Basic Science & Trauma Term

Convening team:

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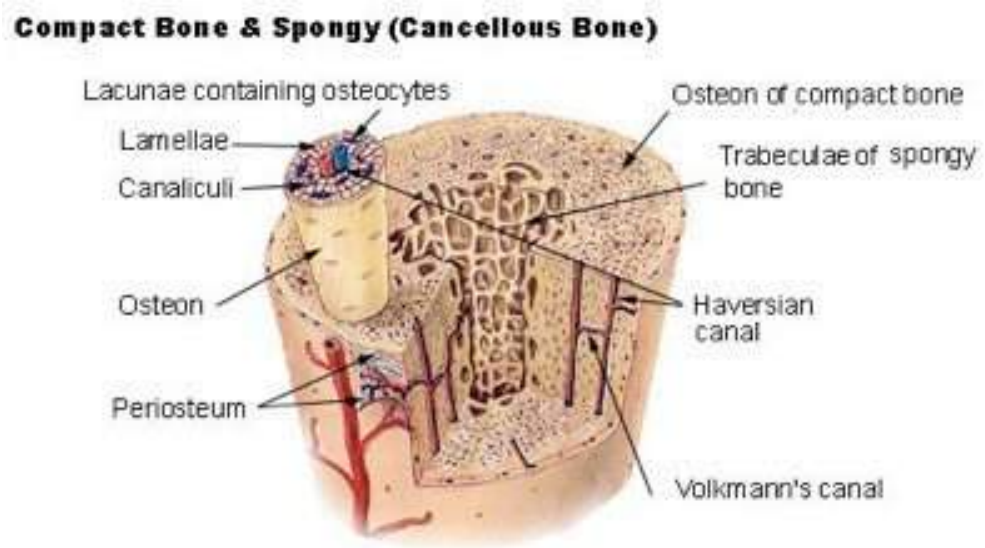
Techniques vs Concepts vs Principles

- **Techniques**: Lag screw, LCP, Static locking…
- **Concepts:** Absolute stability, Relative stability, indirect # reduction, CPM, Early mobilisation
- **Principles:** 'First do no harm'

Think 'concepts' of # fixation, not 'principles'!

"An educated mind can entertain a thought without accepting it" *- Aristotle*



Bone Basics

Amar Rangan

Professor of Orthopaedic Surgery

Bone Trivia

Q: How many bones in the human body?

A: 206 (from 270)

“Funny Bone”

- Latin: “Umerus” – upper arm,

lost in translation to “Humerus”

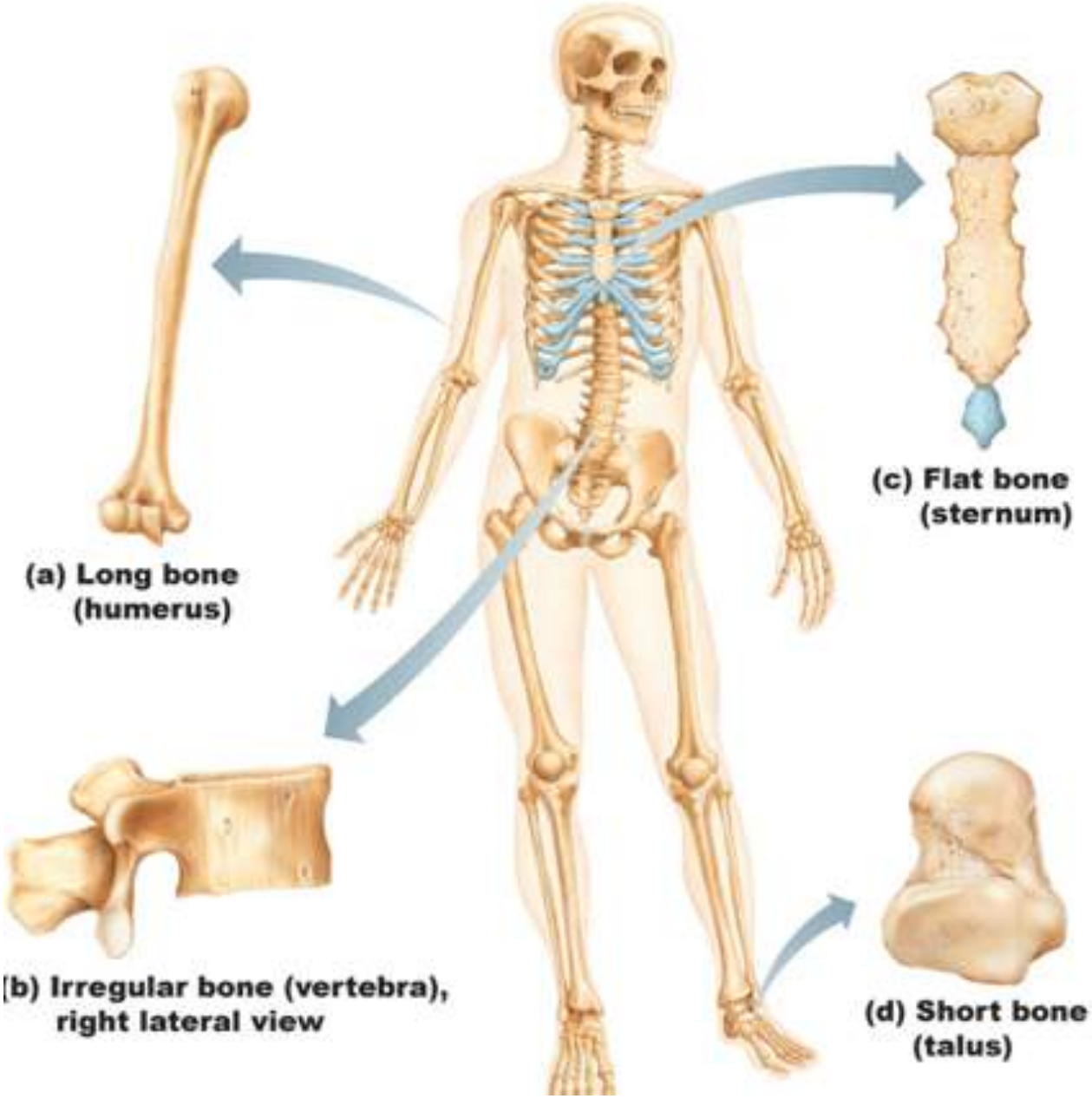
- One explanation is ‘humorous’ for funny bone

Function of Bones:

- ✓Support
- ✓Protection
- ✓Movement
- ✓Mineral storage
- ✓Haematopoiesis

‘Organ’ responsive to mechanical & physiological demands

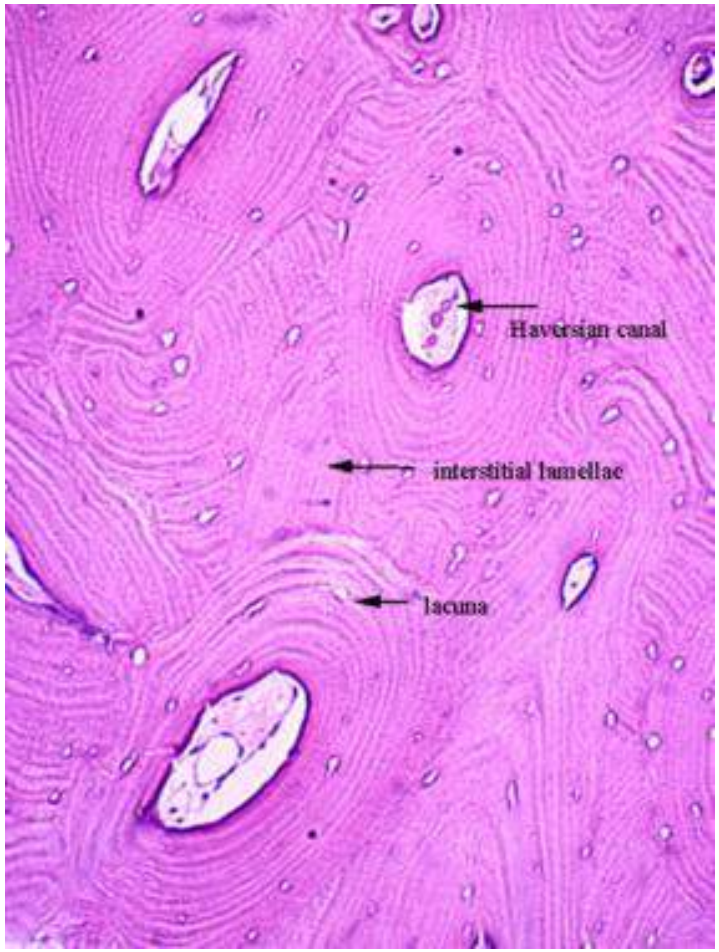
Classification of Bones



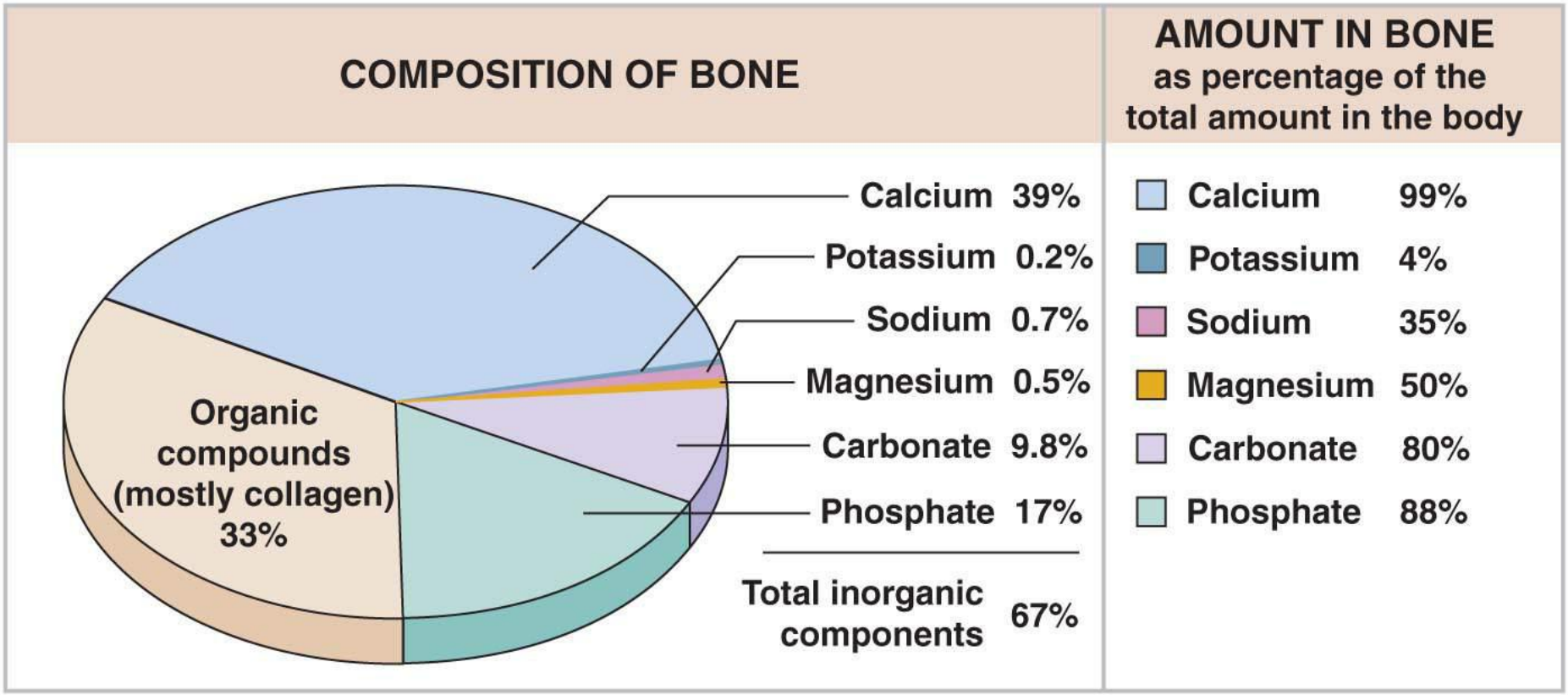
Composition

Bone is a composite material

- The matrix
  - 40% organic
  - 60% inorganic
- The cells
  - Osteoclast
  - Osteoblast
  - Osteocyte
  - Progenitor cells



