

BONE

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Batch-2011
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OBJECTIVES....

- **Introduction**
- **Functions.**
- **Embryological source of bone.**
- **Parts of bones**
- **Laws of ossification**
- **Blood supply of bones**
- **Classification of bones**

...OBJECTIVES

- **Microscopic study of bones.**
 - Compact and cancellous bone
- **Composition of bones.**
- **Ossification of bones.**
 - Intramembranous
 - Endochondral
- **Growth of bones**
- **Factors affecting the bone**

Introduction

- Bone is mineralized dense connective tissue
- Made up of few cells in mineralized matrix
- Consists of 30-40 % of our body weight.
- Dynamic in nature

Function

- Framework of the body.
- Attachment of muscle and tendon.
- Permit the movements in body parts.
- Protection of organs.
- Haematopoiesis
- Reservoir of minerals and fat.

Embryological source

- Embryonic mesodermal cells
- Neural crest cells

Mesenchyme

Primordial for the different types of cells.

Neural tube

Incipient spinal nerve

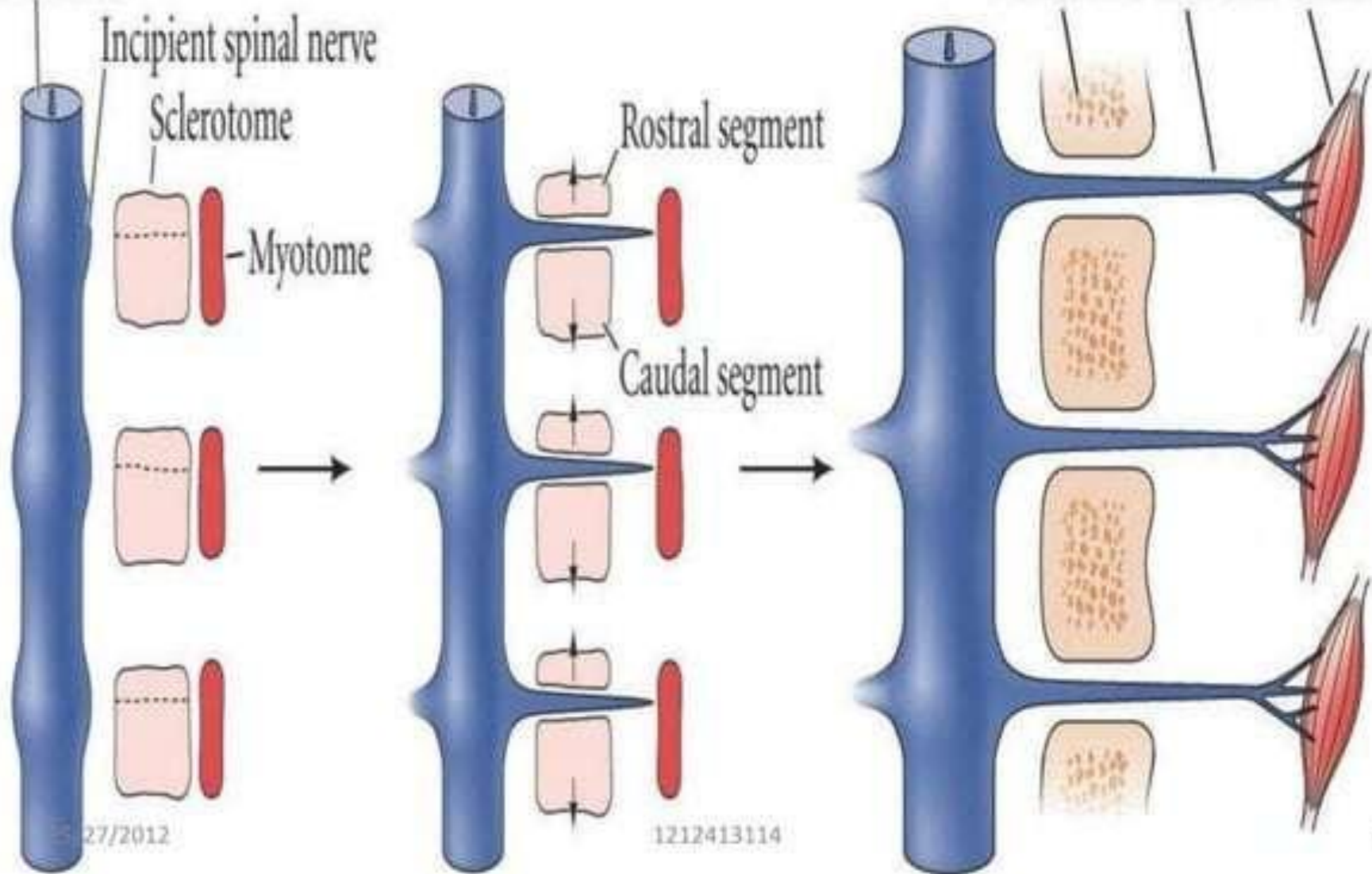
Sclerotome

Myotome

Vertebra Nerve Muscle

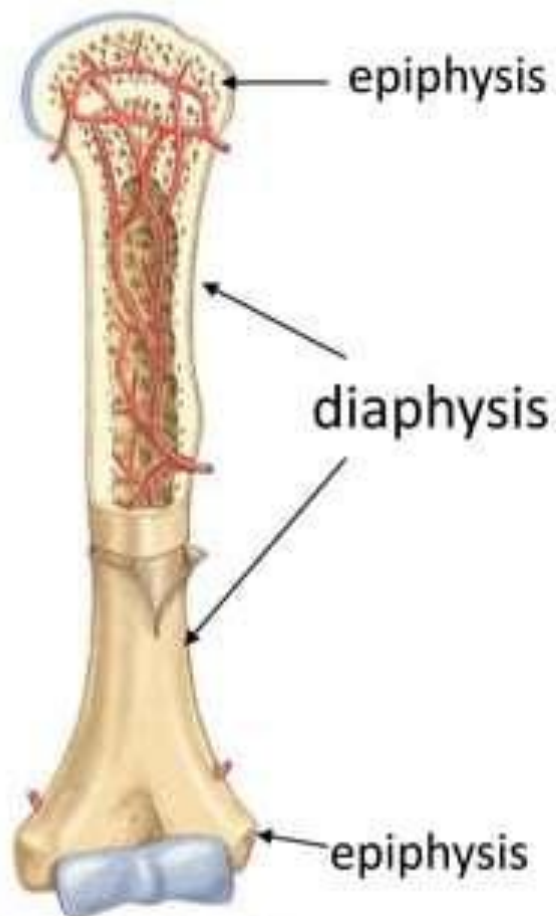
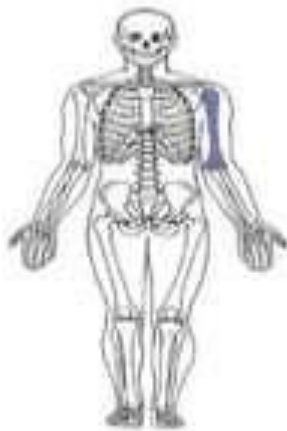
Rostral segment

Caudal segment



Parts of bones

- **Epiphysis** – secondary centers
 - Pressure epiphysis
 - Traction epiphysis
 - Atavistic epiphysis
- **Diaphysis** – primary center
 - Strongest part of bone



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- **Metaphysis**- epiphysial ends of a diaphysis
 - Maximum blood supply
- **Epiphysial plate of cartilage**- separate epiphysis from metaphysis.
 - Maximum growth

Osteomyelitis in children

• Medullary cavity



medullary cavity

- filled with yellow marrow in adults
- lined with *endosteum*

Principles of Ossification

- Primary ossification center –before birth
- Secondary ossification center- after birth
- Ossification center which appears first is usually last to fuse except for Fibula.
- In long bone with single epiphysis, that epiphysis is at the movable end

Principles of ossification

- Larger the epiphysis earlier the ossification center appears in long bone
- If epiphysis develops from more than one centers the various centers coalesce before union occurs with the diaphysis.
- When epiphysis fuses with the diaphysis the growth ceases.
- This fusion occurs 1 year earlier in females than in males.

