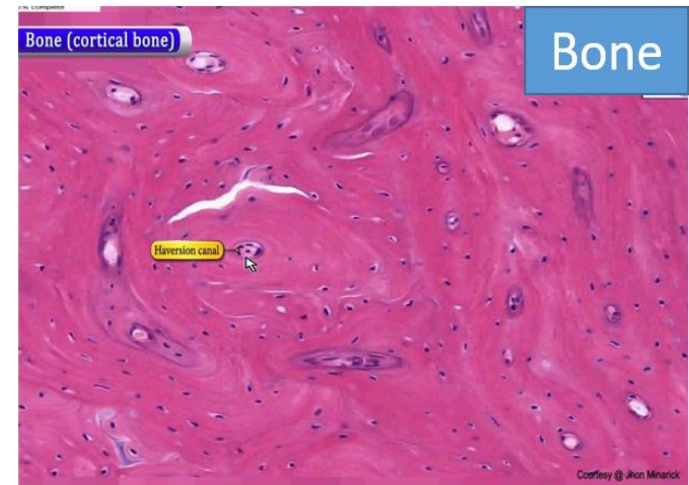
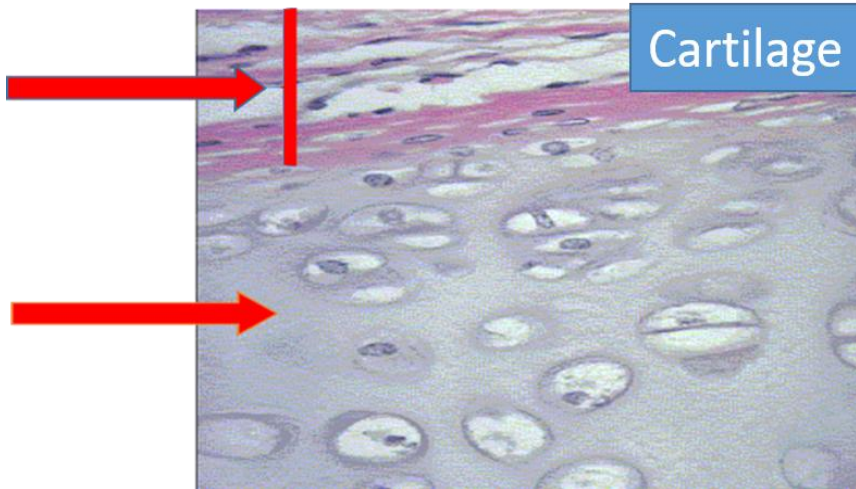
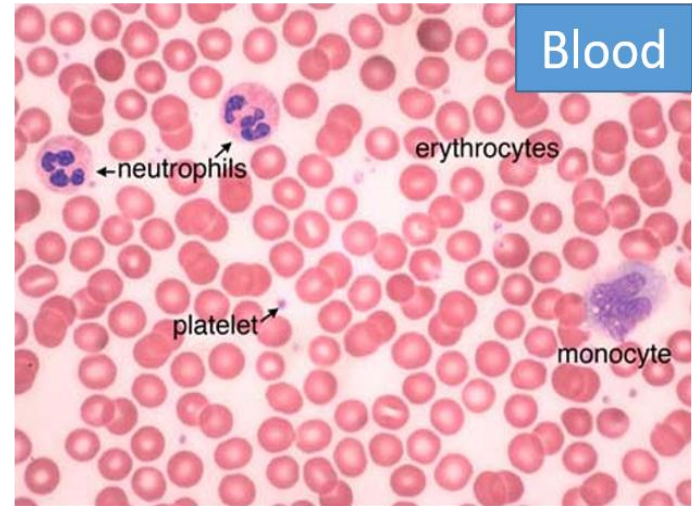


Modified CT



Common characteristics of CT:

- few in number
- widely-separated
- different type with different function.

السبب
→ extracellular matrix → ground substance
↳ fiber
"abundant non-living structure"

1. **Several types of cells** with different function , widely-separated by extracellular matrix .
2. **Extracellular matrix: abundant non-living extracellular matrix**, which separates the living cells = (fibers +ground substance)
3. **Variable degrees of vascularity**: some types of connective tissue have a rich supply of blood vessels, other is poorly-vascularized e.g. dense CT and cartilage is avascular.
4. **Origin**: all types of connective tissues arise from **mesoderm**



Classification of C.T. Depend on ground substance

Jelly like ground substance

Connective tissue proper:

it includes:

- Loose areolar connective tissue.
- Dense irregular connective tissue
- Dense regular connective tissue.
- Elastic connective tissue.
- Reticular connective tissue.
- Adipose connective tissue.
- Muroid connective

Modified types

- ❖ Blood = fluid
- ❖ Cartilage = firm
- ❖ Bone = hard

زینت پھل ہے؟

Supporting connective tissue

➤ Cartilage and bone are modified CT in which ground substance is hardened to provide support for soft tissue

"firm"

➤ Cartilage and bone form the skeleton of the body

نوعين فقط من الخلايا

- Chondro blast
- chondro cyte

CARTILAGE

يتكون الخلايا موجودة داخل space ليس Lacunae وتسمى هذه الخلايا "cell nest"

كيف يحصل في nutrition وهو فاشي blood vessels وبرضو

فما يقدر يحصل عليه من خلال diffusion
ground substance أصبحت firm ?

بالحصول في nutrition من خلال perichondrium

«عبارته كذا» cover // sheath يحيط بـ cartilage

Characteristic features of cartilage

- ❑ Modified connective tissue with firm ground substance & flexible
- ❑ Cartilage cells are isolated in lacunae (small cavities in the ground substance contain cells)
- ❑ Extracellular matrix (ground substance +fibers)
- ❑ **Avascular** (nutrients diffuse through matrix from surrounding CT or from synovial fluid in joint cavities)
- ❑ Cartilage is usually covered by **perichondrium** which is rich in blood vessels

outer fibers layer

inner cellular layer

الطبقتين
لويبة قديم
blood vessel

- ❑ Cartilage has **No lymphatic or nerves**

PERICHONDRIUM

❑ Ensheathes the cartilage

❑ Present in **most** of the hyaline, elastic cartilage, **absent** in fibrocartilage

❑ Fibro-cellular membrane that consists of two layers :

➤ **Outer fibrous** layer houses the blood vessels that nourish chondrocytes

➤ **Inner vascular & cellular** layer (chondrogenic layer) this layer contains chondroblasts which are capable of forming new cartilage

Function :

1. It is responsible for nourishment of chondrocytes
2. It is responsible for growth

(increases growth of the cartilage)

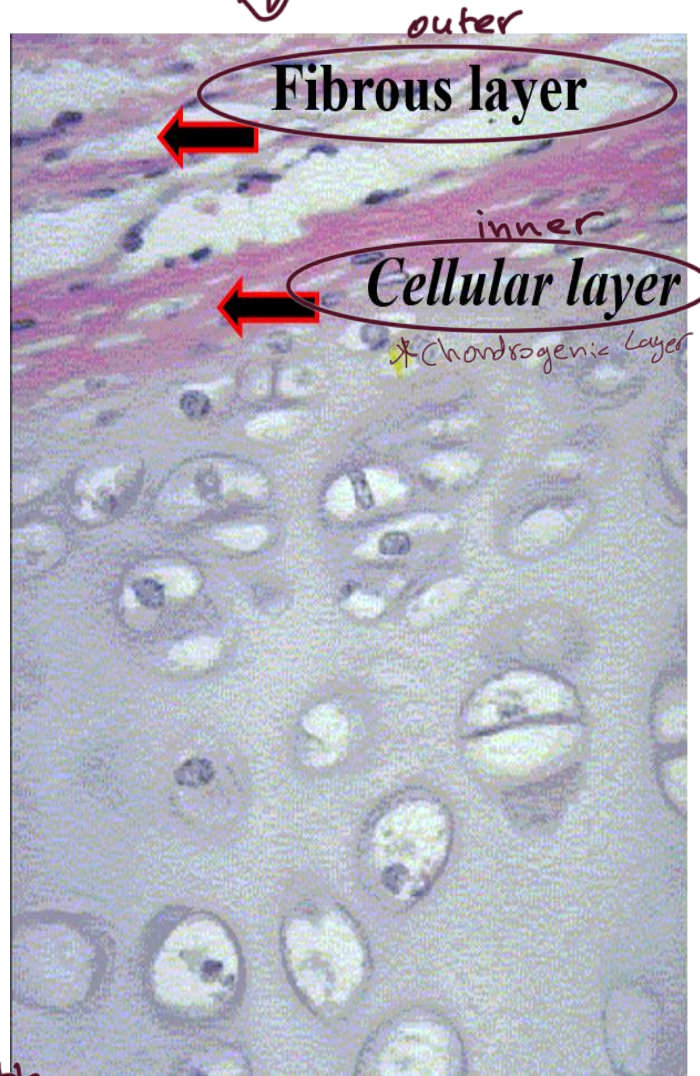
حامل وتحتل
حويصود بي
ear - external meatus

ليقتري يوجب جزء من من فتحة هذا الفتحة
وهو
الذي
دفع
جوانبه
ياخذ انفسه
من
synovial fluid

↳ never covered with perichondrium.

nutrition

ما بتظلم لينة
فوجود راسيا باهتو من
الدمكان التي يوجبونها



Structure of cartilage



Extracellular matrix

1. Ground substance

➤ Glycosaminoglycane e.g. (chondroitin sulfates & keratan sulfate) bound to hyaluronic acid

➤ Proteoglycans & glycoprotein

➤ Adhesive glycoprotein
e.g. **chondronectin**

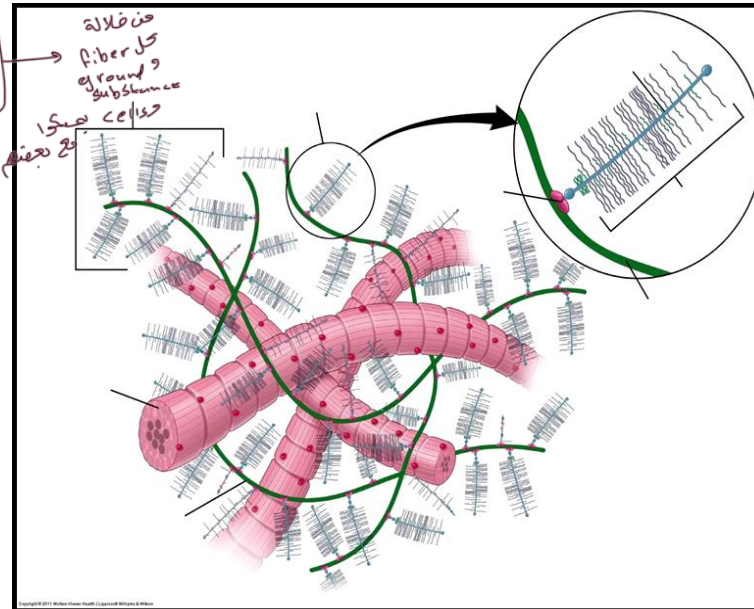
2. Fibers

- ❖ Collagen type II
- ❖ Collagen type I
- ❖ Elastic fibers

[no reticular fiber
"by I&I" in cartilage]

*polysaccharides
Cherin*

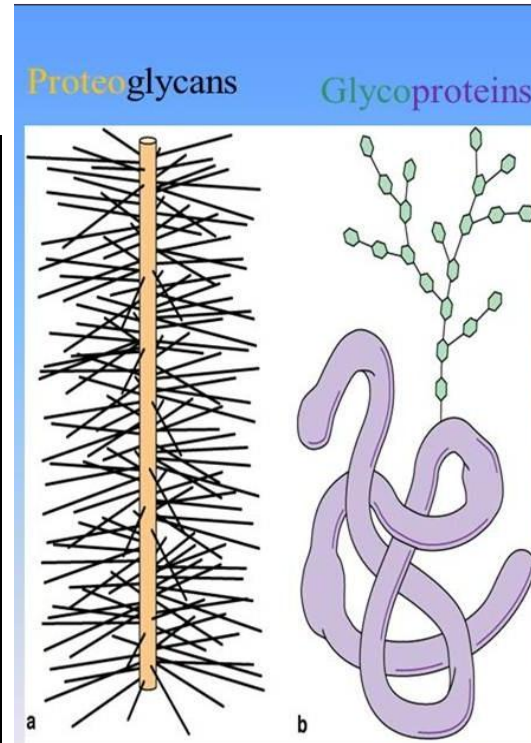
heparin sulfato



Cartilage cells

❑ Chondroblasts

❑ Chondrocytes



↓ Extracellular MATRIX ↓

Ground substance

It is responsible for firmness & flexibility of cartilage

❖ Produced by cartilage cells

❖ Basophilic → *نسبة زهود*
heparin sulfat

➤ Water 60-70 % → *هذا الكي ببطيئة حيزه انه يتحلل*
↳ Pressure.

➤ Glycosaminoglycans (chondroitin sulfates & keratan sulfate)
bound to hyaluronic acid
heparin sulfates

➤ Proteoglycans & glycoprotein

➤ Adhesive glycoprotein e.g. **chondronectin**

Fibers

➤ Collagen type II

➤ Collagen type I

➤ Elastic fibers

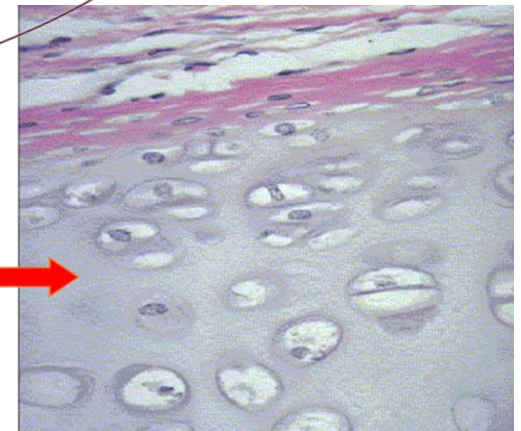
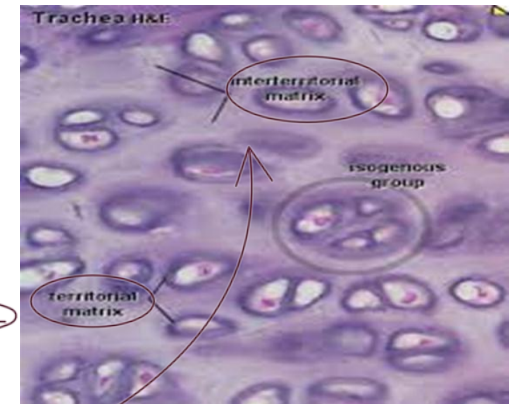
Territorial matrix

(dense ground substant around lacuna !!)

surrounds lacuna (space in which chondrocyte present)

➤ **Interterritorial matrix**

Between the lacunae



Cells of cartilage

1. CHONDROBLAST

→ highly active cell

Origin: cellular layer of perichondrium *"chondrogenic layer"*

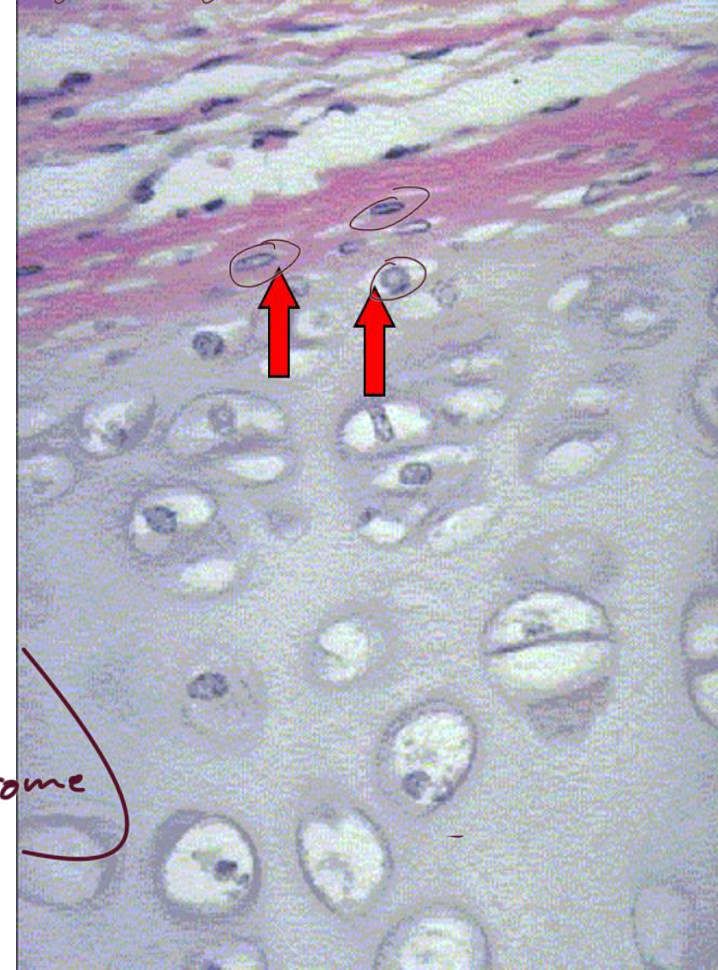
Site: Lines border between perichondrium and *matrix of the cartilage*

Function:

➤ Synthetically active, produce ground substance and fibers = Synthesize type II collagen, proteoglycans and chondronectin.

