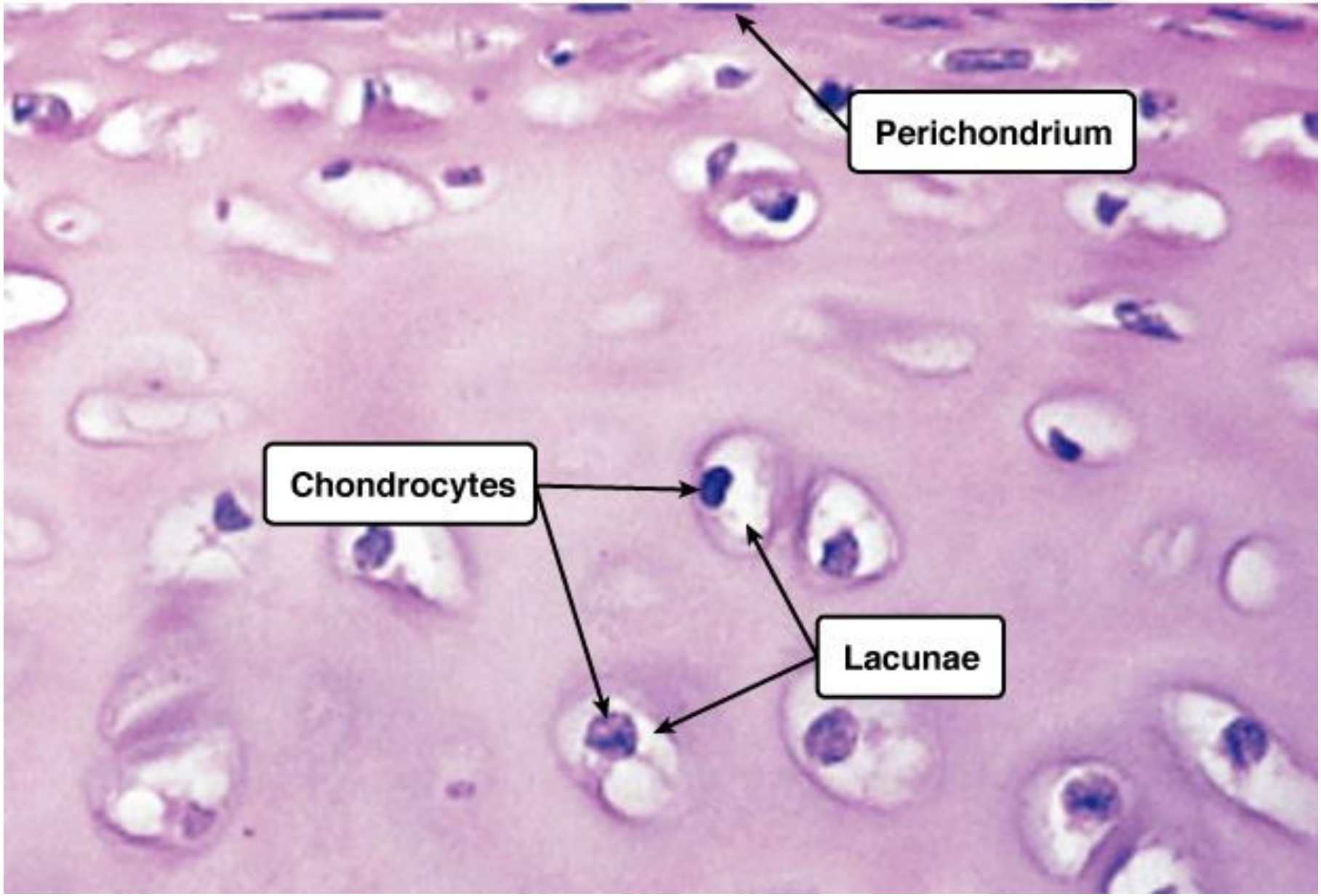
# Histology of cartilage and bone

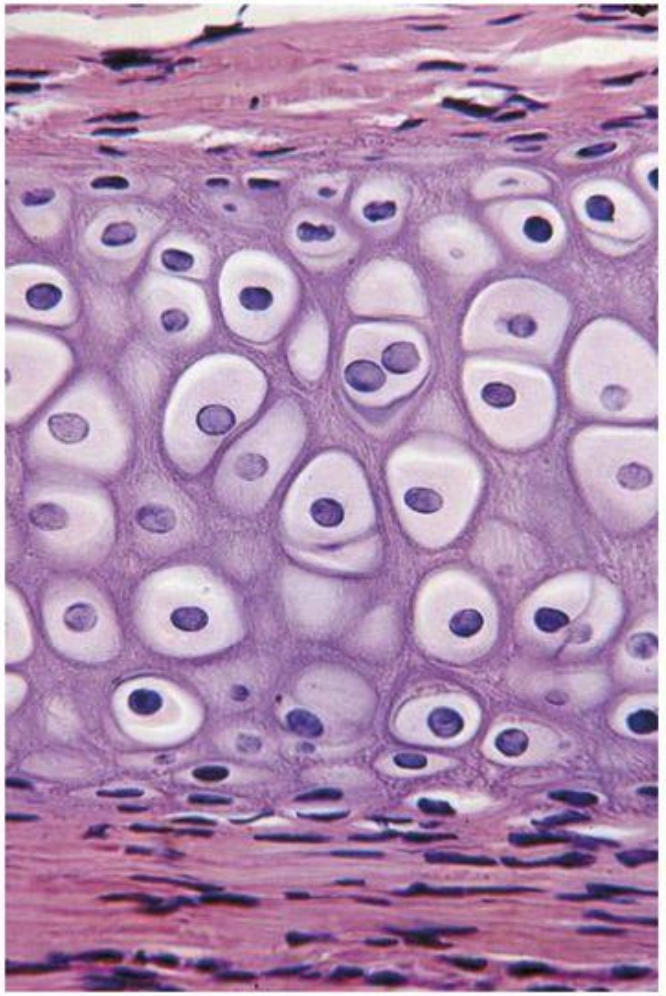
SHABNAM GUL

