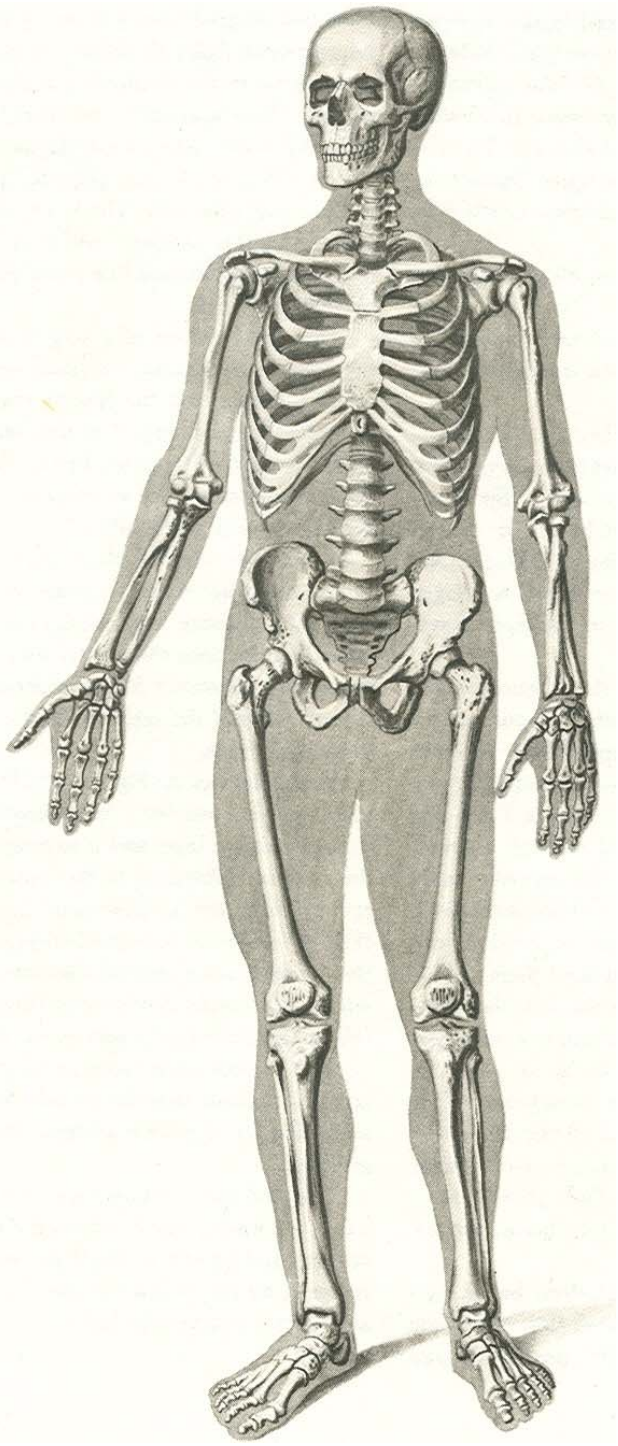
# BONE

- 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



**Bones are**

- Not inert but living material
- Highly vascular
- Have nerve supply, lymphatics
- Power of regeneration
- Subject to disease

# COMPONENTS

- Cells
- Dense intercellular organic matrix
- Inorganic salts – Calcium Phosphate etc.
- Collagen fibers

Cells

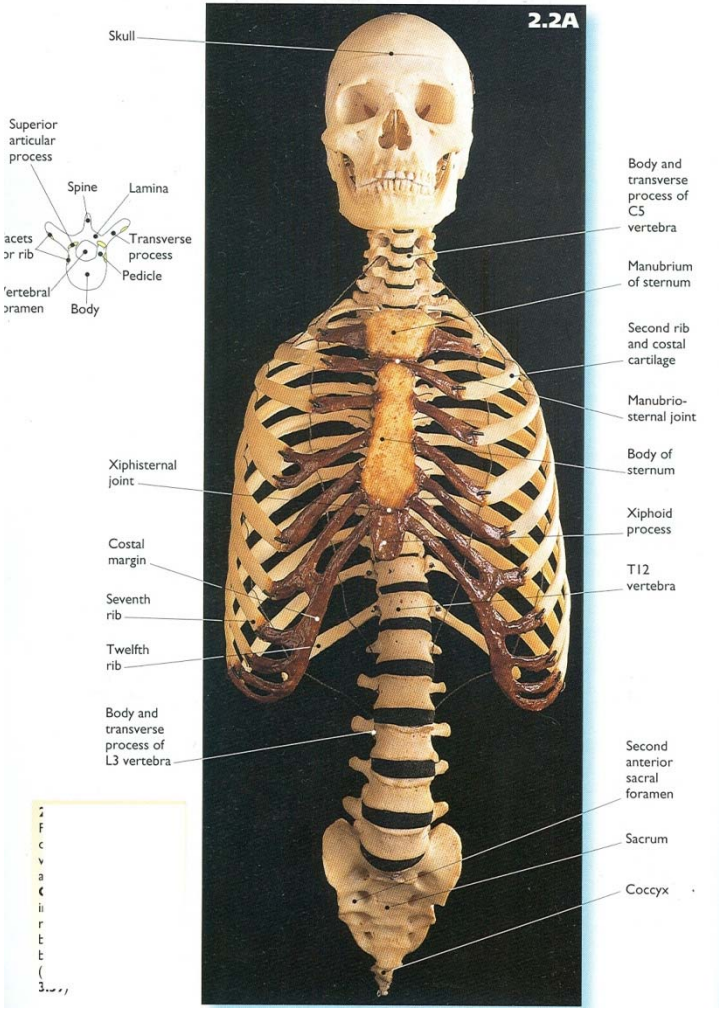
1. Oysteoblasts
2. Oysteocytes
3. Oysteoclast