(after producing it, it gets stuck in it to become chondrocyte

➤ Progenitor of chondrocytes when reside in a space called the **lacuna**
----- **chondrocytes**



2. CHONDROCYTE

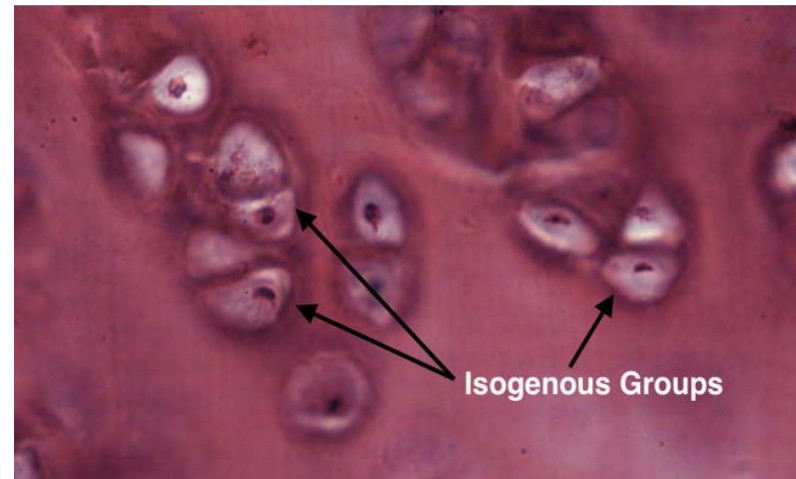
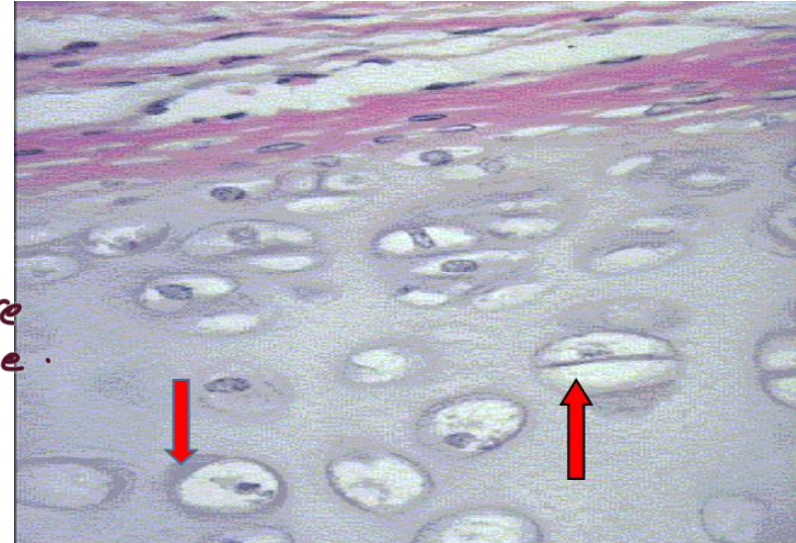
Mature cartilage cell

Origin : From chondroblast

Site: Reside in a space called the **lacuna** form isogenous cell group

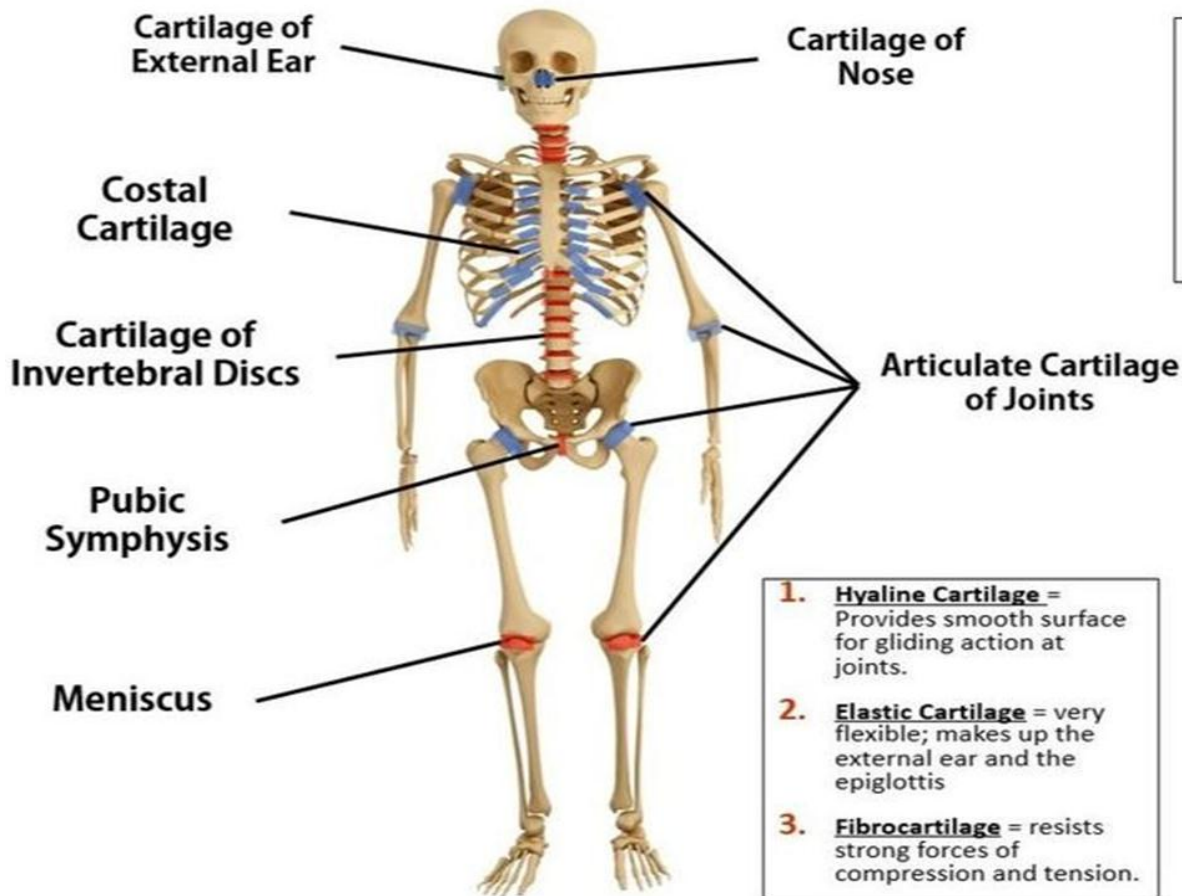
called (**Cell nest**) → *lacuna contains more than one chondrocyte.*

Function : Maintain the extracellular matrix



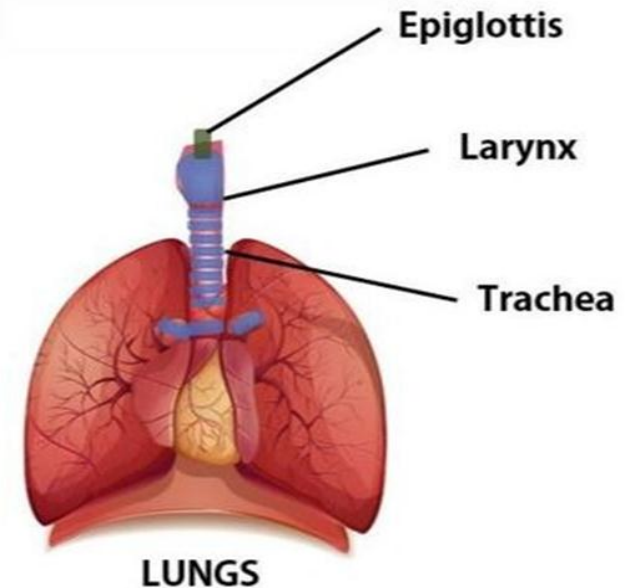
TYPES OF CARTILAGE

- ❑ Hyaline cartilage
- ❑ Elastic cartilage
- ❑ White fibrocartilage



Cartilage Locations Within the Skeleton

- Hyaline Cartilage
- Fibrocartilage
- Elastic Cartilage



between sternum and ribs.

HYALINE CARTILAGE

Adam's Apple
برجوفينا

❑ **Sites:** nasal septum (larynx) Tracheal rings, + 2 main Bronchi
costal cartilage & articular surfaces of joints

❑ **Perichondrium :** may or may not present

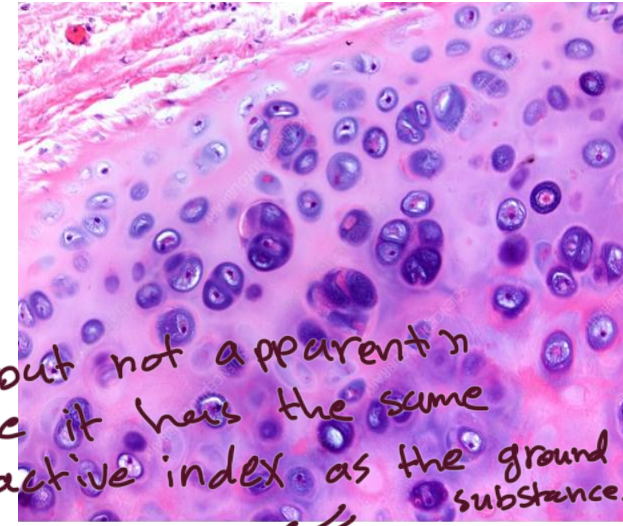
❑ **Cartilage cells:** Present singly or in groups of 2 -8 cells inside lacunae called cell nest
[Larg " few in number]

❑ **Cartilage fibers:** Collagen type II

❑ **Ground substance:** Homogenous, clearly Pale basophilic with **glassy** appearance

❑ **Functions:** → abundant

- supportive
- bone formation in fetal skeleton
- Epiphyseal bone growth
- Provide smooth articulation for joints

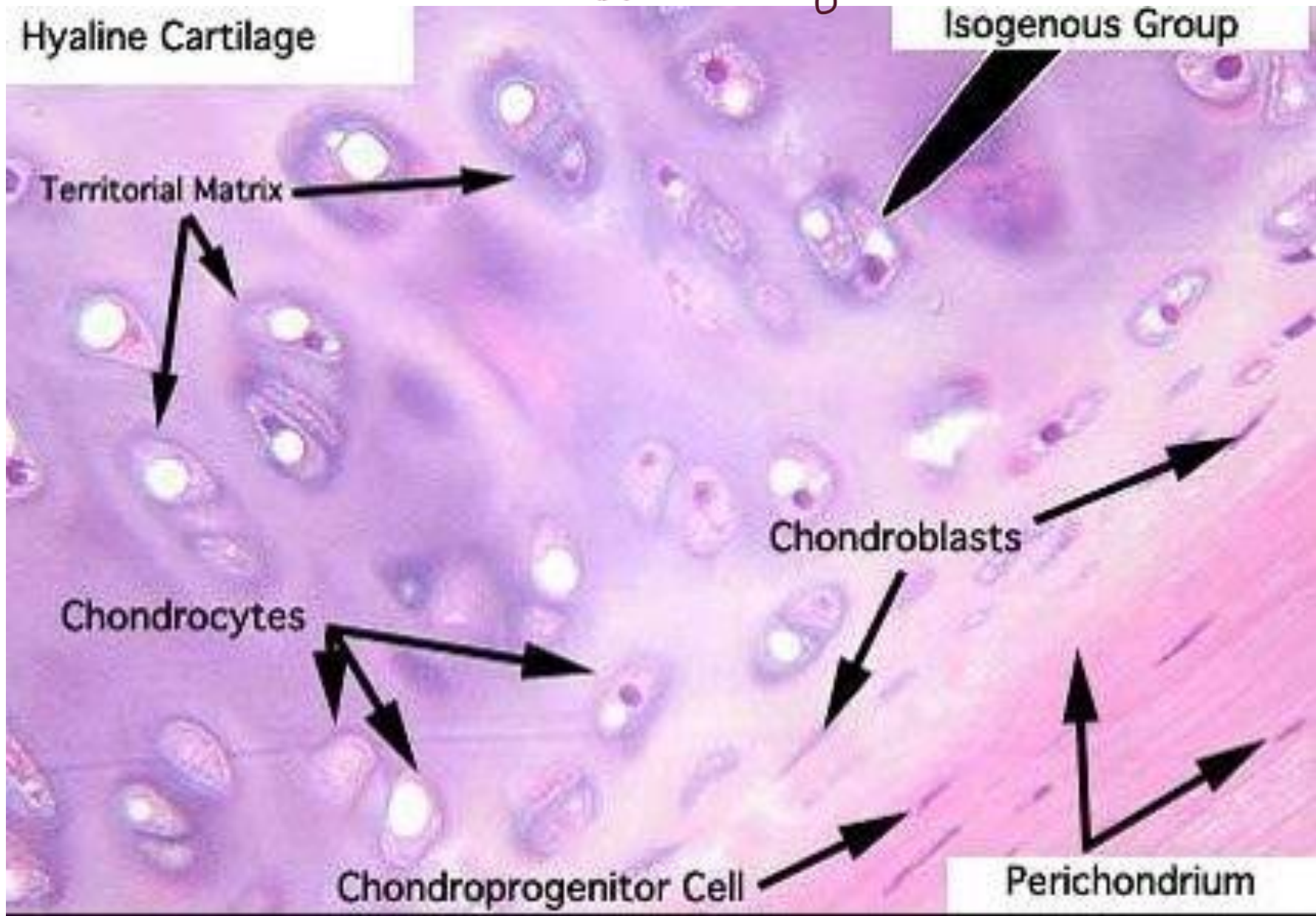


fibers ground substance
بعضها بنحلي

abundant ground substance

Hyaline Cartilage

Isogenous Group



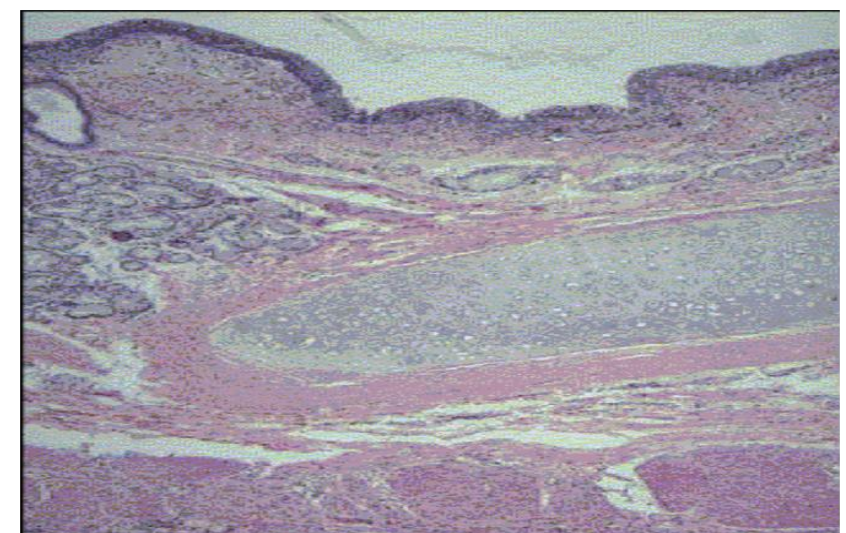
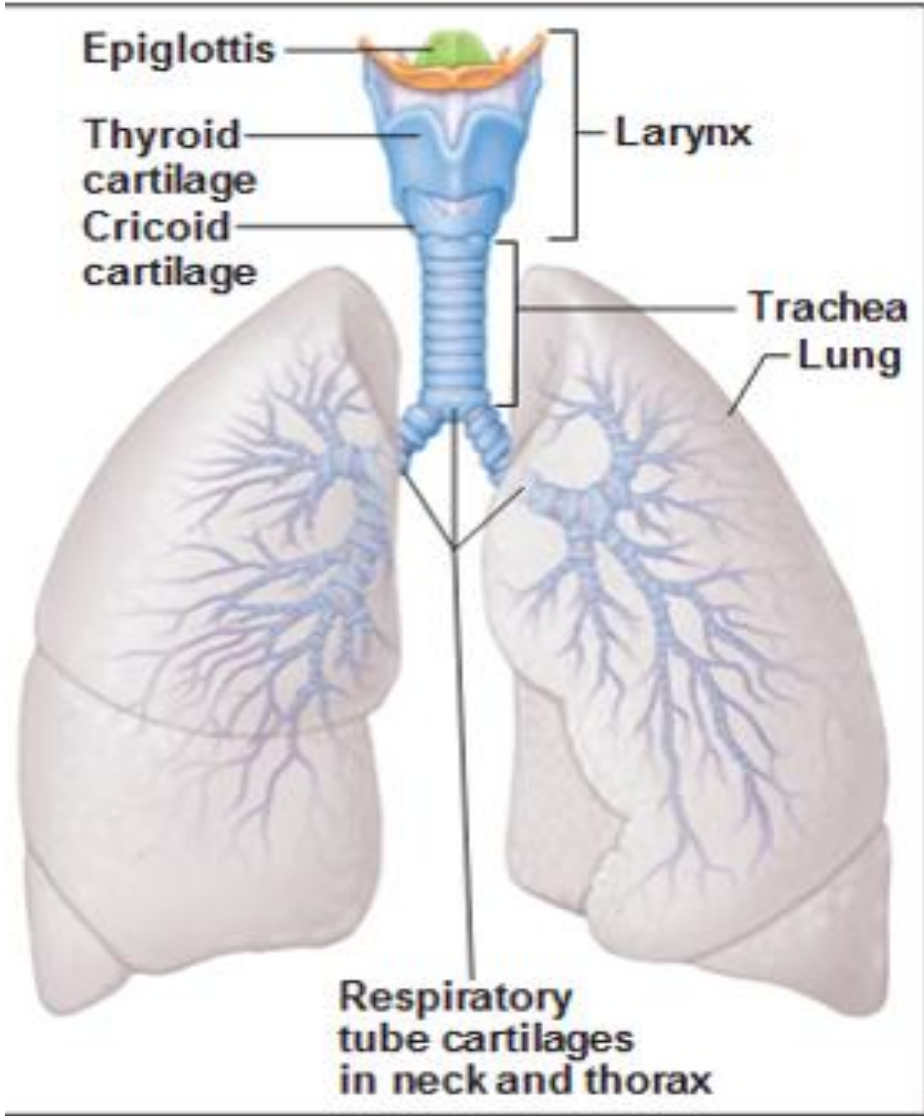
Territorial Matrix

Chondrocytes

Chondroprogenitor Cell

Chondroblasts

Perichondrium



ELASTIC CARTILAGE

❑ **Sites:** Auricle, ext. auditory meatus, auditory tube, epiglottis

ear

❑ **Perichondrium :** always present

❑ **Cartilage cells:** small , more numerous, packed more closely

in groups of 1-3 cells inside lacunae

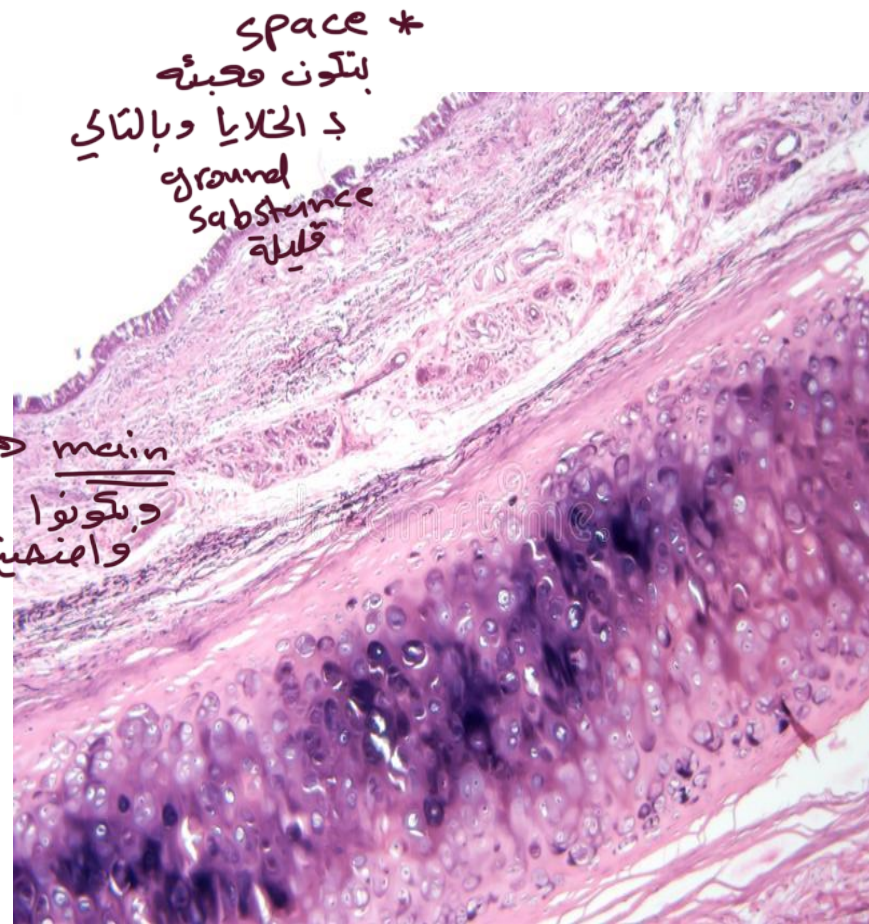
❑ **Ground substance: (little)**

❑ **Cartilage fibers :** Rich in elastic fibers + collagen type II

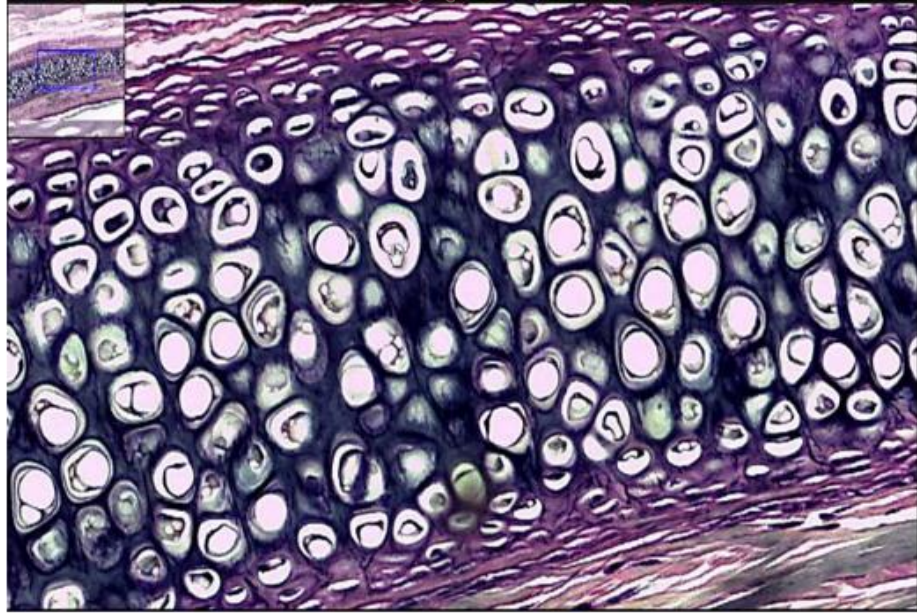
❑ Elastic fibers stain with orcein & VVG // H&E