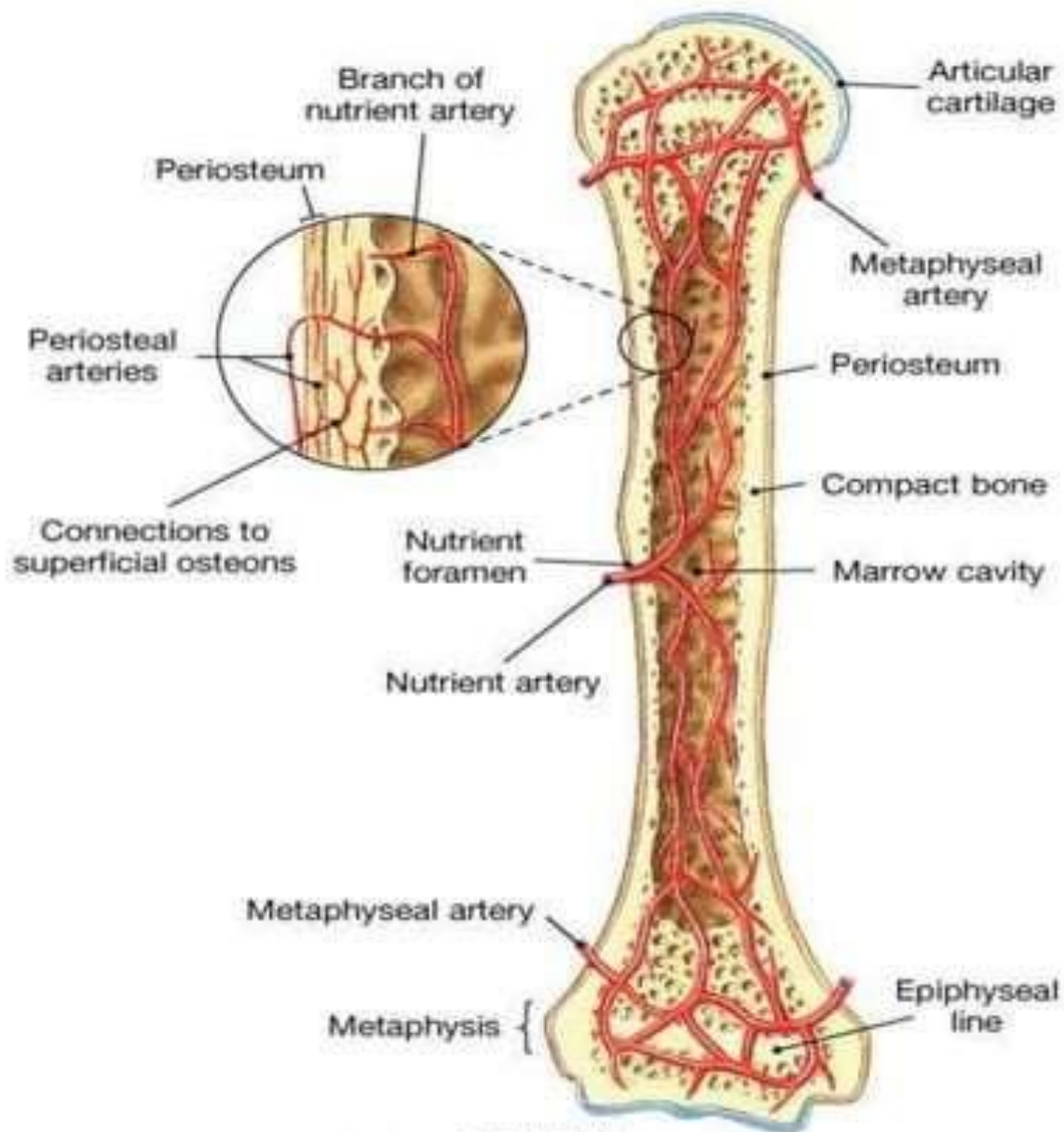
Blood supply

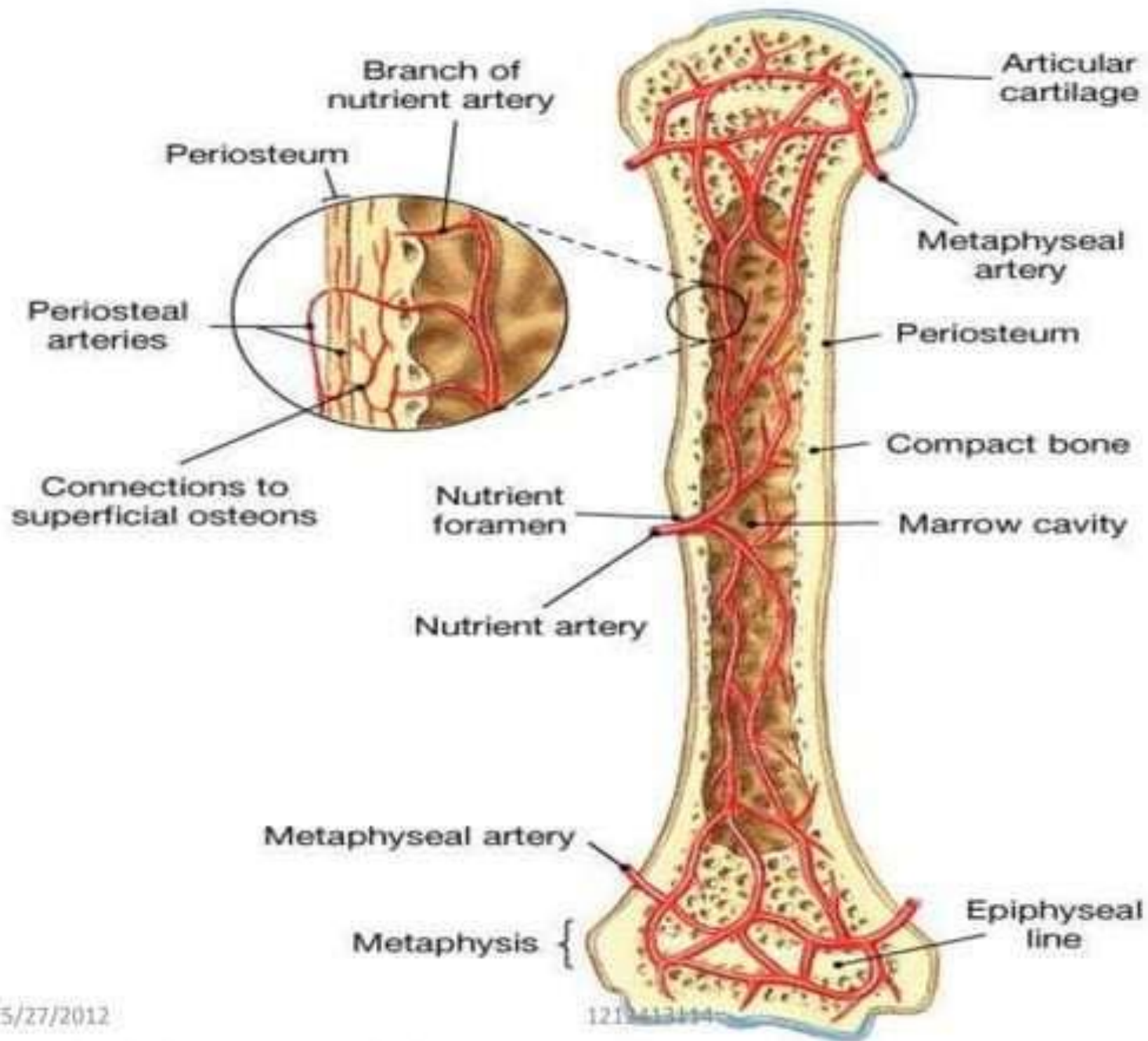
- **Nutrient artery**

- terminates in the adult metaphysis by anastomosing with epiphysial, metaphysial and periosteal arteries.
- Supplies medullary cavity , inner 2/3rd of cortex and metaphysis.

- **Periosteal arteries**

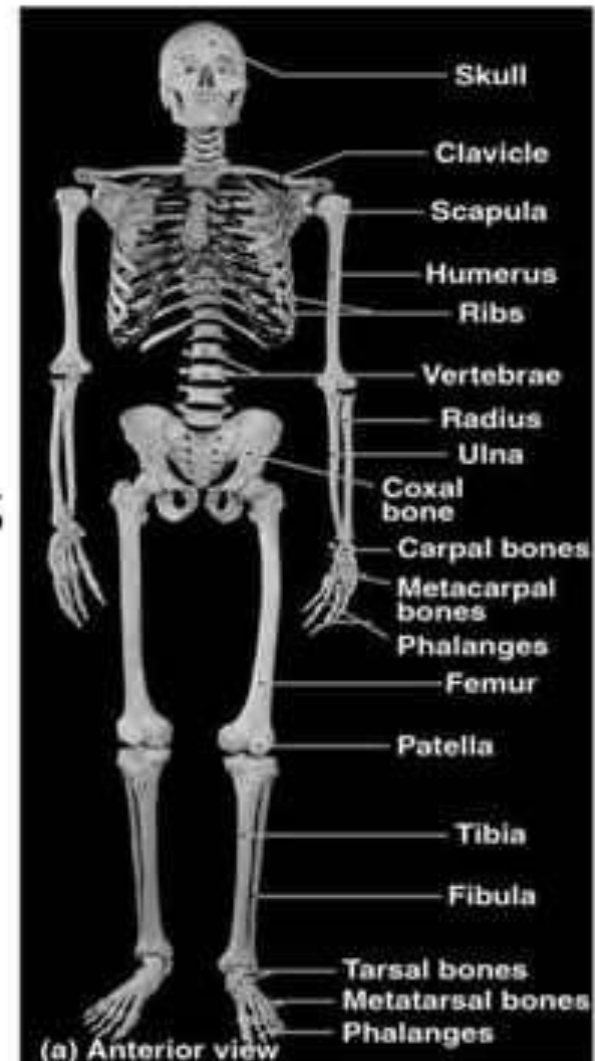
- Enter the Volkmann's canals . Supply outer 1/3rd of cortex.





Classification

- **Regional classification**
 - Axial skeleton- 80 bones
 - Appendicular skeleton-126 bones
- **Microscopic classification**
 - Compact bone
 - Cancellous/trabecular bone



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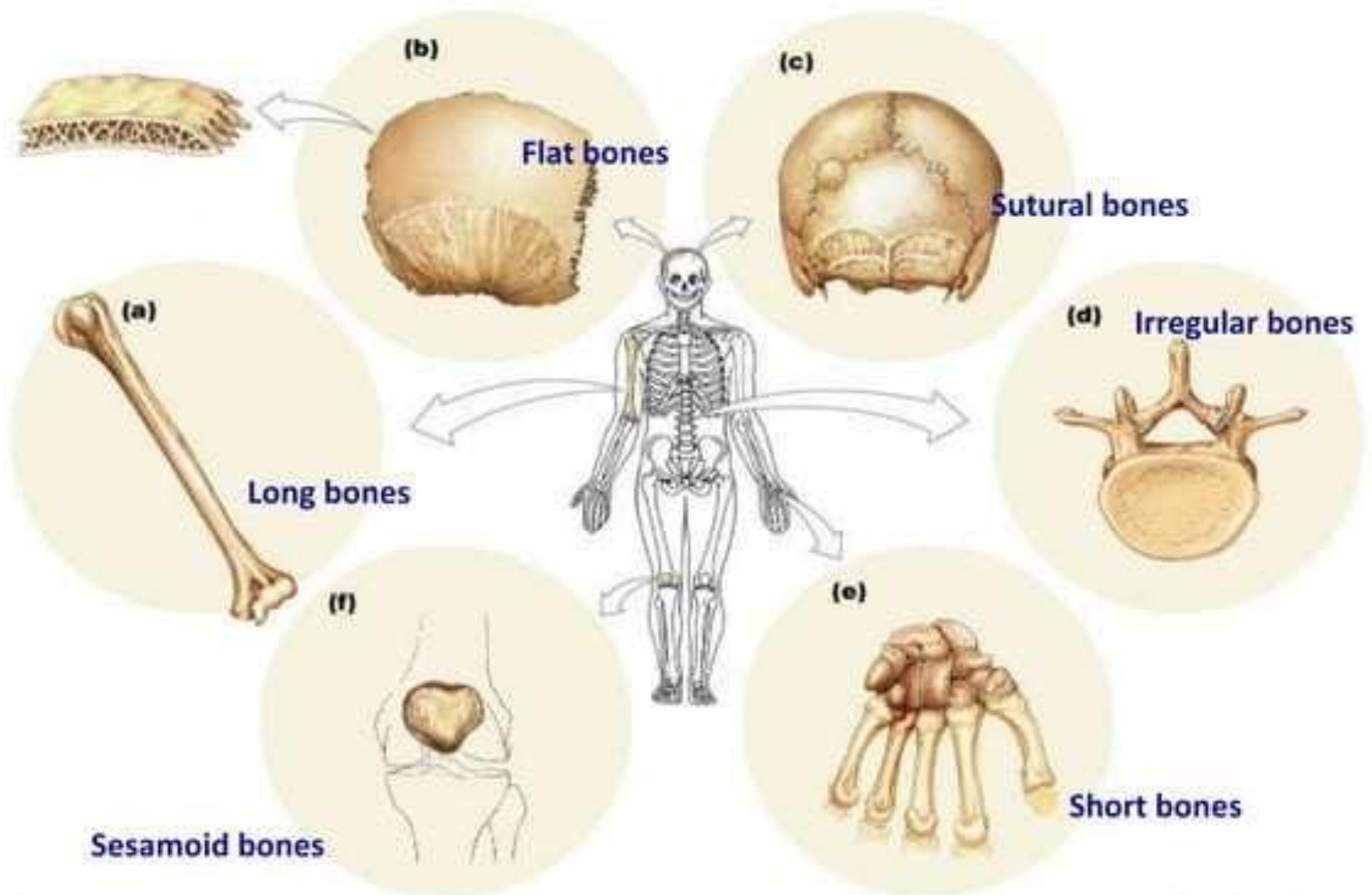
- **Developmental classification**
 - Membranous bones(dermal bone)
 - Cartilaginous bones
 - Membrano-cartilaginous bones

