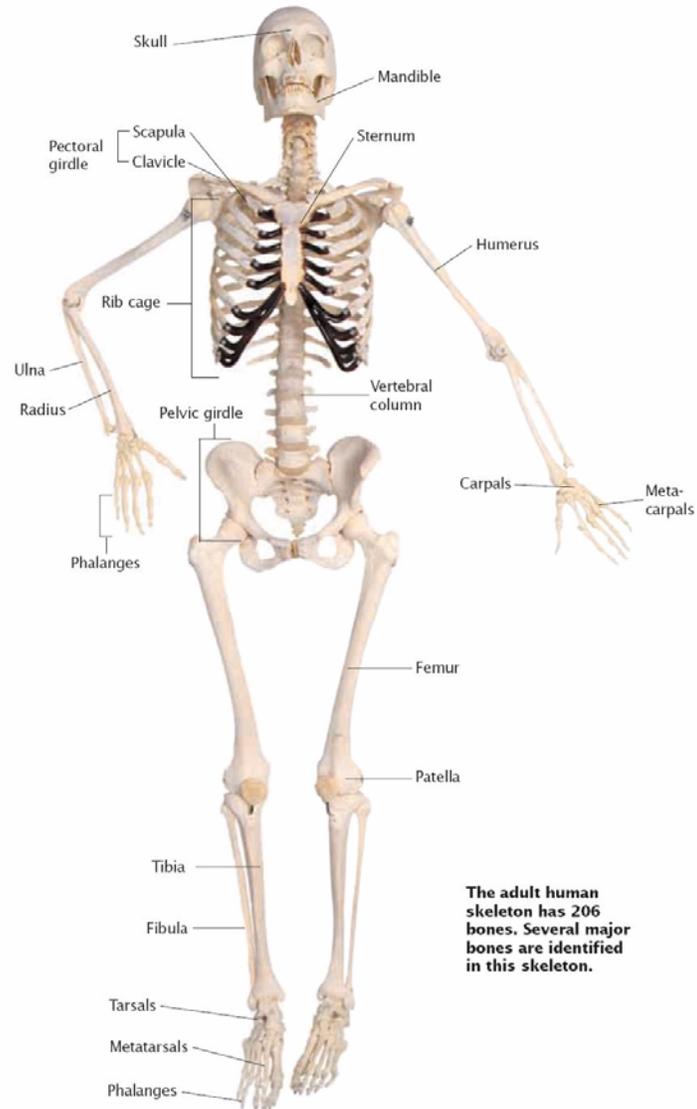


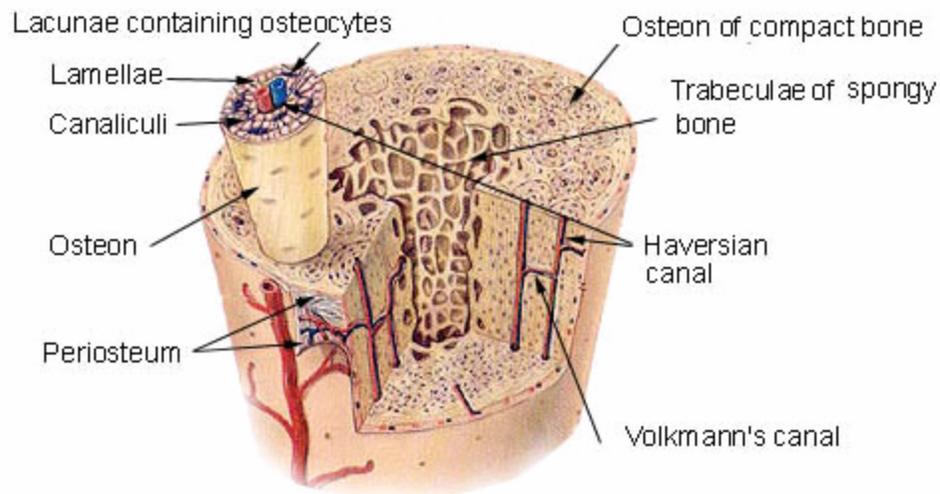
# The Skeleton

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## Human Skeleton



## Compact Bone & Spongy (Cancellous Bone)



### Bone Textures [SEE BONE INTRODUCTION]

- **Compact bone** – dense outer layer
- **Spongy bone** – honeycomb of trabeculae filled with yellow bone marrow

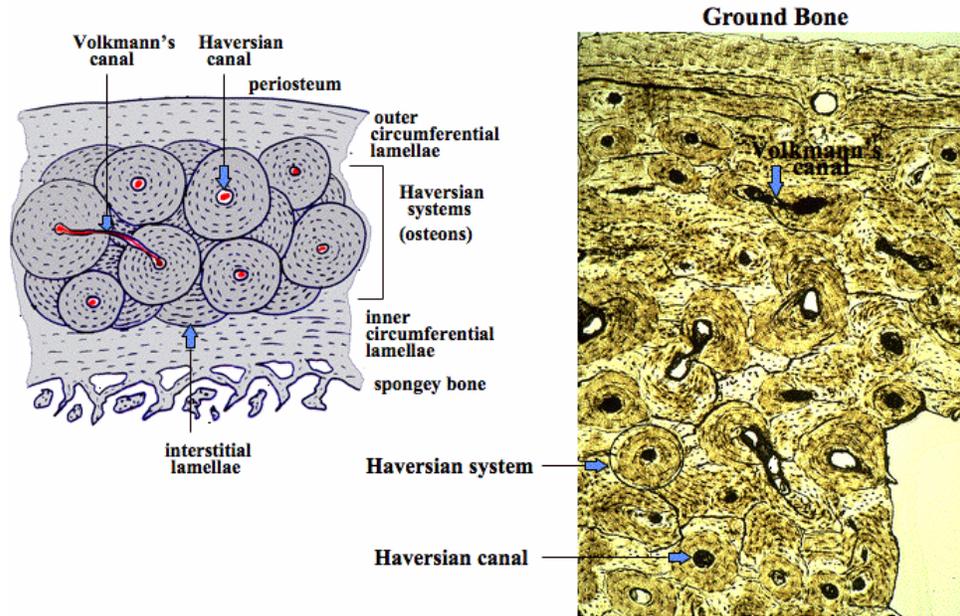
**Compact bone forms the outer shell of all bone and also the shafts in long bones.**