❑ **Functions:** supportive with resilience

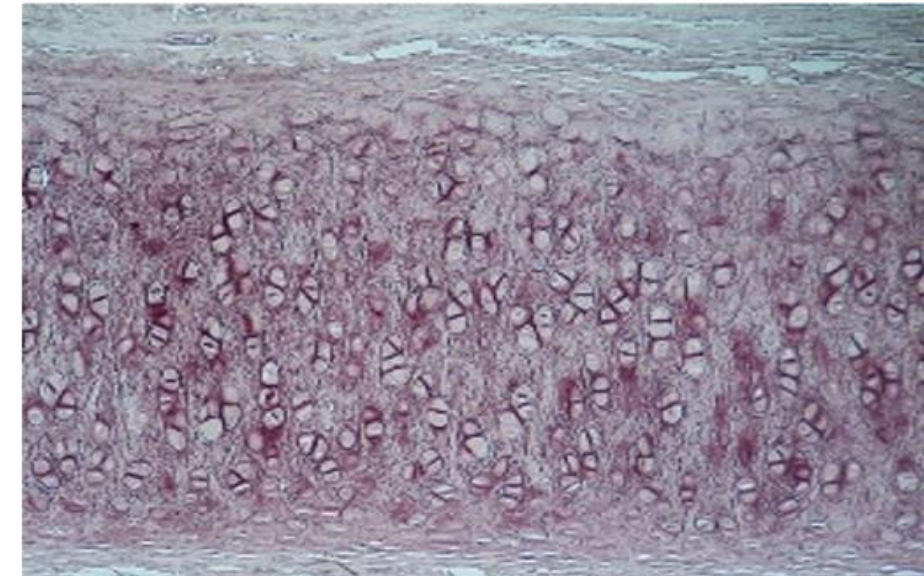
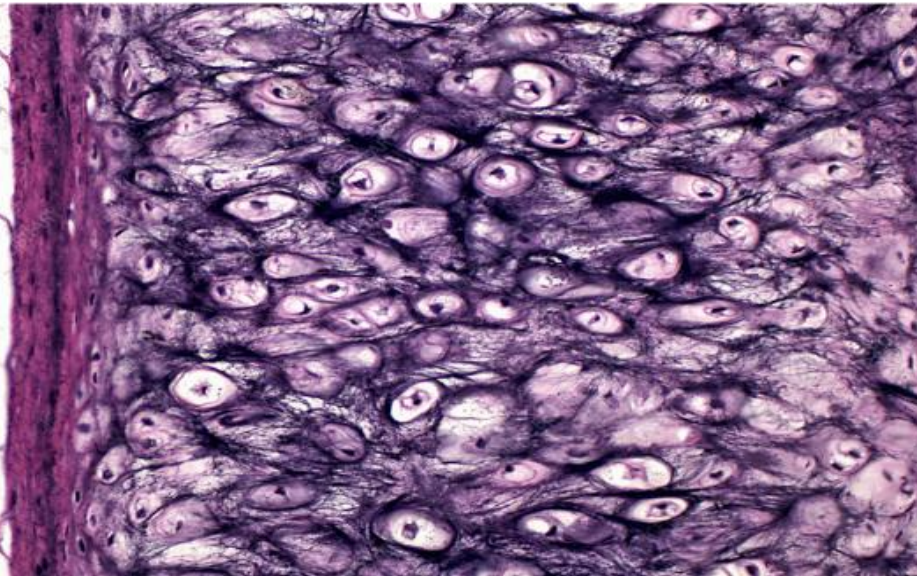
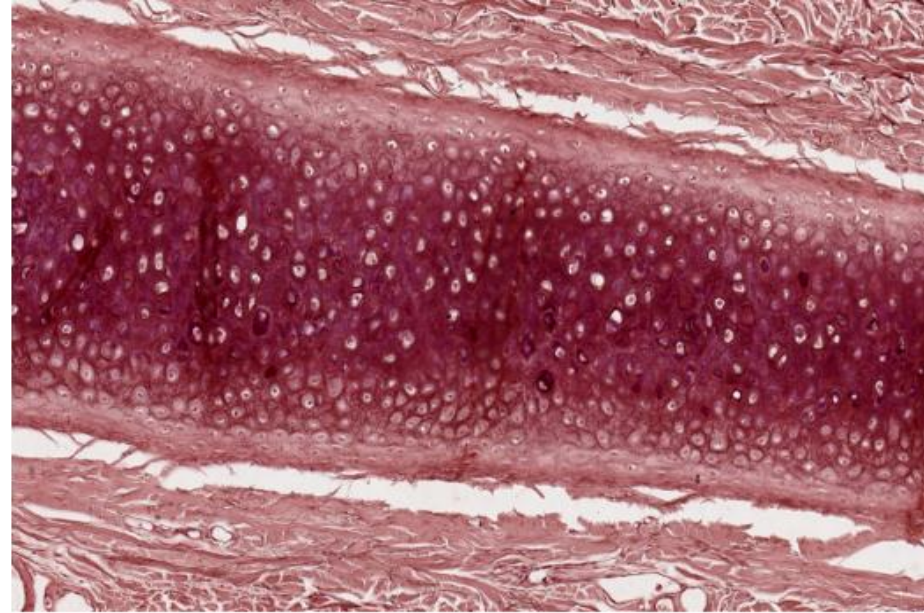
د مرونة



VVG stain → "dark violets"
"black"



Orcein stain
brick red



White FIBROCARILAGE ^m Collagen type I

❑ **Sites:** intervertebral discs, pubic symphysis, sternoclavicular joint, articular disc of Tempromandibular joint.

❑ **Perichondrium :** Never covered

❑ **Cartilage cells:** fewer, smaller, scattered singly or in rows

1-2 cells inside lacunae

❑ **Ground substance:** little

❑ **Cartilage fibers:** mainly collagen type I & few collagen II

❑ **Functions:** supportive with tensile strength

← عبارة عن
حزوة من

الذلياف
تظهر باللون
الذبيح

على شكل

- tendon
- ligament

* حو عدد

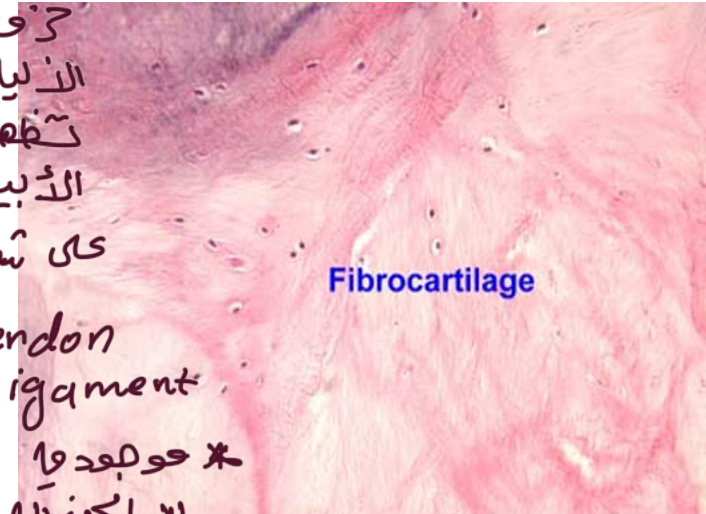
لما كان الى

بمحتاج فيها

تحل الضغط

السنة من ذنه

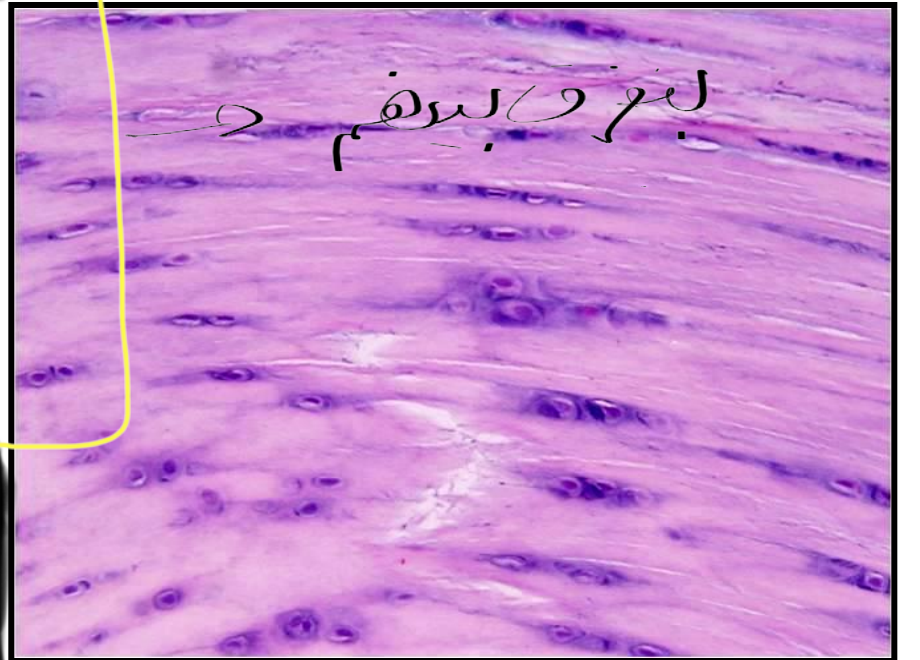
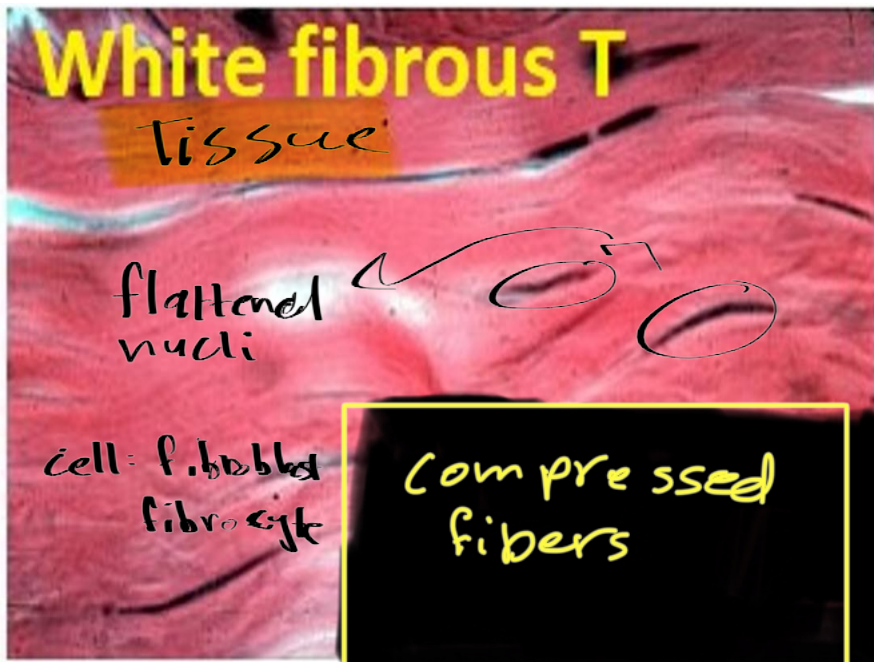
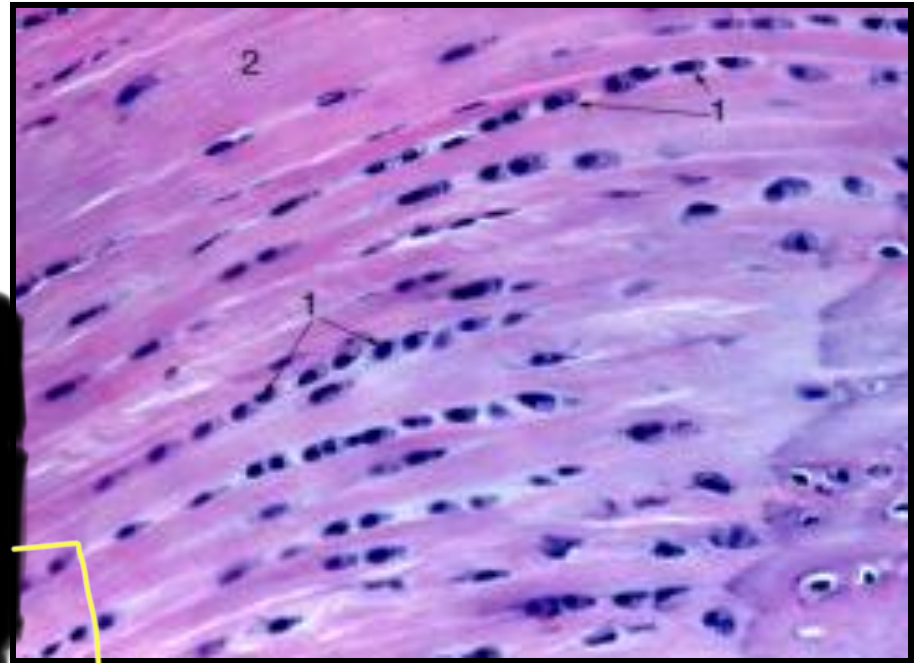
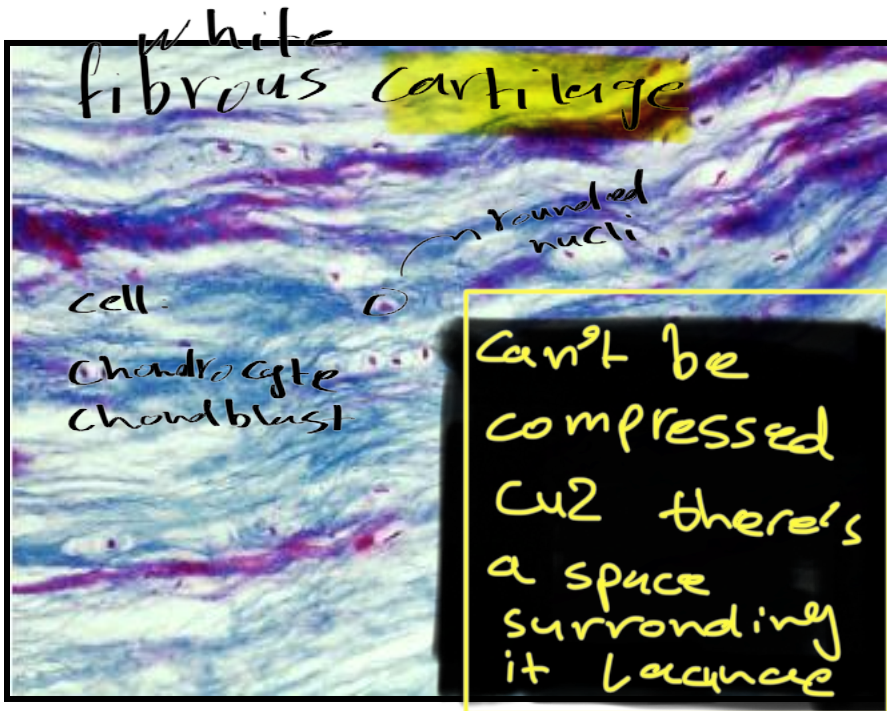
صعب ينضج



Space *
يكون

عينة fiber وبارتاي

ground substance
قليل



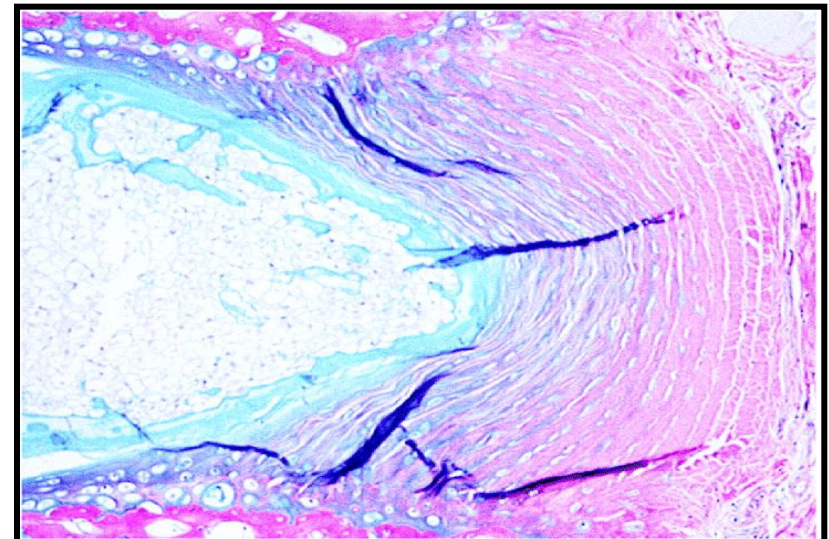
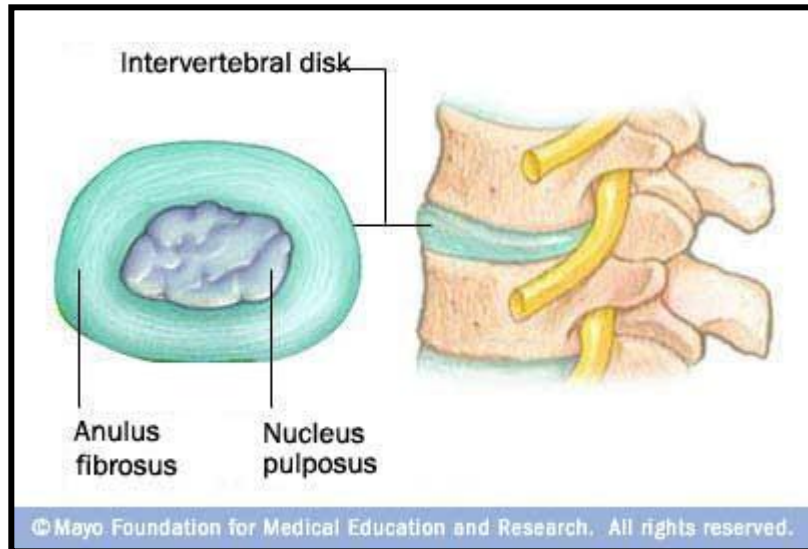
Intervertebral disc 8-

