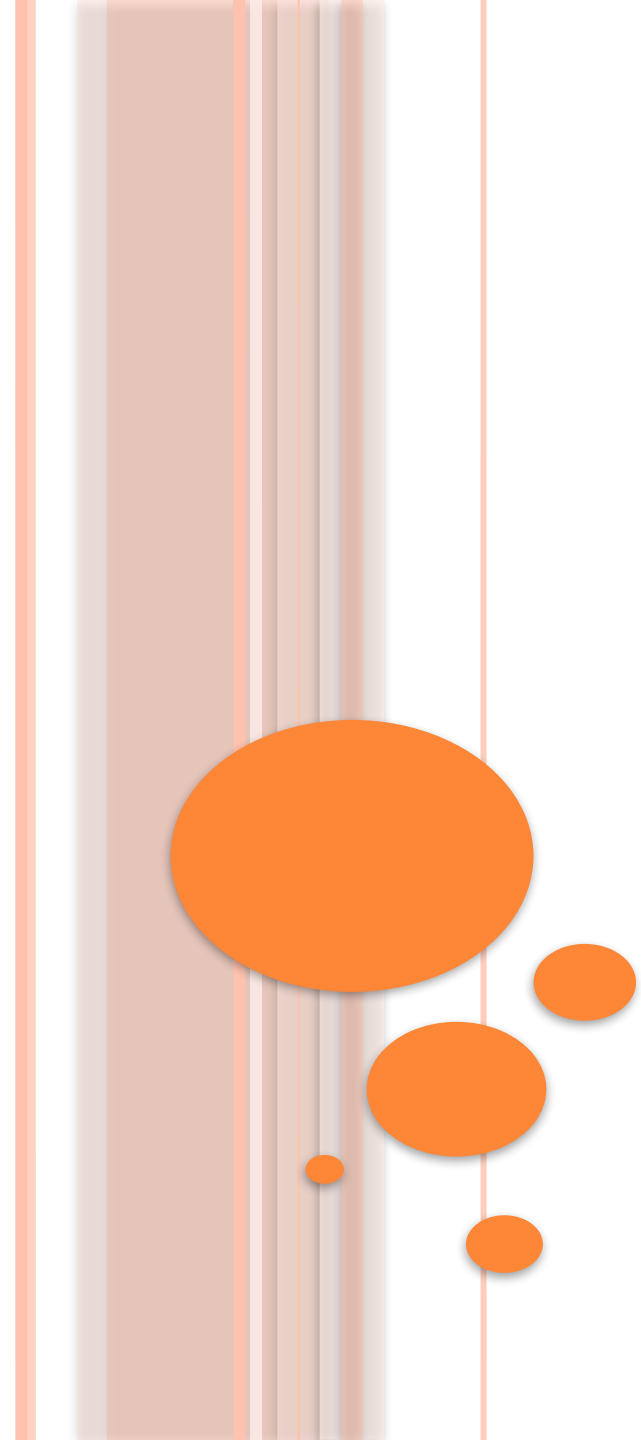


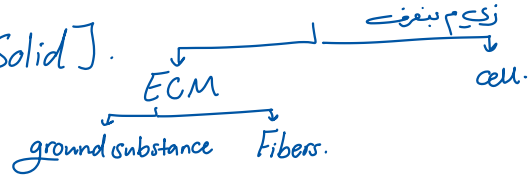


Histology lab- Bone



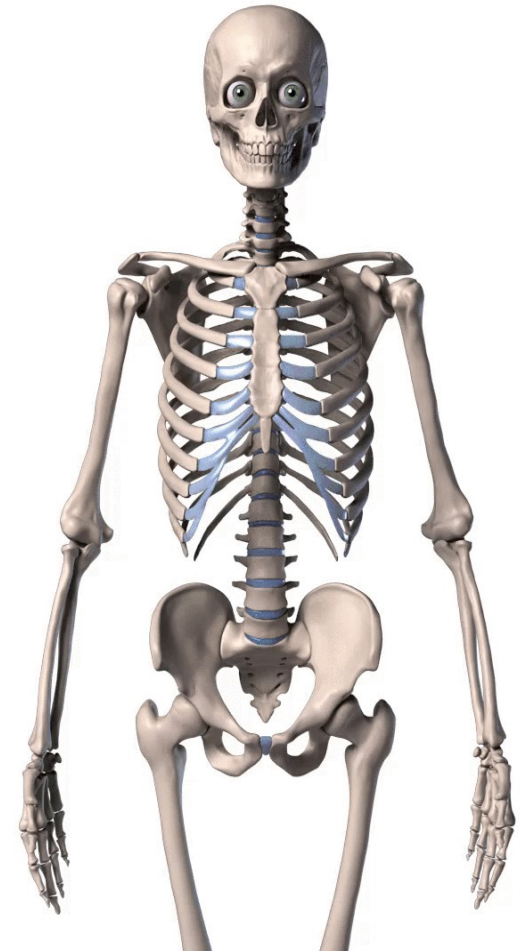
BONE

- Bone is *a modified type* of connective tissue in which the matrix is hard. [Solid].



- **Functions:**

- 1- Locomotion. ✓
- 2- Protection of the vital organs. ✓
lung, heart, brain.
- 3- Metabolic function: by acting as a reservoir for calcium, phosphate and other minerals. ✓



COMPONENTS OF BONE

I- BONE MATRIX

- It is composed of:

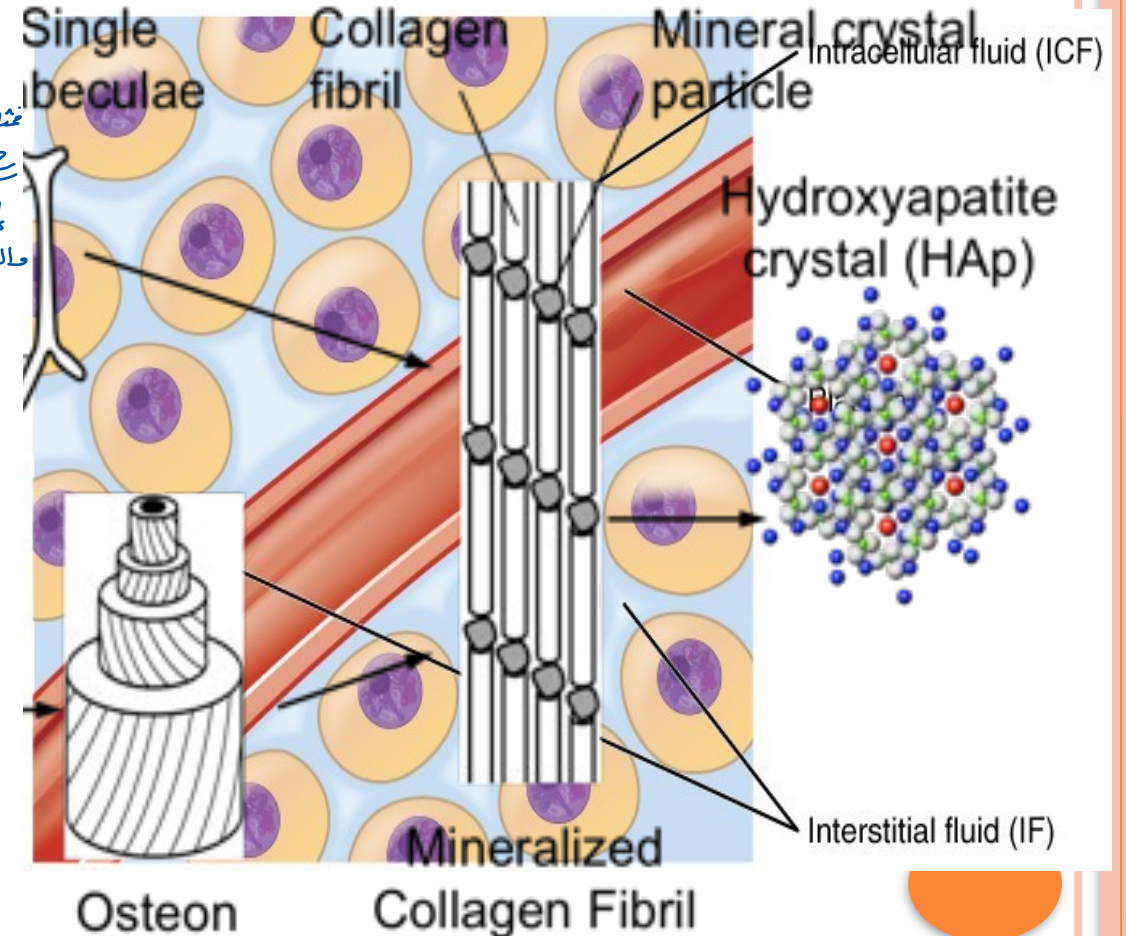
1- Water:

- constitutes about 25% of the bone weight.
- permits exchange of minerals between blood and matrix.

عندما لو كان *Hypercalcemia* مع *Blood* يترك *Ca* من *Blood* إلى *Bone* والعكس، فالمنية يتسفل توسط *يصرف* فيه *Shock* + *تنقص*

2- Inorganic component: constitutes about 45% of the bone weight. It is mainly in the form of:

- calcium phosphates (in the form of hydroxyapatite crystals) & calcium carbonates.
- Few other ions e.g. sodium, magnesium and ferrous.
- It is responsible for the hardness of bone.



Bone softness

COMPONENTS OF BONE

I- BONE MATRIX

ہمارے Softness کے bone سبب Ca^{2+} ↓

Rickets خونی الاطال



Osteomalacia خونی انکبار



COMPONENTS OF BONE

I- BONE MATRIX

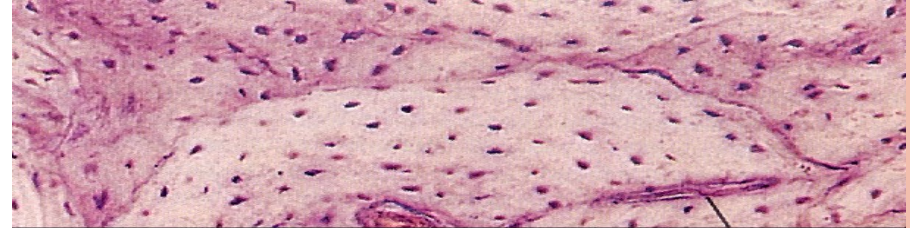
^{موجود في Cartilage}
3- Organic component: it constitutes about 30% of the bone weight. It includes:

◦ Ground substance: formed of:

➤ Proteoglycans,

➤ Adhesive glycoproteins e.g. osteonectin which anchors collagen to the inorganic matrix. ✓

◦ Type I collagen fibers: responsible for the eosinophilic staining of bone matrix in H&E sections.



Tensile strength

Removal

Fragile bone

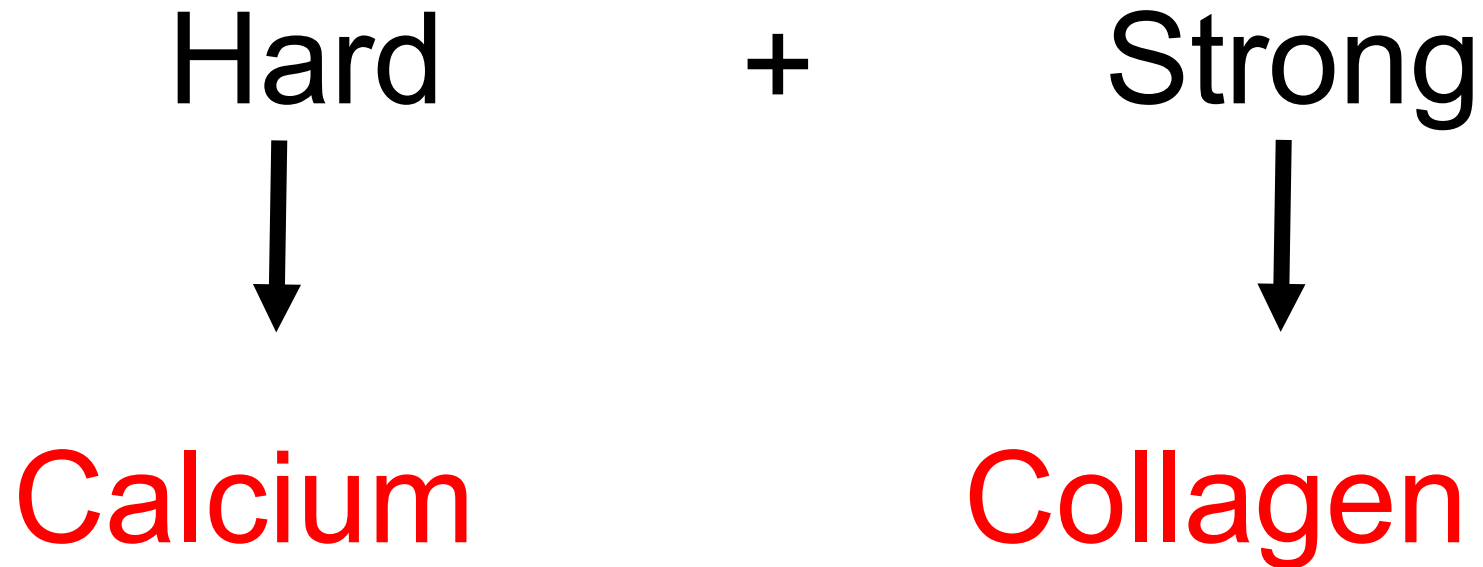
بالنفس موجود
Hyaluronic acid
وكلا عينة
كأنه اسفر
GAG aggregates.

الكسر لغير ريب خلل في collagen
لكنه الليونة بتغير من قلة الكالسيوم.

فانتهى
انها negative charge
فبتجذب بالماء

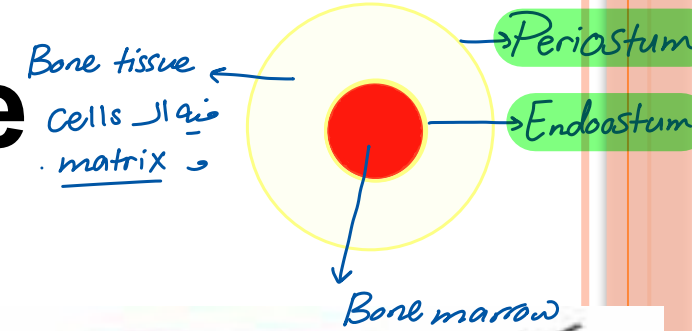
Components of bone

I- Bone matrix



Components of bone

II- Bone coverings



1- The periosteum: ^{من الخارج} it covers the external surfaces of bone. It is similar to the perichondrium, formed of two layers:

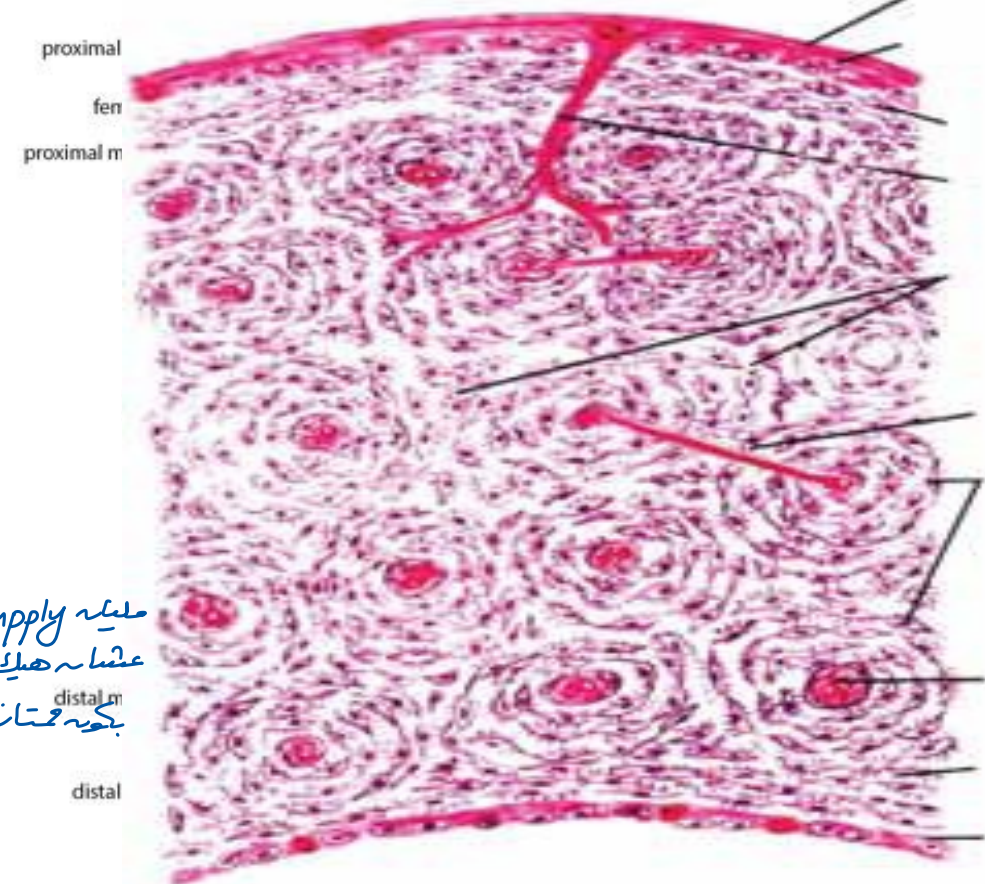
➤ **The outer fibrous layer:** formed of dense ^{للحماية} connective tissue with few blood vessels. ^{لأنه ما يحتاجه}

➤ **The inner vascular and cellular layer:** containing the osteogenic cells ^{Stem cell.}

^{هو الذي يتطلع} (osteoprogenitor cells & osteoblasts) which form new bone during growth and repair. ^{Blood supply}

2- The endosteum: ^{من الداخل} it lines the bone marrow cavities. It is formed of cellular layer of osteogenic cells and blood vessels. ✓

الرسم بزاوية
الصغيرة عالissime
بتوضيح



Components of bone

III- Bone cells

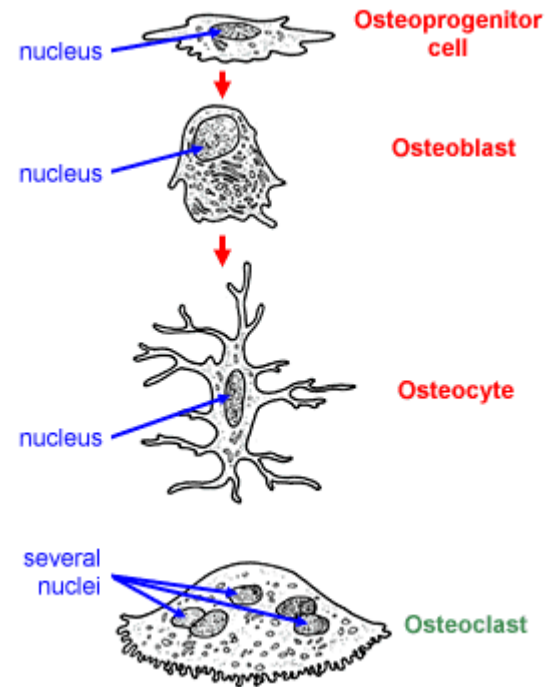
○ There are four types of bone cells:

