Cartilage

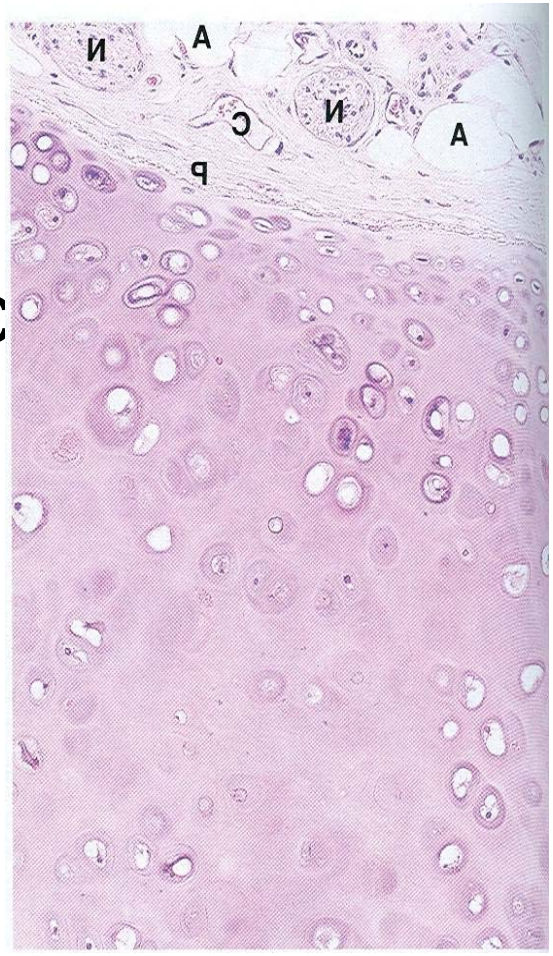
- Specialized dense connective tissue
- Semi rigid ,designed to give support, bear weight & withstand tension ,torsion & bending
- Devoid of blood vessels and not innervated by nerve
- Most of them are calcified in old age.
- Cartilage can grow by interstitial & appositional growth

Composition of cartilage

- Perichondrium
- Ground substance-

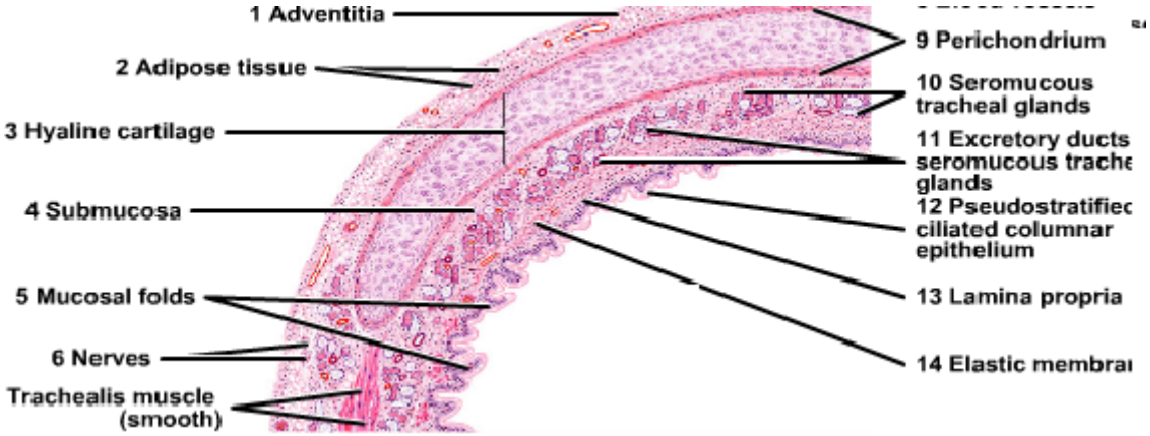
Highly hydrated Contains hyaluronic acid glucoseaminoglycans

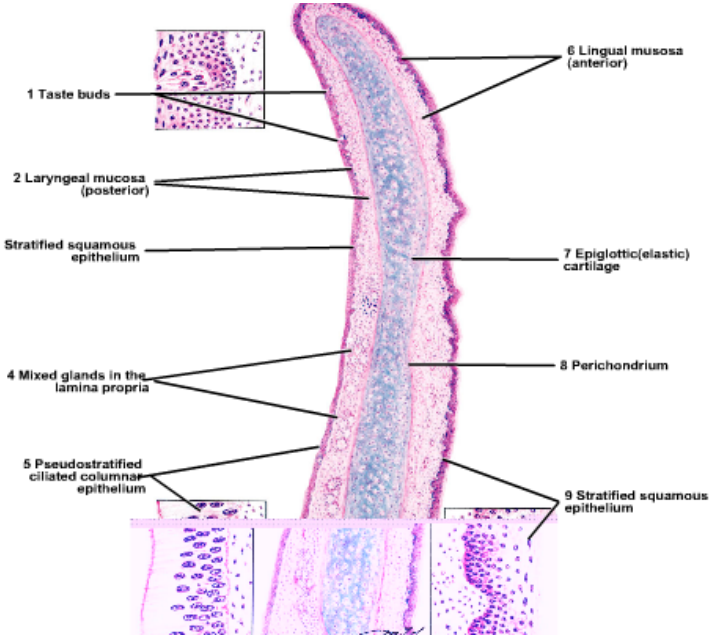
- Cells- chondroblasts, chondrocytes
- Fibers- collagen , elastic fibers