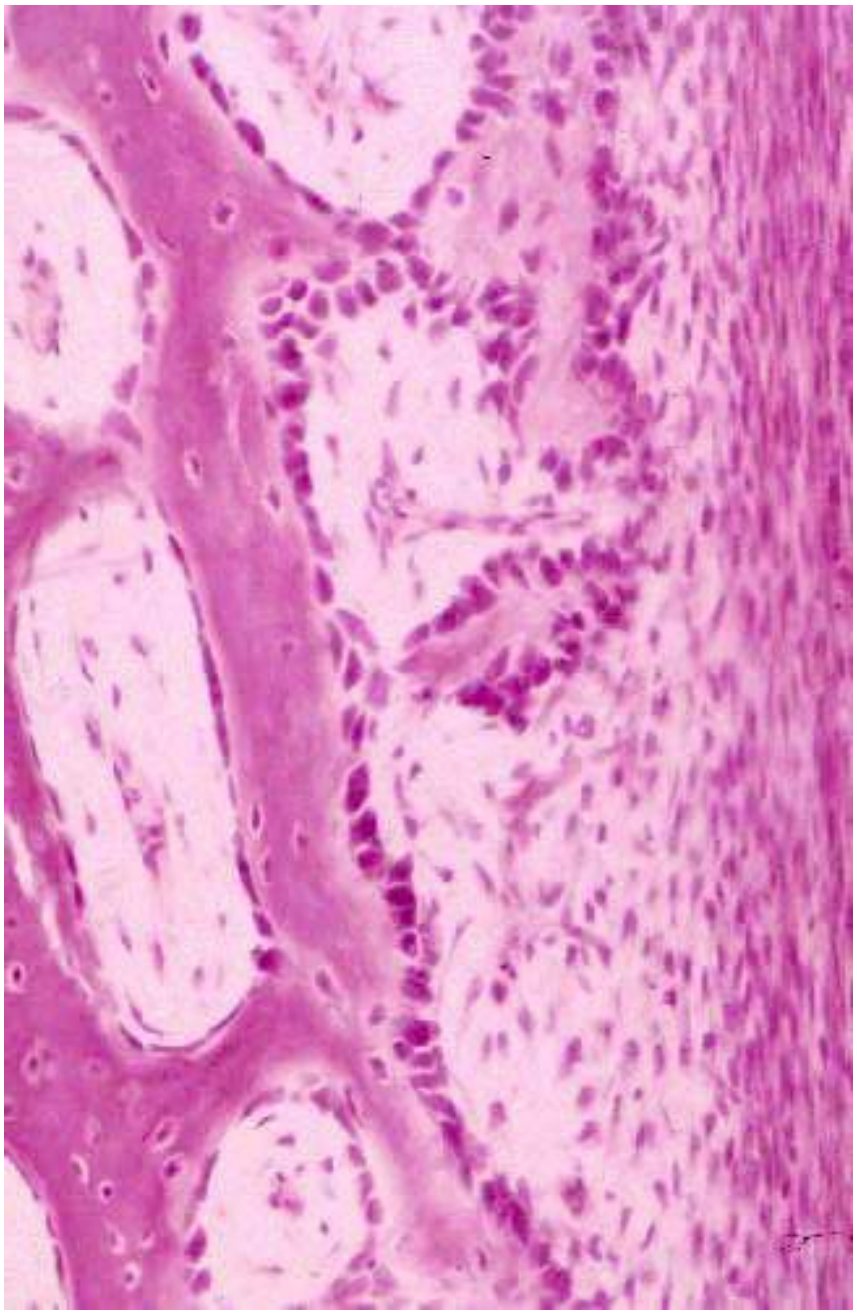
Chemical Composition of Bone



Bone Cells

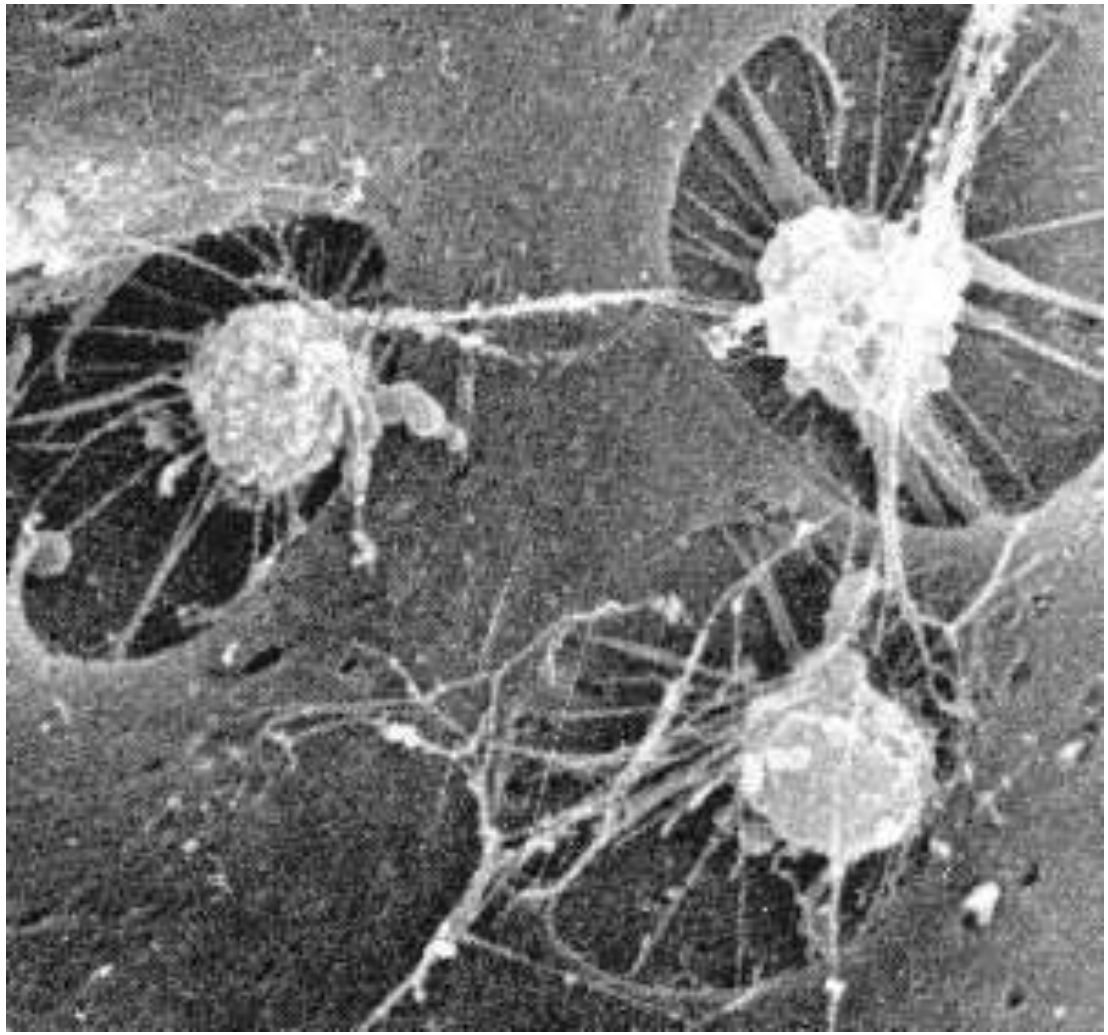
Osteoblasts

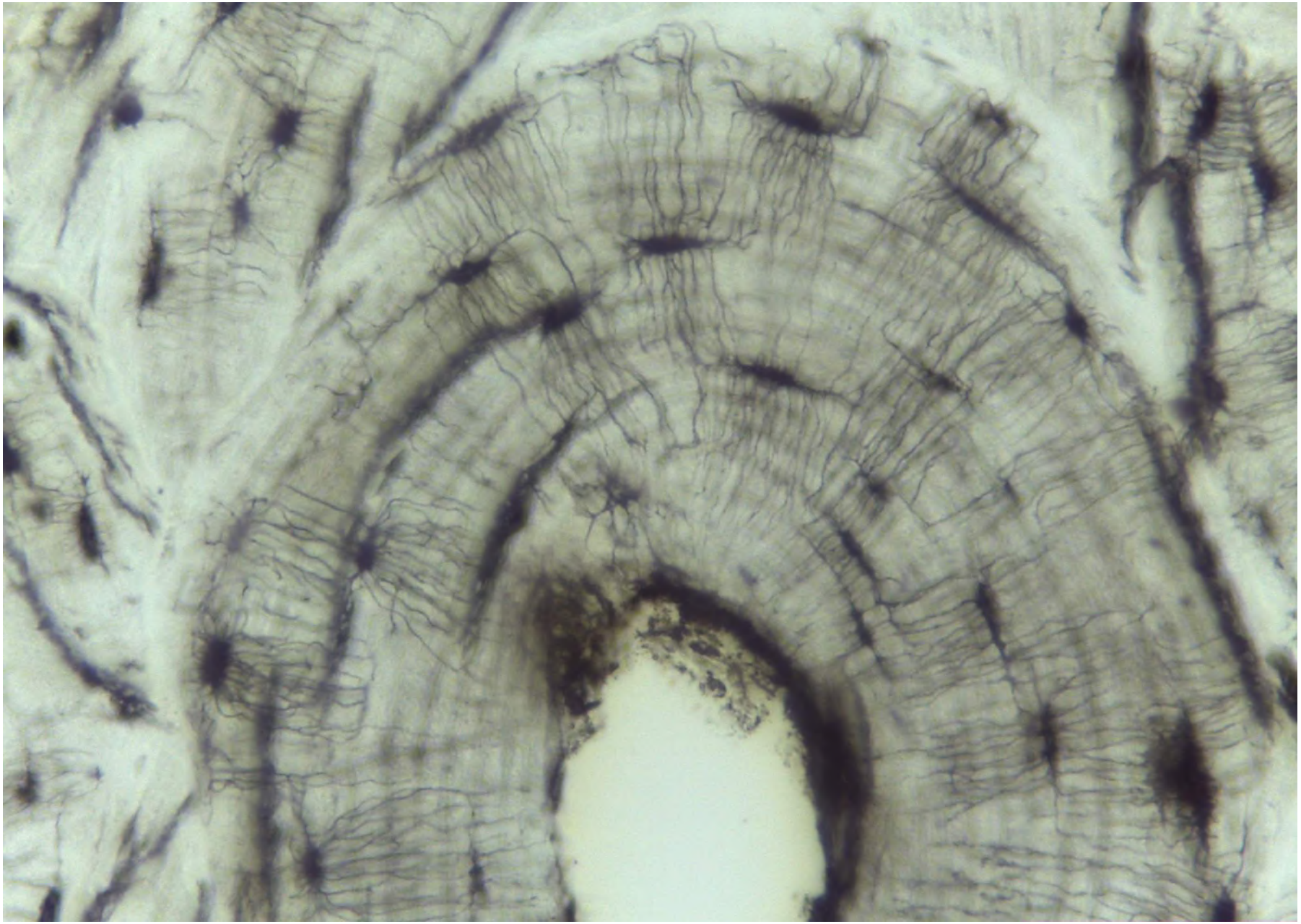
- located on bone surface
- cuboidal - columnar shape
- basophilic cytoplasm
- secretes osteoid