**Spongy bone is found at the expanded heads of long bones and fills most irregular bones.**

**Spongy or cancellous bone consists of a lattice of thin threads of bone called trabeculae**

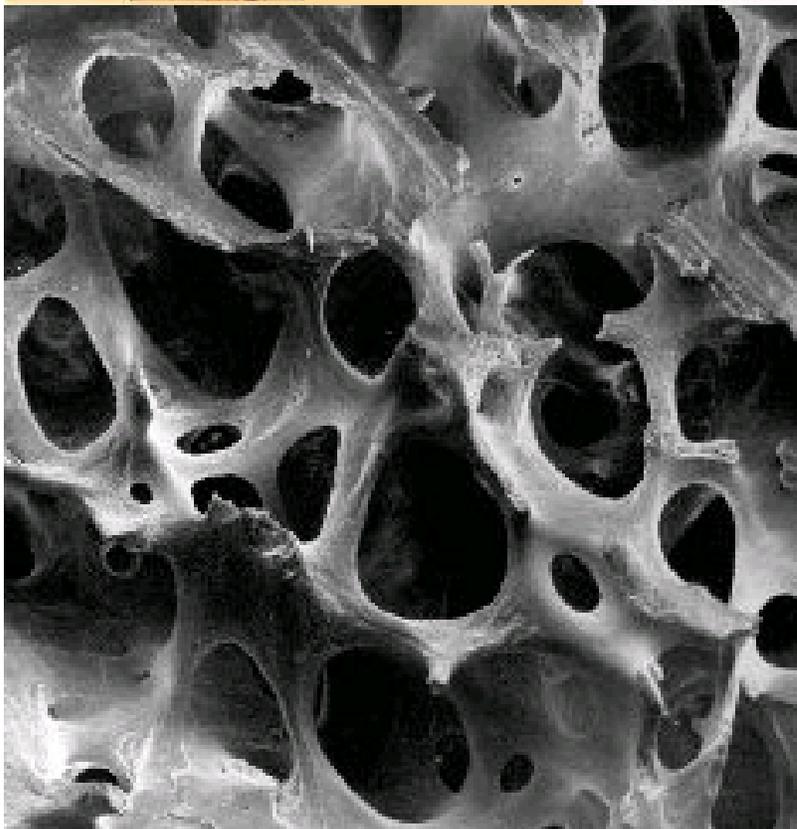
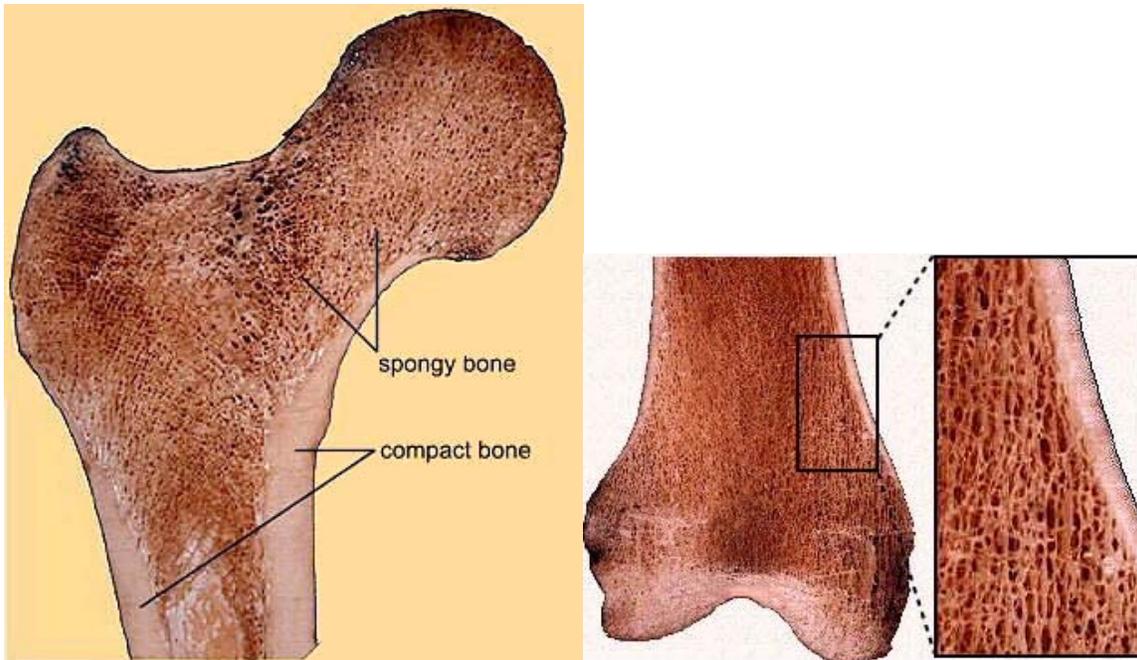
and is less dense than compact bone. The orientation of the trabeculae is affected by the mechanical stress to which the bone is exposed .

## COMPACT BONE



### **COMPACT BONE**

- **Periosteum**
  - Lines external surface of bone
    - 2 layers: fibrous and osteogenic – osteoprogenitors
    -
- **Endosteum**
  - osteoprogenitors, osteoblasts, osteoclasts
  - Lines bone marrow cavity
    - Lines Haversian canal
    -
- **Haversian system (Osteon)**
- **Interstitial lamellae**
  - Oldest bone, remnants of old osteons
  -
- **Inner and outer circumferential lamellae**
- **Volkman's canal**
  - Connects two Haversian canals



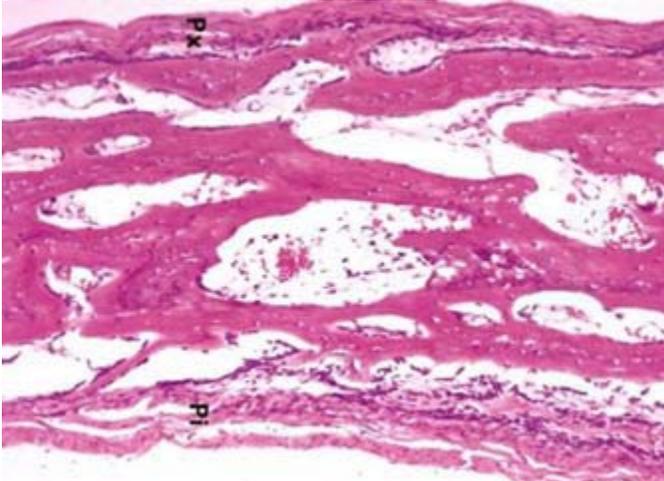
#### **CHARACTERISTICS OF CANCELLOUS BONE**

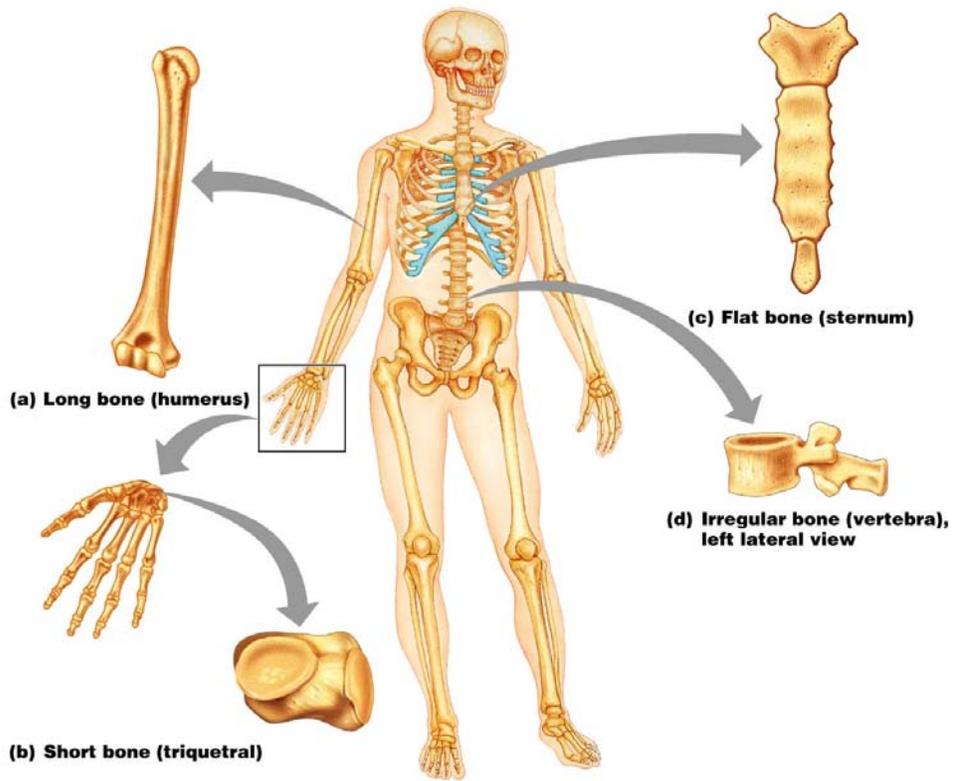
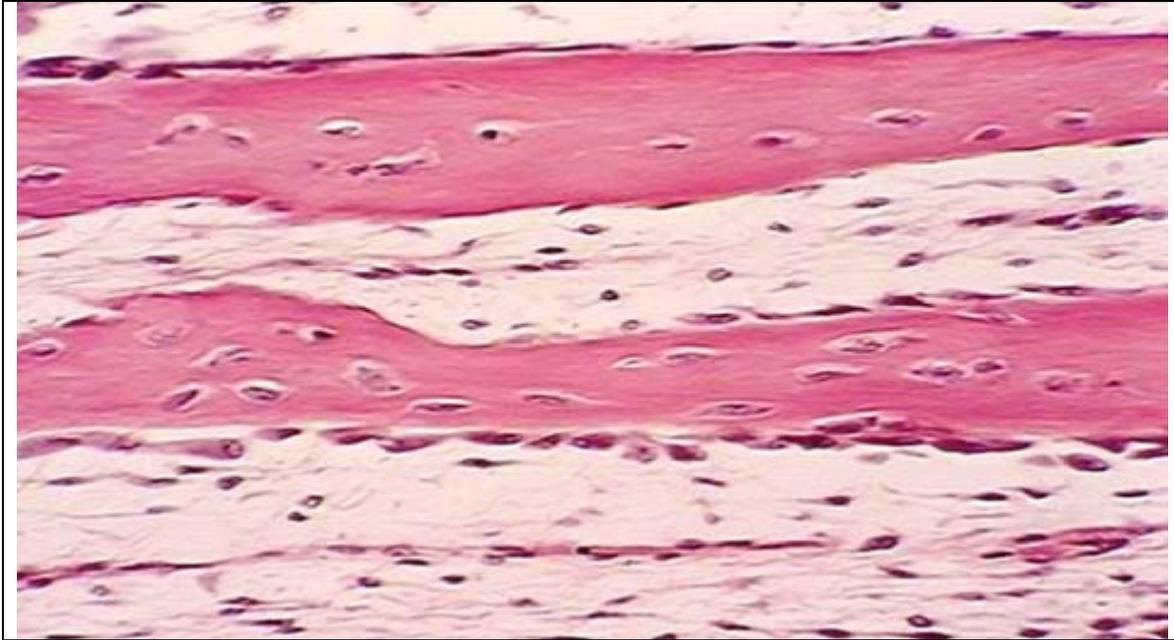
- Also called “spongy bone”
- Branching bony trabeculae and spicules
  - Lined by endosteum
    - Osteoprogenitor cells, osteoblasts, and osteoclasts
  - Bone marrow between adjacent spicules and trabeculae
- Lacks osteons