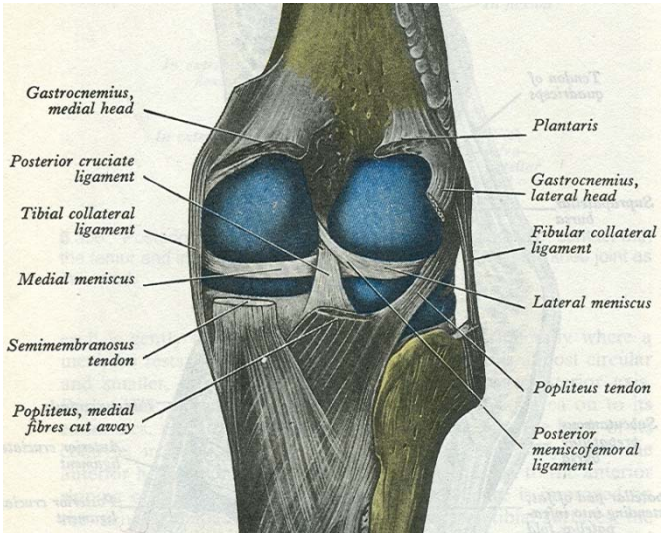


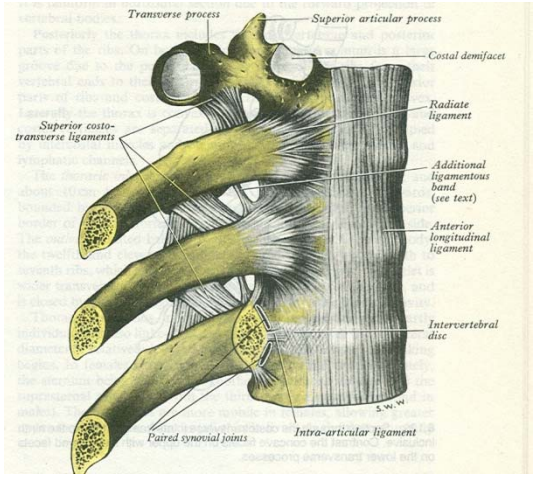
Types of cartilage

- Hyaline cartilage
- Elastic cartilage
- Fibrous cartilage



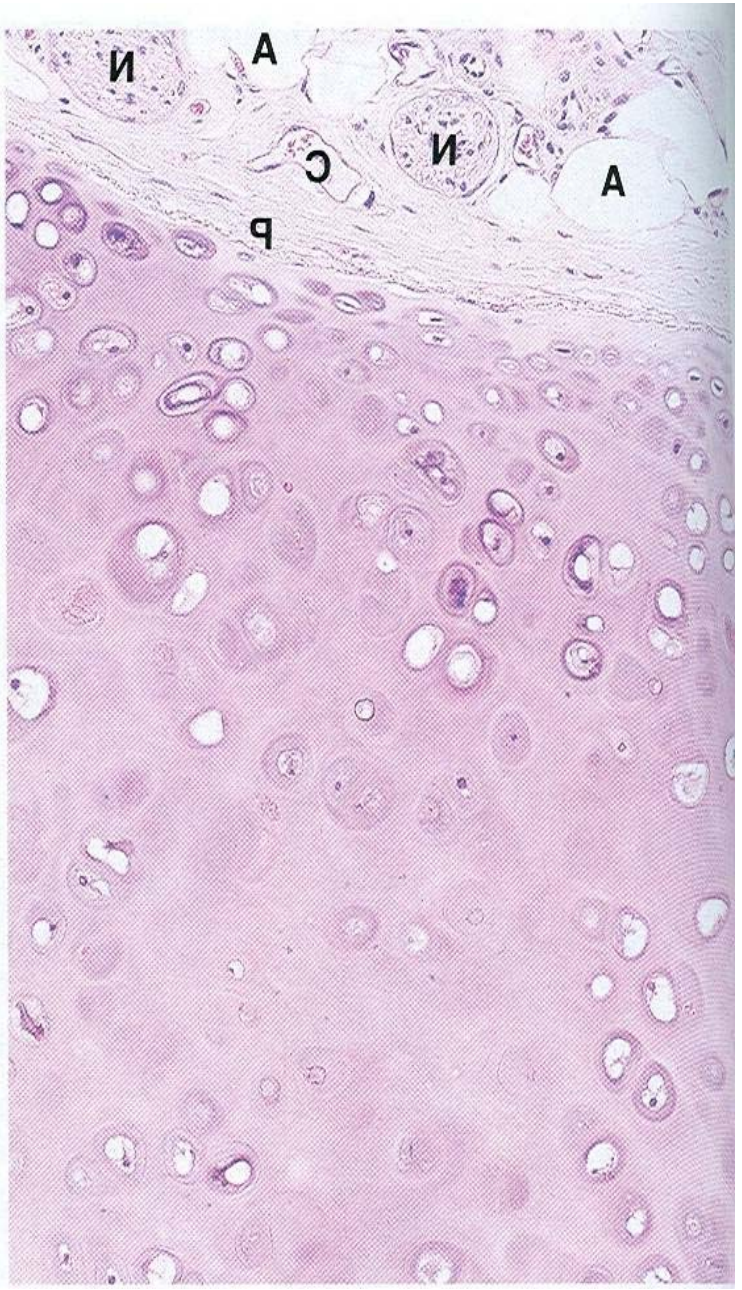






Hyaline cartilage

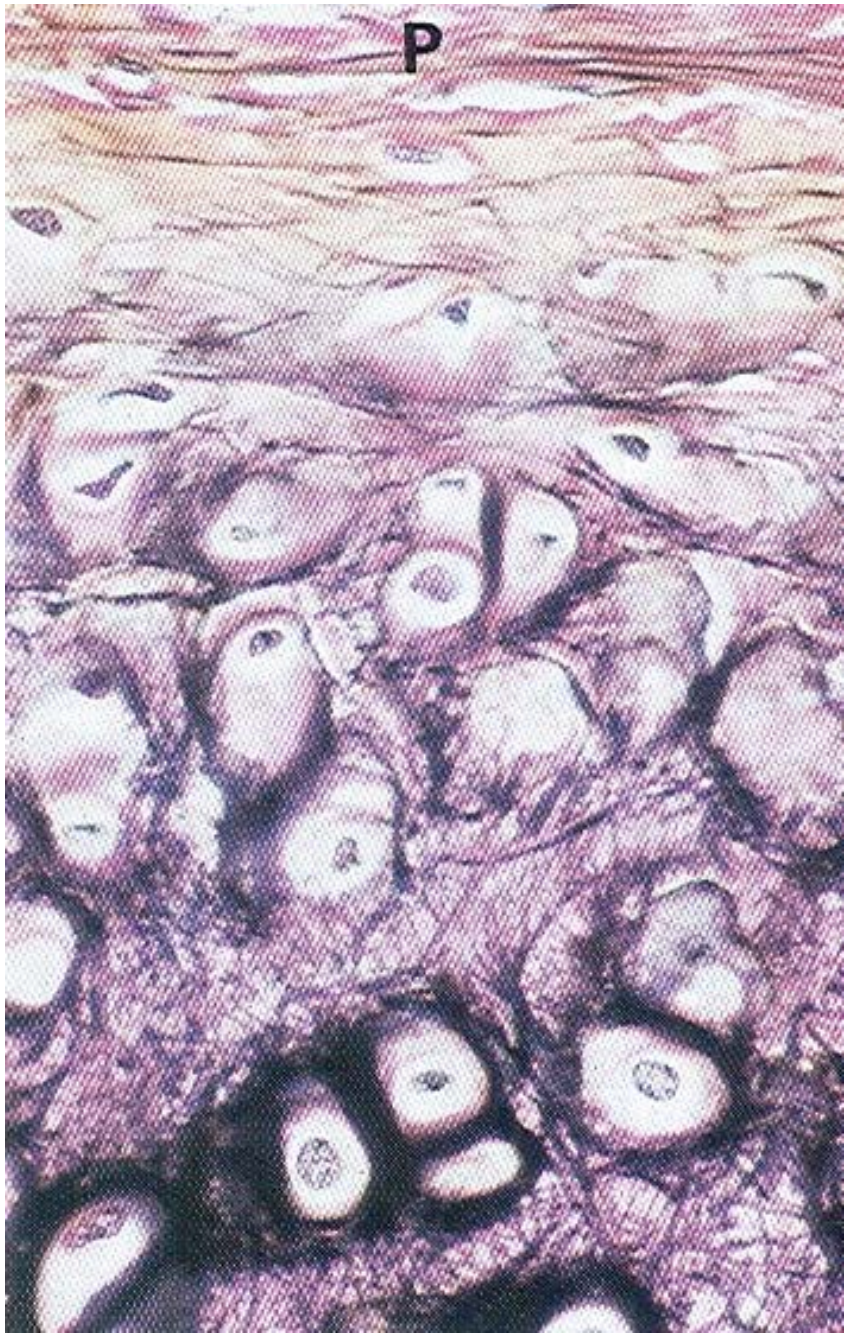
- Most common type
- Makes the skeletal model of most bones in embryo
- Gradually replaced by bone in grown ups except at the articular surface of bones, ends of the ribs, nose, larynx, trachea and bronchi



- In living conditions looks translucent & bluish white in colour
- Covered with perichondrium. Articular cartilage is not covered by perichondrium
- Matrix is homogenous which consists of chondroitin sulphate & collagen fibers
- Cells are chondrocytes arranged in groups in lacunae
- Collagen fibers are not visible in matrix because of the same refractive index as that of matrix

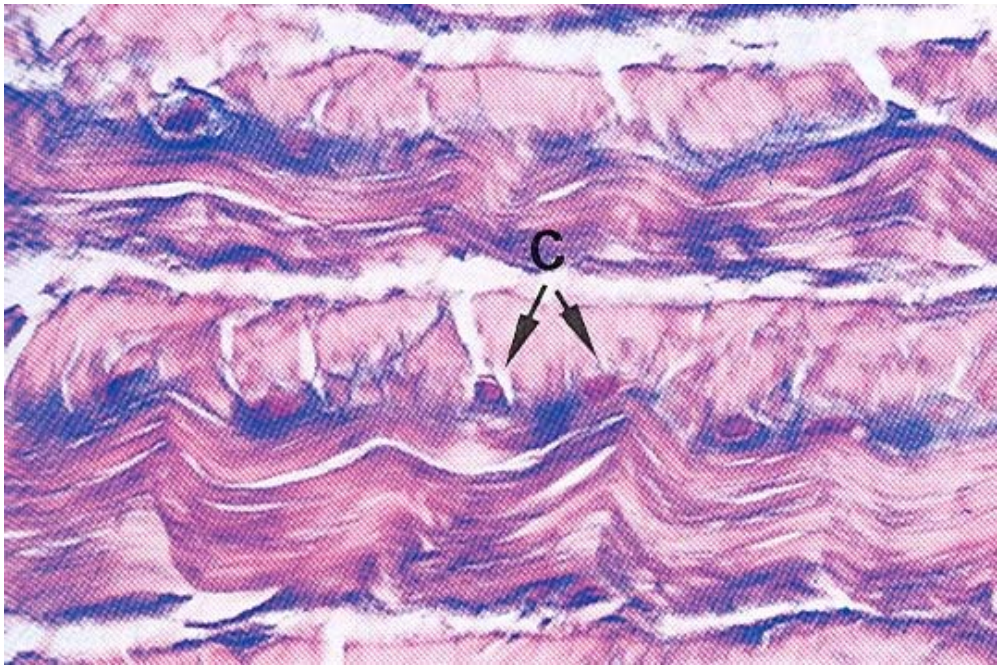
Elastic cartilage

- Present in external ear, epiglottis, auditory tube & few cartilage of larynx
- Covered with perichondrium
- Number of cells are more
- Matrix consist of bundles of branching & anastomosing elastic fibers which give elasticity to the tissue



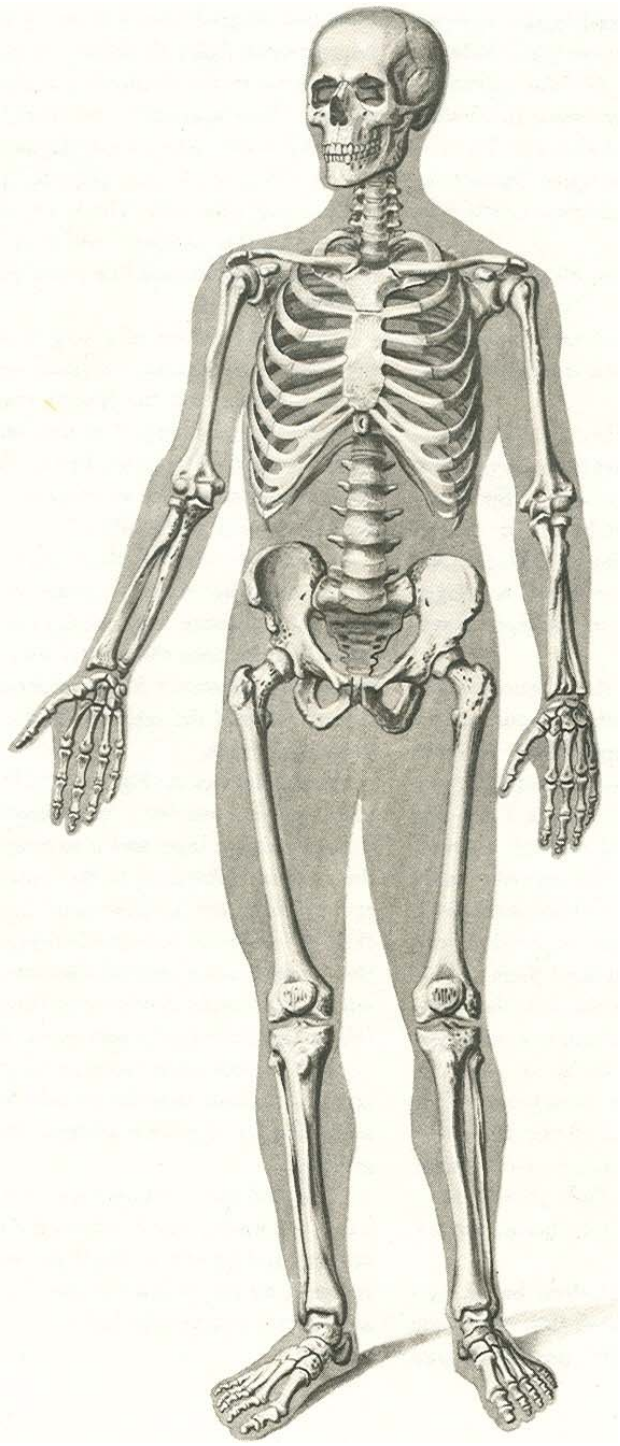
Fibrous cartilage

- Found in intervertebral disc, pubic symphysis, intrarticular disc of certain joints, menisci of knee joint & articular cartilage of temporomandibular cartilage
- Consists of bundles of collagen fibers embedded in minimal amount of matrix
- Cells are usually placed single in between the bundles of collagen fibers
- Not covered with perichondrium



BONE

- Specializes form of dense connective tissue
- Makes supportive frame work
- Support & transmit weight of the body
- Provide the levers for locomotion by forming articulations
- Give attachment to muscles & ligaments
- Provide mechanical protection to the vital organ
- Store calcium
- Form blood in their marrow

