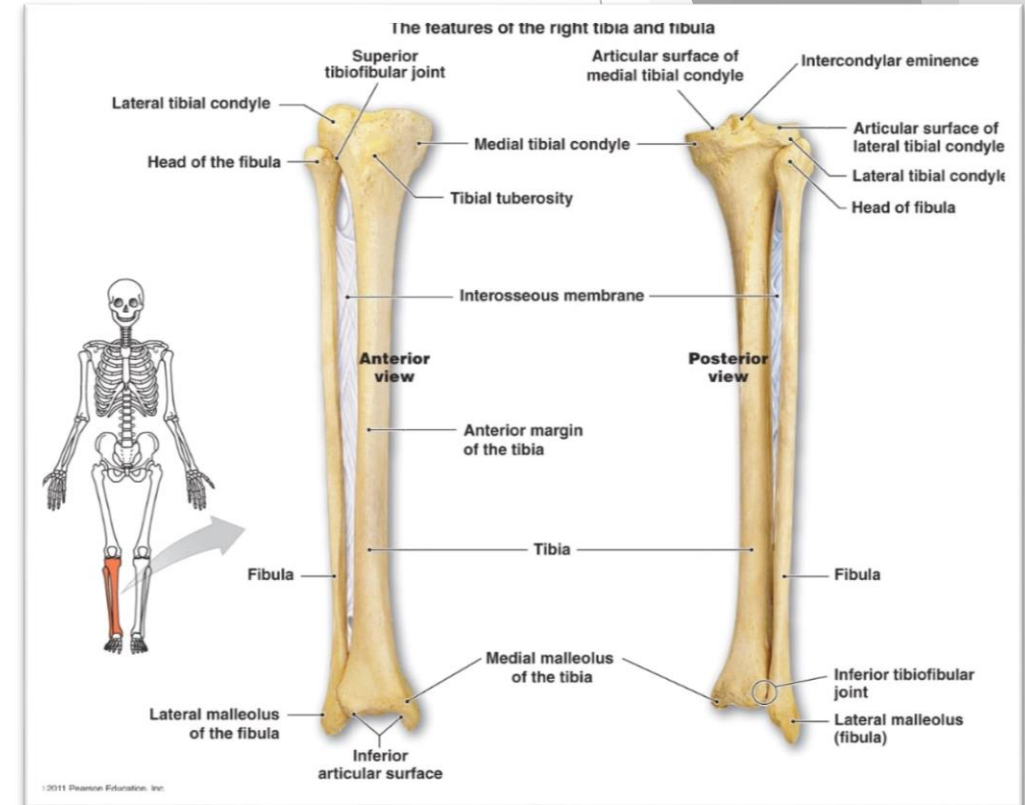
## Fibula

- A thin non-weight-bearing bone
- Serves to stabilize the ankle joint
- The lateral malleolus, on the distal end of the bone, articulates with the talus bone, forming part of the ankle joint

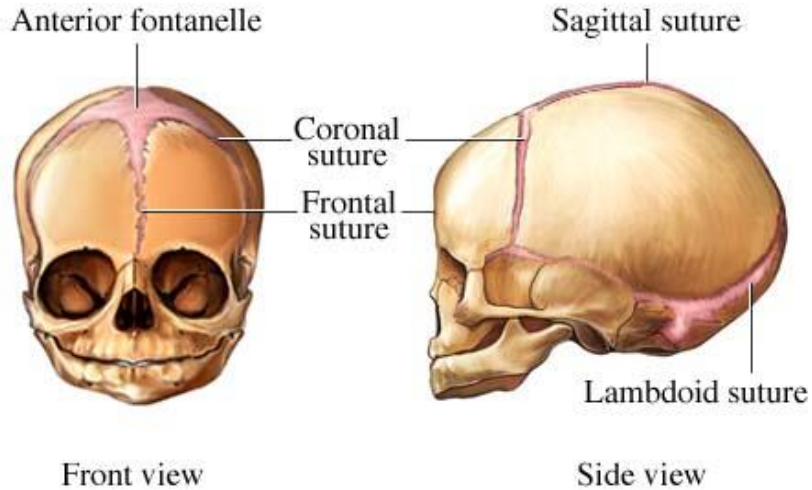
# Tibia and Fibula Bones

## Tibia and fibula

- Long bones

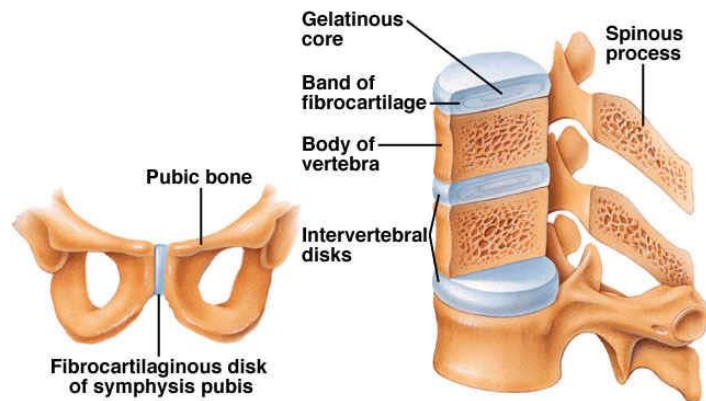


# Joint Types



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## Cartilaginous Joint — Symphysis



Joints are classified according to the way in which they move.

