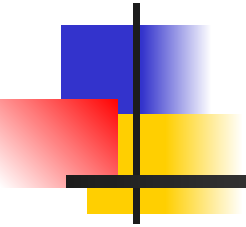


# **SKELETAL TISSUES**



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## **BONE TISSUE**

**Associate Professor Kharchenko S.V.  
Department of Histology and Embryology  
Medical Academy named after S.I. Georgievsky**



# BONE TISSUE

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- This is a specialized type of connective tissue with high mineralization of the intercellular substance.
- It contains 67-70% of inorganic salts represented by salts of calcium phosphates.
- Organic matter of bone is represented by proteins and lipids.

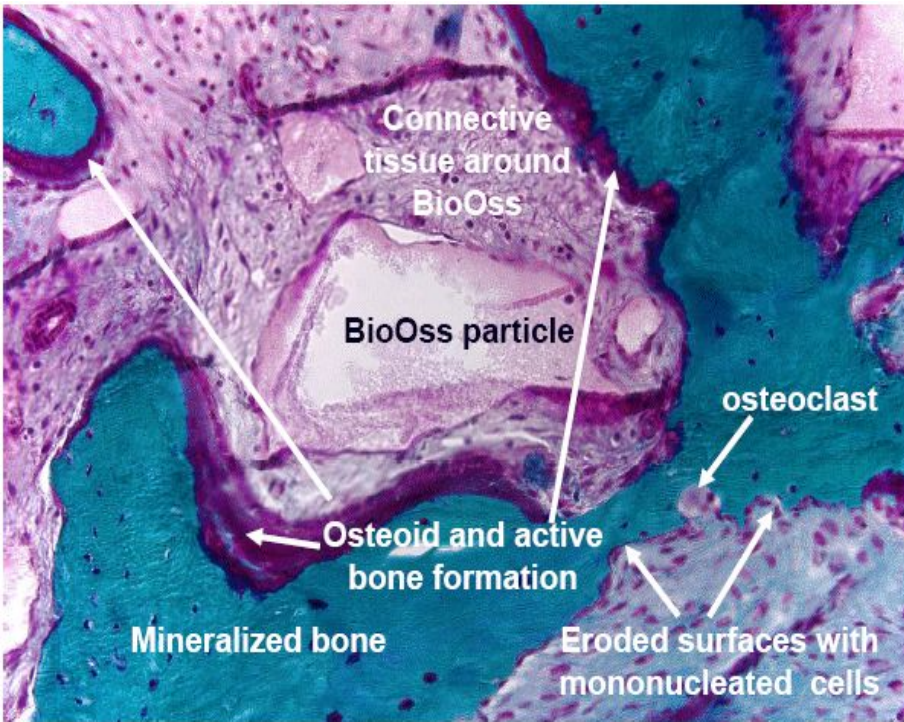
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graph TD; A[BONE TISSUE] --> B[PRIMARY RETICULOFIBROSIS]; A --> C[SECONDARY LAMELLAR];
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**BONE TISSUE**

**PRYMARY  
RETICULOFIBROSIS**

**SECONDARY LAMELLAR**

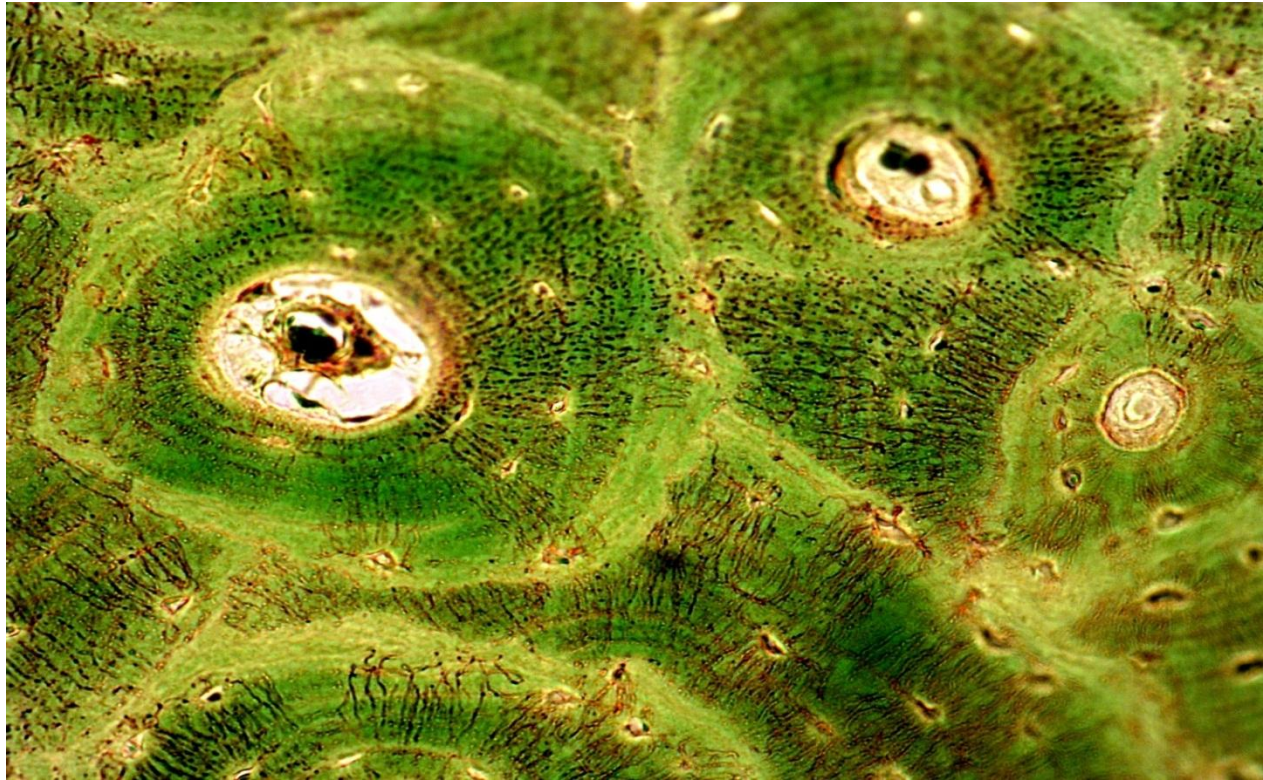
# RETICULARFIBROUS BONE TISSUE



- It is found in skeleton of fetus, in adults - in the places of attachment of tendons to bones, in places of cranial sutures, in dental alveoli, in the bony labyrinth of the inner ear. May appear during regeneration in places of bone damage.



# LAMELLAR BONE



- It is characterized by an ordered arrangement of collagen fibers in the composition of bone lamella.
- Bone lamella form parallel concentric layers - osteons - structural and functional units of the compact bone

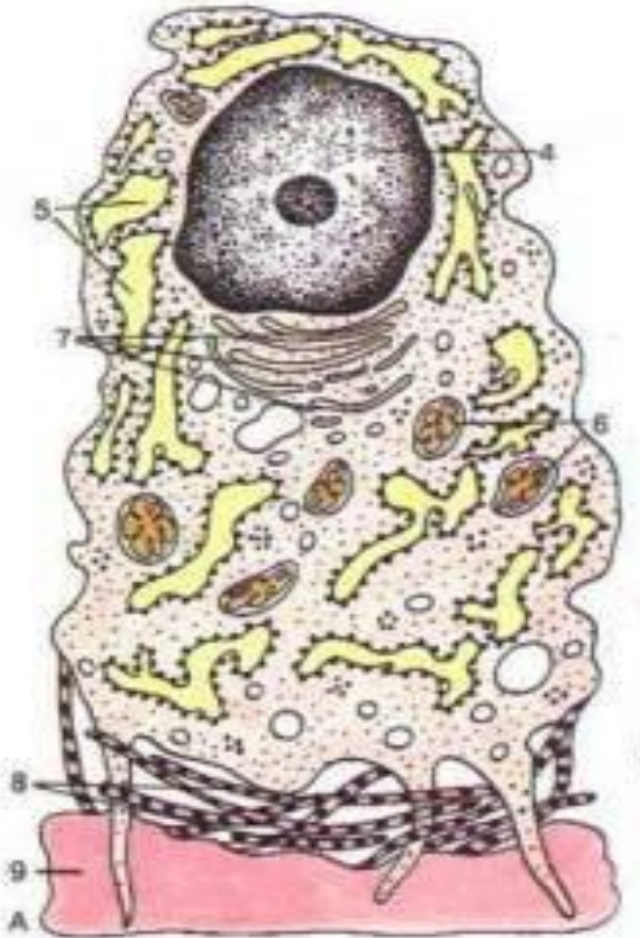


# CELLS OF BONE

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- **OSTEOGENIC DIFFERON**
- Osteogenic cell - osteoblast - osteocyte
- **HEMATOGENOUS DIFFERON**
- PHSC - Promonocyte - Monocyte - Osteoclast

# OSTEOBLASTS - cells building bone tissue



- They are located on the surface of bone spicules in the developing bone.
- After the final formation of the bone - in the deep layers of the periosteum or in places of bone damage.
- They have a cuboidal or polygonal in shape.