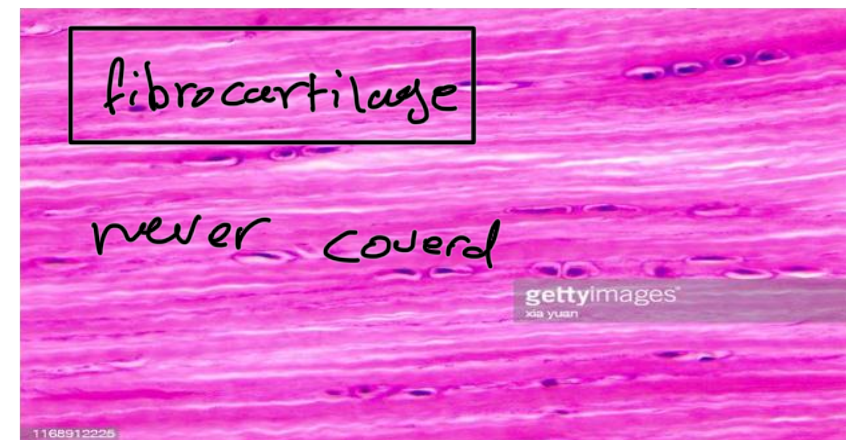
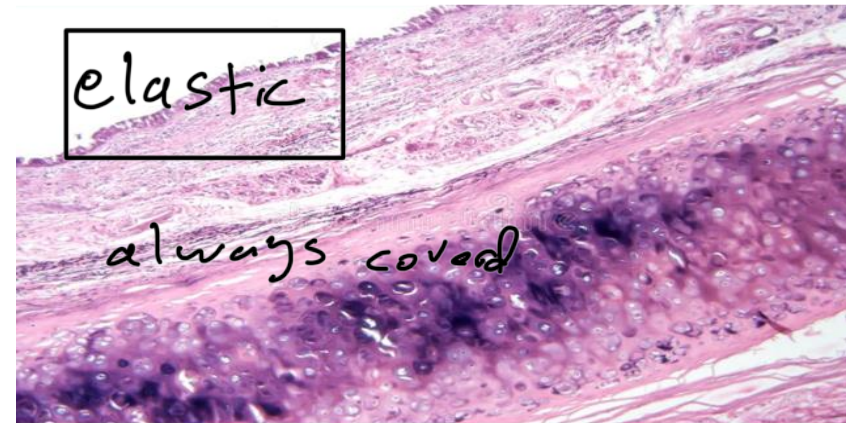
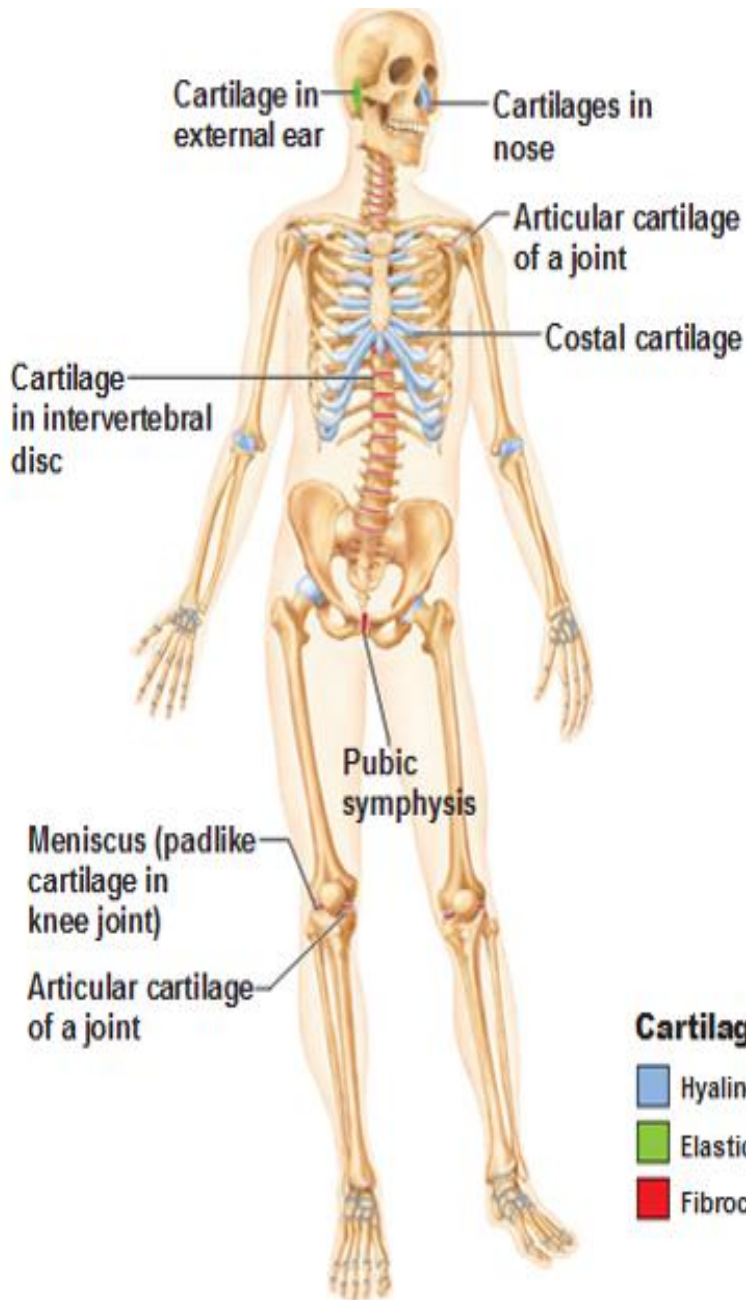
consist of fibrocartilage plates between the vertebrae and act as mechanical shock absorbers.

In sections they are seen to be formed of two components:

① **annulus fibrosus**, which is the outer region consisting of orderly concentric arrangements of cells and matrix dominated by type I collagen = white fibrocartilage

② **nucleus pulposus** (large vacuolated cells)





CARTILAGE GROWTH

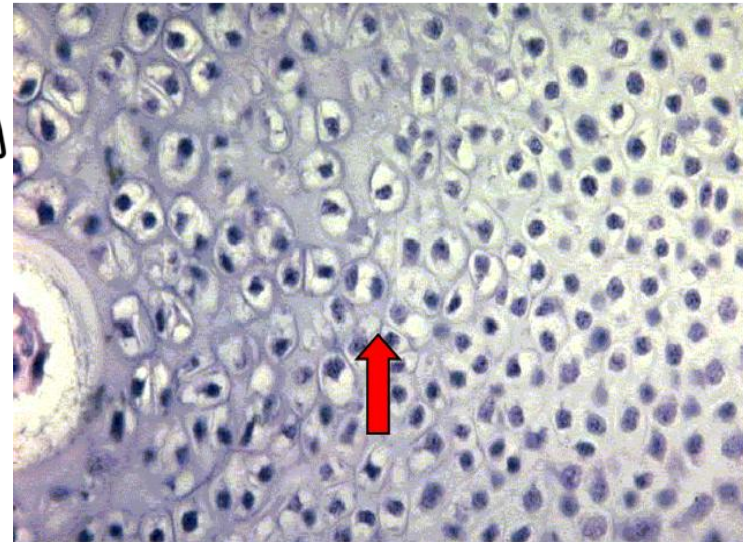
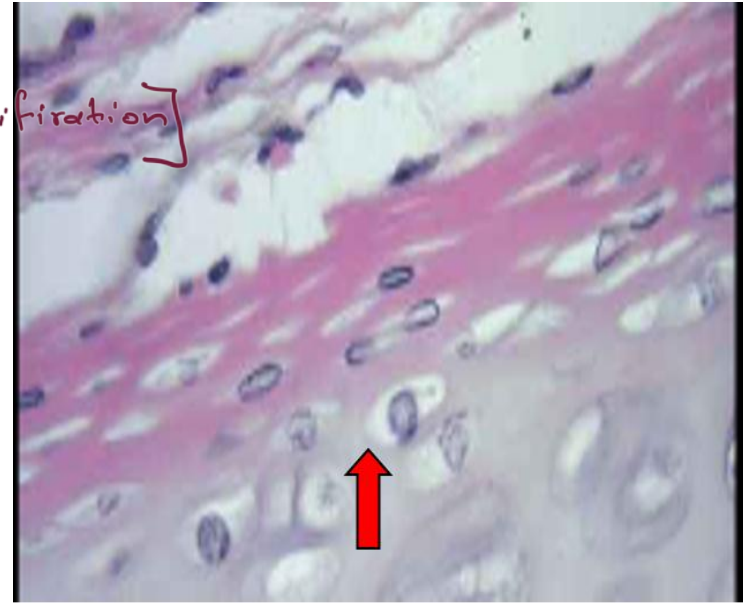
□ **Appositional** → [peripheral growth/proliferation]

Addition of new cartilage over the surface of existing cartilage.

□ **Interstitial** → increasing the number of cells in lacunae.

Newly formed cartilage grows by multiplication of cells throughout its substance.

* cartilage can grow but can't heal or repair in case of injury because → it's avascular





BONE

Functions of Bone:

- Allows body to move by giving attachment to different body muscles
- Supports soft tissues
- Protects vital organs (cranium, thoracic cavity)
- Contains bone marrow ----- Blood formation
- Metabolic function : Reservoir of Ca^{++} , PO_4 to maintain constant concentrations in body fluids

Bone covering

❑ Periosteum:

cover the external surface of bone , formed of two layers

❑ Outer fibrous

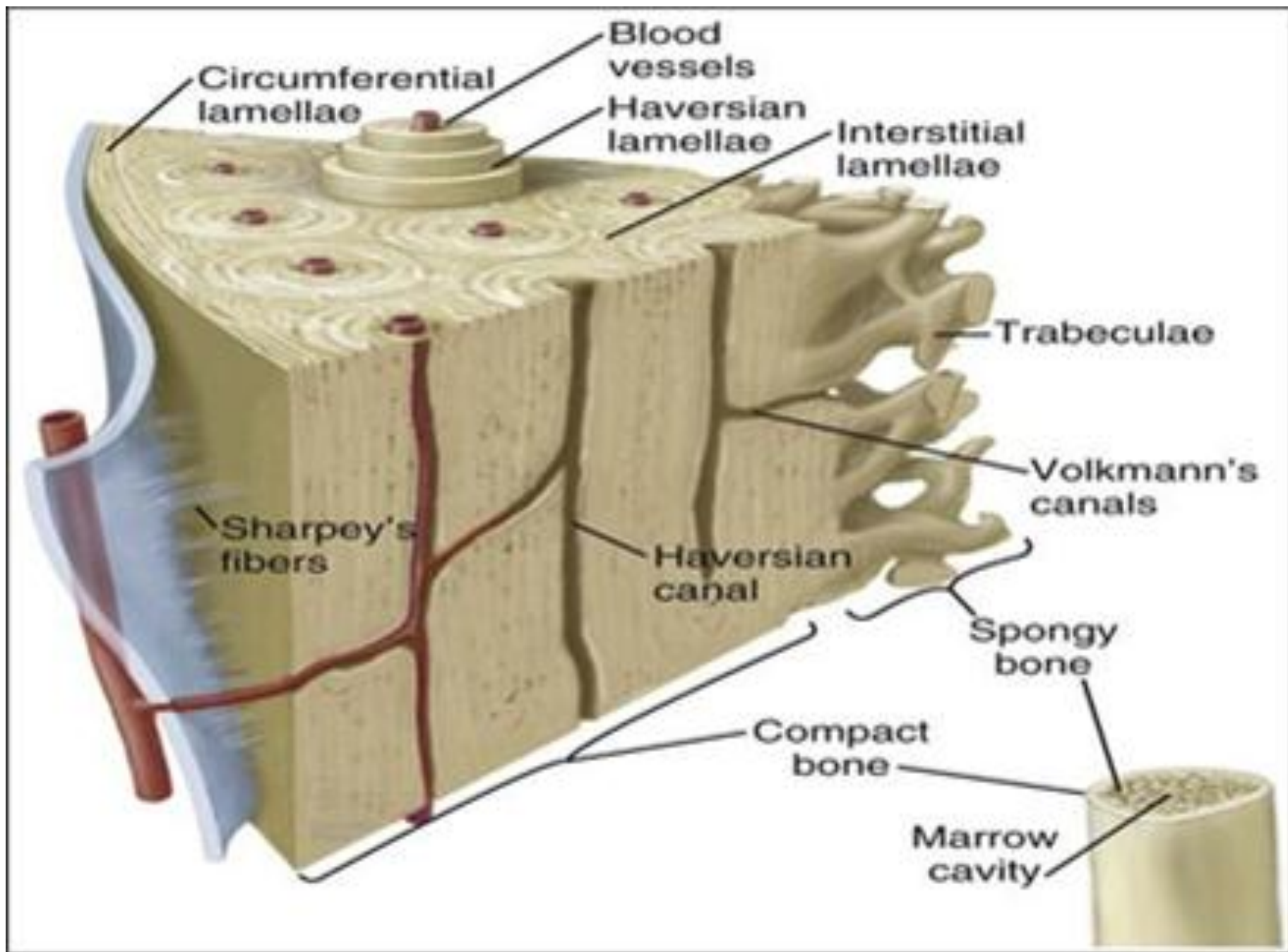
This layer support the bone & gives attachment to the tendon of muscles , at these site collagen fibers are more thickened forming sharpey's fibers that penetrate deep into the bone substance to fix periosteum and prevent its separation

❑ Inner vascular & cellular formed of osteogenic cells

(osteoprogenitor & osteoblasts) and blood vessels important for Nutrition of bone & supply of osteoblasts

❑ Endosteum:

lines the bone marrow cavity formed **only of cellular** layer of osteogenic cells & blood vessels



Bone Components

Bone is composed of **cells** lying in **extracellular calcified matrix**

❑ **Bone matrix**: composed of :

❖ **Water** :**25%** of bone weight permits ion exchanges

❖ **Organic components** = **30%** of bone weight include :

➤ **Ground substance** formed of :

- proteoglycans bound to hyaluronic acid
- Adhesive glycoproteins e.g. osteocalcin & osteonectin

➤ **Matrix fibers**

- type I collagen fibers
- Collagen forms osteoids: strands of spiral fibers that form matrix

❖ **Inorganic components**: **45%** of bone weight

Calcified material in the form of calcium phosphates (**Calcium hydroxyapatite**) & **calcium carbonates** (calcium salts are responsible for the hardens of bone)

□ **Bone cells (4)**

1. **Osteoprogenitor cells (mother cells of bone)**

Origin : arise from UMCs in the connective tissue present where bone formation is initiated

Site :

- present in cellular layer of periosteum
- Endosteum
- Lining Haversian canals

Function

Proliferate and differentiate to osteoblasts

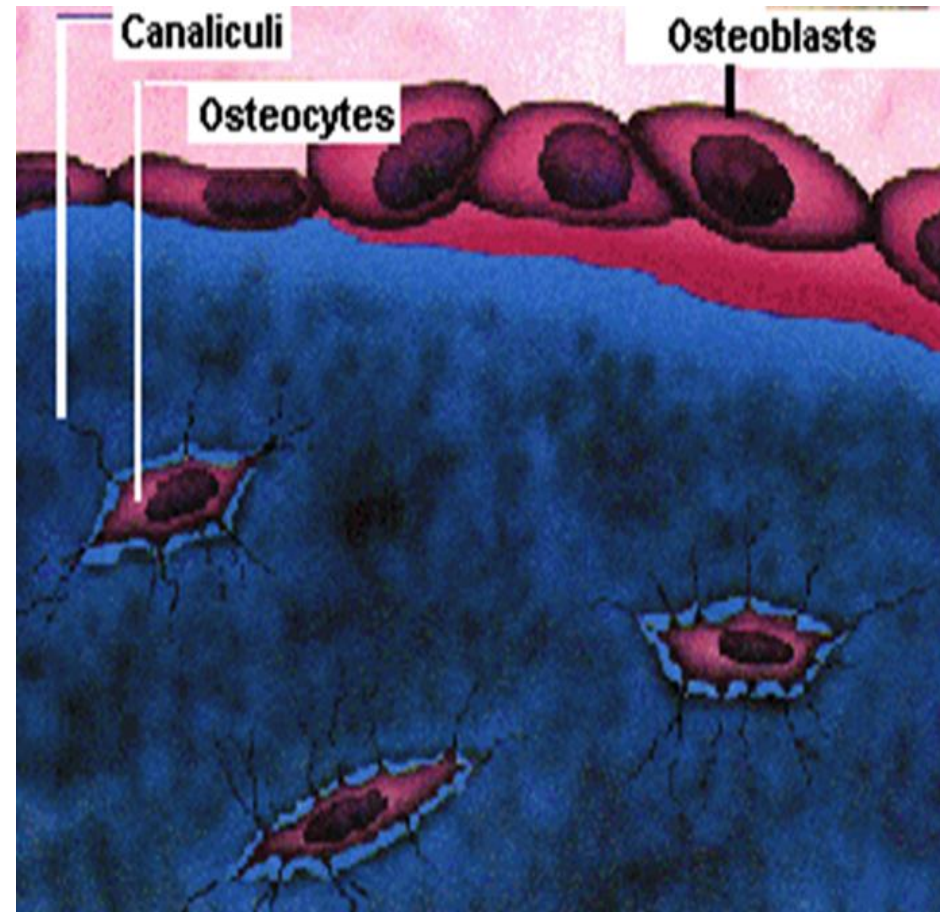
2. Osteoblasts = bone-forming cells

Origin : Osteoprogenitor cells

Site : Lines border between **Periosteum** and matrix

Function :

- Synthesize organic components of matrix (collagen fibers type I, proteoglycans, glycoproteins.)
- Secretion of alkaline phosphatase enzyme essential for deposit of Ca^{++} , PO_4 .



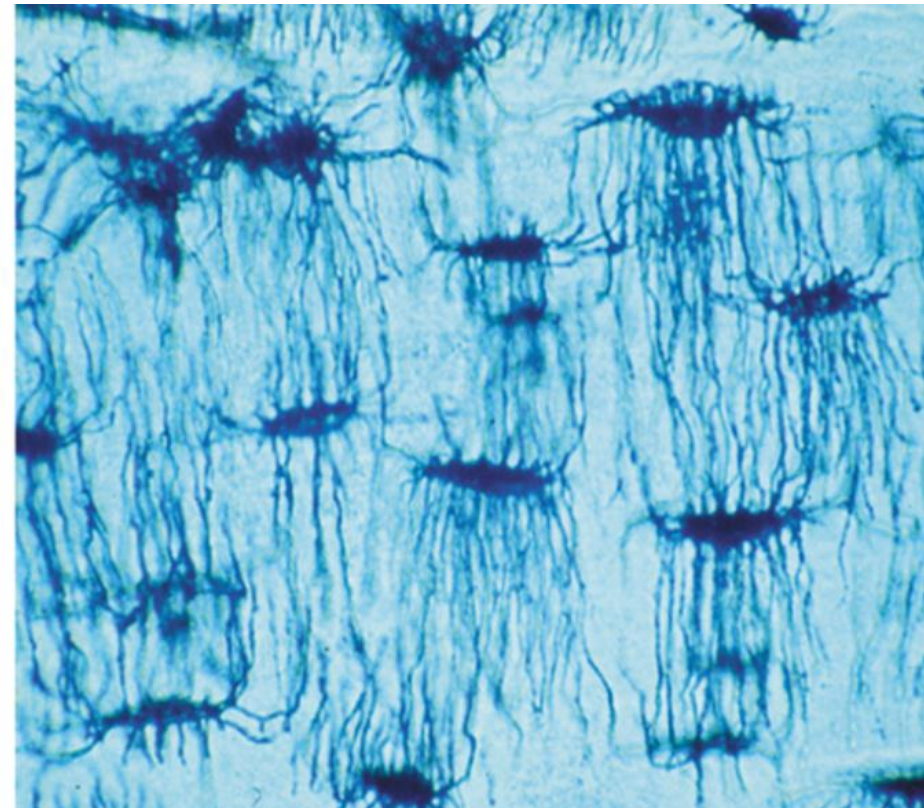
3. Osteocytes = called unit bone cells

Origin : Osteoblasts

Site : Mature bone cells that sit in lacunae

- Osteocyte with cytoplasmic extensions in the canaliculi
- Gap junctions between osteocytes provide nutrition