- Irregular lamellae
- Nutrients diffuse from marrow cavity
- Formed by both endochondral and intramembranous

ossification

- Bounds epiphyseal and diaphyseal surfaces of epiphyseal plate





(a) Long bone (humerus)

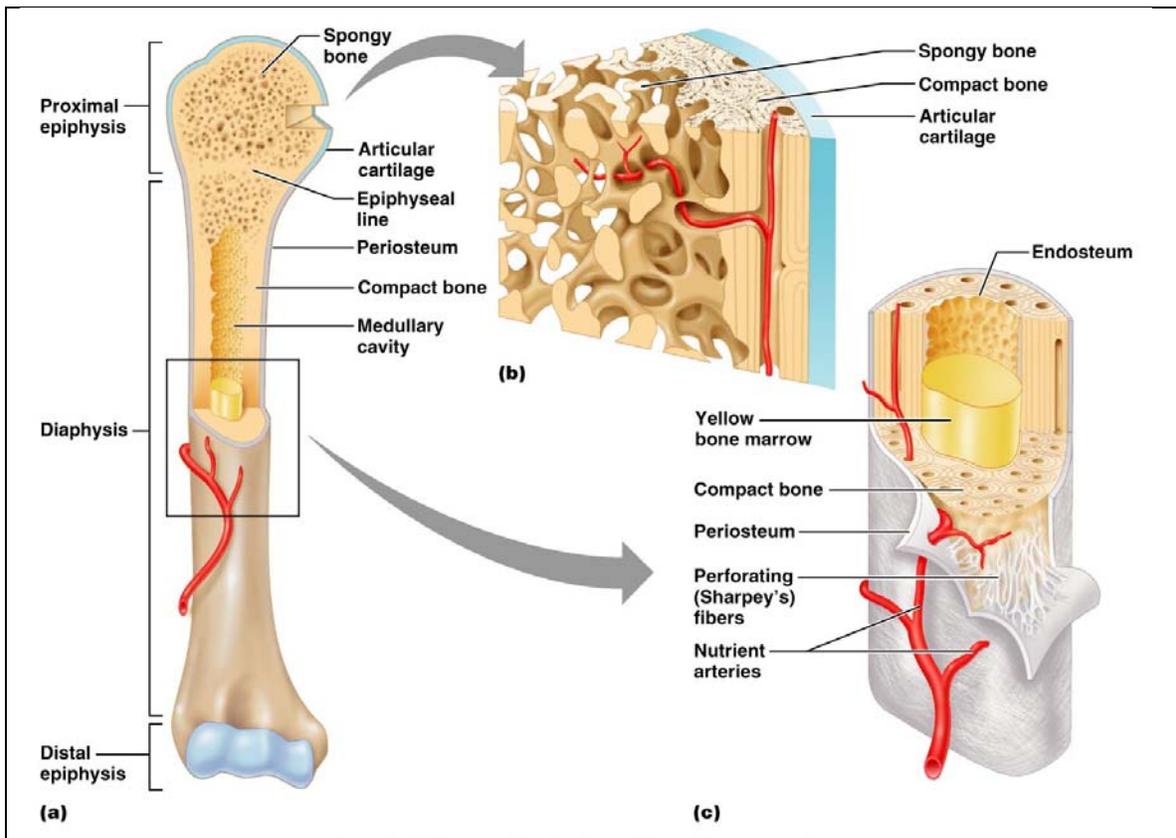
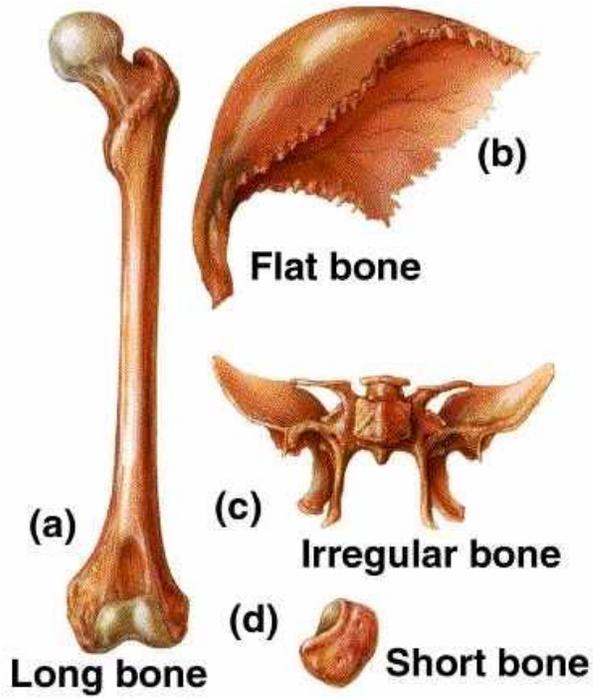
(b) Short bone (triquetral)

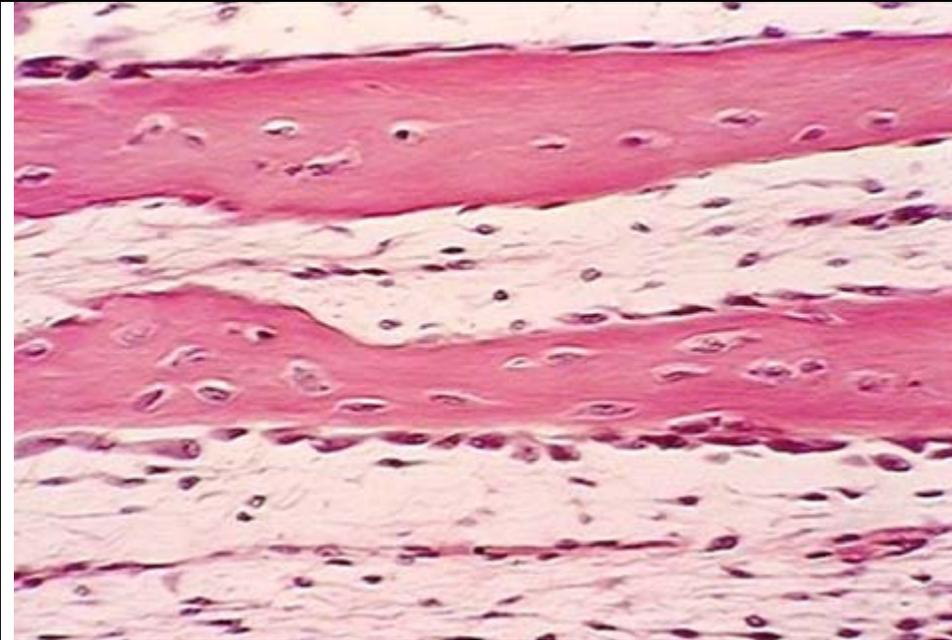
(c) Flat bone (sternum)

(d) Irregular bone (vertebra),  
left lateral view



## Classification of bones





### **Classification of Bones**

- Axial skeleton – **bones of the skull, vertebral column, and rib cage**
- Appendicular skeleton – **bones of the upper and lower limbs, shoulder, and hip**

