BONE

Bone is a specialized connective tissue

Functions

1- Provides solid support for the body

2- Protects vital organs such as brain, heart, lung and bone marrow.

3- Serves as a reservoir of calcium, phosphate, and other ions

4- Form a system of levers during skeletal muscle contraction and transform them into bodily movements.

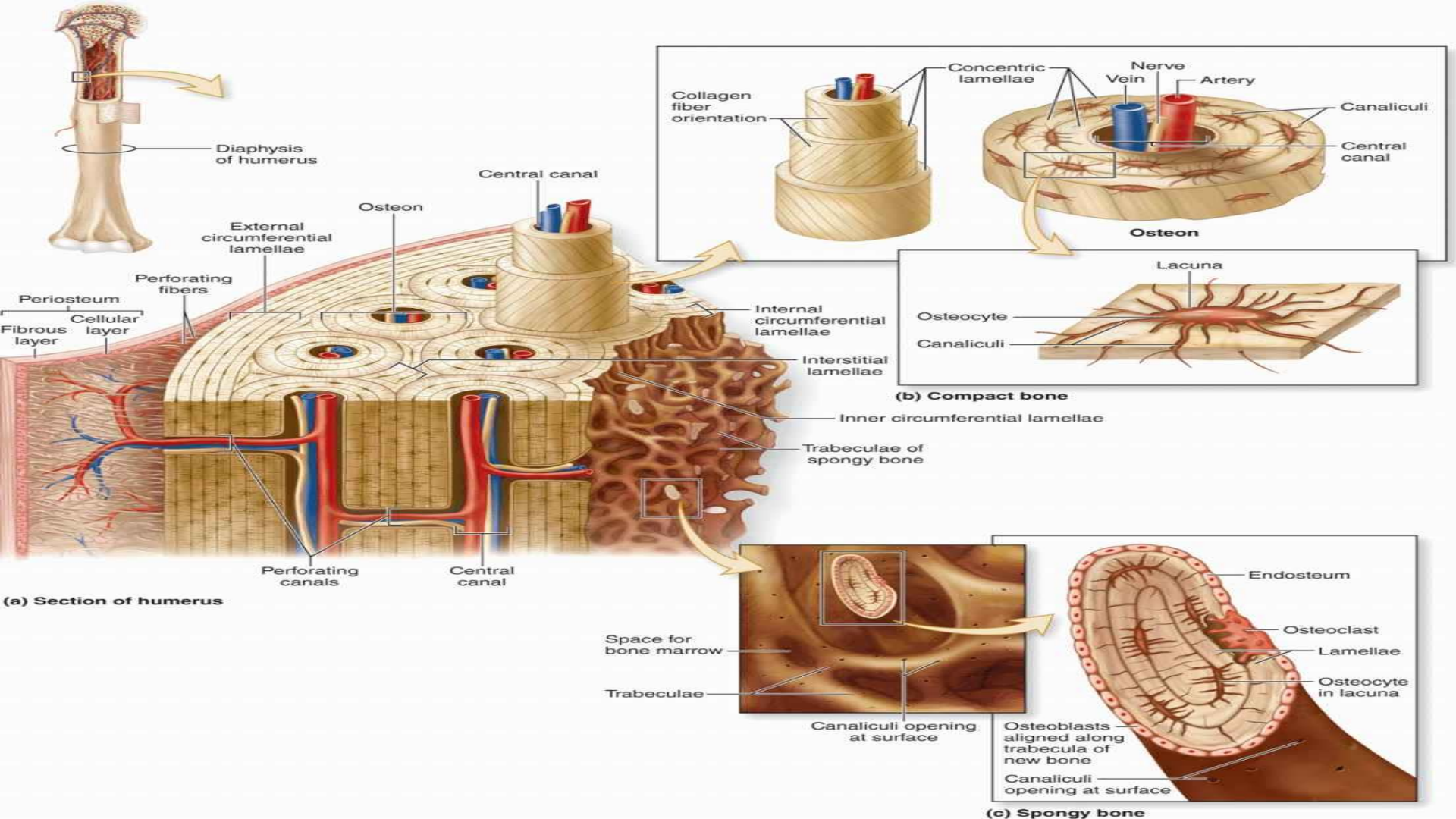
5- Bone marrow is where blood cells are formed.

So bone confers mechanical and metabolic functions to the human body.

