BONE I

بسم الله الرحمن الرحيم

BONE ⇒ specialized C.T (supporting) whose extracellular matrix is calcified (hard)

function

1. Bone support soft tissue and protects vital organs of the body eg Brain & thoracic cage.
2. Bone serves as levers for the muscle attached to them, allows movment of the body
3. BONE serves as storge site for Calcium and phosphate [maintain Blood Ca^{+} level]
4. Bone contain bone marrow which act as haemopoietic organ (blood cell formation).

Structur

- **Covering layer**
  - **Periosteum** — outer surface of bone
    - outer fiber layer
    - inner cellular layer
  - **Endosteum**
- **extracellular matrix**
  - **Inorganic component** — 50% of dry weight of bone
    - Composed 1. Calcium salts mainly (Ca hydroxyapatite)
    - 2. Calcium phosphate
  - **organic component**
    - collagen fibers (type I) (90%) — highly acidophilic
    - Ground substance
      - Glycosaminoglycans
      - proteoglycans
      - Glycoprotein (osteonectin)
- **Bone cells**
  1. osteogenic cells
  2. osteoblast cell
  3. osteocytes
  4. osteoclasts

* the responsible of hardness and resistance of bone tissue?

ans. association of minerals with Collagen fibers during calcification

COVering layer

1. periosteum. "outer surface of the bone"
   - outer fiber layer
     - formed ⇒ dence C.T collagen fibers with fibroblasts & blood vessels
     - Bundle of collagen Called perforating or sharpey's fiber extended from the fibrous layer of periosteum and penetrate the bone matrix binding the periosteum to bone and prevent its separation
   - Inner cellular layer ⇒ composed of osteoprogenitor (osteogenic) and differentiate into osteoblasts.
2. Endosteum "lines all internal surface or cavities within the bone"
   - Composed of single layer of osteogenic & little C.T
   - Functions: Bone nutrition, growth & repair

BONE Cells

	Osteogenic "osteoprogenitor"	osteoblast	osteocytes	osteoclast "Bone macrophages"
origin	UMC	osteogenic cells	osteoblast	Blood monocytes
sites	- periosteum - Endosteum	Bone surface	In lacunae	Howship's lacunae
structure	- small - Pale nucleus - Basophilic cytoplasm	- pale nucleus - Basophilic cytoplasm	- Dark nucleus - less basophilic cytoplasm	- Many nuclei - Acidophilic cytoplasm - Ruffled border
Function	. mother cell (Stem cell)	Bone formation . synthesis of organic components . secretion of high alkaline phosphatase enzyme	maintain of bone matrix	. Bone resorption . Bone remodeling

to be honest :-

* مش كلشي مكتوب
* لال ارجوا المعذرات لاني متعمدة كتير كتير اختصار

Type of bones

primary bone (Immature or woven)

- The first bone to appear in development, fracture and repair
- characterized by :-
  1. More cellular content (osteocytes)
  2. less mineral content
  3. Irregular arrangment of collagen fibers
- It temporary (replaced by any bone) except near structure of skull bone).

secondary bone (lamellar)

- present in adults
- characterized by..
  1. High Calcium content (so it is stronger)
  2. less osteocytes
  3. Regulary arranged collagen fiber, either parallel to each other & concentrically organized around Center Canal

- Compact bone (pore = مسامية) — * lamellar - dense - "ivory"
- Cancellous bone — "Spongy" (يحتوي على مسامات أكثر)

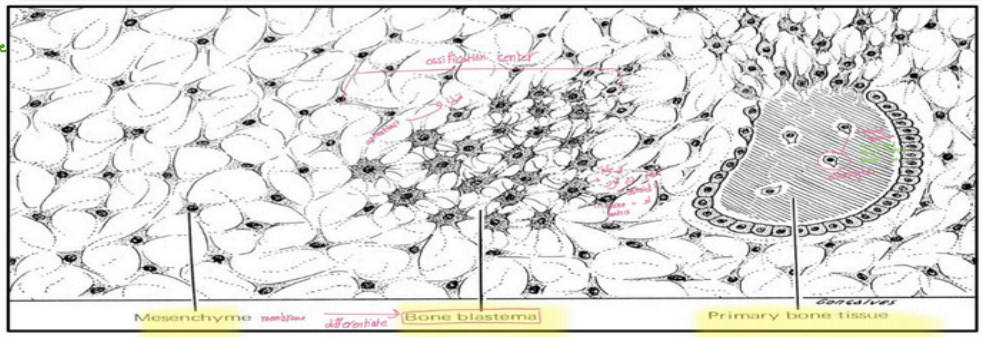
	Compact bone	Cancellous bone
Naked eye	No holes	Many holes
Sites	. Shaft of long bones . outer & inner plates of flat bones	. Flat bones . Epiphysis of long bones
periosteum	present	present
Endosteum	lines one central marrow cavity	lines multiple marrow cavity
Marrow cavity	single	multiple
Bone lamellae	Regular	Irregular
Haversian system	present	Absent