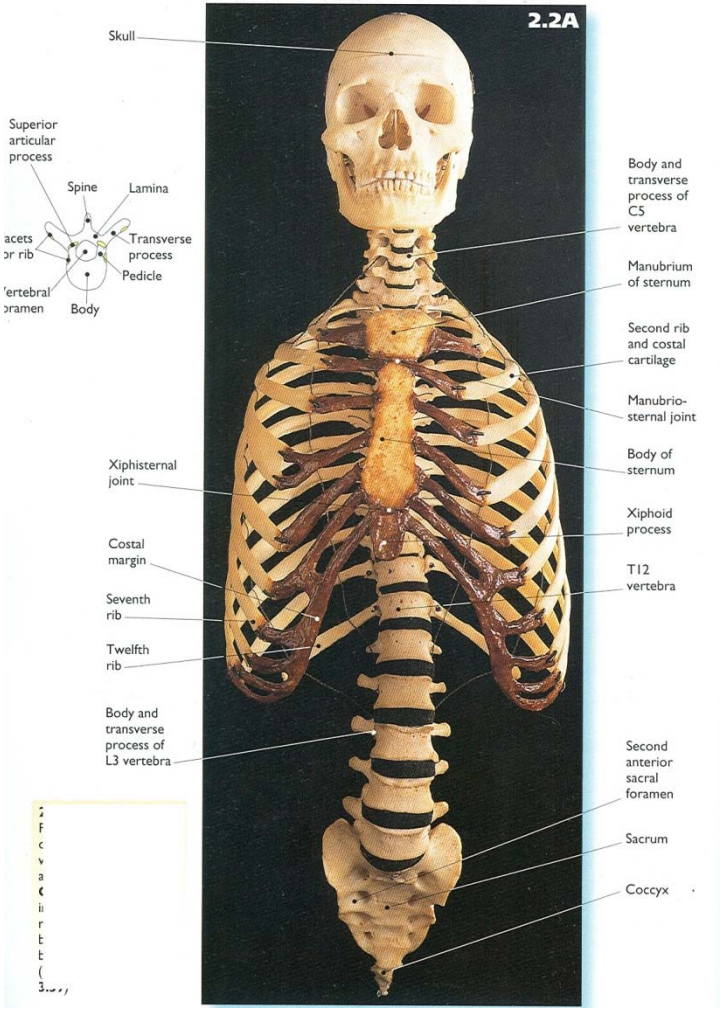


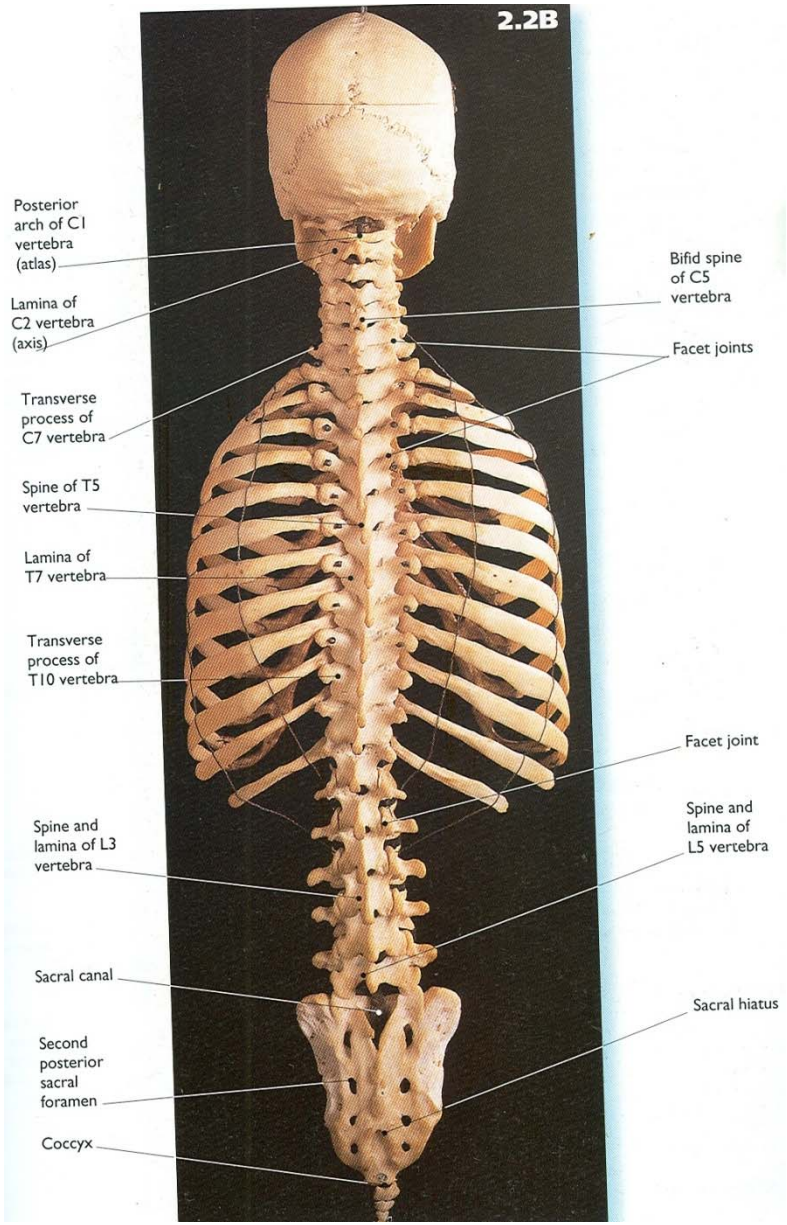
Classification of bones

According to position

Axial

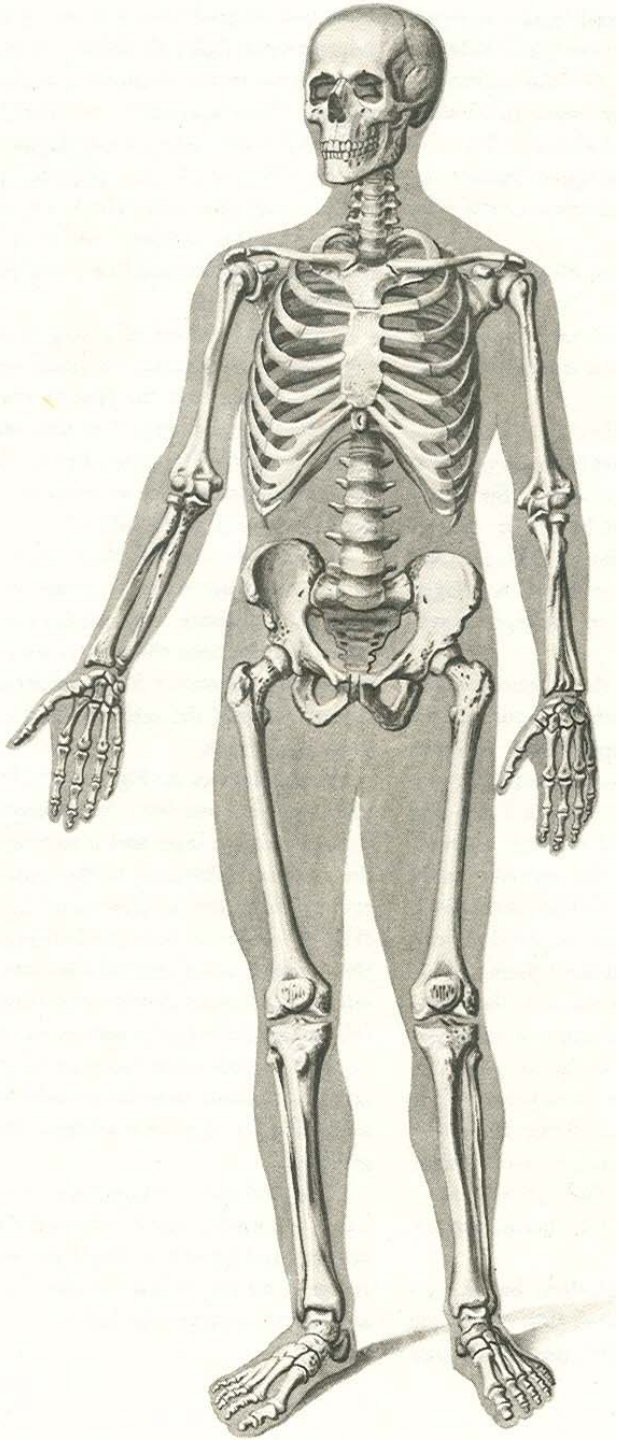
Appendiculer



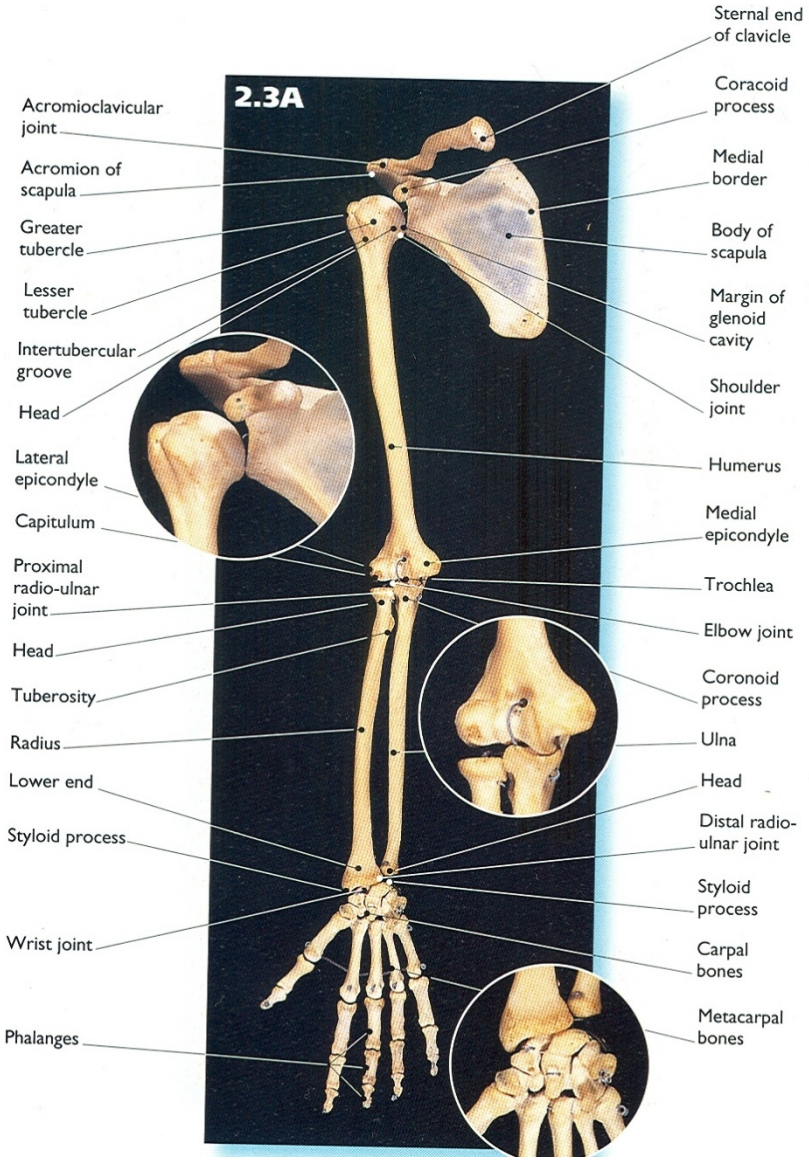


Number of bones

- Total 206 bones
- Upper limbs - 64
- Lower limbs – 62
- Vertebrae – 26(33)
- Skull – 29(26Skull bones + hyoid +6 ossicle)
- Ribs – 24
- Sternum