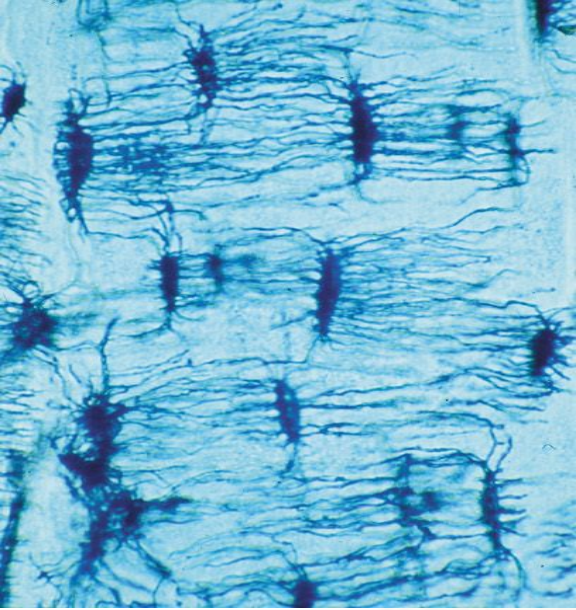
# **FUNCTION OF OSTEOBLAST**

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## **Create a bone in two stages:**

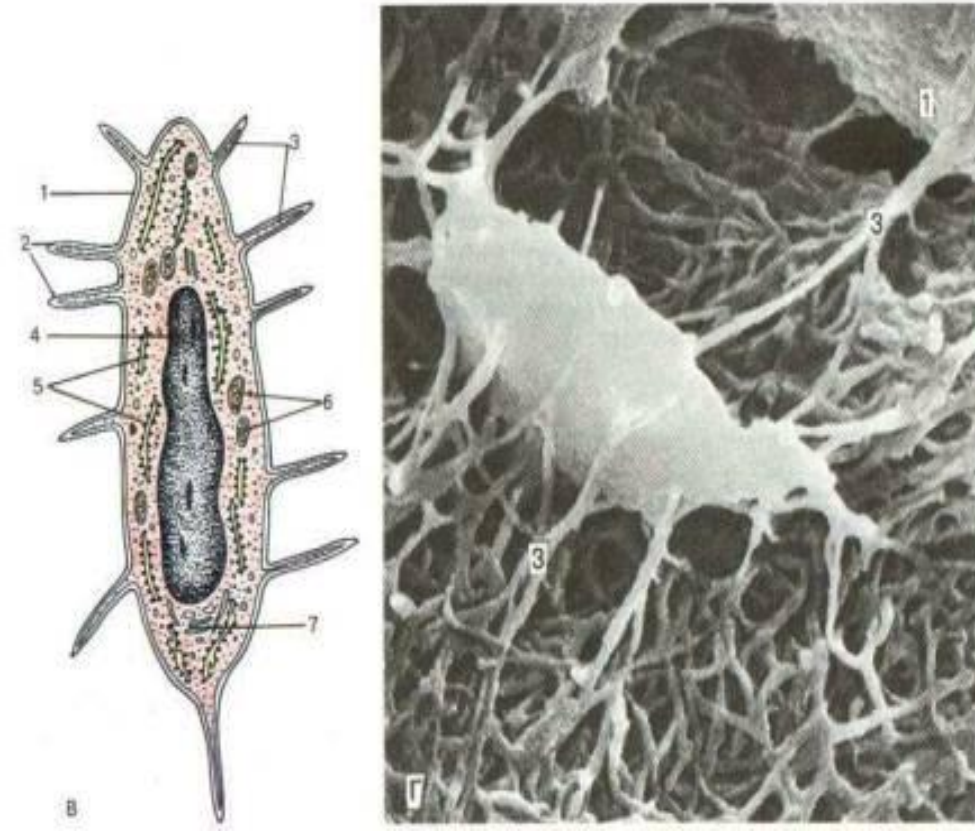
- 1. Actively synthesize the organic bone matrix (osteoid).** For this, the cell contains a well-developed synthetic apparatus.
- 2. Provide mineralization of osteoid** due to the enzyme alkaline phosphatase.

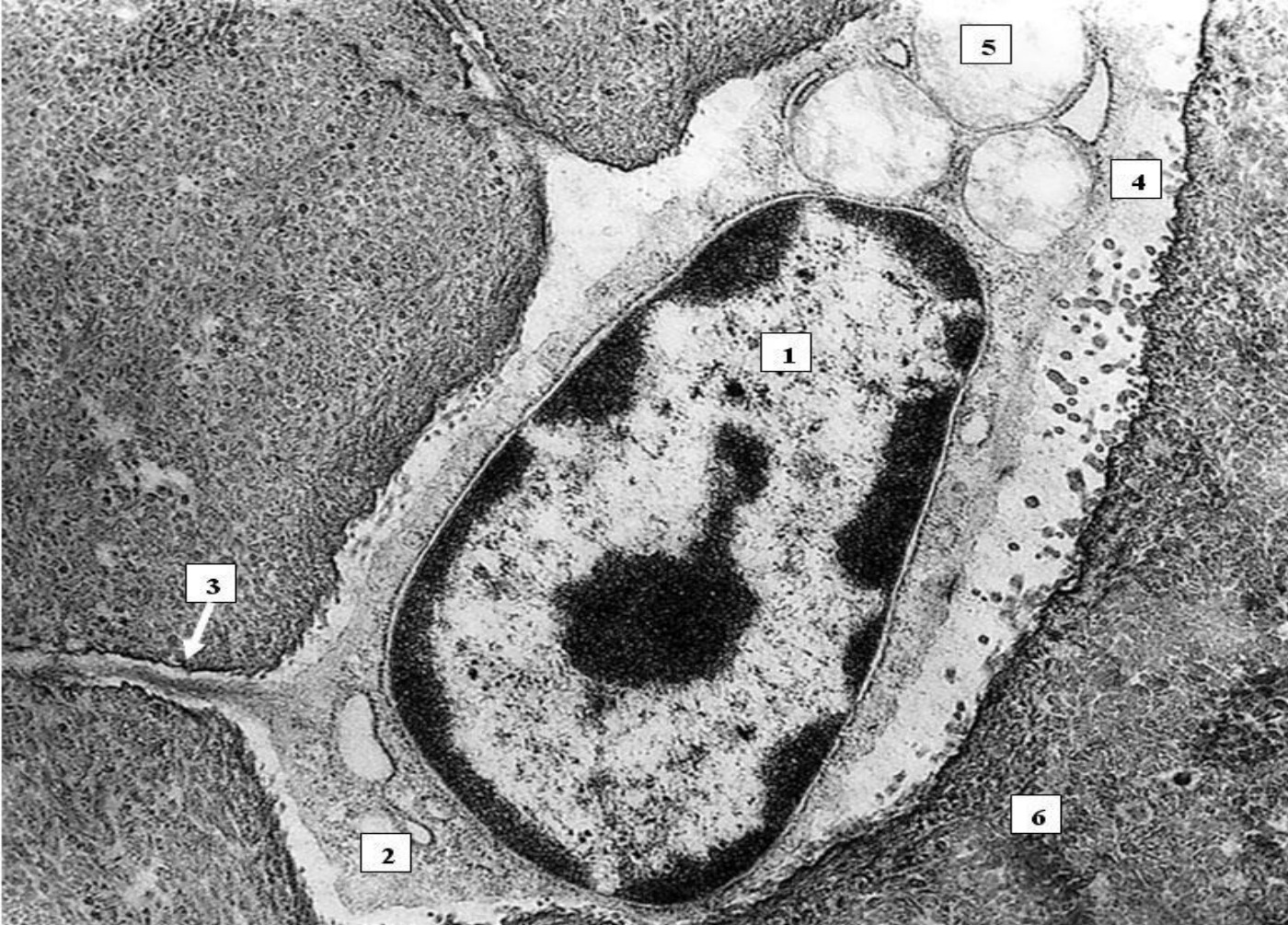




# OSTEOCYTE

- **Highly differentiated cells**
- **They have cell body and process.**
- **with a large nucleus and basophilic cytoplasm.**
- **Body located in bone cavities – lacunae, process in the canaliculi.**
- **Provide the exchange of water, proteins and ions in bone tissue**