Achondroplasia

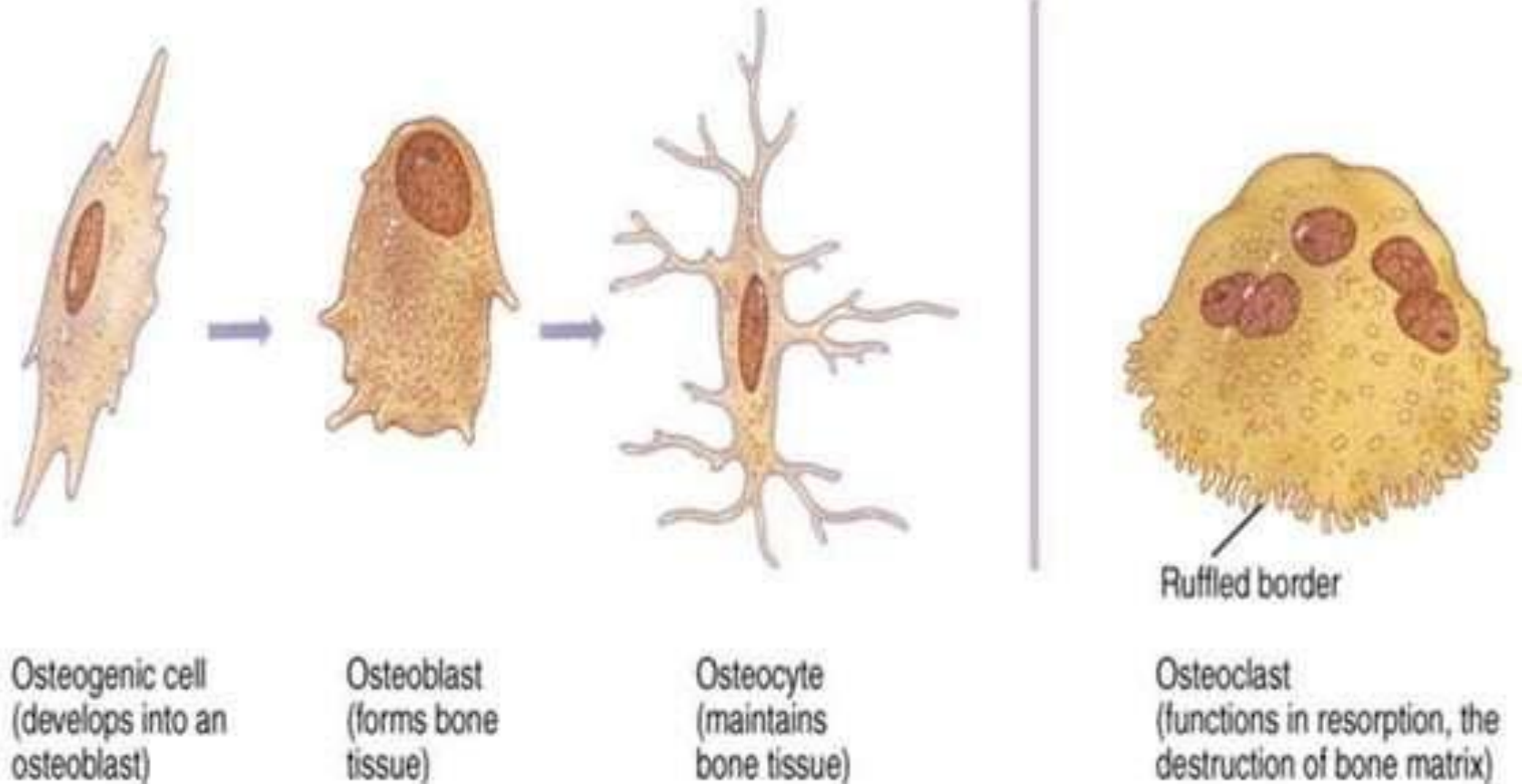
Cleidocranial syndrome

- **Bone shapes**

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

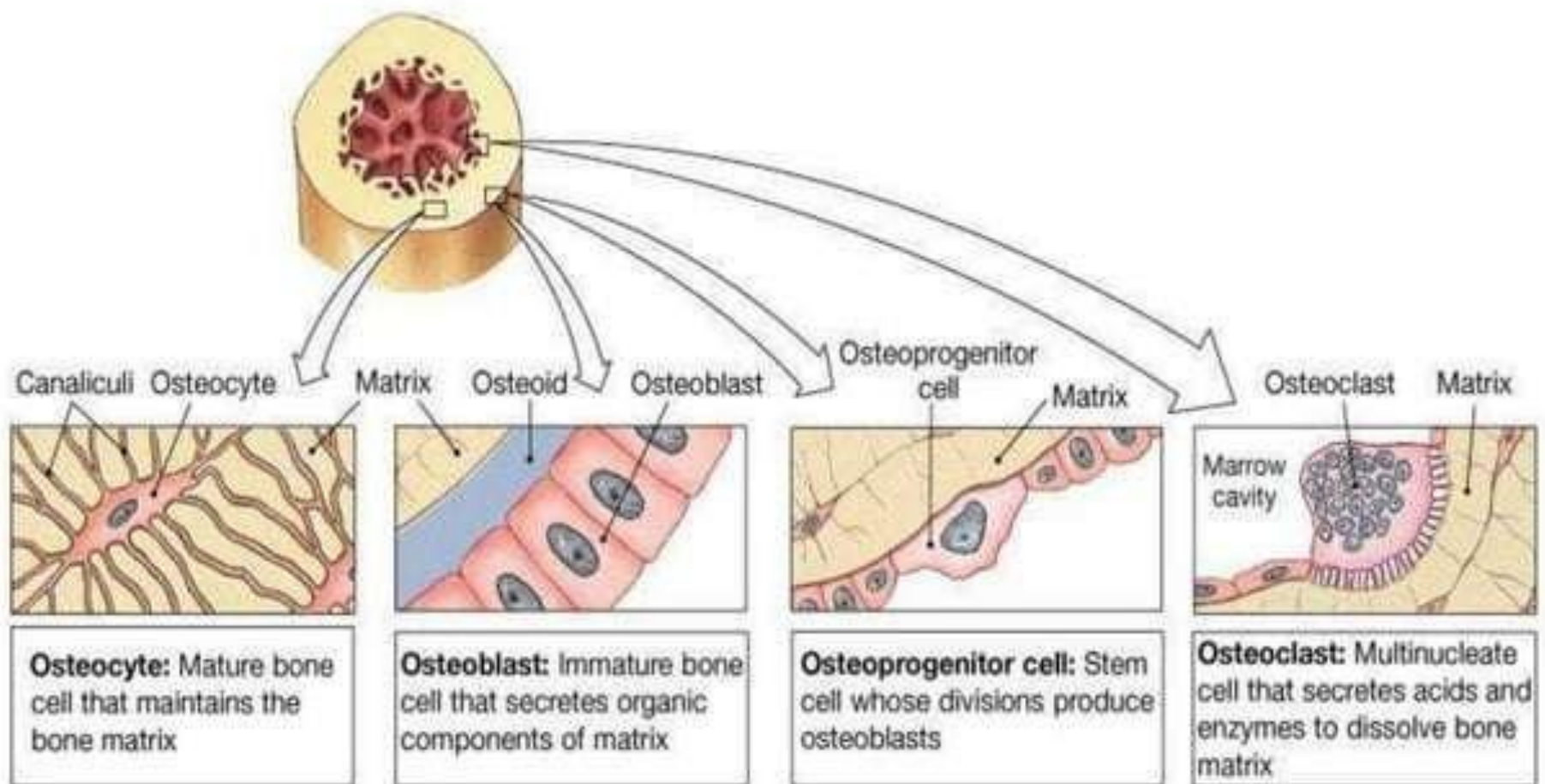


Microscopic study



Bone Cells

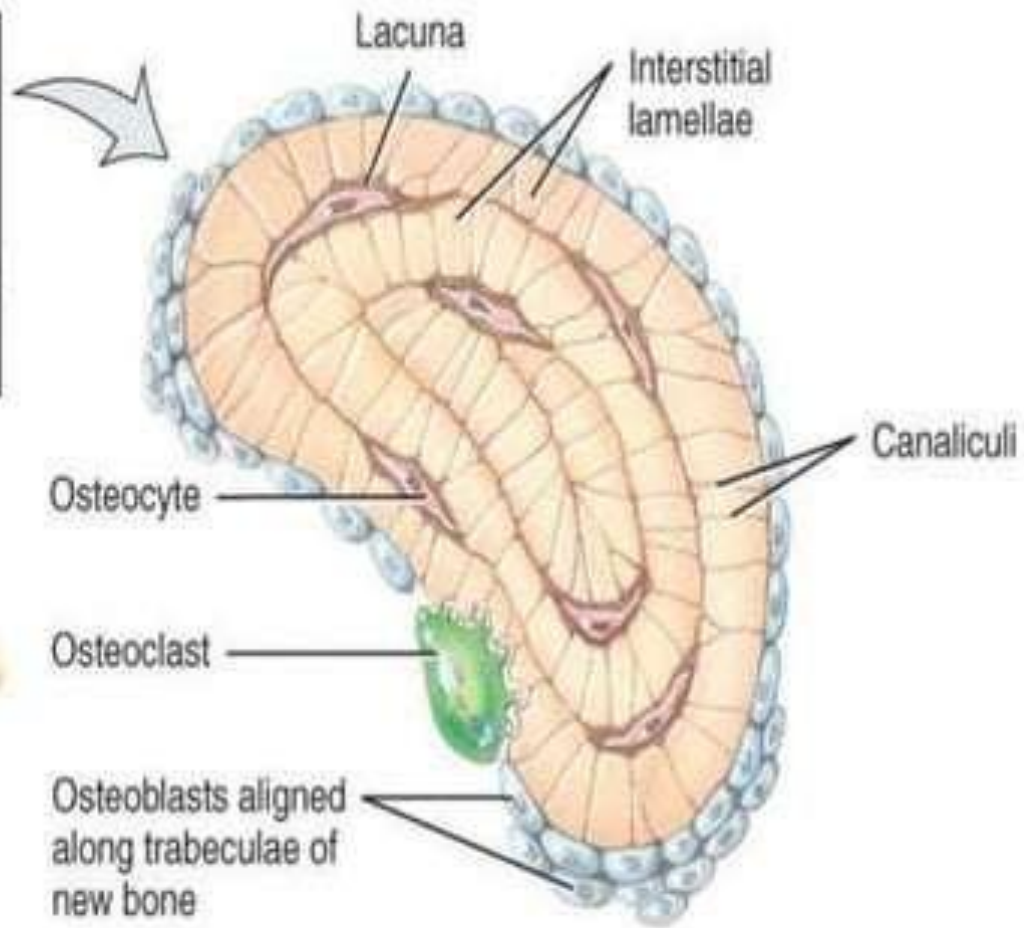
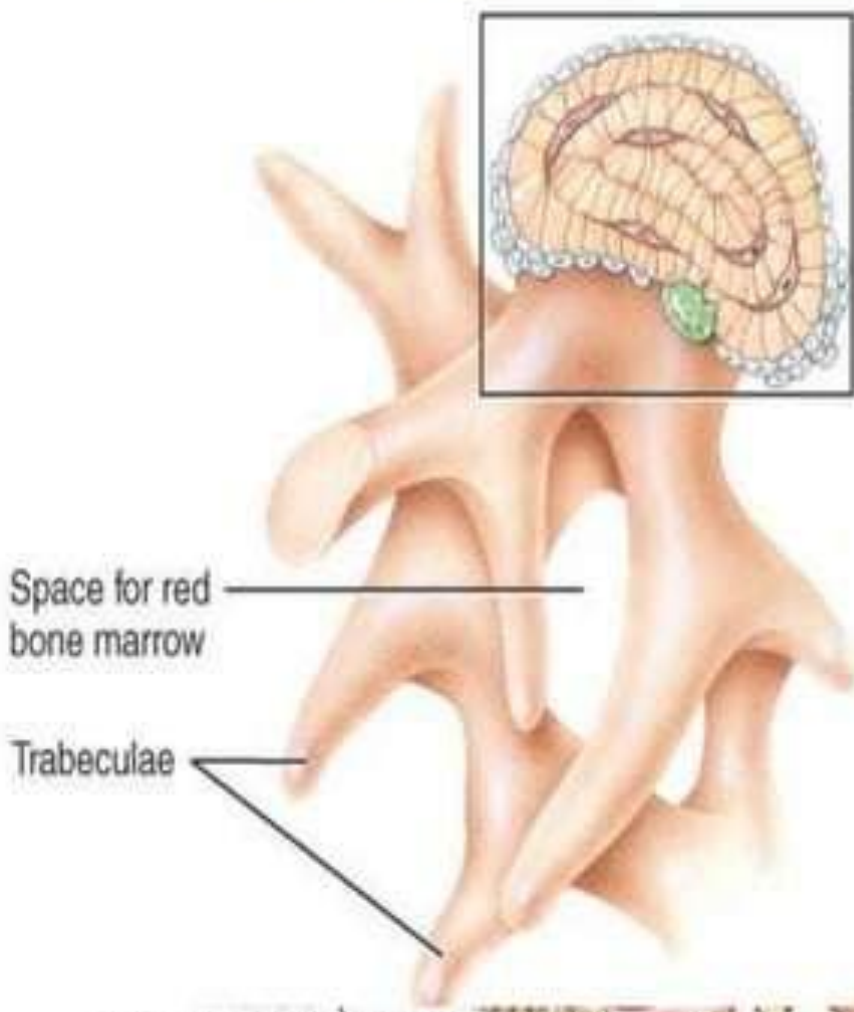
- Osteocytes = mature bone cells
 - In lacunae
 - Connected by canaliculi
- Osteoblasts
 - Osteogenesis
 - Contain Alk phosphatase and pyrophosphatase
- Osteoclasts
 - Osteolysis
- Osteoprogenitor cells
 - differentiate into osteoblasts



Compact and Spongy Bone

trabeculae

osteon