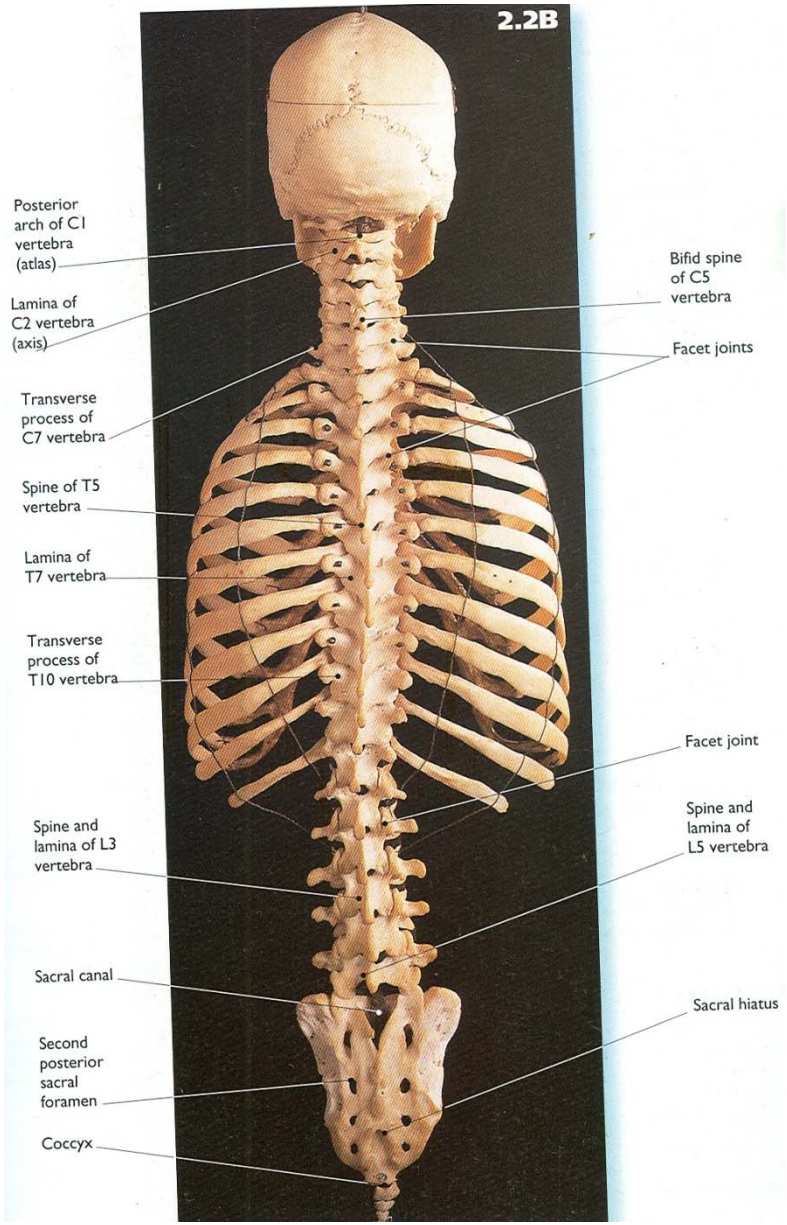
# Classification of bones

## a. According to position

Axial

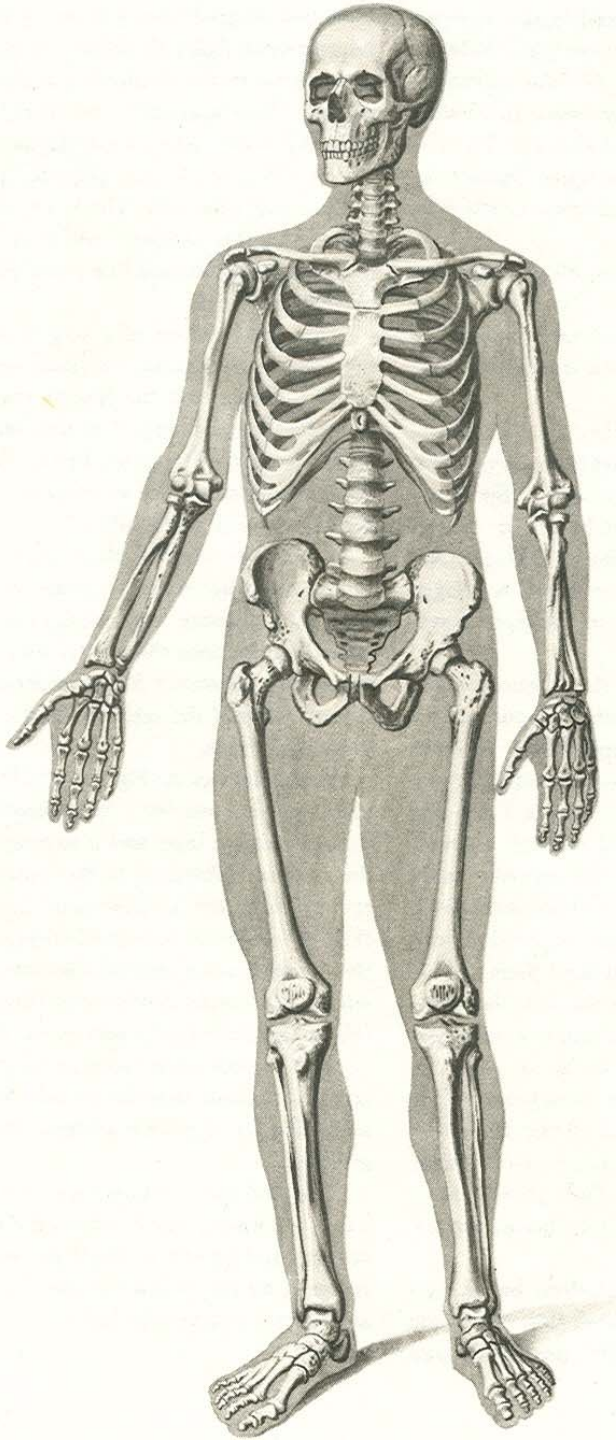
Appendicular



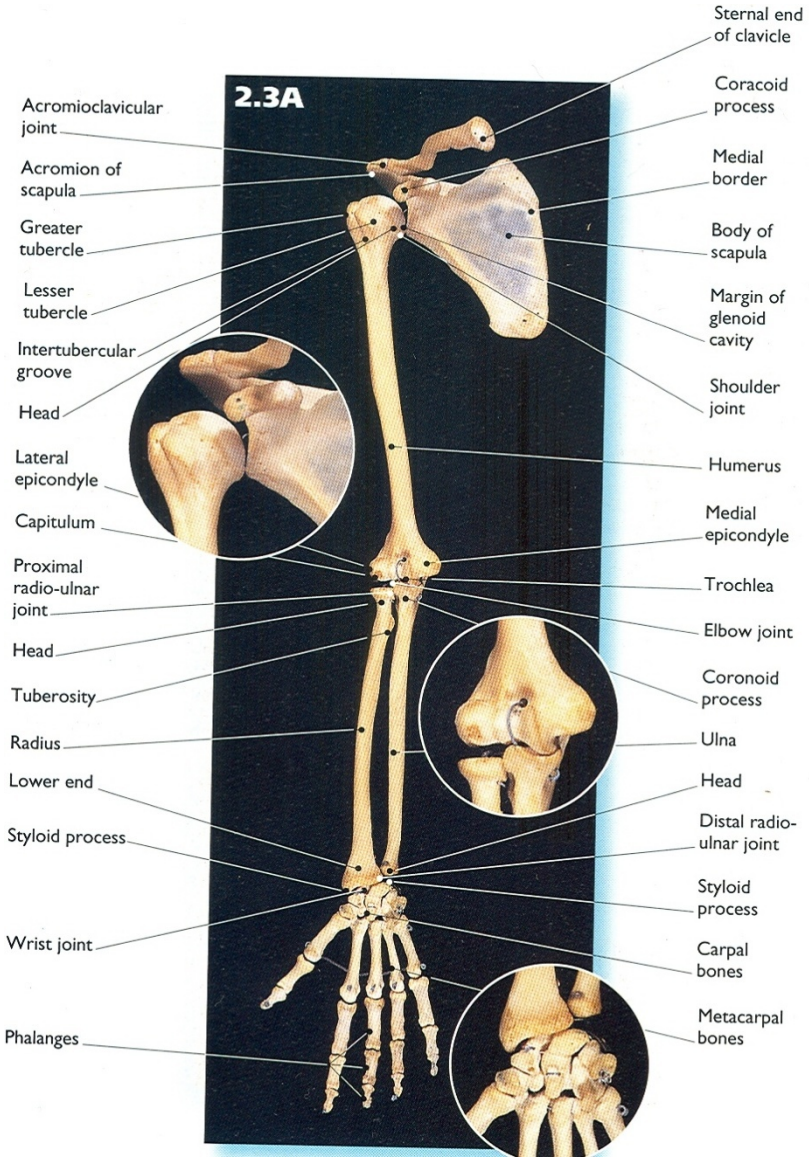



# Number of bones

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



- Appendicular-
  Upper limb
  64

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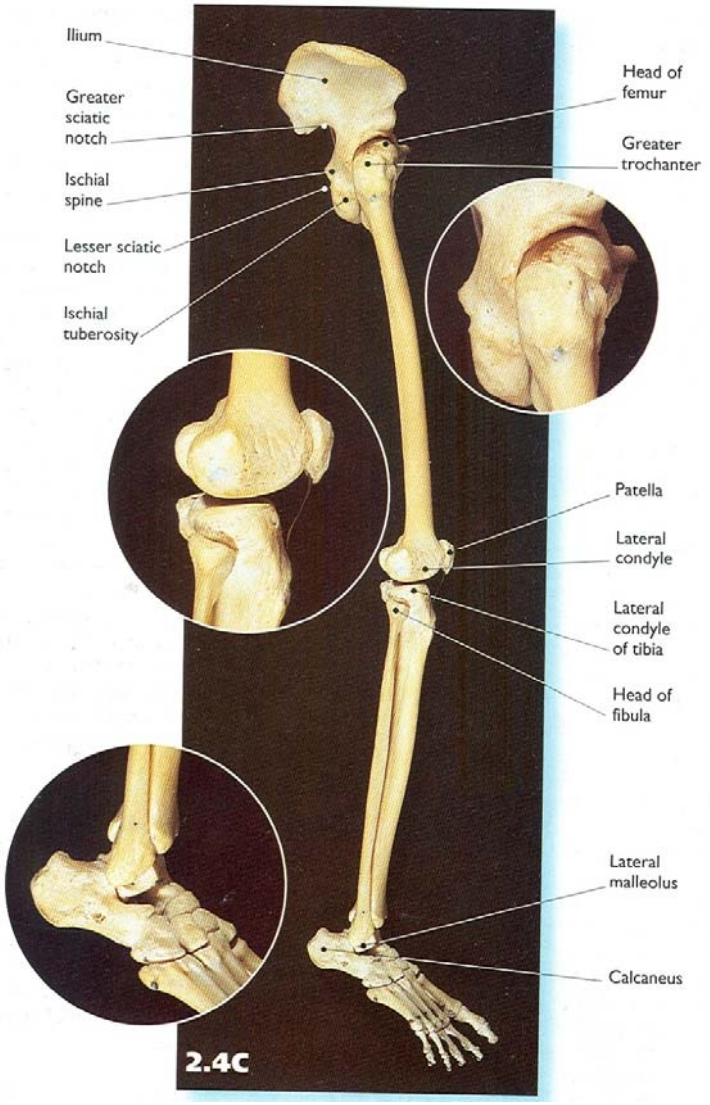