Function : Maintain bony matrix, long living cells

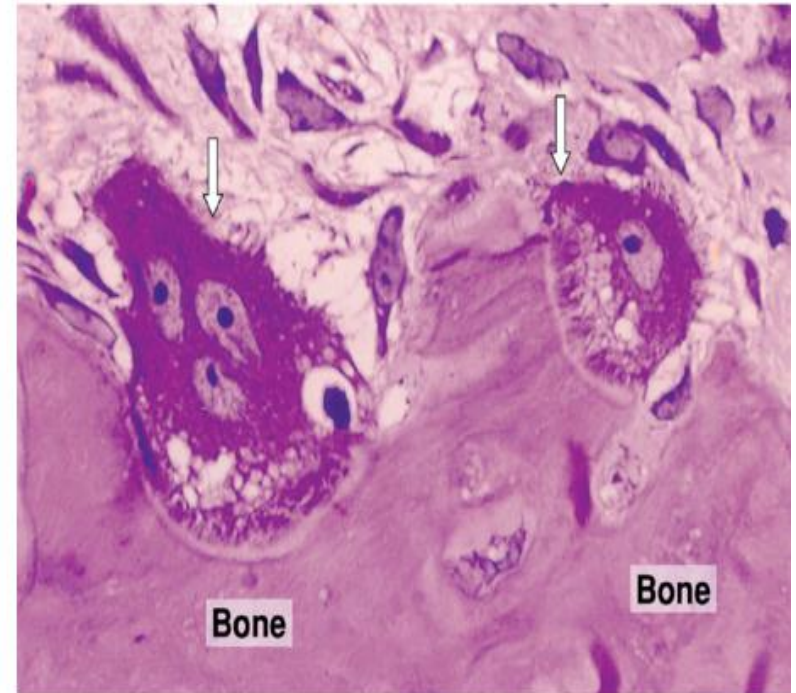
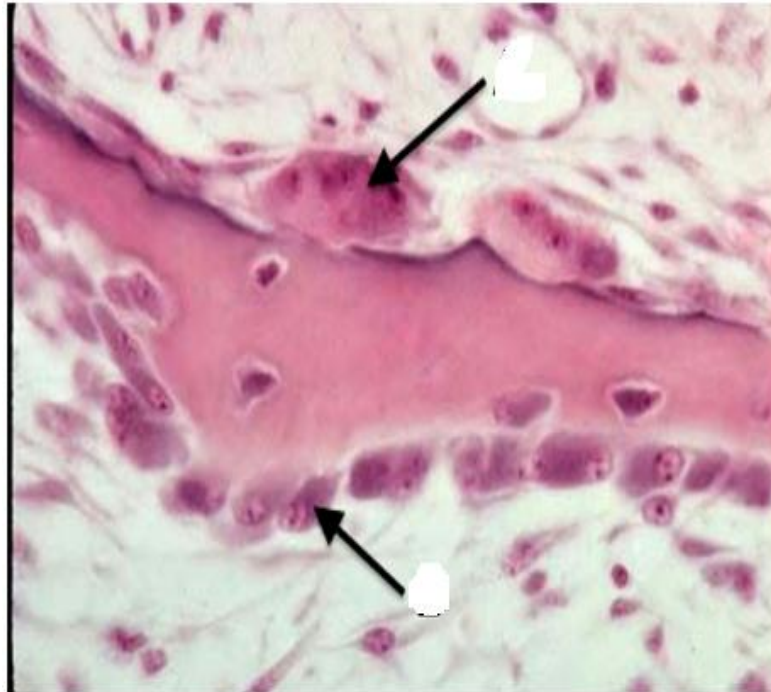


4. Osteoclasts = bone macrophages = bone-eating cells

Origin : Derived from monocytes of the blood engulf bony material

Site : Large, multinucliated cells lying in Howship's lacunae

Function : Secrete enzymes that digest matrix = bone resorption & removal of inorganic & organic matrix





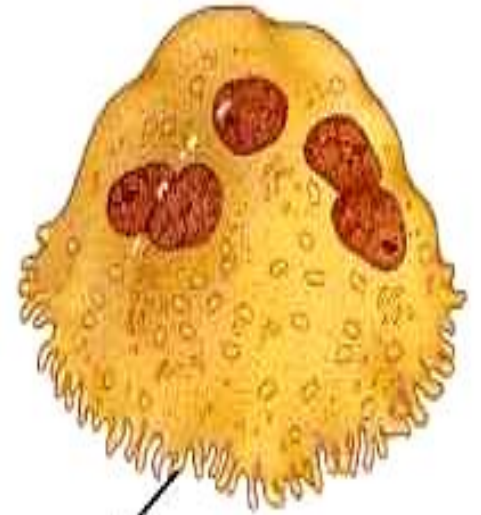
Osteogenic cell
(develops into an
osteoblast)



Osteoblast
(forms bone
tissue)



Osteocyte
(maintains
bone tissue)



Ruffled border

Osteoclast
(functions in resorption, the
destruction of bone matrix)

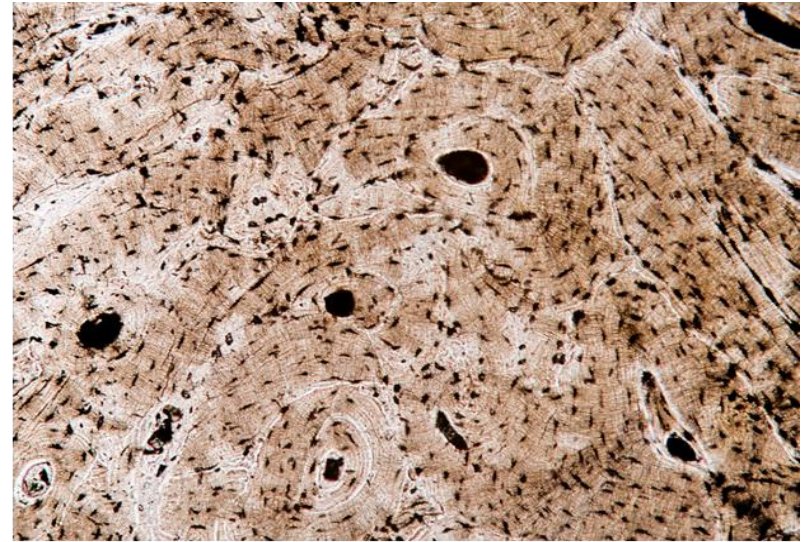
Cell	Origin	Function
1. Osteoprogenitor cells Mother cells of bone	From UMC in the CT	Proliferate & differentiate to osteoblast
2. Osteoblast Bone forming cells	From osteoprogenitor cells	Secretion of organic component of bone matrix Secretion of alkaline phosphatase essential for Calcium salts deposition
3. Osteocytes Unit bone cells	From osteoblast after being entrapped by calcified matrix	Maintenance of the bone matrix
4. Osteoclast Bone macrophages Bone eating cells	From blood monocytes	Bone resorption = removal of the inorganic & organic bone matrix

Methods of histological study of bone

There are **two methods** :

1. Unstained ground bone

In which the bone is grinded by special bone – grinding machine to produce very thin slices of bone the bone is mounted on glass slide , covered with a glass coverslip then examined directly by LM



2. Stained decalcified sections :

The calcium salts are removed from bone using strong acid solution e.g. nitric acid or chelating agent e.g. EDTA thus the bone became soft and is embedded sectioned & stained as usual with routine H&E stain



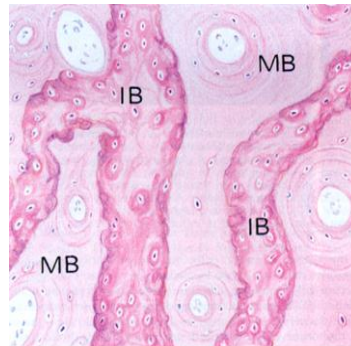
Types of bones

1. Primary bone = woven bone = Immature weak bone

- Deposited during prenatal development & bone repair
- It is temporary and replaced later on by secondary bone

Characters

1. Low calcium
2. Irregular collagen
3. Abundant irregular osteocytes



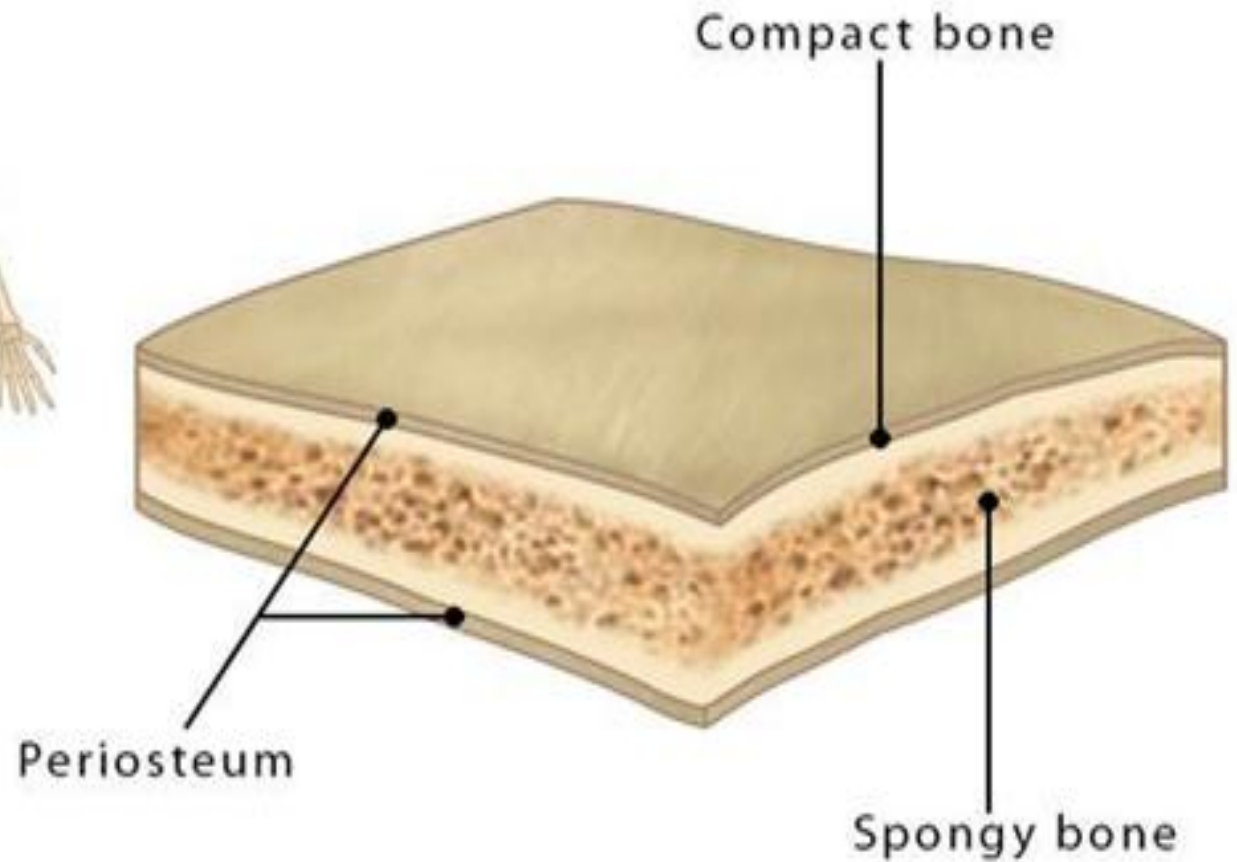
2. secondary bone = Mature

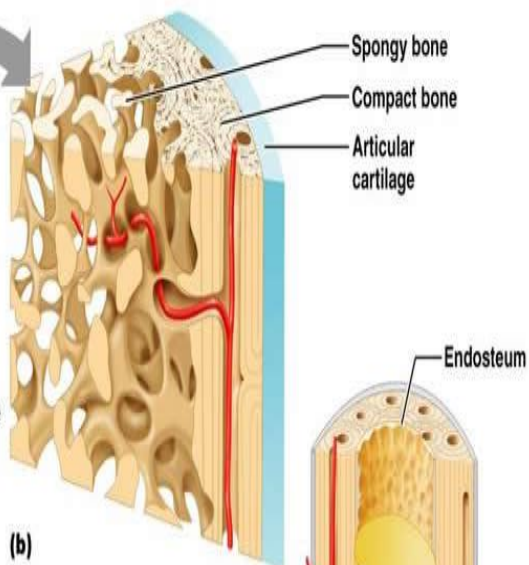
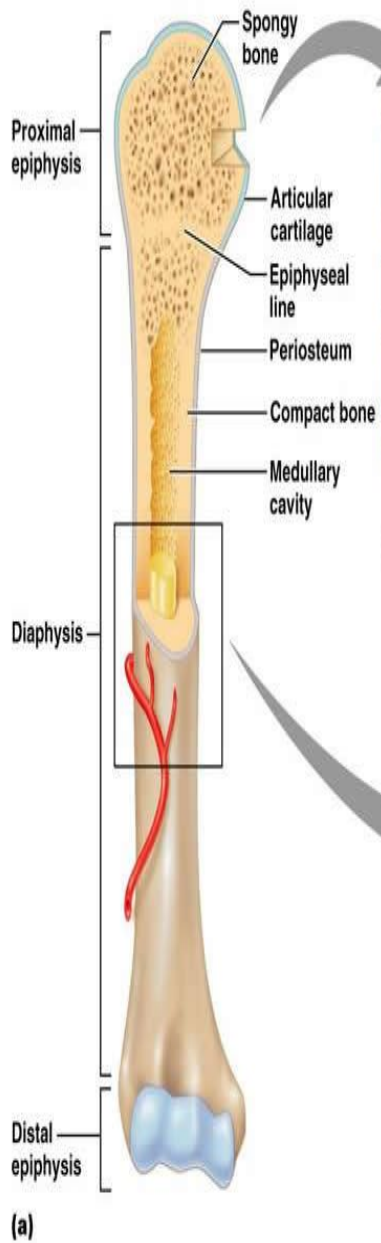
strong bone that replaces primary bone

Characters

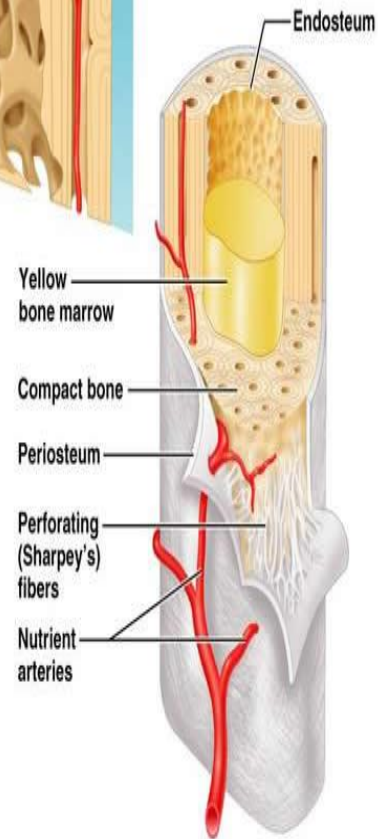
1. High calcium content so it is stronger
2. Regular collagen form lamellae
3. Less abundant osteocytes regularly arranged along the lamellae

Flat Bone

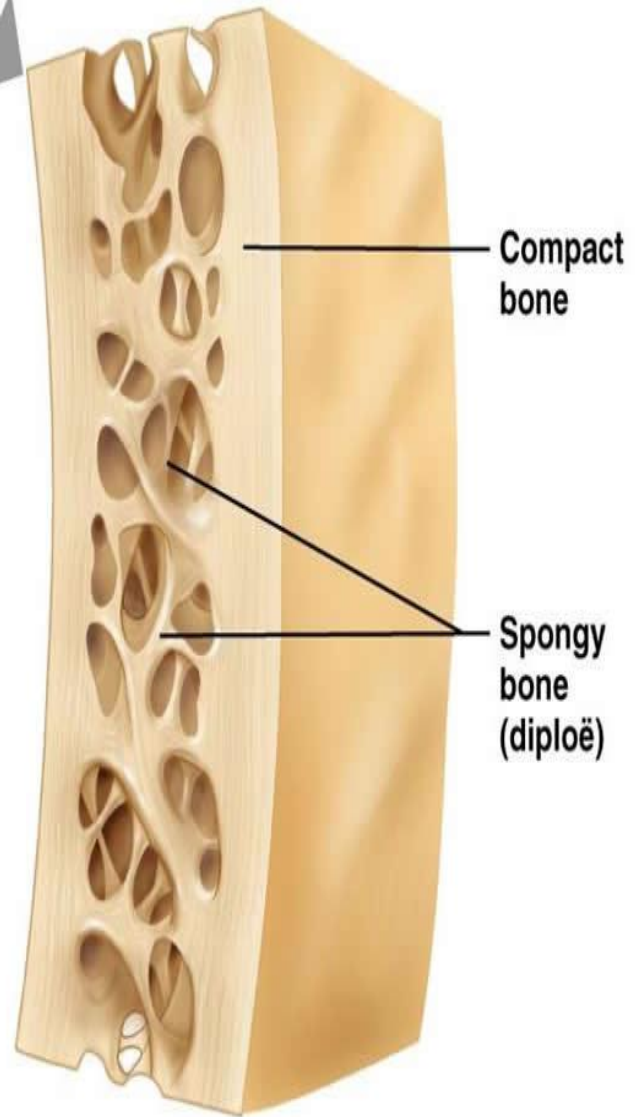
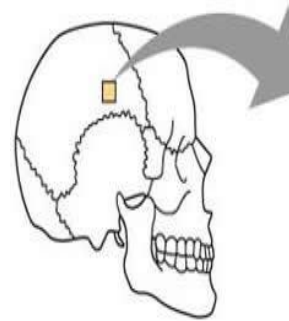




(b)



(c)



Articular cartilage: covers epiphysis

Epiphysis: ends of bone

Epiphyseal plate: growth plate

Metaphysis: epiphysis and diaphysis

Diaphysis: shaft of long bone

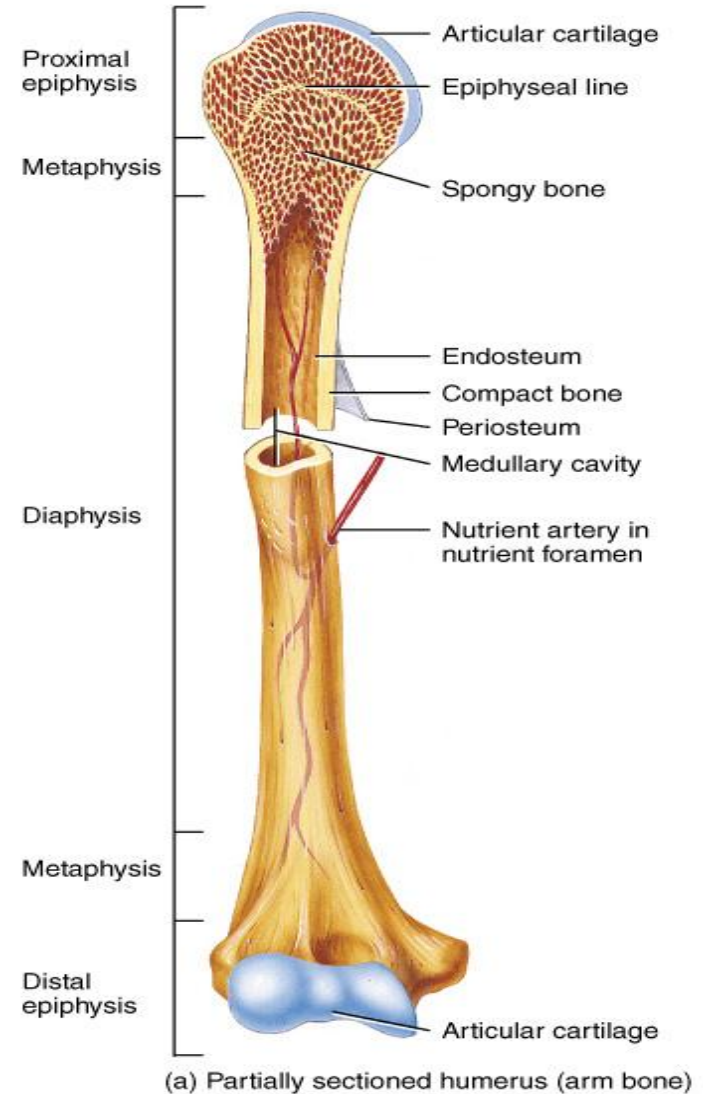
Periosteum: bone covering

Sharpey's fibers: periosteum attaches to underlying bone

Endosteum: thin layer lining the medullary cavity

Medullary cavity: Hollow chamber in bone

- red marrow produces blood cells
- yellow marrow is adipose



Mature bone



❑ Compact bone

- Is also called **dense bone** = Lamellar bone = Ivory bone
- Found in:
 - ❖ metaphysis & diaphysis of long bone
 - ❖ Outer & inner tables of flat bone
- Compact bone is composed of closely packed **osteons**.
- An osteon is also called a **Haversian system**.
- Haversian system or osteon is a Structural and functional unit of the compact Bone



❑ Spongy bone

- is also referred to as **cancellous (trabecular) bone**, It is non-lamellar bone or **bundle bone**
- Found in :
 - ❖ Epiphysis of long bone
 - ❖ Diploe of flat bone
- The mineralized tissue is seen as plates and bars.
- Trabeculae are the bars seen in the spongy bone.
- Multiple marrow spaces are also present.