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Central canal

Perforating canal

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Endosteum

Lamellae

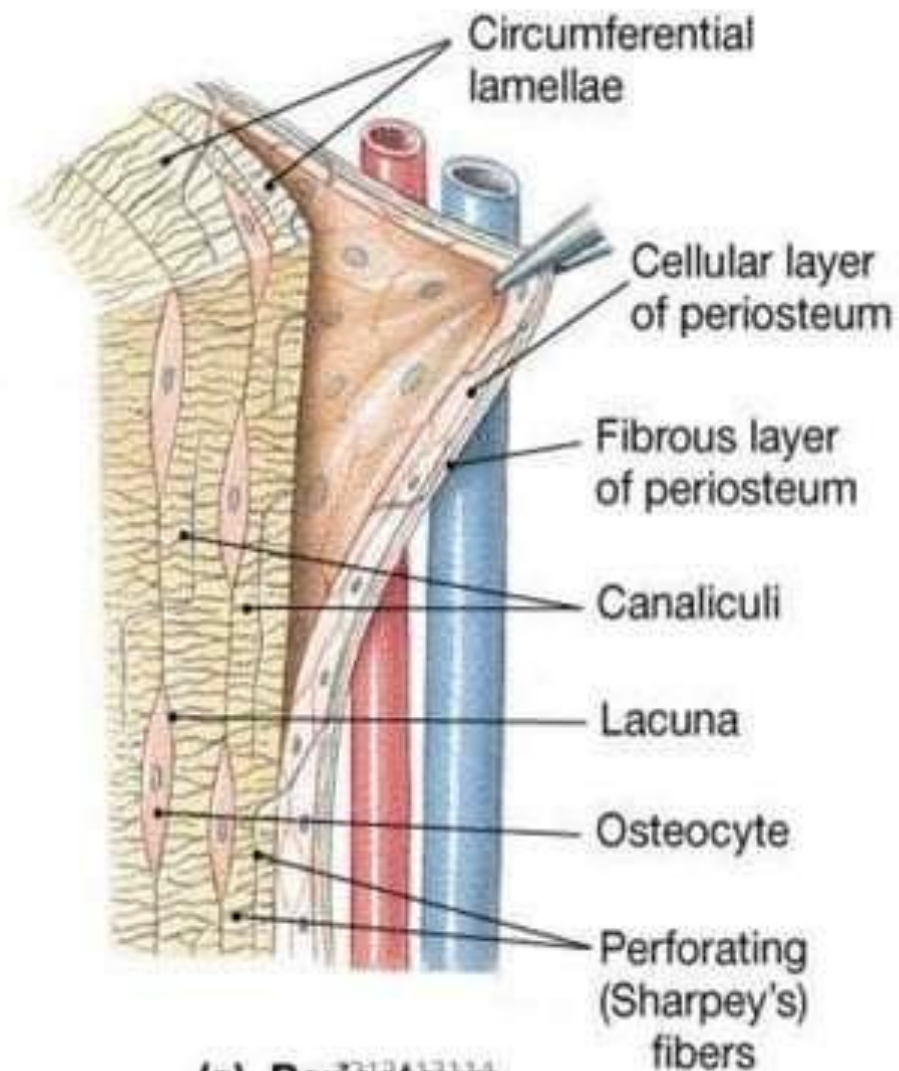
(a)

Compact and Spongy Bone

- Compact bone located where stresses are limited in direction.
- Spongy bone located where stresses are weaker or multi-directional.

Periosteum and endosteum

- Periosteum
 - Superficial surface of all bone except in joint cavities.
 - Provide route for blood and nerve supply
 - Participate in bone growth and repair
 - Outer fibrous layer and inner cellular layer
 - perforating fibers called as **Sharpey's fibers**



