Orthopedic Biomechanics

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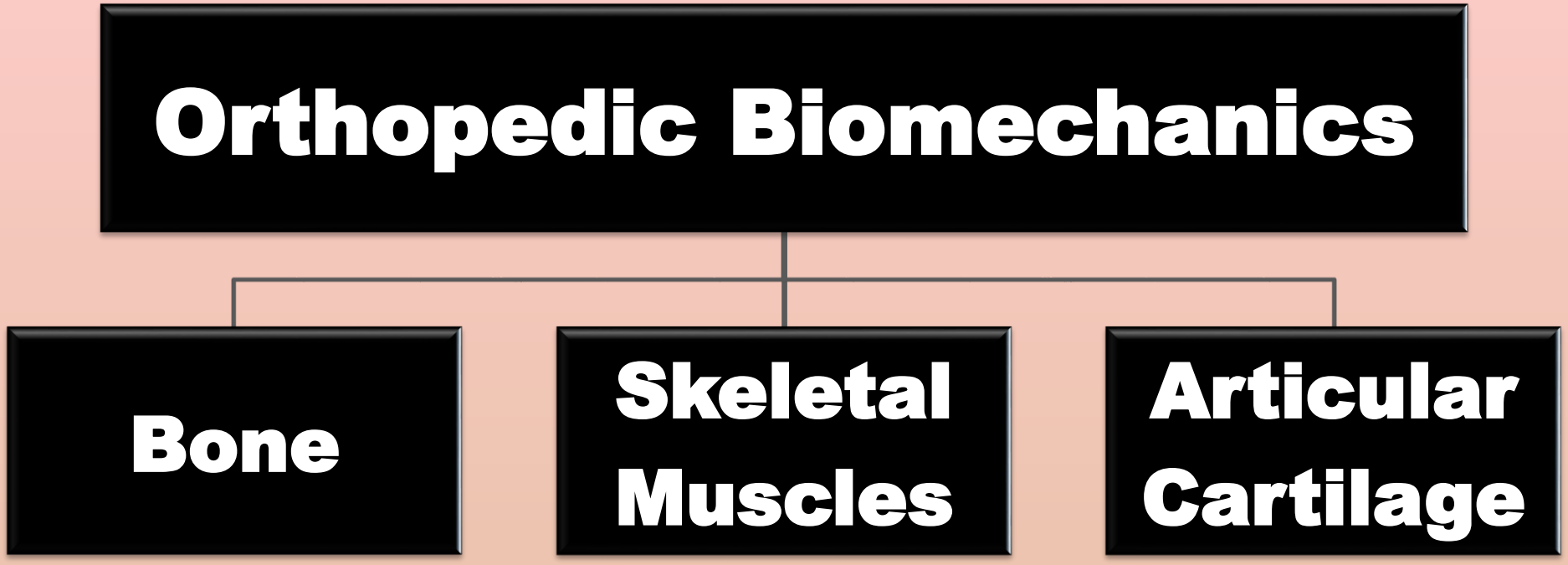

Orthopedic Biomechanics
Bone
Skeletal Muscles
Articular Cartilage

Biomechanics of bone

- Introduction
- Constituents of bone
- Bone remodeling
- Structure of Bone tissue
- Trabecular system of bone

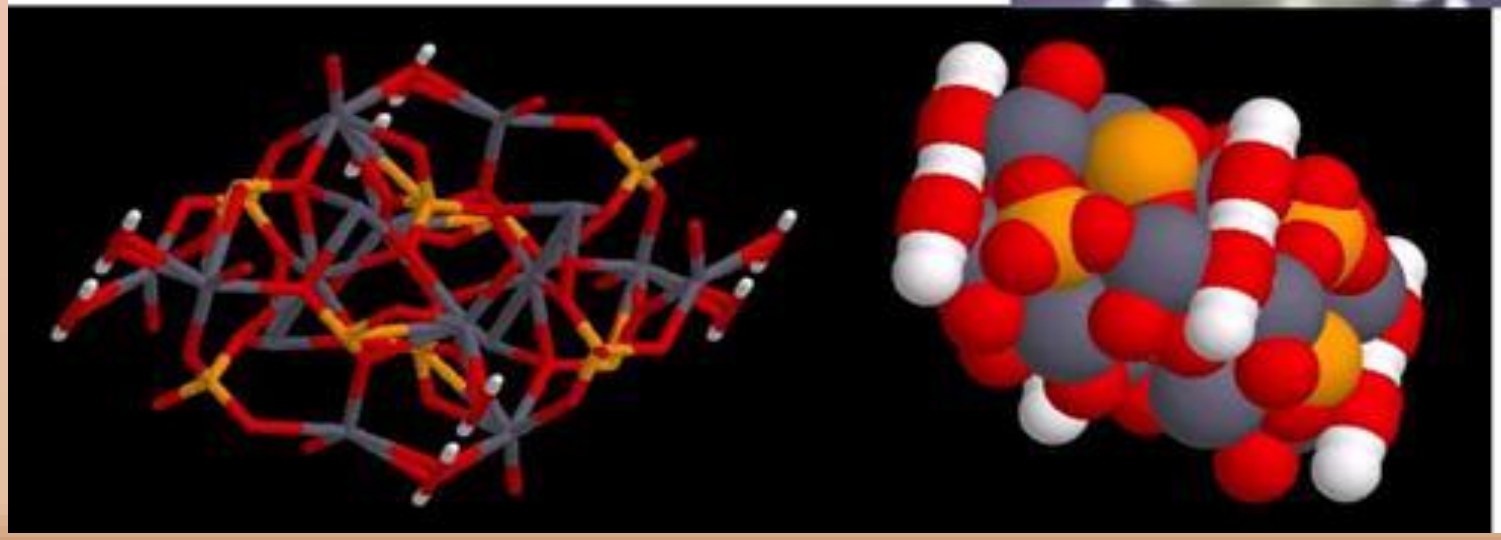
Bone tissue Content

- **Inorganic material (45%)**
  - Mainly calcium in a hydroxyapatite crystals
    - **Hardness and rigidity**
- **Organic matrix (30%)**
  - **Collagen**
    - **Elasticity and flexibility**
- **Water (25%)**

Hydroxyapatite crystals

Hydroxyapatite

$Ca_5(PO_4)_3OH$



Bone Functions

Mechanical functions

- Support the body
- Protection of internal organs
- providing points of attachment for muscles tendons and ligaments