osteocytes

- Lacunae, osteocytes, & canaliculi

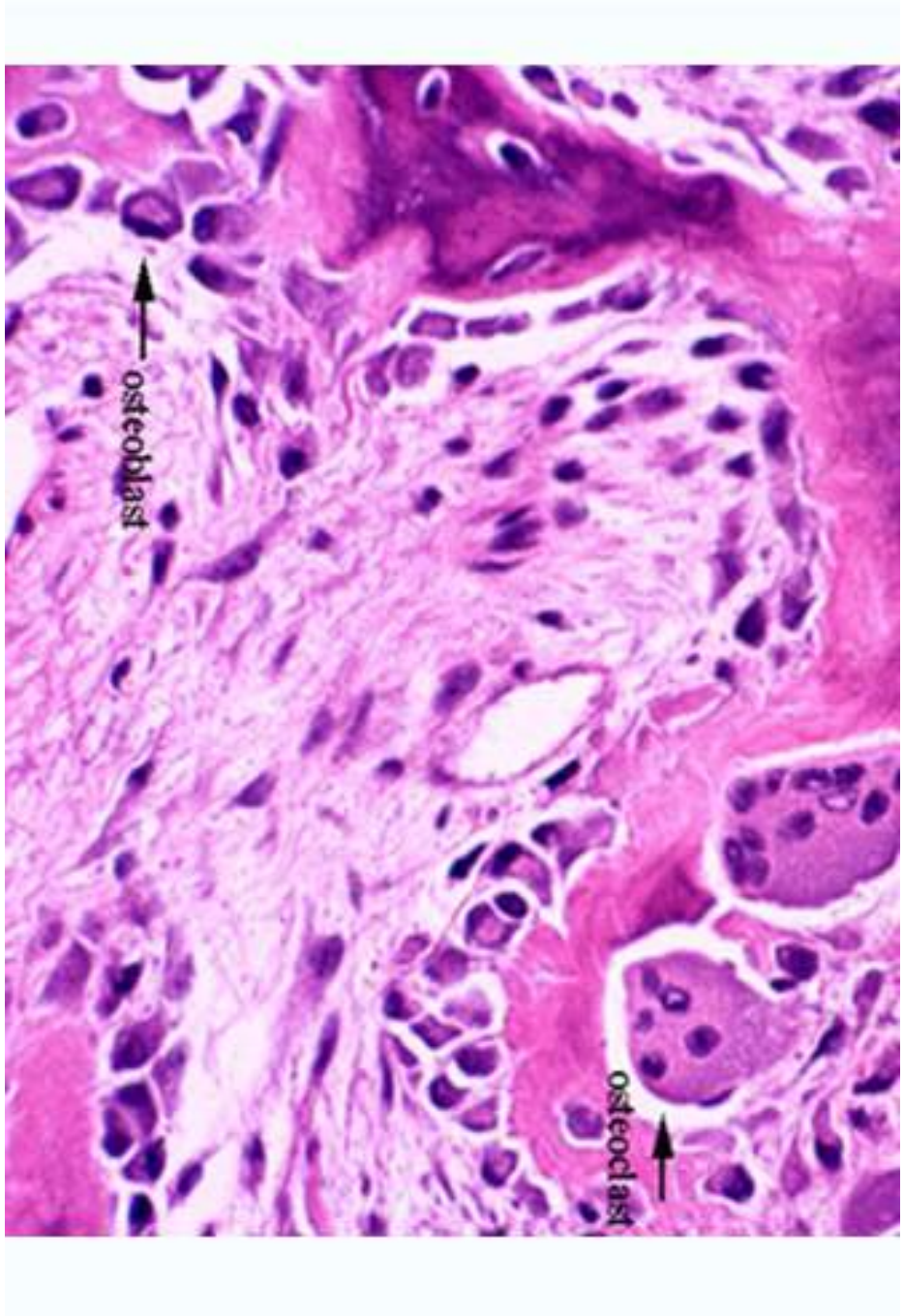


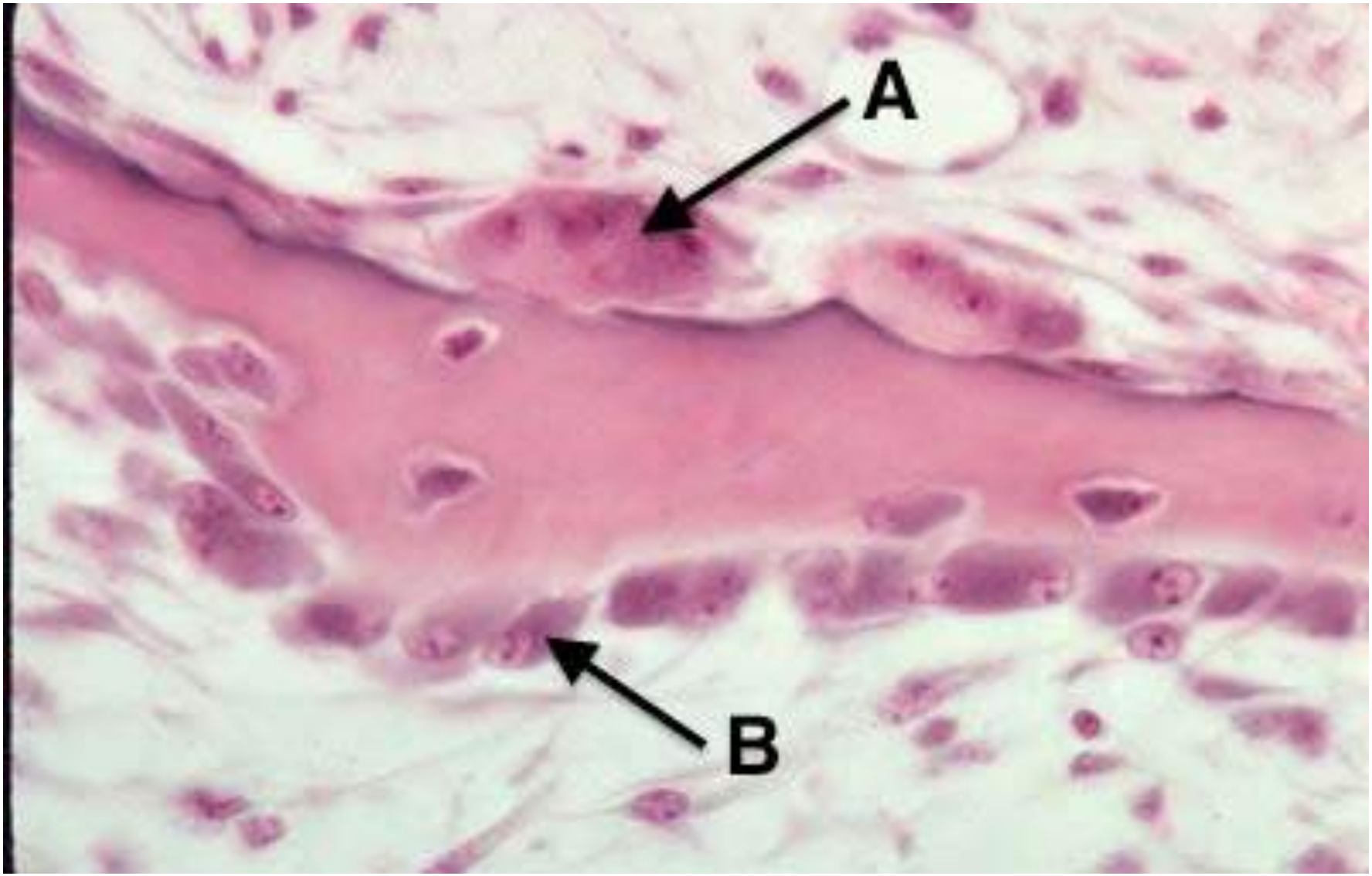


Bone Cells

Osteoclasts

- Multinucleated
- located in Howship's lacunae
- secretes collagenase and acid
- dissolves bony matrix




A
B

Woven (Immature) Bone

Embryonic/neonatal/metaphyseal upto 4yrs

In adults - sites of fracture healing and in pathological conditions – Pagets, OI