### **Classification of Bones: By Shape**

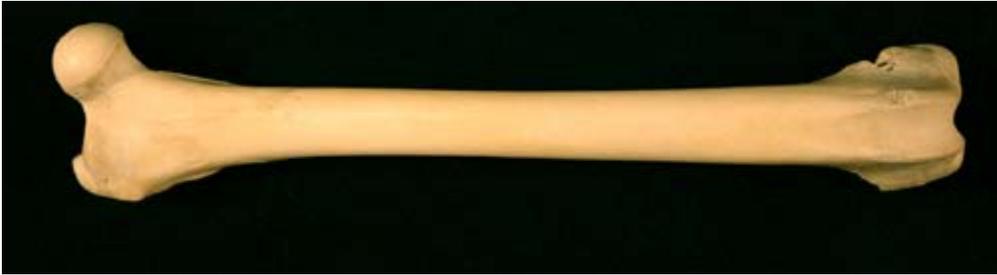
- Long bones – **longer than they are wide**  
(e.g., humerus)
- Short bones
  - Cube-shaped bones of the wrist and ankle
  - Bones that form within tendons (e.g., patella)
- Flat bones – thin, flattened, and a bit curved (e.g., sternum, and most skull bones)
- Irregular bones – bones with complicated shapes (e.g., vertebrae and hip bones)

The skeleton is made up of many bones which change in proportion between man and his close relatives but are easily recognisable. The easiest way to classify bones is by shape.

### **Long bones**

#### **Structure of Long Bone**

- Long bones consist of a diaphysis and an epiphysis
- Diaphysis
  - Tubular shaft that forms the axis of long bones
  - Composed of compact bone that surrounds the medullary cavity
  - Yellow bone marrow (fat) is contained in the medullary cavity
- Epiphyses
  - Expanded ends of long bones
  - Exterior is compact bone, and the interior is spongy bone
  - Joint surface is covered with articular (hyaline) cartilage
  - Epiphyseal line separates the diaphysis from the epiphyses



### Bone Membranes

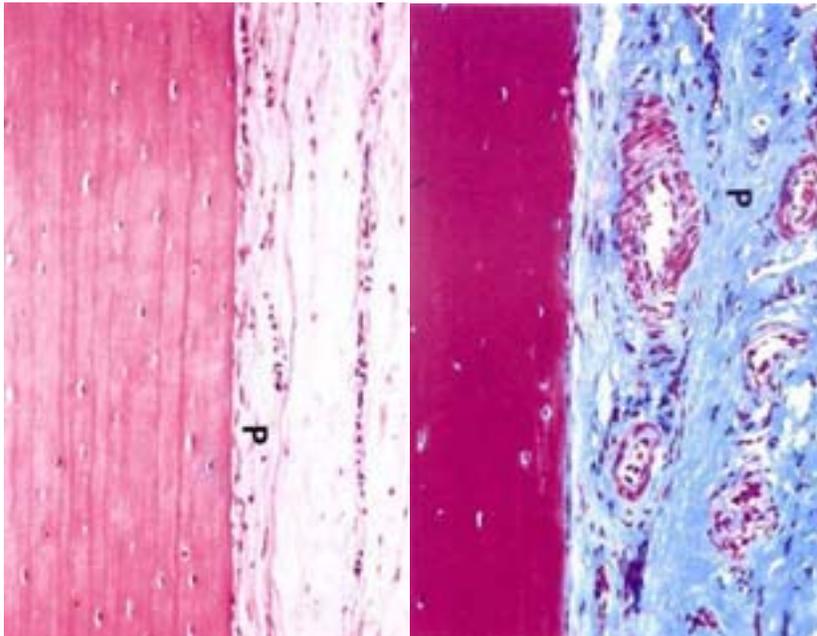
- **Periosteum** – double-layered protective membrane
  - Outer fibrous layer is dense regular connective tissue
  - Inner osteogenic layer is composed of osteoblasts and osteoclasts
  - Richly supplied with nerve fibers, blood, and lymphatic vessels, which enter the bone via nutrient foramina
  - Secured to underlying bone by Sharpey's fibers
  
- **Endosteum** – delicate membrane covering internal surfaces of bone

### PERIOSTEUM

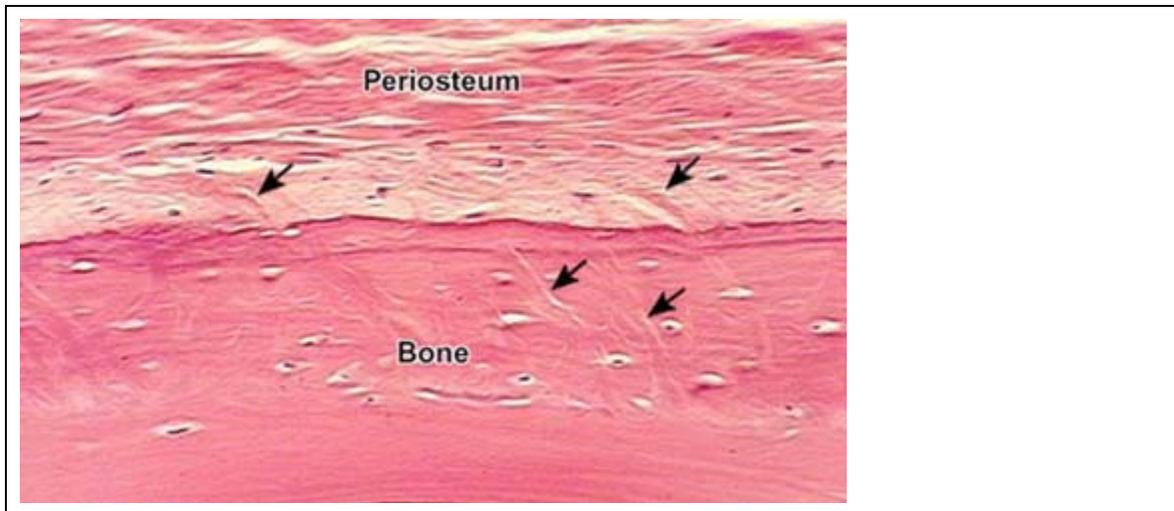
- Connective tissue membrane covering bone
- Active in children because of it's role in the deposition of

cortical bone (growth in bone diameter)

- Resting in adults
- 2 layers:
  - Inner Layer:
    - Osteoprogenitor cells (important in bone repair)
  - Outer Fibrous Layer:
    - Dense fibrous connective tissue
    - Contiguous with joint capsules



### SHARPEY'S FIBERS



### **Structure of Short, Irregular, and Flat Bones**

- Thin plates of periosteum-covered compact bone on the outside with endosteum-covered spongy bone (diploë) on the inside
- Have no diaphysis or epiphyses
- Contain bone marrow between the trabeculae

#### **•Short bones**

Short bones are found in the wrist and ankle, carpals and tarsals respectively.

They have no shaft, as they do not increase dramatically in size in one dimension during growth, and tend to be cuboidal in shape.

They are rather like a Malteser in construction, with cancellous bone in the centre and a hard outer shell of compact bone.

#### **Flat bones**

- Flat bones like those of the cranium or the scapula are sandwiches of spongy bone between two layers of compact bone.
- They are usually curved, so we can refer to an inner and outer table with diploe between them.
- These diploe, especially in the skull, may become pneumatized, i.e. filled with air.
- A ring of facial sinuses around the nose may become infected, leading to sinusitis.



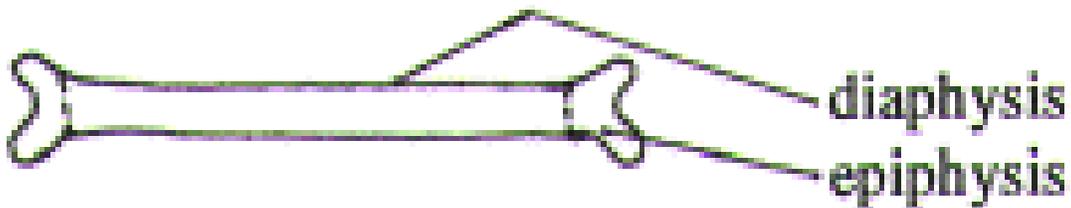
### Irregular bones

•Any bones which don't fit these arbitrary categories (bones of the face, vertebrae) are referred to as irregular.