# Structure of Hyaline Cartilage



# Hyaline Cartilage Chondrocytes

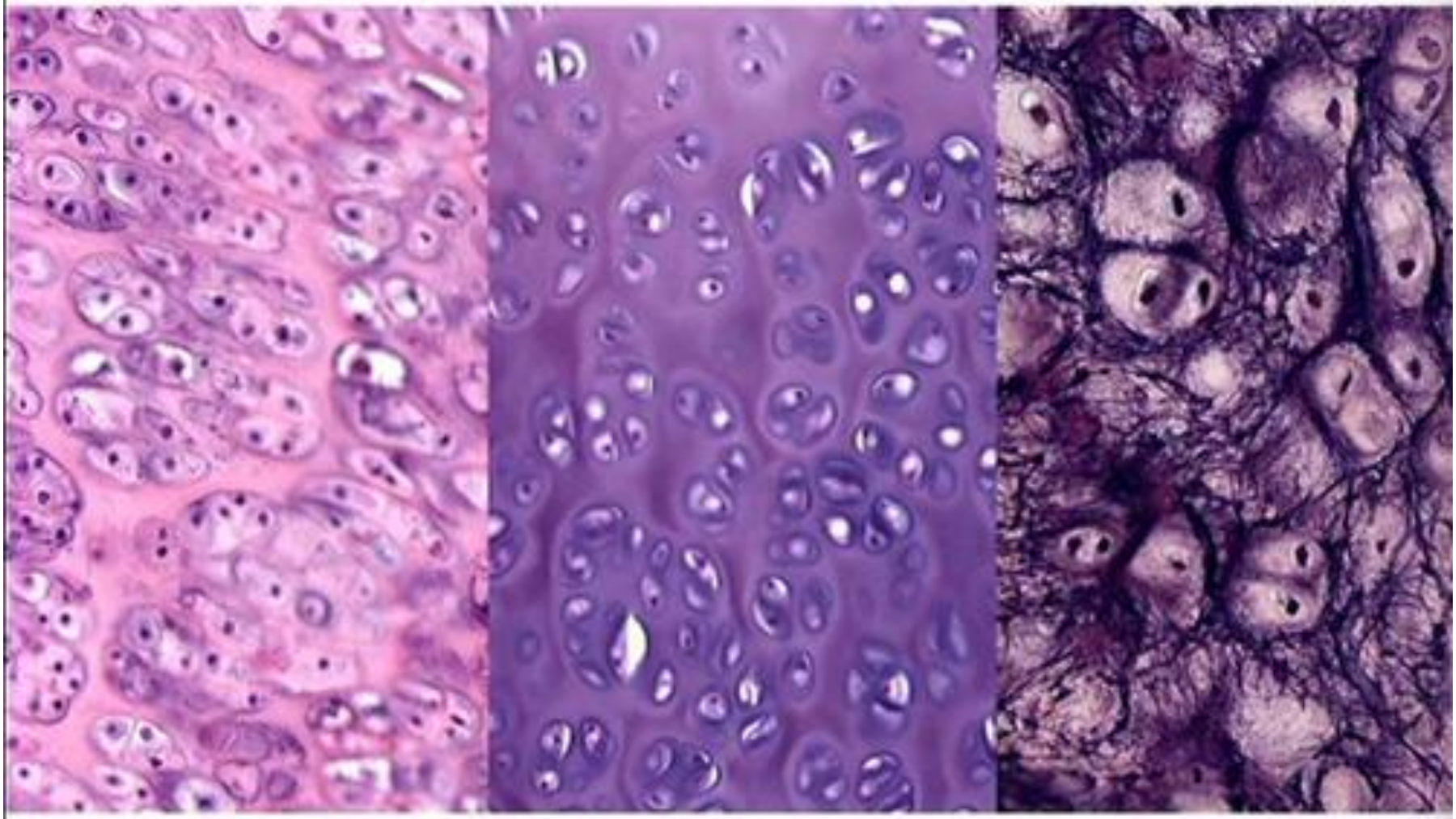
- May be in groups of up to 8.
- Lined up in rows in epiphyseal plate.
- Function of hyaline cartilage:
  - Reduces friction in joints.
  - Forms template for embryonic skeleton.
  - Structure and support.