1- Osteoprogenitor cells. *Stem cell*

2- Osteoblasts. *↓ بنطري*

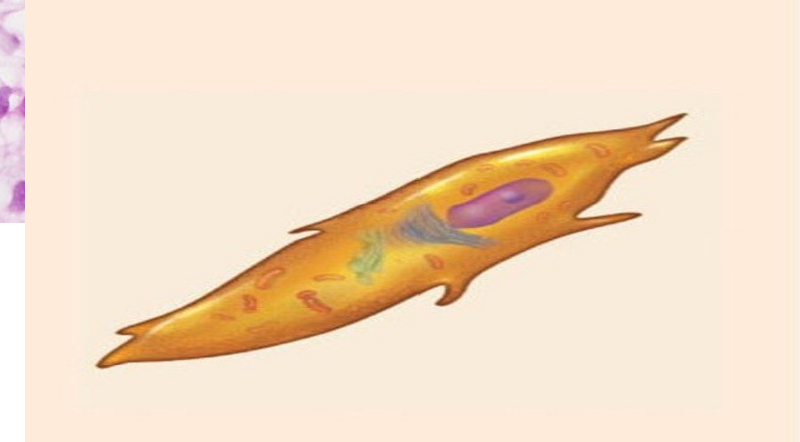
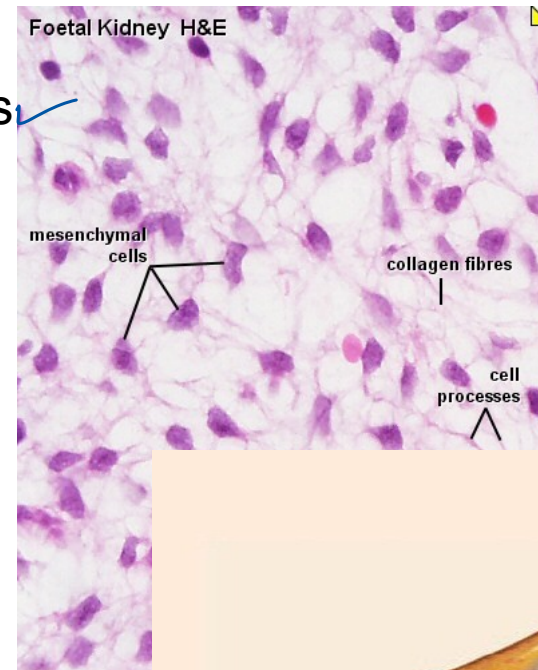
3- Osteocytes. *↓ بنطري*

4- Osteoclasts. → *دخيلة عليهم لشفا*
Macrophage



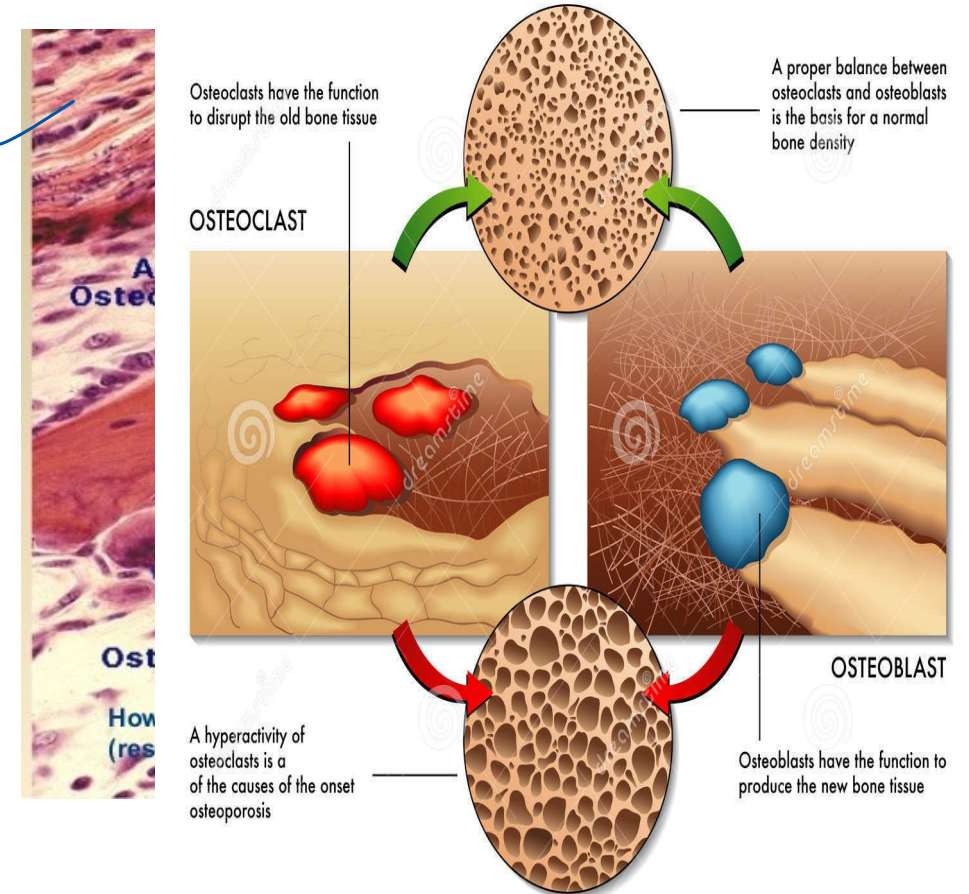
1-OSTEOPROGENITOR CELLS= MOTHER CELLS OF THE BONE

- **Origin:** from undifferentiated mesenchymal cells.
نفسه ال Cartilage
- **Function:** whenever there is bone formation ,the osteoprogenitor cells proliferate and differentiate to osteoblasts. ✓
- **Sites:**
 - Cellular layer of the periosteum. ✓
 - Endosteum. ✓
 - Lining the Haversian canals. ✓
- **LM picture:**
 - **Shape:** small & spindle. ✓
 - **Nucleus:** oval.
 - **Cytoplasm:** pale basophilic. ✓
- **EM picture:** few organelles, mainly polysomes. ✓



2- OSTEOBLASTS= THE BONE FORMING CELLS

- **Origin:** from osteoprogenitor cells.
- **Sites:** in the same sites as osteoprogenitor cells. ✓
- **Function:** bone formation by:
 - 1- Secretion of the osteoid which is the uncalcified organic components of the bone matrix. ✓
 - 2- Secretion of alkaline phosphatase enzyme responsible for the deposition of calcium salts from the blood into the bone matrix (bone mineralization).
حین بطع فی حالات بنای از Bone فطری یکنه عالی عند خلقت عمر ۱۰ سنوات
 - 3- The osteoblast is entrapped by the calcified matrix in a lacuna and becomes an osteocyte.



[لایہ بطع صہ آئرمہ علامہ خالصہ آئرمہ Differential diagnosis]
Biliary tress ← placenta
Obstruction
Alkaline phosphatase
و بیلیس فی حالات

2- OSTEOLASTS= THE BONE FORMING CELLS

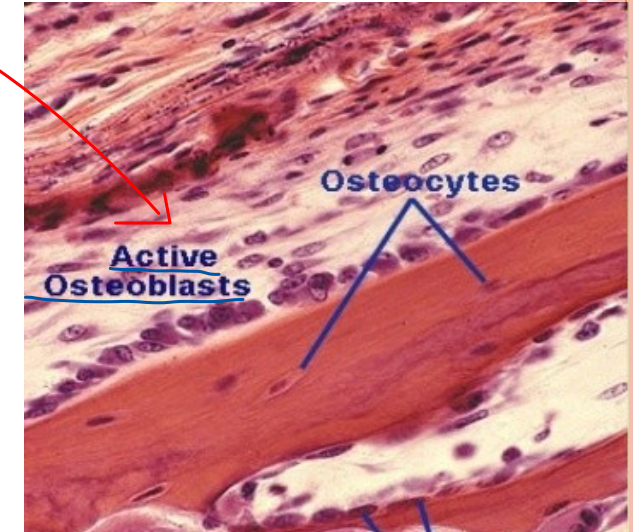
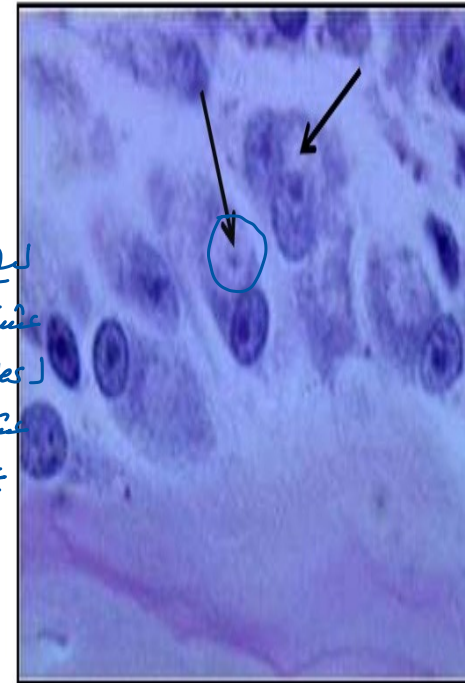
◦ LM picture:

- **Shape:** cuboidal or columnar, arranged in one row (resembling the simple epithelium), attached to each other by short processes.

- **Nucleus:** eccentric (WHY) & pale.
- **Cytoplasm:** deep basophilic with a juxtannuclear negative Golgi image.

- **EM picture:** It shows the ultrastructure features of **protein synthesizing cells** (constitutive secretion).

لديه بكونه فيه Golgi لترتبه
ما يتنصب بـ H.E
L.M. Picture of Negative Golgi image



Osteoblast

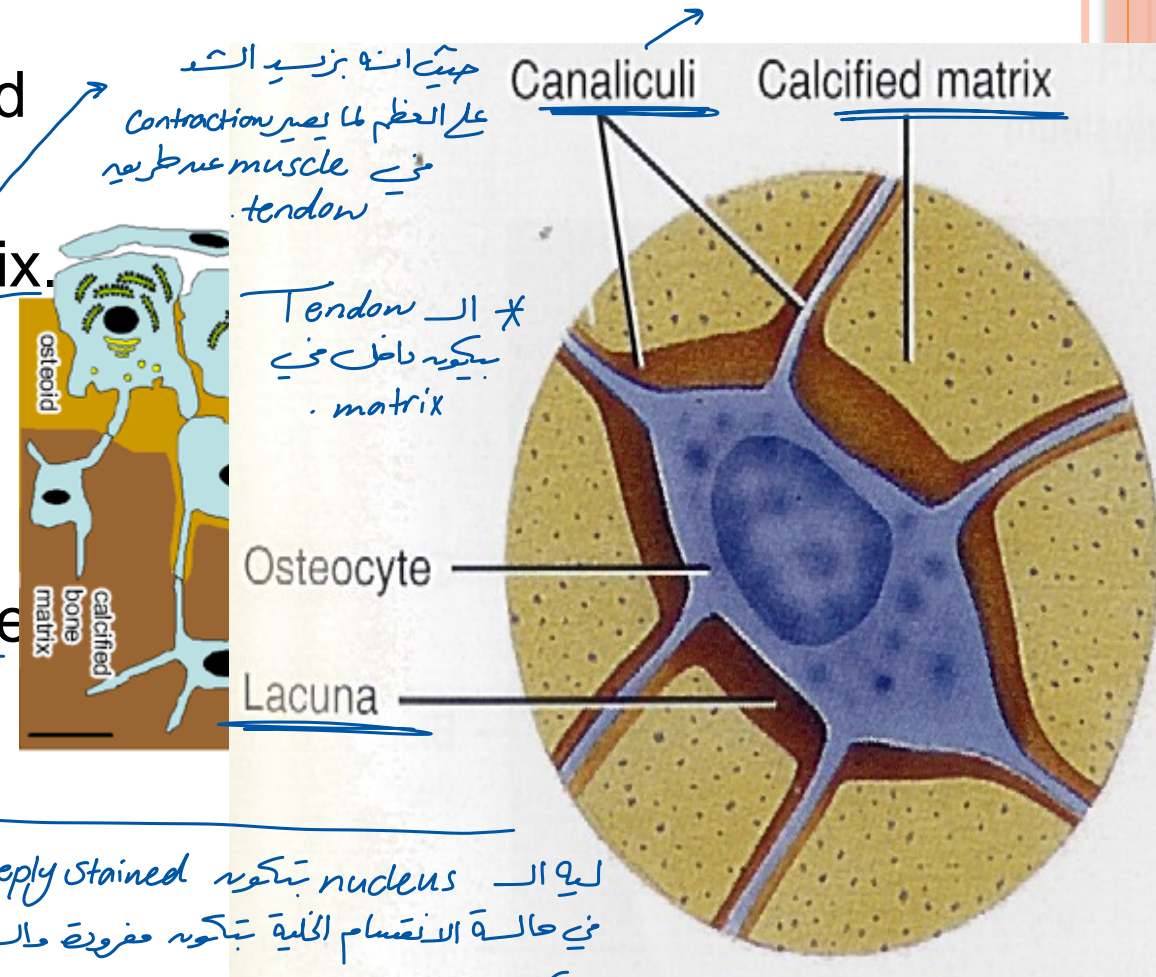
منه فيه كثير polysomes
هيك يتكونه Deep basophilic

له هاي الزوايا عشانه يكونها مرتبطة في بعضهم
عشانها ما يقدر اشارة معينة كلية تحصل باح الخلايا

III-OSTEOCYTES= THE UNIT BONE CELLS

تُخَيَّفَتُهَا / تَكُونُ دَاخِلَهَا processes
عِشَّةً تَرْتَبِطُ الْخَلَايا مَع بَعْضِهَا

- **Origin:** from osteoblasts; when entrapped within the lacunae (cavities).
- **Function:** maintenance of the bone matrix.
- **Sites:** inside lacunae within the bone matrix. ✓
- **LM picture:**
 - **Shape:** flattened cells with many processes
 - **Nucleus:** deeply stained.
 - **Cytoplasm:** pale basophilic.



ليه ال nucleus تَكُونُ Deeply stained؟ هيا احاسا تَكُونُ pale Osteoblast لأنها active حين بها تنقسم، حيث انه في حالة الانقسام الخلية تَكُونُ مفردة وال Chromatin fiber مشدودة وبعيدة عن بعضها.

لكن في Osteocyte تَكُونُ Inactive ما راج لتقسم في ال Chromatin fiber تَكُونُ مائعة فوه بعضها فتكون غائقة.

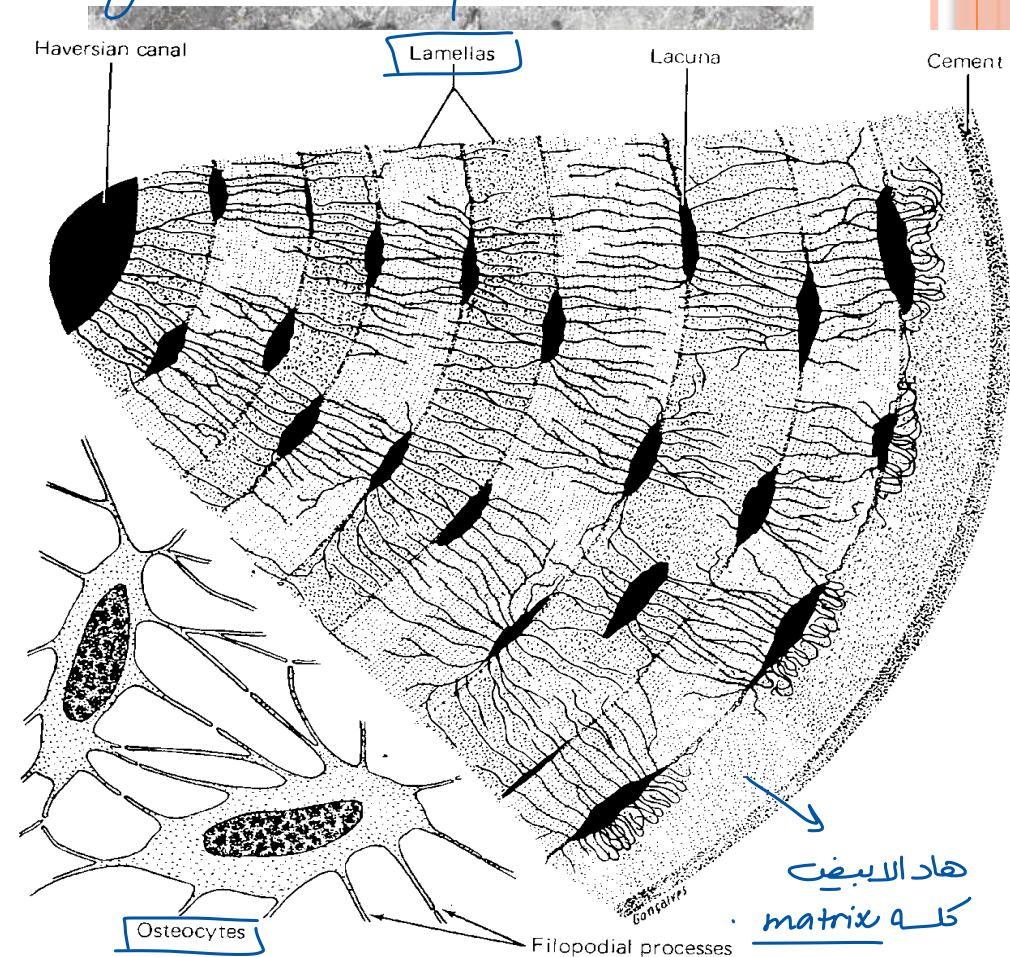
III-OSTEOCYTES= THE UNIT BONE CELLS

← عبارة عن *collagen fibers* التي يتكون من *matrix* ، ويتشبي عمودية على بعضها.

○ EM picture:

- **Nucleus:** more heterochromatic than that of osteoblast. ✓
- **Cytoplasm:** moderate amounts of organelles. ✓
- They are present within lacunae. ✓
- Their processes are present within minute spaces in the bone matrix called canaliculi. ✓
- The lacunae and canaliculi communicate with each other. ✓
- The processes of neighboring osteocytes are connected via gap junctions. ✓

كل وحدة منهم يطلق منها *process* ويرتبطوا مع بعض بواسطة gap junctions.



IV-OSTEOCLASTS= THE BONE EATING CELLS

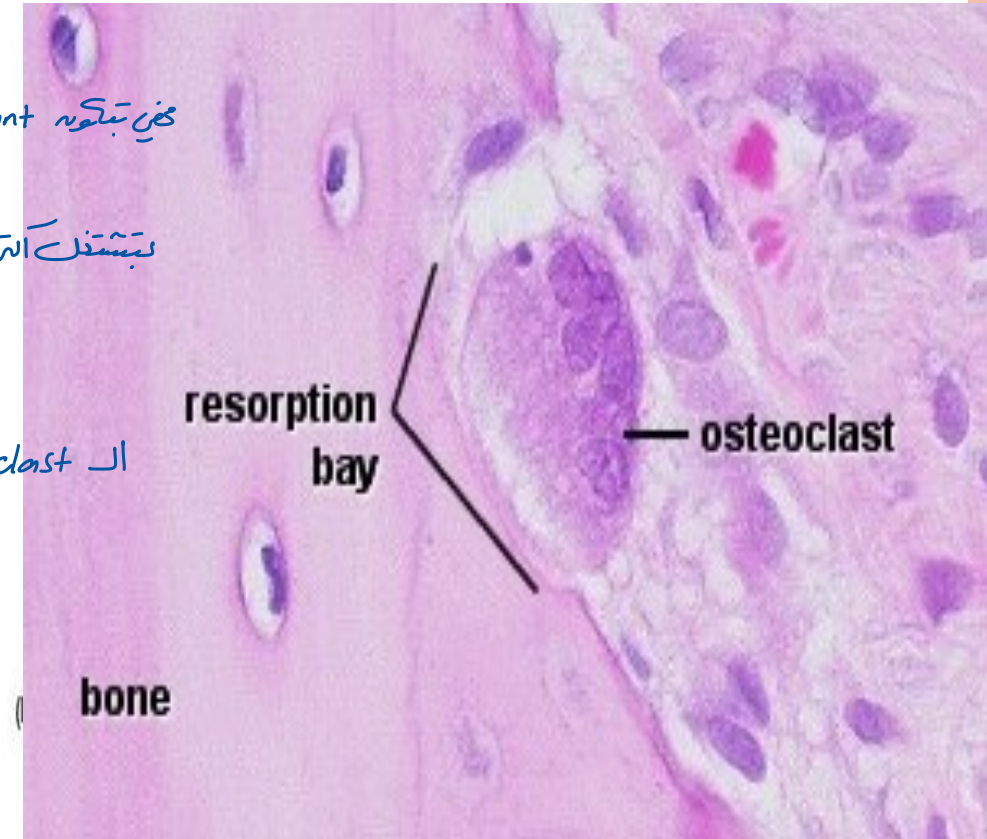
لبشبه langerhans مے Skin .