## *Three types of joints*

### Immovable

- An immovable joint is called a **synarthrosis**
- The bones in this type of joint are in close contact, and separated by a thin cartilage
- The cranial bones are separated by immovable joints

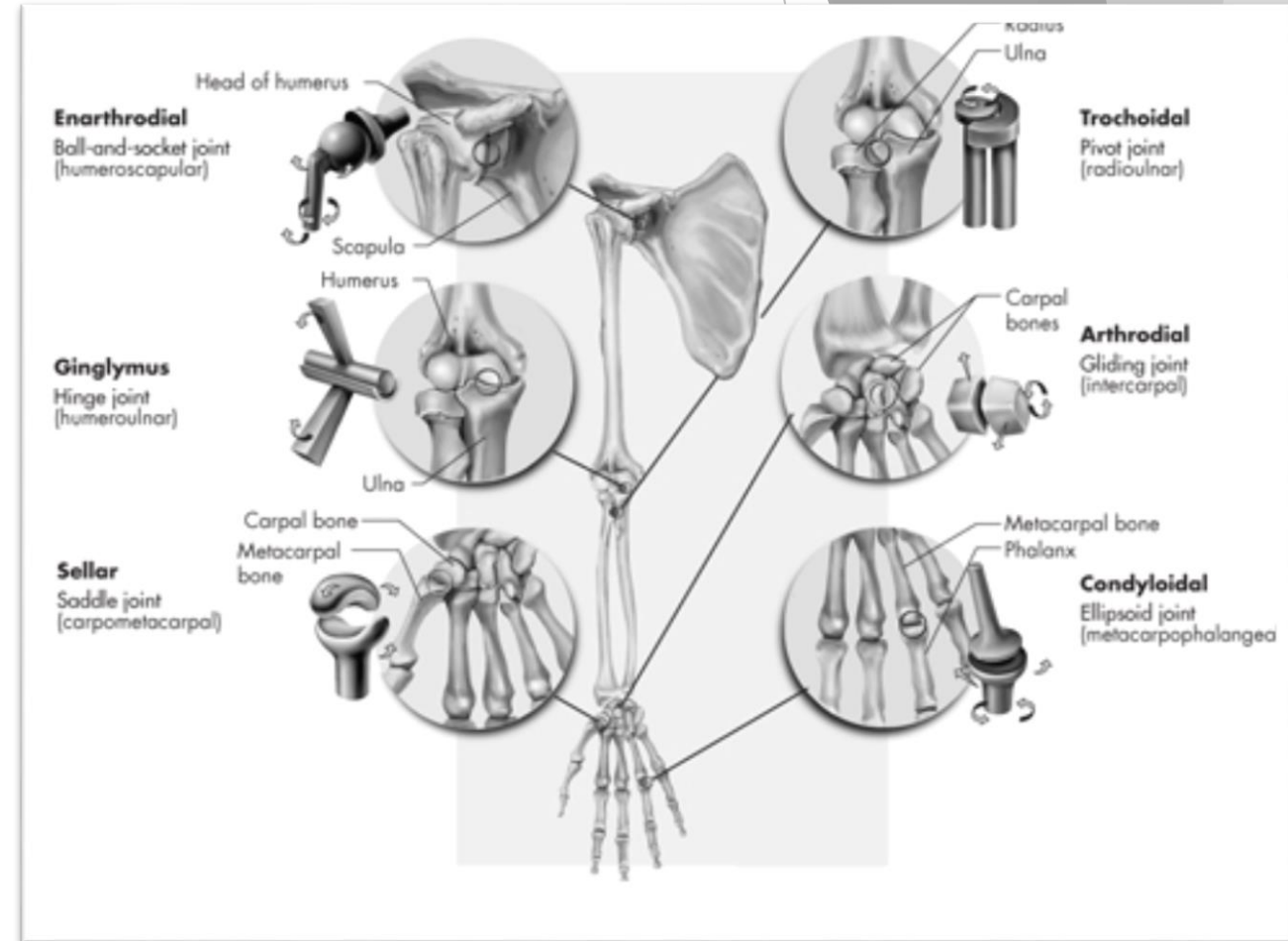
### Slightly movable

- A slightly movable joint is called an **amphiarthrosis**
- The pubic symphysis and the vertebral joints are examples of slightly movable joints

# Joint Types

## Freely movable

- A freely movable joint is called a **diarthrosis**
- Also referred to as a synovial joint
- There are 6 types of movable joints
  1. Ball-and-socket joints
  2. Condyloid joints
  3. Gliding joints
  4. Hinge joints
  5. Pivot joints
  6. Saddle joints



# Joint Types

The **ball-and-socket** joint permits the widest range of motion of all the joint types.

- A ball-shaped head on one bone fits into a cup-shaped socket of another bone
- This joint permits movement in all directions, and rotation
- The hip and shoulder are ball-and-socket joints

The **condyle** of 1 bone fits into the fossa of another bone.

- Example: temporomandibular joint

A **gliding** joint permits twisting, and motion side-to-side.

- The bones in a gliding joint are either flat, or slightly curved
- The carpals of the wrist form a gliding joint

A **hinge** joint allows movement in one direction.

- The concave surface of 1 bone articulates with the concave surface of another bone
- The elbow is a hinge joint

A **pivot** joint permits rotational only.

A **saddle** joint allows movement on a number of planes