Bone is a specialized connective tissue composed of calcified extracellular material, the bone matrix, and following three major cell type :

1- Osteoblasts
2- Osteocytes
3- Osteoclasts

Note: Both the internal and external surfaces of all bones have coverings of connective tissue : endosteum on the internal surface surrounding the marrow cavity and periosteum on the outer surface.The periosteum consists primarily of fibrous layer covering a more cellular layer. Bone is vascularized by small vessels that penetrate the matrix from the periosteum.


Diaphysis of humerus
Central canal
Osteon
External circumferential lamellae
Perforating fibers
Periosteum
Cellular layer
Fibrous layer
Internal circumferential lamellae
Interstitial lamellae
Inner circumferential lamellae
Trabeculae of spongy bone
Perforating canals
Central canal
(a) Section of humerus
Collagen fiber orientation
Concentric lamellae
Nerve
Vein
Artery
Canaliculi
Central canal
Osteon
Lacuna
Osteocyte
Canaliculi
(b) Compact bone
Space for bone marrow
Trabeculae
Canaliculi opening at surface
Endosteum
Osteoclast
Lamellae
Osteocyte in lacuna
Osteoblasts aligned along trabecula of new bone
Canaliculi opening at surface
(c) Spongy bone

Osteoblasts, Osteocytes, and Osteoclasts

Osteoblasts: Originating from mesenchymal stem cells, produce the organic components of bone matrix. After completing their synthetic activity, some osteoblasts differentiate as osteocytes, others flatten and cover the matrix surface as bone lining cells, and the majority undergo apoptosis.

Osteocytes: (bone cells) which are found in cavities (lacunae) between bone matrix layers (lamellae).

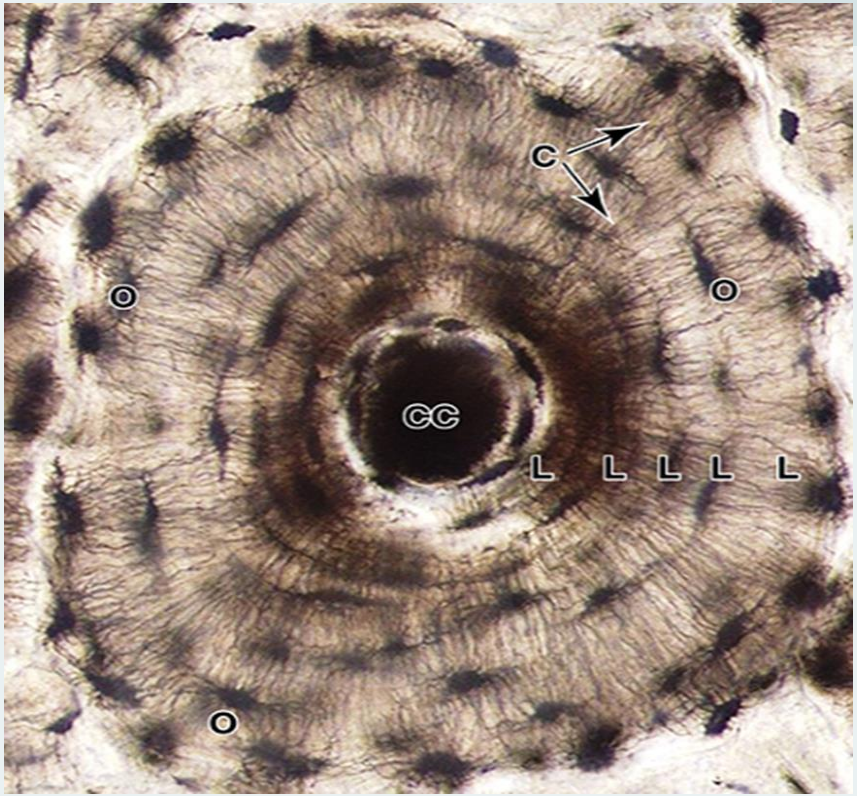
Osteocytes extend many long dendritic processes, canaliculi, through which nutrients derived from blood vessels diffuse and are passed from cell to cell in living bone.