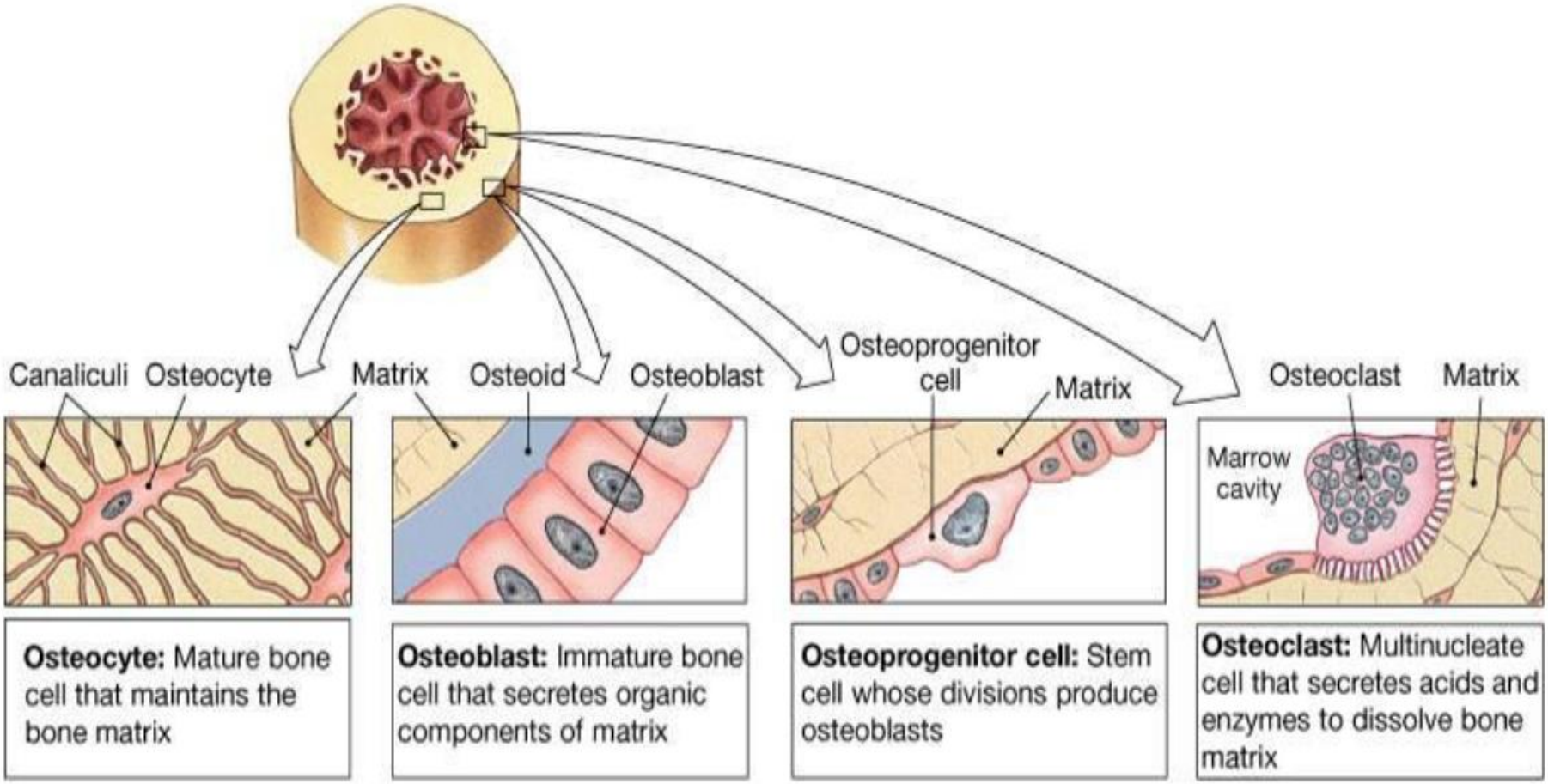
Biological functions

- Hematopoietic activity (blood cell formation)
- Reservoir or storage of minerals

Constituents of Bone

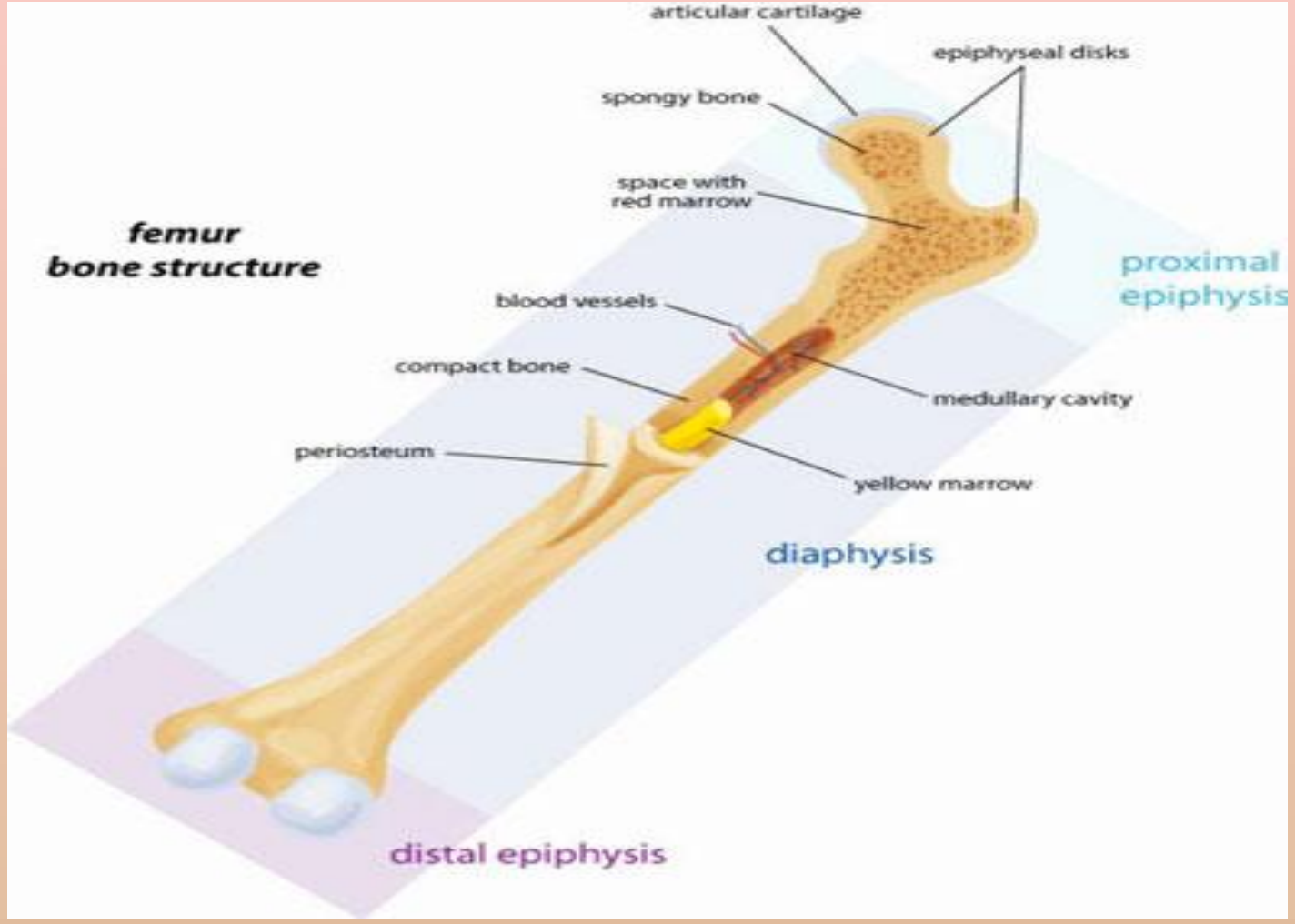
- **Bone matrix** of calcified tissues
- **Bone cells** (osteogenic, osteoblasts, osteoclasts, osteocytes)
- **Periosteum** (outer bone covering)
- **Endosteum** (inner lining of bone)