(a) Periosteum

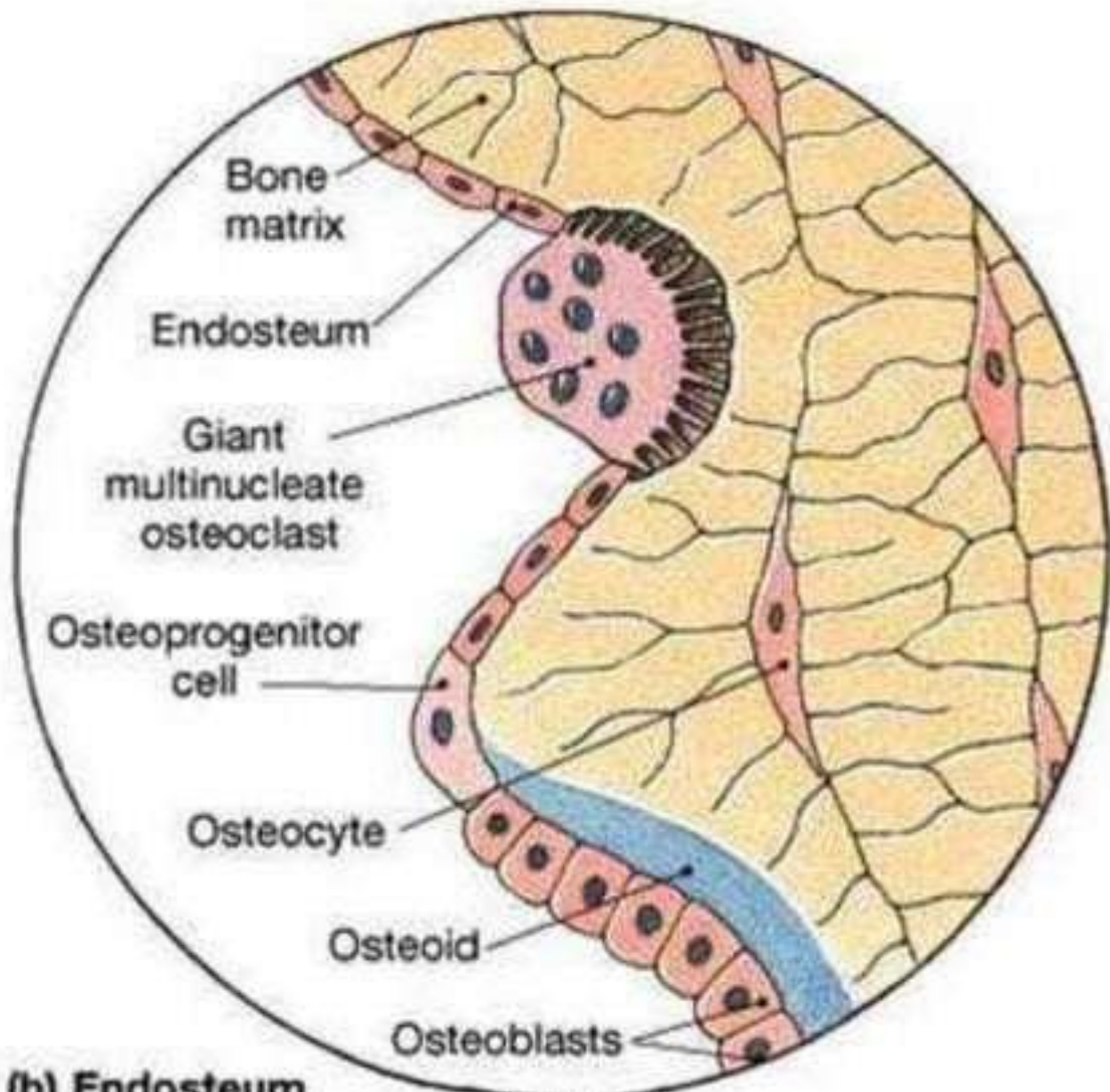
- Endosteum

- Lines the marrow cavity

- Incomplete cellular layer

- Where layer is incomplete, Osteoblasts and osteoclasts can deposit or remove matrix components.

- Shallow groove formed by osteoclasts called as **Howship's lacunae**

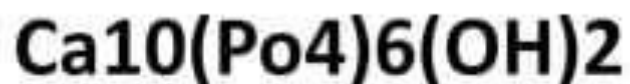


(b) Endosteum

Composition of Bone

- cellular structures in ground substance
- Ground substance made up of
 - Inorganic minerals and organic matrix
- Organic matrix(**35%**)
 - Collagen type 1
 - Glycosaminoglycans
 - Proteoglycans, osteonectin and osteocalcin

- Inorganic content(**65%**)
 - largely made up of Ca^{++} , PO_4^{---} and OH^- .
- These ions arranged parallel to the direction of collagen fibers by forming a crystalline structure called as Hydroxyapatite .



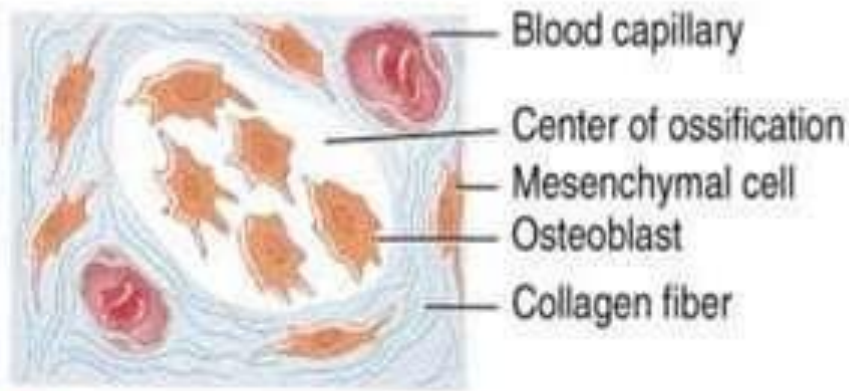
- Living bone contain 20% of water

- **Inorganic** content give **rigidity** to the bone
- **Organic** content give the **elasticity** to the bone.
- Lack of inorganic content- soft bone
- Lack of organic content- brittle bone

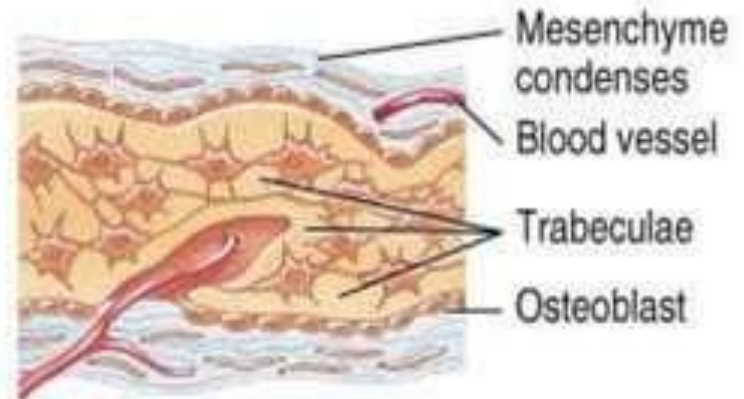
LOBSTEIN SYNDROME

Intramembranous osteogenesis

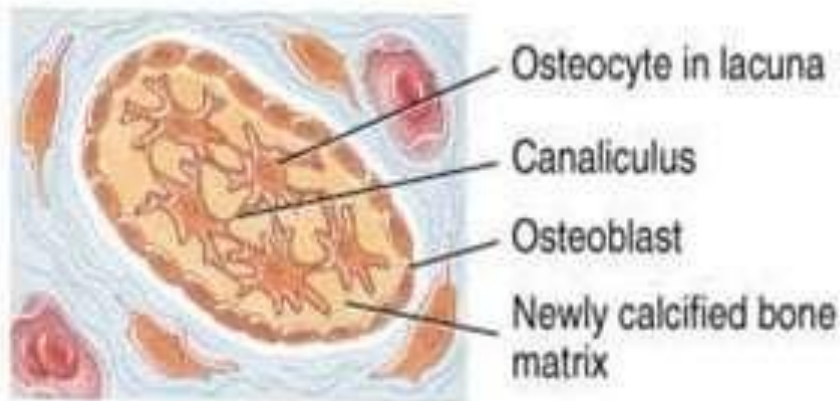
- Bone formation directly from the mesenchymal sheath(formed by collagen fibers in between the mesenchymal cells)
- Not the common process
- Also called as dermal ossification because of its presence in deeper layers of dermis.
- Roofing bones of skull, clavicle and mandible.



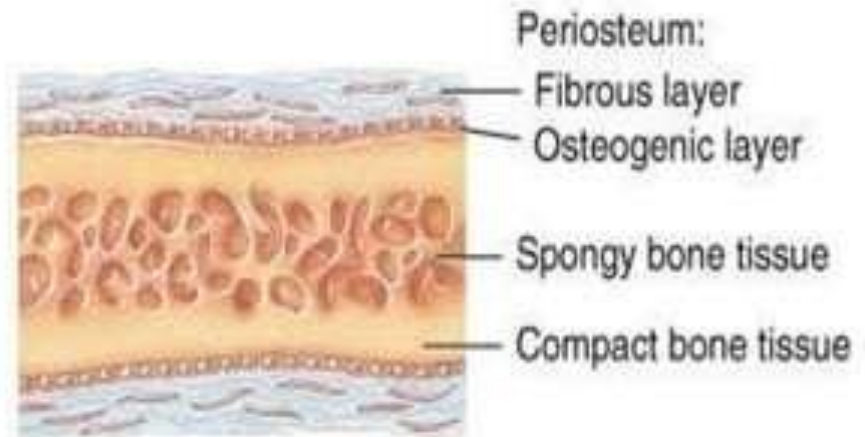
1 Development of center of ossification



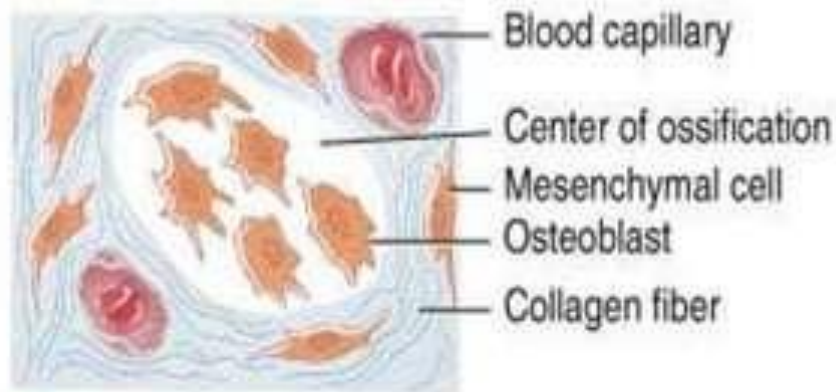
3 Formation of trabeculae



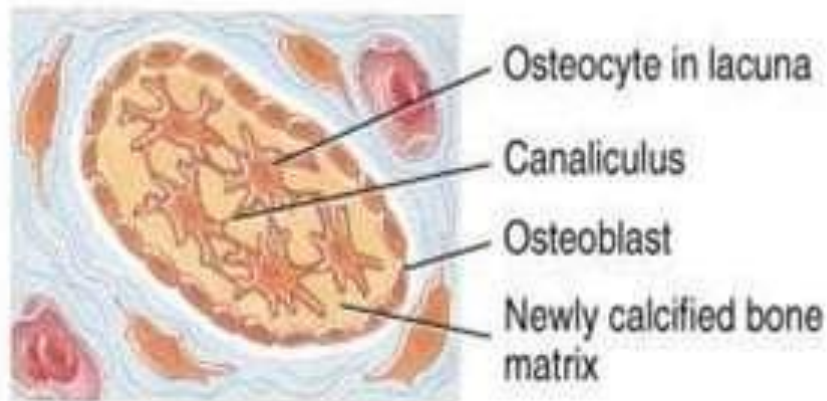
2 Osteocytes deposit mineral salts (calcification)