### Sesamoid

•Sesamoid bones are interesting because they **occur in tendon**, especially where a tendon turns a corner, and is thus exposed to friction.

1) Spongy (Cancellous) Bone = consists of a latticework of slender trabeculae enclosing large numbers of marrow cavities; found in flat bones of the skull, sternum and epiphysis of long bones



- Blood cells and red bone marrow found in marrow cavities

2) Compact Bone = lamellar bone made of osteons (Haversian Systems) = concentric layers of bone surrounding central Haversian canal; small amount of soft tissue present



- Haversian Canals = carry nerves, blood and lymph vessels along longitudinal plane of bone

- Volkman's Canals = carry nerves, blood and lymph vessels between marrow cavity, Haversian systems, and periosteum

- Sharpey's Fibers = direct extensions of dense irregular CT from periosteum into compact bone. Functions to anchor tendon (with fibers penetrating periosteum to bone) to bone. Formation by appositional bone growth around original attachment site.

- Transition between compact bone and periosteum:

1) outer bone layers = outer circumferential lamellae, enclose entire bone

2) Periosteum outside of circumferential lamellae - 2 zones:

a) Osteogenic Zone = gives rise to osteogenic cells

b) Fibrous Zone = dense irregular CT

### Surface markings of bone.

- In places, like joint surfaces, the bone will be covered with smooth articular cartilage.
- Bone is constantly growing or being reshaped, and this takes place on the surface.
- At high magnification we can see, in a dried bone, what it was up to the point of death. This picture shows a hole for a blood vessel, a foramen.
- Around roughly half its diameter the collagenous bone is rough, the other half smooth.
- The rough is resorbing bone, being eaten by large osteoclasts which leave pits and the smooth is depositional, bone being formed. This indicates that the foramen was on the move as the bone grew.
- Other areas also show deposition and resorption: these would be building up and hollowing out respectively. On a macroscopic scale these effects can be seen as points of attachment to the bone - of ligaments, tendons or the fibrous insertions of muscles.
- All these structures transmit forces, and demand a well organised junction.
- Any part of this structure which has deposited calcium will appear as a bit of bone. Within the bone we often see rows of trabeculae or thick ropes of collagen, Sharpey's fibres running across the marrow cavity to insert in the cortical bone opposite.
- Blood vessels and nerves similarly have canals.

▪The various lumps for fixing things to have different names according to shape, usually derived from a dead language. There are lots of these, but common ones are:

- lumps and bumps
- process
- spine - if sharp
- tubercle - if rounded
- cornu - if horn shaped
- hamulus - if hooked
- crest - ridge
- line - low ridge
- depressions and holes
- sulcus - groove
- canal - tunnel
- foramen - hole
- fossa - depression
- articular surfaces
- facet - if small
- condyle - if rounded
- epicondyle - if near a condyle
- trochlea - if pulley shaped

**TABLE 6.1 Bone Markings**

<b>NAME OF BONE MARKING</b>	<b>DESCRIPTION</b>
<b>PROJECTIONS THAT ARE SITES OF MUSCLE AND LIGAMENT ATTACHMENT</b>	
Tuberosity (too"bĕ-ros'ĩ-te)	Large rounded projection; may be roughened
Crest	Narrow ridge of bone; usually prominent
Trochanter (tro-kan'ter)	Very large, blunt, irregularly shaped process (the only examples are on the femur)
Line	Narrow ridge of bone; less prominent than a crest
Tubercle (too'ber-kl)	Small rounded projection or process
Epicondyle (ep"ĩ-kon'dĩl)	Raised area on or above a condyle
Spine	Sharp, slender, often pointed projection
Process	Any bony prominence

**TABLE 6.1 Bone Markings (continued)**

NAME OF BONE MARKING	DESCRIPTION
<b>PROJECTIONS THAT HELP TO FORM JOINTS</b>	
Head	Bony expansion carried on a narrow neck
Facet	Smooth, nearly flat articular surface
Condyle (kon'dīl)	Rounded articular projection
Ramus (ra'mus)	Armlike bar of bone
<b>DEPRESSIONS AND OPENINGS ALLOWING BLOOD VESSELS AND NERVES TO PASS</b>	
Meatus (me-a'tus)	Canal-like passageway
Sinus	Cavity within a bone, filled with air and lined with mucous membrane
Fossa (fos'ah)	Shallow, basinlike depression in a bone, often serving as an articular surface
Groove	Furrow
Fissure	Narrow, slitlike opening
Foramen (fo-ra'men)	Round or oval opening through a bone

**Bony Landmarks**

*Depressions and Openings*

- **Foramen** - hole in bone for nerves, vessels, etc...
- **Fissure** - narrow opening between bones (cleft)
- **Fossa** - depression in or on a bone
- **Sinus** - cavity

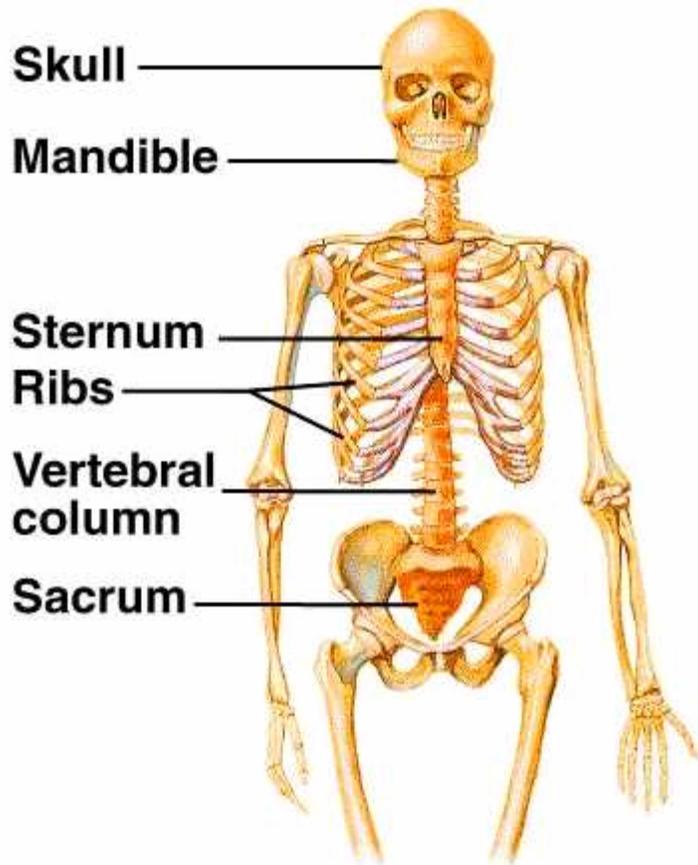
*Process - any kind of projection*

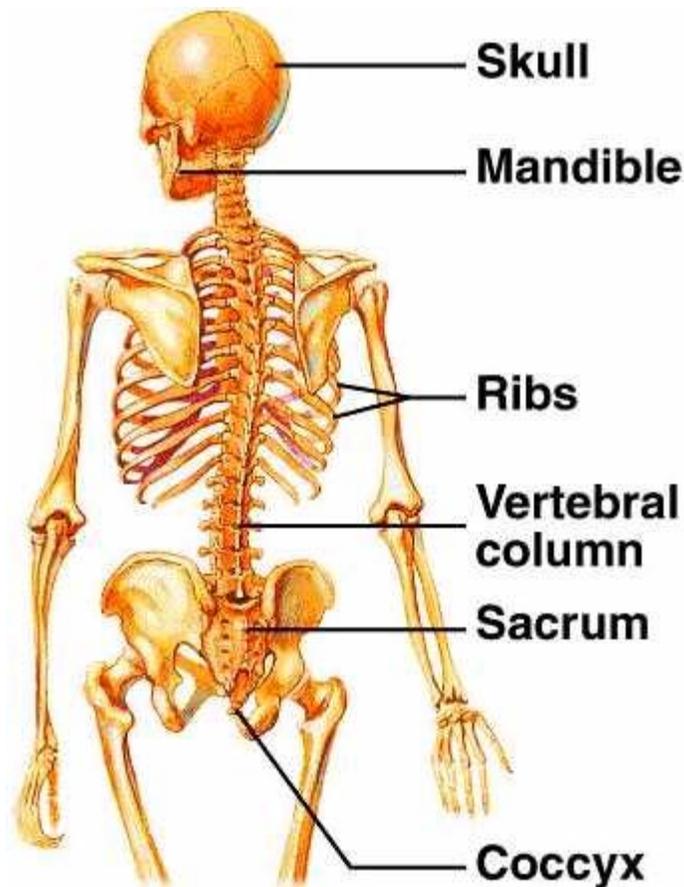
- **Condyle** - large rounded projection, fits into a joint
- **Head** - rounded part that fits into a joint, has an anatomical neck