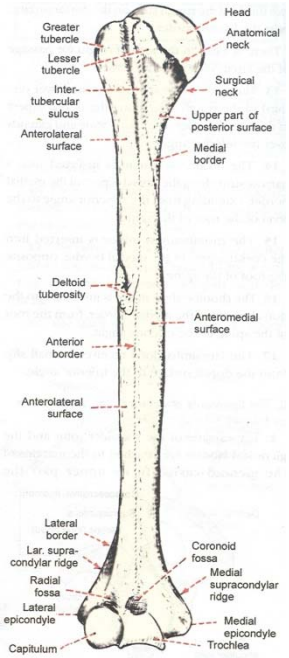
## b. According to size & shape

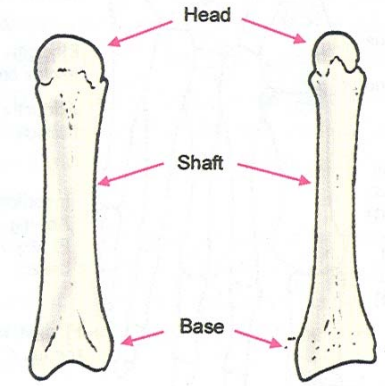
Long bones

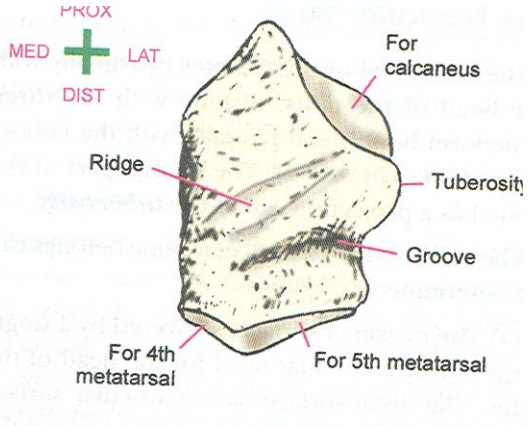
Long Short bones

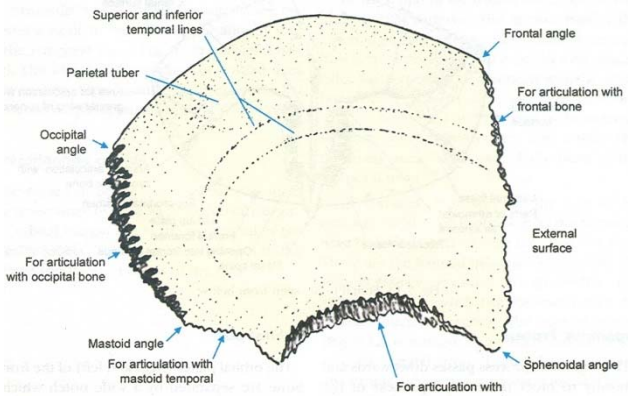
Short bones

Flat bones

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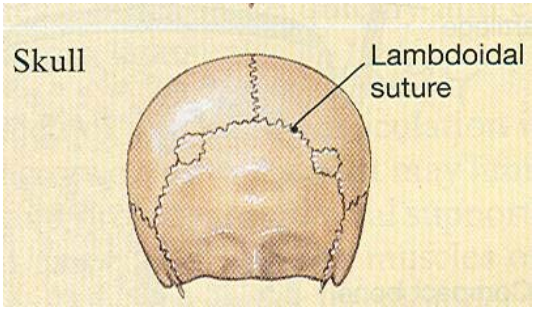
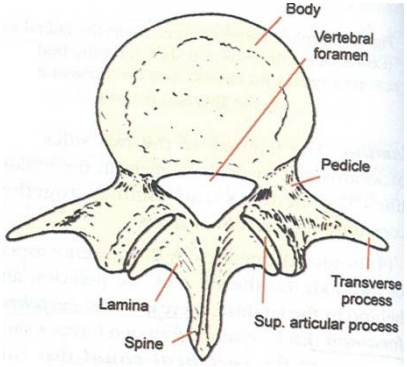
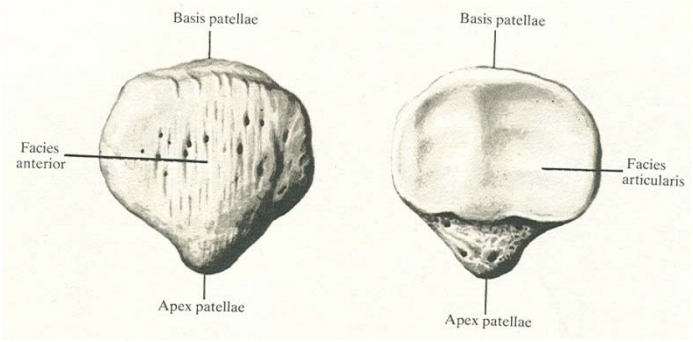
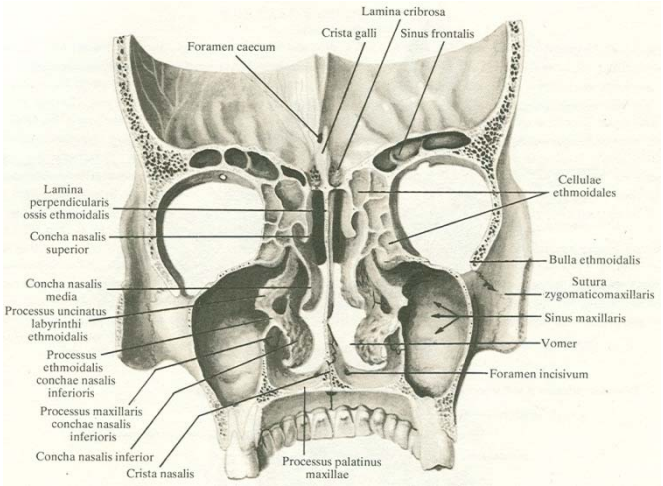
# According to size & shape