- Appendicular-
  Upper limb
    64



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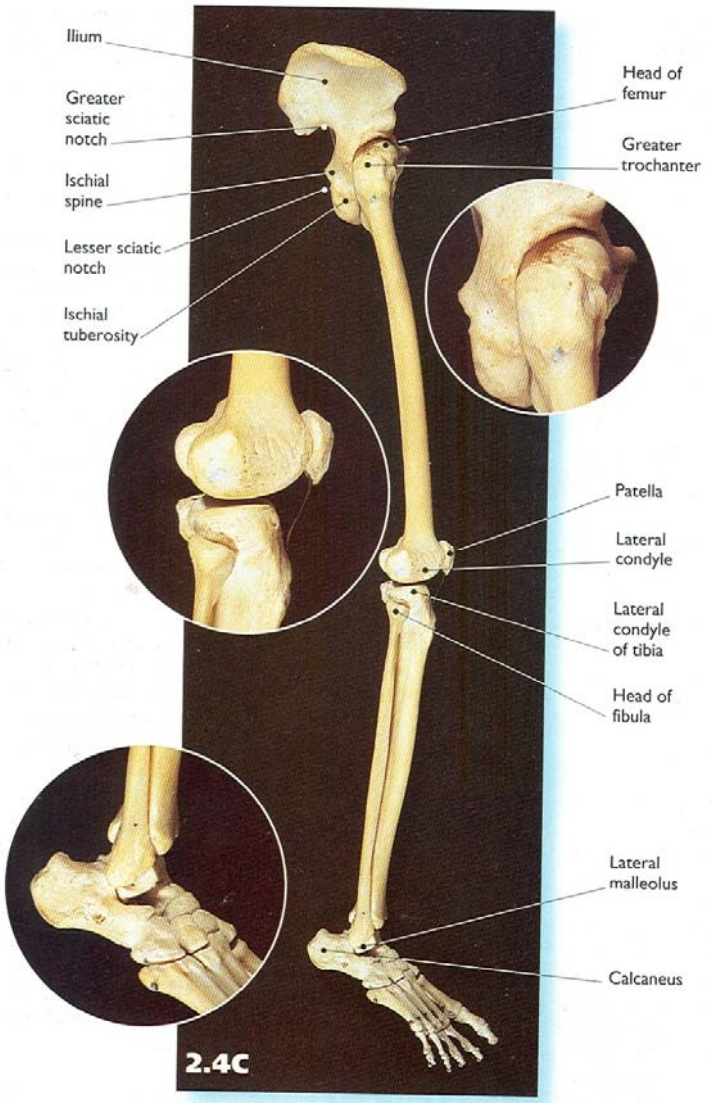
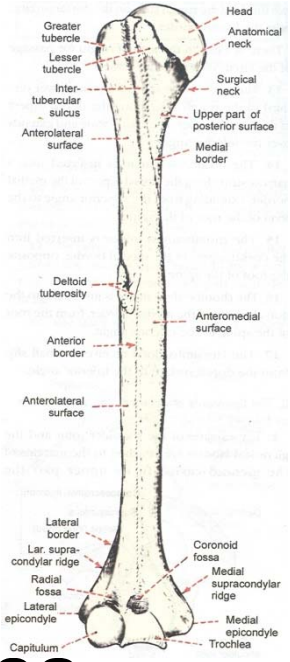
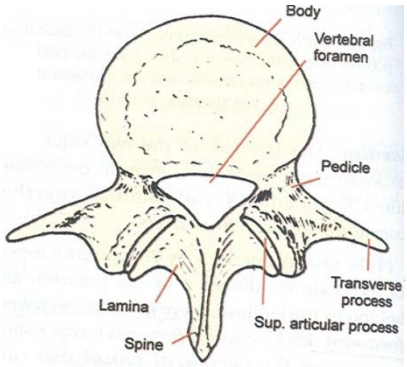
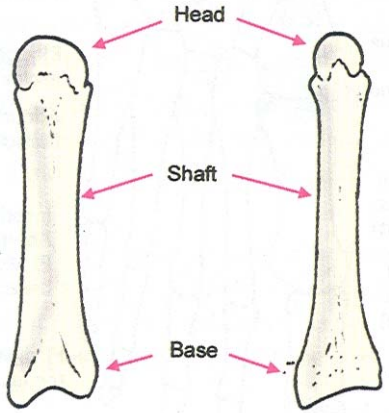


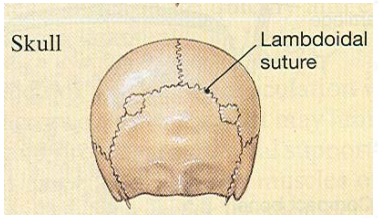
According to size & shape

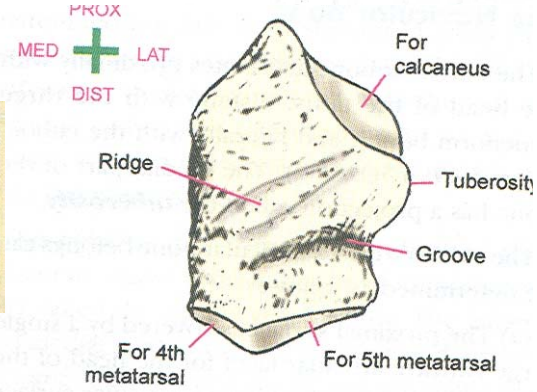
- Long bones
- Short bones
- Short bones
- Flat bones
- Irregular bones
- Pneumatic bones
- Sesamoid bones
- Accessory bone