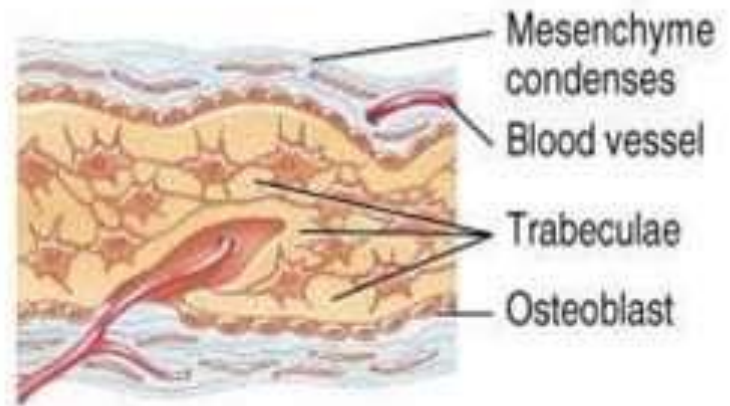
4 Development of periosteum, spongy bone, and compact bone tissue



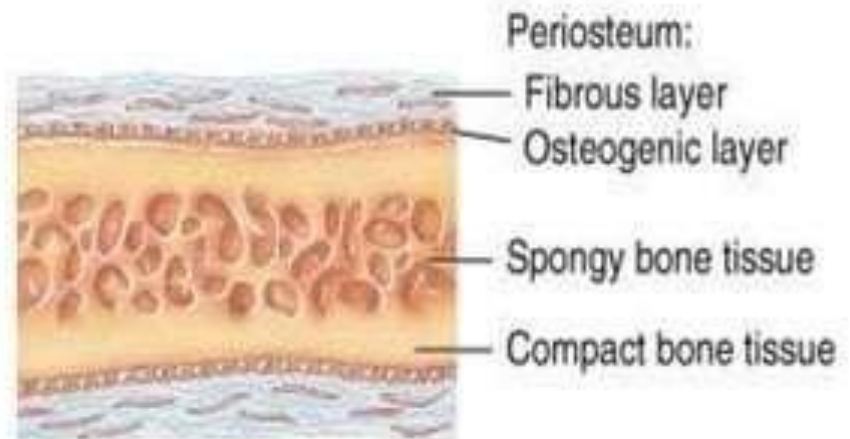
1 Development of center of ossification



2 Osteocytes deposit mineral salts (calcification)



3 Formation of trabeculae



4 Development of periosteum, spongy bone, and compact bone tissue

Endochondral ossification

- Most bone formed by this way
- Cartilaginous model is replaced(!!) by the bone.
- Chondrocyte hypertrophy
- Degeneration and calcification
- Vascular invasion
- ossificaton

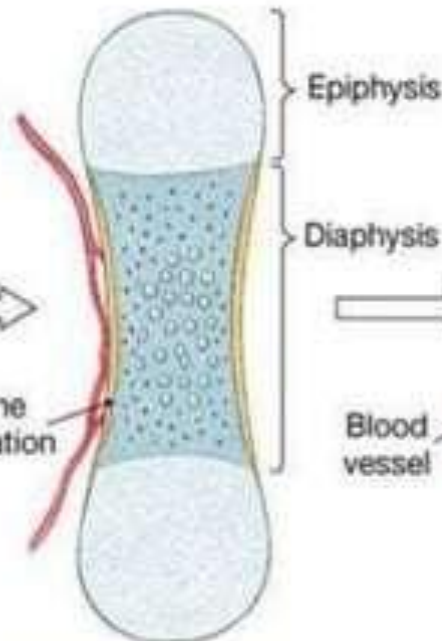
Enlarging chondrocytes within calcifying matrix



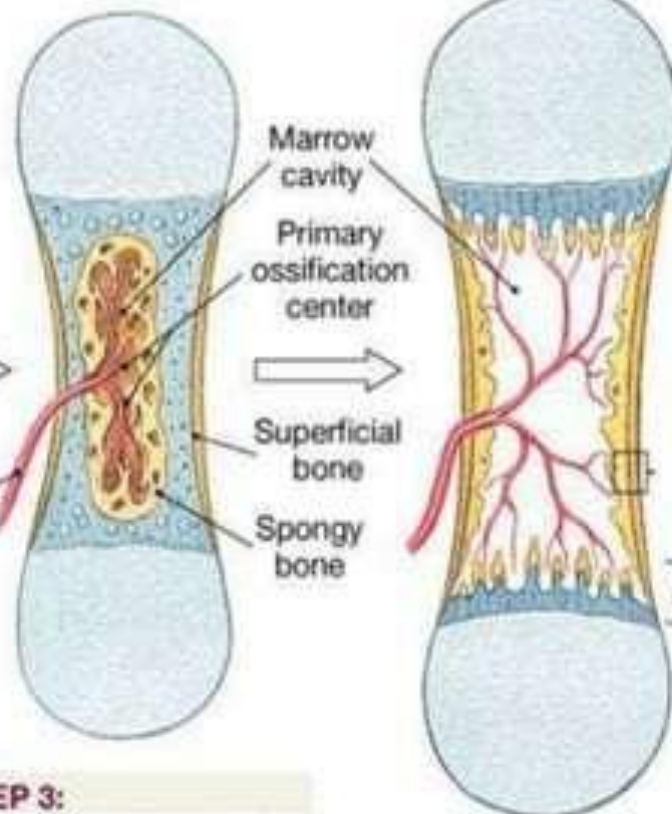
Hyaline cartilage



Bone formation



Blood vessel



Marrow cavity
Primary ossification center

Superficial bone
Spongy bone



Metaphysis

STEP 1:

As the cartilage enlarges through appositional and interstitial growth, chondrocytes near the center of the shaft increase greatly in size. The matrix is reduced to a series of small struts that soon begin to calcify. The enlarged chondrocytes then die and disintegrate, leaving cavities within the cartilage.

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STEP 2:

Blood vessels grow around the edges of the cartilage, and the cells of the perichondrium convert to osteoblasts. The shaft of the cartilage then becomes ensheathed in a superficial layer of bone.

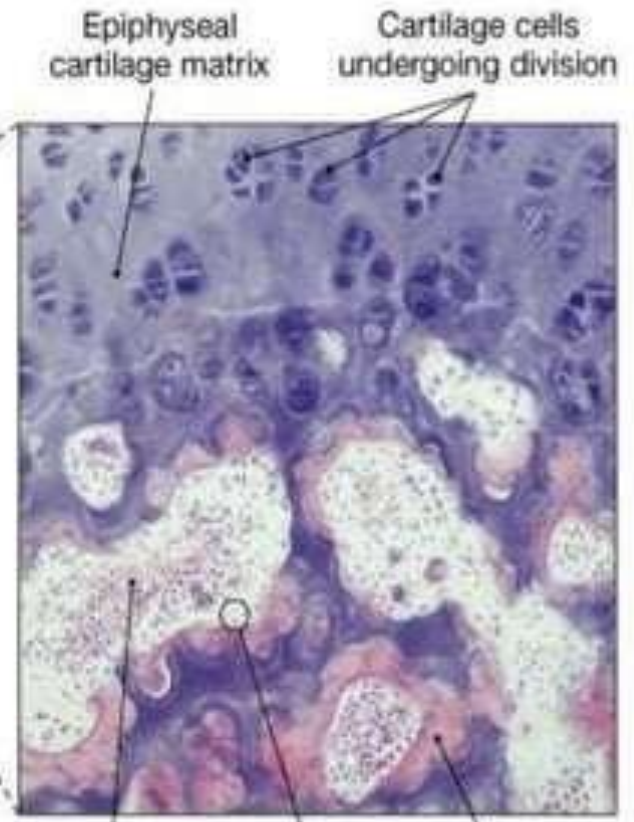
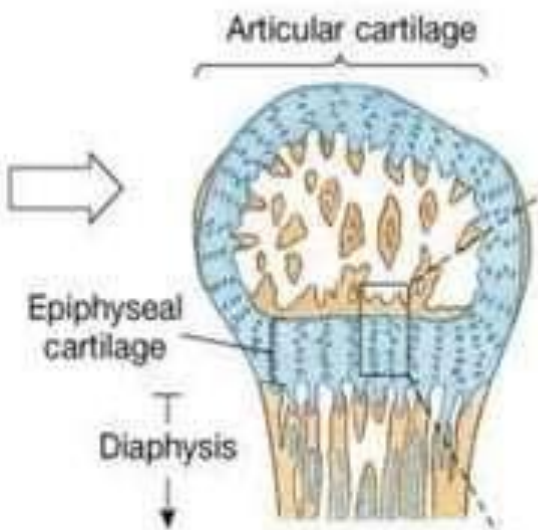
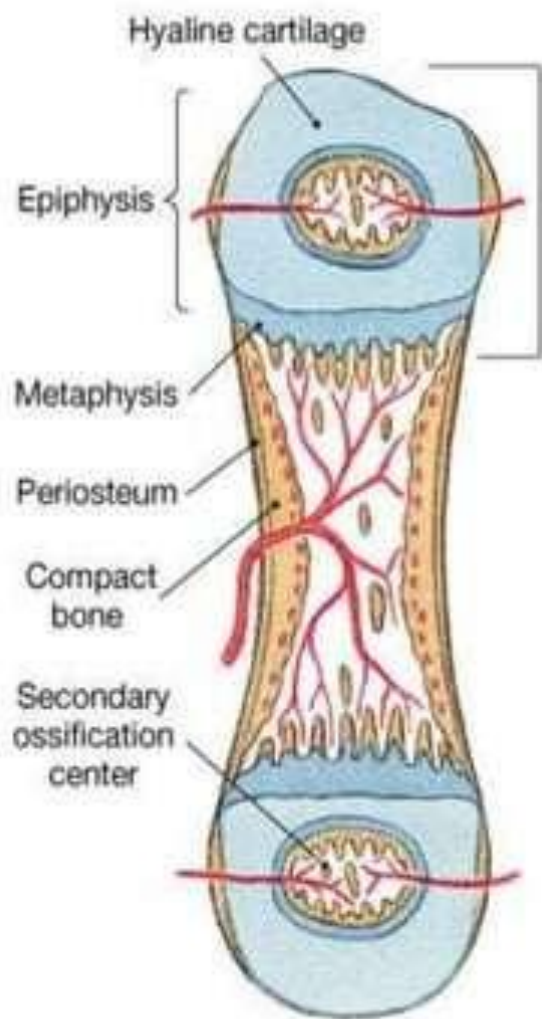
STEP 3:

Blood vessels penetrate the cartilage and invade the central region. Fibroblasts migrating with the blood vessels differentiate into osteoblasts and begin producing spongy bone at a primary center of ossification. Bone formation then spreads along the shaft toward both ends.