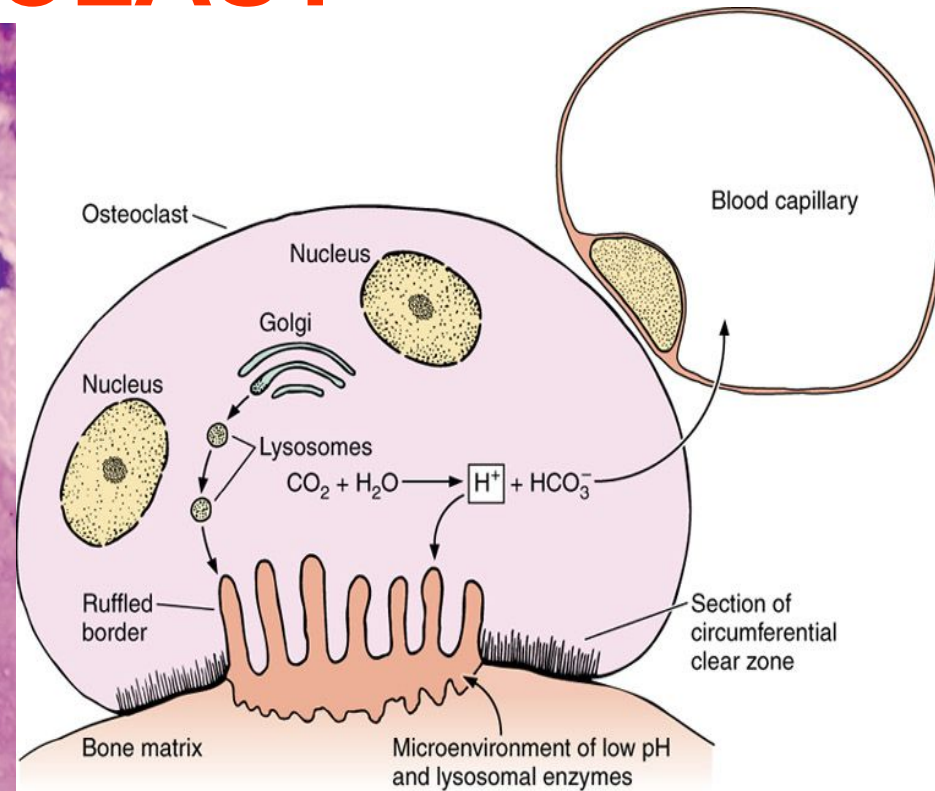
■ Compact substance of the diaphysis of the long bone. УВ×7000

- 1- nucleus
- 2- cytoplasm;
- 3-process;

- 4- lacuna;
- 5- osseomucoid;
- 6- ossein fibers

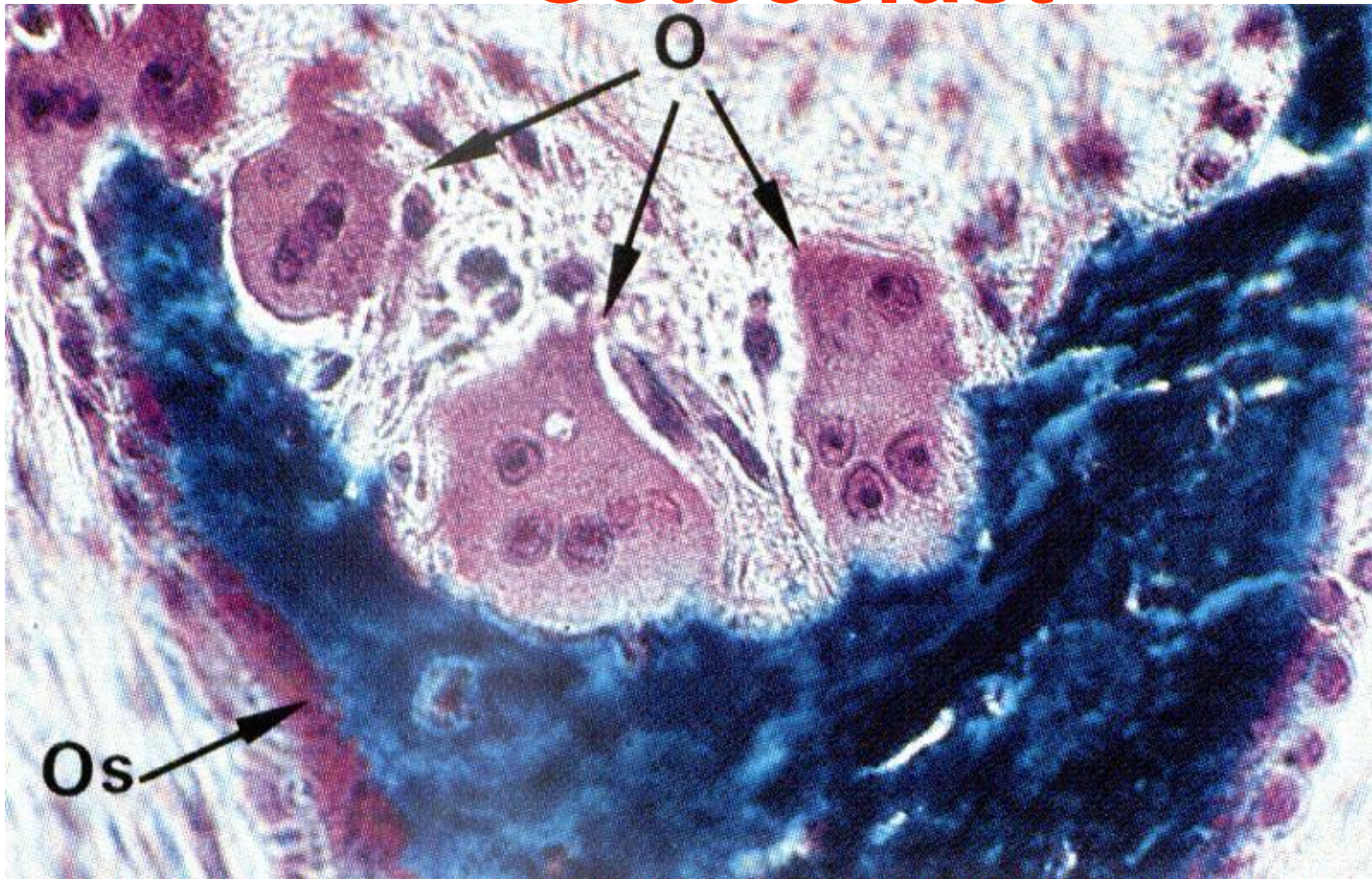


# OSTEOCLAST



- **Polynuclear macrophages** of bone tissue are formed from blood monocytes. They are located on the surface of bone plates.
- The osteoclast cytoplasm zone adjacent to the bone plate forms a **ruffled border** (cytoplasmic outgrowths that contain **many lysosomes**)

# Osteoclast



- On the periphery of the osteoclast there is a zone of tight fit, which seals the area of action of enzymes
- Functions - destruction of calcified cartilage and bone



# Long bone as an organ

- Consists of:
  - - head of the long bone - epiphysis
  - - long bone bodies - diaphysis
  - - bone marrow cavity
- The epiphysis is formed by a spongy substance and contains red bone marrow
- The diaphysis is formed by several layers. It basically has a compact substance.
- The bone marrow cavity is filled with yellow bone marrow