Histology of Compact Bone

= **dense bone** = Lamellar bone = Ivory bone

Site : it is found in :

1. Diaphysis (shaft) of long bones e.g. humerus & femur
 2. Outer & inner tables of flat bone e.g. skull
- Has a single centrally located bone marrow cavity

Covering :

❑ **Periosteum.** The outer surface of the bones is covered by a double-layered coat.

➤ **The outer fibrous** layer of periosteum is dense connective tissue.

➤ Support osteogenic layer

Function : Nutrition , supply osteoblast for bone formation (repair- Growth he bone

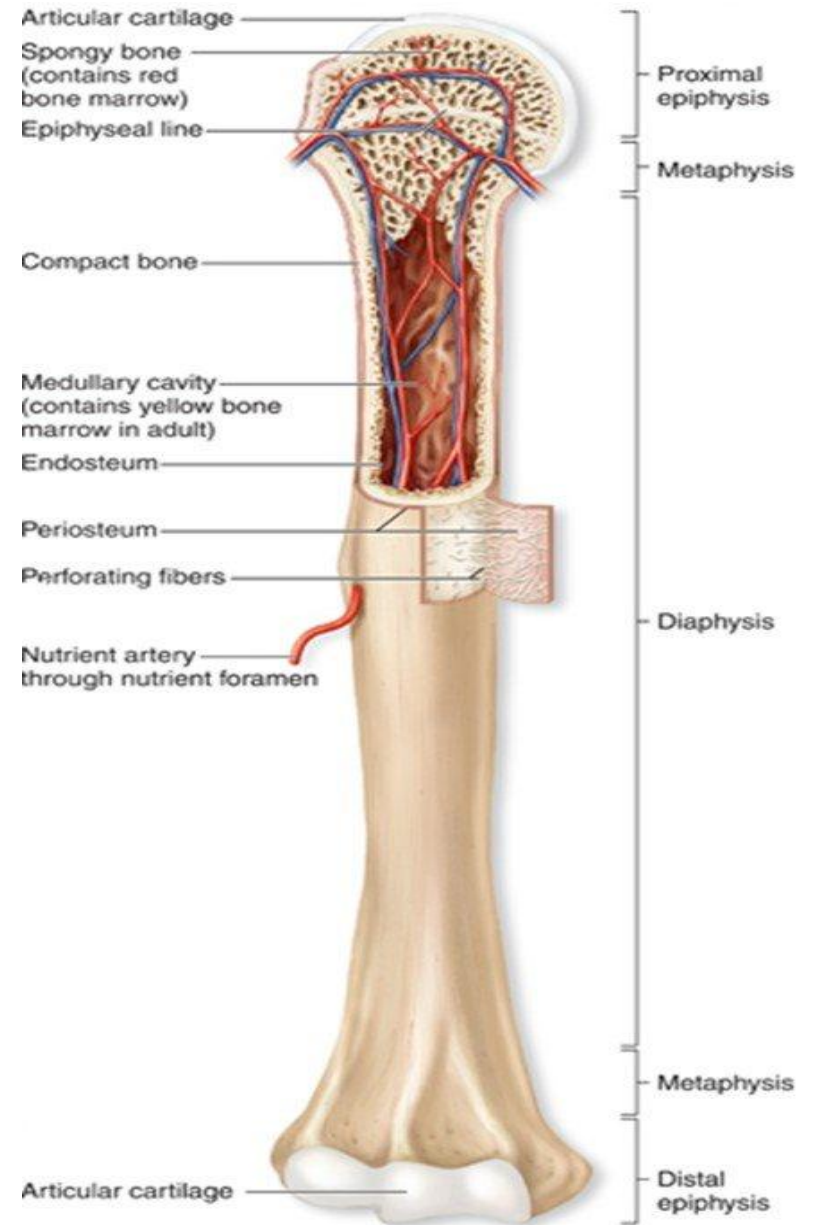
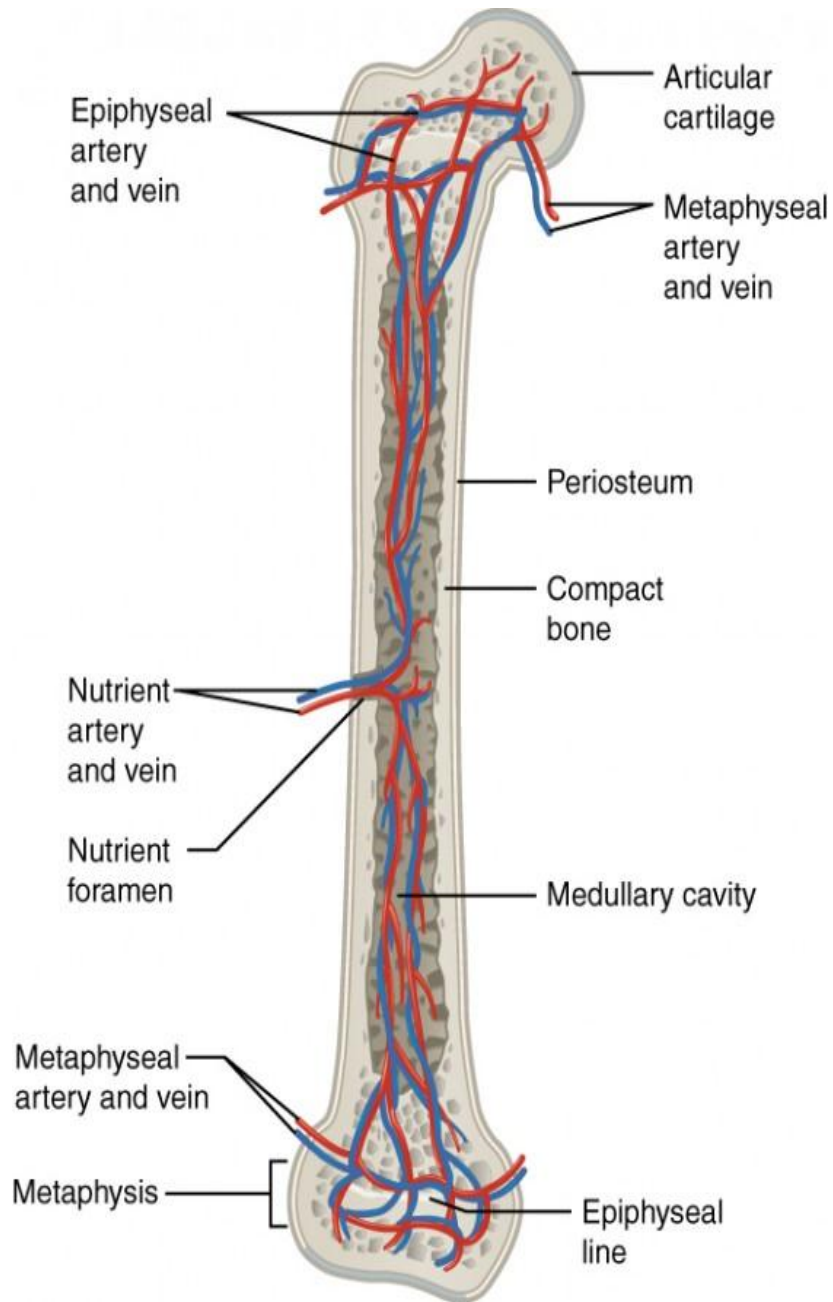
❖ Gives attachment to tendons of muscle

❖ At these site collagen fibers penetrate deep into the bone forming sharpey‘ s fibers
fix periosteum to inside of the bone

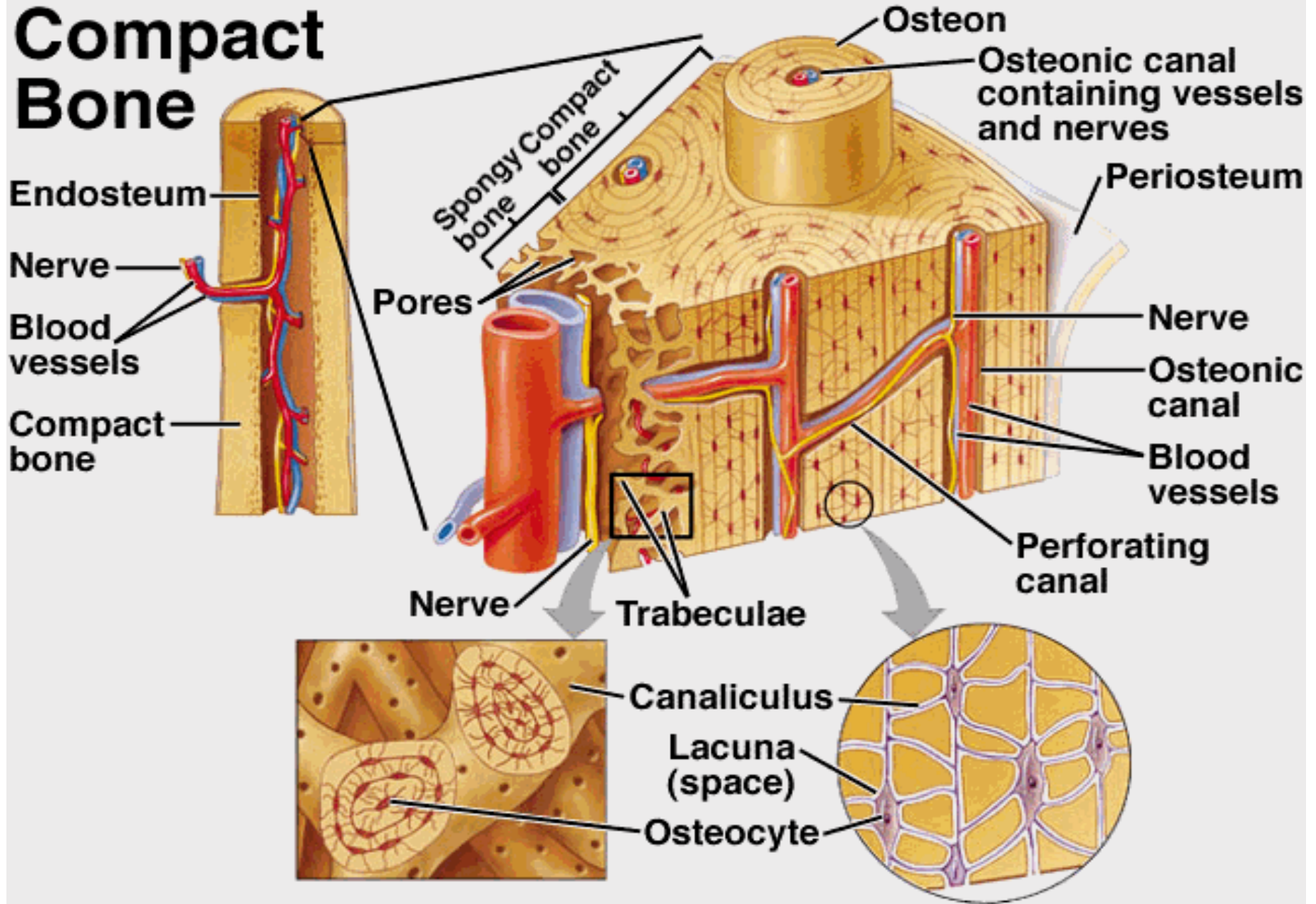
➤ **The inner cellular** is a loose CT containing osteoprogenitor cells.

❑ **Endosteum** : lines the internal surface of bone formed of osteogenic cells & blood vessels

The same function as the cellular layer of periosteum



Compact Bone



Bone tissue: it is called bone lamellae

- It is regular in compact bone
- Formed of type I collagen fibers and osteocytes in lacunae
- Osteocytes communicate together through bony canaliculi to maintain nutrition

In compact bone :

1. External (outer) circumferential lamella
2. Internal (inner) circumferential lamella
3. Haversian system (osteon)
4. Interstitial lamella

Filling the spaces between Haversian system

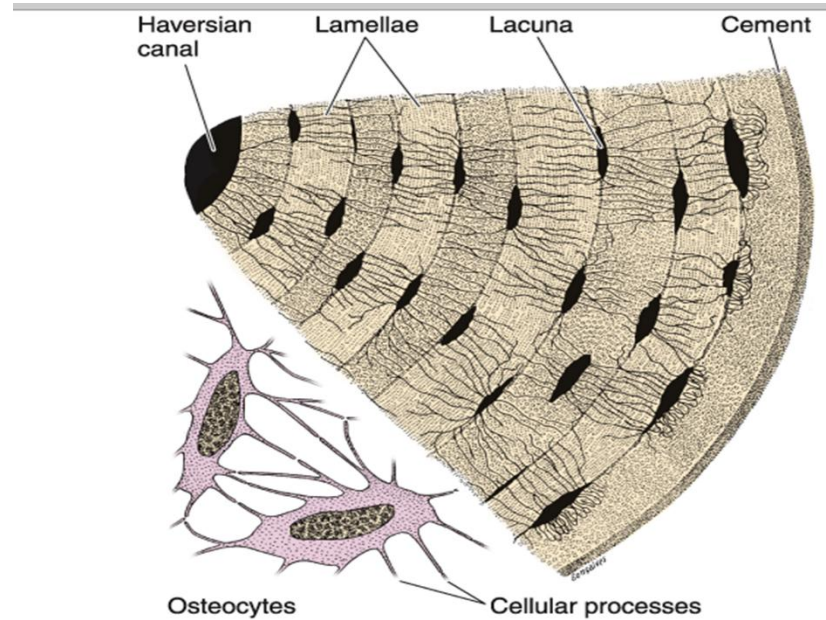
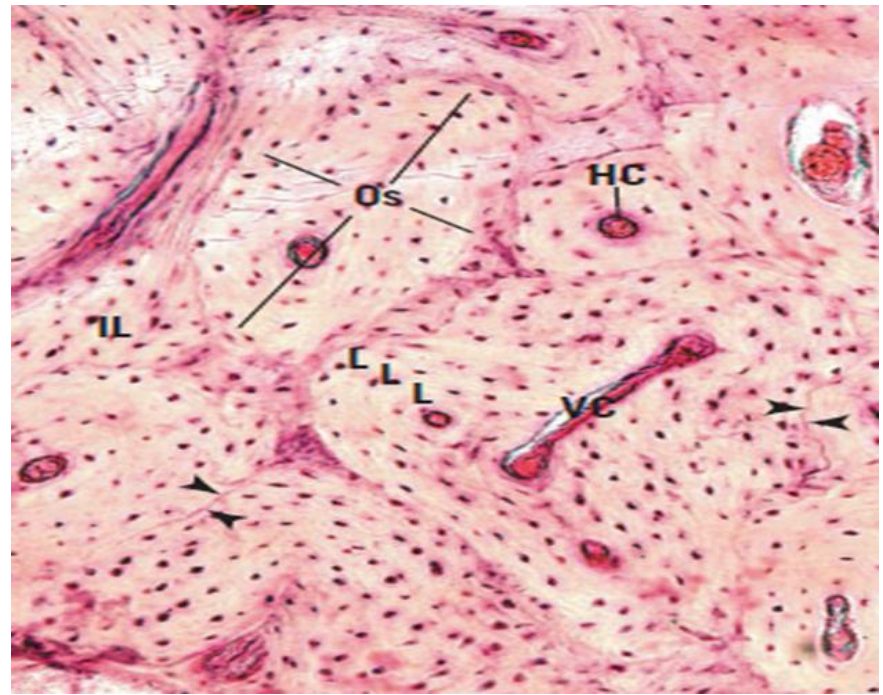
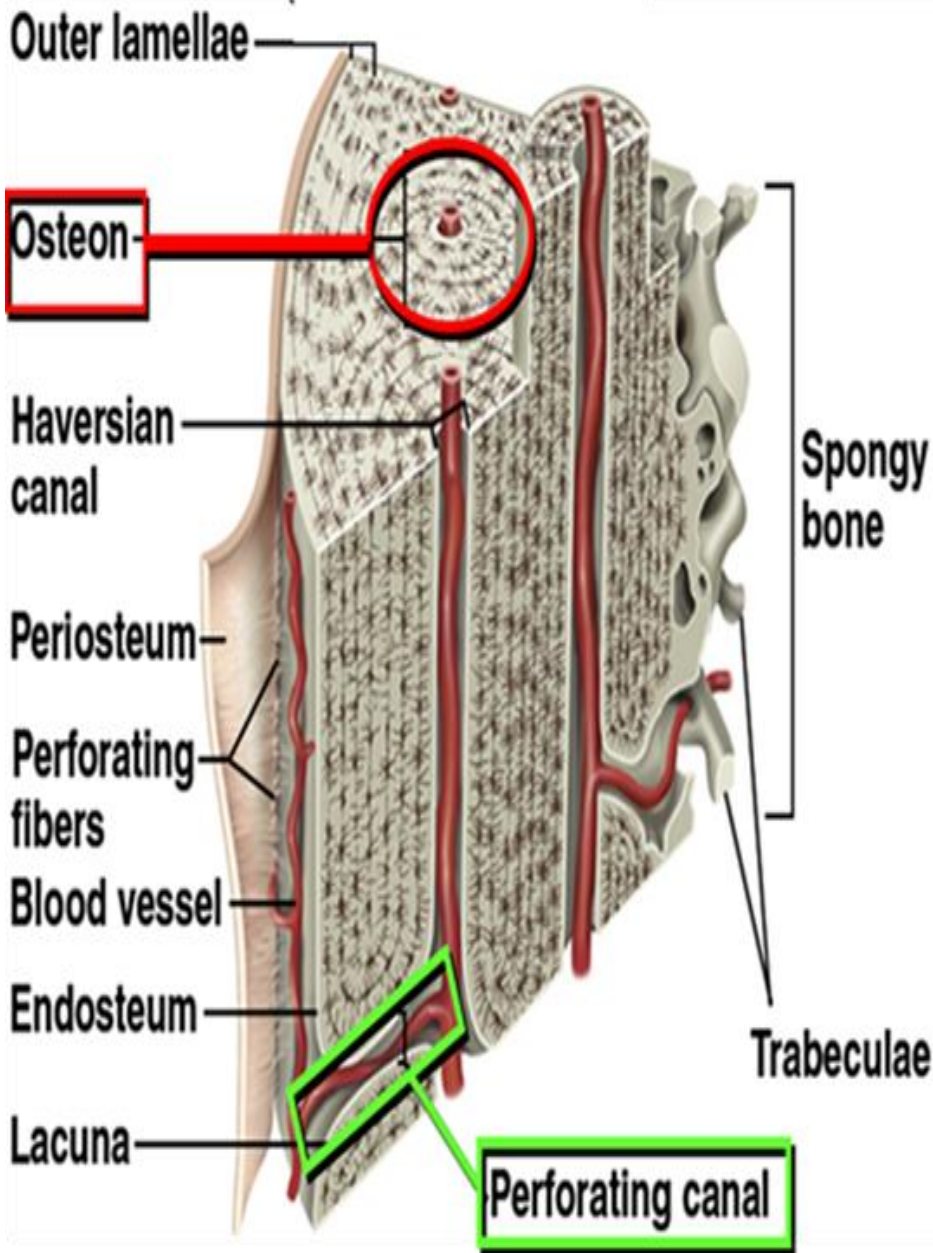
Represent the that left behind during the process of continuous renewal of bone