Bone cells

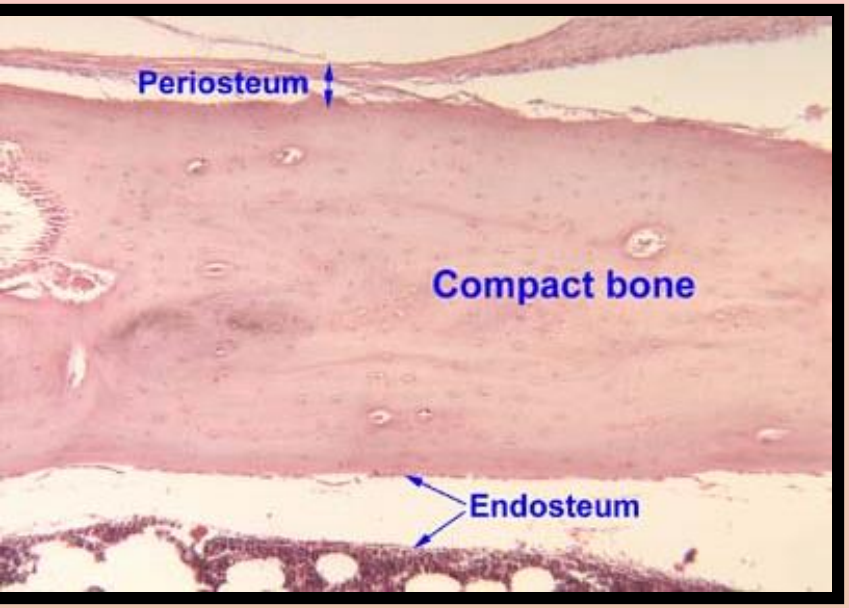


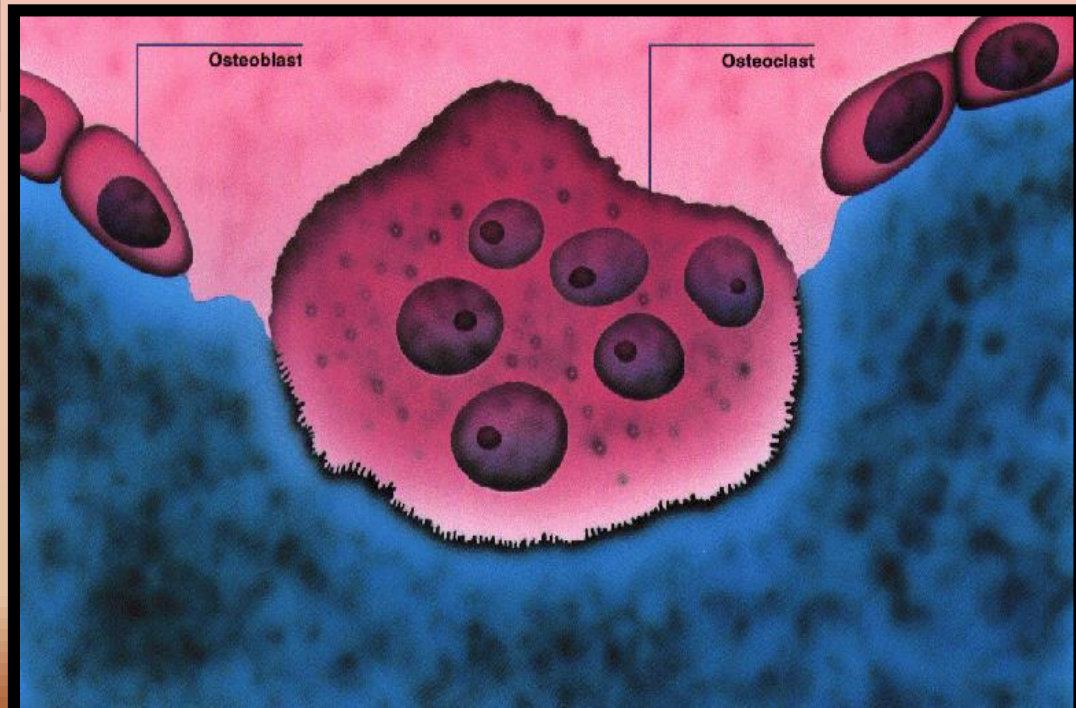
(a) Cells of bone

Long bone components



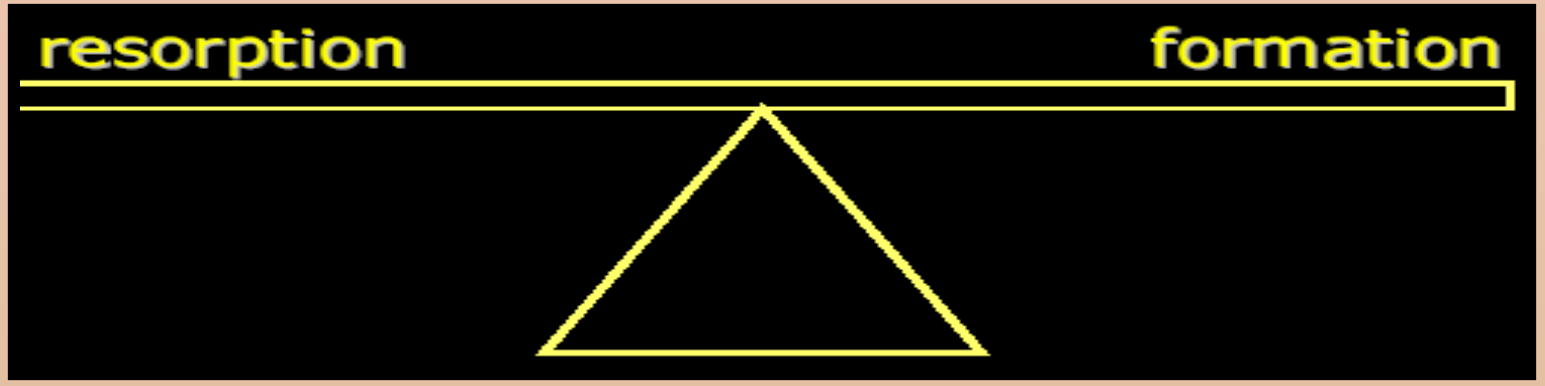
Constituents of Bone



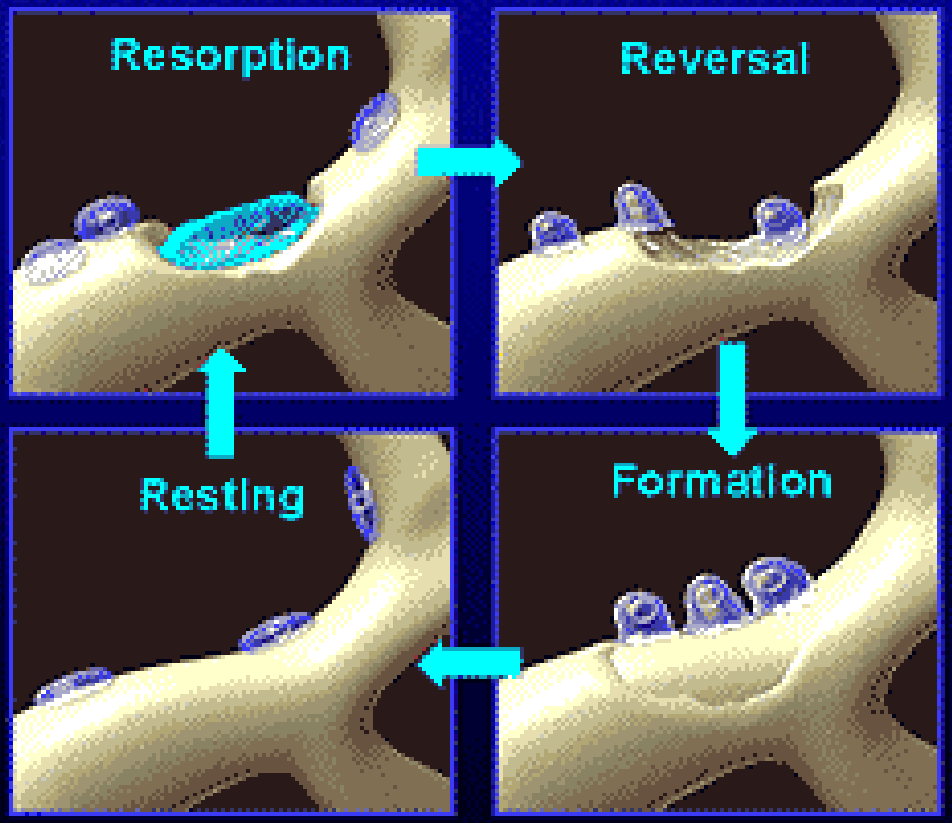


Bone Remodeling

It is a continuous and highly regulated process of bone resorption and bone formation. This process is due to balance in activities between osteoclasts and osteoeoblasts.