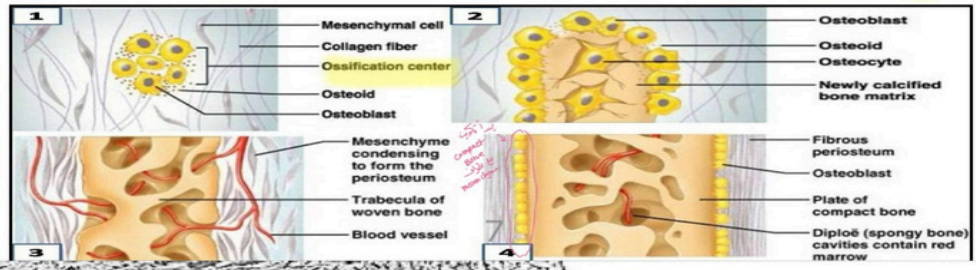
BONE FORMASION

- formation of bone in an embryo (development)
  - directly — By mesenchyme — "Intermembranous ossification" — ⇒ Flat Bones
  - indirectly — By Cartilage — "Endochondral ossification" — most bone in the body (short & long)
- Growth of bones until adulthood
  - interstitial growth of epiphyseal plate ‖ Increase in length
  - appositional growth by osteoblast ‖ Increase in wide
  - epiphyseal plate ⇒ present at the junction of the epiphysis with the diaphysis of the long bones
- Repair of fractures
- Remodeling of bone

Intramembranous ossification

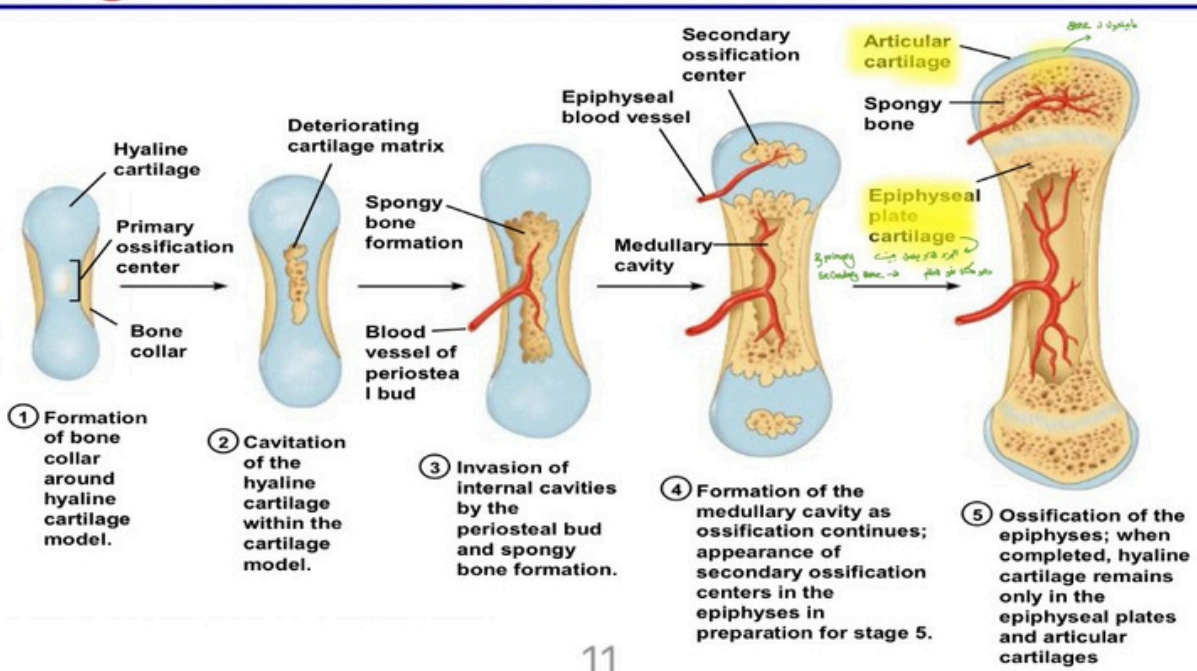
- mesenchyme tissue → mesenchyme cell → differtiate
- ossification center ← Osteoblast
- forming → osteocytes
- secrete → Osteoid (accumulating btw embryonic blood vessels)
- Vascularized mesenchyme condenses on the external face of the bone ⇒ periosteum
- network of trabeculae
- periosteum → thicken to form → Woven bone → then replaced by compact bone
- trabeculae → form → Spongy bone → its vascular tissue → become red bone marrow.