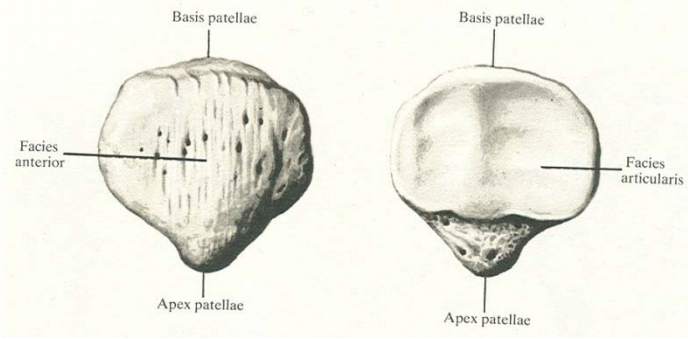


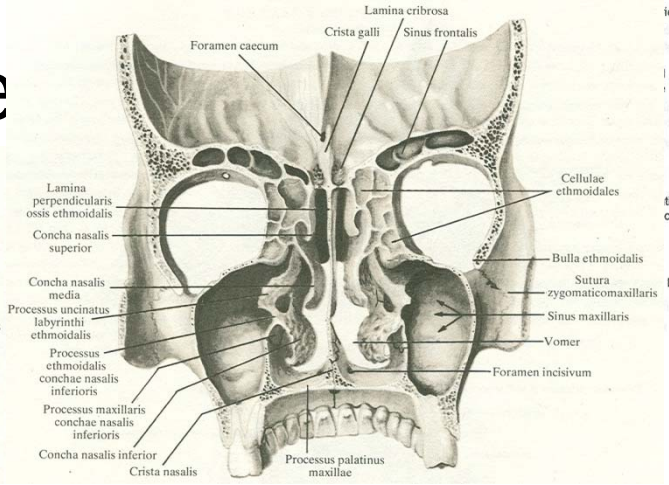


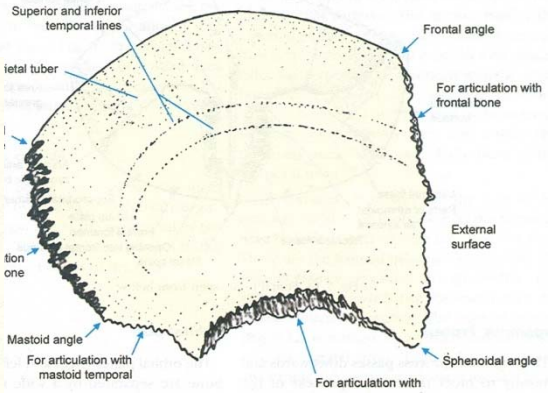










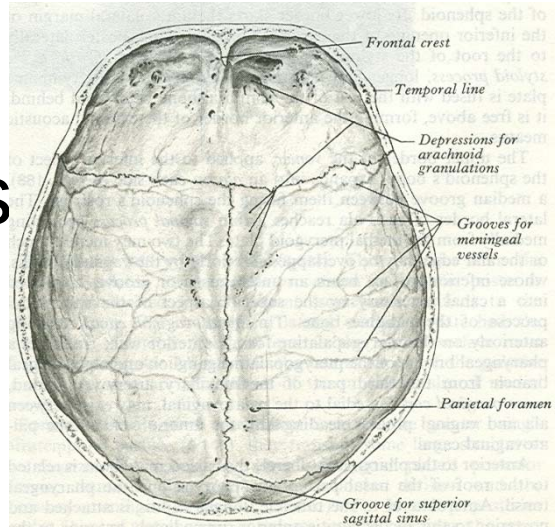


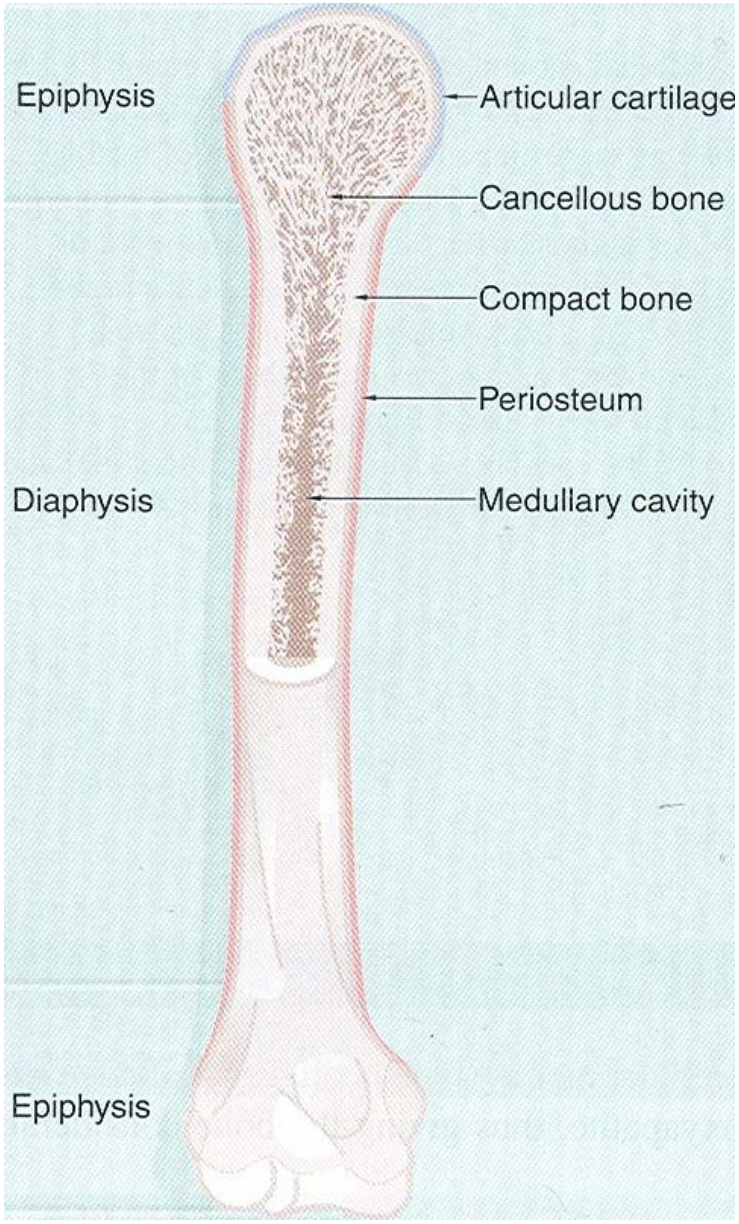
According to gross structure

- Compact (Lamellar) bone

- Spongy (cancellous) bone

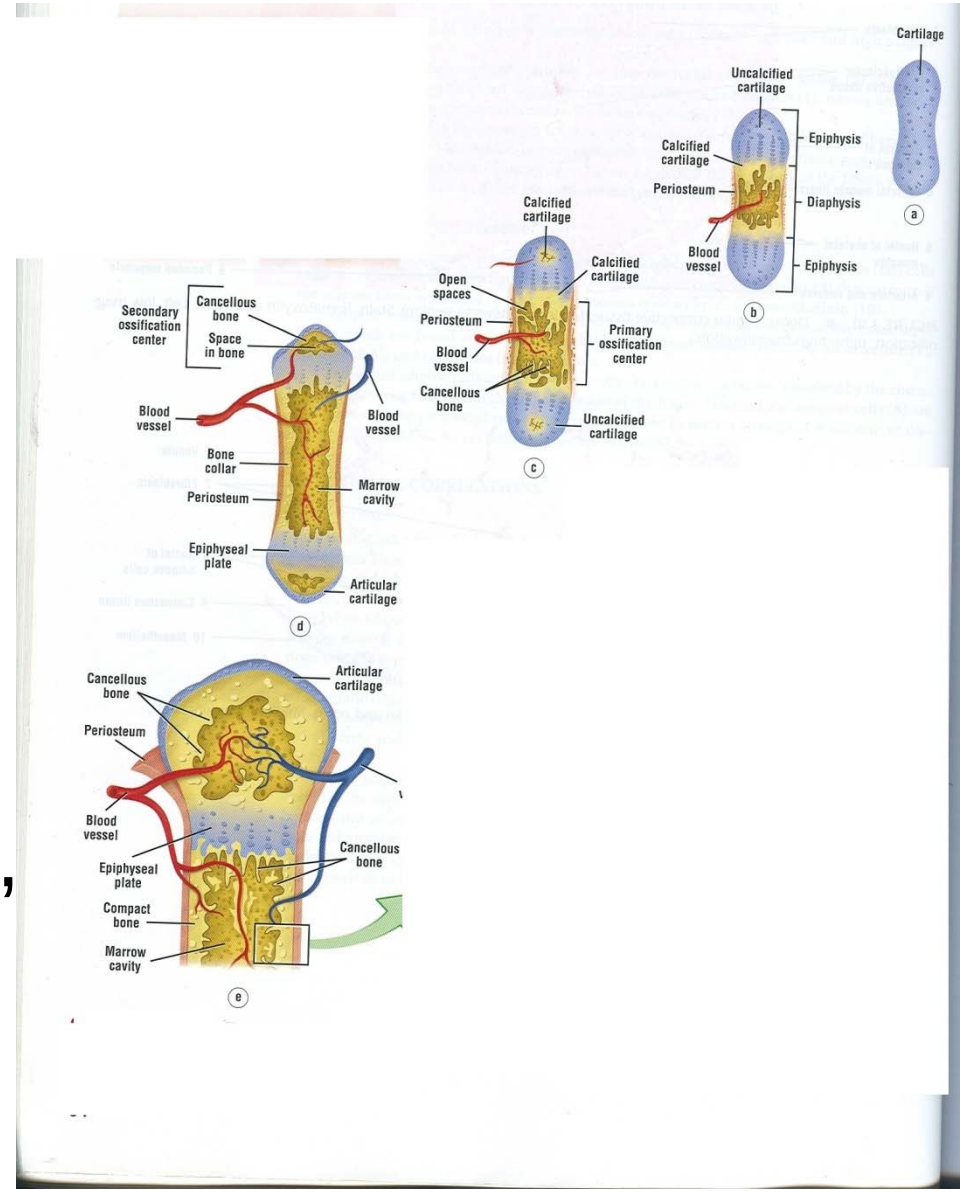
- Diploic bones





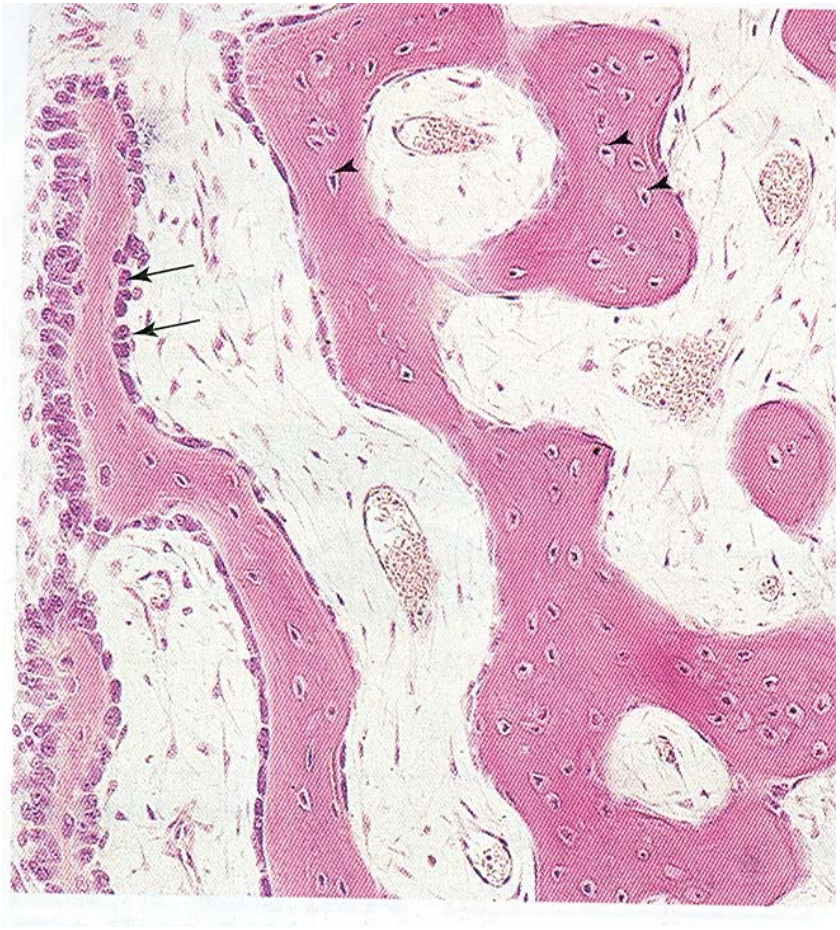
According to development

- Membranous bones- Bone is laid down directly in the fibrous membrane e.g. bones of vault of skull, mandible
- Cartilaginous bones- Formation of bone is proceeded by the formation of a cartilage, which is later replaced by a bone e.g. femur, tibia