- **Origin:** from the blood monocytes (mononuclear phagocyte system), migrate to the bone, fuse together → giant and differentiate into osteoclasts (motile cell).
مکونہ motile .
- **Function:** **bone resorption** during osteogenesis. → لبشبهفک الٹر عنف لکبار .
- **Sites:** present within shallow depressions in bone matrix called **the resorption bays or Howship's lacunae** (formed by the osteoclasts activity).
اسیہ Depression مہبہ bone مہ شویہ مہ osteoclast ال مکارہ م اکتے ، ولتقد مہ .
- **LM picture:**
- **Size:** Giant. ✓
- **Shape:** irregular outline.
- **Nucleus:** multinucleated(may contain up to 50 dense nuclei).
لڈخا حایہ مہ اتحاد اکثر مہ cell مع بعضہم .
- **Cytoplasm:** deeply eosinophilic & vacuolated.

مکونہ مہبہ lysosomal enzyme لڈخا macrophage

مہبہ کلا الماسیہ یصل Fracture

لوفشوق Osteoporosis ← Osteoblast
Osteopetrosis ← Osteoclast ~ ~



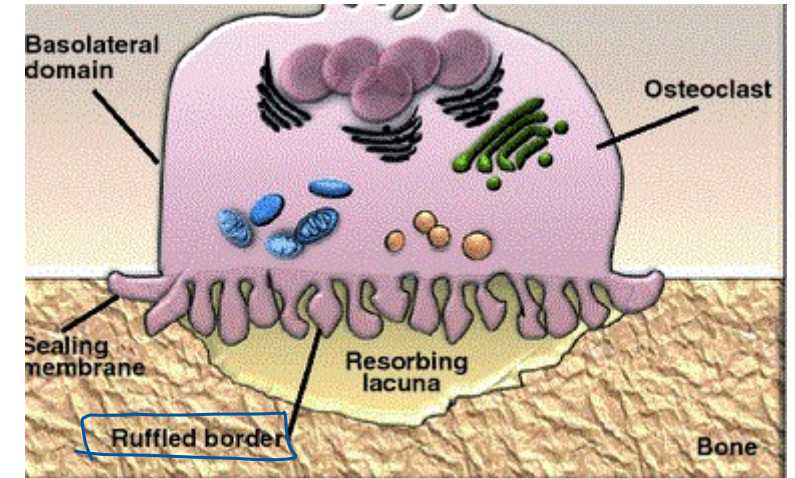
IV-OSTEOCLASTS= THE BONE EATING CELLS

◦ EM picture:

➤ It has two surfaces: a smooth surface and a ruffled surface, towards the area of bone resorption, with many irregular projections separated by narrow clefts.

➤ **Cytoplasm:** contains:

- 1- Many mitochondria,
- 2- Well developed Golgi apparatus,
- 3- Large number of lysosomes, vesicles and vacuoles.

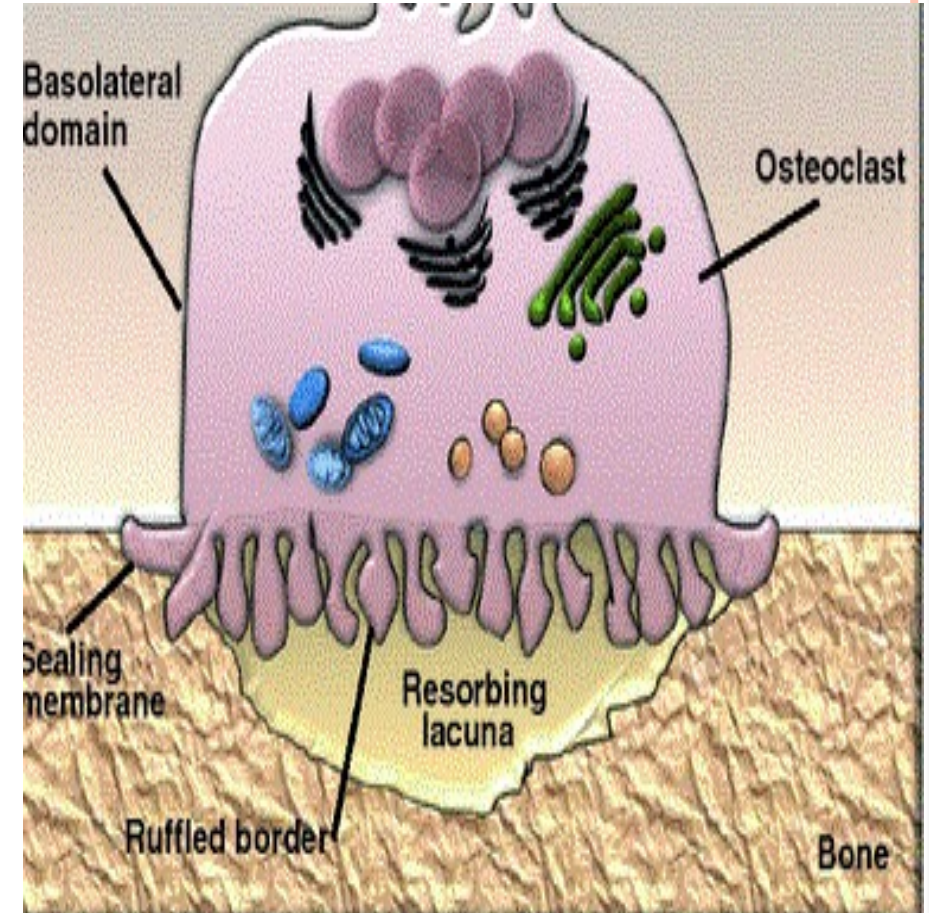


The cell has a polarity → [تنظيم حالائير]

POLARITY OF OSTEOCLAST

1. **Ruffled border:** face the resorption area.
2. **Smooth surface:** away from area of resorption.
3. **Mitochondria** under ruffled border border. *عنه رتائل ال Bone*
4. **Nuclei** toward smooth surface.

لونه ماله وخيطة عن رuffled border



OSTEOCLASTS= THE BONE EATING CELLS

- **Function: bone resorption** during osteogenesis.

كيفية؟
هناك هياكل الخلية المختلفة في Osteoblast ، حيث Osteoblast يتفقد بني عظم جديد

في Osteoclast يبدأ تتخلص من العظم القديم .

خائلي بصير / انه هياكل الخلية (Osteoclast) لا تأخذ O_2 من Blood supply ، يتطلع CO_2 ك waste product لكنه قبل من تطلعه بترطه مع شئ فينتج HCO_3^- و H^+ ، ينطلقه على صيغة HCO_3^- في vessels و H^+ يتدخله على Bone ، عشاءه هيك هي يتكونه Ruffled border عشاءه تزود مساحة السطح و يطلع H^+ اكثر .
ينطلق H^+ عن طريقه channels فيحتاج طاقة عشاءه هيك ال mitochondria موجودة ، فيدخل H^+

ويتحلل low pH و يتحلل ال matrix .

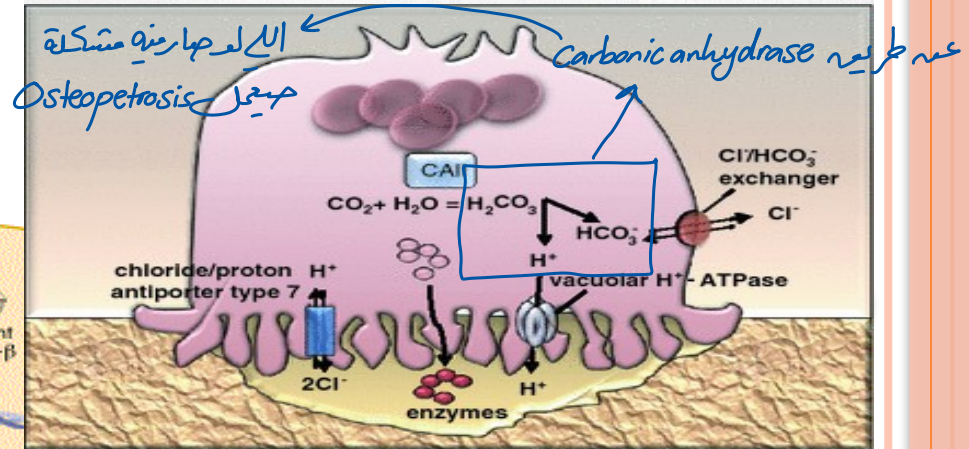
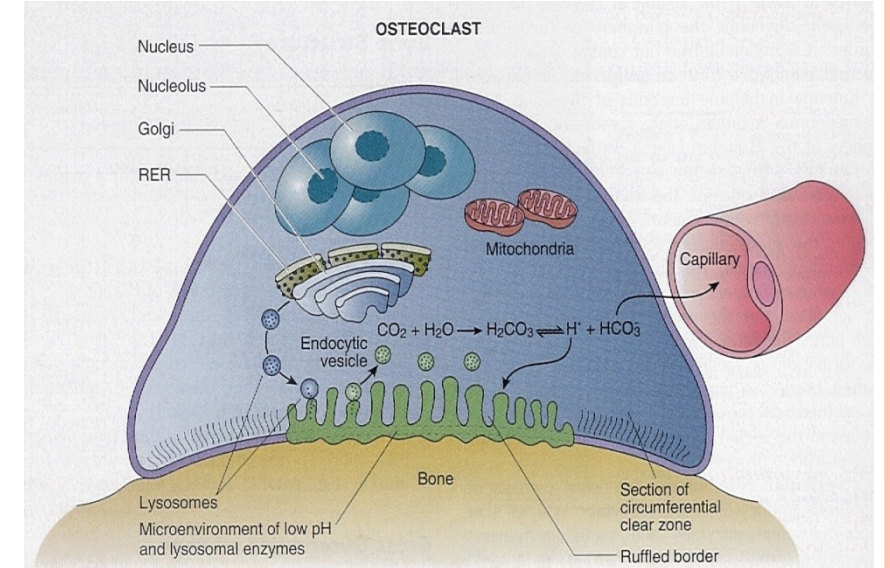
وسنرى لب هيك ، يتحلل ب مكانه وسيلة لان العظم عنه Component كثيرة

Organic و Inorganic . فشو يتحلل ؟ يتطلع ال lysosomal/enzyme

في ال matrix عن طريقه ال Diffusion ، وهاي حالة نادرة جدا انه lysosome

يتسفن برا ال macrophage .

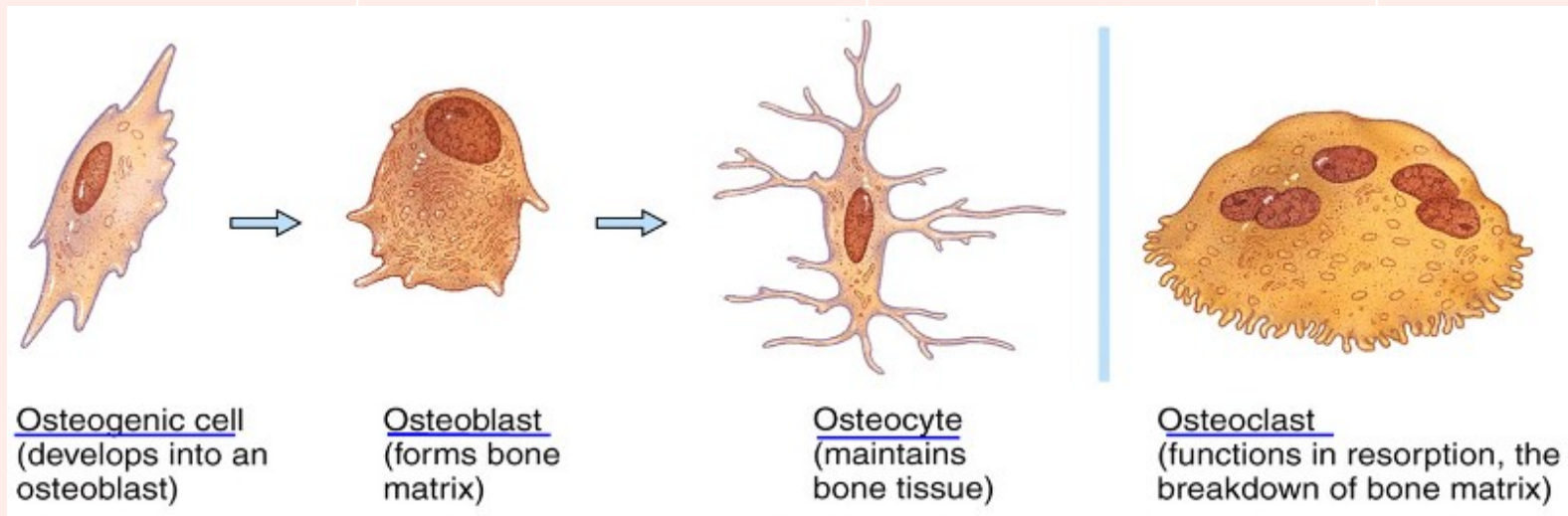
في المهم / هاي ال low pH و lysosomal/enzyme كاشية تملك ال matrix -



Osteoclast	Osteocyte	Osteoblast	Osteoprogenitor	
Blood monocytes	Osteoblast	Osteoprogenitor	Undifferentiated mesenchymal cells	Origin
Giant (resulted from fusion of 50 cells) Irregular with smooth & ruffled surfaces.	Flattened with processes	cuboidal;columnar in a row with processes.	Small (few organelles) Spindle	LM: Shape
Multinucleated (up to 50)	Dark	Eccentric, pale	Oval,pale (division)	Nucleus
Deep acidophilic (mitochondria) & vacuolated (lysosomes)	Pale basophilic (moderate organelles)	Deep basophilic (rER) & negative golgi image (Golgi)	Pale basophilic (few organelles mainly ribosomes)	Cytoplasm

Osteoclast	Osteocyte	Osteoblast	Osteoprogenitor	Types
•Large number of lysosomes (resorption), •Golgi. •endocytotic vesicles (contain degradation products.) •Mitochondria (energy to pump H)	•Moderate amount of organelles (less active) •Cells are within lacunae. •Processes are within canaliculi.	<u>Protein synthesizing cell</u> abundant rER, Golgi& secretory vesicles.	few organelles mainly ribosomes for division	<u>EM</u>
Within depressions on the resorbing matrix called resorption bays or Howship s lacunae.	Within lacunae while their processes within canaliculi.	The same as osteoprogenitor	Sites of initiation of bone formation: 1- inner cellular layer of periosteum. 2- endosteum 3- lining Haversian canal.	<u>Sites</u>

Osteoclast	Osteocyte	Osteoblast	Osteoprogenitor	
The bone eating cell; bone resorption during osteogenesis, growth & repair.	The unit bone cell; maintain matrix	Bone forming cell 1- secretion of organic components of matrix. 2- secretion of alkaline phosphatase (calcification) 3- transformed into osteocytes.	The mother cell of the bone; Divide and give osteoblasts	<u>Functions</u>



TYPES OF BONES

- 1- Primary bone: definition & structure. *بتطبع بلدية وعمل ossification*
- 2- Secondary bone: definition & types: *حيات mature لهائية*
 - a) Compact bone: sites & structure.
 - b) Cancellous bone: sites & structure.



TYPES OF BONE

I-PRIMARY BONE OR WOVEN BONE

• Disorganized یعنی

- It is the first bone to be deposited during the bone development, growth & repair.

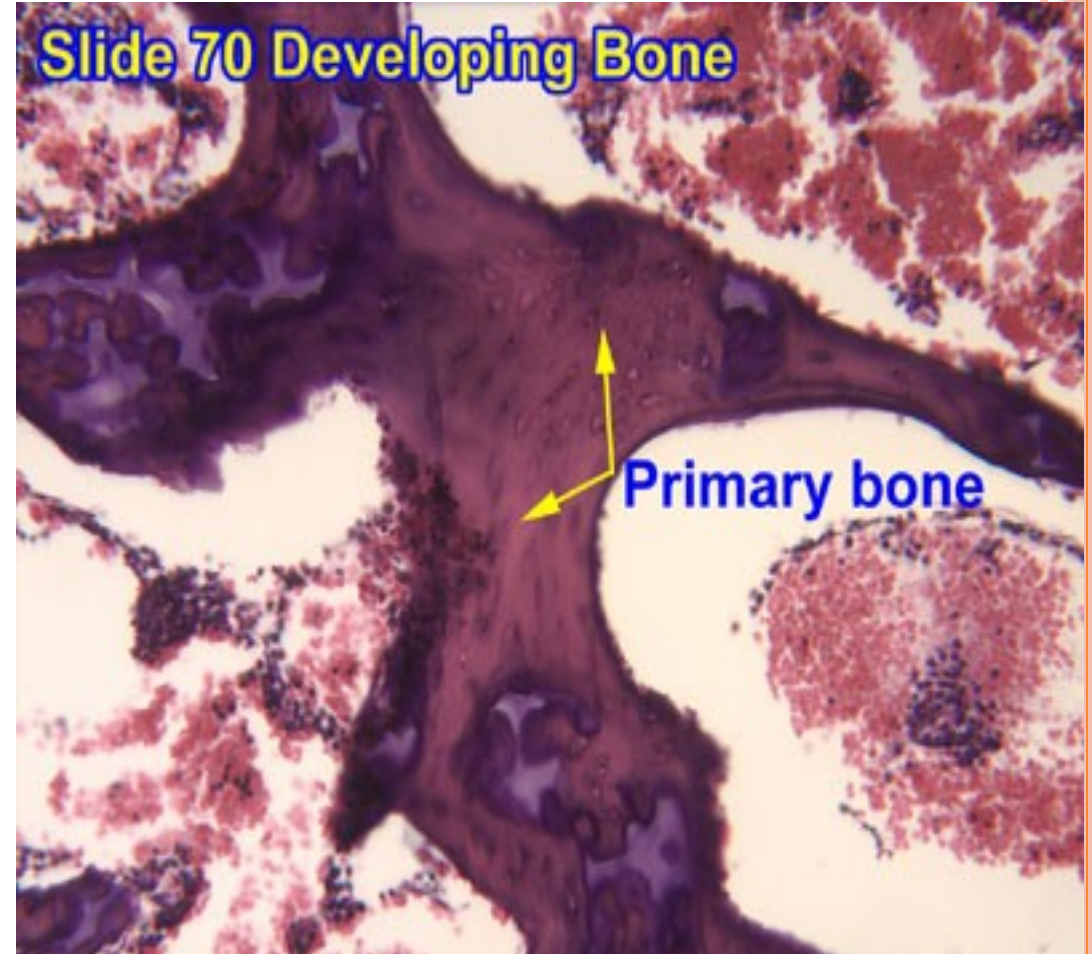
- **It has the following characters:**

- 1- It is immature weak bone due to low calcium content. ✓

- 2- Irregular arrangement of collagen fibers. woven یعنی

- 3- Osteocytes are numerous and irregularly arranged. یعنی صفیہ کل اشی بس مشو مرتب