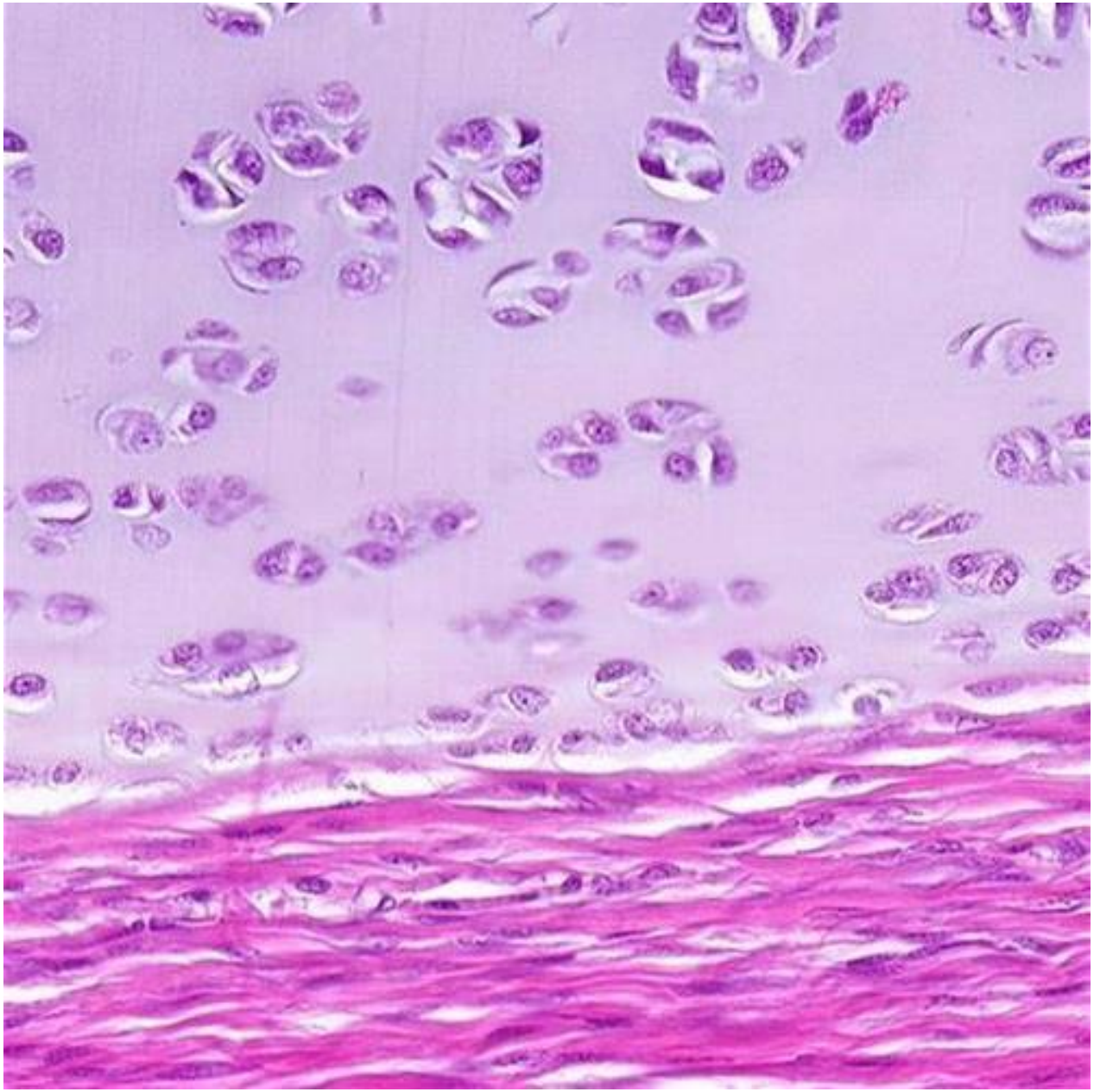


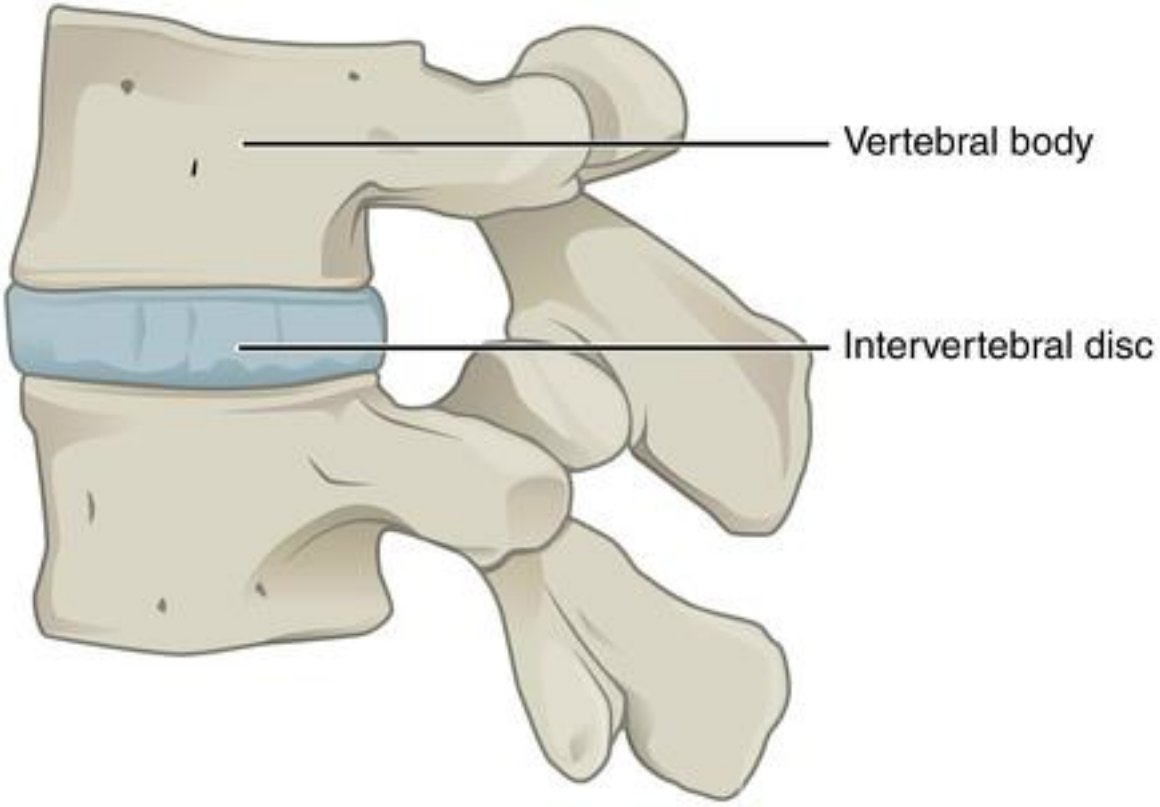
Fibrocartilage

Hyaline cartilage

Elastic cartilage