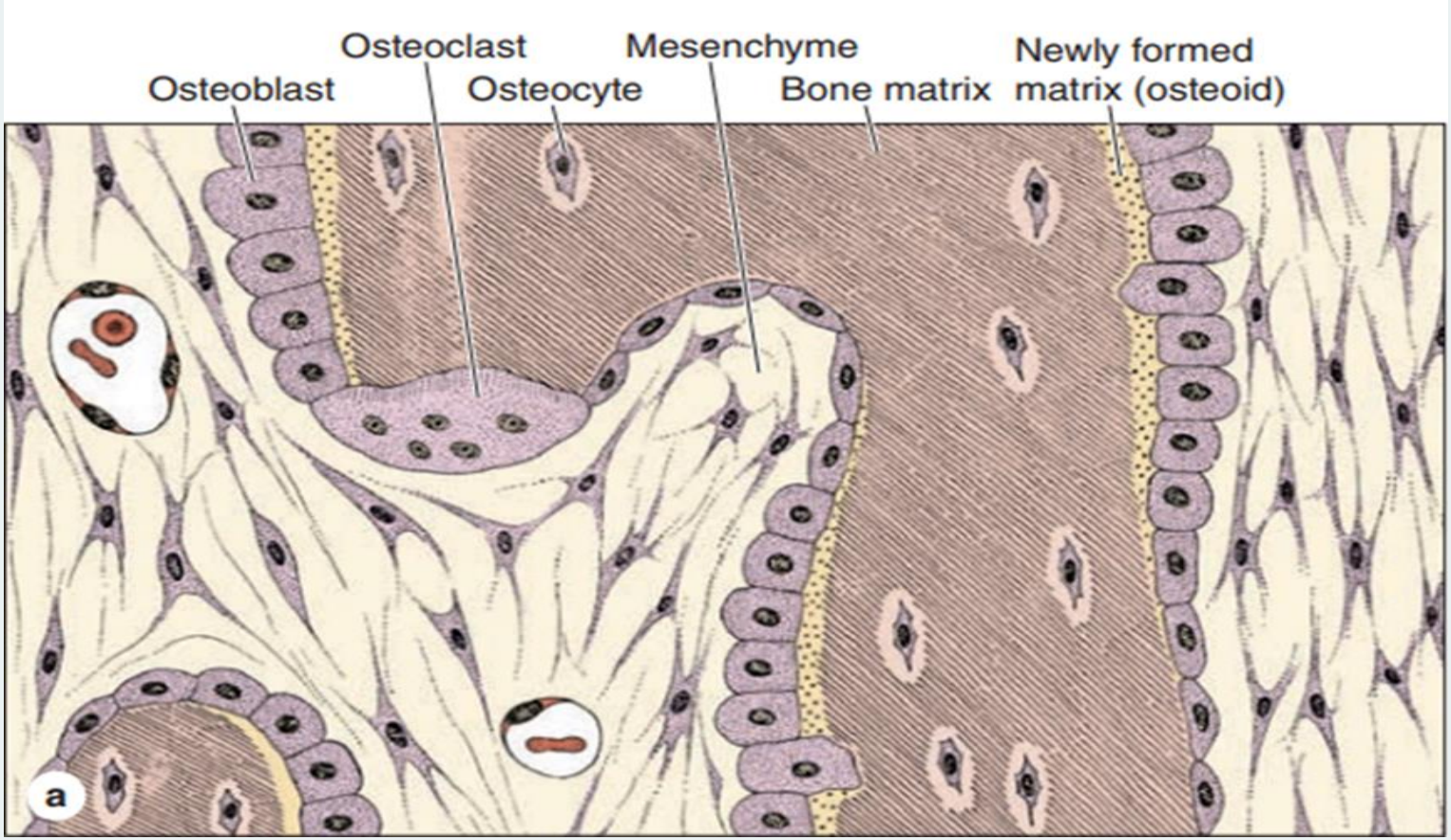
Osteoclasts: which are giant, multinucleated cells involved in removing calcified bone matrix and remodeling bone tissue

BONE MATRIX

Inorganic matter : make up about 50% of the dry weight of bone matrix, with calcium hydroxyapatite most abundant.

Organic matter: Type I collagen comprises 90% of it, and also includes small proteoglycans and multiadhesive glycoproteins such as osteonectin