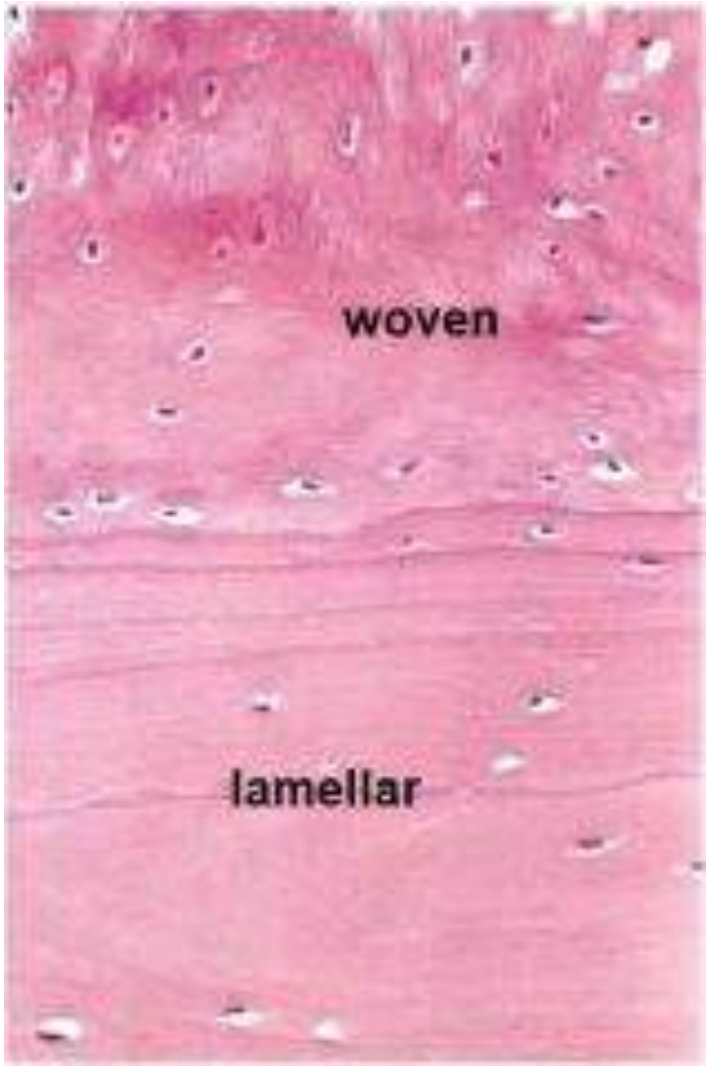
Collagen fibres - Randomly aligned

No Lamellae

Weaker and more flexible

Isotropic Characteristics – uniform properties in all directions

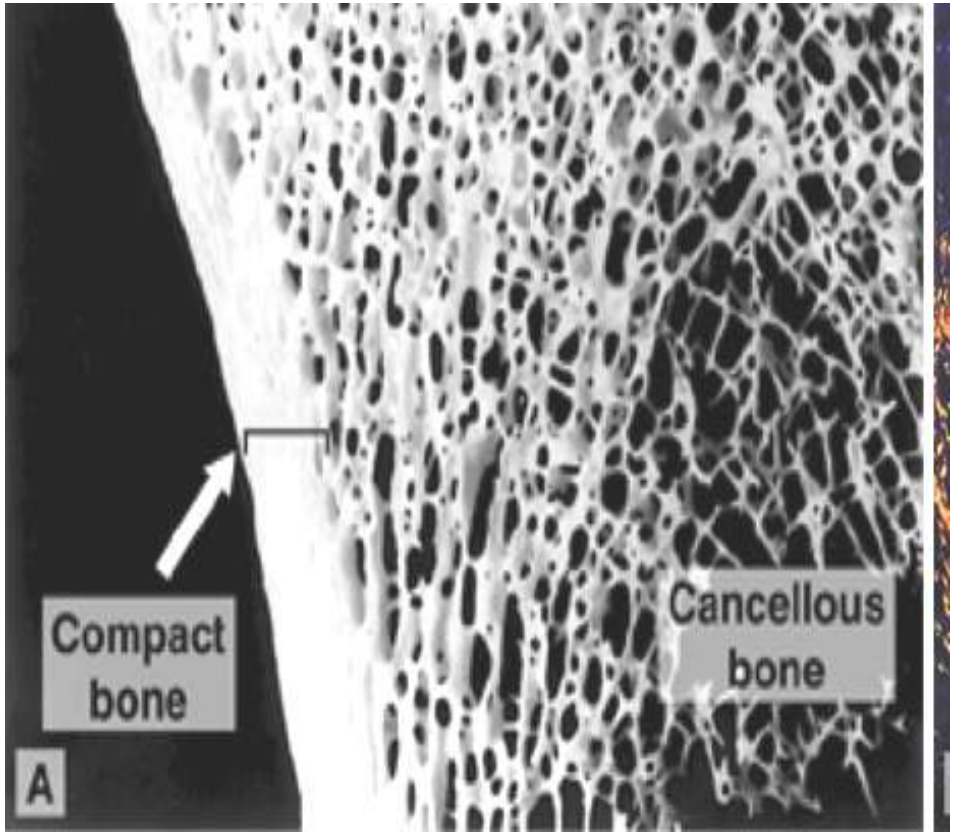
Rapid turnover



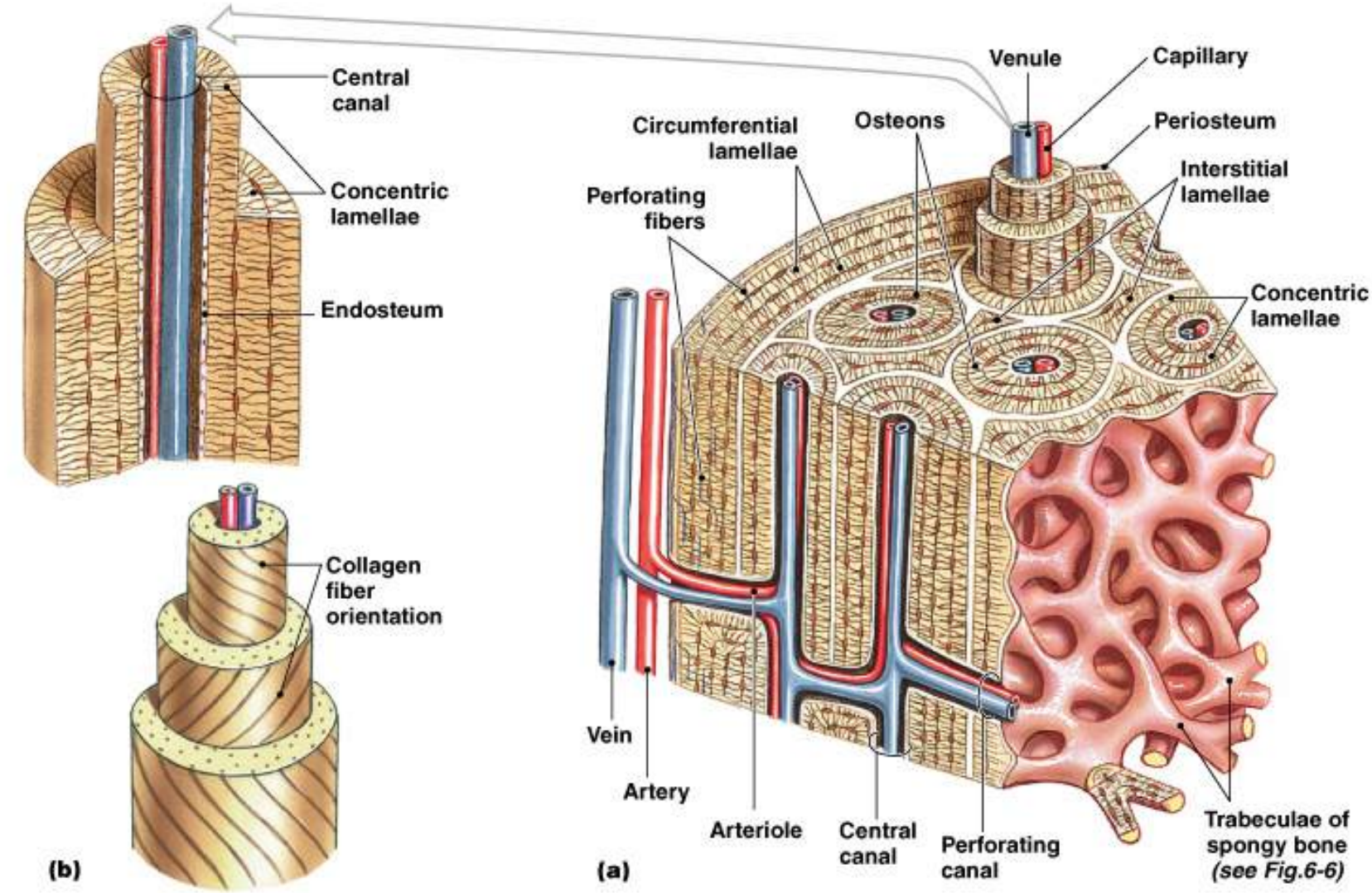
Lamellar Bone

- Cortical (Compact) bone
- Cancellous (Trabecular) bone

- Collagen fibres – aligned in Lamellae