- Irregular bones
- Pneumatic bones
- Sesamoid bones
- Accessory bones



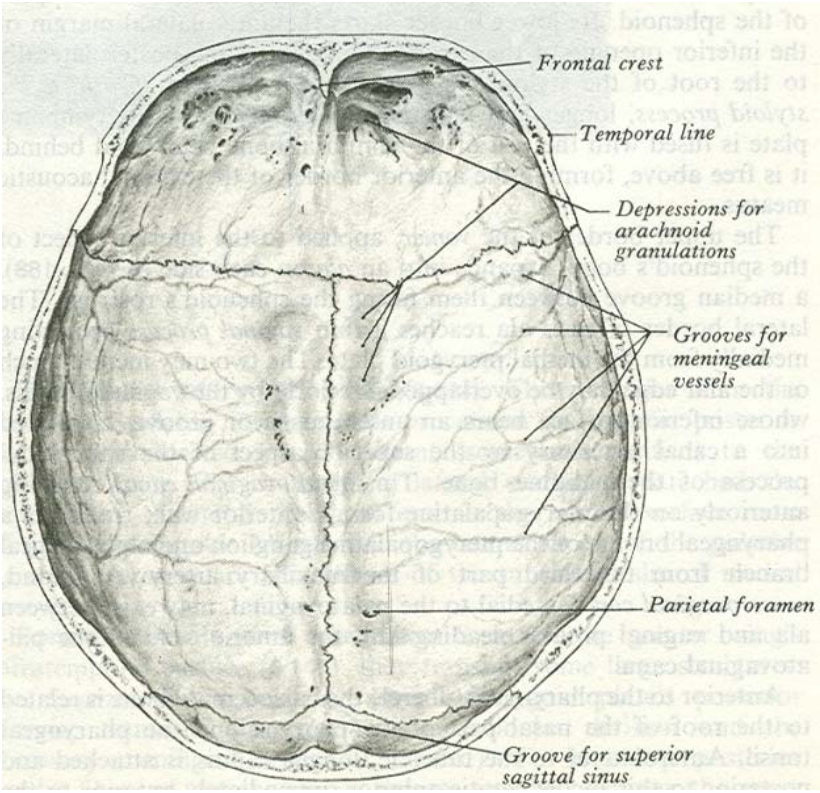



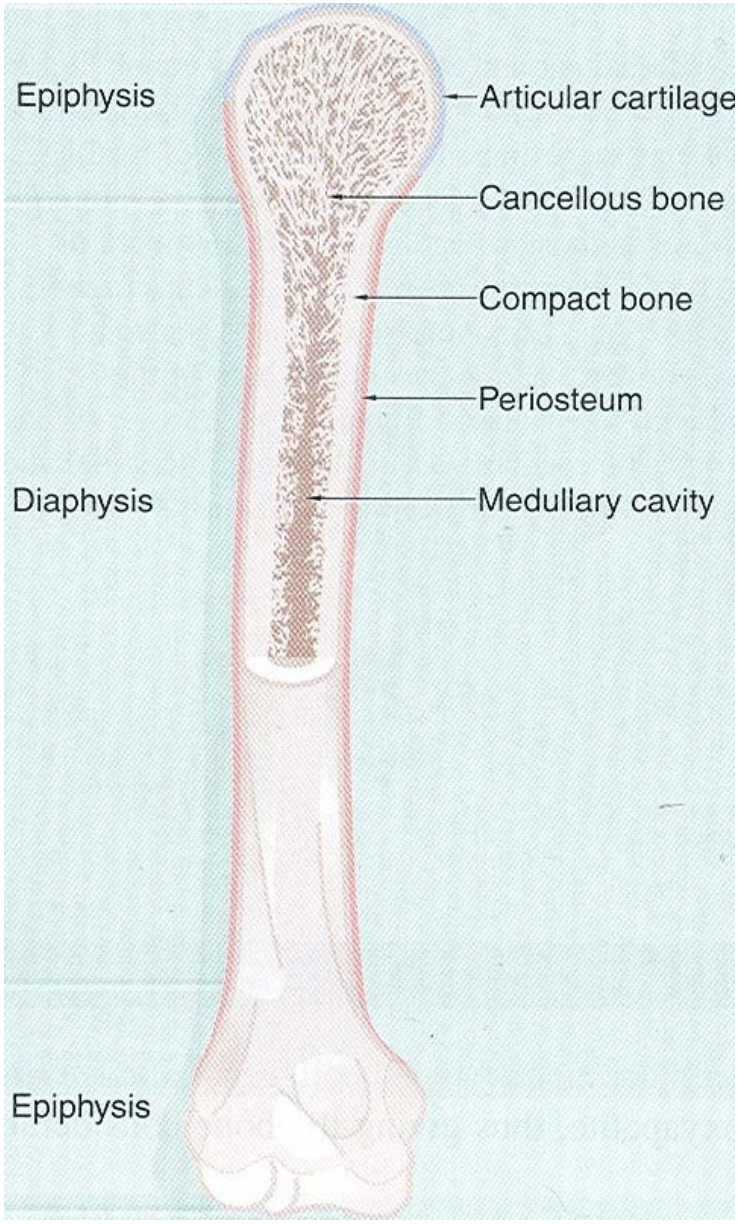



## c. According to gross structure

- Compact (Lamellar) bone
- Spongy (cancellous) bone
- Diploic bones



## d. 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

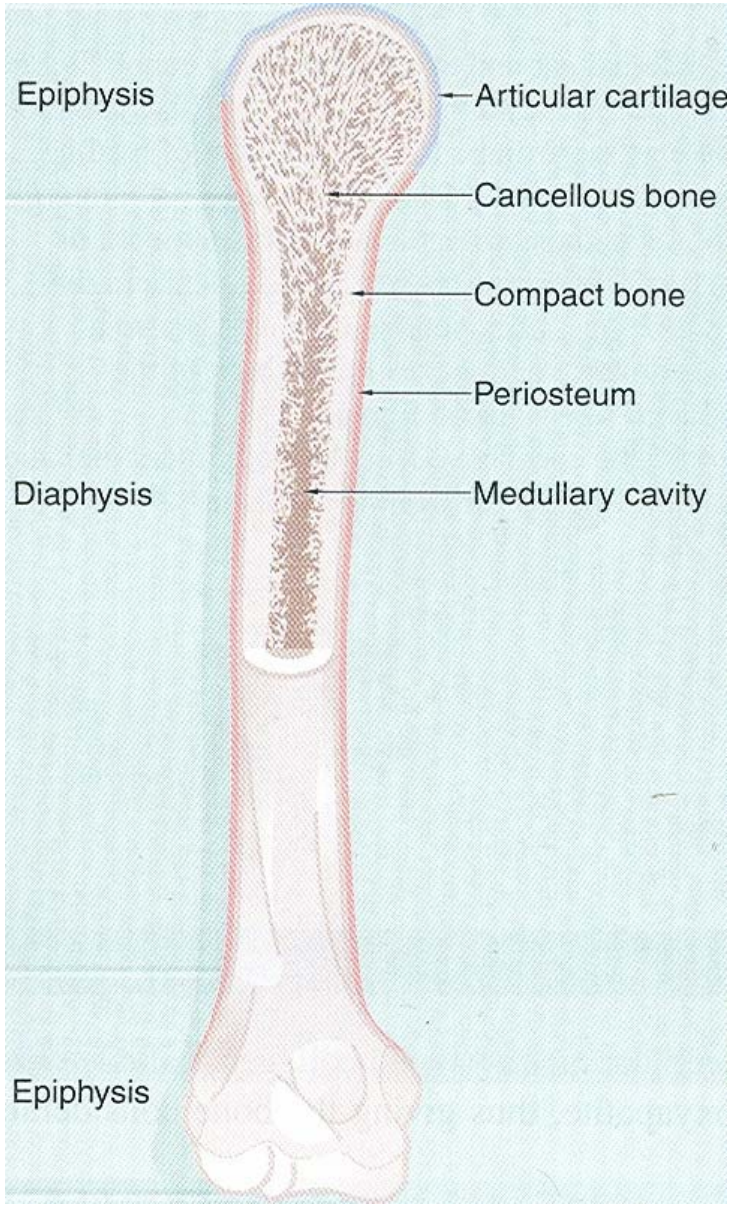