- 4- Temporary and is replaced later on by the secondary bone. ✓

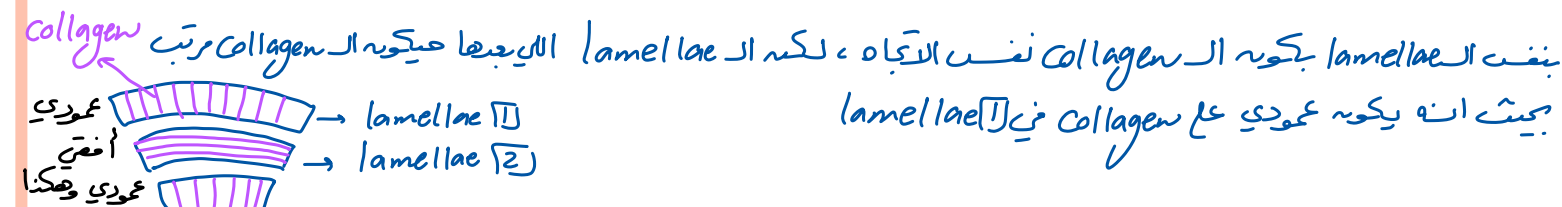
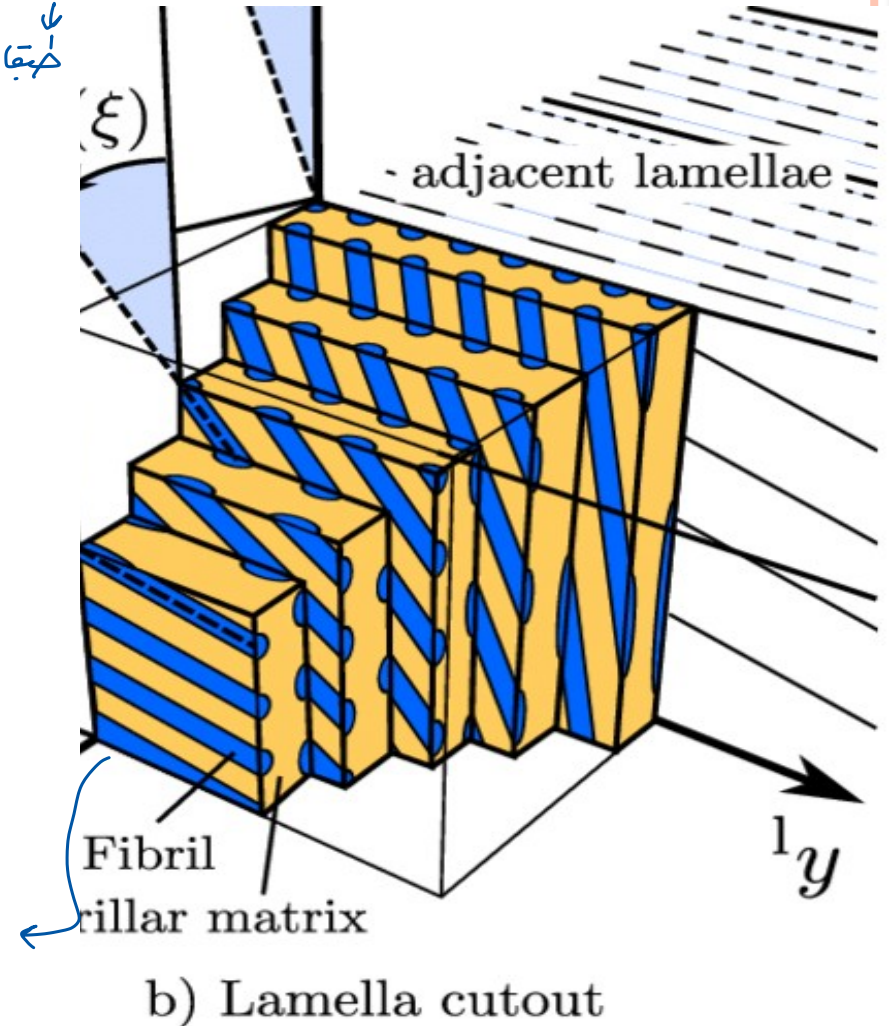


Types of Bone

II- ^{Mature} Secondary or lamellar bone

○ It is characterized by:

- 1- It is mature strong bone with high calcium content. ✓
- 2- Regular arrangement of collagen fibers in the form of multiple layers or lamellae(the histological unit of bone)where collagen fibers in each lamella are organized parallel to each other.
- 3- Osteocytes are less abundant, regularly aligned inside their lacunae along the lamellae.



Secondary, mature, lamellar bone	Primary bone	Types
High	Low ✓	Calcium content ✓
Regular arranged in lamellae	Irregularly deposited ✓	Collagen ✓
Less Regularly arranged within lamellae.	More Irregularly arranged.	Osteocyte

TYPES OF MATURE LAMELLAR BONE

- 1- The compact bone. مصمتے [خشک فیہ فراغات]
- 2- The cancellous bone (Spongy bone).



Cancellous bone

Compact bone

I-COMPACT BONE

○ Site:

- 1- The diaphysis (shaft) of long bones. ✓
- 2- The outer and inner tables of flat. ✓

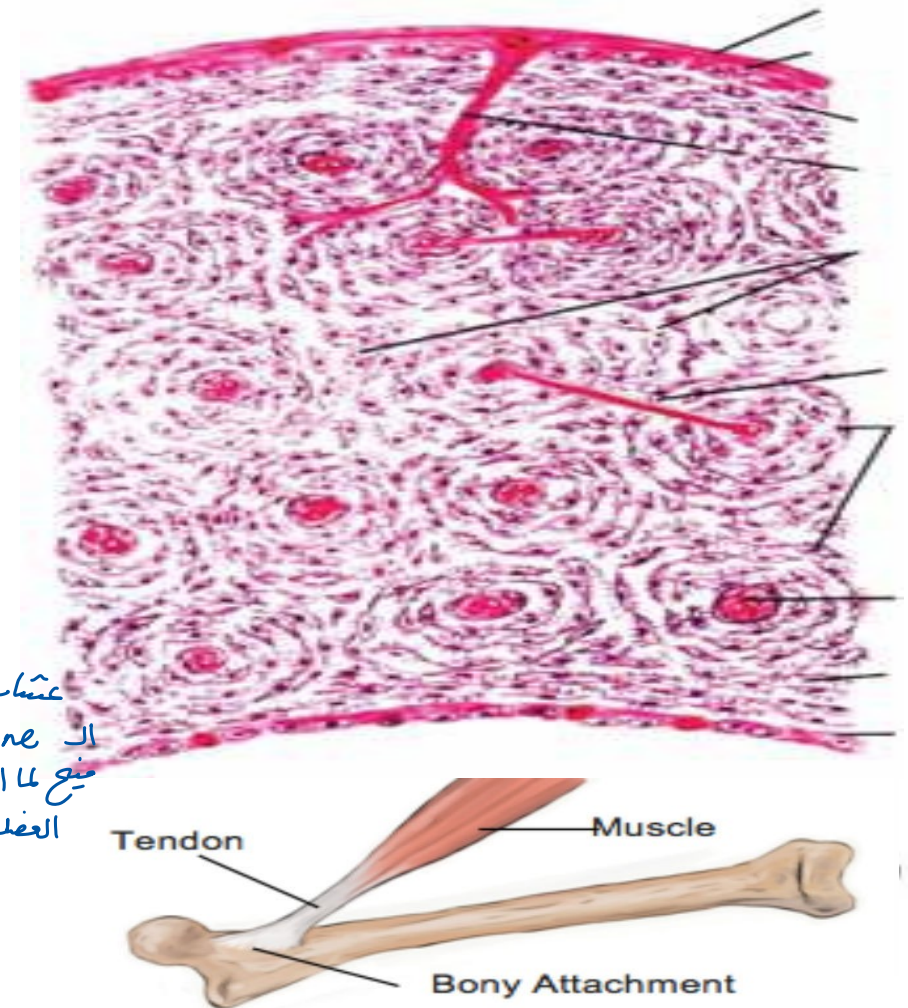
○ Structure:

1- The bone coverings: The external surface is covered by the periosteum, while its single medullary cavity in long bones is lined by the endosteum. ✓

- At the site of attachment of the periosteum to the tendon, the collagen fibers are thickened forming the Sharpey's fibers that penetrate deep into the bone substance to be fixed to the external circumferential lamellae and interstitial lamellae. → عظامنا أشد

2- The bone tissue: the bone lamellae are regularly arranged in three patterns.

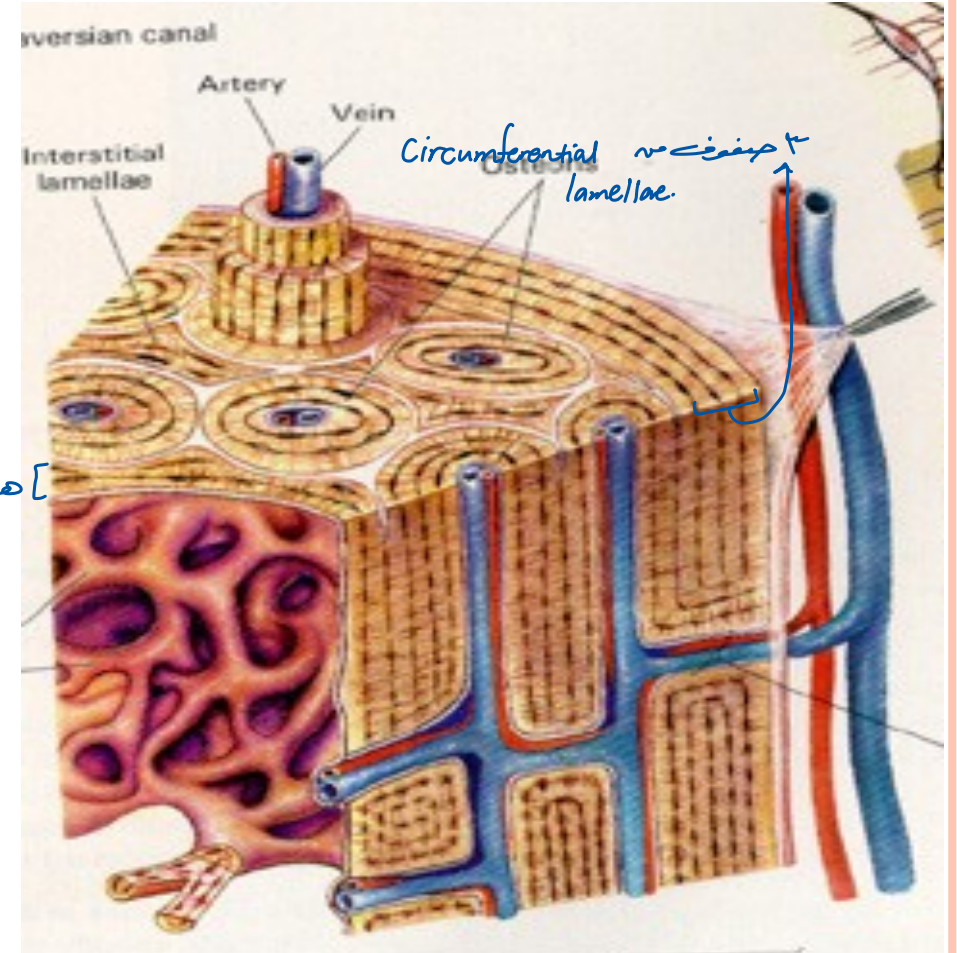
ال Bone
منع لما احرك
العضلة



1-THE CIRCUMFERENTIAL LAMELLAE

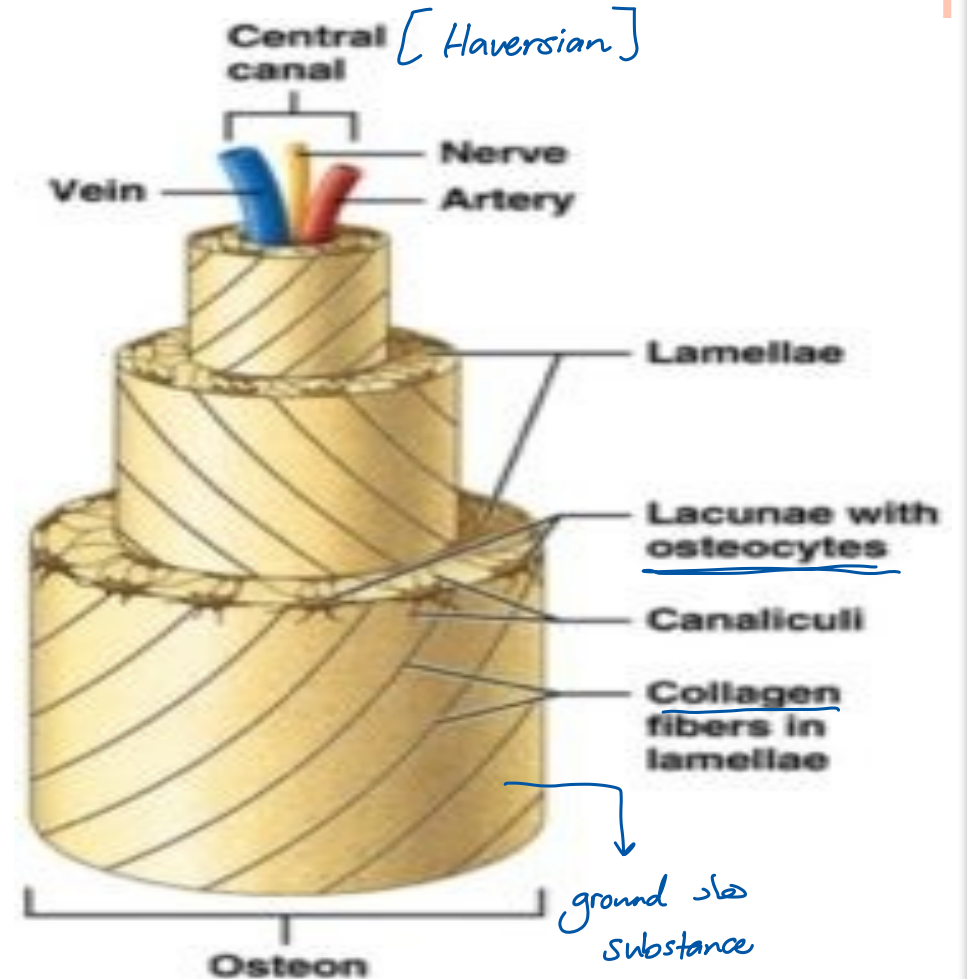
- These are 2-3 parallel bone lamellae that encircle the whole circumference of the bone shaft. ✓
دائري صيورة
- According to their localization, there are:
 - A- **The outer circumferential lamellae:** lie just beneath the periosteum. ✓
[حول ال Inner]
 - B- **The inner circumferential lamellae:** surround the central medullary cavity just beneath the endosteum. ✓

لم يتكويه مغلفة الـ



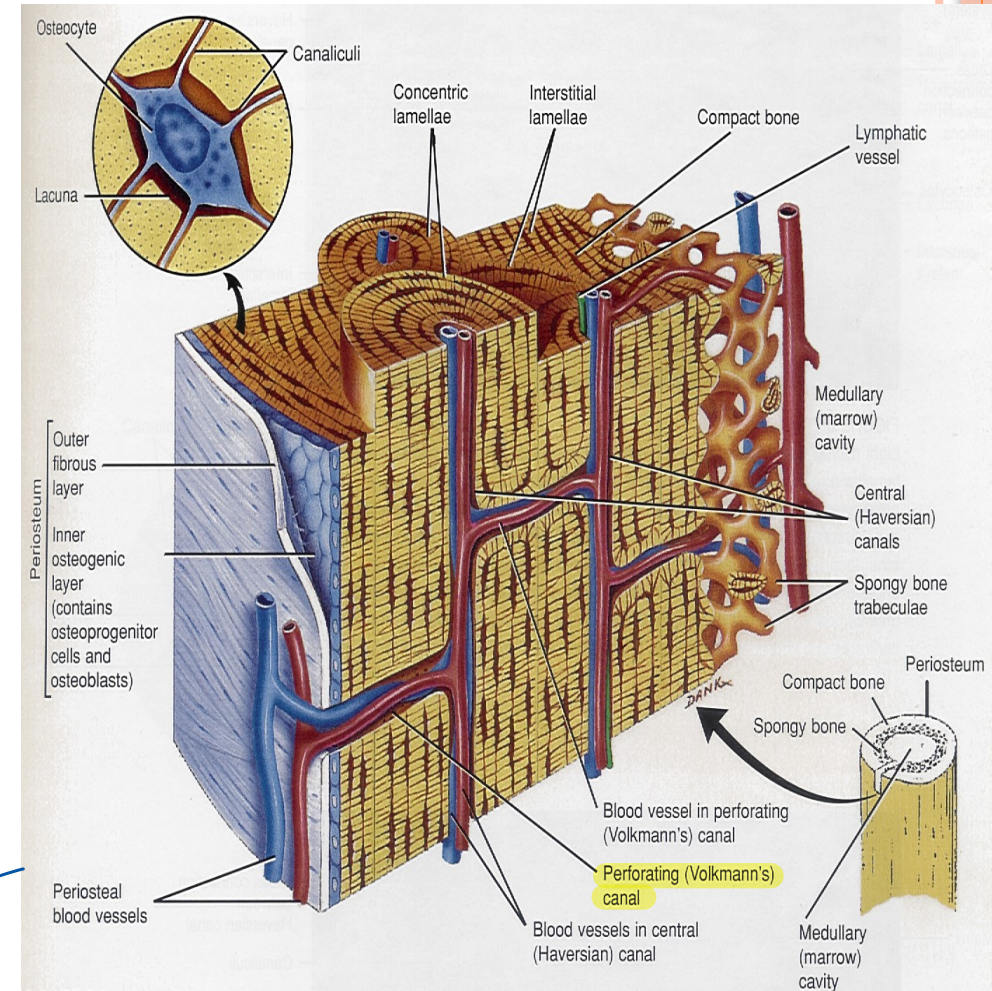
2-THE HAVERSIAN SYSTEMS (THE OSTEONS)

- It is the characteristic structural unit in compact bone.
- **Each osteon is formed of:**
 - A cylinder of 4-20 concentric bone lamellae that are telescoped inside each other.
 - The lamellae are concentrically arranged around a central Haversian canal that runs parallel to the long axis of the bone.
 - The Haversian canal is lined by osteogenic cells and contains loose connective tissue rich in blood vessels and nerves. ✓



VOLKMANN'S CANALS

- They are transverse or oblique bony canals that connect the blood vessels of **Haversian canals** with each other and with the blood vessels of the **periosteum** and the **endosteum**. ✓ (روابط)
- They differ from Haversian canal in:
 - 1- They are not surrounded by concentric bone lamellae; instead, they perforate the lamellae. ✓
 - 2- They extend in an oblique or a transverse direction and not in a longitudinal direction as the Haversian canal. ✓
- **Function of Haversian and the Volkmann's canals:**
They represent the vascular channels that transport nutritive substances throughout the compact bone. ✓