1212413114

STEP 4:

Remodeling occurs as growth continues, creating a marrow cavity. The bone of the shaft becomes thicker, and the cartilage near each epiphysis is replaced by shafts of bone. Further growth involves increases in length (Steps 5 and 6) and diameter (Figure 6-10).



STEP 6: Soon the epiphyses are filled with spongy bone. An articular cartilage remains exposed to the joint cavity; over time it will be reduced to a thin superficial layer. At each metaphysis, an epiphyseal cartilage separates the epiphysis from the diaphysis.

STEP 5: Capillaries and osteoblasts migrate into the epiphyses, creating secondary ossification centers.

Growth at epiphysial plate

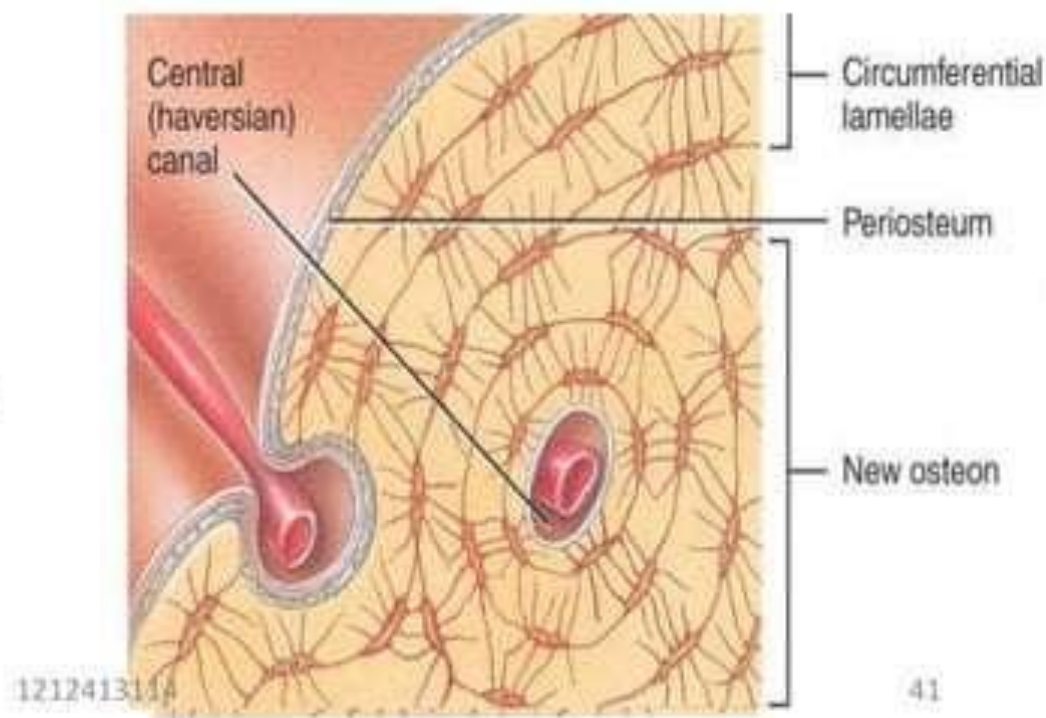
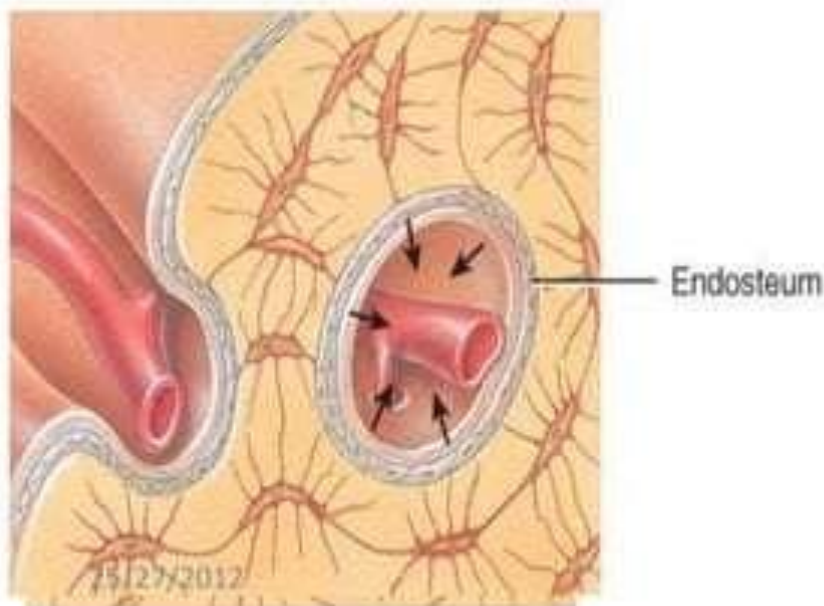
Histology Lab Part 10: Slide 62

- Zone of resting cells
- Zone of proliferating cells
- Zone of hypertrophic cells
- Zone of calcified cells
- ❖ **Increase in length**



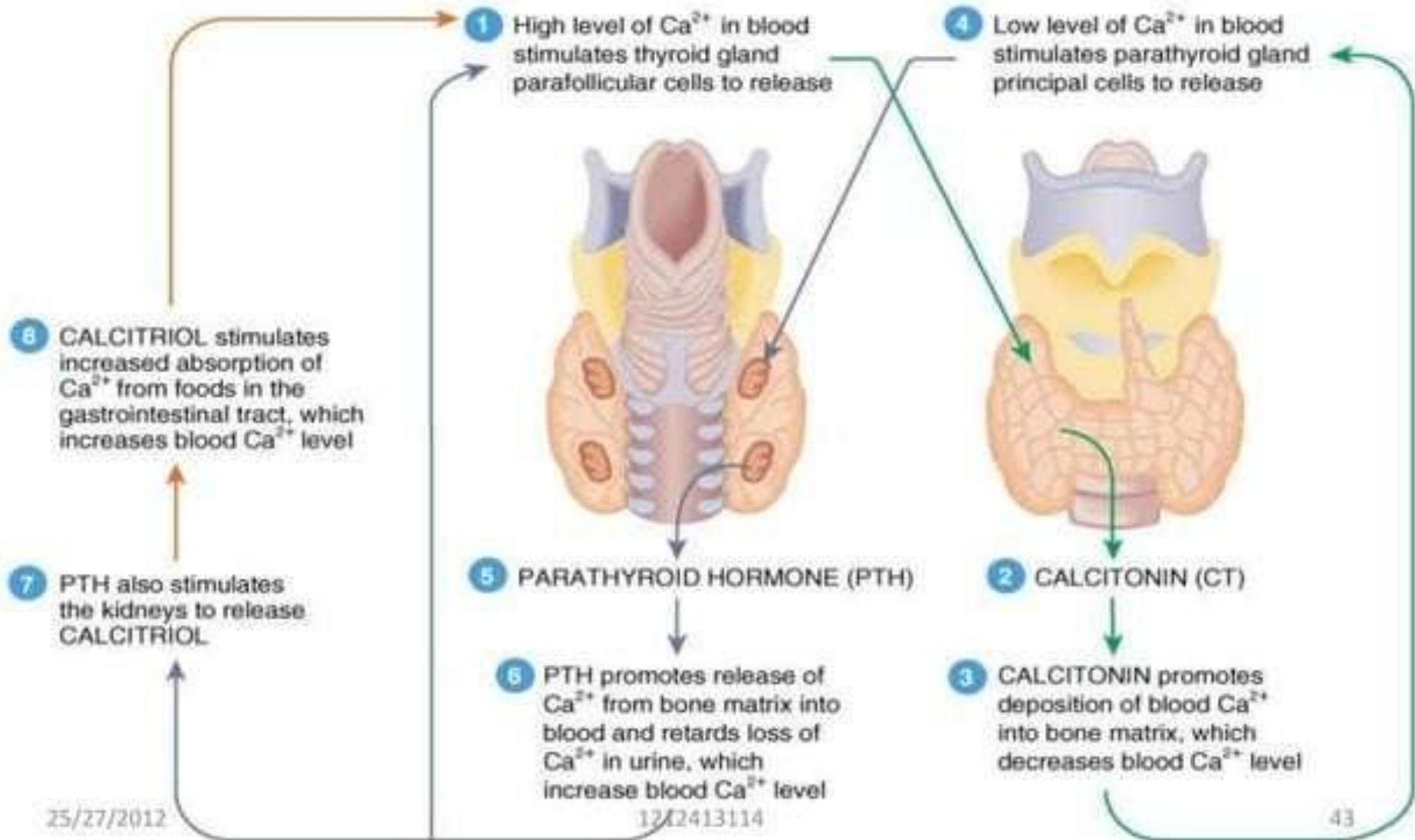
Appositional growth

- ❖ Increased in thickness of bone.
- Occurs in bony surface.