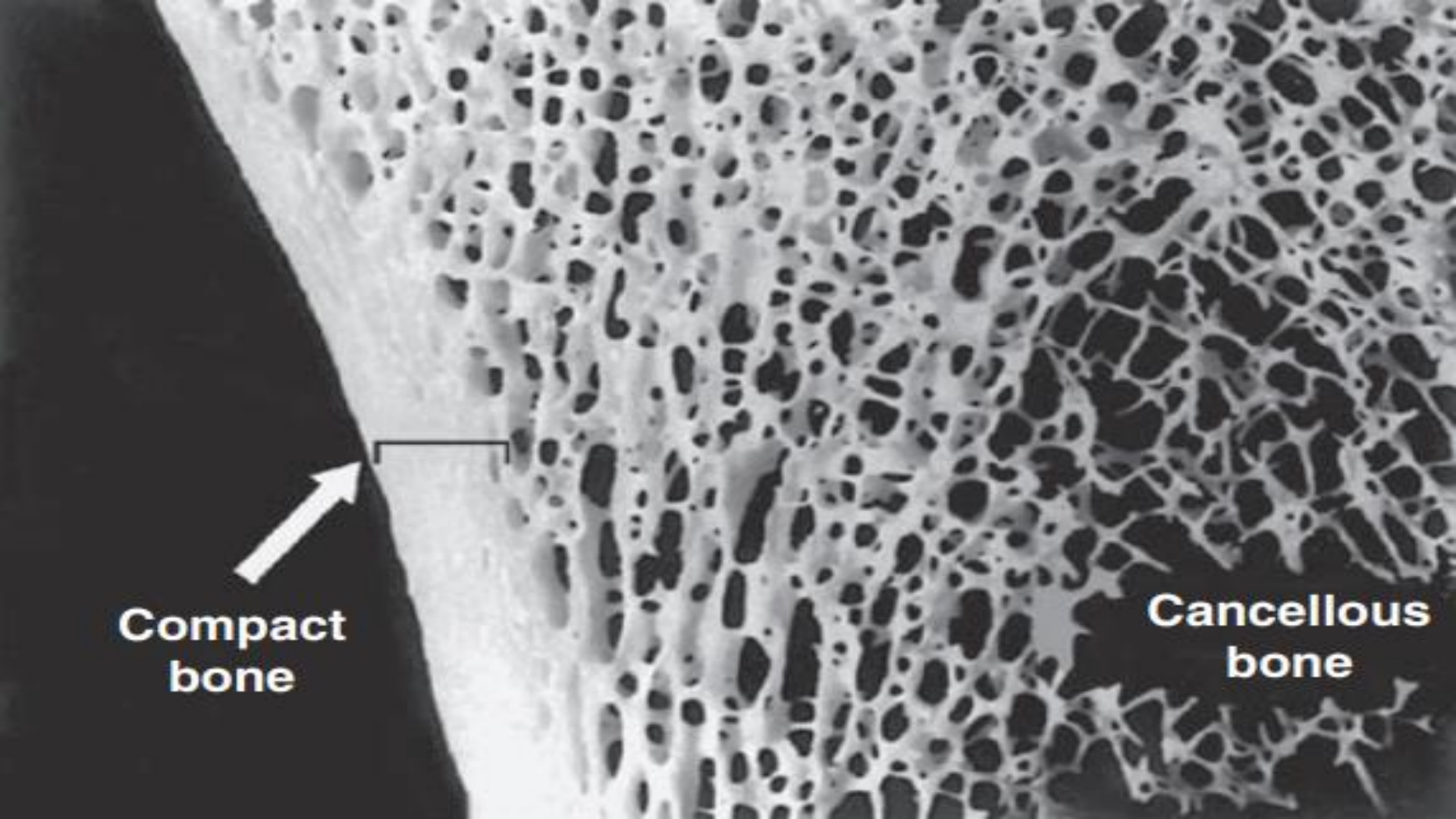



Osteoblast
Osteoclast
Osteocyte
Mesenchyme
Bone matrix
Newly formed matrix (osteoid)
a

TYPES OF BONE

Gross observation of a bone in cross section shows

- a dense area near the surface corresponding to compact (cortical) bone, which represents 80% of the total bone mass,
- deeper areas with numerous interconnecting cavities, called cancellous (trabecular or spongy) bone, constituting about 20% of total bone mass.


Compact bone
Cancellous bone

BONE REMODELING & REPAIR

Bone growth involves both the continuous resorption of bone tissue formed earlier and the simultaneous laying down of new bone at a rate exceeding that of bone removal.