- Anisotropic Characteristics



Microscopic Structure of Compact Bone

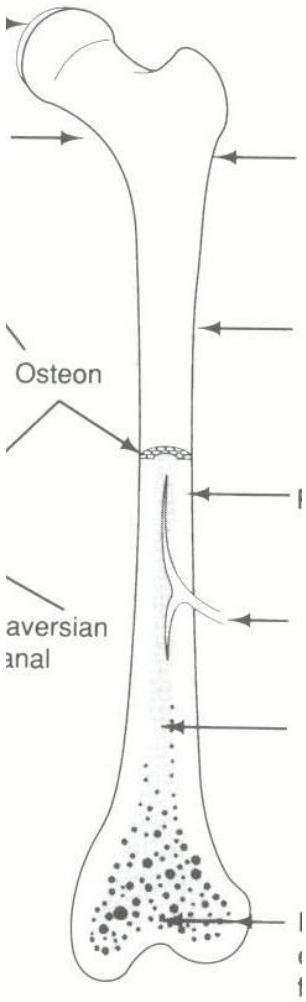


Osteon with central haversian canal containing

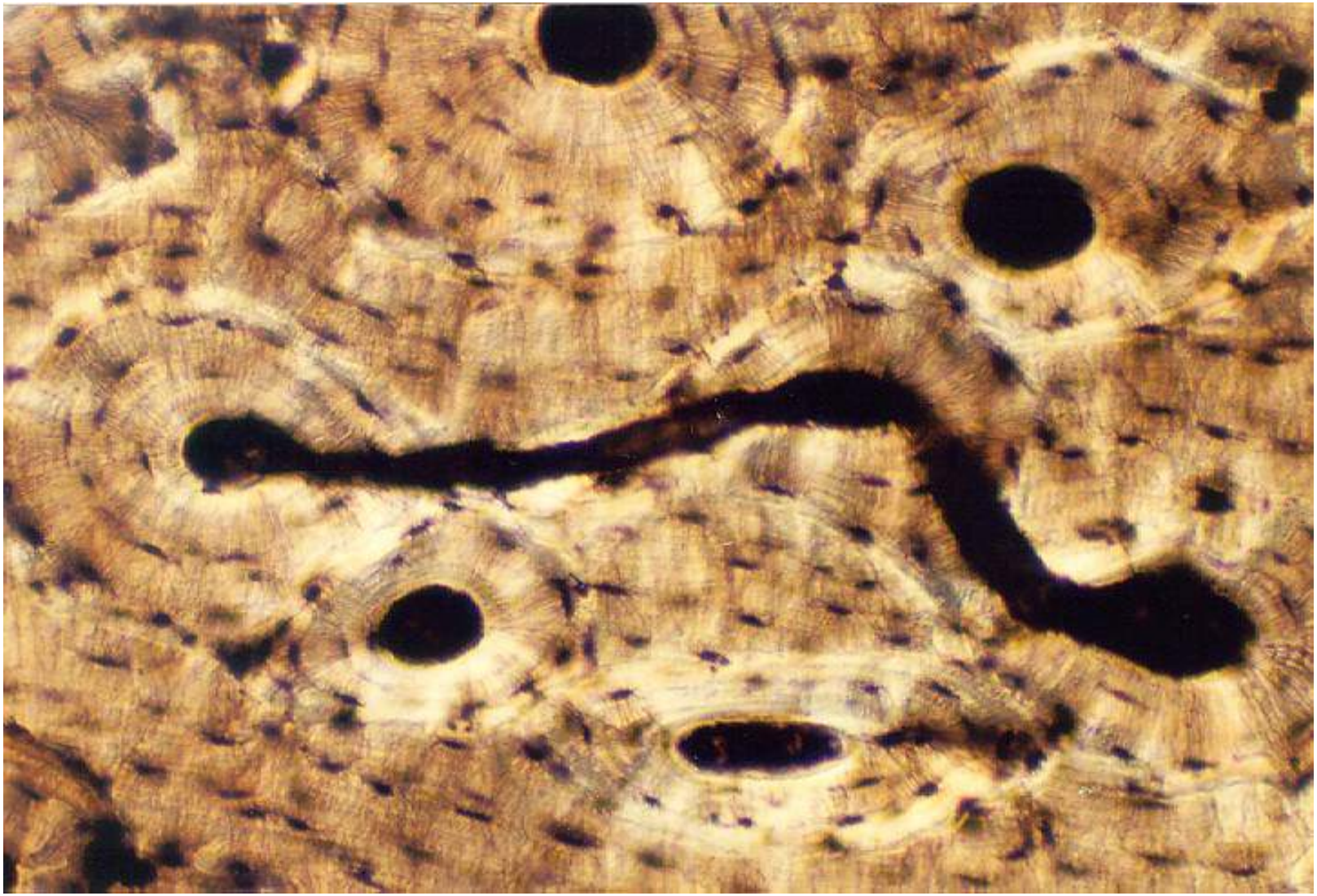
Vessels and Nerves

Cortical blood supply

- Nutrient artery: medullary, 80-85%
- Capillary rich periosteum: 15-20%, higher if medullary supply damaged
- Metaphyseal vessels: anastomose with medullary supply