**Composition of bone** -

- 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, Fluoride, and magnesium phosphate

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

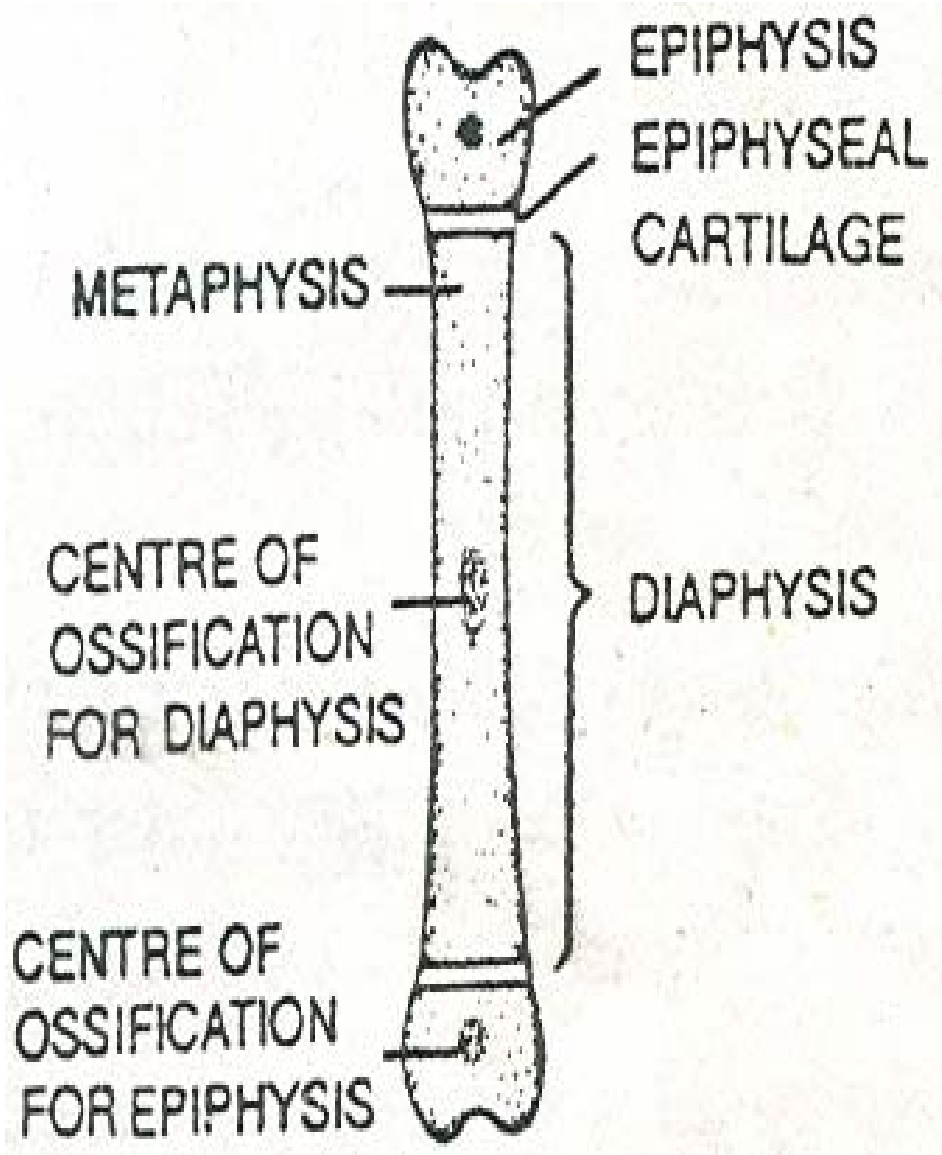
# Macroscopic structure of living adult bone

- Compact bone
  - Periosteum
  - Endosteum
  - Medullary cavity
- Cancellous bone
  - Bone marrow – red
    yellow