- **Facet** - smooth flat surface
- **Tubercle** - small round process
- **Tuberosity** - large, round, rough
- **Trochanter** - large, blunt projection (only on femur)
- **Crest** - prominent ridge
- **Line/Linea** - less prominent ridge than a crest
- **Spinous Process** -sharp slender process
- **Epicondyle** - above a condyle

### **The Axial Skeleton**

- Eighty bones segregated into three regions
  - Skull
  - Vertebral column
  - Bony thorax
- Axial Skeleton - "central skeleton" (skull, vertebrae, sternum, and ribs), ~80 bones
- vertebral column = 26 bones, ribs = 24 bones, sternum, hyoid, cranium = 8 bones, facial = 14 bones, auditory ossicles = 6 bones





### **Bones of the Axial Skeleton**

#### **The Skull**

- The skull, the body's most complex bony structure, is formed by the cranium and facial bones
- Cranium – protects the brain and is the site of attachment for head and neck muscles
- Facial bones
  - Supply the framework of the face, the sense organs, and the teeth
  - Provide openings for the passage of air and food
  - Anchor the facial muscles of expression

#### **Anatomy of the Cranium**

- Eight cranial bones – two parietal, two temporal, frontal, occipital, sphenoid, and ethmoid
- Cranial bones are thin and remarkably strong for their weight

#### **Frontal Bone**

- Forms the anterior portion of the cranium
- Articulates posteriorly with the parietal bones via the coronal suture
- Major markings include the supraorbital margins, the anterior cranial fossa, and the frontal sinuses (internal and lateral to the glabella)

#### **Parietal Bones and Major Associated Sutures**

- Form most of the superior and lateral aspects of the skull
- Four sutures mark the articulations of the parietal bones

- Coronal suture – articulation between parietal bones and frontal bone anteriorly
- Sagittal suture – where right and left parietal bones meet superiorly
- Lambdoid suture – where parietal bones meet the occipital bone posteriorly
- Squamosal or squamous suture – where parietal and temporal bones meet

### **Occipital Bone and Its Major Markings**

- Forms most of skull's posterior wall and base
- Major markings include the posterior cranial fossa, foramen magnum, occipital condyles, and the hypoglossal canal

### **Temporal Bones**

- Form the inferolateral aspects of the skull and parts of the cranial floor
- Divided into four major regions – squamous, tympanic, mastoid, and petrous
- Major markings include the zygomatic, styloid, and mastoid processes, and the mandibular and middle cranial fossae
- Major openings include the stylomastoid and jugular foramina, the external and internal auditory meatuses, and the carotid canal

### **Sphenoid Bone**

- Butterfly-shaped bone that spans the width of the middle cranial fossa
- Forms the central wedge that articulates with all other cranial bones
- Consists of a central body, greater wings, lesser wings, and pterygoid processes
- Major markings: the sella turcica, hypophyseal fossa, and the pterygoid processes
- Major openings include the foramina rotundum, ovale, and spinosum; the optic canals; and the superior orbital fissure

### **Ethmoid Bone**

- Most deep of the skull bones; lies between the sphenoid and nasal bones
- Forms most of the bony area between the nasal cavity and the orbits
- Major markings include the cribriform plate, crista galli, perpendicular plate, nasal conchae, and the ethmoid sinuses

### **Wormian Bones**

- Tiny irregularly shaped bones that appear within sutures

### **Facial Bones**

- Fourteen bones of which only the mandible and vomer are unpaired
- The paired bones are the maxillae, zygomatics, nasals, lacrimals, palatines, and inferior conchae

### **Mandible and Its Markings**

- The mandible (lower jawbone) is the largest, strongest bone of the face
- Its major markings include the coronoid process, mandibular condyle, the alveolar margin, and the mandibular and mental foramina

### **Maxillary Bones**

- Medially fused bones that make up the upper jaw and the central portion of the facial skeleton
- Facial keystone bones that articulate with all other facial bones except the mandible
- Their major markings include palatine, frontal, and zygomatic processes, the alveolar margins, inferior orbital fissure, and the maxillary sinuses

### **Zygomatic Bones**

- Irregularly shaped bones (cheekbones) that form the prominences of the cheeks and the inferolateral margins of the orbits

### **Other Facial Bones**

- Nasal bones – thin medially fused bones that form the bridge of the nose
- Lacrimal bones – contribute to the medial walls of the orbit and contain a deep groove called the lacrimal fossa that houses the lacrimal sac
- Palatine bones – two bone plates that form portions of the hard palate, the posterolateral walls of the nasal cavity, and a small part of the orbits
- Vomer – plow-shaped bone that forms part of the nasal septum
- Inferior nasal conchae – paired, curved bones in the nasal cavity that form part of the lateral walls of the nasal cavity

### **Orbits**

- Bony cavities in which the eyes are firmly encased and cushioned by fatty tissue
- Formed by parts of seven bones – frontal, sphenoid, zygomatic, maxilla, palatine, lacrimal, and ethmoid

### **Nasal Cavity**

- Constructed of bone and hyaline cartilage
- Roof – formed by the cribriform plate of the ethmoid
- Lateral walls – formed by the superior and middle conchae of the ethmoid, the perpendicular plate of the palatine, and the inferior nasal conchae
- Floor – formed by palatine process of the maxillae and palatine bone

### **Paranasal Sinuses**

- Mucosa-lined, air-filled sacs found in five skull bones – the frontal, sphenoid, ethmoid, and paired maxillary bones
- Air enters the paranasal sinuses from the nasal cavity and mucus drains into the nasal cavity from the sinuses
- Lighten the skull and enhance the resonance of the voice

### **Hyoid Bone**

- Not actually part of the skull, but lies just inferior to the mandible in the anterior neck
- Only bone of the body that does not articulate directly with another bone
- Attachment point for neck muscles that raise and lower the larynx during swallowing and speech

### **Vertebral Column**

- Formed from 26 irregular bones (vertebrae) connected in such a way that a flexible curved

structure results

- Cervical vertebrae – 7 bones of the neck
- Thoracic vertebrae – 12 bones of the torso
- Lumbar vertebrae – 5 bones of the lower back
- Sacrum – bone inferior to the lumbar vertebrae that articulates with the hip bones

### **Vertebral Column: Curvatures**

- Posteriorly concave curvatures – cervical and lumbar
- Posteriorly convex curvatures – thoracic and sacral
- Abnormal spine curvatures include scoliosis (abnormal lateral curve), kyphosis (hunchback), and lordosis (swayback)

### **Vertebral Column: Ligaments**

- Anterior and posterior longitudinal ligaments – continuous bands down the front and back of the spine from the neck to the sacrum
- Short ligaments connect adjoining vertebrae together

### **Vertebral Column: Intervertebral Discs**

- Cushion-like pad composed of two parts
  - Nucleus pulposus – inner gelatinous nucleus that gives the disc its elasticity and compressibility
  - Annulus fibrosus – surrounds the nucleus pulposus with a collar composed of collagen and fibrocartilage

### **General Structure of Vertebrae**

- Body or centrum – disc-shaped, weight-bearing region
- Vertebral arch – composed of pedicles and laminae that, along with the centrum, enclose the vertebral foramen
- Vertebral foramina – make up the vertebral canal through which the spinal cord passes
- Spinous processes project posteriorly, and transverse processes project laterally
- Superior and inferior articular processes – protrude superiorly and inferiorly from the pedicle-lamina junctions
- Intervertebral foramina – lateral openings formed from notched areas on the superior and inferior borders of adjacent pedicles

### **Cervical Vertebrae**

- Seven vertebrae (C<sub>1</sub>-C<sub>7</sub>) are the smallest, lightest vertebrae
- C<sub>3</sub>-C<sub>7</sub> are distinguished with an oval body, short spinous processes, and large, triangular vertebral foramina
- Each transverse process contains a transverse foramen