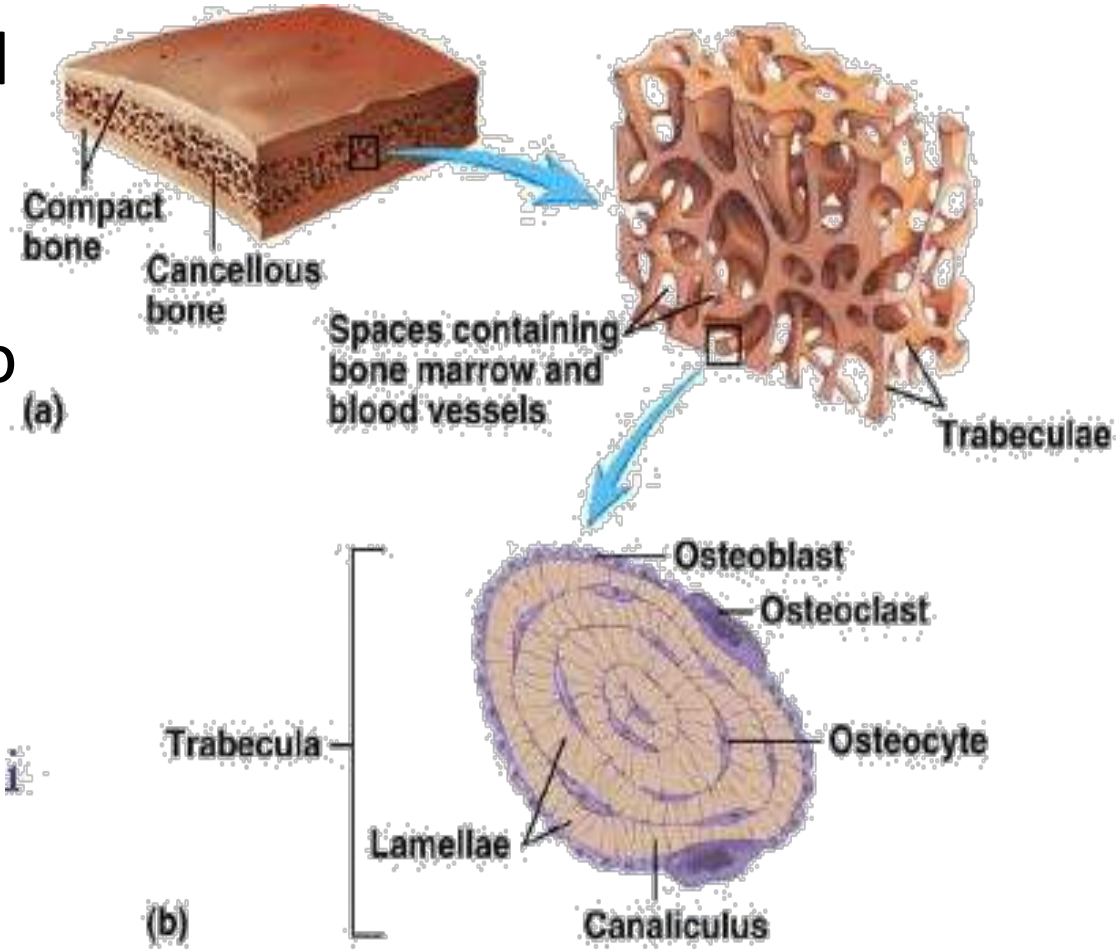


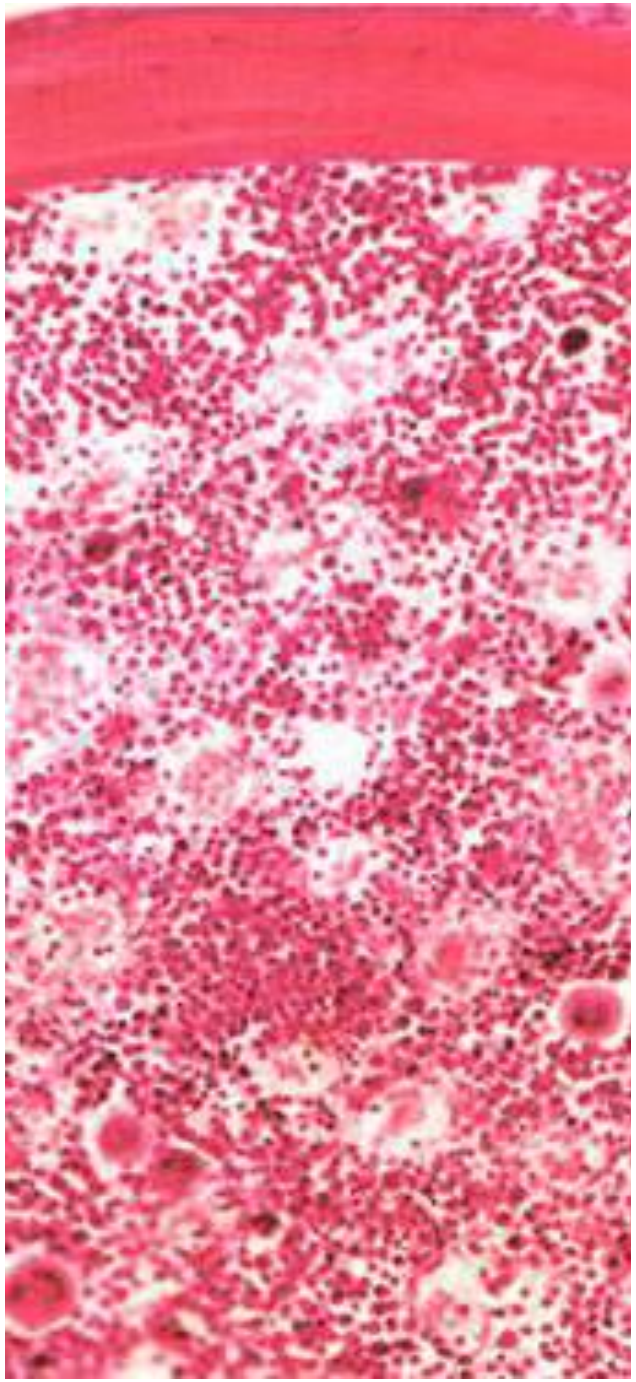
Haversian System



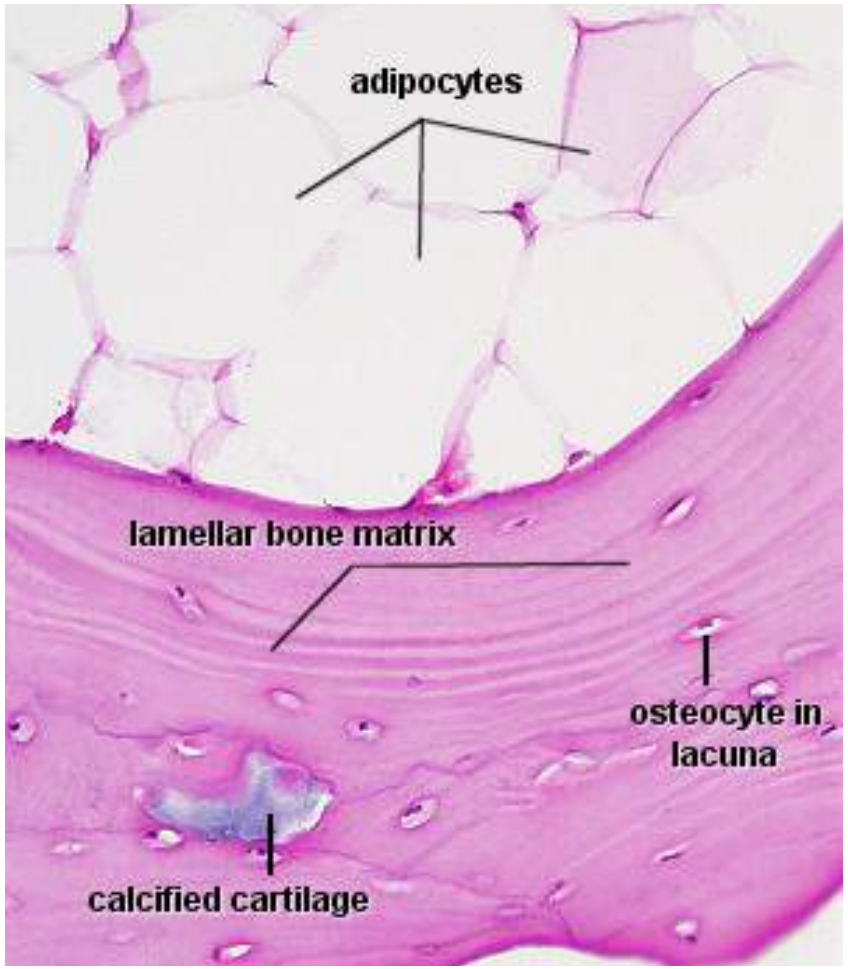
Cancellous Bone Structure

- **Trabeculae** – functional unit of spongy bone
- Bars or extensions of bone which project into red marrow
- Contains osteocytes, Canaliculi and lamellae but no central canal





Red vs Yellow Marrow



	Cortical	*Cancellous*
Physical Description	Thick & Dense protective shell	Rigid lattice designed for strength; Interstices are filled with marrow
Location	Around all bones, beneath periosteum; Primarily in the shafts of long bones	In vertebrae, flat bones (e.g. pelvis) and the ends of long bones
% of Skeletal Mass	80%	20%

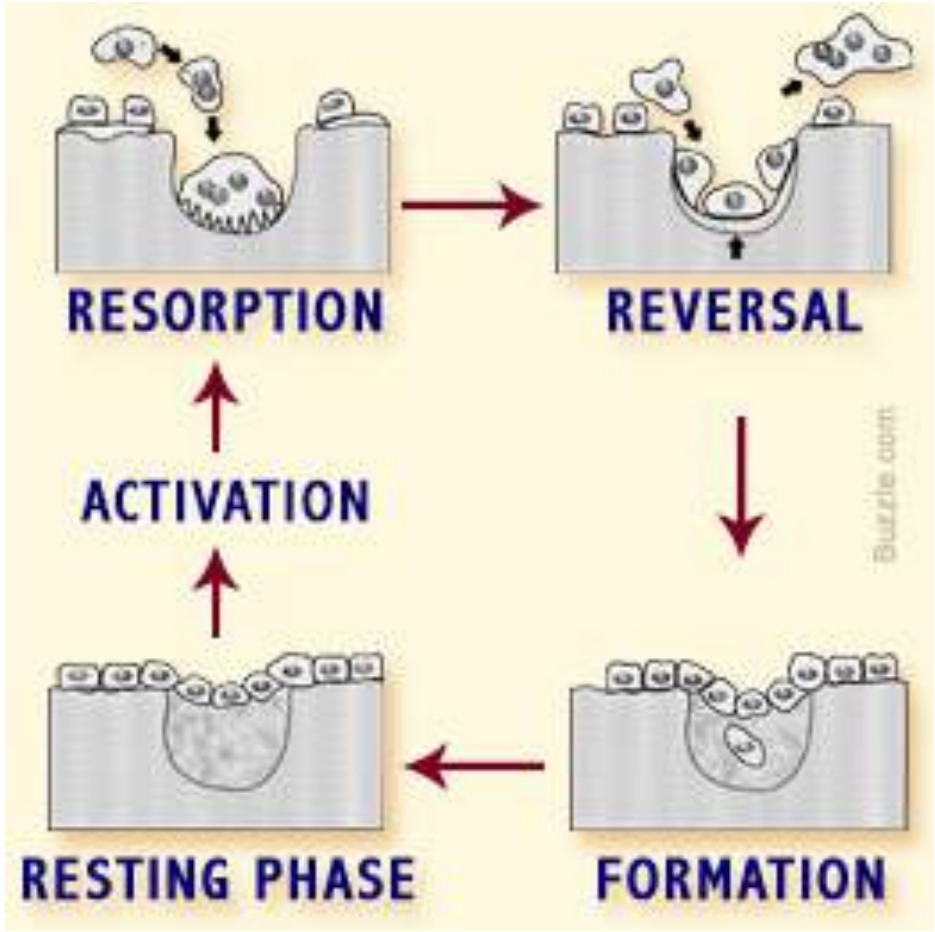
	Cortical	*Cancellous*
Strength	Withstand greater ***stress***	Withstand greater ***strain***
Direction of Strength	Bending and torsion, e.g. in the middle of long bones	Compression; Young's modulus is much greater in the longitudinal direction
Stiffness	Higher	Lower
Fracture Point	Strain>2%	Strain>75%

Bone Remodelling by BMU (Basic Multicellular Units) = 10 osteoclasts + several hundred osteoblasts

- Both cortical and trabecular bone remodels but the latter is more metabolically active
- Serves to repair skeletal fatigue microdamage and to improve skeletal strength
- Coupling between osteoclasts and osteoblasts
- Responds to mechanical and chemical / hormonal stimuli