- Bone is the dynamic tissue so its composition varies according to the regulating factors.
- 99% of body calcium, 80% of phosphorus and 65% of sodium and magnesium is reserved in the bone
- Calcium is needed for many physiological function so it is tightly regulated at normal level (**9-11mg/dl**)

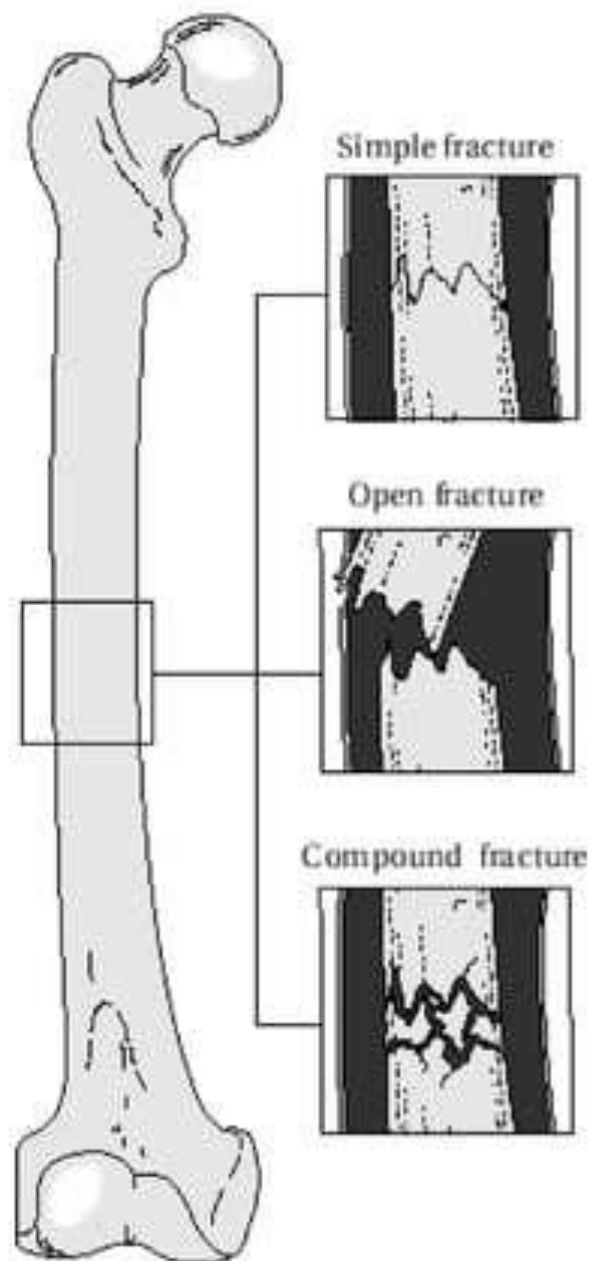
Factors affecting bone growth



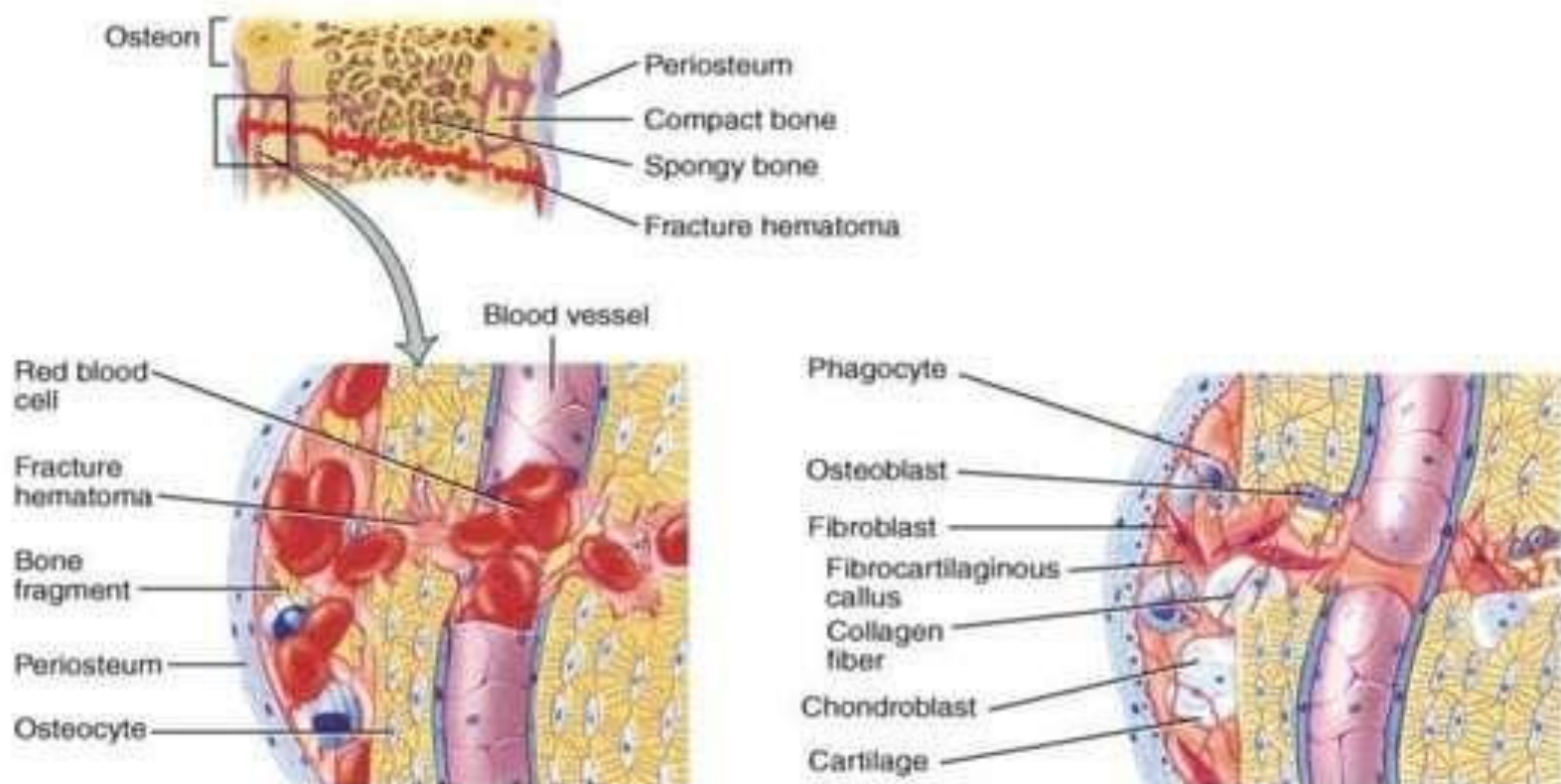
Clinical Aspects

- Subluxation
 - Incomplete or partial displacement of joint
- Dislocation / Luxation
 - Complete displacement of joint
- Fracture
 - Loss of continuity of bone due to abnormal forces or due to weakening of bone.

- Types of fractures
 - Simple or Closed
 - Compound or Open
 - Comminuted
 - Greenstick
- Not complete
- Common in children.



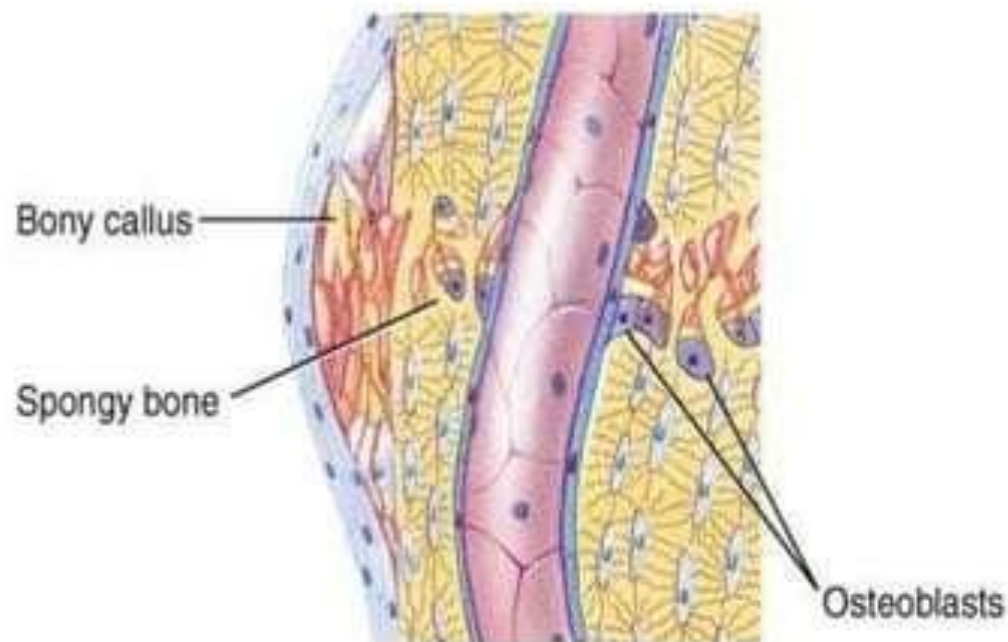
Healing of fracture wound



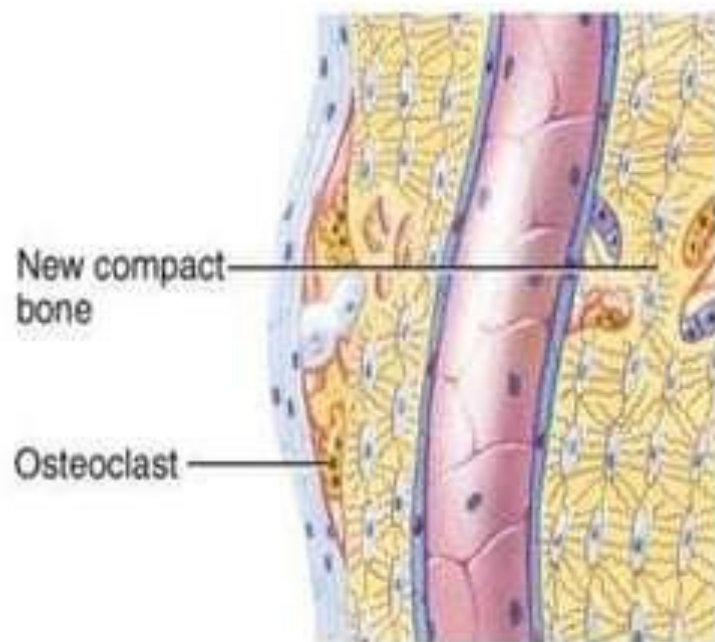
1 Formation of fracture hematoma

2 Fibrocartilaginous callus formation

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3 Bony callus formation



4 Bone remodeling

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Bone disorders


- Osteopenia
 - Decreased in bone mineral density(BMD)
- Osteoporosis
 - Loss of both bone salts and collagen content
- Osteomalacia/ Rickets
 - Loss of mineral content but not the collagen

Bone disorders

- Paget's disease
 - Abnormal bone remodeling , lead to abnormal thickening of the bone
 - Consequences ???
- Osteomyelitis
 - Inflammation of bone marrow
 - Most commonly by staphylococcus aureus

Bone disorders

- Osteogenic sarcoma (osteosarcoma)
 - Bone cancer that affects osteoblast

A landscape photograph featuring a large, leafy tree in the foreground. A wooden ladder is leaning against the tree's trunk. The background shows rolling hills under a dramatic, cloudy sky with a bright light source breaking through the clouds. The overall color palette is dominated by greens and blues.

Dream as
if you'll live forever,
live as if you'll die today

THANK YOU

??????