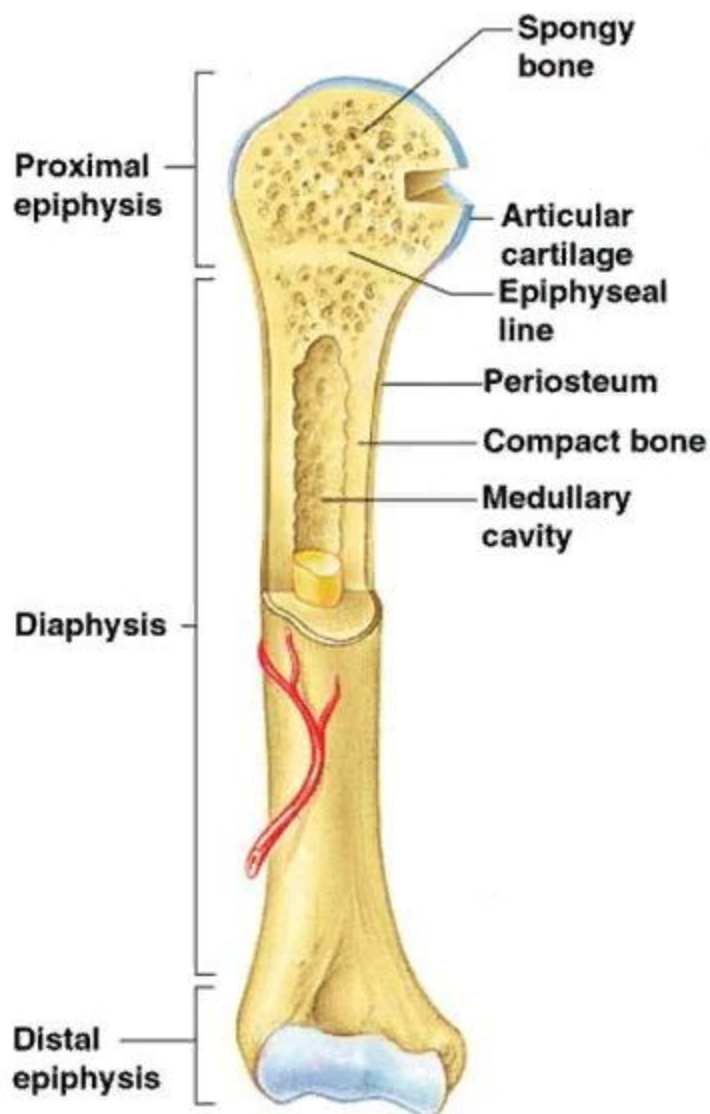
## II. Bone Structure

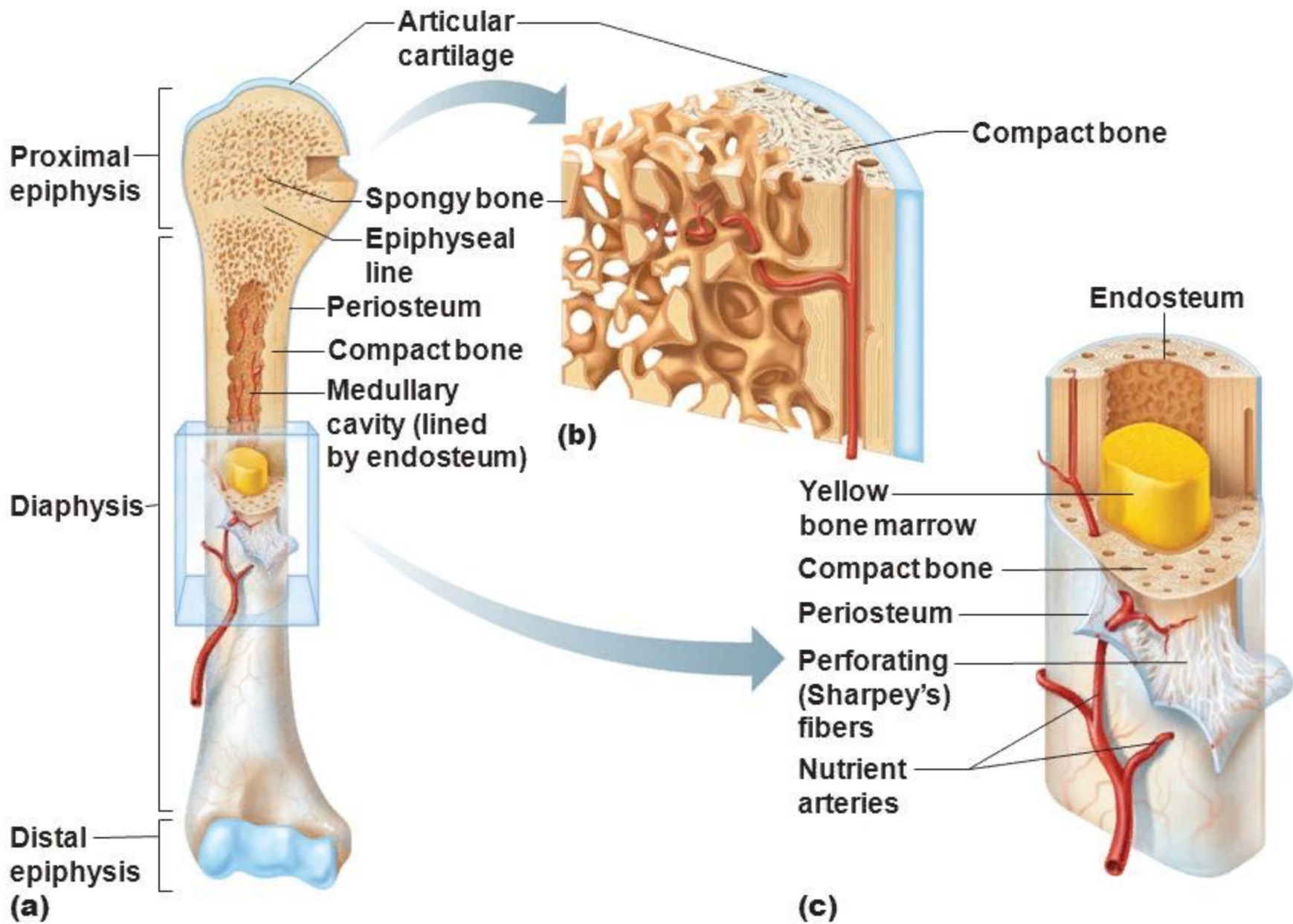
### A. Gross Anatomy of a typical long bone

1. Diaphysis - the bone shaft that makes up most of the bones length and is composed of compact bone

a. The diaphysis is covered with a fibrous connective tissue membrane called the periosteum. Sharpey's Fibers (connective tissues) secure the periosteum to long bone.

b. The diaphysis surrounds a central medullary cavity or marrow cavity (yellow marrow) primarily used for storing adipose (fat) tissue. In infants this area forms blood cells, and red marrow is found here. In adults, the red marrow is confined to the cavities of spongy bone of flat bones and the epiphyses of long bones



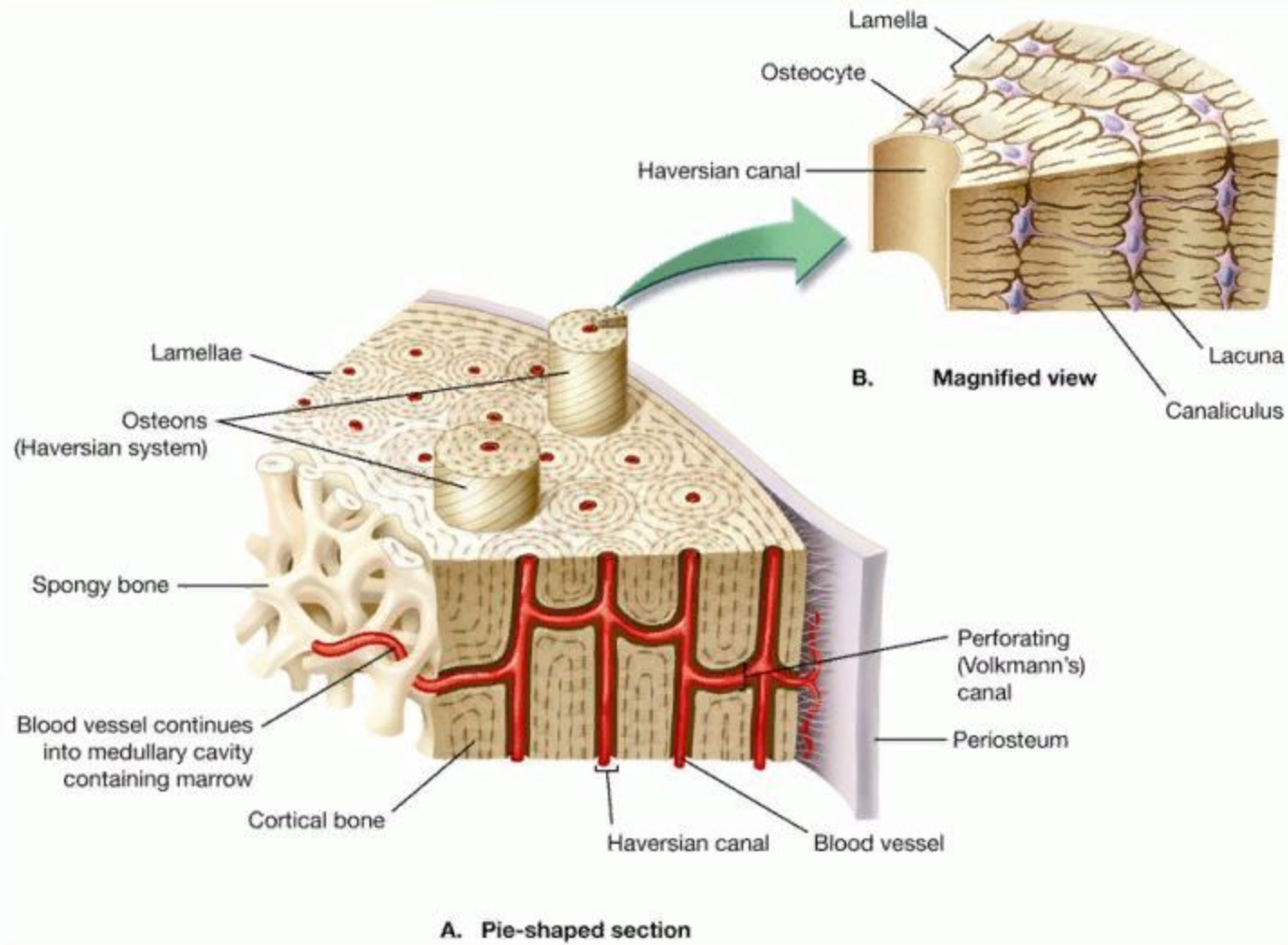


# The structure of the diaphysis of the long bone

histologically consists of three layers:

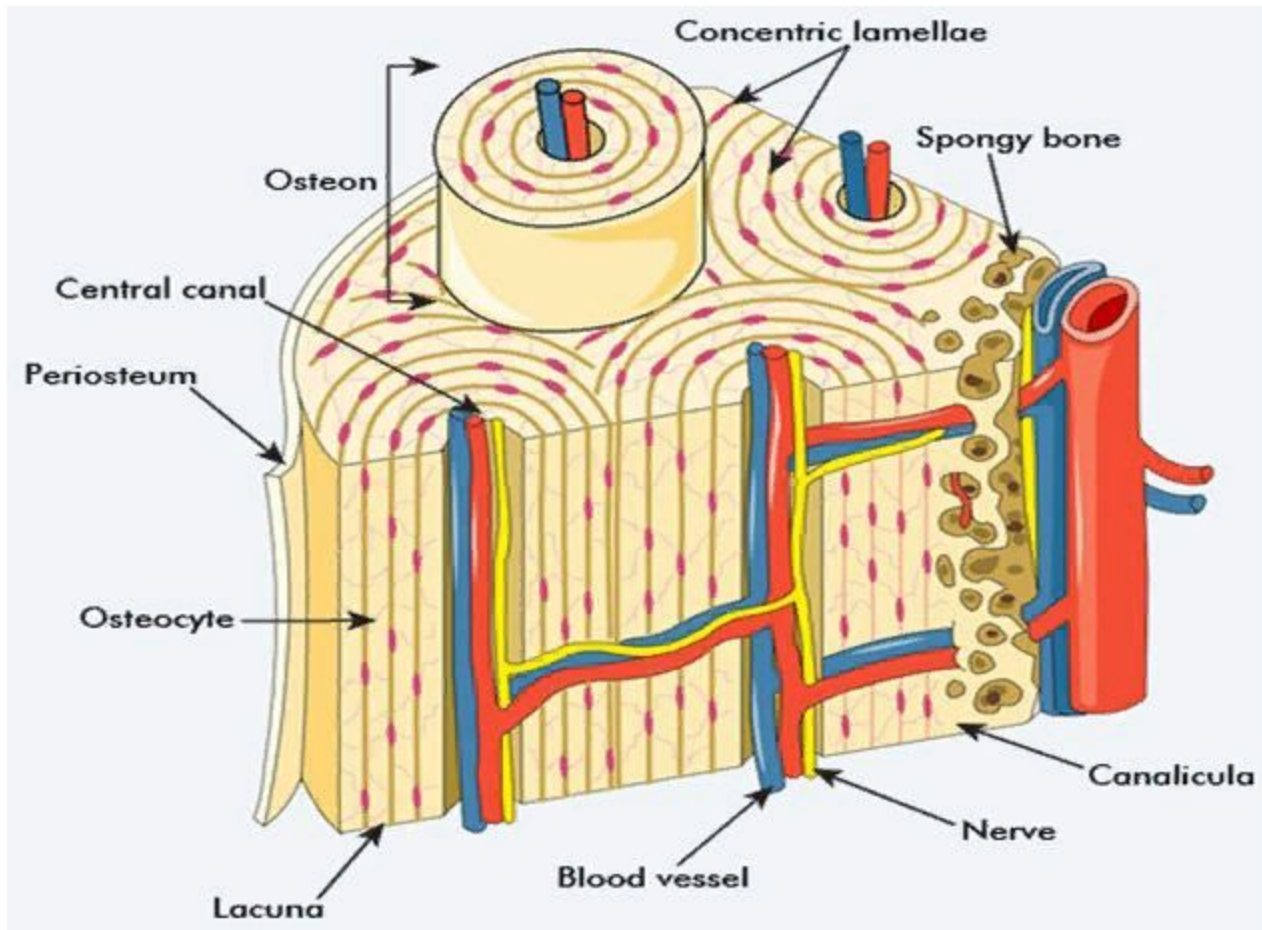
- 1. The periosteum
- 2. Compact bone
- 3. Endostium

# Anatomical Structure of Long Bones



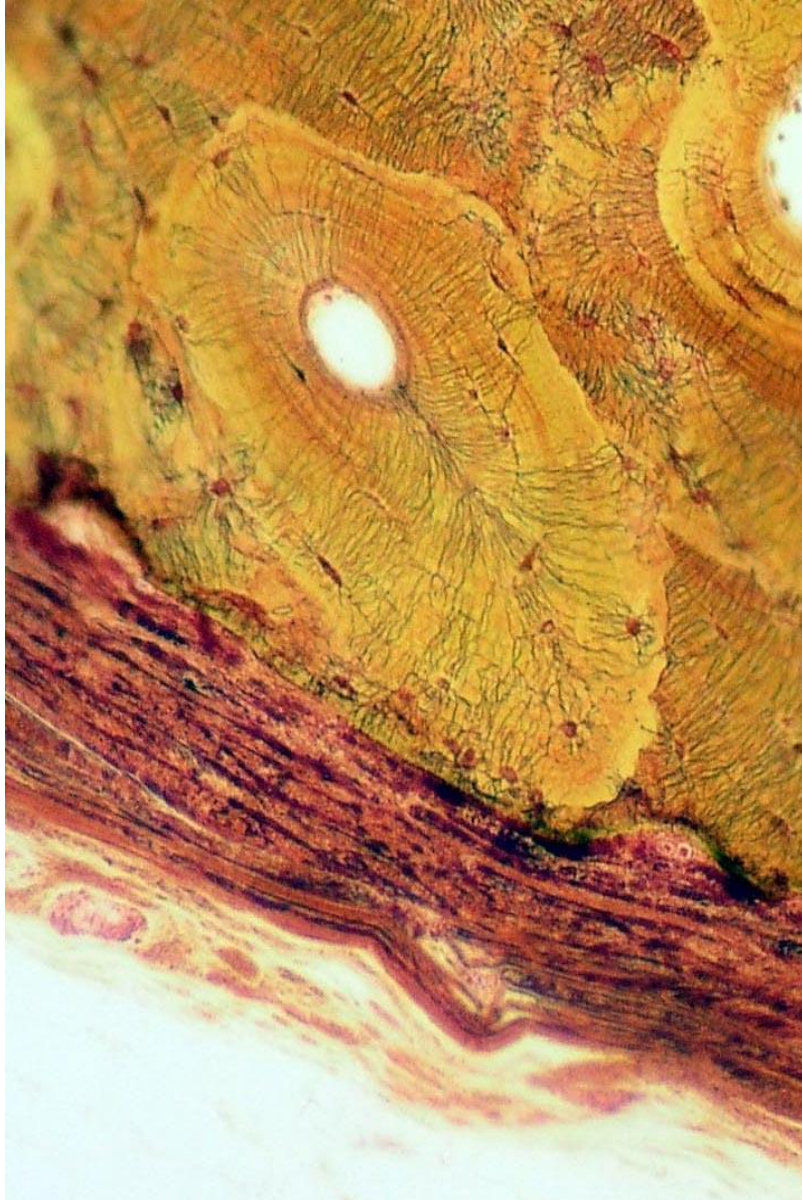


# Compact bone



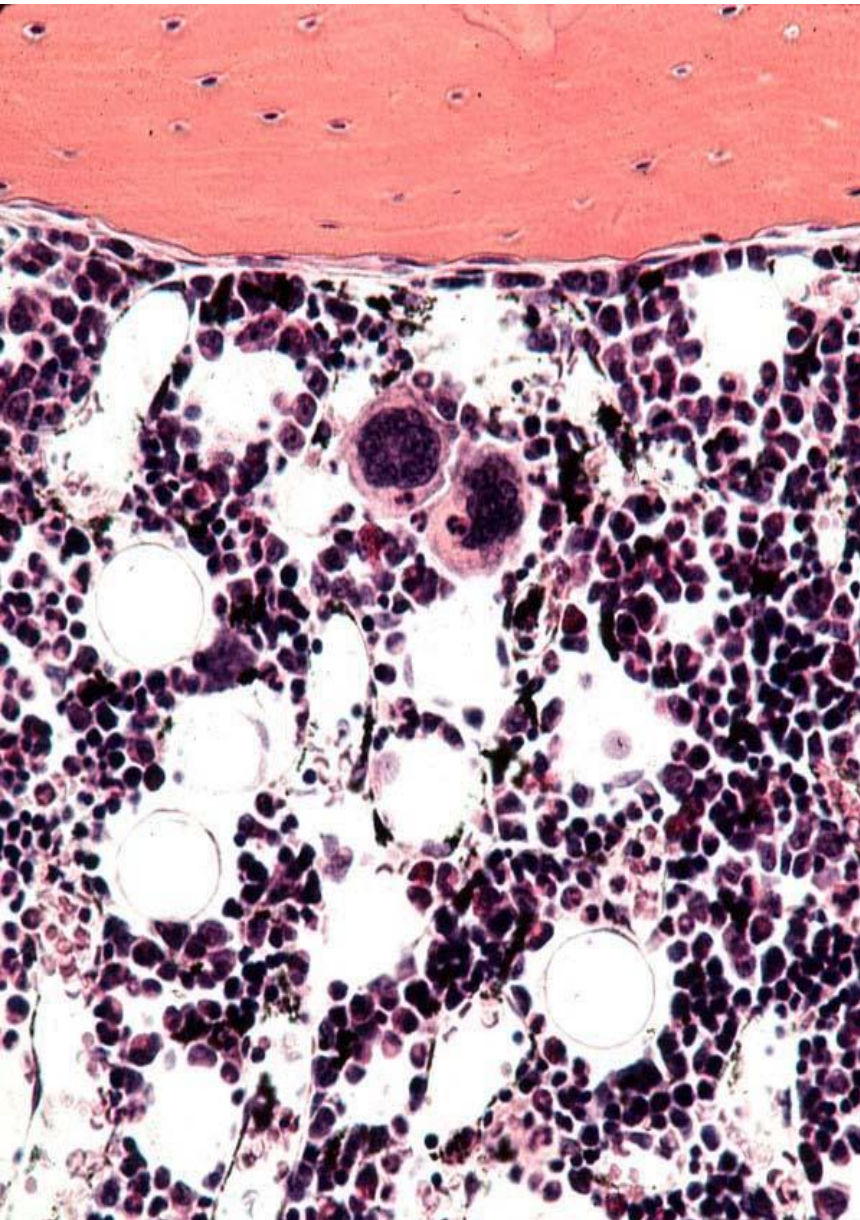


# PERIOSTEUM



- **PERIOSTIUM** consists of 2 layers:
- **1. external - fibrous**  
(contains collagen fibers and blood vessels enter the bone through it)
- **2. internal - osteogenic**  
(contains osteoblasts that provide bone growth in thickness and bone regeneration in case of injury)