# Parts of a developing long bone

- **Diaphysis**- intermediate region or shaft
- **Metaphysis-** developing extra epiphyseal regions of shaft
- **Epiphysis-** ends of bone which ossify with a separate centre of ossification (secondary)



# 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.

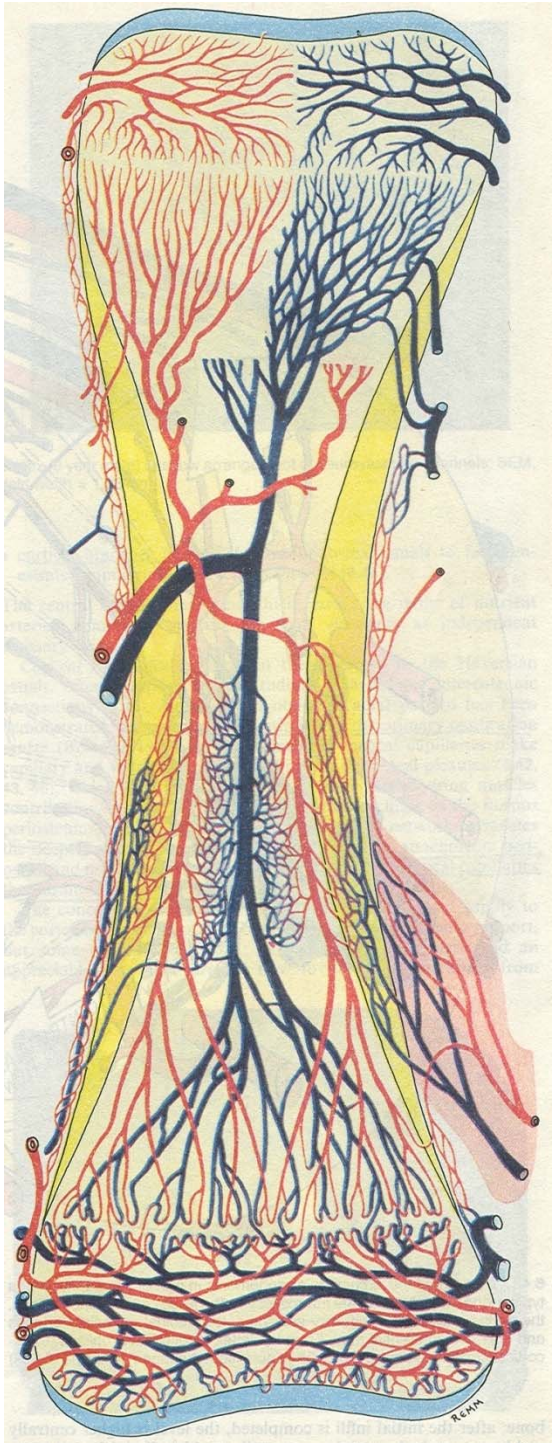
- Tendons are attached here which exert a traction on the epiphysis
- Ossify later then the pressure epiphysis e.g. trochanters of tubercles of humerus

**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**

- 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)

# OSSIFICATION AND CALCIFICATION

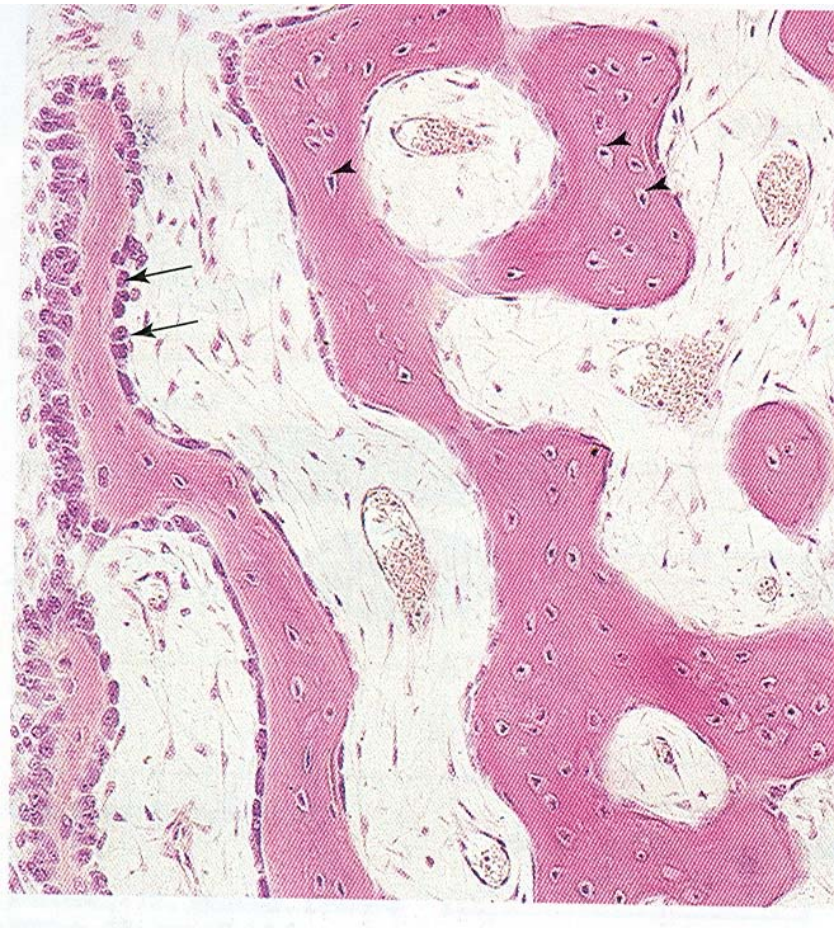
- Involves differentiation of osteoblasts which secrete organic intercellular substances and collagen fibers.
- Calcification takes place by depositing calcium crystals within the collagen fibers (calcification is only a part of ossification)