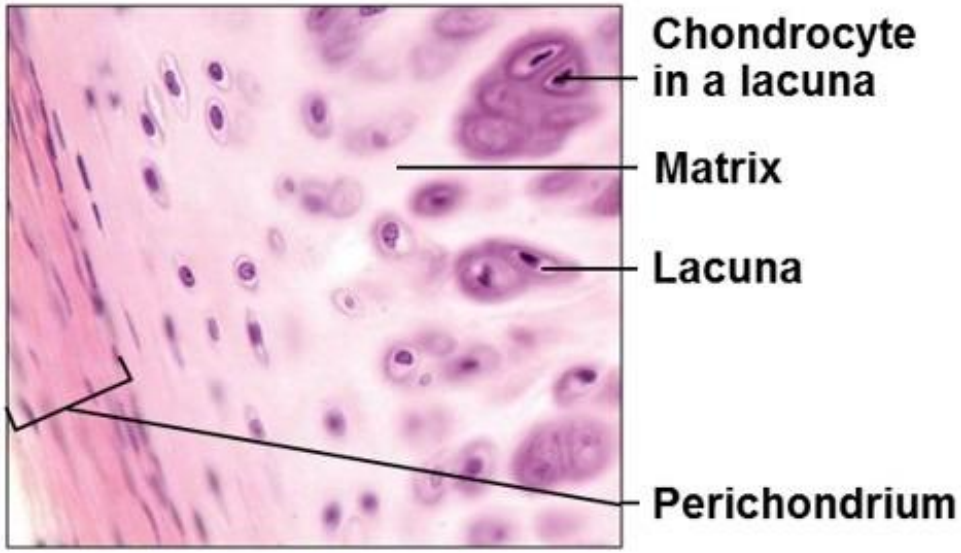




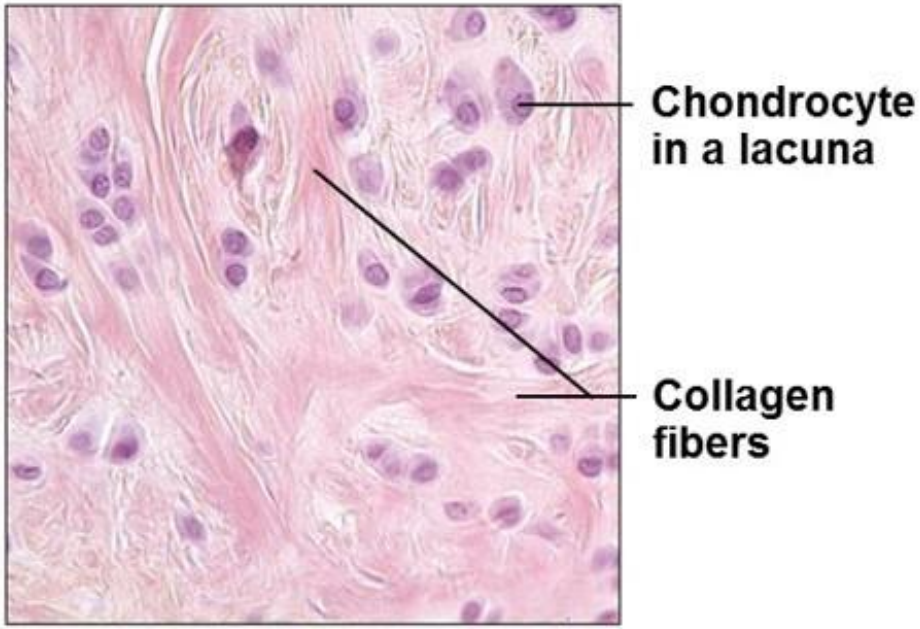



Lateral view

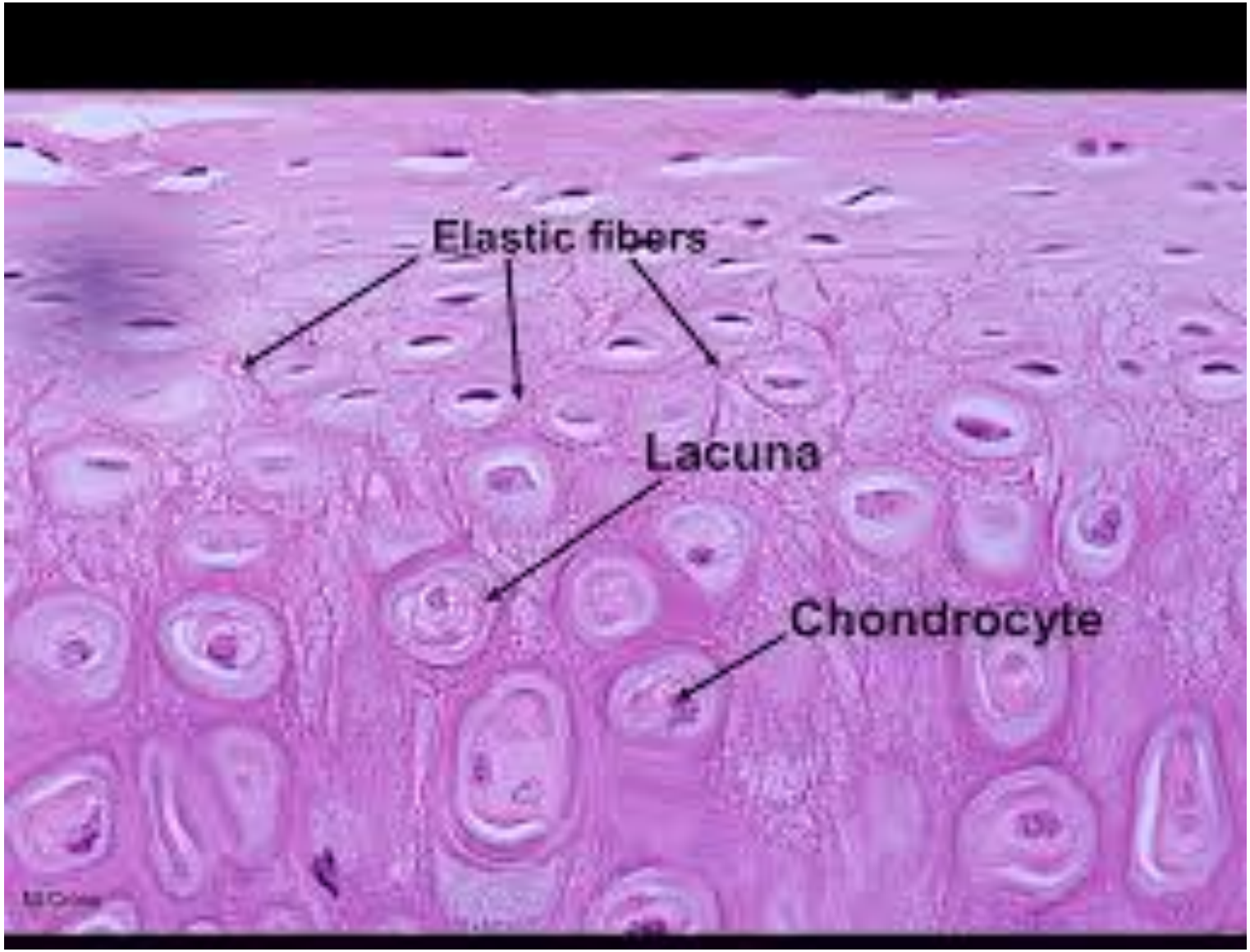