# ENDOSTIUM



- Is lining the medullary canal
- It is formed by loose fibrous connective tissue,
- where there are osteoblasts, osteoclasts and cells of loose connective tissue



# COMPACT BONE



- Consists of three layers of bone lamella

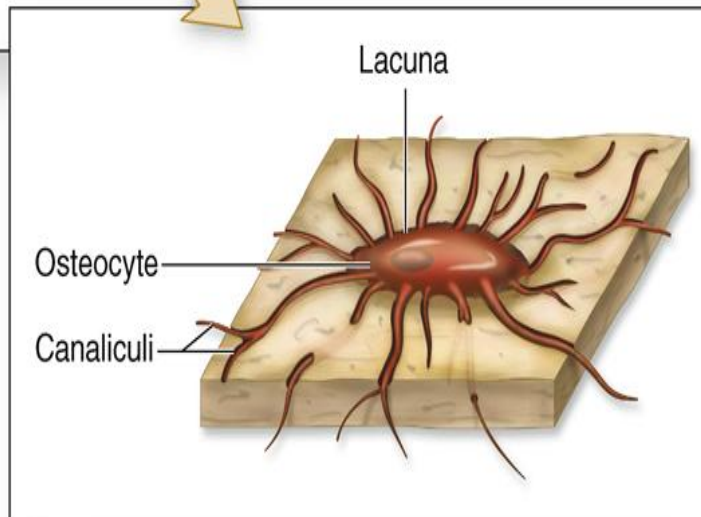
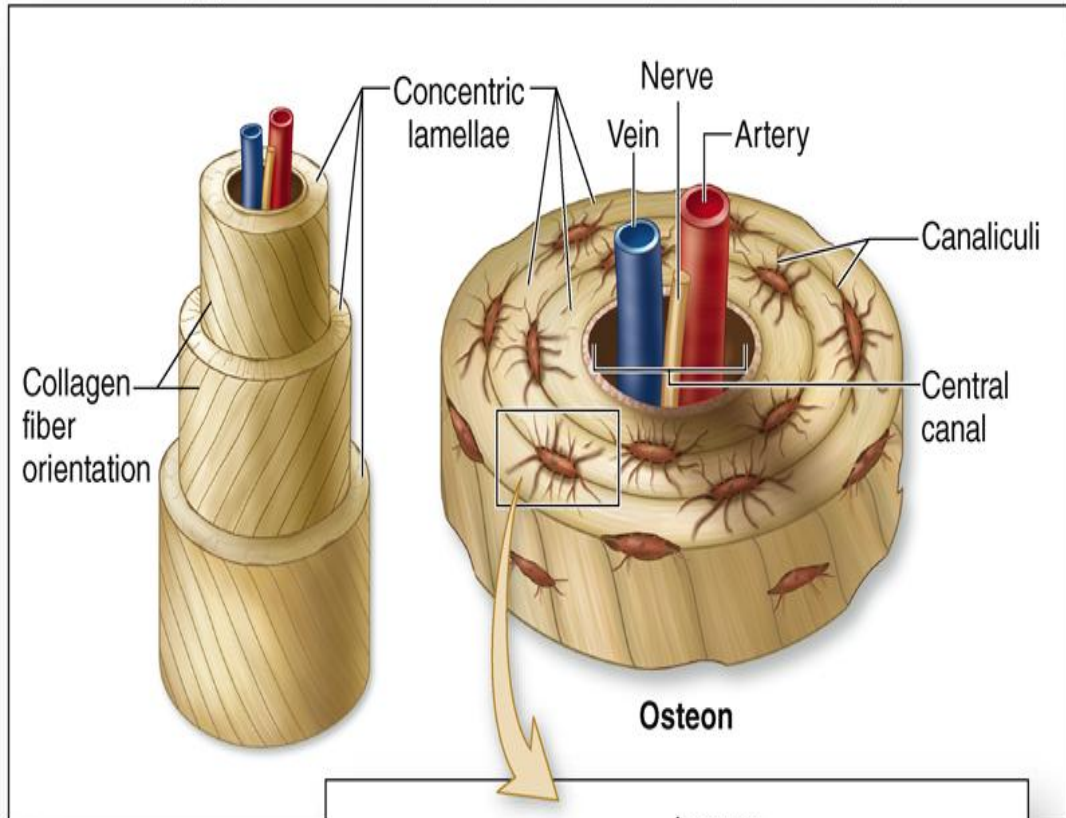
- 1. External circumferential (general) bone lamella

- 2. Osteon layer

- 3. Internal circumferential (general) bone lamella

# OSTEON (haversian system)

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**Is structural and functional unit of bone consists of bone lamella concentrically stacked on top of each other in the form of cylinders inserted one into the other.**

**Osteocytes lie between the bony plates in the gaps**

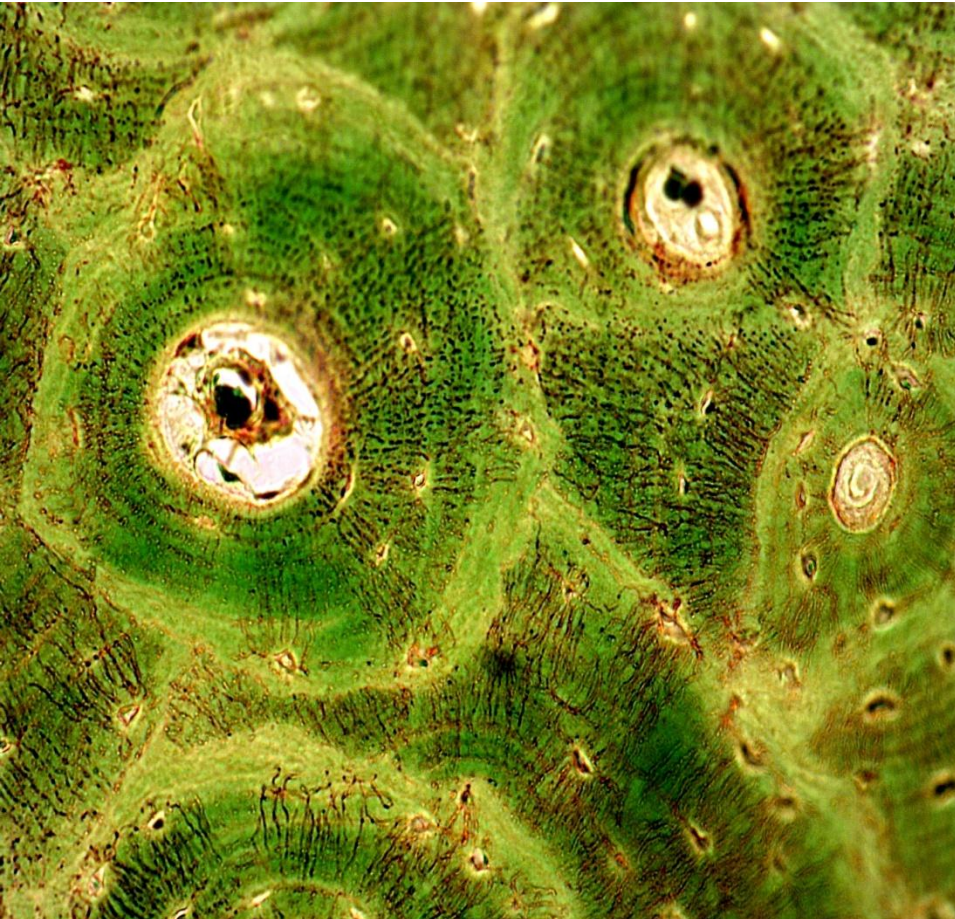


# ЛАКУНАРНО-КАНАЛЬЦЕВАЯ СИСТЕМА





# ГАВЕРСОВА СИСТЕМА



- A blood vessel passes through the osteon canal or Haversian canal.
- Between the osteons are inserted bone lamella (remnants of decaying osteons).