Normal Bone Remodeling



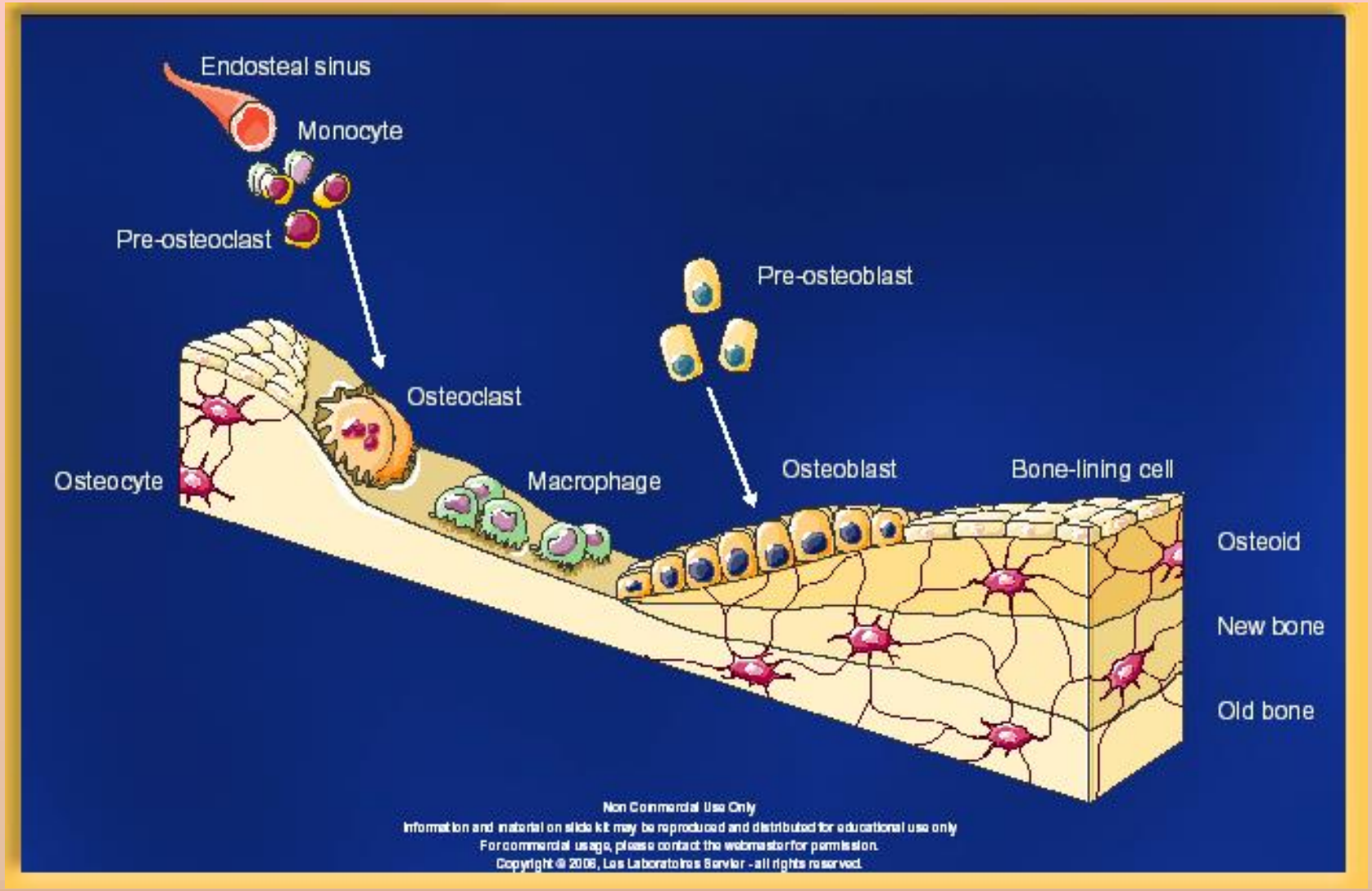
Resorption
Osteoclasts remove bone mineral and matrix, creating an erosion cavity (3-4 weeks)

Reversal
Mononuclear cells prepare bone surface for new osteoblasts to begin building bone

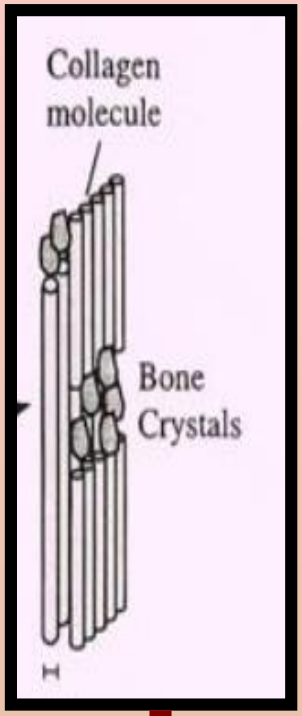
Formation
Osteoblasts synthesize a matrix to replace resorbed bone with new bone (3-4 months)

Resting
A prolonged resting period follows until a new remodeling cycle begins

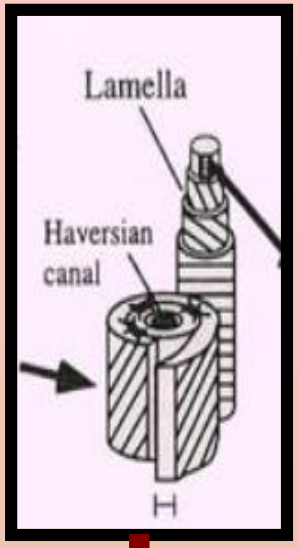
remodeling process Bone



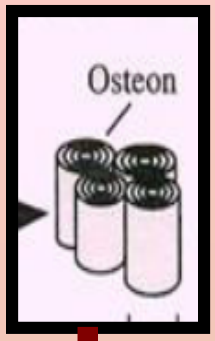
Bone Tissue Structure



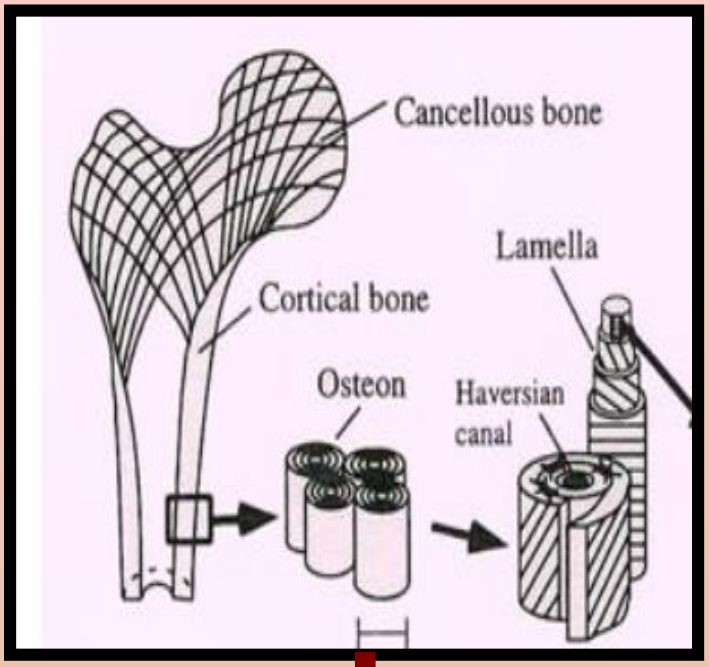
1st level
Collagen/hydroxyapatite composite



