

Skeletal System

Components

- Bone
- Cartilage
 - Model for bone growth
 - Anti-friction
- Tendons
 - Muscle to bone
- Ligaments
 - Bone to bone

Skeletal System Functions

- Support
- Protection
- Movement
- Storage
- Blood cell production

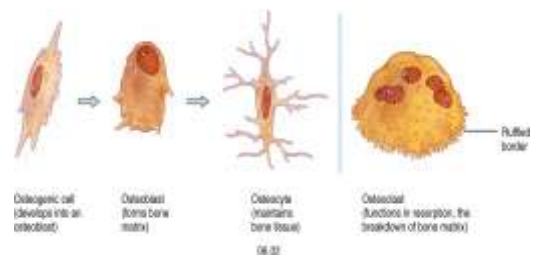
Bone Composition

- Lots of intercellular matrix (with few cells)
 - Calcium carbonate & calcium phosphate → 67%
 - Collagenous fibers → 33%
 - Small amounts of fluoride, magnesium hydroxide and sulfate

Types of Bone Cells

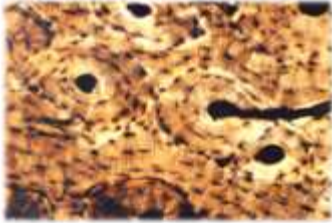
- Osteoprogenitor Cells
 - unspecialized bone cells
 - become osteoblasts
- Osteoblasts
 - deposit mineral salts and collagenous fibers (builds bone)
- Osteocytes
 - maintains bone tissue
- Osteoclasts
 - break down bone tissue

Bone Cells



Classification of Bone

- Compact Bone (Dense Bone)
 - little space between the solid components



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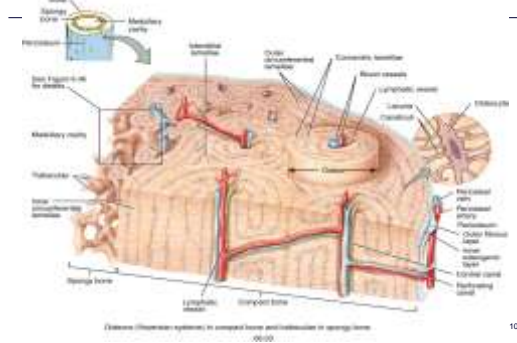
Compact Bone Structure

- Sheets of bone create Lamellae
- Lamellae form concentric circles to form Osteons or Haversian Systems
- Haversian/Central Canal
 - hollow central canal within osteon that houses blood vessels and nerves

Compact Bone Structure

- Osteocytes embedded in spaces called Lacunae
- Radiating in all directions from lacunae are minute canals called Canaliculi
 - Connect to other lacunae and eventually with Central Canal
- This entire structure or network of Lamellae, Cells, Canals, and Bone Matrix is called an Osteon or Haversian System

Compact Bone



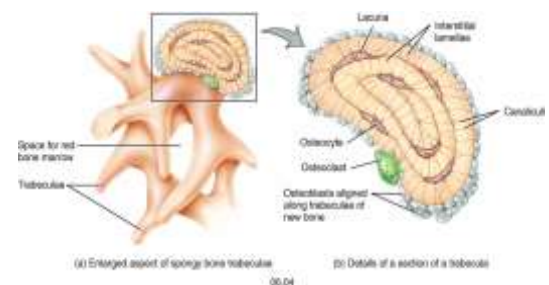
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Classification of Bones

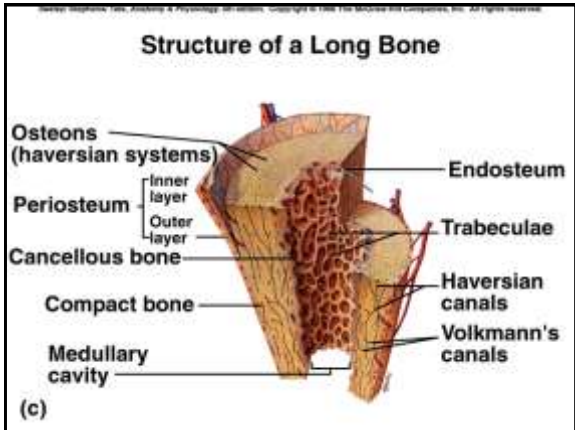
- Spongy Bone (Cancellous Bone)
 - Lots of space between the solid components
 - made up of an irregular network of thin plates of bone (trabeculae) with lots of intercellular space
 - Spaces filled with Red Bone Marrow
 - Hematopoiesis