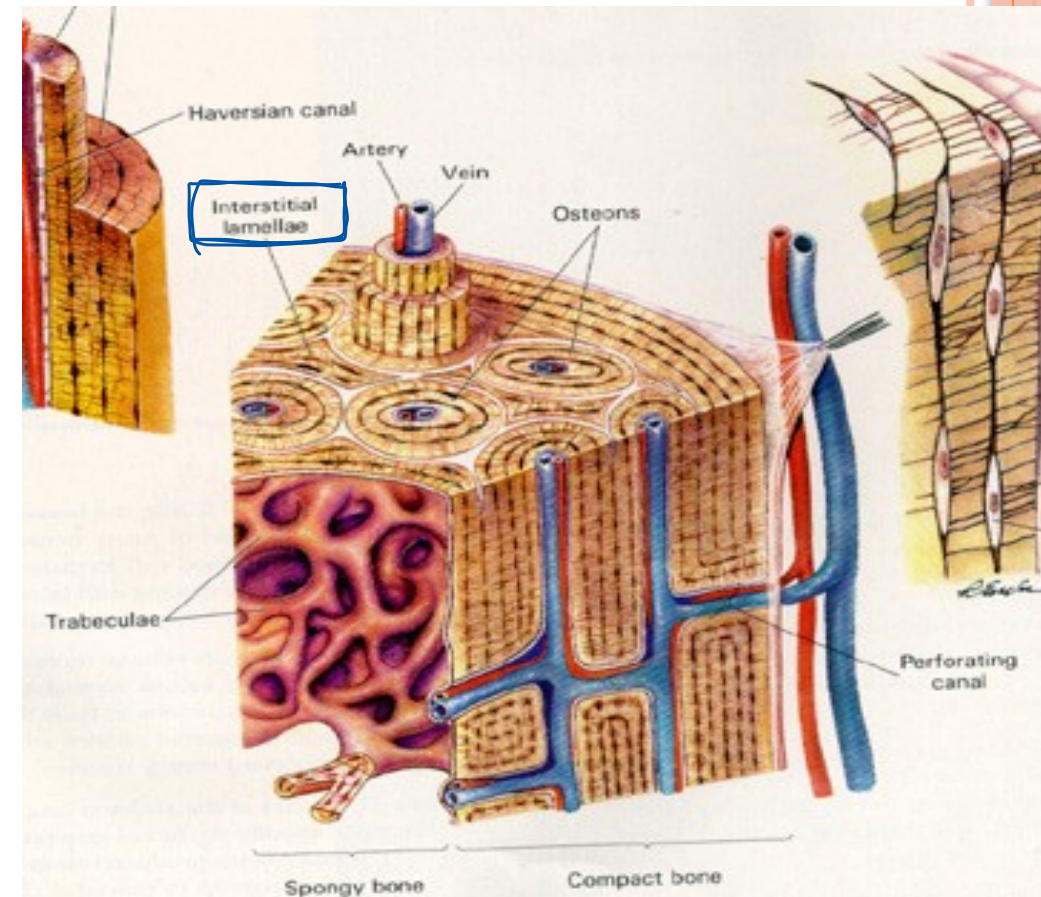


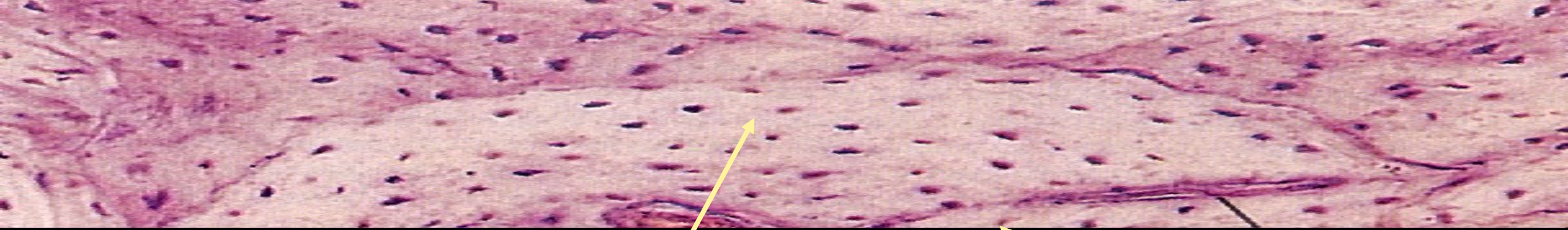
Volkman canal	Haversian canal	Types
Transverse; oblique to the long axis of bone ✓	Parallel to long axis of bone	Direction
Not surrounded by concentric bone lamellae	Surrounded by concentric bone lamellae	Surrounding structure
Nutritive canal: connect the blood vessels of Haversian canals with each other and with the blood vessels of the periosteum and the endosteum	Nutritive canal: nourish the osteon	Function

3- THE INTERSTITIAL LAMELLAE

- These are irregular groups of parallel bone lamellae filling the spaces between the Haversian systems. ✓
- They represent the lamellae that are *left behind from the old osteons* during the process of continuous remodeling of bone. ✓

- بقايا الـ Bone التي تبقي من التي سبق الـ Interstitial lamellae





Osteon

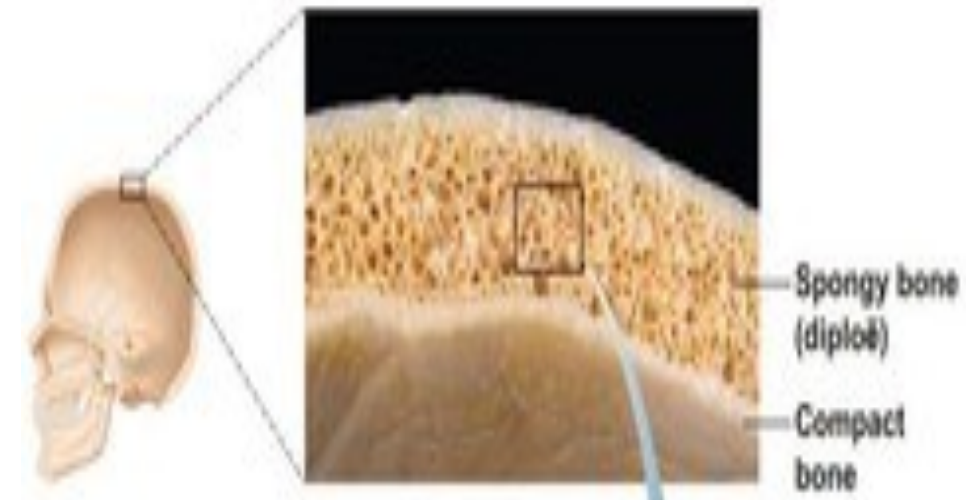
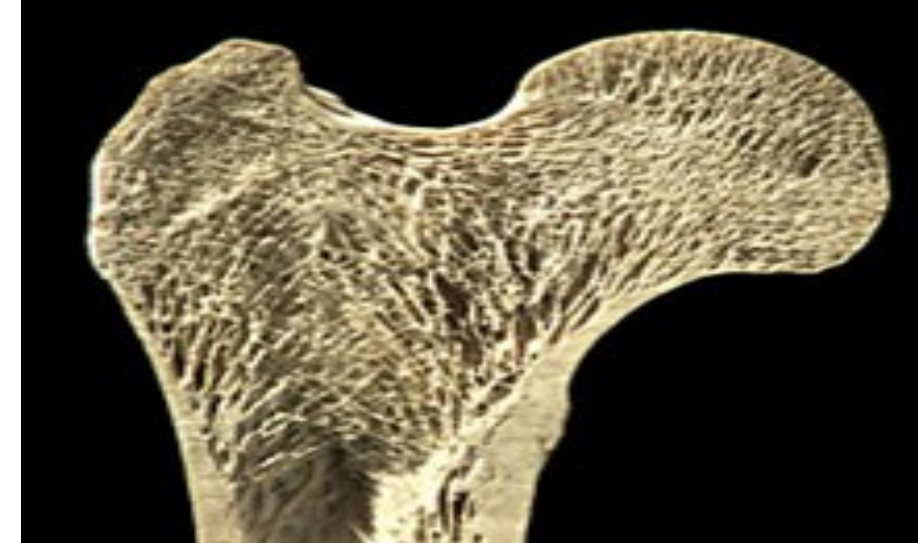
H

II- CANCELLOUS BONE

بنكوز نري الاسفنجية مليانة fluid.

○ Site:

- 1- The epiphysis of long bones(the outer surface is covered by a thin layer of compact bone).
- 2- The area between the outer & inner tables of flat bones(Diploë).



COMPONENTS OF CANCELLOUS BONE

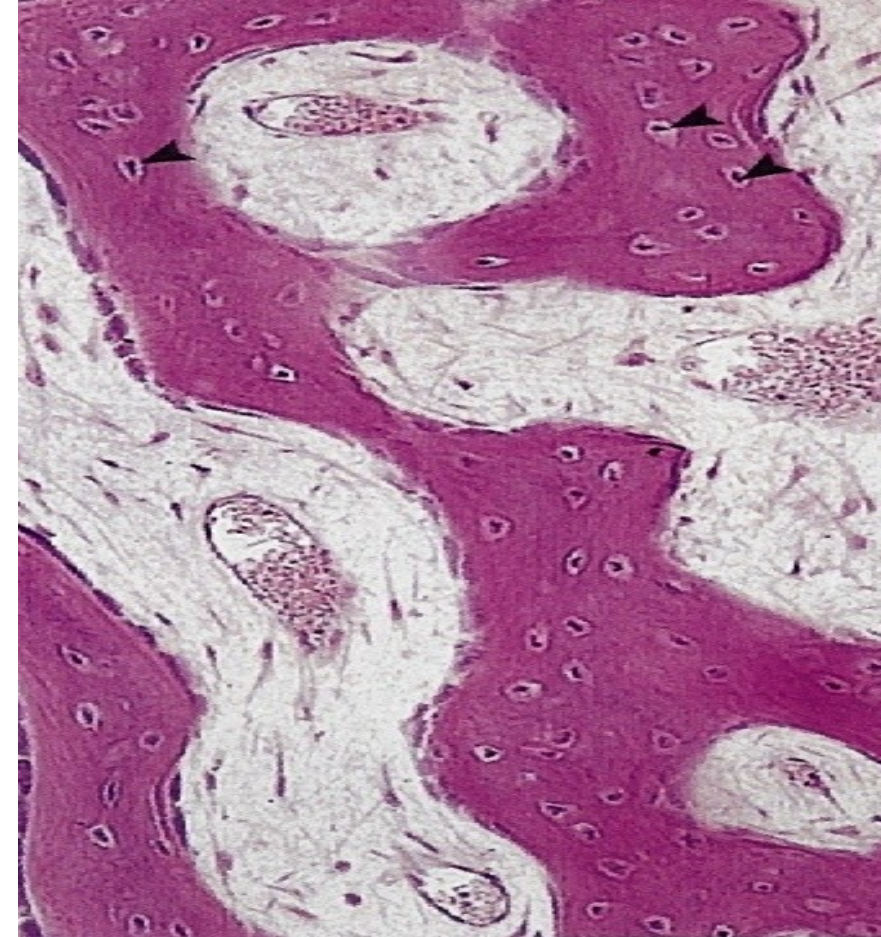
بلاک ال lamellae

1- The bone trabeculae:

- Thin interconnected bone trabeculae.
- Each trabecula is made up of bone lamellae not arranged as osteons. ✓
- Primitive Haversian systems might be present.
ما شتمثل نى الينغ Compact بكونه

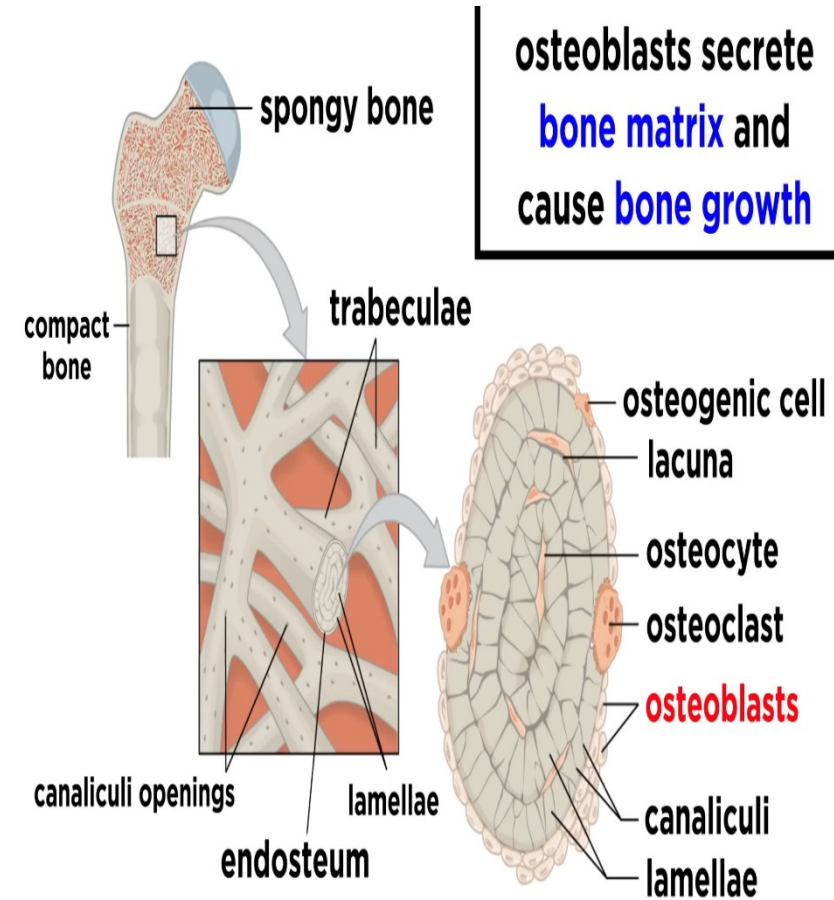
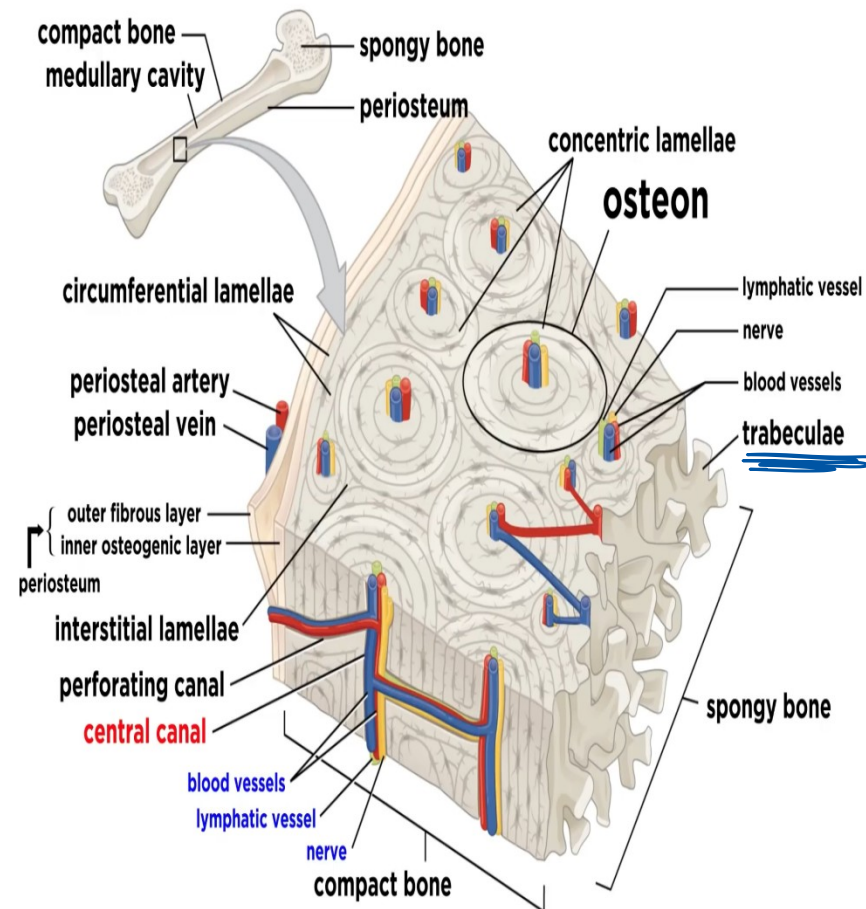
2- The bone marrow cavities:

- These are numerous cavities of separating the bone trabeculae & responsible for nourishment of the bone tissue. ✓
- They are lined by endosteum.
- They are filled with myeloid tissue (active red bone marrow, but in old age the red marrow is largely replaced by adipose tissue). ✓



Bone coverings: Endosteum which line bone marrow cavities

COMPACT VERSUS CANCELLOUS BONE



Cancellous bone	Compact bone	Types
Spongy with many holes	Dense with no holes	<u>Naked eye</u>
- Diploë of flat bones - Epiphysis of long bones	- Shaft of long bones - Outer& inner tables of flat bones	<u>Sites</u>
		<u>Structure</u>
absent	present	Periosteum
Lines the central marrow cavities.	Lines the central marrow cavity.	Endosteum
Multiple cavities.	Single, central cavity.	Bone marrow
- lamellae <i>Irregular</i>. - They form bone trabeculae	-Regularly arranged.. -They form Haversian systems, interstitial and circumferential lamellae	Bone lamellae
Immature, primitive Haversian systems might be present.	Mature, fully developed	Haversian system
The vascular channels are lacking as bone marrow cavities are present instead.	Volkman's canals, to the Haversian canals, to the bone canaliculi of osteocytes .	<u>Nutrition</u>

الای متن منکور جیسو دکتر حسام
متن مطلوب ۳۰

HISTOGENESIS OF BONE (OSTEOGENESIS)

1-Bone means ^{ملیہ کانیہ Endocrine sys} **vascularization**.

2- For the matrix of the bone to be secreted, it needs a **surface** to be laid upon it. This surface may be a mesenchymal tissue or a piece of cartilage.