### **Cervical Vertebrae: The Atlas (C<sub>1</sub>)**

- The atlas has no body and no spinous process
- It consists of anterior and posterior arches, and two lateral masses
- The superior surfaces of lateral masses articulate with the occipital condyles

### **Cervical Vertebrae: The Axis (C<sub>2</sub>)**

- The axis has a body, spine, and vertebral arches as do other cervical vertebrae
- Unique to the axis is the dens, or odontoid process, which projects superiorly from the body

- and is cradled in the anterior arch of the atlas
- The dens is a pivot for the rotation of the atlas

### **Thoracic Vertebrae**

- There are twelve vertebrae (T<sub>1</sub>-T<sub>12</sub>) all of which articulate with ribs
- Major markings include two facets and two demifacets on the heart-shaped body, the circular vertebral foramen, transverse processes, and a long spinous process
- The location of the articulate facets prevents flexion and extension, but allows rotation of this area of the spine

### **Lumbar Vertebrae**

- The five lumbar vertebrae (L<sub>1</sub>-L<sub>5</sub>) are located in the small of the back and have an enhanced weight-bearing function
- They have short, thick pedicles and laminae, flat hatchet-shaped spinous processes, and a triangular-shaped vertebral foramen
- Orientation of articular facets locks the lumbar vertebrae together to provide stability

### **Sacrum**

- Sacrum
  - Consists of five fused vertebrae (S<sub>1</sub>-S<sub>5</sub>), which shape the posterior wall of the pelvis
  - It articulates with L<sub>5</sub> superiorly, and with the auricular surfaces of the hip bones
  - Major markings include the sacral promontory, transverse lines, alae, dorsal sacral foramina, sacral canal, and sacral hiatus

### **Coccyx**

- Coccyx (Tailbone)
  - The coccyx is made up of four (in some cases three to five) fused vertebrae that articulate superiorly with the sacrum

### **Bony Thorax (Thoracic Cage)**

- The thoracic cage is composed of the thoracic vertebrae dorsally, the ribs laterally, and the sternum and costal cartilages anteriorly
- Functions
  - Forms a protective cage around the heart, lungs, and great blood vessels
  - Supports the shoulder girdles and upper limbs
  - Provides attachment for many neck, back, chest, and shoulder muscles
  - Uses intercostal muscles to lift and depress the thorax during breathing

### **Sternum (Breastbone)**

- A dagger-shaped, flat bone that lies in the anterior midline of the thorax
- Results from the fusion of three bones – the superior manubrium, the body, and the inferior xiphoid process
- Anatomical landmarks include the jugular (suprasternal) notch, the sternal angle, and the xiphisternal joint

## **Ribs**

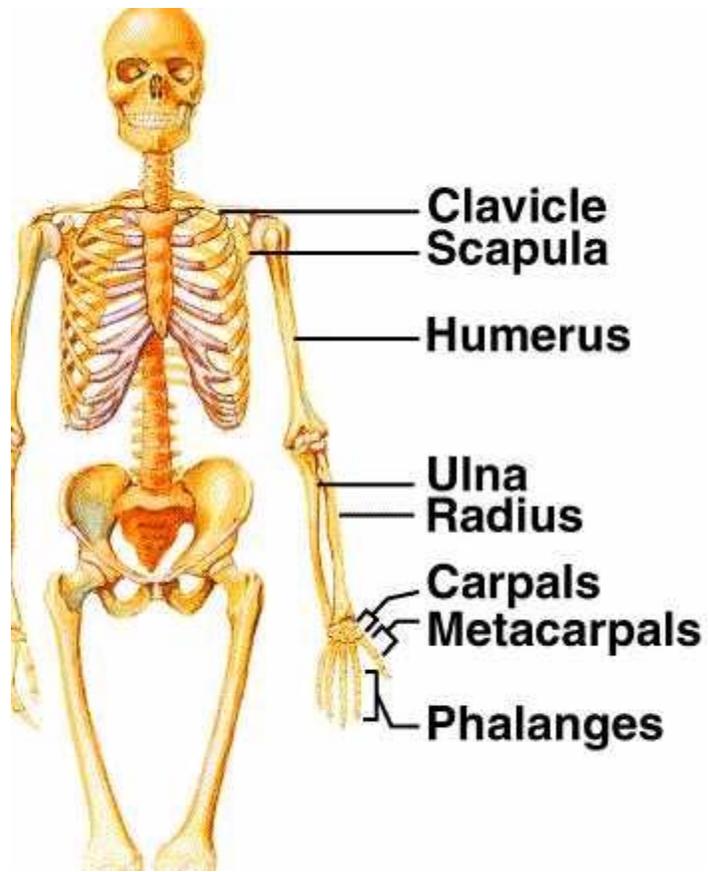
- There are twelve pair of ribs forming the flaring sides of the thoracic cage
- All ribs attach posteriorly to the thoracic vertebrae
- The superior 7 pair (true, or vertebrosteral ribs) attach directly to the sternum via costal cartilages
- Ribs 8-10 (false, or vertebrocondral ribs) attach indirectly to the sternum via costal cartilage
- Ribs 11-12 (floating, or vertebral ribs) have no anterior attachment

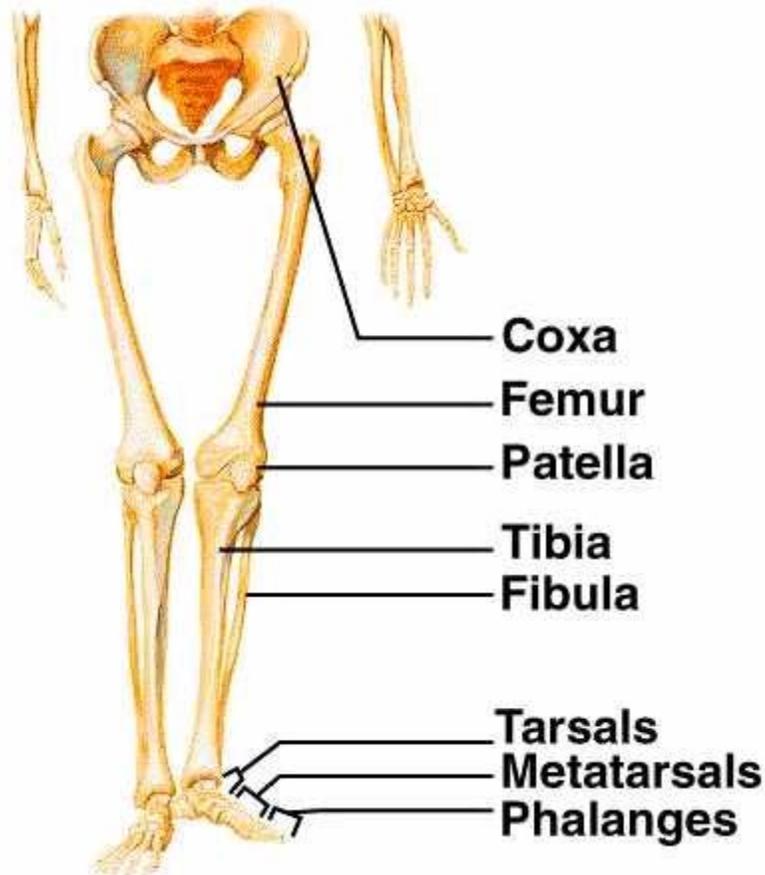
## **Structure of a Typical True Rib**

- Bowed, flat bone consisting of a head, neck, tubercle, and shaft

## **Appendicular Skeleton**

- The appendicular skeleton is made up of the bones of the limbs and their girdles
- Pectoral girdles attach the upper limbs to the body trunk
- Pelvic girdle secures the lower limbs
- Appendicular Skeleton - "girdles and appendages", ~126 bones
  - shoulder girdle = 4 bones, upper limbs = 60 bones, pelvic girdle = 2 bones, lower limbs = 60 bones





**Pectoral Girdles (Shoulder Girdles)**

- The pectoral girdles consist of the anterior clavicles and the posterior scapulae
- They attach the upper limbs to the axial skeleton in a manner that allows for maximum movement
- They provide attachment points for muscles that move the upper limbs

**Clavicles (Collarbones)**

- Slender, doubly curved long bones lying across the superior thorax
- The acromial (lateral) end articulates with the scapula, and the sternal (medial) end articulates with the sternum
- Provide attachment points for numerous muscles, and act as braces to hold the scapulae and arms out laterally away from the body