Spongy Bone Structure

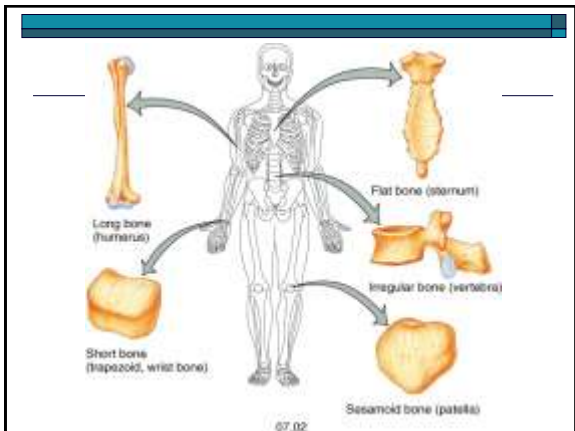


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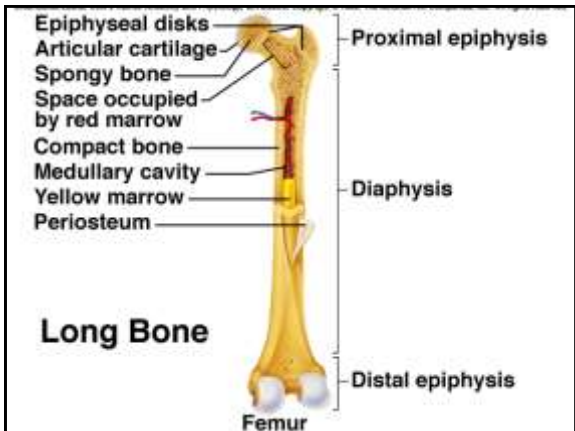
Bone Shape

- Long bones
- Flat bones
- Short bones
- Irregular bones
- Sesamoid bones



Long Bones

- greater length than width
- have a distinct diaphysis and a variable number of epiphysis
- slightly curved for strength
- Examples: humerus, ulna, radius, phalanges, metacarpals



Short Bones

- cubed shaped bones
- nearly equal in length and width
- spongy texture on inside of the bone
- carpal and tarsal bones

Flat Bones

- generally thin and flat
- compact bone on anterior and posterior surfaces with spongy bone in the middle
- provides protection to organs
- great surface area for muscle attachment
- cranial bones, sternum, scapula, ribs

Structure of a Flat Bone



Irregular Bones

- complex shaped bones
- can't be classified into other categories
- vary in the amount of spongy and compact bone
- vertebrae, facial bones



Sesamoid Bones

- small bones situated in tendons where considerable pressure develops
- vary in number between individuals
- kneecaps



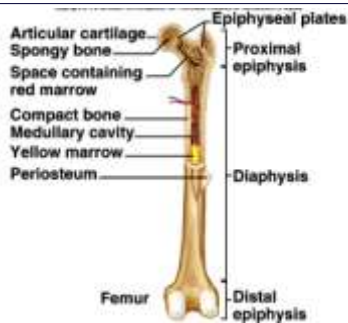
Long Bone Structure

- Diaphysis = shaft of a long bone
 - composed of compact bone
 - continuous membrane no gaps
- Epiphysis = Distal/proximal ends of long bones
 - Articulating surfaces covered with hyaline cartilage
 - articulates = forms joint w/ another bone
 - composed mostly of spongy bone
- Metaphysis = the area between the diaphysis and the epiphysis
 - contains the epiphyseal plate

Bone Structure

- Periosteum = covering on the outside of the bone
- Medullary Cavity = hollow in shaft filled with marrow
- Endosteum = lining of the medullary cavity

Long Bone Structure



Proximal End of a Long Bone



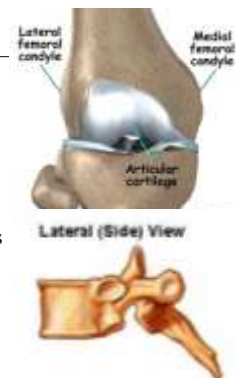
Bone Features

- Body/shaft/diaphysis
- Head
 - Humerus, femur
- Neck
 - Femoral neck



Bone Features

- Condyle
 - Distal femur, posterior mandible, occipital condyles
- Facet
 - Thoracic vertebral bodies