2nd level
Sheets/ lamellae

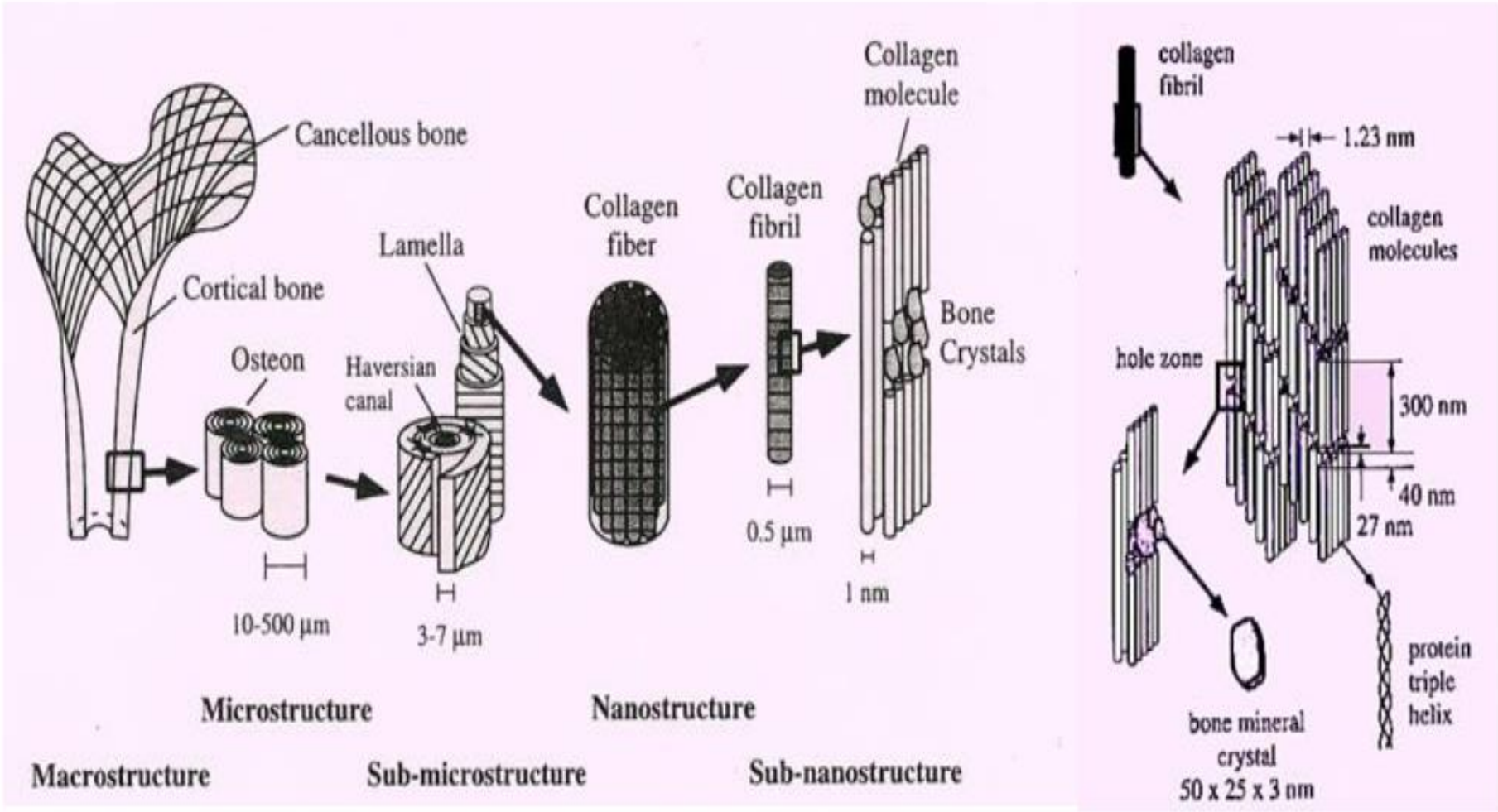


3rd level
Haversian osteon (Haversian system)

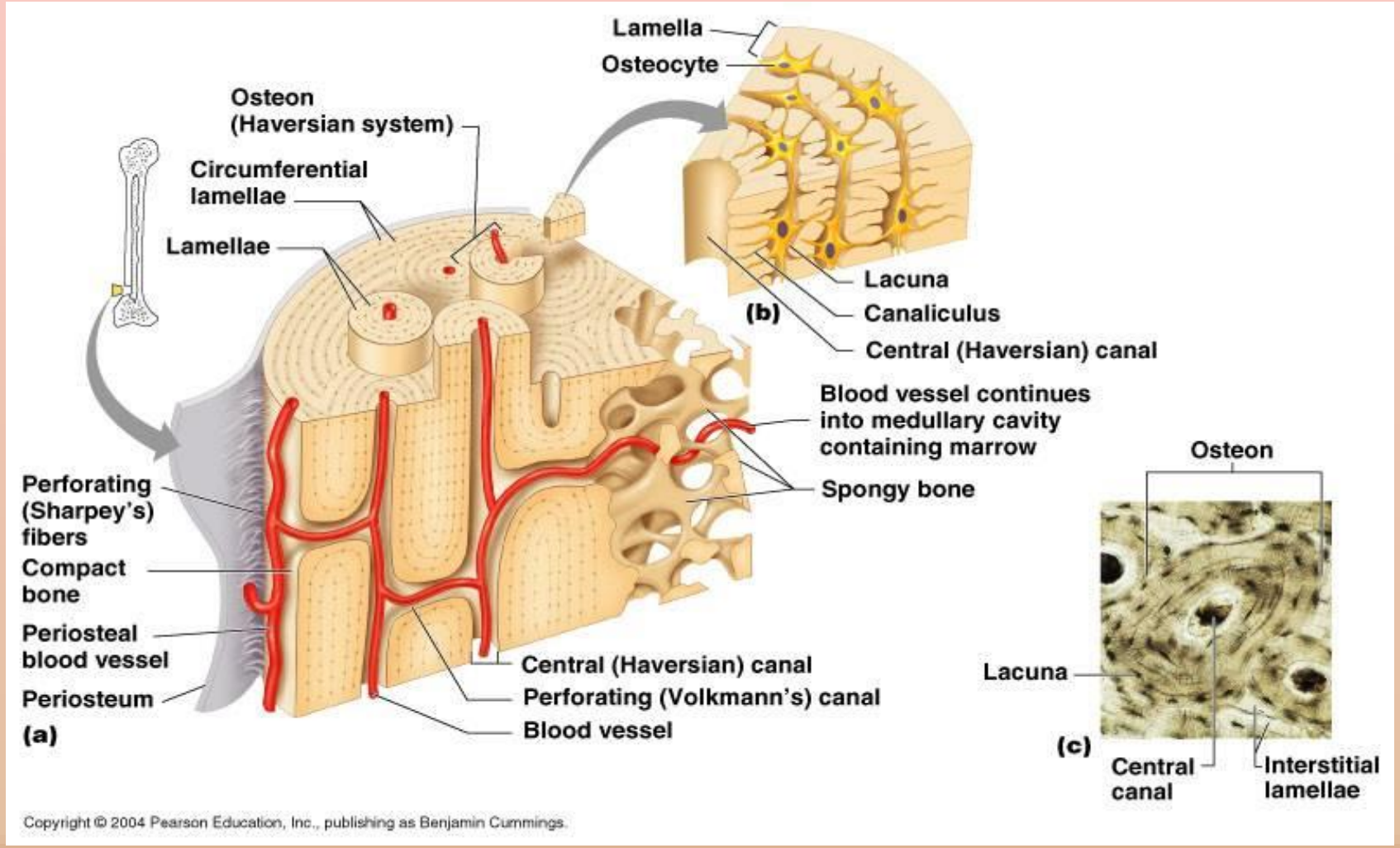


4th level
Bone strength (compact or spongy)