OSTEONS

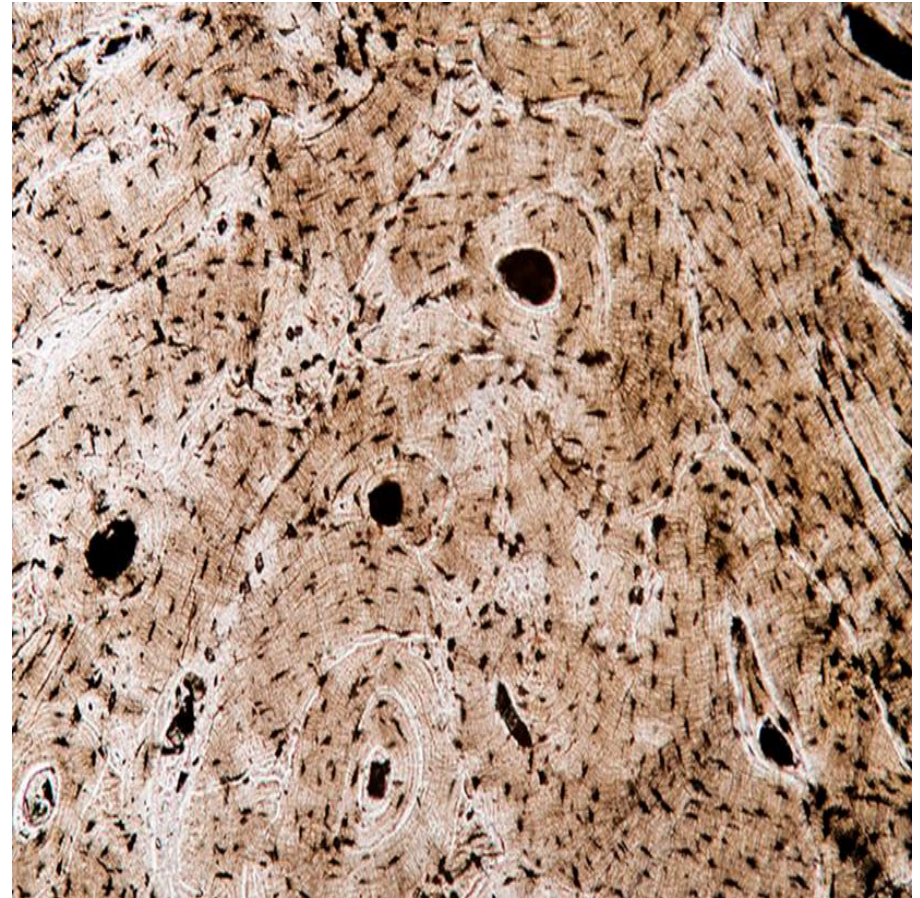
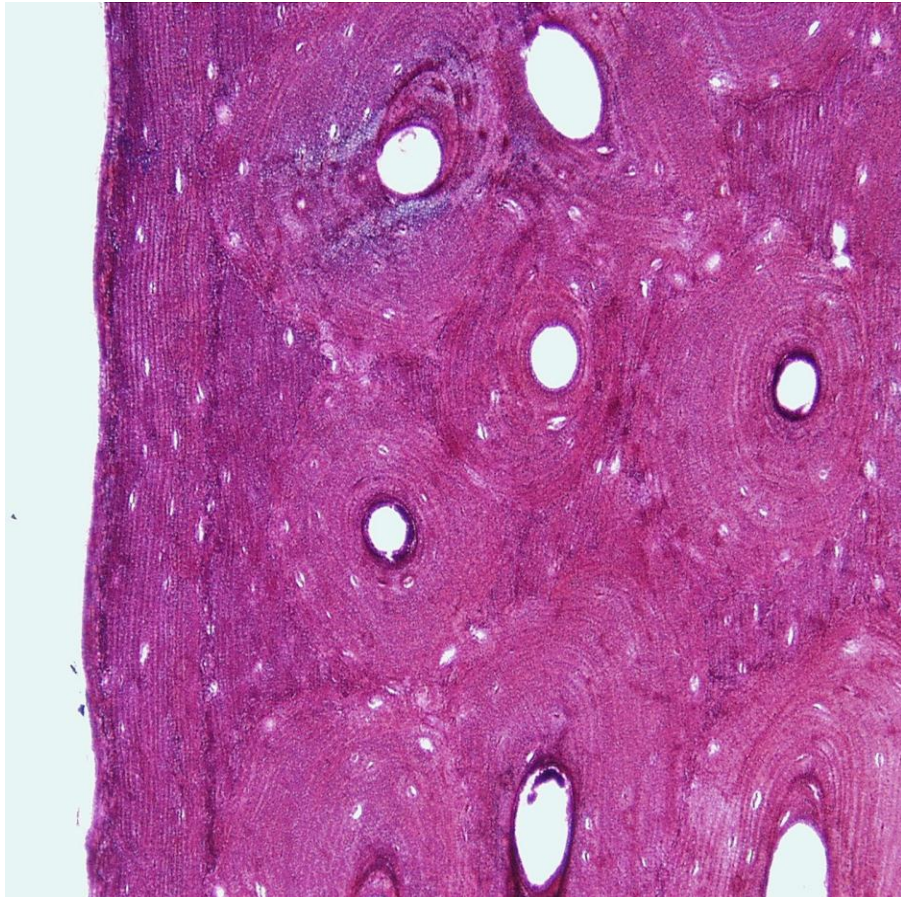
=Haversian system

Definition :

- Osteon (Haversian system) is the whole complex of concentric lamellae of the bone surrounding a canal containing blood vessels, nerves, and loose connective tissue is called a **Haversian system**, or **osteon** .
- Haversian canals communicate with marrow cavity, periosteum, other canals through Volkmann's canals
- In each lamella, type I collagen fibers are parallel to each other.
- Lacunae containing osteocytes are found between , and occasionally within, the lamellae.
- One bone marrow cavity in young age contain active bone marrow (Red BM)
- In adult contain yellow inactive bone marrow



OSTEONS



Cancellous bone

= Spongy bone=trabecular bone

It contains many bone marrow cavities giving the bone a spongy appearance

Site : Flat bone , Epiphysis of long bone

Bone covering :

- 1. Periosteum**
- 2. Endosteum**

Bone tissue : Formed of two main components

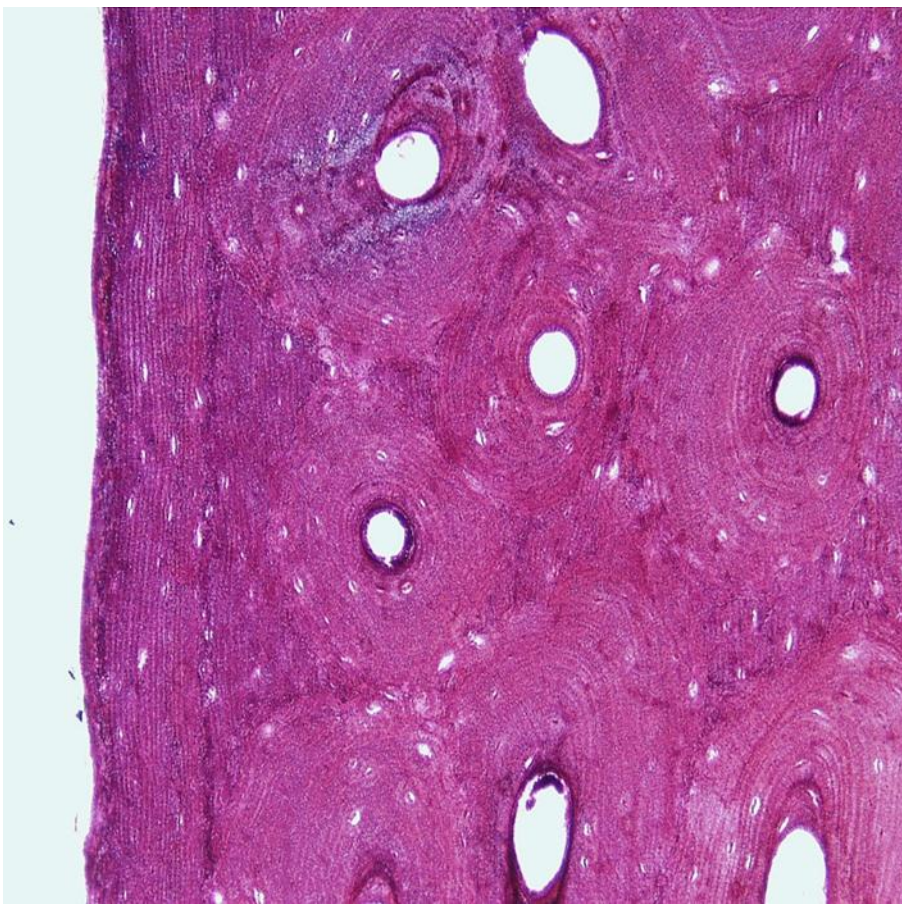
1. Bone trabeculae

- irregular & anastomosing bone lamellae with scattered osteocytes in lacunae
- Poorly developed Haversian system

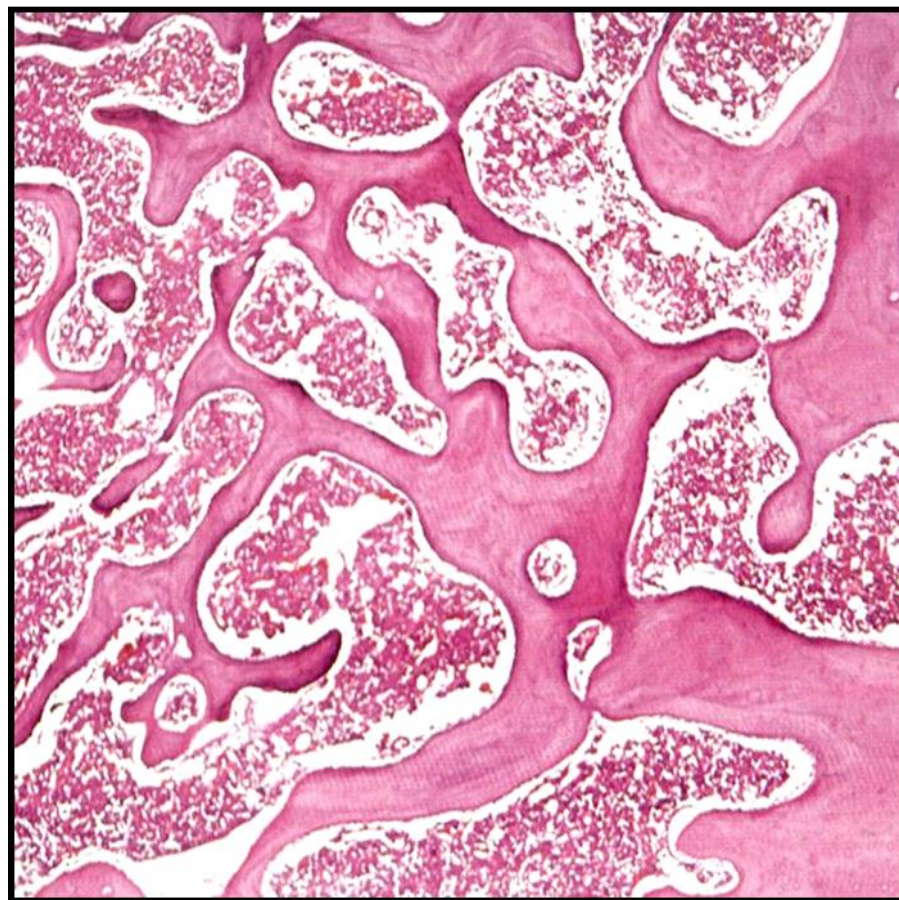
2. Bone marrow cavities :

Multiple irregular BM cavities contain active red bone marrow

Compact bone



Cancellous bone



Compact bone**Cancellous bone**

Naked eye appearance	Dense with no hole	Spongy with many hole
Sites	Shaft of long bones Outer & inner tables of flat bones	Flat bone Epiphysis of long bone
Periosteum	Present	Present
Endosteum	Lines central single marrow cavity	Lines multiple marrow cavities
Marrow cavity	Central single	Multiple cavities
Bone lamellae	Regular , parallel form Haversian system , circumferential and interstitial lamellae	Irregular , incomplete lamellae Form bone trabeculae
Haversian system	Mature , well developed	Immature , primitive Haversian
Matrix	Well organized collagen	Irregular collagen
Nutrition	Bone nutrient vessels , periosteal vessels . Volkman canal , Haversian canals, canaliculi of all osteocytes	Bone nutrient vessels , periosteal vessels, multiple marrow cavities, bone canaliculi

Bone

Cartilage

Characters	Hard , inflexible	Firm & flexible
Covering	Periosteum & endosteum	Perichondrium Except White fibrocartilage & articular surface of hyaline
Matrix	Rich in Ca ++ , less hydrated 25% water	Well hydrated 60-70 % water
CT fibers	Collagen I well organized into lamellae	Collagen II Elastic fibers Collagen I in WFC
Cells	4 Types Osteocytes single inside lacunae communicating by processes	2 Types Chondrocytes single or in group inside lacune forming cell nest
Vascularity	Vascular	Avascular

BONE FORMATION

The process of bone formation is called **ossification**

Formation of Bone in an Embryo

- ❖ Bone may develop (**directly**) from mesenchyme
- ❖ Replacement of cartilage (**indirectly**).

Postnatal :

- Growth of bones until adulthood
- Remodeling of bone
- Repair of fractures

BONE FORMATION

Formation of Bone in an Embryo

begins at the 6th week of embryo development and continues up to age of 25 weeks

two patterns

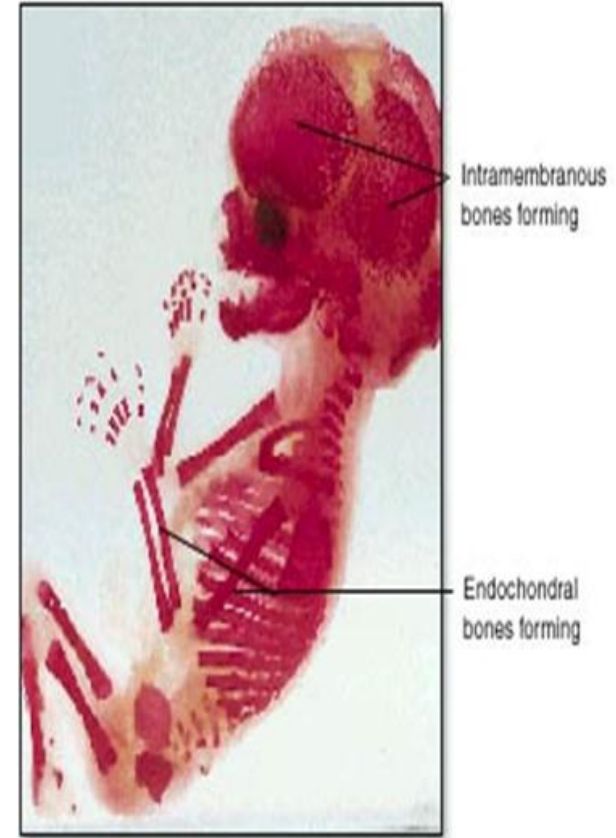
- **Intramembranous ossification**

Flat bones of the skull, mandible & clavicle are formed in this way

- **Endochondral ossification**

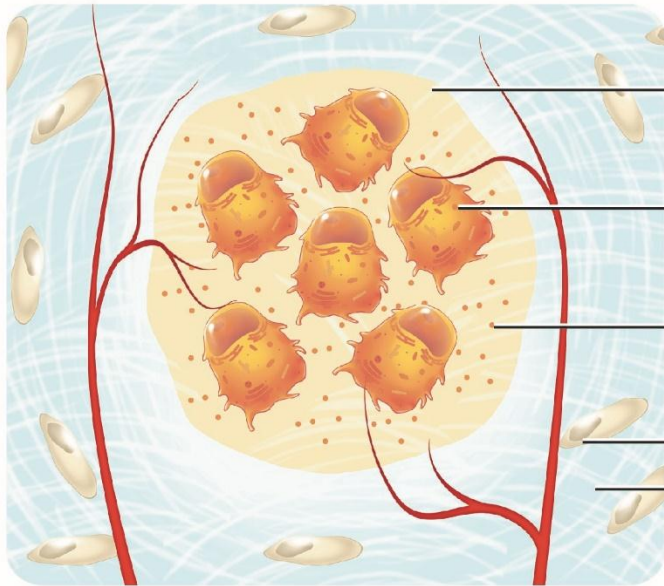
cartilage formation and ossification occurs during the sixth week of embryonic development

- The replacement of cartilage by bone
- Most bones of the body are formed in this way including long bones



Intramembranous Ossification

- ❑ In the mesenchymal connective tissue membrane
- ❑ Mesenchyme cells differentiate into osteoblasts and an ossification center appears.
Osteogenic islands.
- ❑ Osteoblasts secrete bone matrix within the fibrous membrane
- ❑ Osteoblasts surround themselves with bone matrix, forming osteocytes =
Osteoblasts mature into osteocytes
= It is **osteoid stage.**
- ❑ Osteoid becomes mineralized through crystallization of Ca^{++} salts using enzyme alkaline phosphatase and is called primary ossification center(OC). It is **ossification stage and formation of spicules.**
- ❑ Blood vessels begin to grow spicules that meet and fuse together.
- ❑ **Woven Bone (primary spongy bone).**
- ❑ Osteoclasts erode the primary bone matrix . **It is remodeling or Secondary bone formation.**