Bone Features

- Crest
 - Sagittal crest
- Process
 - Mastoid process (temporal), styloid process (distal radius & ulna)



Bone Features

- Tubercle:
 - greater & lesser tubercle on humerus,
- Tuberosity:
 - radial tuberosity, tibial tuberosity, deltoid tuberosity (humerus)



Bone Features

- Trochanter
 - Greater & lesser trochanters on proximal femur
- Epicondyle
 - Lateral epicondyle of humerus



Bone Openings or Depressions

- Foramen/foramina
 - Mental foramen (lateral mandible)
- Canal/meatus
 - Canal: carotid canal (base of skull)
 - Meatus: external auditory meatus



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Bone Openings or Depressions

- Fissure
 - Superior orbital fissure, inferior orbital fissure
- Sinus
 - Frontal sinus
- Fossa
 - Olecranon fossa (posterior, distal humerus)
 - Fovea capiti on femoral head (fovea smaller than fossa)

Epiphyseal Plate



Ossification

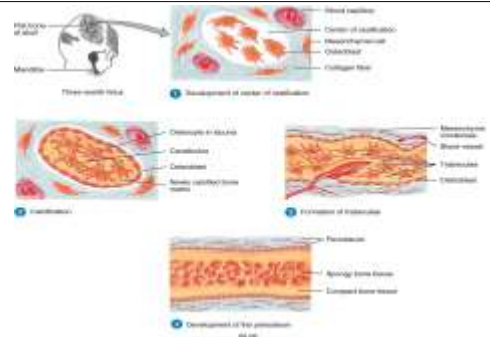
- The process by which bones form in the body (osteogenesis) in the fetus
- The replacement of pre-existing connective tissue with bone
- Intramembranous Ossification (between membranes)
 - For skull & shoulder girdle bones
 - (Periosteum - width-wise growth)
- Endochondral Ossification (from cartilage model)
 - Base of skull & rest of bones
 - (Epiphyseal Plate - length-wise Growth)

Ossification

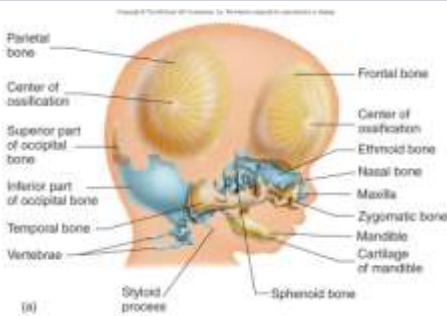
- Cartilage model formed by chondrocytes
- Ossification centers: osteoblasts move outward from here building bone matrix (carried here by blood vessels)
- Activity of osteoclasts (“clean up crew”) break down and remove bone tissue forming trabeculae

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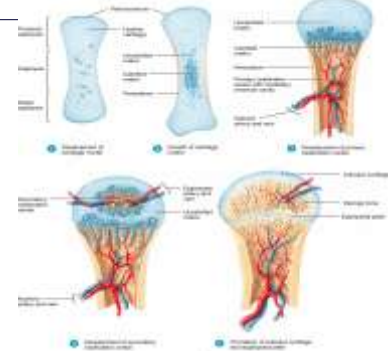
Intramembranous Ossification



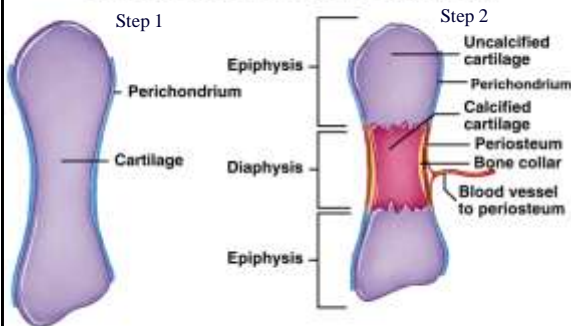
Intramembranous Ossification



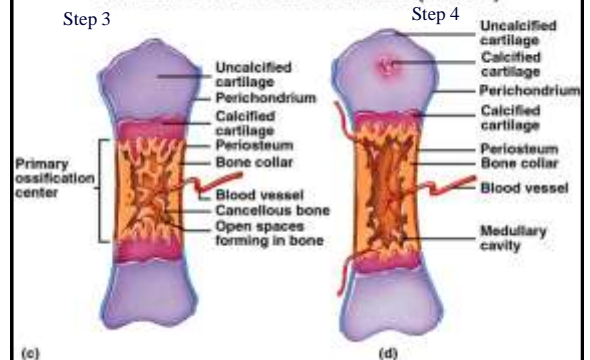
Endochondral Ossification



Endochondral Ossification (Part 1)