Endochondral (Intracartilagenous) ossification

Stages of Endochondral Ossification



- Zones of epiphyseal growth plate :-

① Resting Zone ⇒ Small, randomly oriented chondrocytes

② proliferative Zone ⇒ chondrocytes undergo mitosis and form columns parallels to the long axis of the bone

③ Hypertrophic Zone ⇒ chondrocytes increase in size, accumulate glycogen and lipids and become separated by thin matrix septa

- Alkaline phosphatase enzyme is secreted, promoting Ca salt precipition in the deeper matrix.

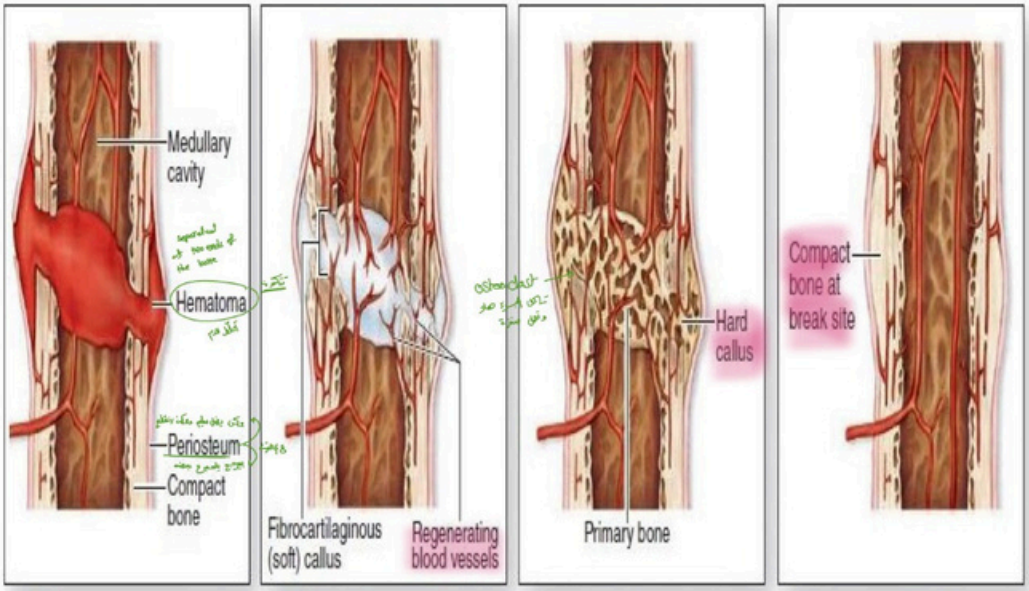
④ Calcification Zone :- The Cartilage matrix becomes calcified, preventing nutrient diffusion and causing chondrocyte death.

The lacunae of degenerated chondrocytes appear as empty spaces

⑤ ossification Zone ⇒ Blood vessels and osteoprogenitor cells (change to osteoblasts) invade the empty space

Osteoblasts lay down new bone matrix over the septa of calcified Cartilage, and some trapped cells transform into osteocytes

Fracture and repair



(a) A fracture hematoma forms. (b) A fibrocartilaginous (soft) callus forms. (c) A hard (bony) callus forms. (d) The bone is remodeled.

Types of bone marrow

	Red	Yellow
Activity	Active	Inactive
Site	In fetus present in all bones. In adult present in spongy bone.	Adult long bones
structure	• *Stroma:* A delicate network formed of reticular CT. containing developing blood cells (*Hematopoietic cords*) in its meshes. • *Sinusoidal capillaries*	Yellow in color due to great number of adipose(fat) cells.
function	Formation of blood cells	• Stores fat. • Under certain conditions, such as severe hemorrhage.

Myeloid Tissue ⇒ is specialized vascular CT rich in cells that are responsible for formation of blood cells