Membranous ossification

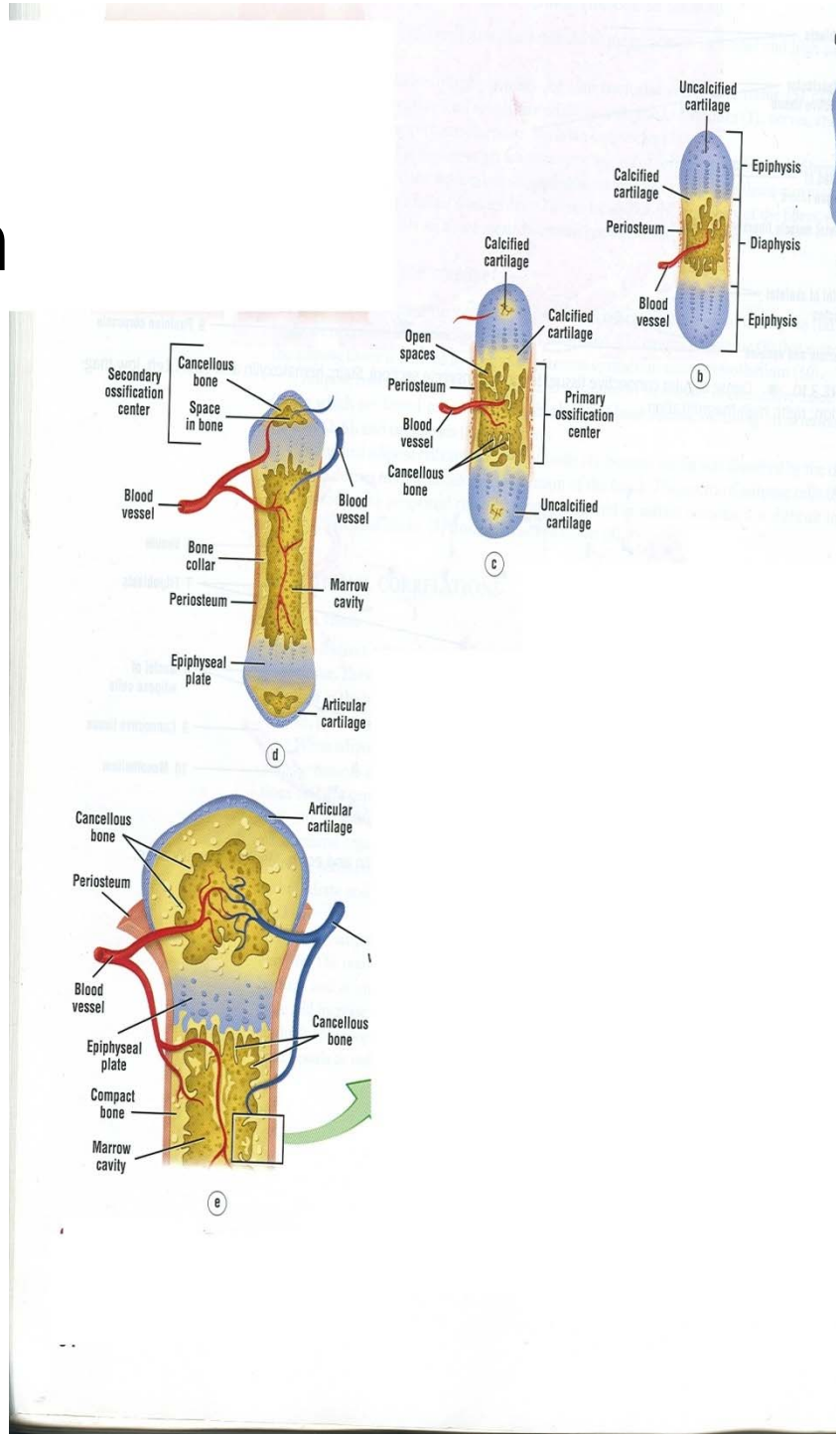
- Bone is formed in mesenchyme
- The cells in mesenchyme secrete ground substance & collagen fiber around themselves
- Thus ground substance, fiber & cells form a membrane
- Vascularization of membrane & differentiation of osteoblast cells
- Formation of osteoid matrix
- Formation of calcified matrix
- Formation of trabeculae, bone cells (osteocytes) & lacunae
- Subperiosteal ossification



Development

Endochondral ossification

- Condensation of mesenchymal cells occur at the site of bone formation
- Mesen. Cells are transformed in to chondroblast which now form hyaline cartilage
- Formation of perichondrium which is highly vascular
- Hypertrophy of cartilage cells & formation of calcified matrix
- Subperiosteal ossification
- Vascular invasion & osteogenesis



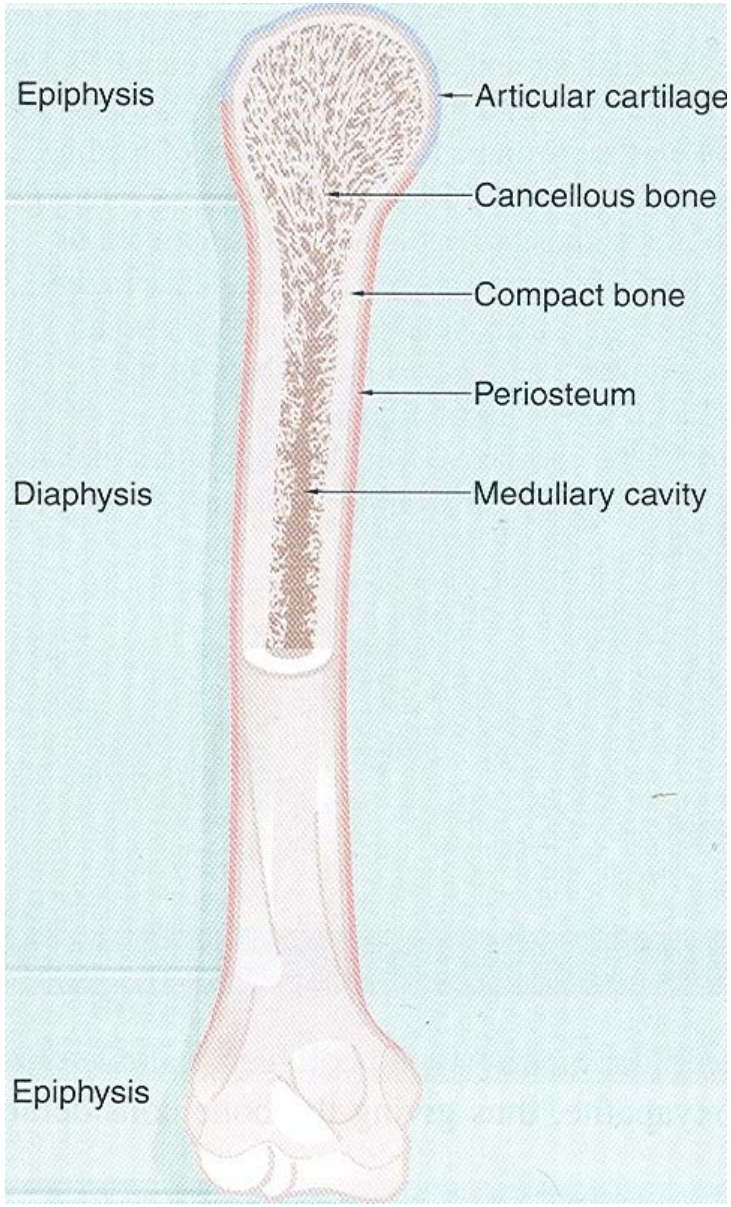
Composition of bone -

- organic matter- forms 1/3 weight of bone. Consists of fibrous material & cells. Responsible for toughness & resilience
- Inorganic matter- forms 2/3 weight of bone. Consists of mineral salts like **calcium** carbonate, cal. Fluoride, and magnesium phosphate

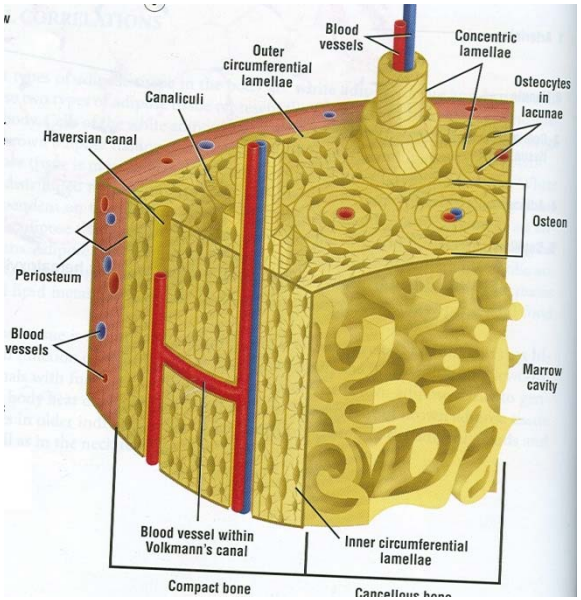
  Responsible for rigidity & hardness. Cal. In bone makes it opaque to x-ray

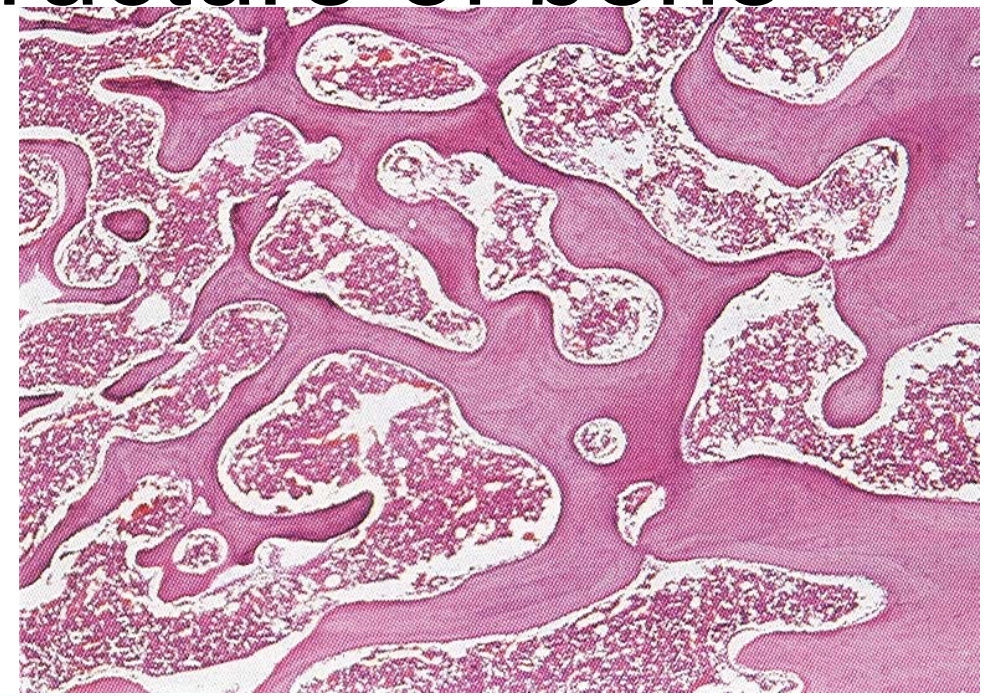
Macroscopic structure of living adult bone