یعنی بصریح bone لطیفیہ اما cartilage اولہ Bone
او mesenchyma Bone

واصلتہ Embryo حکینا بکونہ کلا Hyaline cartilage
ولعیرالہ ossification



HISTOGENESIS OF BONE (OSTEOGENESIS)

- **Bone can be formed by either of two ways:**

1- **Intramembranous ossification:** in which osteoblasts secrete bone matrix within a membrane of mesenchymal tissue. ✓

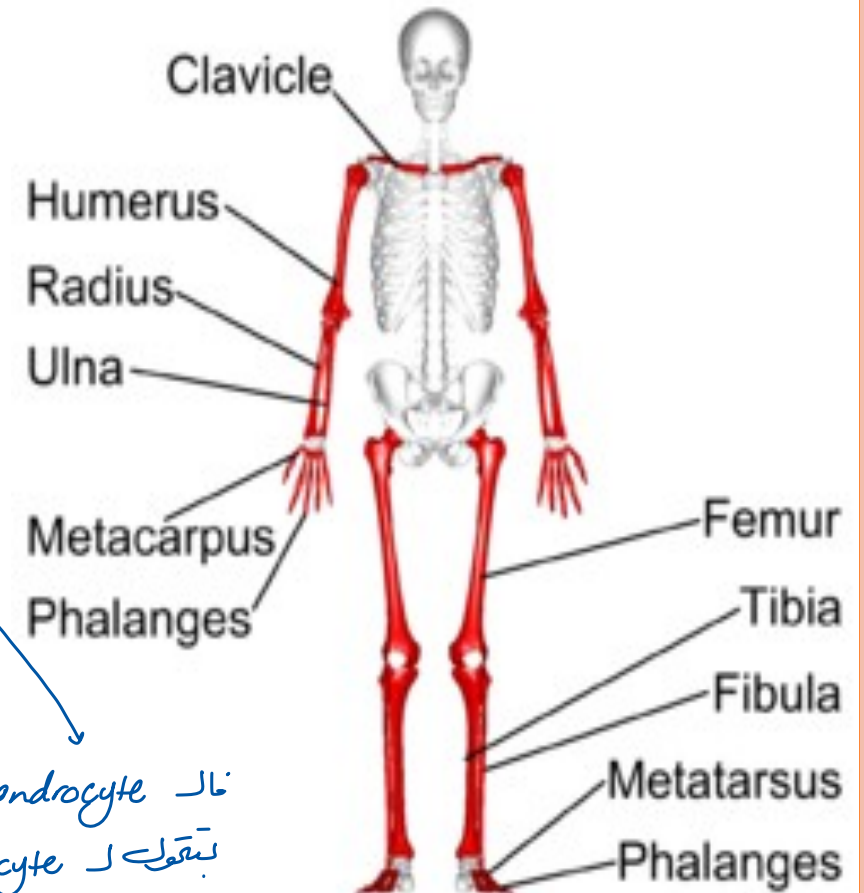
2- **Endochondral ossification:** in which the matrix of preexisting hyaline cartilaginous model is eroded and replaced by bone matrix.

- During osteogenesis of all types of bone, areas of woven bone, areas of resorption and areas of lamellar bone usually appear side by side.

لہٰذا جنی میں شاملہ صورت
Primary woven bone الیٰ ہی
Remodeling resorption لہٰذا جنی میں
Secondary bone شاملہ ہوتا ہے

Calcification
Bone

Chondrocyte
Osteocyte



I-INTRAMEMBRANOUS OSSIFICATION

- **It occurs during:**

- **Embryonic life:** results in the formation of flat bones.
- **During postnatal life:** results in increase in width of long bones.

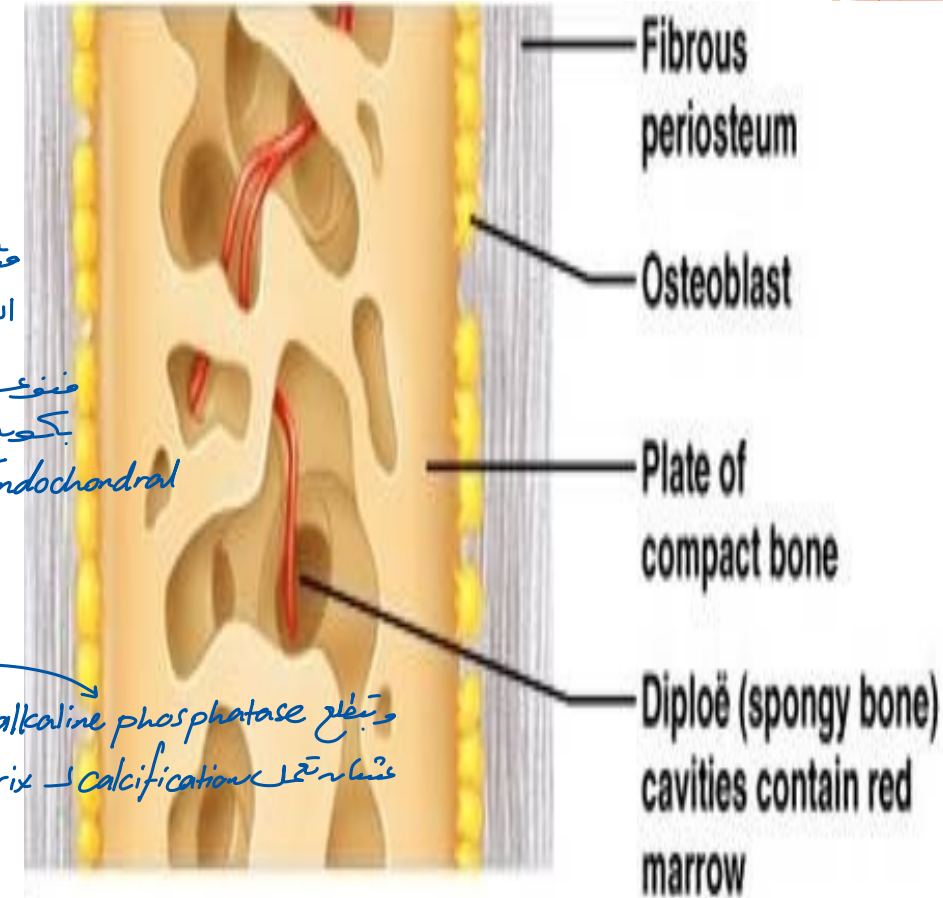
- **Steps of intramembranous ossification :**

1- **Development of one or more ossification centers:** by condensation of mesenchymal connective tissue in the area of the developing bone with increased vascularity to provide enough mineral needed for bone formation.

2- **In response to specific growth factors and enough oxygen tension:** mesenchymal cells proliferate and differentiate into osteoprogenitor cells.

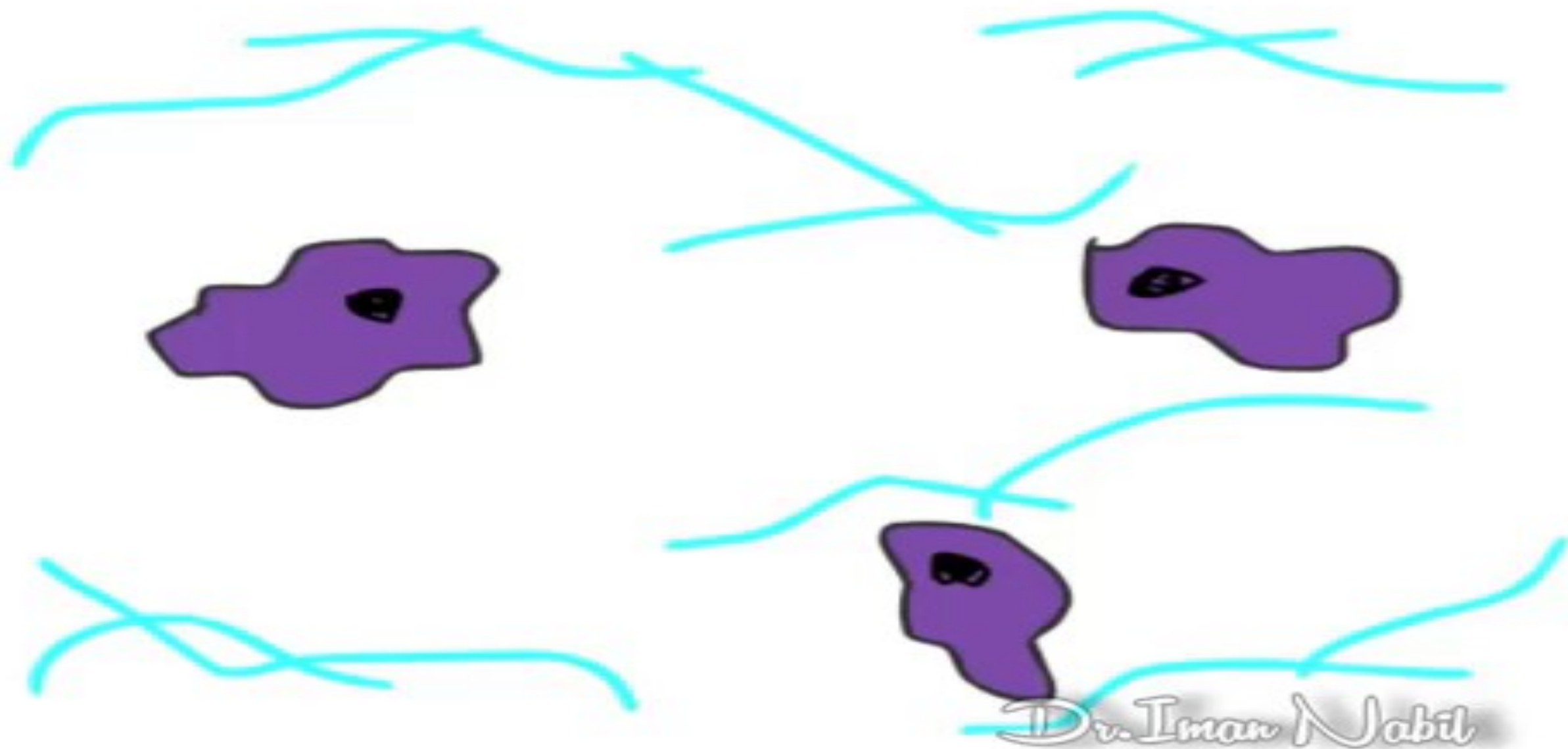
3- **Osteoprogenitor cells:** proliferate and differentiate into osteoblasts secreting bone matrix, then the osteoblasts transform into osteocytes.

4- **Trabeculae of developing bones:** are formed and fuse together giving the spongy bone with bone marrow cavities in between.



primary lamellae تتباعد على شكل trabeculae ، تتصلب ال primary bone تتكون بشكل Spongy bone ، تتصلب ال Osteons spongy bone وتتصلب ال

Trabeculae تتباعد ال Flat bone تتكون ال Spongy bone تتكون ال Flat bone تتكون ال

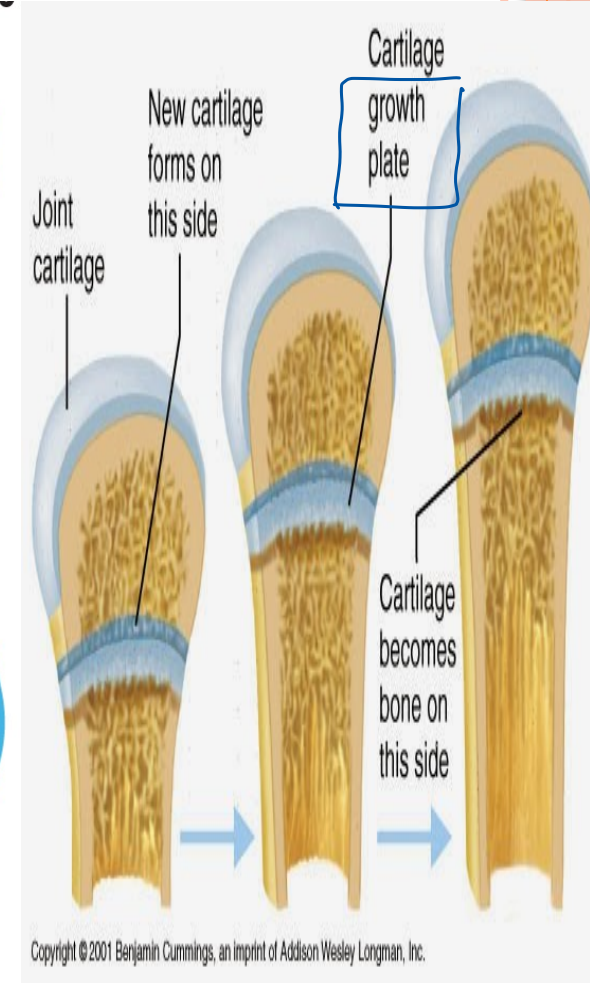
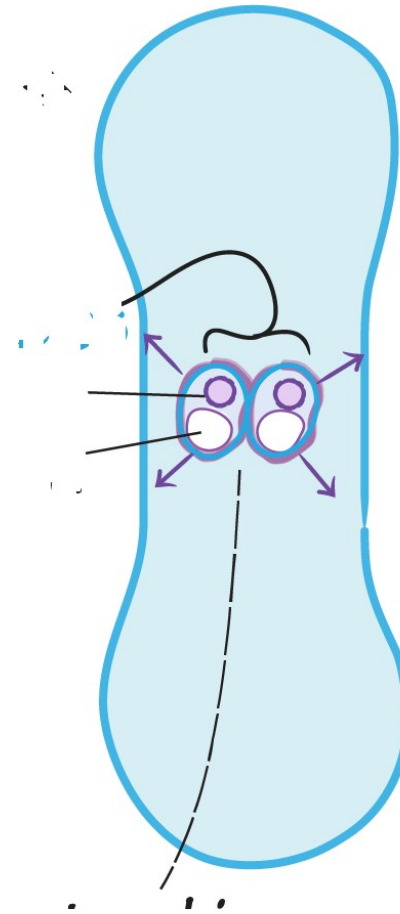


ENDOCHONDRAL (INTRACARTILAGINOUS) OSSIFICATION

اھول ال Cartilage لے bone
مستقلاً عن تھیل ال Bones

- During embryonic life, many parts of the skeleton are laid down first as hyaline cartilage, which gradually replaced by bones results in the formation of long bones.
- Later in the fetal and early postnatal life: these cartilaginous models become gradually replaced by bone tissue **except** in two places: the epiphyseal plate and the articular cartilage.

عین ال Hyaline cartilage بھول ل Bone اول م ینولد المتخصص
ال مکی نیہ الیہا / Epiphysial plate , articular cartilage
ما بھول ل Bone
طوط حیاتیہ طوطاً
بھول ل Bone
على Adult life
تمت شائیر الحروفیات



GROWTH OF BONE

- **During postnatal life, bone formation occurs for:**

1- Growth of bone: which includes increase in length, increase in width and bone remodeling.

2- Repair of bone fractures. ✓



ال Compact bone يكون فيها single marrow cavity ، عكس ال Spongy يكون فيها مسند .

I-INCREASE IN LENGTH OF LONG BONE

سponge bone عبارة عن

- It occurs at the epiphyseal plate by endochondral ossification.
- Steps of endochondral bone formation**

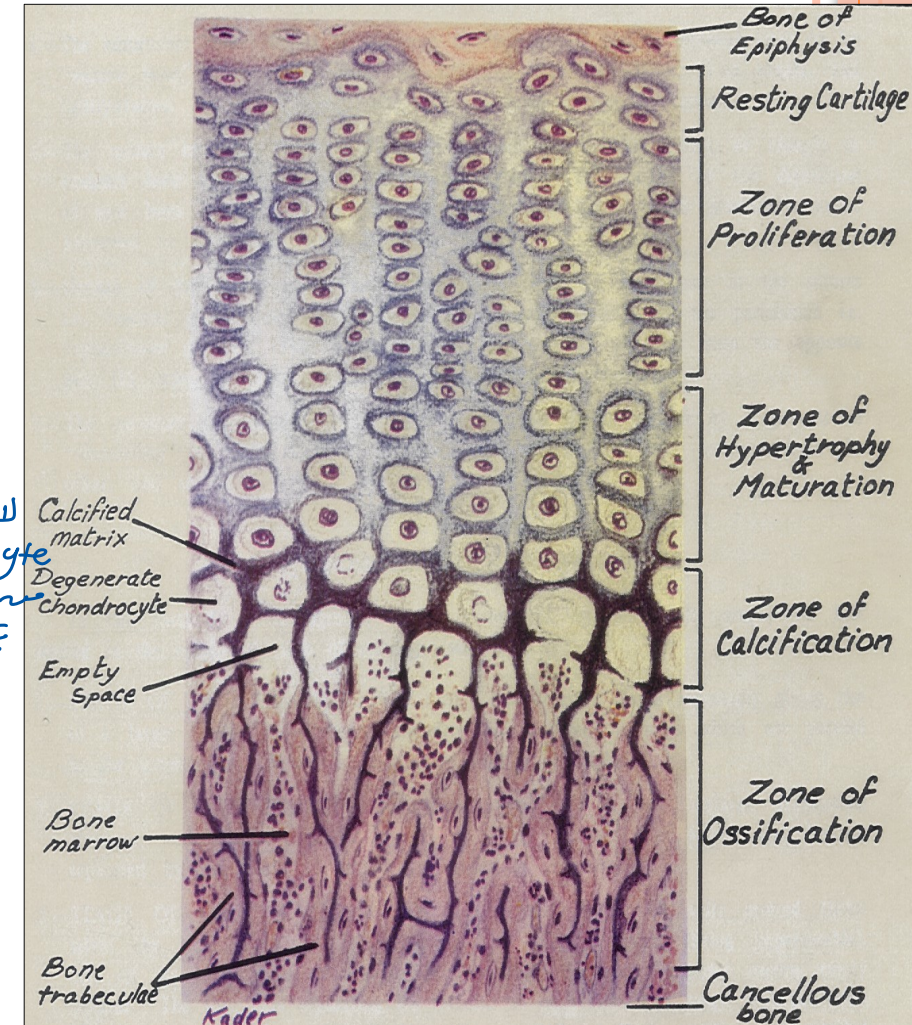
The following zones are seen starting from the epiphyseal side of cartilage:

1- Zone of resting cartilage: ^{المنطقة Epiphysis} chondrocytes do not show any signs of activity. It acts as a reserve. [استراحة ال Estrogen]

2- Zone of proliferation and arrangement: in response to growth hormone chondrocytes proliferate by interstitial growth forming longitudinal rows resembling stacks of coins. ✓

3- Zone of hypertrophy: chondrocytes accumulate large amounts of glycogen enlarged and pale the matrix is compressed into thin septa between the chondrocytes.

لأنه ال Glycogen يصبغ
أنا جفرا للصبغة.

