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

Appendicular
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

- Acromioclavicular joint
- Acromion of scapula
- Greater tubercle
- Lesser tubercle
- Intertubercular groove
- Head
- Lateral epicondyle
- Capitulum
- Proximal radio-ulnar joint
- Head
- Tuberosity
- Radius
- Lower end
- Styloid process
- Wrist joint
- Phalanges

- Sternal end of clavicle
- Coracoid process
- Medial border
- Body of scapula
- Margin of glenoid cavity
- Shoulder joint
- Humerus
- Medial epicondyle
- Trochlea
- Elbow joint
- Coronoid process
- Ulna
- Head
- Distal radio-ulnar joint
- Styloid process
- Carpals
- Metacarpal bones

- Greater trochanter
- Ischial spine
- Lesser sciatic notch
- Ischial tuberosity

- Head of femur
- Femoral condyle
- Lateral condyle of tibia
- Head of fibula
- Lateral malleolus
- Calcaneus
According to size & shape

- Long 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
- Mesenchymal cells are transformed into chondroblasts 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.

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 than 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 8th 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 to 18 years.
- Age at which epiphysis of the bone appears and fuses with the diaphysis is fairly constant. This can provide the age till 25 years.
- After 25 years age is estimated by the closing of cranial sutures & changes occurring 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 with 85-90% accuracy by metrical & nonmetrical data developed from cranial & other parts of skeleton.