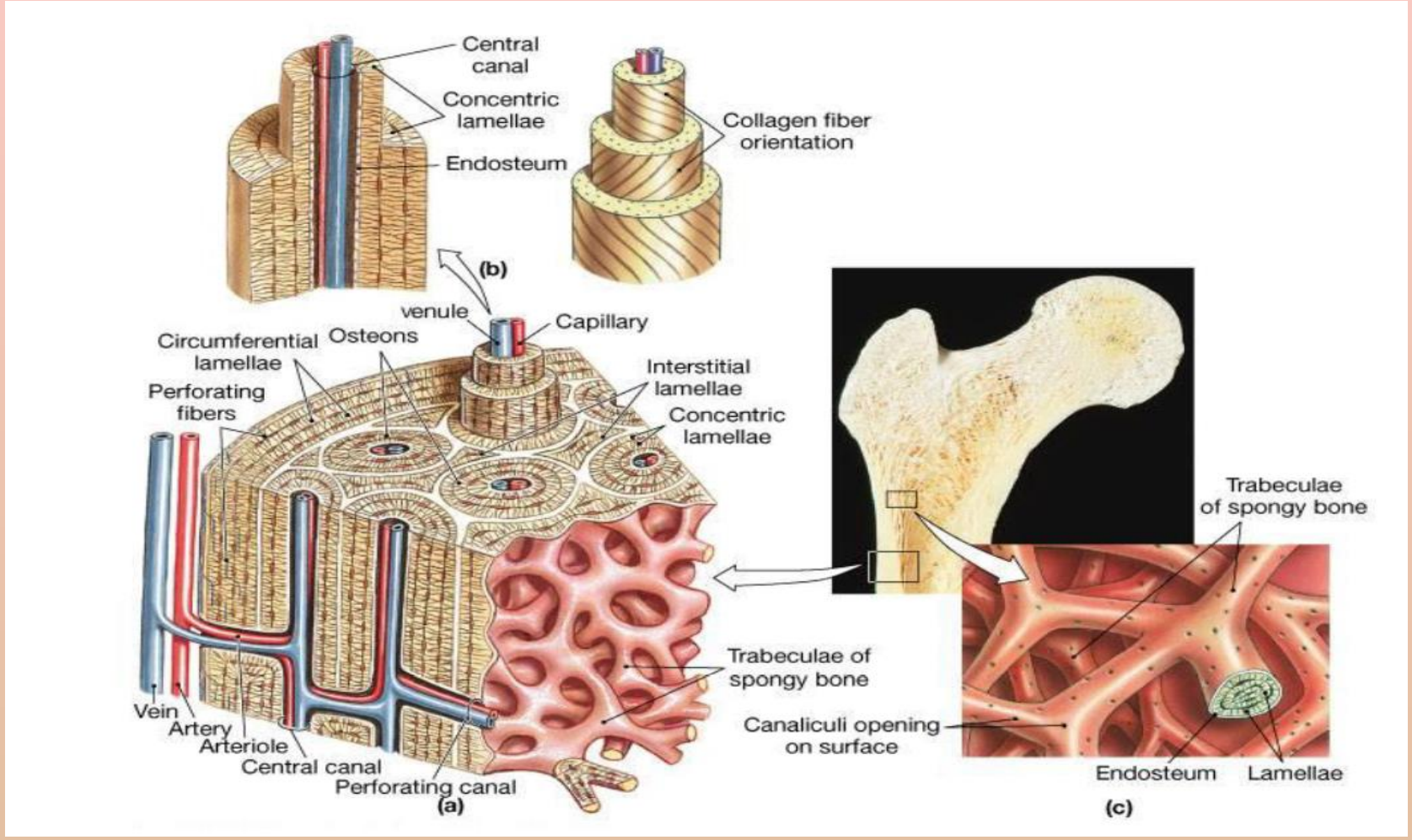
Bone Tissue Structure

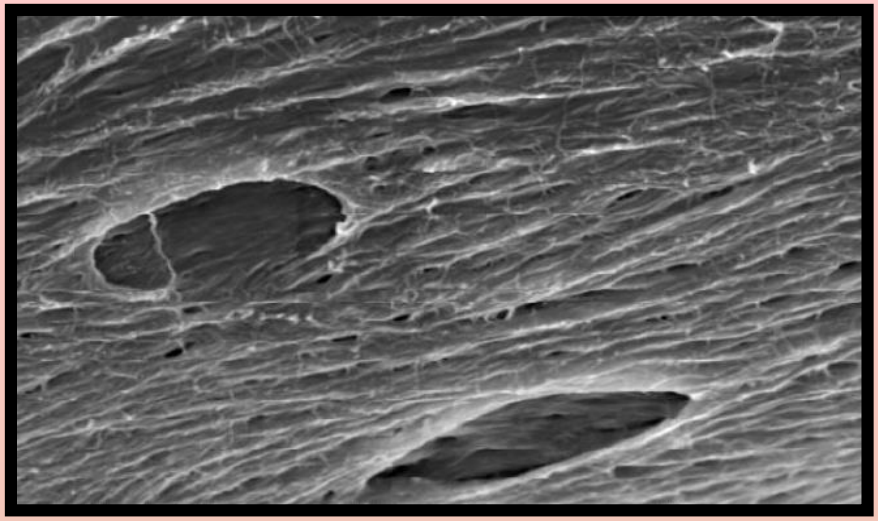


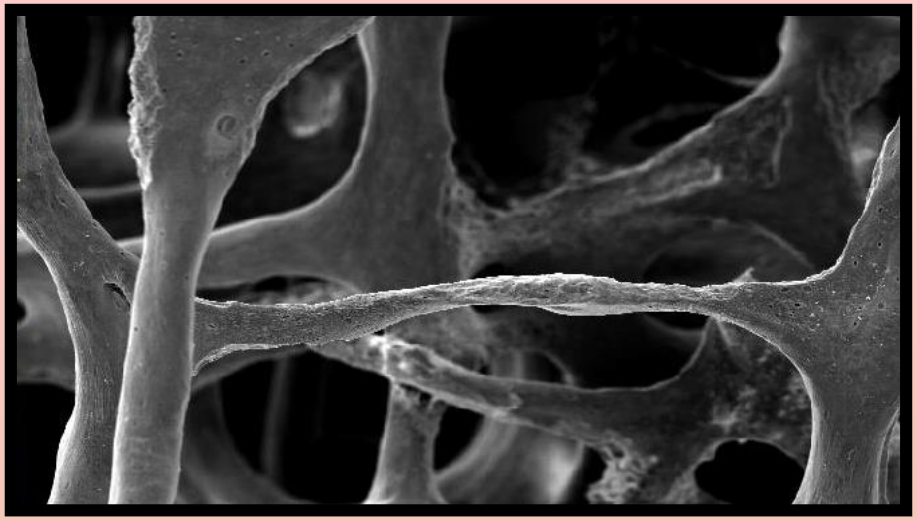
structure pic 1 Bone



structure pic 2 Bone

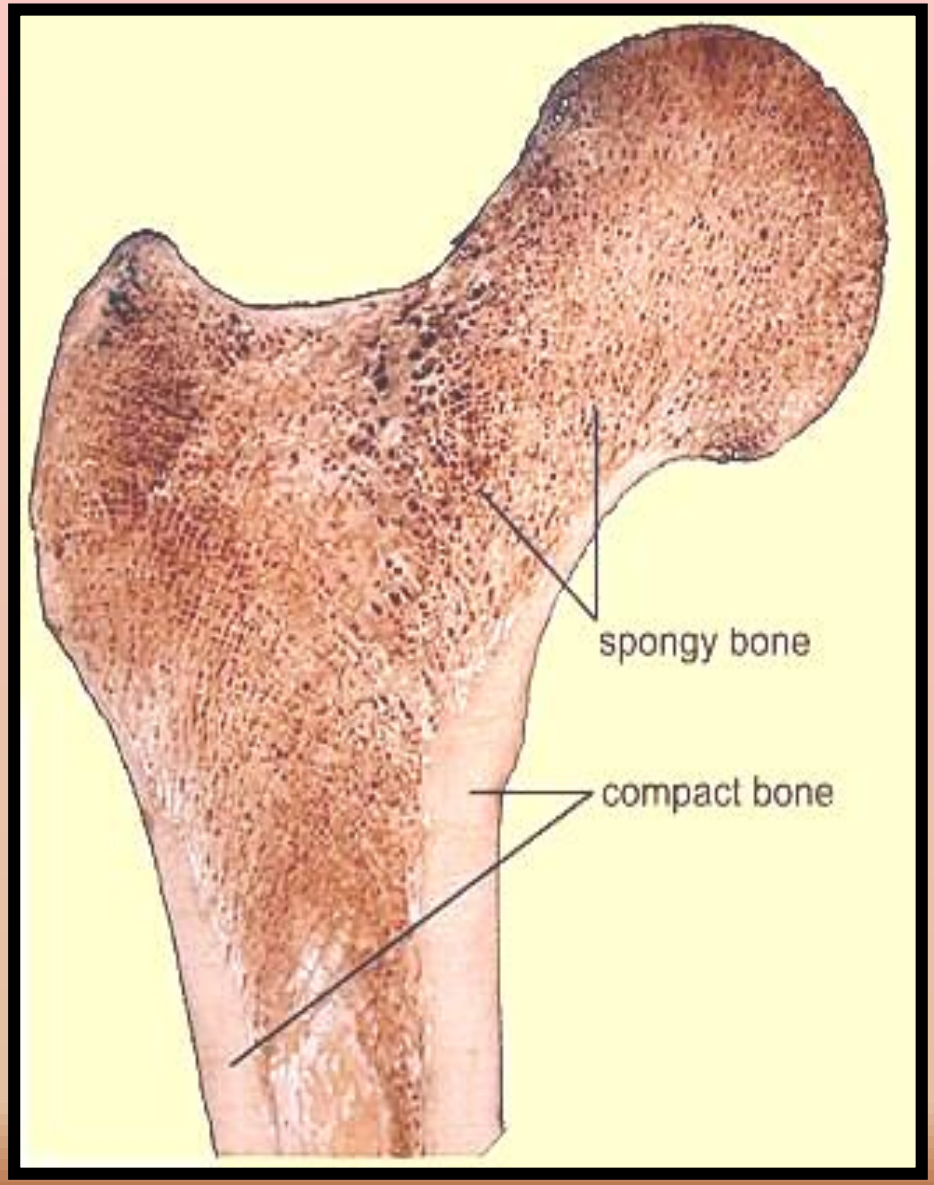


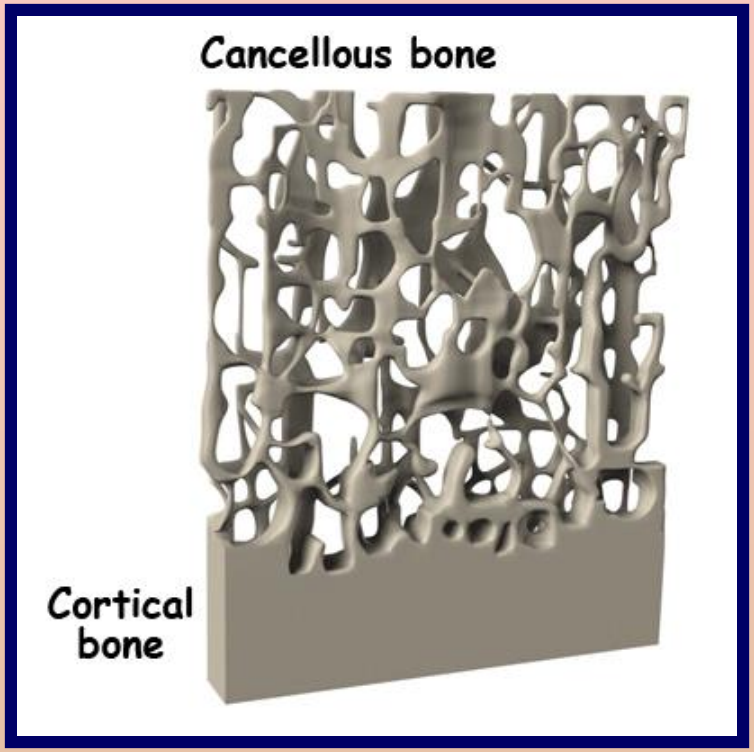




Cortical (compact)	Cancellous (spongy)
Shafts of long bone (diaphysis) e.g. shaft of femur	**Ends** of long bone (diaphyses and metaphysis e.g. head of femur
Thin shell around cancellous bone	**Short bones** and irregular bones (carpus, tarsus, vertebrae)
Function: **Weight bearing** bone	Function: **shock absorbing** bone
Includes Haversian system and canal	Does not include Haversian canal