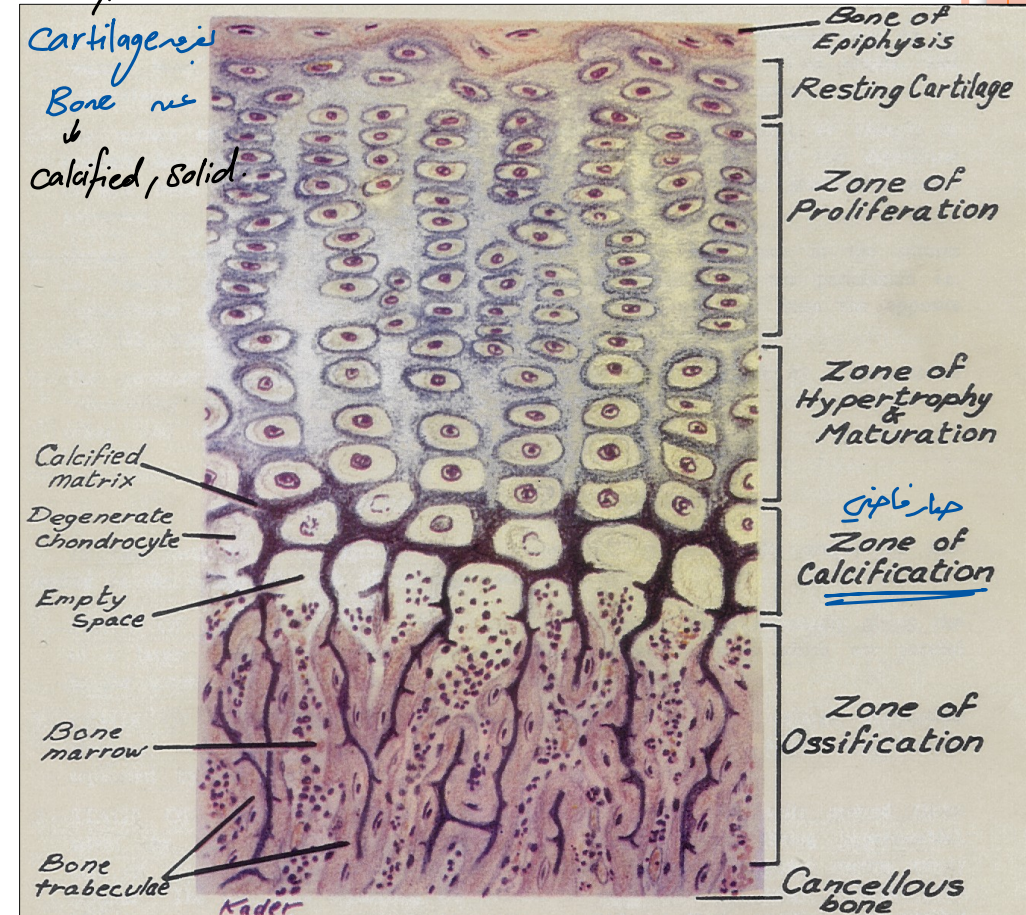


I-INCREASE IN LENGTH OF LONG BONE

bone لسان
 Cartilage عباره عن
 Cartilage لسان
 4- **Zone of calcification**: the hypertrophied chondrocytes start to release **alkaline phosphatase enzyme** → calcification of the cartilage matrix (in H&E sections the pale bluish staining of hyaline cartilage is intermingled with the reddish staining of the calcium salts deposited in the matrix) → the insoluble calcium salts in the matrix interfere with diffusion of sufficient nutrients to the chondrocytes → **degeneration and death** of the chondrocytes leaving empty cavities. ✓

Blood supply
 Shaft
 بطلع الخلع
 من حمار
 matrix
 Solid
 بطلع حمار
 Blood supply
 بطلع
 chondrocyte حنقوت

Uncalcified, Firm matrix



I-INCREASE IN LENGTH OF LONG BONE

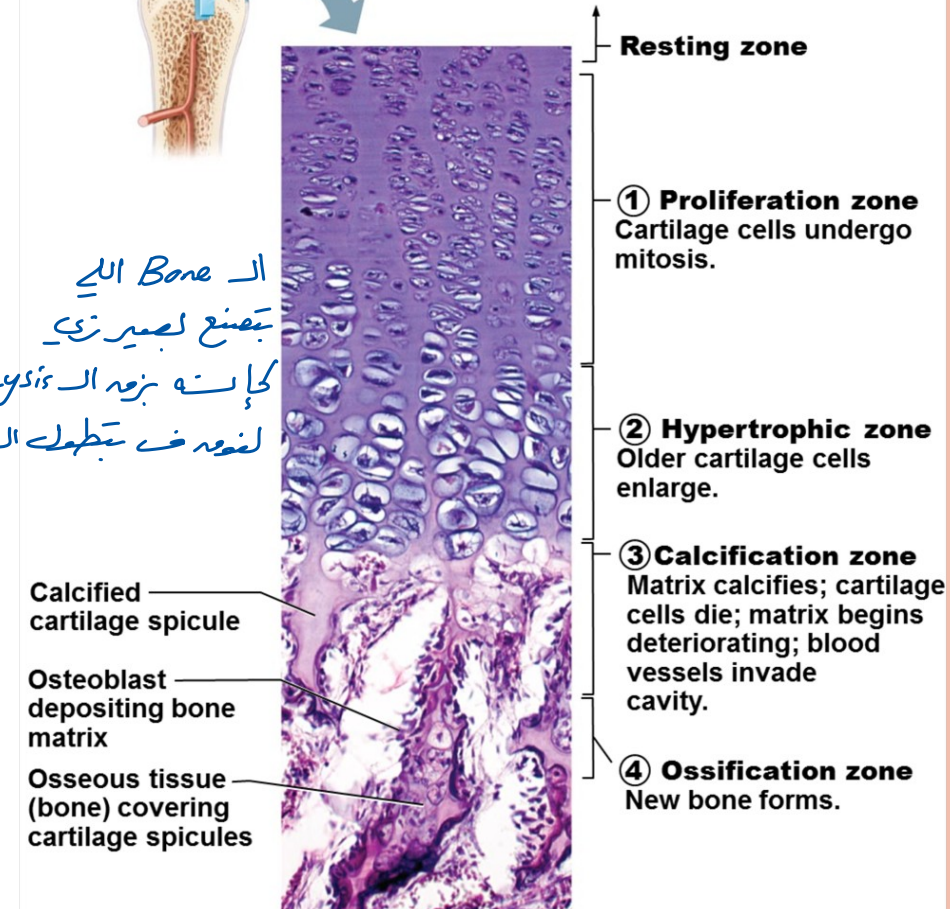
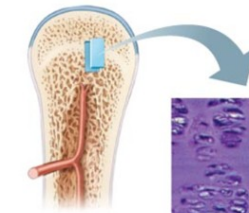
5- Zone of ossification:

- Blood capillaries and osteogenic cells grow from the diaphysis and from the periosteum to occupy the empty cavities. ✓
- Osteoblasts secrete bone matrix on the calcified cartilage remnants become entrapped within lacunae changed to osteocytes. ✓
- This process proceeds resulting in the formation of woven bone which will be replaced by lamellar compact bone surrounding a single marrow cavity. ✓

این‌ها‌ی‌العملیة‌تمدید‌قبل‌primary bone
 لایه‌جدید‌ساخت‌هفته‌شده‌عندی‌ال‌primary bone
 رسیدن‌ال‌Remodelling‌در‌شکله‌Secondary bone

رئانه‌تشنل‌هنا.

ال‌Bone‌الی
 بتفیع‌لجیری
 کما‌نه‌نزه‌ال‌Epiphysis
 لغرض‌ف‌تطویل‌ال‌Bone



I-INCREASE IN LENGTH OF LONG BONE

- Because *the rates of the proliferation and destruction are nearly equal*, the thickness of epiphyseal plate does not change. ✓

في الارتفاع آتت
او Osteoblast

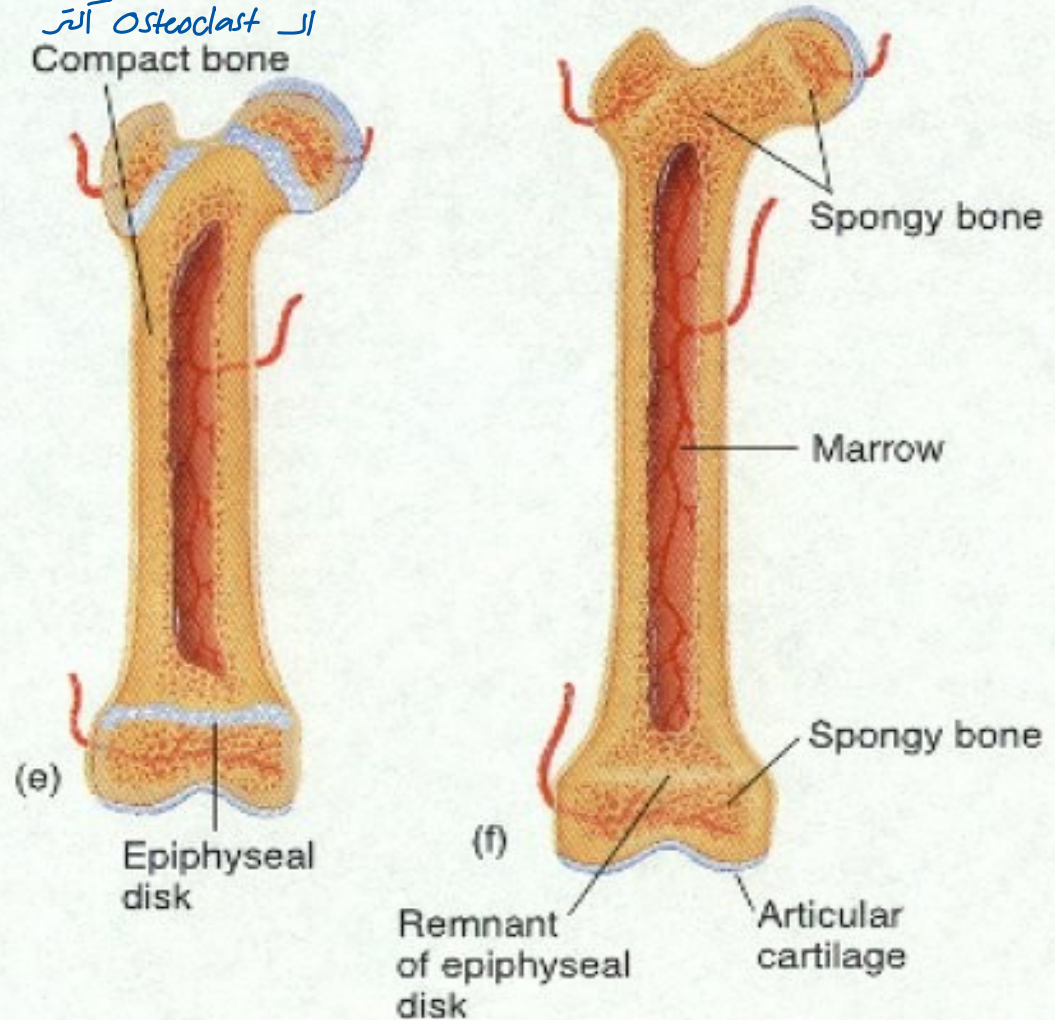
Instead, *it is displaced away from the middle of the diaphysis*, resulting in growth in length of the bone. ✓

- Growth of long bones stops at adulthood when the epiphyseal plates are eliminated (*closure of the epiphyses*). Once the epiphysis is closed, increase in length of the bone becomes impossible. ✓):

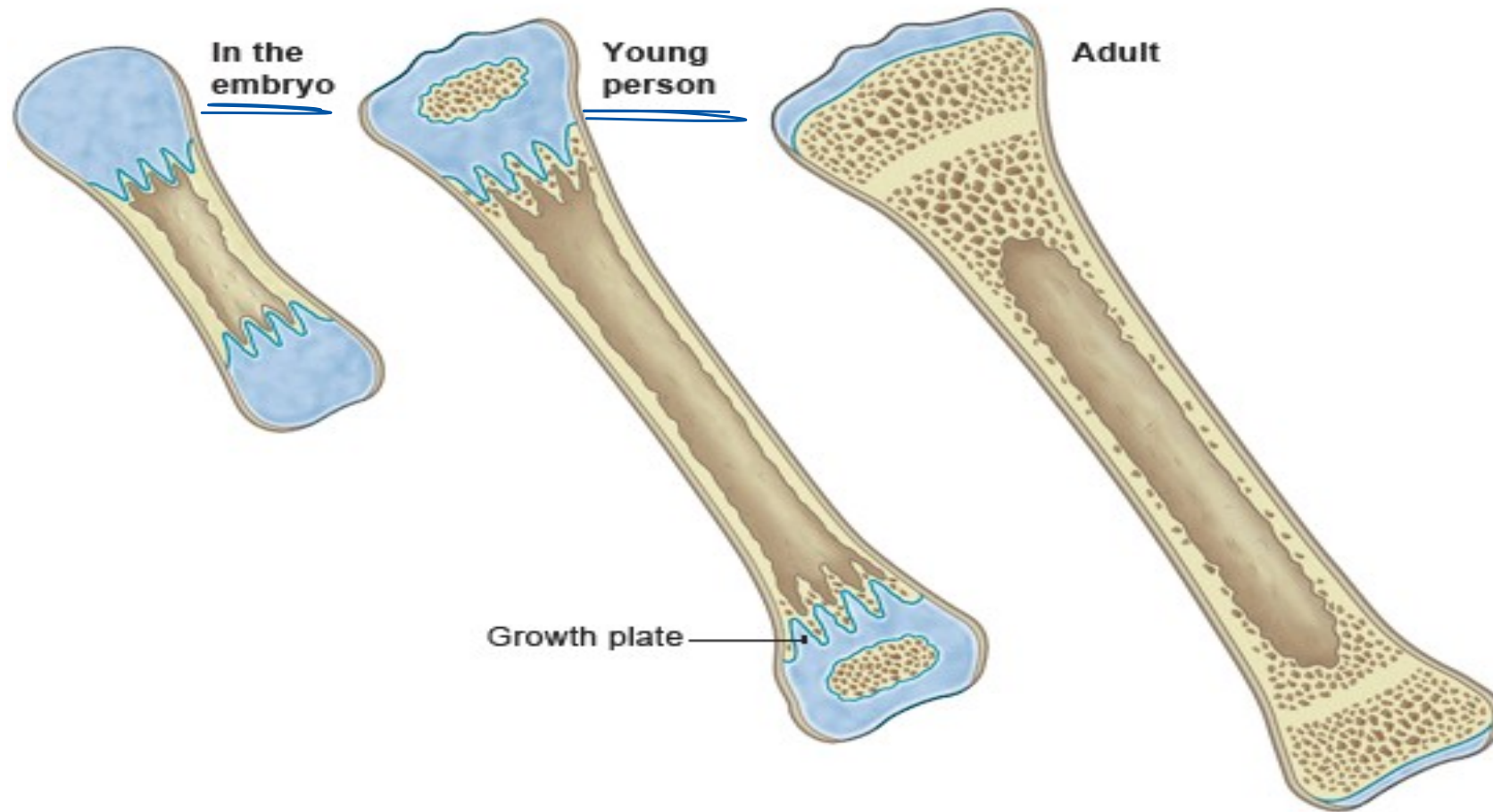
- Different bones have different time of closure of their epiphyses. This is of *medicolegal importance* to determine the bone age of a person.

بغير الطب الشرعي
حيث كل bone يسكن
او Epiphysis على عمره
فيمكنه استخدام ال Bone
لمعرفة عمر الجثة.

في Osteoporosis
او Osteoclast آتت
Compact bone



INCREASE IN LENGTH OF LONG BONE



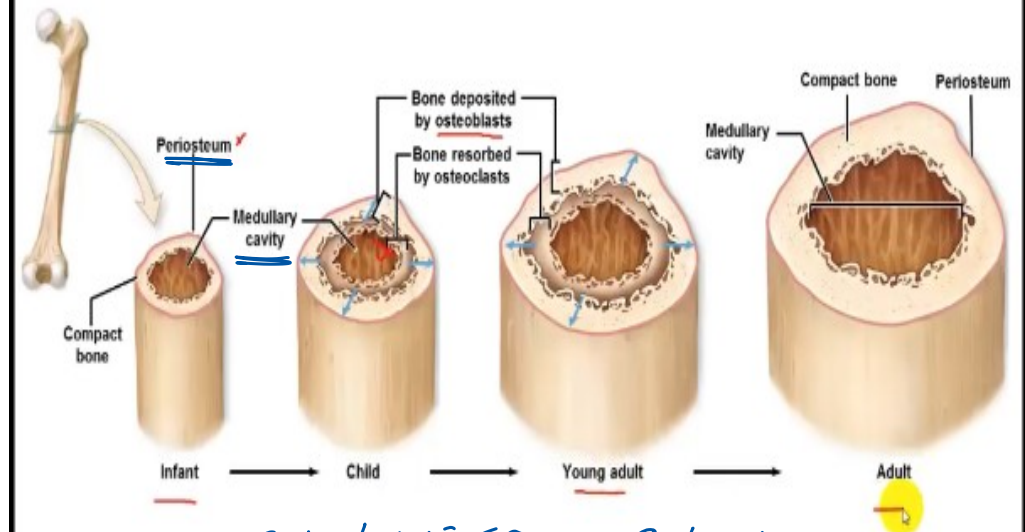
II-INCREASE IN WIDTH OF LONG BONES

- It occurs by two parallel mechanisms:
 - **Subperiosteal bone formation:** by osteoblasts from outside, it occurs by an appositional intramembranous ossification.
 - **Bone resorption by osteoclast:** at the endosteum from inside, to enlarge the marrow cavity.

- يزيد عرض ال Bone لبرا .

- يتجه ال marrow ل Adult اعرض
من الطنف ، طبيعي لأنه بيت Blood supply
التر لظفه الا عرض .

← فال Osteoclast يتاكل العظم اليه ع جهة ال Endosteum
عشانه تزود ال Bone marrow ل Cavity لجهه الله .



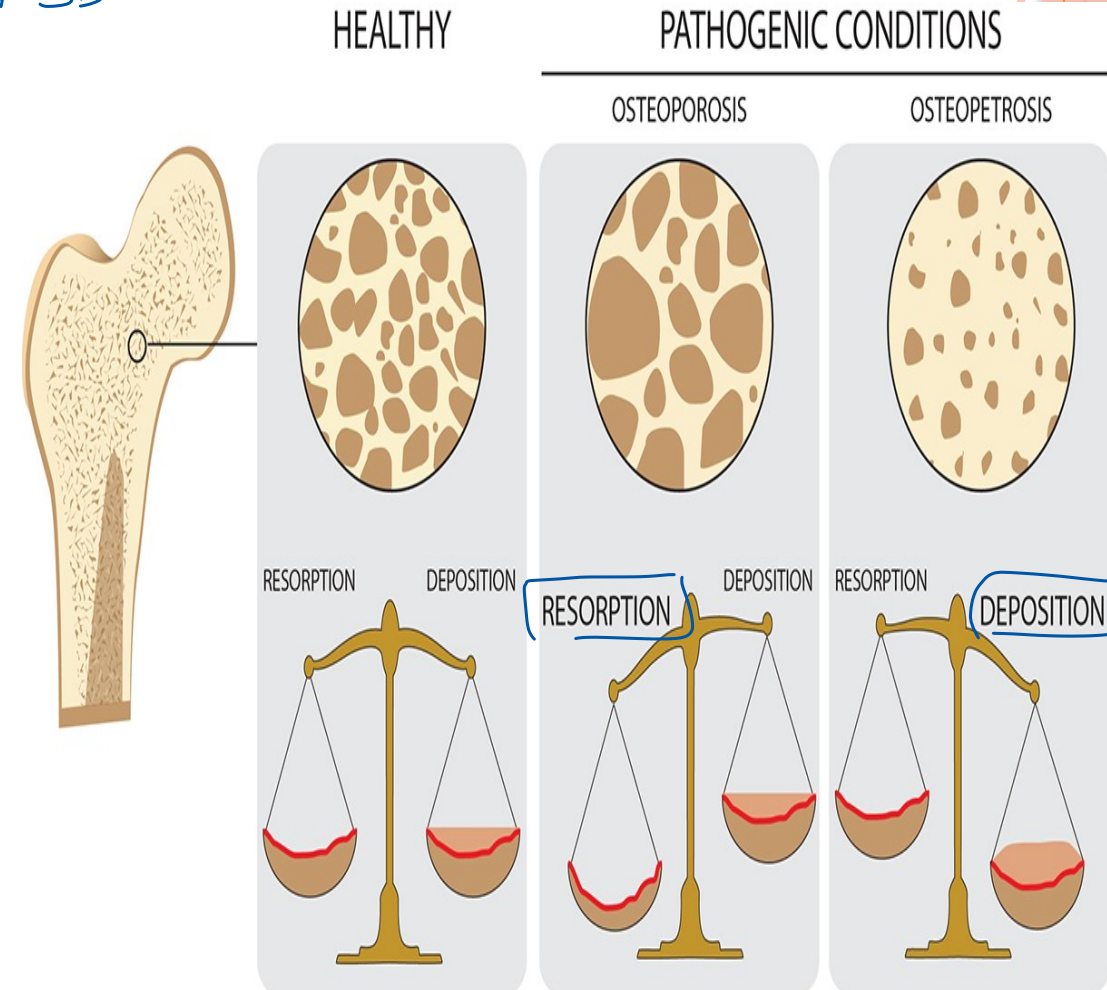
Osteopetrosis ← مشكلة في Osteoclast
له عتباره هيك لغير معهم pancytopenia