# OSTEOGENESIS PRENATAL

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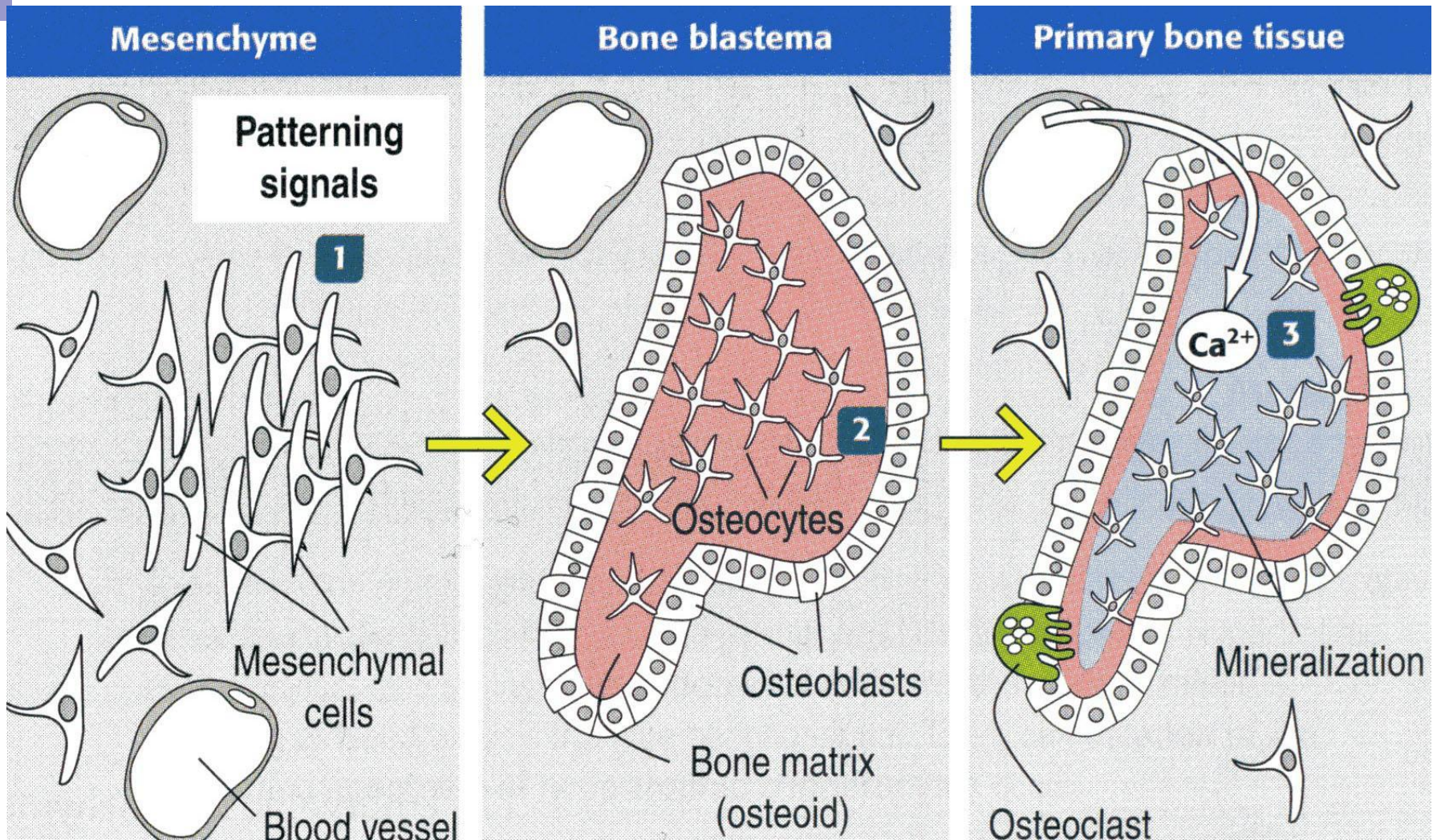
- **BONE FORMATION BEGINS ON 1 MONTH OF PRENATAL DEVELOPMENT**
- **CONTINUES UNTIL 25 YEARS**
- **1. INTRAMEMBRANOUS BONE FORMATION** (DIRECT OSTEOGENESIS FROM Mesenchyma)
- **Characteristic for coarse fibrous bone tissue - flat bones of the skull, collarbone, phalanx of the fingers**
- **2. ENDOCHONDRAL BONE FORMATION** (INDIRECT OSTEOGENESIS from the cartilage model to the long bone)

# INTRAMEMBRANOUS BONE FORMATION

- **1. osteogenic islet formation** -mesenchymal cells in places of future flat bones condense and form dense clusters - skeleton islets! Mesenchymal cells later differentiate into preosteoblasts-osteoblasts
- **2. osteoid stage** - osteoblasts begin to form the intercellular substance of the bone (due to secretion of ECM components - collagen)
- **3. mineralization of the intercellular substance** (impregnation with calcium salts due to enzyme alkaline phosphatase of osteoblasts ).
- **4. bone remodeling** and growth - old sections of primary reticulofibrous bone are gradually destroyed (due to osteoclasts) and new sections of lamellar bone are formed in their place (due to osteoblasts)

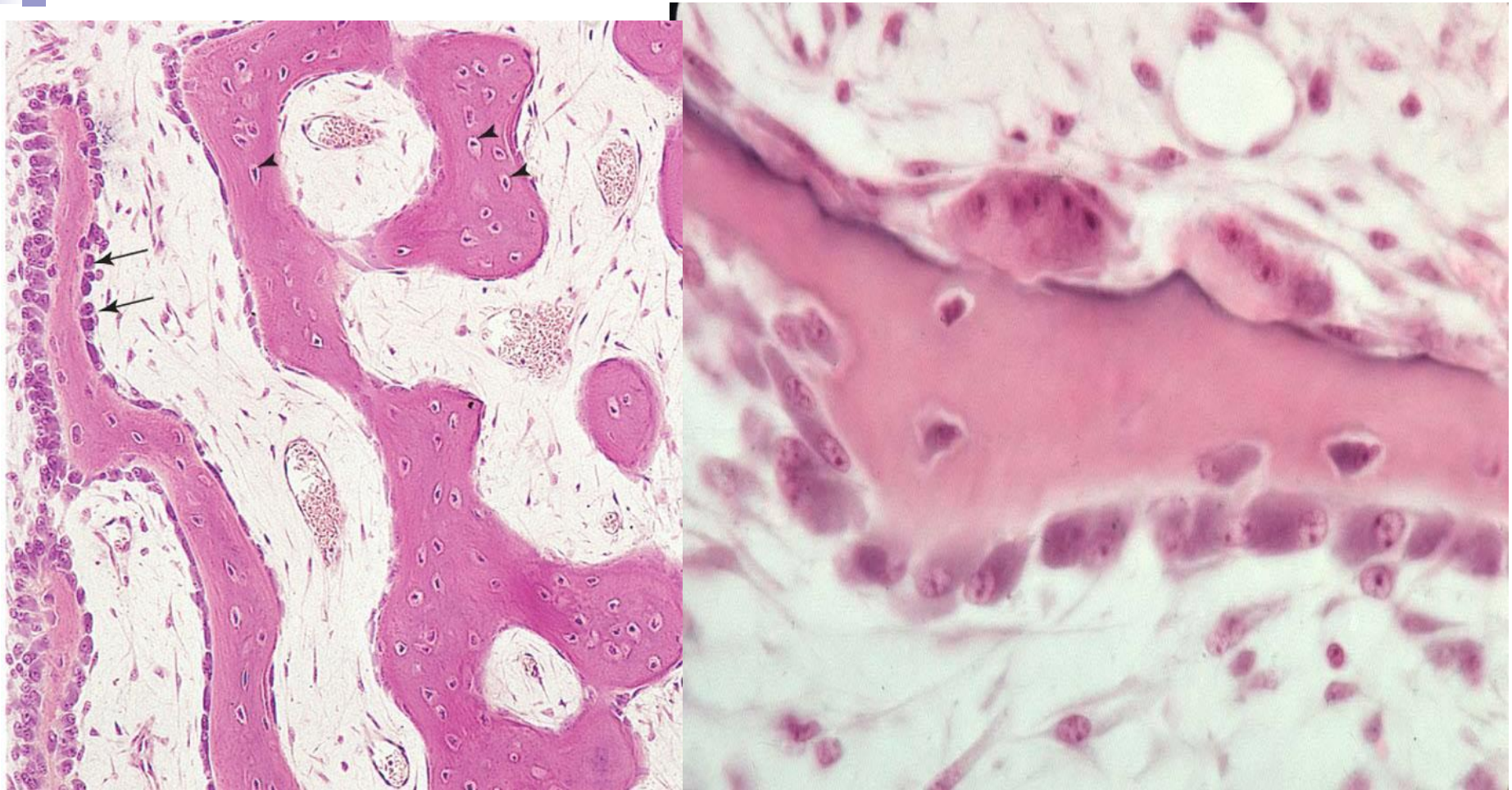


# INTRAMEMBRANOUS BONE FORMATION



- **FORMATION OF OSTEOGENIC ISLANDS**
- **CELL DIFFERENTIATION AND OSTEOID FORMATION**
- **ORIGINAL OSTEOID**





- The development of bone spicules, trabeculae occurs with the appositional growth of bone tissue.
- SUCH BONE - PRIMARY SPONGE
- THEN primary bone IS REPLACED BY A - SECONDARY SPONGY bone