**TYPES:**

- Intramembranous
- Intracartilaginous

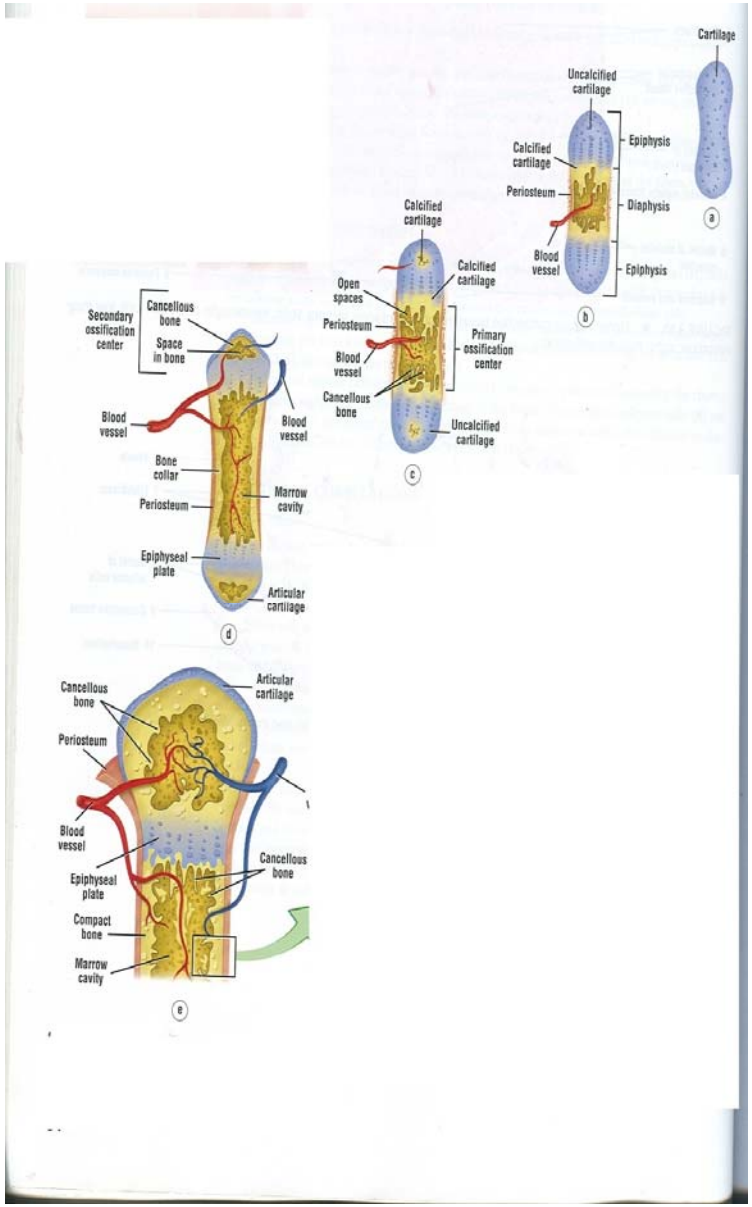
# Membranous ossification

- 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



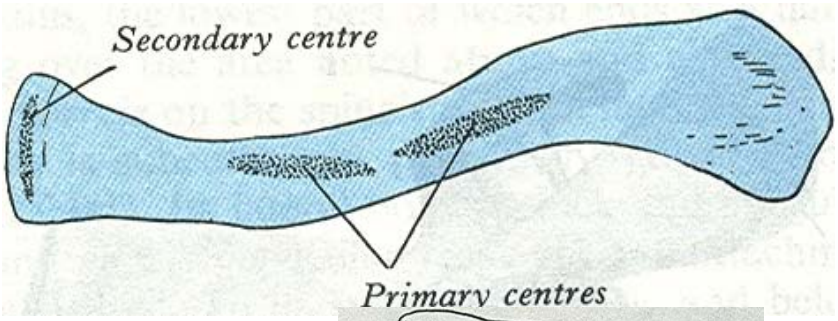
# Intracartilaginous (Endochondral ossification)

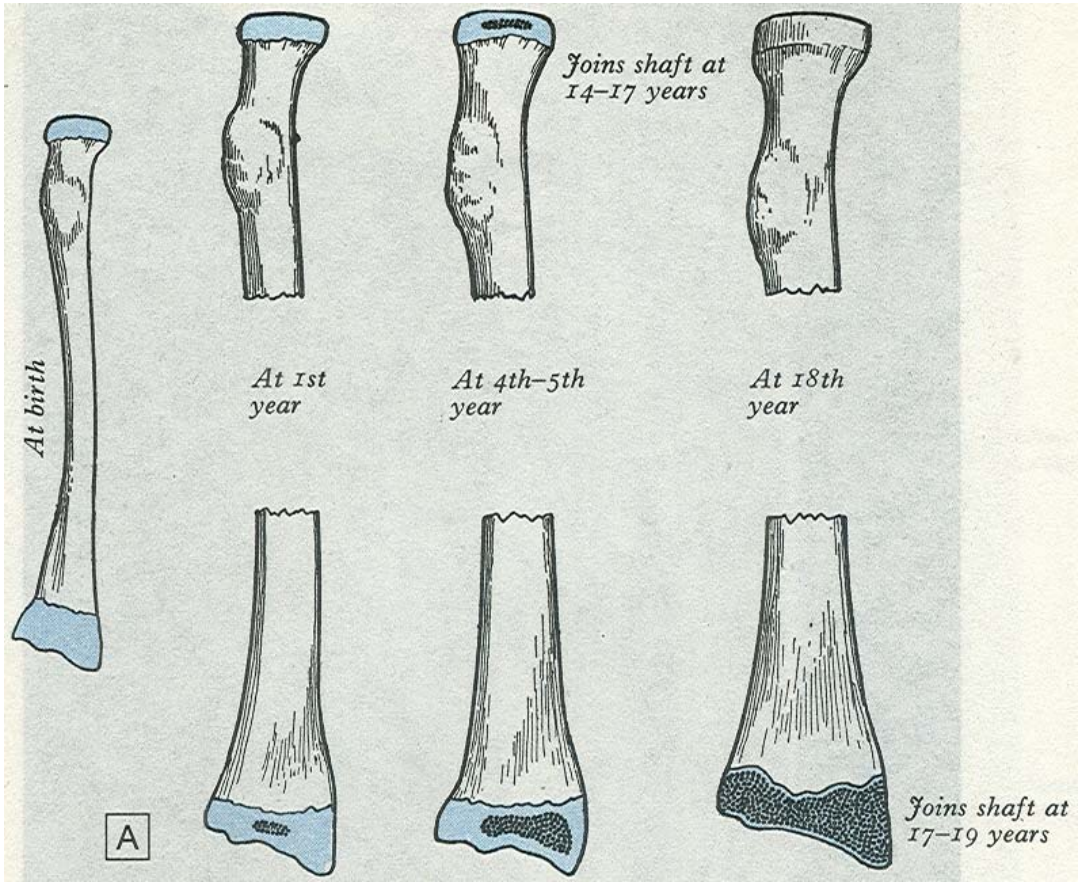
- Condensation of mesenchymal cells occur at the site of bone formation
- Mesen Cells are transformed in to chondroblast which now form hyaline cartilage
- Formation of perichondrium which is highly vascular
- Hypertrophy of cartilage cells & formation of calcified matrix
- Subperiosteal ossification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

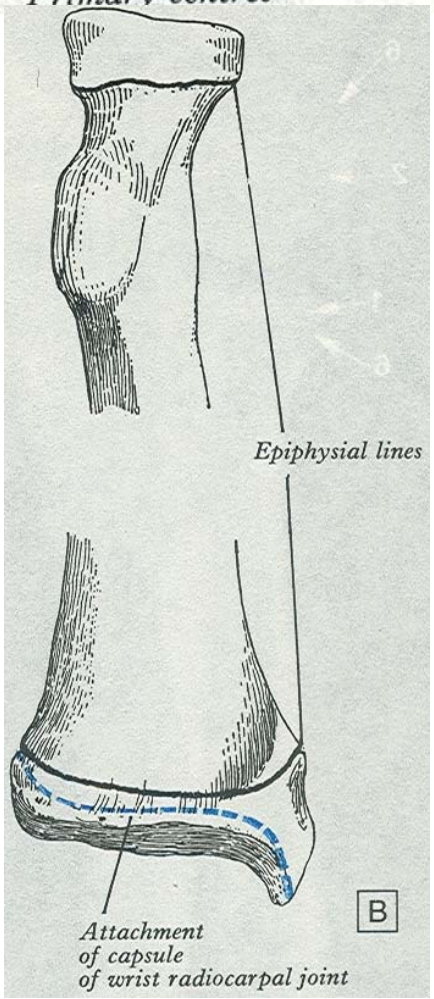


# Centers of ossification

- Primary center
- Secondary center
- Epiphyseal line



# Some important points about ossification

- Ossification begins constantly at a prefixed spot & at a fairly constant time
- Centers may be primary or secondary
- Primary center may be single or multiple but as a rule appear before birth between $6^{th}$ to $8^{th}$ wk of fetal life. Exceptions - cuneiform & navicular bones
- Secondary centers usually multiple & appear after birth. Exception is 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 secondary 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

# GROWTH OF A LONG BONE

- Appositional
  - Growth at the periphery of the bones resulting in increase in diameter of long bones
- Endocondral
  - Results in increase in length of long bones. It occurs due to the multiplication of the cells of the epiphysial phase.