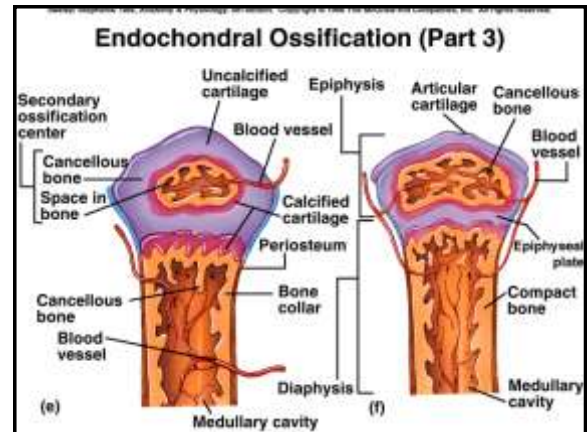


Endochondral Ossification (Part 2)

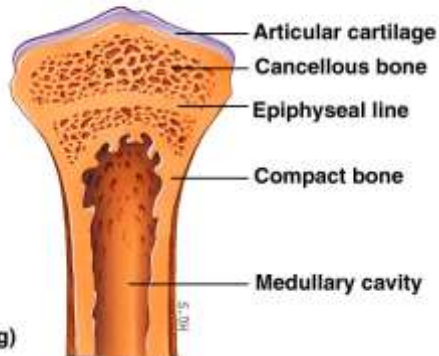


Endochondral Bone Growth

- Centers of ossification appear in the epiphysis (ends) of bone
- Epiphyseal plate (“Growth plate”) : gradually the cartilage is transformed into bone
- Epiphyseal line: marks where two centers of ossification have fused together



Endochondral Ossification (Part 4)



Bone Growth

- Appositional growth - adds width
 - Remove bone from endosteum
 - Add bone to periosteum
- Adding length – at epiphyseal plate
 - Ossification occurs
 - Chondrocytes create cartilage model
 - Cartilage matrix is calcified
 - Osteoblasts replace cartilage

Types of Fractures

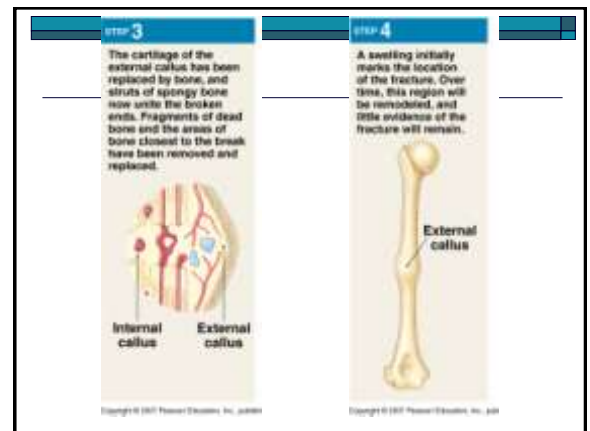
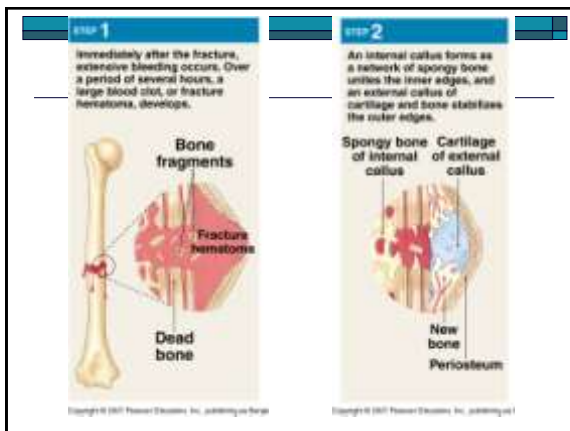
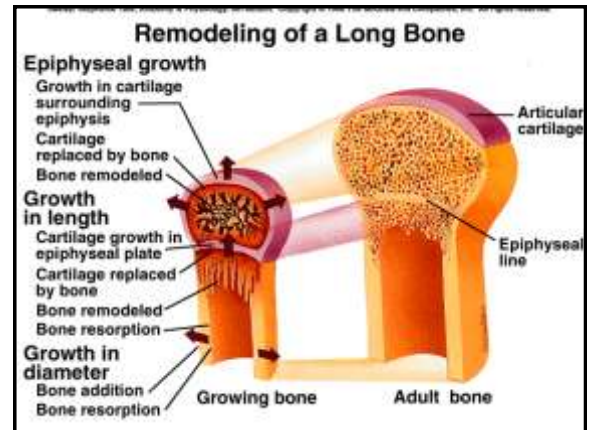
- Closed
 - internal, not thru skin
- Open =compound
 - break through skin
- Transverse
 - across long axis
- Spiral
 - twisting
- Comminuted
 - shattered