Bone Remodelling

- Activation
- Resorption
- Reversal
- Formation
- Mineralization
- Quiescence



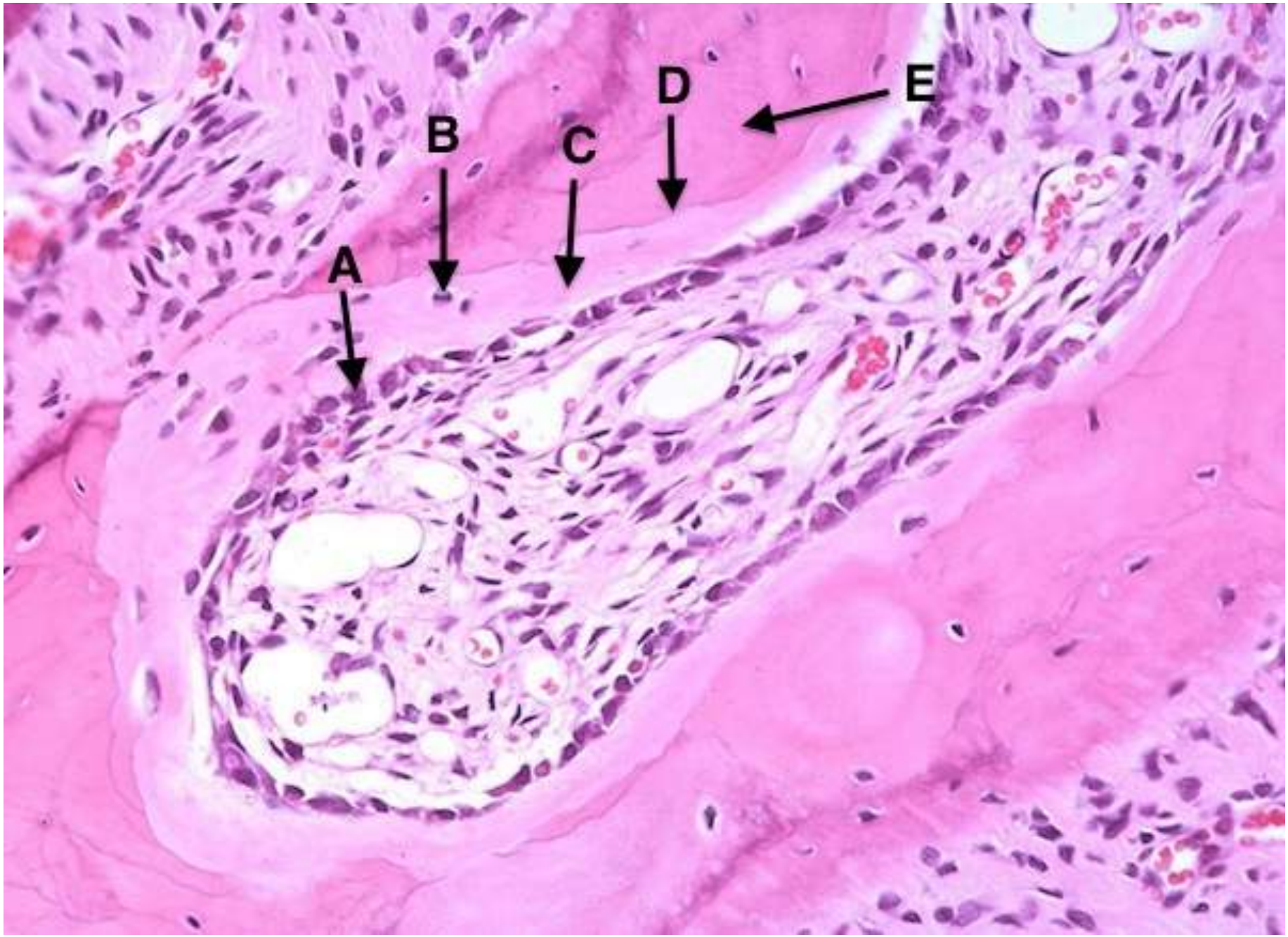
Bone Remodelling

Activation:

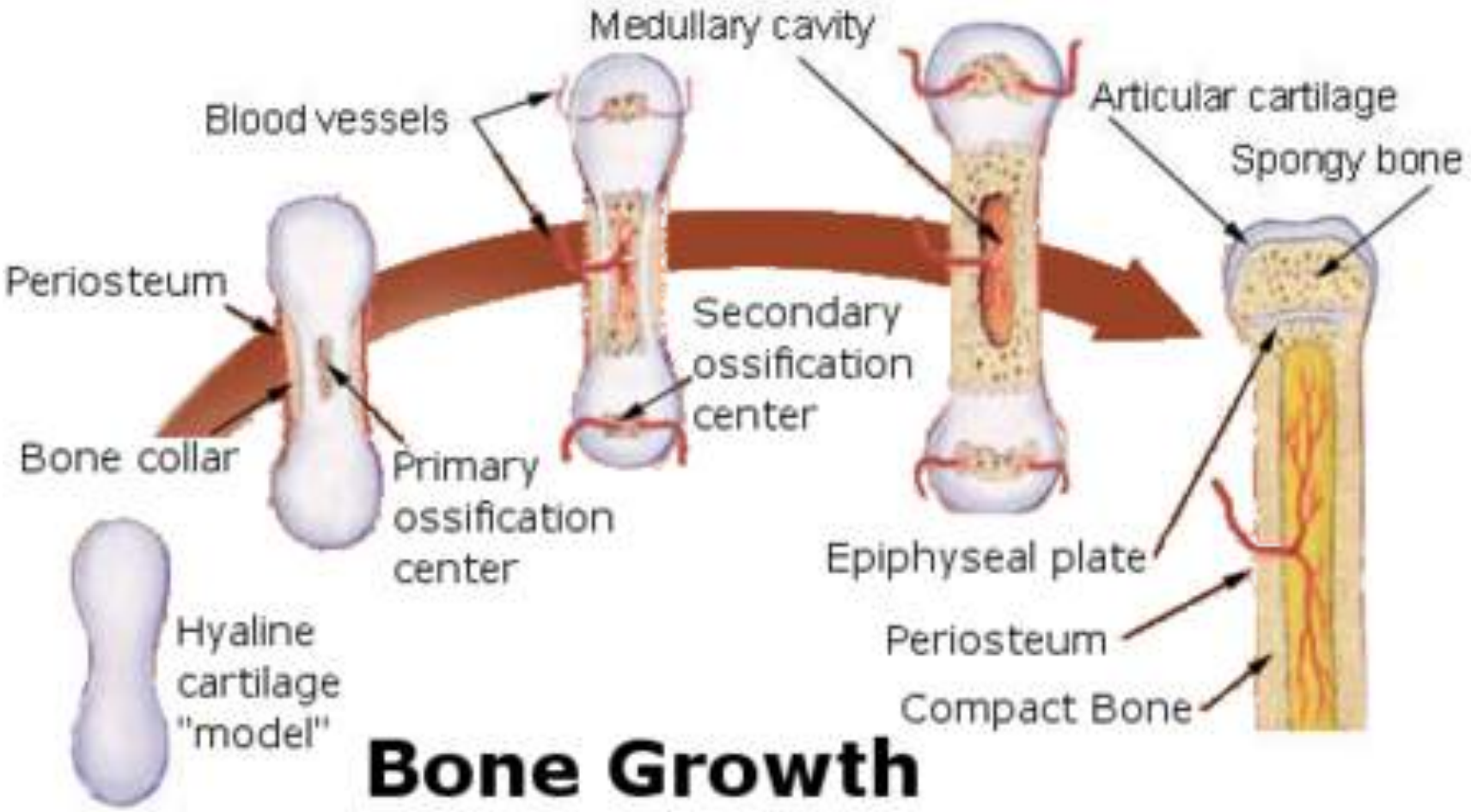
Osteoblast first then Osteoclast

Receptor Activator for Nuclear factor k B-Ligand (RANK-L) on Osteoblasts' surface, binds with RANK on Osteoclasts to 'turn them on'

PTH effect – transient increase in bone production 'blast' before resorption 'clast'


A
B
C
D
E

Osteogenesis



Bone Basics - Summary

- Morphology, structure & composition
- Function
- Differences between compact and trabecular
- Immature and Mature Bone
- Bone formation
- Bone as an organ – autoregulation – remodelling
- Apply this knowledge to future topics during the term