**Remodeling of the bone**

- Surface remodeling
- Internal remodeling

# FACTORS EFFECTING GROWTH OF BONES

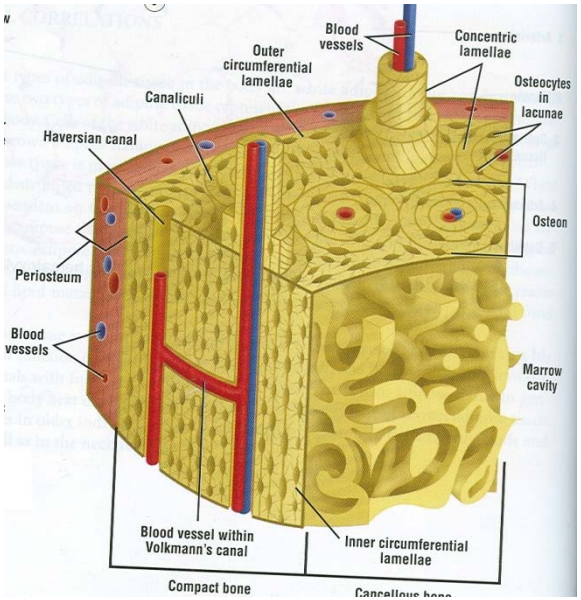
- Nutritional factors
  - Vitamin A, C, D
- Hormonal factors
- Genetic factors
- Mechanical factors

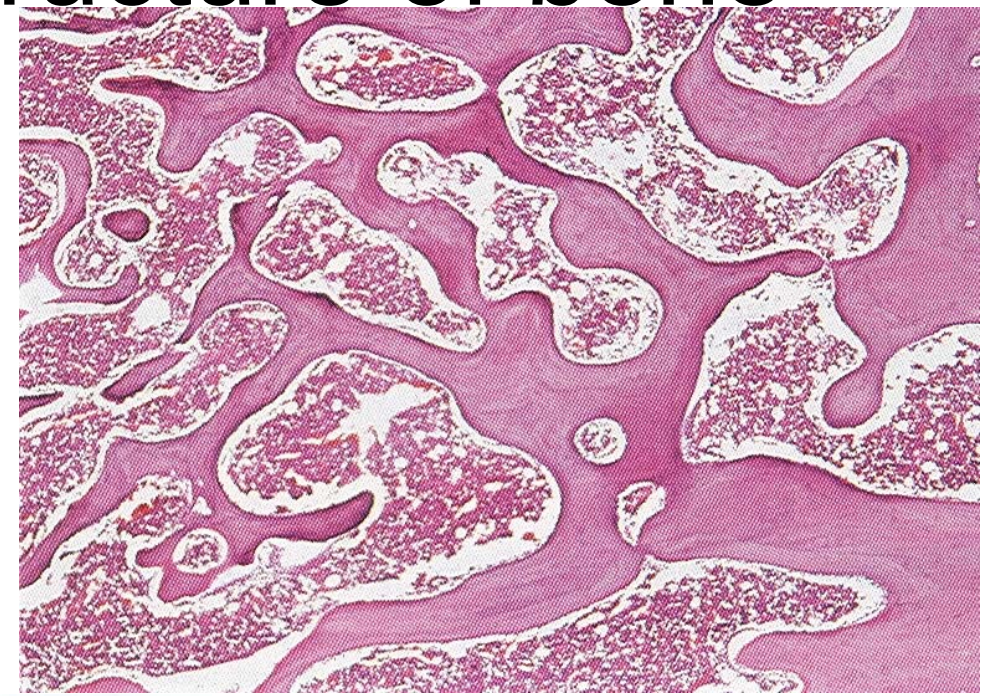
# Estimation of age, sex &height from the bones

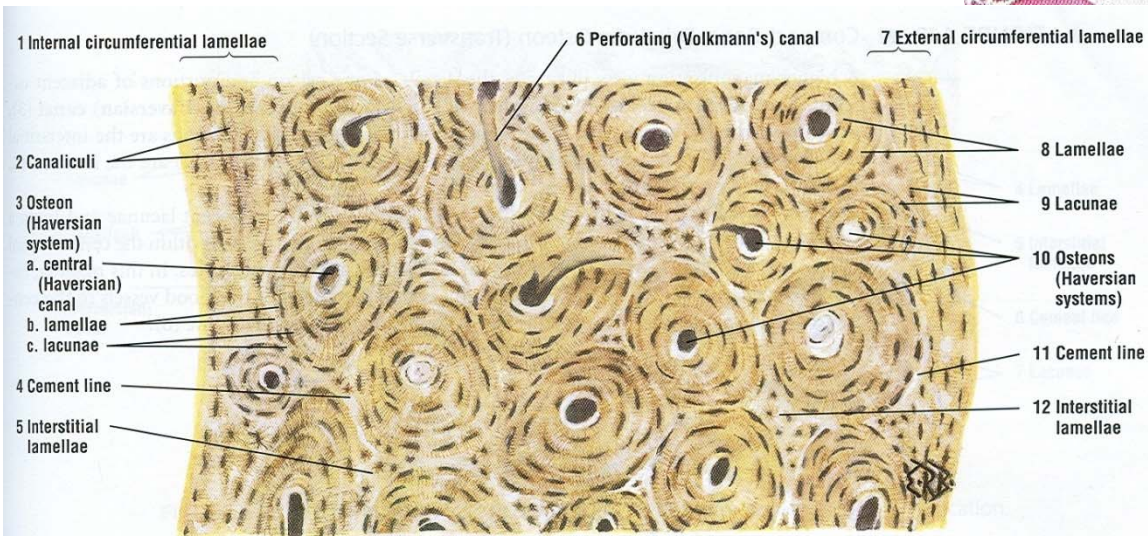
- Timing of eruption of milk teeth & permanent teeth can estimate age up to18 years
- Age at which epiphysis of the bone appears and fuses with the diaphysis is fairly constant. This can provides the age till 25 years
- After 25 years age is estimated by the closing of cranial sutures &changes occuring at the medial surface of pubic bones. By 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 with 85-90% accuracy by metrical & nonmetrical data developed from cranial &other parts of skeleton.

# Microscopic structure of bone





# Epiphyseal cartilage

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