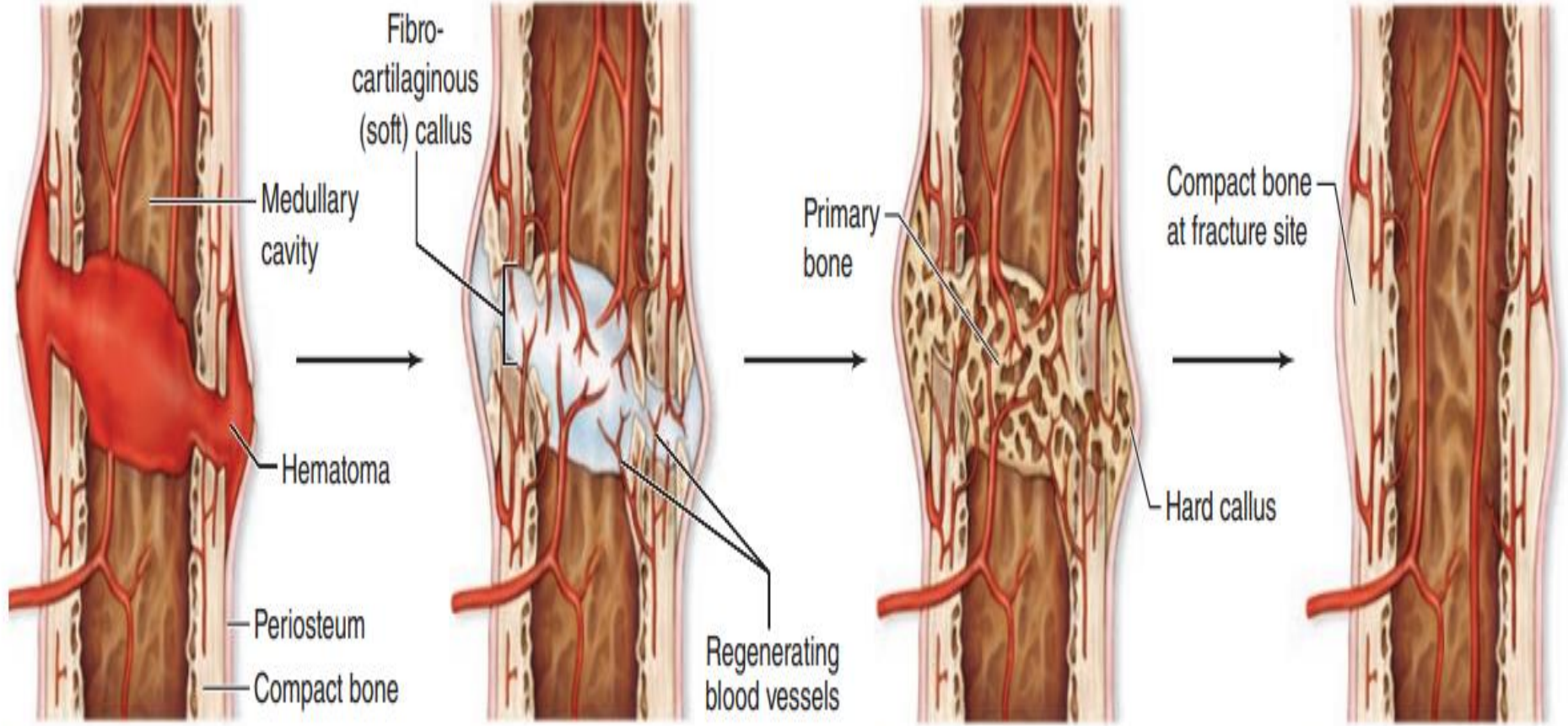
The rate of bone turnover are very active in children, 200 times faster than that of adult.

Bone renewed in adult in process of bone remodeling that involves localized cellular activities for bone resorption, and bone formation.

BONE REMODELING & REPAIR

Bone repair after fracture include :

1. Large fracture hematoma
2. Formation of fibrocartilage
3. Replacement with a temporary callus of woven bone.
4. Woven bone is then remodeled as compact and cancellous bone restoring the original bone structure.



1 A fracture hematoma forms.

2 A fibrocartilaginous (soft) callus forms.

3 A hard (bony) callus forms.

4 The bone is remodeled.

Metabolic Role of Bone

- The skeleton serves as the calcium reservoir, containing 99% of the body's total calcium.
- The principal mechanism for raising blood calcium levels is the mobilization of ions from hydroxyapatite to interstitial fluid, primarily in cancellous bone.
- Hormones that affecting calcium deposition and removal from bone are PTH, calcitonin, growth hormone and sex hormones.

JOINTS

- Joints are regions where adjacent bones are meet and held together firmly by other connective tissues, allowing the potential for bending or movements in that part.
- The type of joint determines the degree of movement between the bones.

Joints are classified as :

A- Synarthroses: allow very limited or no movement

Major subtypes of synarthroses include the following:

1- Synostoses: involve bones linked to other bones and allow essentially no movement. Ex. skull bones

2- Syndesmoses: join bones by dense connective tissue Ex:ligament of the inferior tibiofibular joint

3- Symphyses have a thick pad of fibrocartilage between the thin articular cartilage covering the ends of the bones, as the intervertebral discs and pubic symphysis

B- Diarthroses: permit free bone movement such as the elbow and knee generally unite long bones and allow great mobility.

Thank you