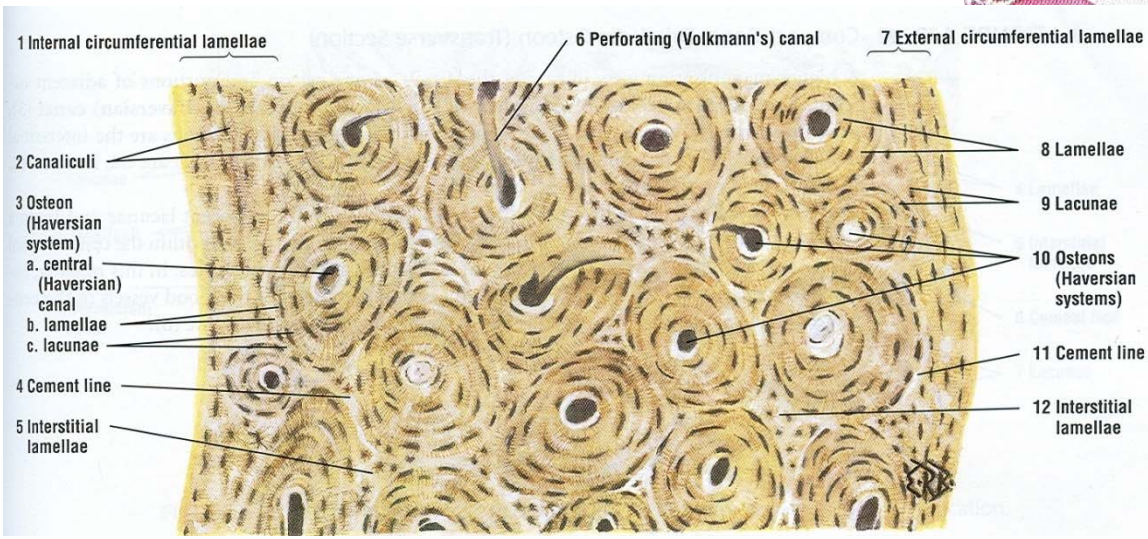
- Compact bone
- Cancellous bone



Microscopic structure of bone

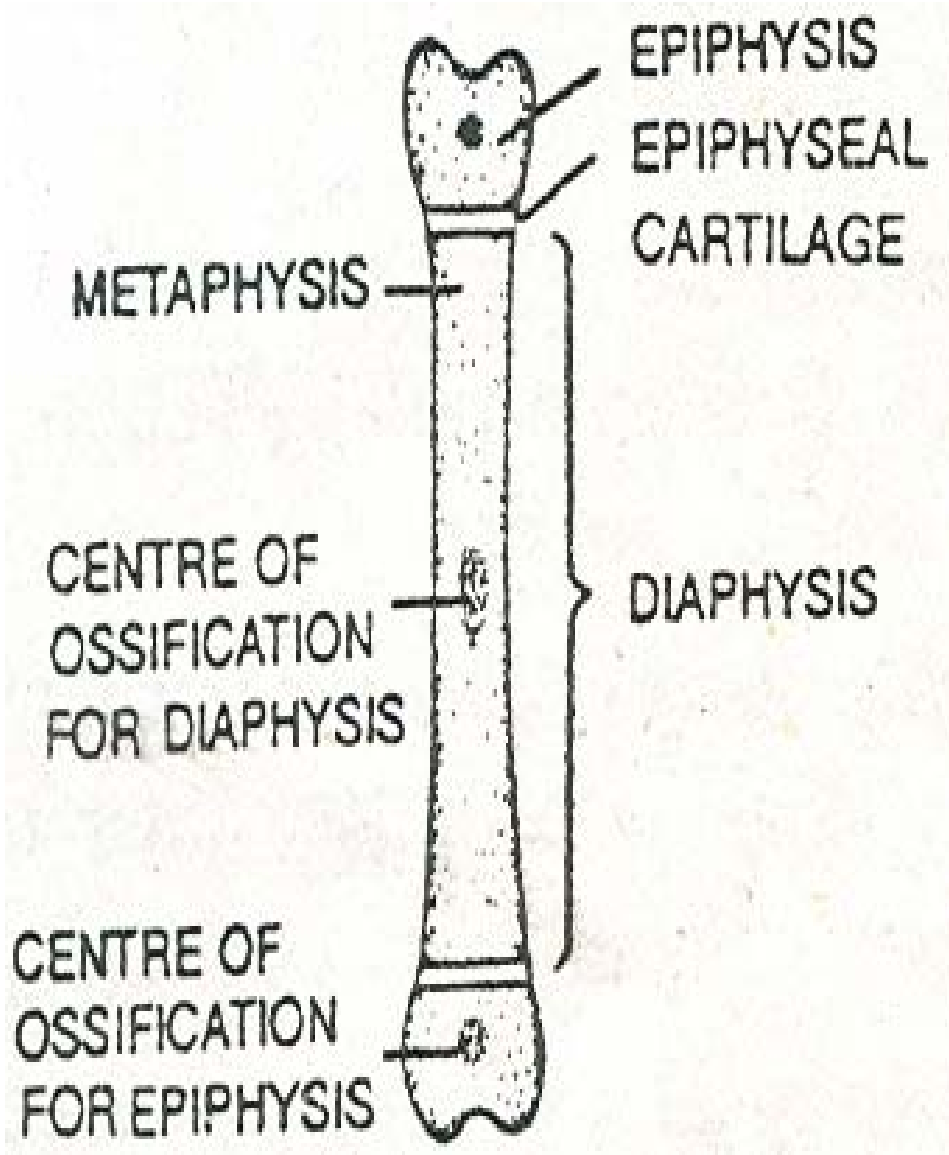






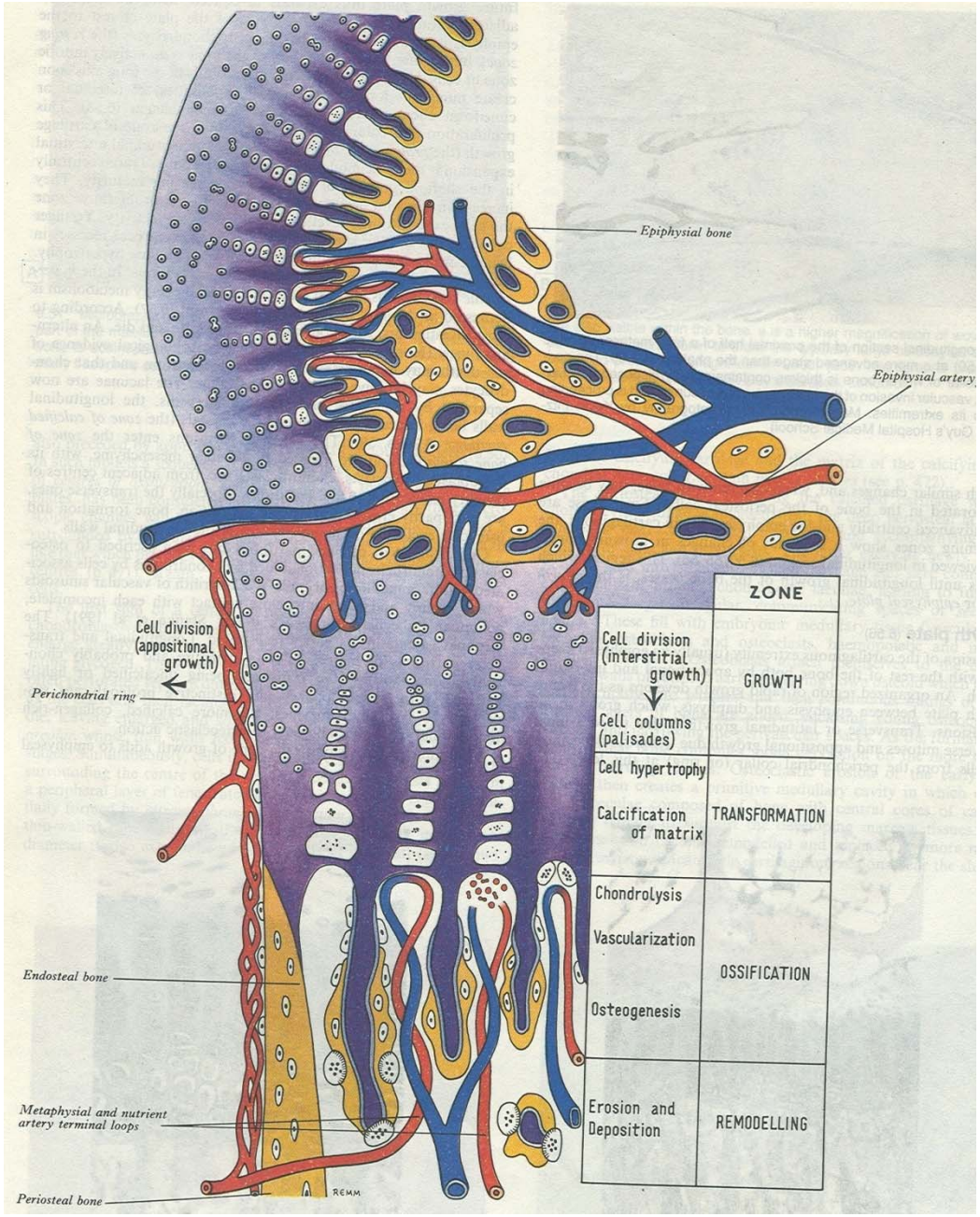
Parts of a developing long bone

- **Diaphysis**- intermediate region or shaft
- **Metaphysis-** developing extraepiphyseal regions of shaft
- **Epiphysis-** ends of bone which ossify with a separate centre of ossifi. (secondary)