Structure of Long Bone

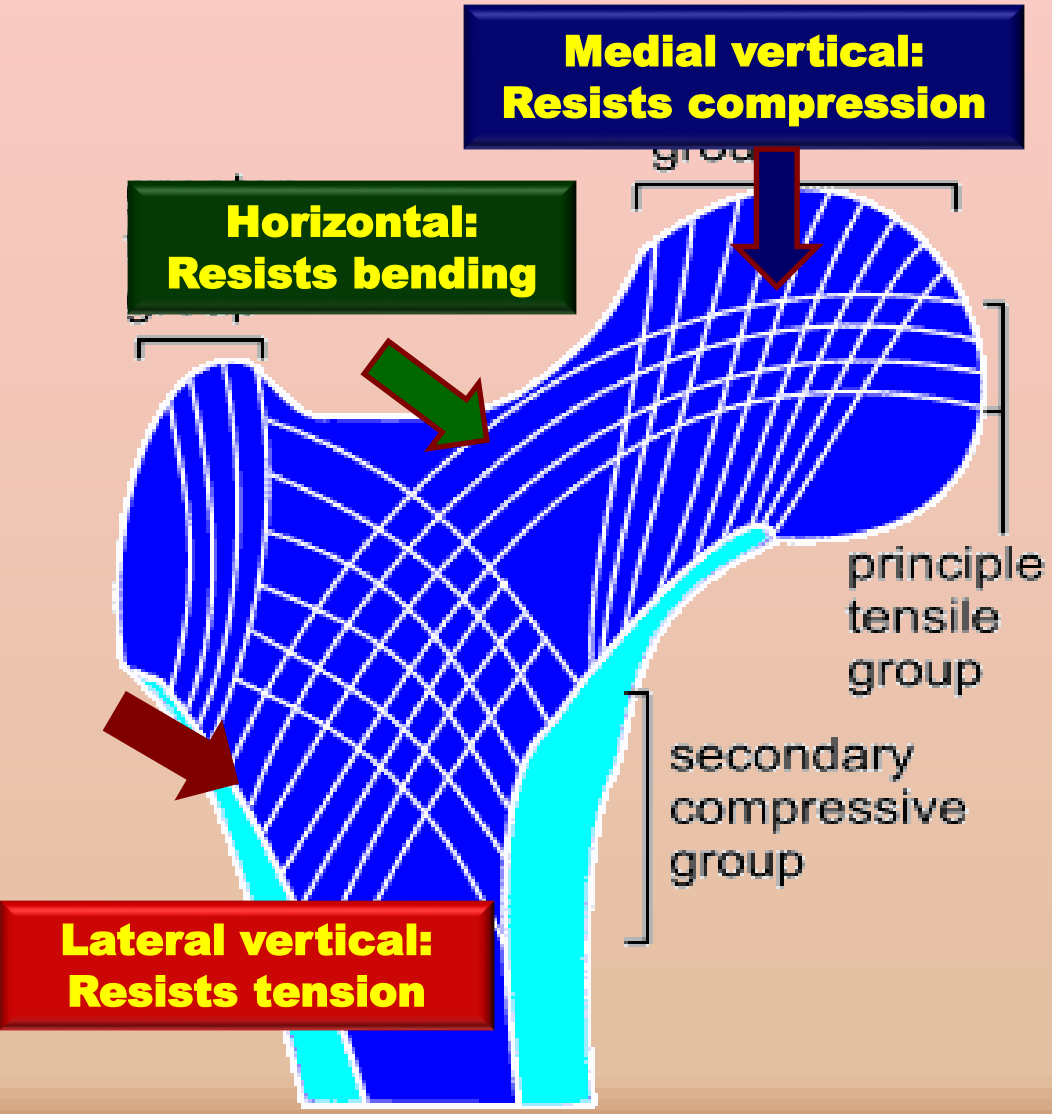


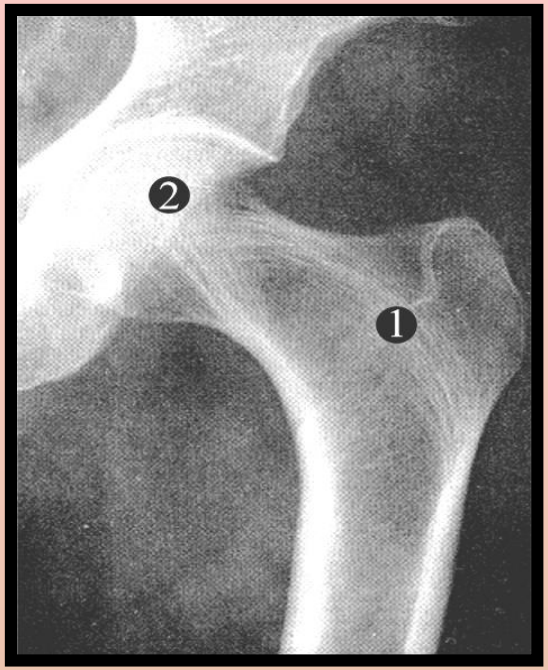


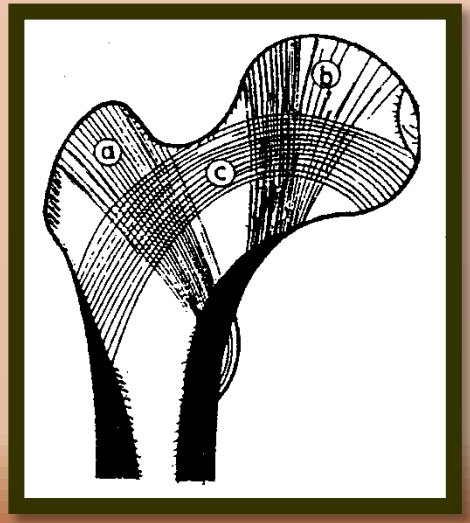
Trabecular system of bone

Trabecular system is a parts of spongy bone at which there is a network of bony plates (horizontal trabeculae) and columns (vertical trabeculae). These trabeculae give more strength to the bones when any outside load is applied.

Trabecular System of the Head of the Femur

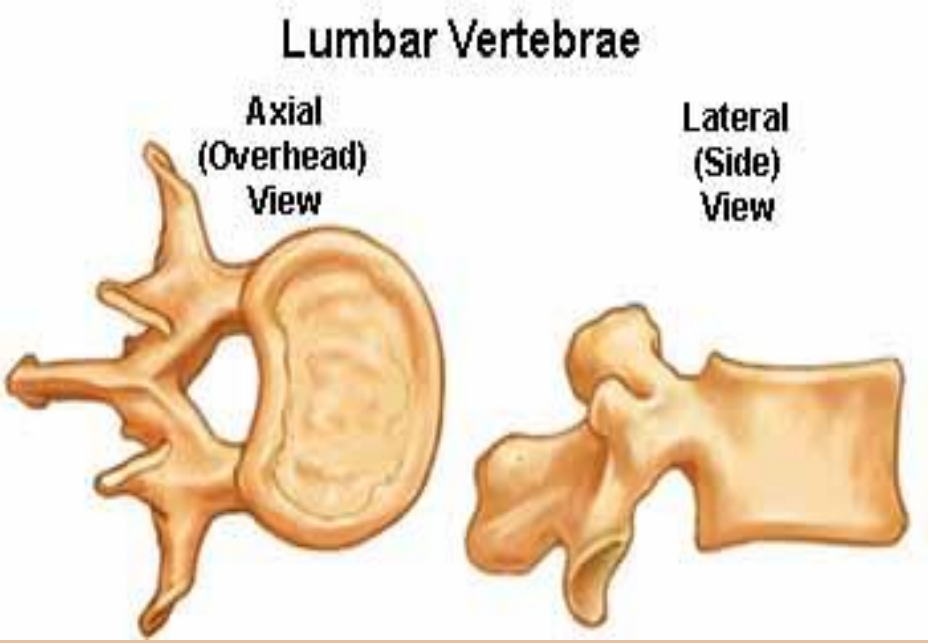






Trabecular system of irregular bone

Trabecular system of the vertebral body



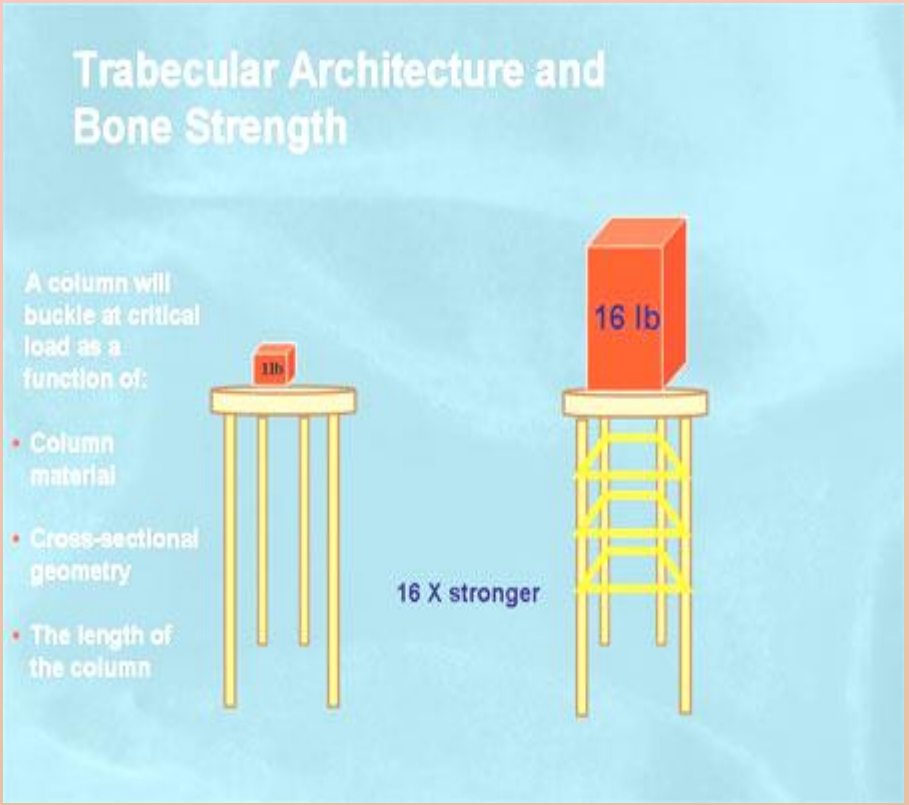
Trabecular system of Irregular bone

Trabeculae of vertebra

- **Horizontal**
- **Vertical**

Trabecular system of the vertebral body

- **Trabecular orientation**
  - **Vertical**
  - **Horizontal**



- http://scholar.cu.edu.eg/?q=dr_ayman_matar/classes