**Scapulae (Shoulder Blades)**

- Triangular, flat bones lying on the dorsal surface of the rib cage, between the second and seventh ribs
- Scapulae have three borders and three angles
- Major markings include the suprascapular notch, the supraspinous and infraspinous fossae, the spine, the acromion, and the coracoid process

**The Upper Limb**

- The upper limb consists of the arm (brachium), forearm (antebrachium), and hand (manus)
- Thirty-seven bones form the skeletal framework of each upper limb

**Arm**

- The humerus is the sole bone of the arm
- It articulates with the scapula at the shoulder, and the radius and ulna at the elbow

- Major markings
  - Proximal humerus includes the head, anatomical and surgical necks, greater and lesser tubercles, and the intertubercular groove
  - Distal humerus includes the capitulum, trochlea, medial and lateral epicondyles, and the coronoid and olecranon fossae
  - Medial portion includes the radial groove and the deltoid process

### **Forearm**

- The bones of the forearm are the radius and ulna
- They articulate proximally with the humerus and distally with the wrist bones
- They also articulate with each other proximally and distally at small radioulnar joints
- Interosseous membrane connects the two bones along their entire length

### **Bones of the Forearm**

#### **Ulna**

- The ulna lies medially in the forearm and is slightly longer than the radius
- Forms the major portion of the elbow joint with the humerus
- Its major markings include the olecranon, coronoid process, trochlear notch, radial notch, and the styloid process

#### **Radius**

- The radius lies opposite (lateral to) the ulna and is thin at its proximal end, widened distally
- The superior surface of the head articulates with the capitulum of the humerus
- Medially, the head articulates with the radial notch of the ulna
- Major markings include the radial tuberosity, ulnar notch, and styloid process

#### **Hand**

- Skeleton of the hand contains wrist bones (carpals), bones of the palm (metacarpals), and bones of the fingers (phalanges)

#### **Carpus (Wrist)**

- Consists of eight bones
  - Scaphoid, lunate, triquetral, and pisiform proximally
  - Trapezium, trapezoid, capitate, and hamate distally

#### **Metacarpus (Palm)**

- Five numbered (1-5) metacarpal bones radiate from the wrist to form the palm
  - Their bases articulate with the carpals proximally, and with each other medially and laterally
  - Heads articulate with the phalanges

#### **Phalanges (Fingers)**

- Each hand contains 14 miniature long bones called phalanges
- Fingers (digits) are numbered 1-5, beginning with the thumb (pollex)
- Each finger (except the thumb) has three phalanges – distal, middle, and proximal

- The thumb has no middle phalanx

### **Pelvic Girdle (Hip)**

- The hip is formed by a pair of hip bones (os coxae, or coxal)
- Together with the sacrum and the coccyx, these bones form the bony pelvis

The pelvis

- Attaches the lower limbs to the axial skeleton with the strongest ligaments of the body
- Transmits weight of the upper body to the lower limbs
- Supports the visceral organs of the pelvis

### **Ilium**

- The ilium is a large flaring bone that forms the superior region of the coxal bone
- It consists of a body and a superior winglike portion called the ala
- The broad posterolateral surface is called the gluteal surface
- The auricular surface articulates with the sacrum (sacroiliac joint)
- Major markings include the iliac crests, four spines, greater sciatic notch, iliac fossa, arcuate line, and the pelvic brim

### **Ischium**

- The ischium forms the posteroinferior part of the hip bone
- The thick body articulates with the ilium, and the thinner ramus articulates with the pubis
- Major markings include the ischial spine, lesser sciatic notch, and the ischial tuberosity

### **Pubis**

- The pubic bone forms the anterior portion of the hip bone
- It articulates with the ischium and the ilium
- Major markings include superior and inferior rami, the pubic crest, pubic tubercle, pubic arch, pubic symphysis, and obturator foramen (along with ilium and ischium)

### **Comparison of Male and Female Pelvic Structure**

- Female pelvis
  - Tilted forward, adapted for childbearing
  - True pelvis defines birth canal
  - Cavity of the true pelvis is broad, shallow, and has greater capacity
- Male pelvis
  - Tilted less forward
  - Adapted for support of heavier male build and stronger muscles
  - Cavity of true pelvis is narrow and deep

### **The Lower Limb**

- The three segments of the lower limb are the thigh, leg, and foot
- They carry the weight of the erect body, and are subjected to exceptional forces when one

jumps or runs

### **Femur**

- The sole bone of the thigh is the femur, the largest and strongest bone in the body
- It articulates proximally with the hip and distally with the tibia and fibula
- Major markings include the head, fovea capitis, greater and lesser trochanters, gluteal tuberosity, lateral and medial condyles and epicondyles, linea aspera, patellar surface, and the intercondylar notch

### **Leg**

- The tibia and fibula form the skeleton of the leg
- They are connected to each other by the interosseous membrane
- They articulate with the femur proximally and with the ankle bones distally
- They also articulate with each other via the immovable tibiofibular joints

### **Tibia**

- Receives the weight of the body from the femur and transmits it to the foot
- Major markings include medial and lateral condyles, intercondylar eminence, the tibial tuberosity, anterior crest, medial malleolus, and fibular notch

### **Fibula**

- Sticklike bone with slightly expanded ends located laterally to the tibia
- Major markings include the head and lateral malleolus

### **Foot**

- The skeleton of the foot includes the tarsus, metatarsus, and the phalanges (toes)
- The foot supports body weight and acts as a lever to propel the body forward in walking and running

### **Tarsus**

- Composed of seven bones that form the posterior half of the foot
- Body weight is carried primarily on the talus and calcaneus
- Talus articulates with the tibia and fibula superiorly, and the calcaneus inferiorly
- Other tarsus bones include the cuboid and navicular, and the medial, intermediate, and lateral cuneiforms

### **Calcaneus**

- Forms the heel of the foot
- Carries the talus on its superior surface
- Point of attachment for the calcaneal (Achilles) tendon of the calf muscles

### **Metatarsus and Phalanges**

- Metatarsals
  - Five (1-5) long bones that articulate with the proximal phalanges
  - The enlarged head of metatarsal 1 forms the "ball of the foot"
- Phalanges
  - The 14 bones of the toes
  - Each digit has three phalanges except the hallux, which has no middle phalanx

### **Arches of the Foot**

- The foot has three arches maintained by interlocking foot bones and strong ligaments
- Arches allow the foot to hold up weight
- The arches are:
  - Lateral longitudinal – cuboid is keystone of this arch
  - Medial longitudinal – talus is keystone of this arch
  - Transverse – runs obliquely from one side of the foot to the other

### **Developmental Aspects: Fetal Skull**

- Infant skull has more bones than the adult skull
- At birth, fetal skull bones are incomplete and connected by fontanelles
- Fontanelles
  - Unossified remnants of fibrous membranes between fetal skull bones
  - The four fontanelles are anterior, posterior, mastoid, and sphenoid

### **Developmental Aspects: Fetal Skull**

- Skull bones such as the mandible and maxilla are unfused

### **Developmental Aspects: Growth Rates**

- At birth, the cranium is huge relative to the face
- Mandible and maxilla are foreshortened but lengthen with age
- The arms and legs grow at a faster rate than the head and trunk, leading to adult proportions

### **Developmental Aspects: Spinal Curvature**

- Only thoracic and sacral curvatures are present at birth
- The primary curvatures are convex posteriorly, causing the infant spine to arch like a four-legged animal
- Secondary curvatures – cervical and lumbar – are convex anteriorly and are associated with the child's development

### **Developmental Aspects: Old Age**

- Intervertebral discs become thin, less hydrated, and less elastic
- Risk of disc herniation increases
- Loss of stature by several centimeters is common after age 55
- Costal cartilages ossify causing the thorax to become rigid
- All bones lose mass

### **VASCULAR SYSTEM OF BONE**

#### **• Blood supply is from 4 sources:**

- Nutrient arteries:
  - enter shaft at nutrient foramen, go as deep as marrow cavity
- Periosteal system:
  - microvascular network that supplies the periosteum
- Metaphyseal system:
  - microvascular network that supplies the metaphysis
- Epiphyseal system:

– microvascular system that supplies the epiphysis

- **Arterial supply of the cortex**

- is *centrifugal* (inside to out).

- **Venous flow**

- is *centripetal* with cortical capillaries draining to venous sinusoids to emissary venous system.