Bone Growth & Development

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Types of Bone Cells

- **Osteocyte** – mature bone cell, enclosed in lacuna
- **Osteoblast** – bone-forming cell; secretes ECM of bone tissue (collagen fibers & calcium salts)
- **Osteoclast** – bone-destroying cell; breaks down ECM to release calcium into the bloodstream
Bone Formation

- Bone is formed a process called Osteogenesis or ossification.
- Bones are originated from mesenchymal cells.
- This process begins before birth (during 6th week of embryonic development) & continues till 21 years of age.
TYPES

Bones are developed in 2 ways

- **Intramembranous ossification**
  Bones develop from fibrous membrane (membrane model)
  eg: Flat bones of skull & clavicle

- **Intra cartilageous ossification**
  (Enchondral ossification)
  Bones develop from hyaline cartilage (cartilage model)
  eg: Long bones

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OSSIFICATION PROCESS

During the process of bone development osteoblasts secrete osteoid which gradually replaces the initial model. Then this osteoid is progressively calcifies & forms bones.
DEVELOPMENT OF LONG BONES (ENCHONDRAL OSSIFICATION)

- Long bones develop in the fetus from rods of cartilage (cartilage model)
- Ossification begin from the primary centres of ossification
Bone collar develops around the diaphysis
Cartilage in primary ossification center calcifies, then the cells die and cavities form (cavitates)

- Bone collar provides stability during cavitation
Periosteal bud (lymph, blood vessels, nerves) enters cavity. Osteoblasts secrete osteoid components in the shaft. So the bone tissue replaces cartilage.

- The ossification continues & spreads to the epiphyses. So the bone lengthens.
- **Secondary ossification centre form in the epiphyses.** Osteoclasts in this area produce spongy bone that replace the cartilage.

- **Osteoclasts break down the central bone tissue in the middle of the shaft.** This forms a medullary canal.
- Hyaline only remains in epiphyseal surface (forms articular cartilage) and diaphysis and epiphysis junction (forms epiphyseal plates)
During childhood long bones continue to lengthen due to epiphyseal plate at each end of the bone. It produces new cartilage & is then turned to bone.

At puberty due to sex hormones the epiphyseal plate growth slows down & is replaced by bone. Then further lengthening of bone is not possible.
1. Formation of bone collar around hyaline cartilage model.

2. Cavitation of the hyaline cartilage within the cartilage model.

3. Invasion of internal cavities by the periosteal bud and spongy bone formation.

4. Formation of the medullary cavity as ossification continues; appearance of secondary ossification centers in the epiphyses in preparation for stage 5.

5. Ossification of the epiphyses; when completed, hyaline cartilage remains only in the epiphyseal plates and articular cartilages.
Bone Growth

- During childhood all bones grow in thickness by appositional growth & long bones lengthen by interstitial growth.
Longitudinal Growth (Growth in length)

- The epiphyseal plate or growth plate is a cartilage between the diaphysis & epiphysis of long bones.
- The activity of the epiphyseal plate makes the bone to grow in length.
As the bone grows, new chondrocytes are formed on the epiphyseal side of the plate while old chondrocytes on the diaphyseal side of the plate are replaced by bone. In this way, the bone on the diaphyseal side increases in length.
Appositional Bone Growth (Growth in thickness)

- As the new bone tissue is deposited on the outer surface of the bone, the bone tissue lining the medullary cavity is destroyed by osteoclasts.
- In this way the medullary cavity enlarges as the bone increases in thickness.
The epiphyseal cartilage cells stop dividing & get replaced by bone at about 18 years in females 21 years in males leaving a bony structure called the epiphyseal line.