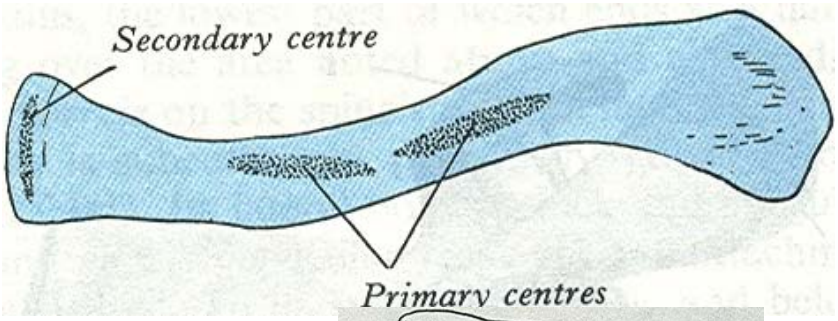
Epiphyseal cartilage

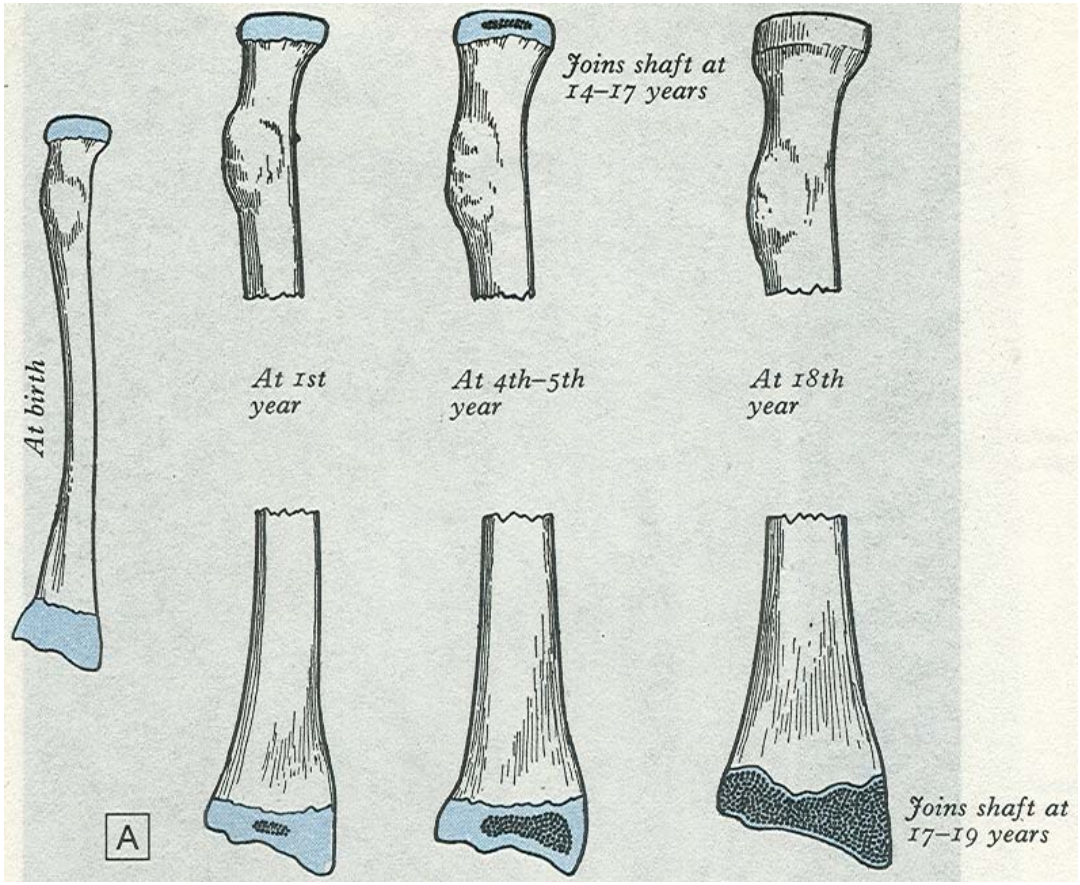
- Zone of resting cartilage
- Zone of proliferating cartilage
- Zone of hypertrophied cartilage
- Zone of calcified cartilage

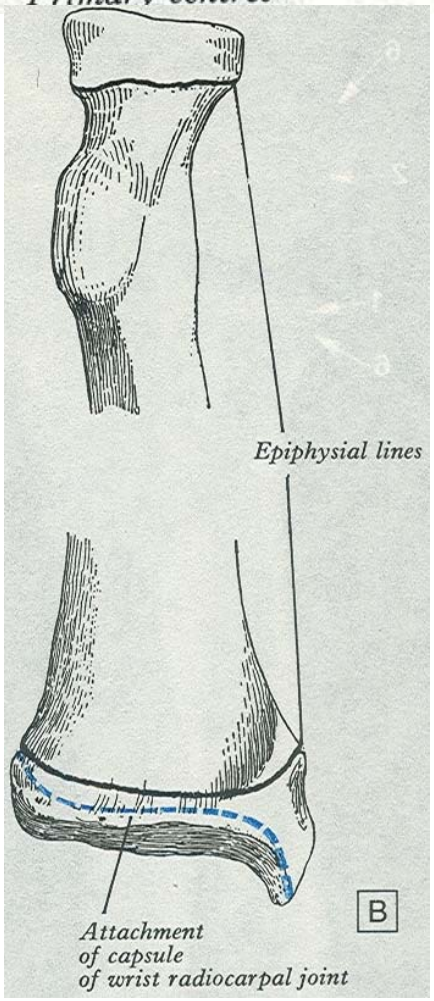


Centers of ossification

- Primary center
- Secondary center
- Epiphyseal line







Types of epiphysis

Pressure epiphysis- articular & take part in transmission of weight e.g. head of femur, lower end of radius

Traction epiphysis- Nonarticular & does not take part in the transmission of the weight.

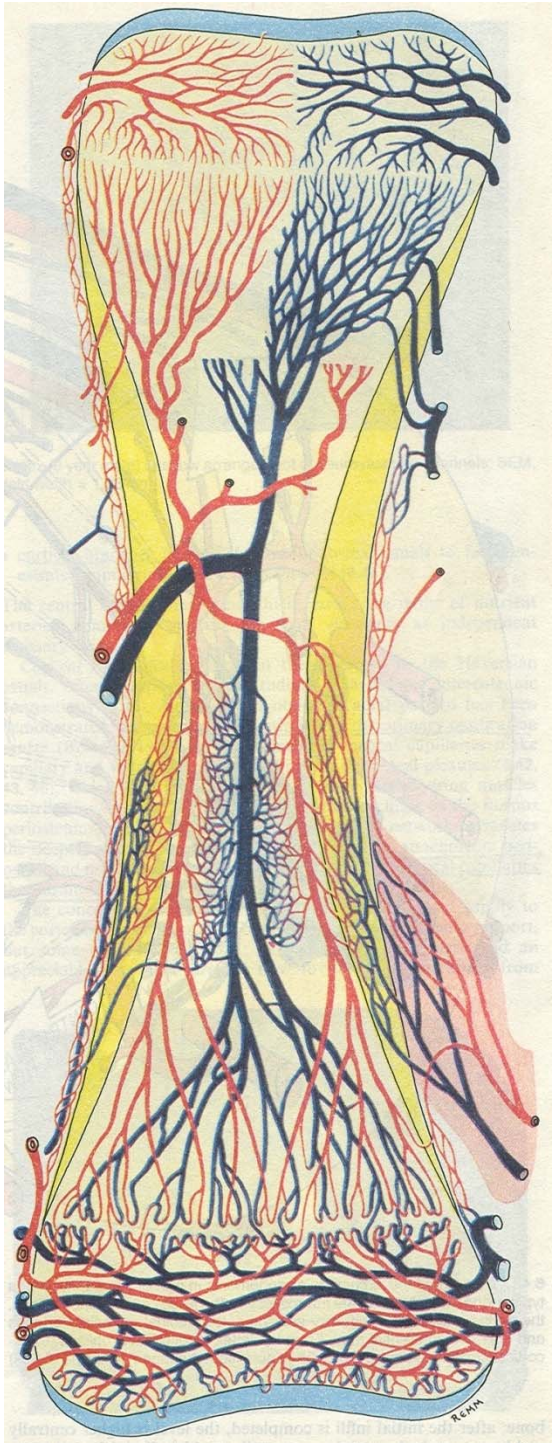
- Tendons are attached here which exert a traction on the epiphysis
- Ossify later then the pressure epiphysis e.g. trochanters of tubercles of humerus

Atavistic epiphysis- femur, Phylogenetically an independent bone which in man become fused to another bone e.g. coracoid process of scapula & os trigonum

Aberrant epiphysis- Not always present e.g. epiphysis at the head of first metacarpal & at the base of other metacarpal bones

Blood supply of bone

- Nutrient artery
- Periosteal vessels
- Metaphyseal vessels
- Epiphyseal vessels



- Lymphatic supply- lymphatics present only in periosteum & Haversian system
- Accompany blood vessels
- No lymphatic in the bone marrow
- Lymphatic of the haversian system drain in to periosteal vessels
- Nerve supply- Most numerous at the articular ends of the long bones vertebrae & flat bones
- Distributed freely to the periosteum & with the branches of nutrient artery.
- Consist of both sensory & autonomic fibers (blood vessels)

Some important points about ossification

- Ossification begins constantly at a prefixed spot & at a fairly constant time
- Centre may be primary or secondary
- Primary center may be single or multiple but appear & as a rule appear before birth
- Between 6 to 8^{th} wk of fetal life. Exception cuneiform & navicular bones
- Secondary center usually multiple & appear after birth. Exception are lower end of femur

- Most long bones have epiphysis at both ends the epiphysis which ossifies first unites with the diaphysis last & the epiphysis which ossifies last fuses first. **Exceptions.** Lower end of fibula where epiphysis ossifies first, also fuses last with shaft
- The end of the long bone where epiphysis appear first & fuses last is called the growing end of the bone
- The direction of the nutrient artery is always away from the growing end of the bone given away by rhyme,

To the elbow I go, from the knee I flee”

- The different centers of ossification first unite together & then they unite with the shaft
- In long bones growing ends of the bone fuses with the shaft at about 20 years & the opposite end at about 18 years i.e. 2 years earlier
- Fusion of epiphysis with diaphysis occurs 2 years earlier in women than in men. Epiphysis also appear earlier in women
- Epiphysis in bones other than long bones fuses with main part of the bone between 20-25 years

Estimation of age, sex &height from the bones

- Timing of eruption of milk teeth & permanent teeth can estimate age up to18 years
- Age at which epiphysis of the bone appears and fuses with the diaphysis es fairly constant. This can provides the age till 25 years
- After 25 years age is estimated by the closing of cranial sutures &changes occuring at the medial surface of pubic bones. this age can be estimated till 60 years

- **Sex** can be determined by studying morphological feature of the bone & the measurement of skull & pelvis
- **Race** can be determined with85-90% accuracy by metrical & nonmetrical data developed from cranial &other parts of skeleton.