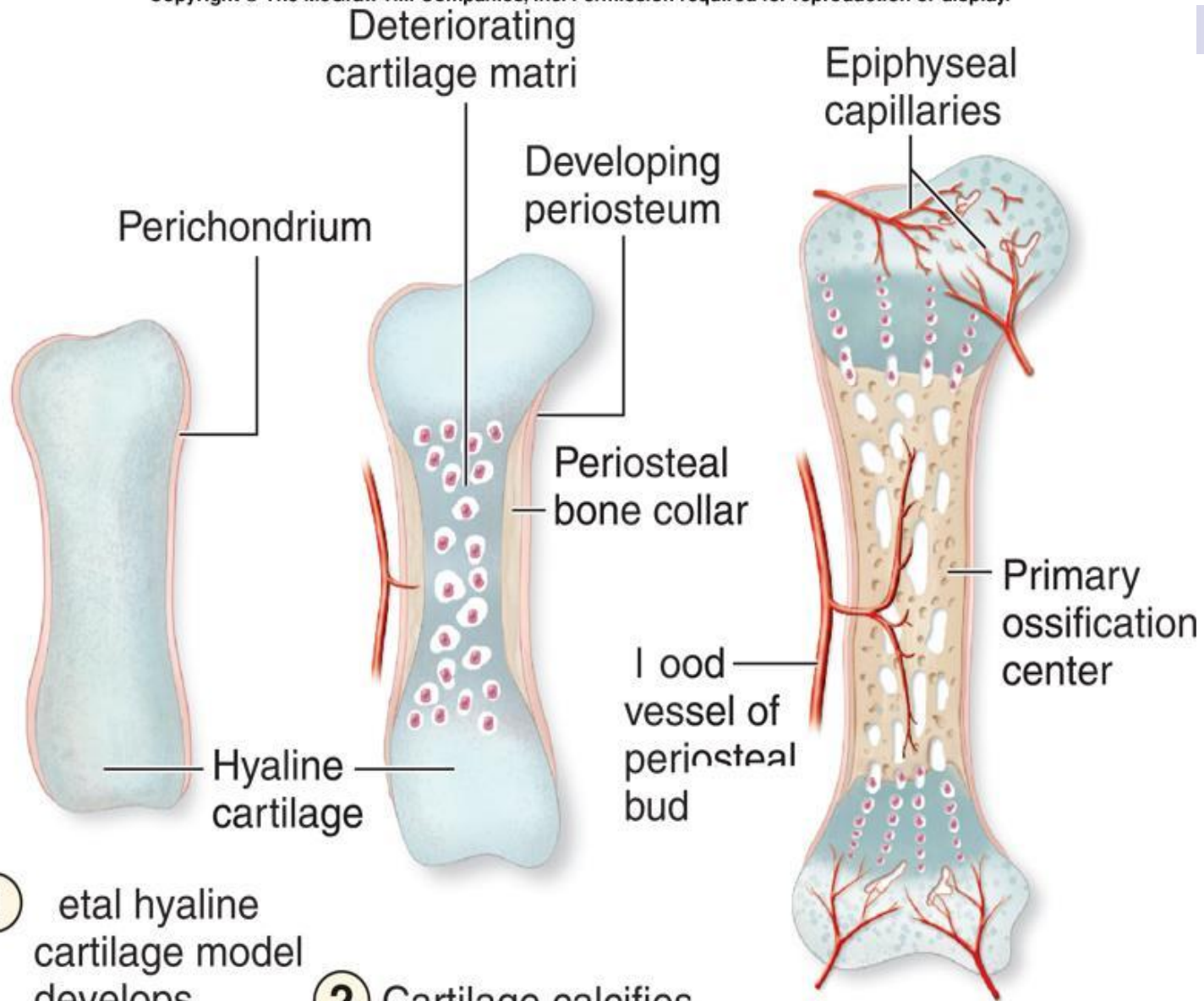


# ENDOCHONDRAL BONE FORMATION

- BEGINS ON THE SECOND MONTH
- FORMATION OF THE CARTILAGE MODEL
- FORMATION OF THE PERIOSTEAL BONE COLLAR (PERICONDRAL OSSIFICATION)
- ENDOCHONDRAL OSSIFICATION IN THE DIAPHYSIS
- ENDOCHONDRAL OSSIFICATION IN THE EPIPHYSIS
- FORMATION OF EPIPHYSICAL PLATES OF GROWTH

# ENDOCHONDRAL BONE FORMATION

- 1. the formation of a cartilage model (hyaling) of the future bone;
- 2. in the area of the diaphysis of the cartilaginous model, perichondral ossification occurs
  - while the perichondrium turns into the periosteum, in which stem (osteogenic) cells differentiate into osteoblasts;
  - osteoblasts begin to form bone tissue in the form of common plates forming a **PERIOSTEAL BONE COLLAR**



① fetal hyaline cartilage model develops

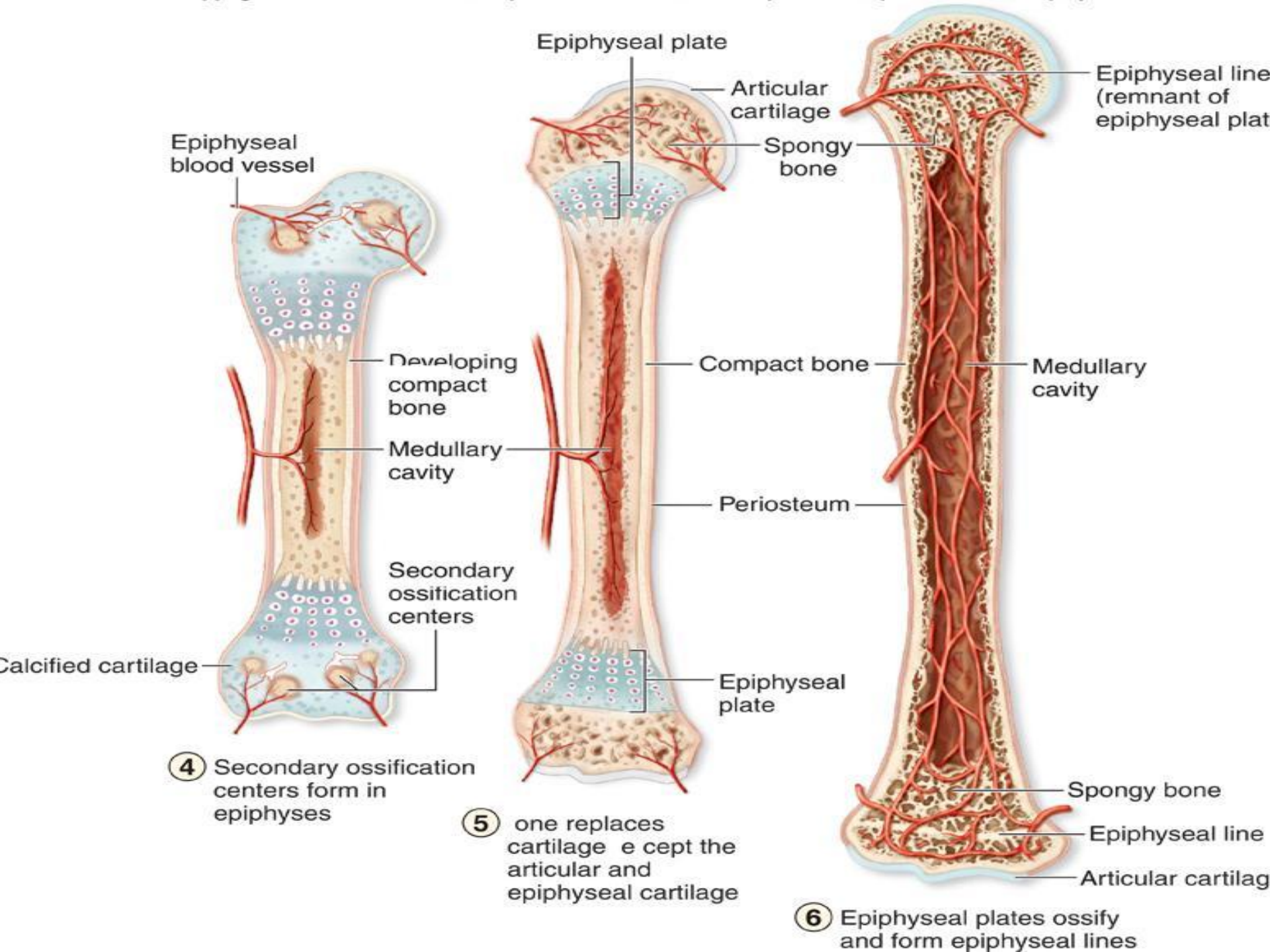
② Cartilage calcifies and bone collar forms around diaphysis

③ Primary ossification center forms in the



# endochondral ossification

- 3. In parallel with this, endochondral ossification is also observed, which occurs both in the diaphysis and in the epiphysis; ossification of the epiphysis is carried out only by endochondral ossification; blood vessels grow into the cartilage, in the adventitia of which there are osteogenic cells that turn into osteoblasts.
- Osteoblasts, producing intercellular substance, form bone plates around the vessels in the form of osteons; cartilage destruction occurs simultaneously with bone formation



④ Secondary ossification centers form in epiphyses

⑤ Bone replaces cartilage except the articular and epiphyseal cartilage

⑥ Epiphyseal plates ossify and form epiphyseal lines



# Victory Day





