III-BONE REMODELING

عنه Osteoblast قطن bone جديد
وال Osteoclast تخلصه من القديم

- It is a continuous process that occurs throughout life.
- It involves **bone resorption** and **bone formation**.
- During childhood: **bone formation** exceeds bone resorption, ✓
- In adults: bone formation is balanced with bone resorption. ✓

مع ال age بيزيد ال resorption

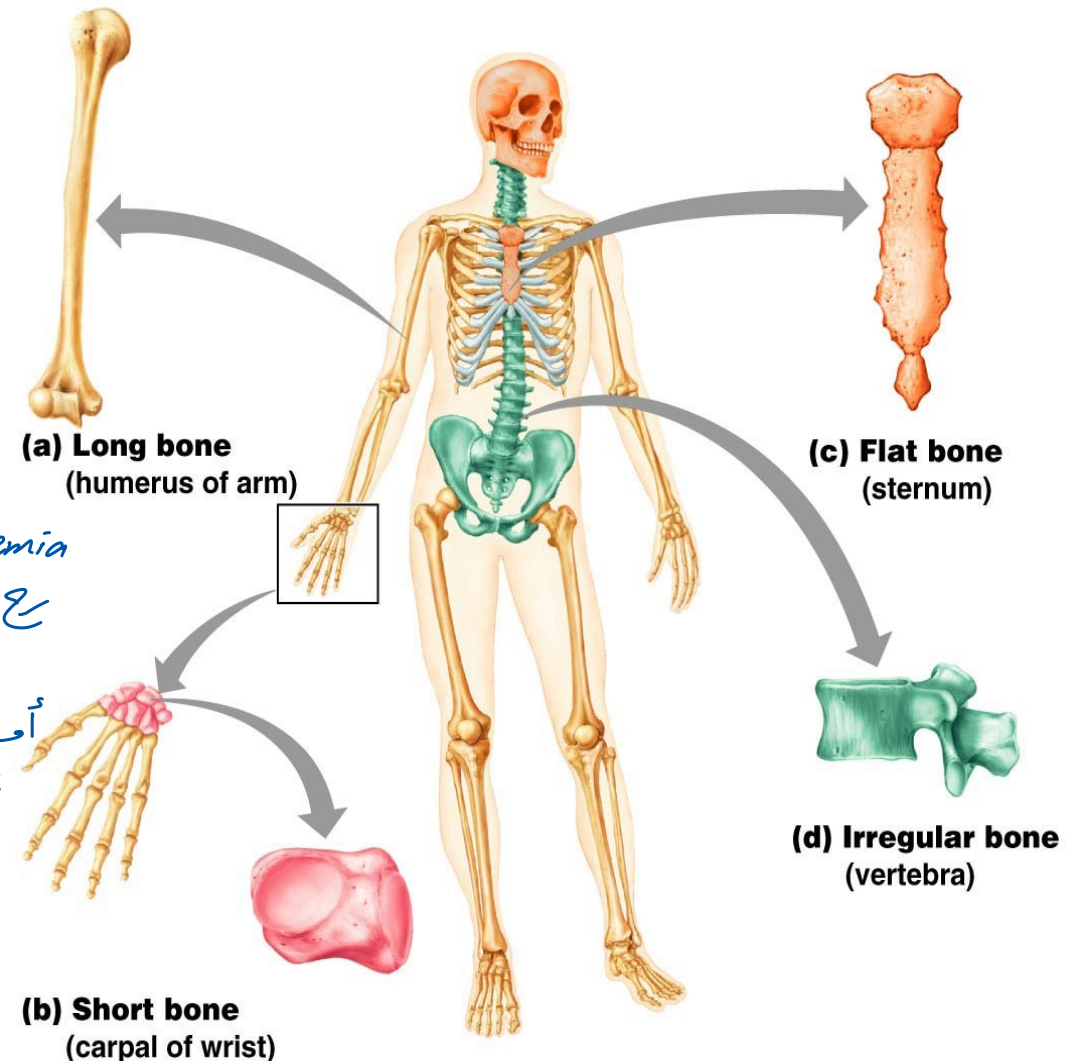


BONE REMODELING

- Bone remodeling is important for:

- Replacement of immature bone woven by mature lamellar bone. ✓
- Renewal of bone (resorption of old osteons and formation of new ones). ✓
- Maintenance of plasma calcium homeostasis. ✓
- Maintenance of bone shape to adapt mechanical stresses (weight and posture). ✓
- Repair of fracture. ✓

عنه مثل لو عندي
Osteoclast ال hypocalcemia
ح شغل عنده تطلع Ca^{+2}
لدم. تحت تأثير PTH
أوجهار Hypocalcemia
فال Osteoblast تشغل.



PTH ، غدد كلى ، [C cells] parafollicular cell ، Thyroid ، افما تطلع calcitonin بطلع من
Blood حبيز تغير لـ activity لـ Osteoblast
زود الـ

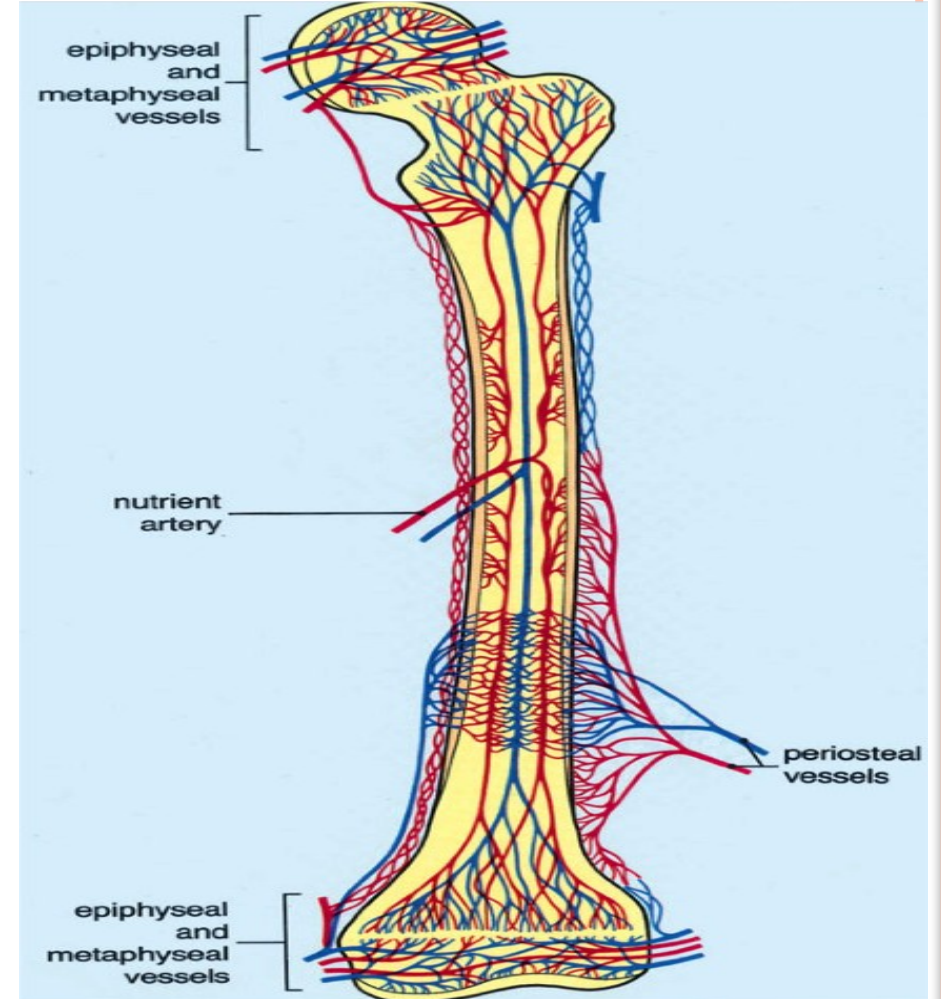
وبقلل Ca^{+2} absorption من kidney
GIT

REPAIR OF BONE FRACTURE

لوما جيبست اكسر ، ليجر Healing بـ بـ بـ Disorganized

- Bone has an excellent capacity for repair because:

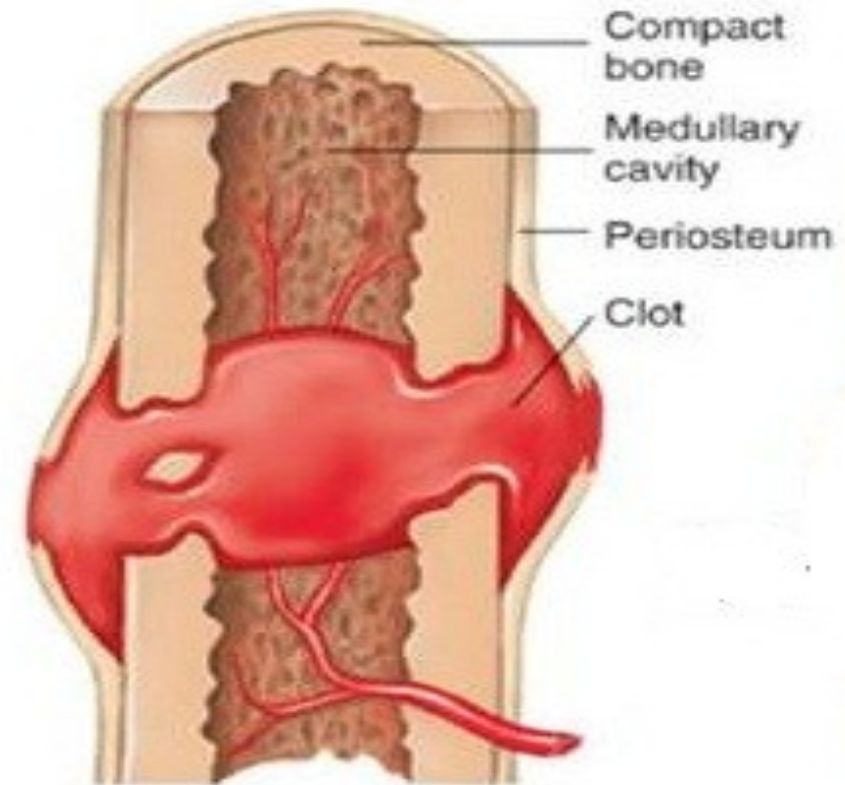
- 1- It contains osteoprogenitor cells in the periosteum and endosteum. ✓
- 2- It has an excellent blood supply. ✓



PHASES OF FRACTURE HEALING

1- CLOT FORMATION

- When a bone is fractured → the blood vessels are disrupted ~~hemorrhage~~ and the bone cells adjoining the fracture site die. ✓
- A *blood clot* is formed to stop the hemorrhage. ✓



Clot formation

2- CALLUS FORMATION (SOFT CALLUS)

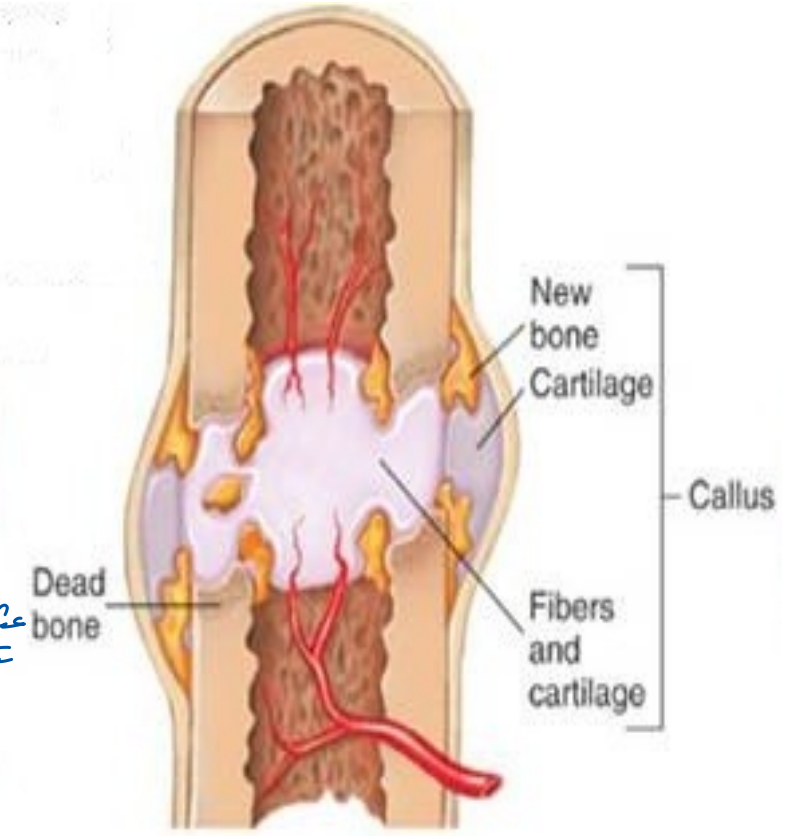
لے زخم اسے ال Healing ل tissue معینہ بیگہ ب granulation
 [Fibrosis لبرعہ طرہ Cartilage ل Healing ل Bone بیگہ بال Callus formation]

- The blood clot is removed by macrophages and adjacent bone matrix is resorbed by osteoclasts. ✓
- The periosteum and endosteum at the site of fracture show **enhanced activity of their osteoprogenitor cells**, which under this conditions of low oxygen tension, form a soft callus of fibro-cartilage like tissue that surrounds the fracture and penetrates between its ends. ✓

عشانہ ال O_2 low
 ماح لبرعہ
 Intramembranous
 Ossification
 واسه تفرک
 Osteoblast → osteocyte

لغہ Cartilage

عشانہ تفرک تفرک
 Endochondral



Callus formation

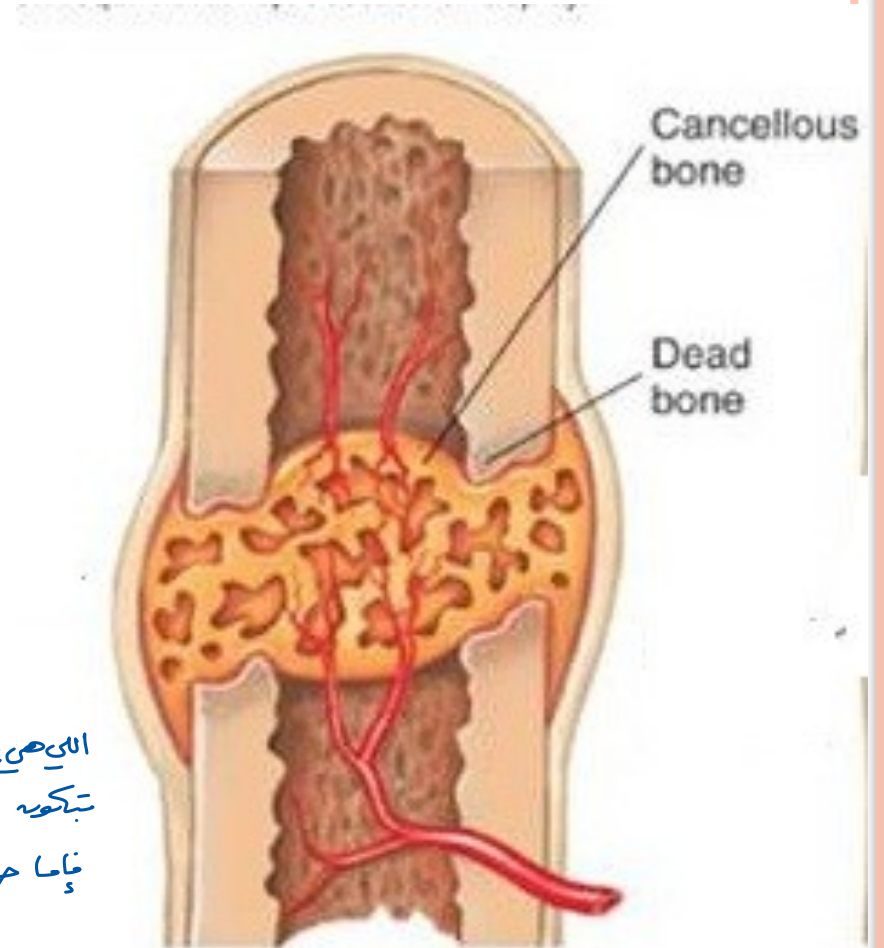
3- CALLUS OSSIFICATION (HARD CALLUS)

- Primary bone formation is initiated by:

1- Intramembranous ossification: through the osteoprogenitor cells in the periosteum. → *لأنه فيه Stem cell عند الأطراف*

2- Intracartilaginous ossification. *من الداخل
تبدأ قطع الخلايا جديدة*

- Thus, histological examination of a repairing fractured bone reveals areas of cartilage together with areas of intramembranous and endochondral ossification. ✓
- As repair proceeds a hard bone callus is formed. It is made up of irregular bone trabeculae of primary bone that unite the extremities of the fractured bone. *التي هي primary bone
تكون Irregular
فيما هي regular و هي Spongy bone أو هي Osteon [compact bone]*



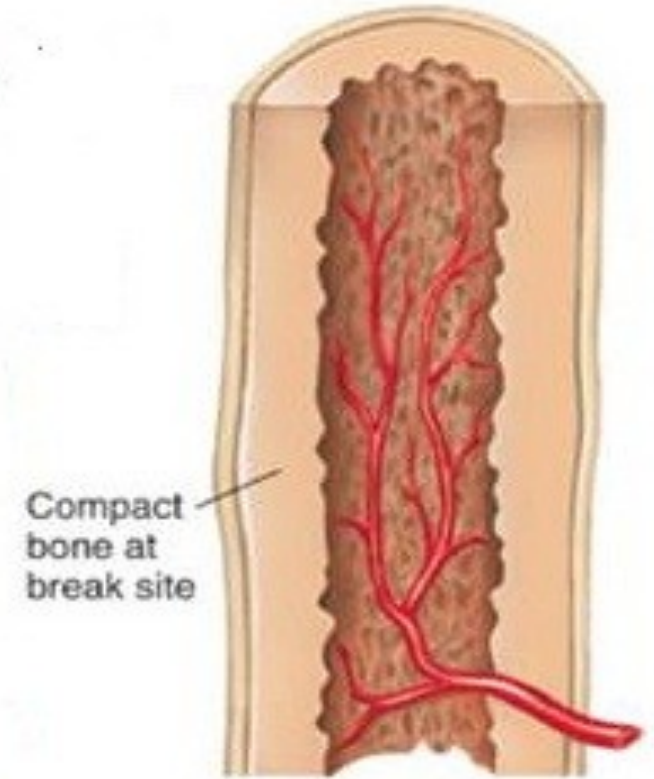
Callus ossification

4- BONE REMODELING

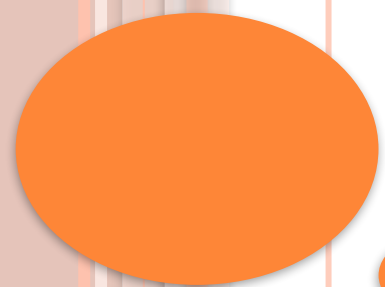
تَرميم لـ Shape يَمنى.

- The primary bone of the callus is gradually **resorbed and replaced** by secondary bone. ✓
- Further **remodeling** restores the original bone structure and contour.

* تَرميم حَكِينَا لَدَرم اَظ Cast عَشاء لَيمِر اَظ Healing حَظ.



Bone remodeling



THANK YOU