Bone Fractures

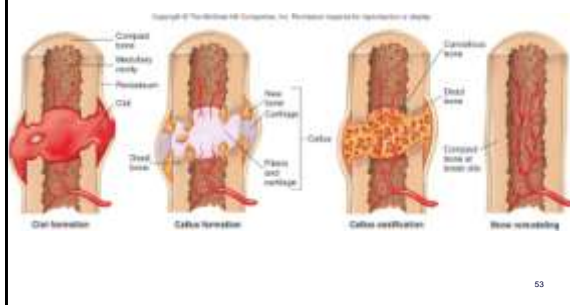


Bone Remodeling & Repair

- Bone Remodeling – depositing new bone matrix in a mature bone... why?
 - Changes bone shape, stress adjustment, bone repair, blood calcium regulation
- Bone Repair – fixing bone when broken
 - Form clot
 - Callus formation
 - Callus ossification
 - Bone remodeling

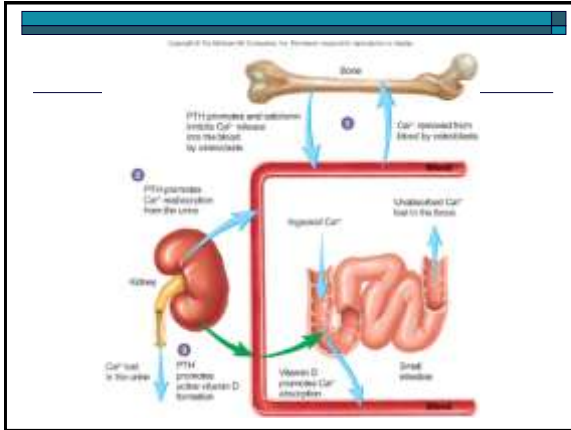


Bone Repair



Bone & Calcium Homeostasis

- **Parathyroid hormone** – releases Ca^{2+} in blood
 - \uparrow 's Ca^{2+} by \uparrow 'g osteoclast activity
 - \uparrow Ca resorption from urine in kidney
 - Stimulates vit D prod'n
 - Stimulated by \downarrow Ca^{2+}
- **Calcitonin** – stores Ca^{2+} in bone
 - \downarrow 's Ca^{2+} by \downarrow 'g osteoclast activity
 - Stimulated by \uparrow Ca^{2+}



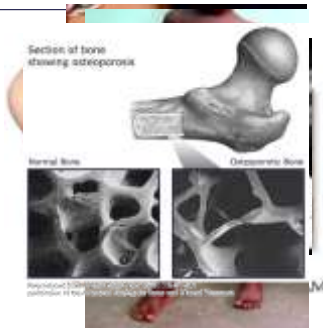
Skeletal Disorders

- Growth & Development
 - Giantism
 - Dwarfism
 - Osteogenesis imperfecta



Skeletal Disorders

- Bacterial Infection
 - Osteomyelitis
- Bone tumor
- Decalcification
 - Osteomalacia
 - Osteoporosis



Bone Marking	Description	Example
Tuberosity		
Crest		
Trochanter		
Tubercle		
Condyle		
Epicondyle		
Spine		
Process		
Head		
Neck		
Facet		
Ramus		