1 Development of ossification center

Ossification center

New bone matrix

Osteoblast

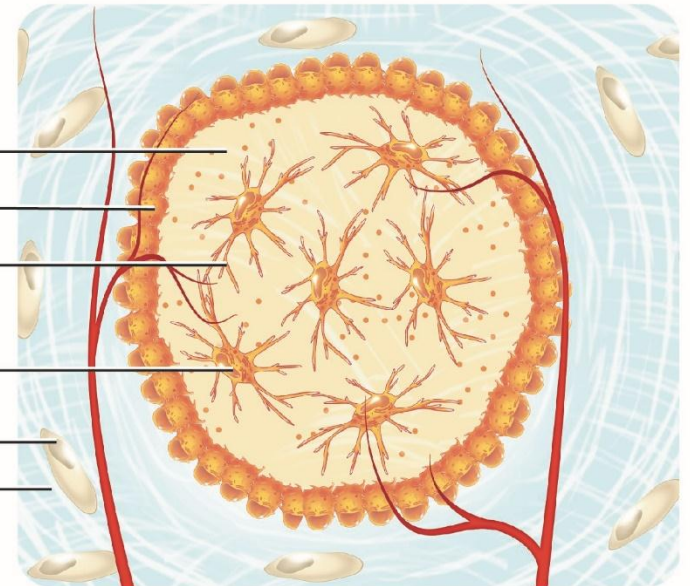
Canaliculi

Osteoid

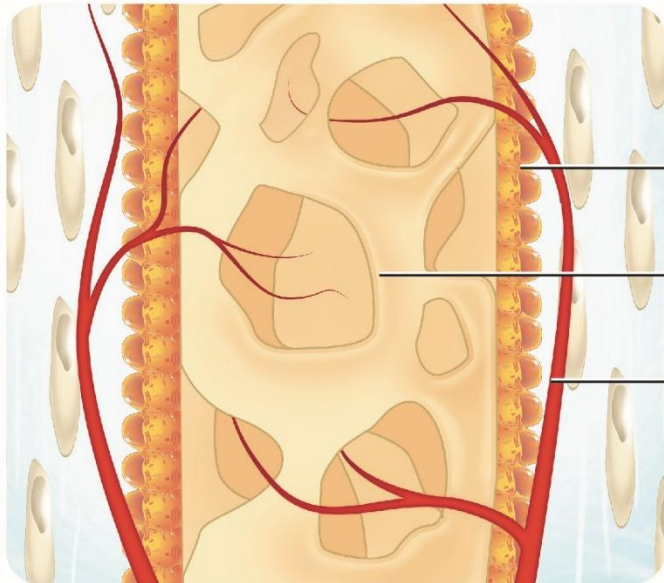
Osteocyte

Mesenchymal cells

Collagen fibers



2 Calcification



3 Development of trabeculae

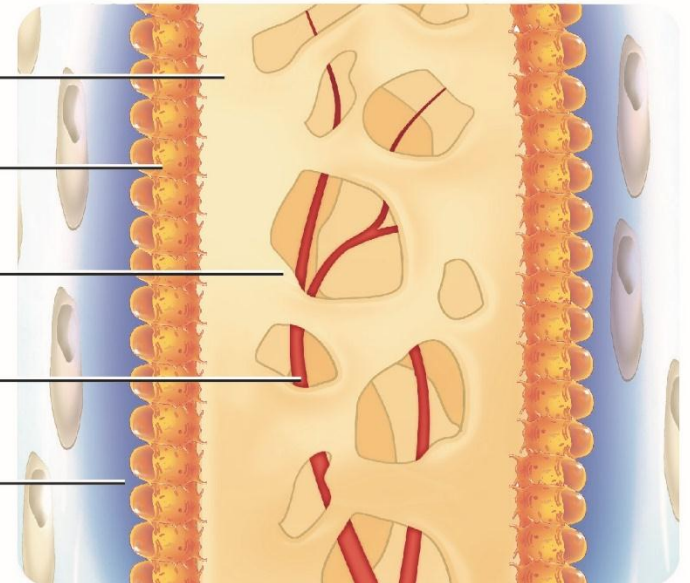
Compact bone

Osteoblast

Spongy bone

Blood vessel

Periosteum



4 Development of periosteum

Endochondral (indirect) Ossification

Bone develops from pre-existing model of hyaline cartilage

- Formation of primary ossification center (**OC**) and marrow cavity in shaft of model
- Cartilage model stem cells give rise to osteoblasts
- The periosteal bone collar (perichondral ossification) bony collar developed by osteoblasts
- Proliferation, hypertrophy, calcification of the cartilage (chondrocytes swell and die) = bone laid down and marrow cavity created
- Formation of primary marrow cavity and Periosteal bud- small cluster of blood vessels
- Secondary ossification centers and secondary marrow cavities are formed in the ends of the bone
- primary and secondary marrow cavities united
- Cartilage remains as articular cartilage and epiphyseal (growth) plates
- growth plates provide for increase in length of bone during childhood and adolescence

Stages of Endochondral Ossification

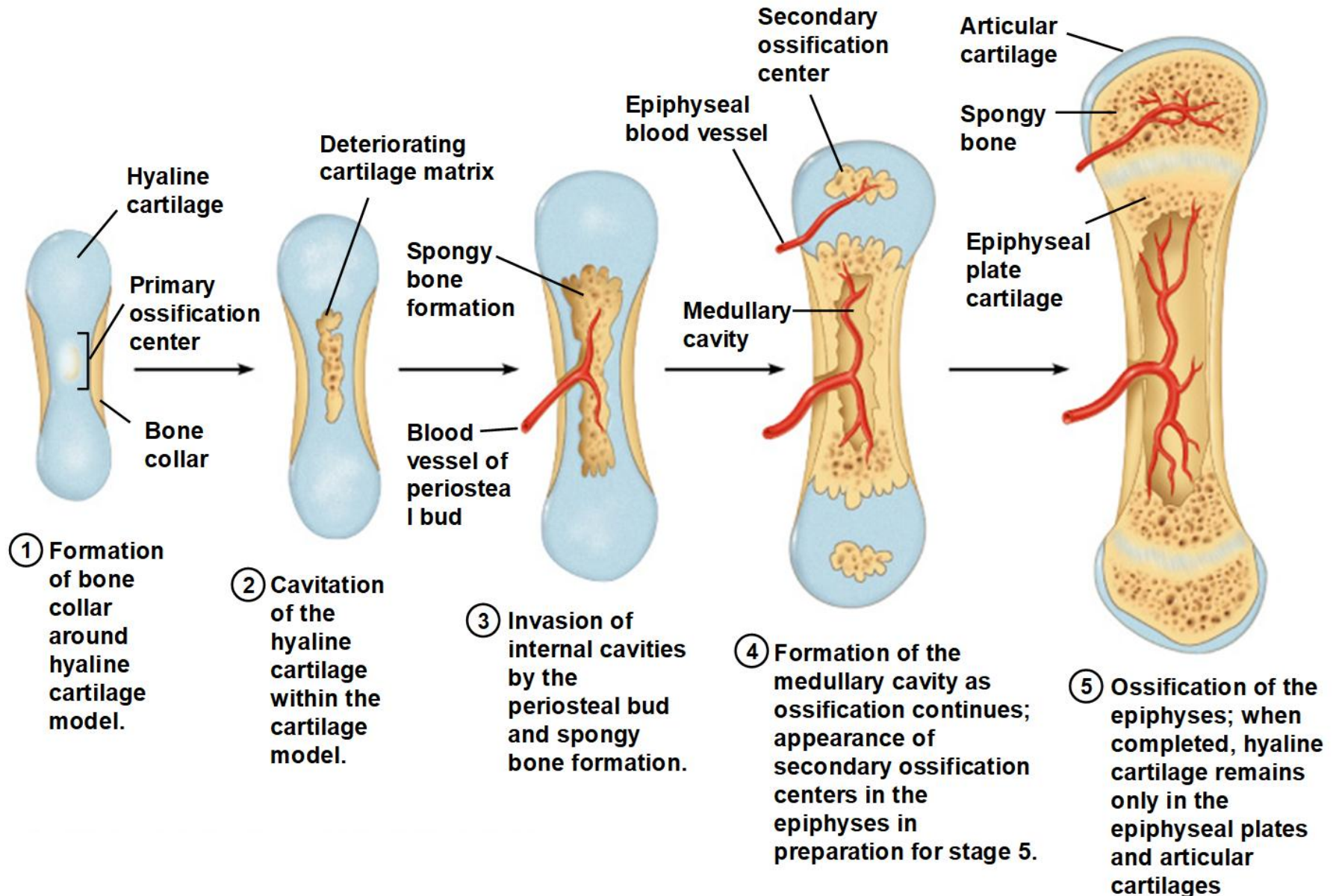
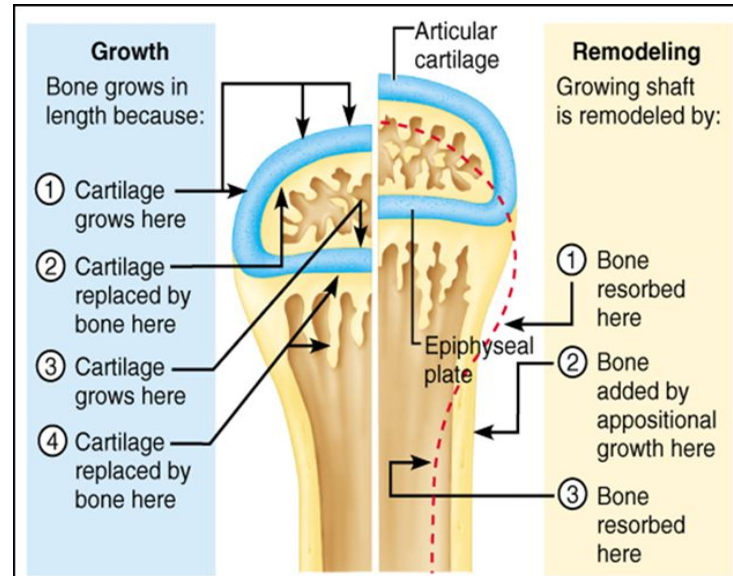


Figure 6.8

Bone Growth

bone growth during childhood and adolescence

- ❑ Bones increase in length = **interstitial growth** of epiphyseal plate
- growth plates provide for increase in length of bone during childhood and adolescence



- ❑ Bones increase in width = **appositional growth**

osteoblasts lay down matrix in layers on outer surface and osteoclasts dissolve bone on inner surface

Structure of the epiphyseal plate

Zone of reserve cells (resting cartilage): A thin layer of small, randomly oriented chondrocytes adjacent to the bony trabeculae on the articular side of the growth plate.

1. Zone of proliferation: Chondrocytes are stacked in prominent rows, mitotic figures and the cartilage matrix becomes more basophilic

Zone of maturation: No mitoses; gradual cellular enlargement.

2. Zone of hypertrophy:

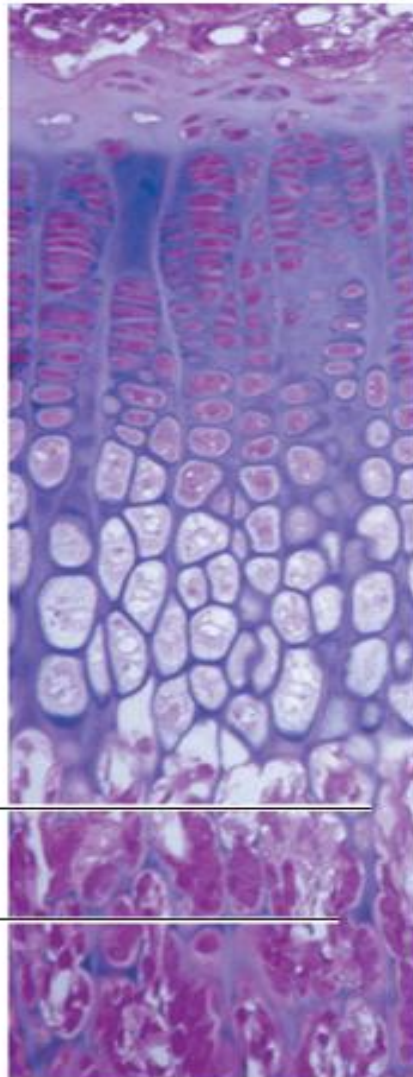
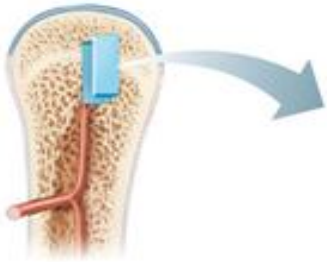
Chondrocytes and their lacunae increase in size.

3. Zone of calcification: Deposition of minerals in the matrix surrounding the enlarged lacunae causing cell death.

4. Zone of ossification: Osteoblasts deposit bone matrix on the exposed plates of calcified cartilage.

Zone of resorption: Osteoclasts absorb the oldest bone spicules.

Organization of Cartilage within Epiphyseal Plate of Growing Long Bone



Resting zone – small, inactive cartilage cells

① Proliferation zone

Chondroblasts quickly divide and push the epiphysis away from the diaphysis, lengthening the bone.

② Hypertrophic zone

Older chondrocytes enlarge and signal the surrounding matrix to calcify.

③ Calcification zone

Matrix becomes calcified; chondrocytes die, leaving behind trabeculae-shaped calcified cartilage. **THIS IS NOT YET BONE!**

④ Ossification zone

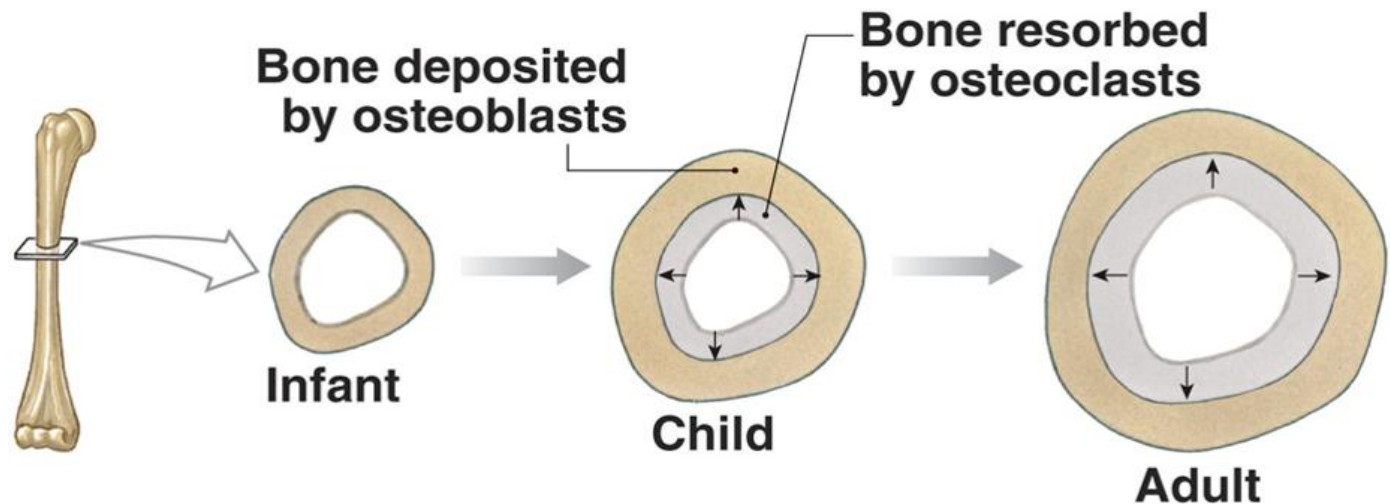
Osteoclasts digest the calcified cartilage, and *osteoblasts* replace it with actual bone tissue in the shape of the calcified cartilage – resulting in bone trabeculae.

Calcified cartilage spicule

Osseous tissue

APPOSITIONAL BONE GROWTH

- Growing bones widen as they lengthen
- Appositional growth – growth of a bone by addition of bone tissue to its surface
- Bone is resorbed at endosteal surface and added at periosteal surface
 - Osteoblasts – add bone tissue to the external surface of the diaphysis
 - Osteoclasts – remove bone from the internal surface of the diaphysis



BONE REMODELING

Remodeling is secondary bone formation

bone continually renews itself

- never metabolically at rest
- enables Ca^{++} to be pulled from bone when blood levels are low
- osteoclasts are responsible for matrix destruction
- produce lysosomal enzymes and acids
- Osteoclasts erode the primary bone matrix, blood vessels, nerves and lymphatics invade the cavity and osteogenic cells develop in osteoblasts and osteocytes, which create concentric lamellae and osteons.

Remodeling helps reshape growing bones to adapt to changing loads.

- spongy bone replaced every 3 - 4 years
- compact bone every 10 years

Fractures

Any bone break.

Closed reduction - bone ends coaxed back into place by manipulation

- Open reduction – by surgery secured together with pins or wires

➤ blood clot will form around break

----- fracture hematoma

➤ inflammatory process begins

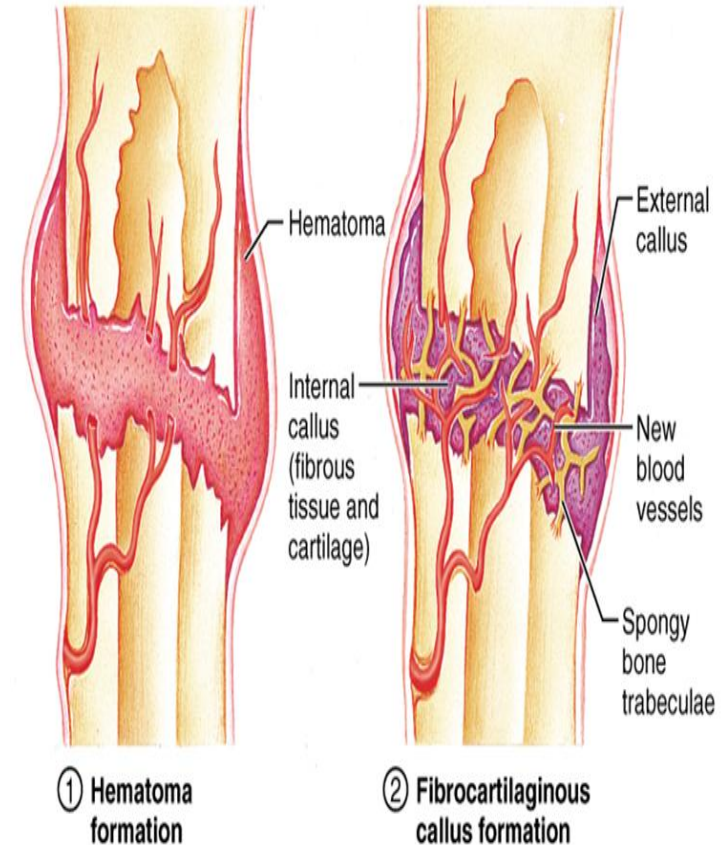
➤ blood capillaries grow into clot

➤ phagocytes and osteoclasts

-----remove damaged tissue

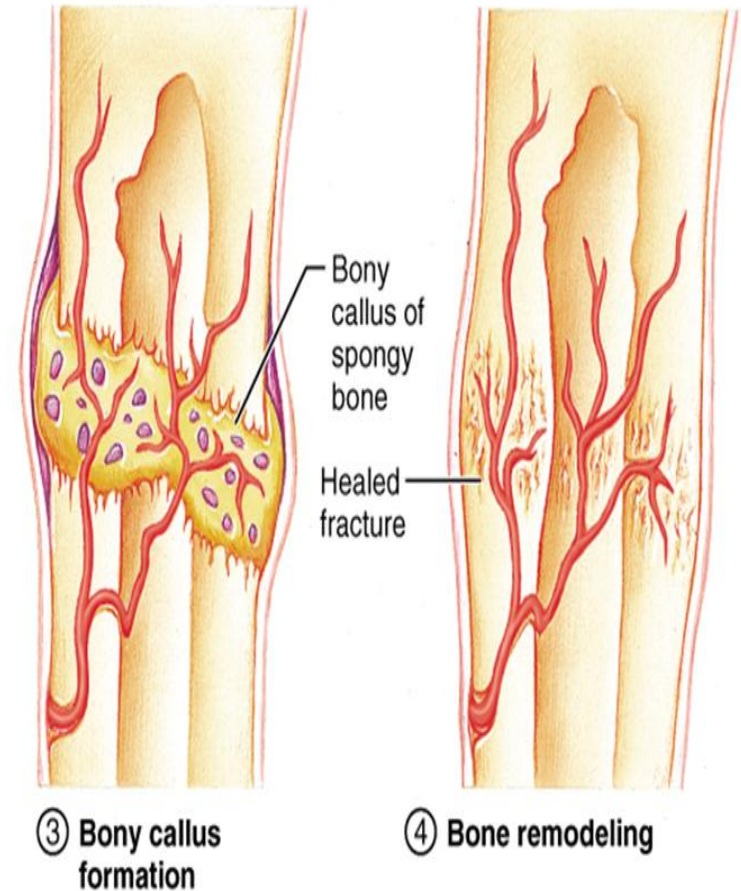
➤ procallus forms and is invaded by

osteoprogenitor cells and fibroblasts



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- collagen and fibrocartilage turns
- procallus to fibrocartilagenous (soft callus)
- broken ends of bone are bridged by callus (spongy bone)
- bony (hard) callus is formed
callus is resorbed by osteoclasts and compact bone replaces spongy bone.
- Remodeling : the shaft is reconstructed to resemble original unbroken bone.

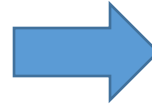


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Types of Bone Tissue

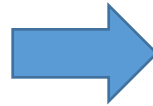
(Classification)

According to its architecture:



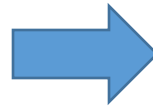
- Spongy (cancellous)
- Compact (dense)

According to its fine structure:



- Primary (woven)
- Secondary (lamellar)

According to its histogenesis:



- Intramembranous
- Endochondral