Slide 12 Epiglottis
Elastic cartilage




(a) Hyaline cartilage (260×)




(c) Fibrocartilage (320×)

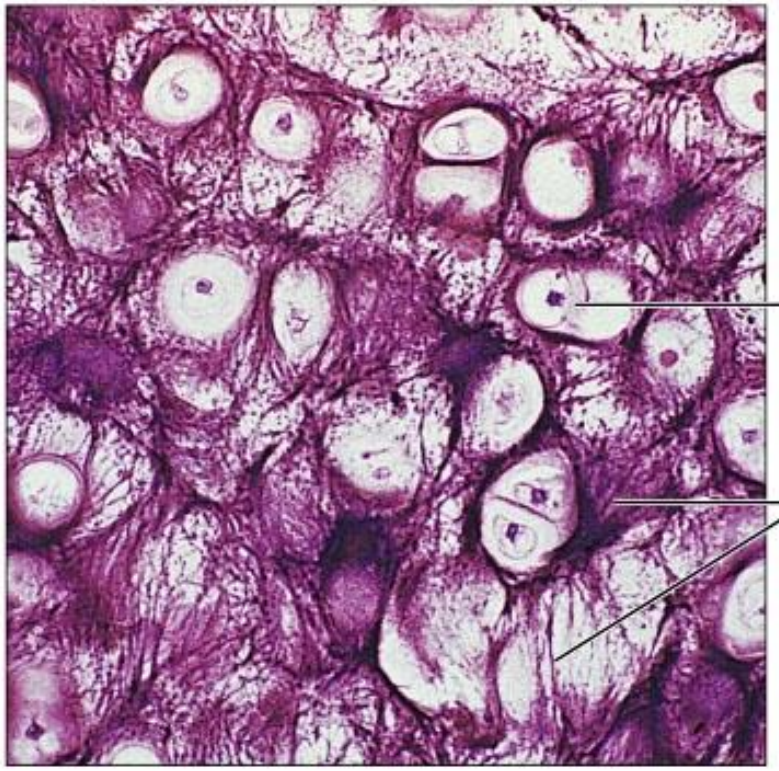

Elastic fibers
Lacuna
Chondrocyte

## (h) Cartilage: elastic

**Description:** Similar to hyaline cartilage, but more elastic fibers in matrix.

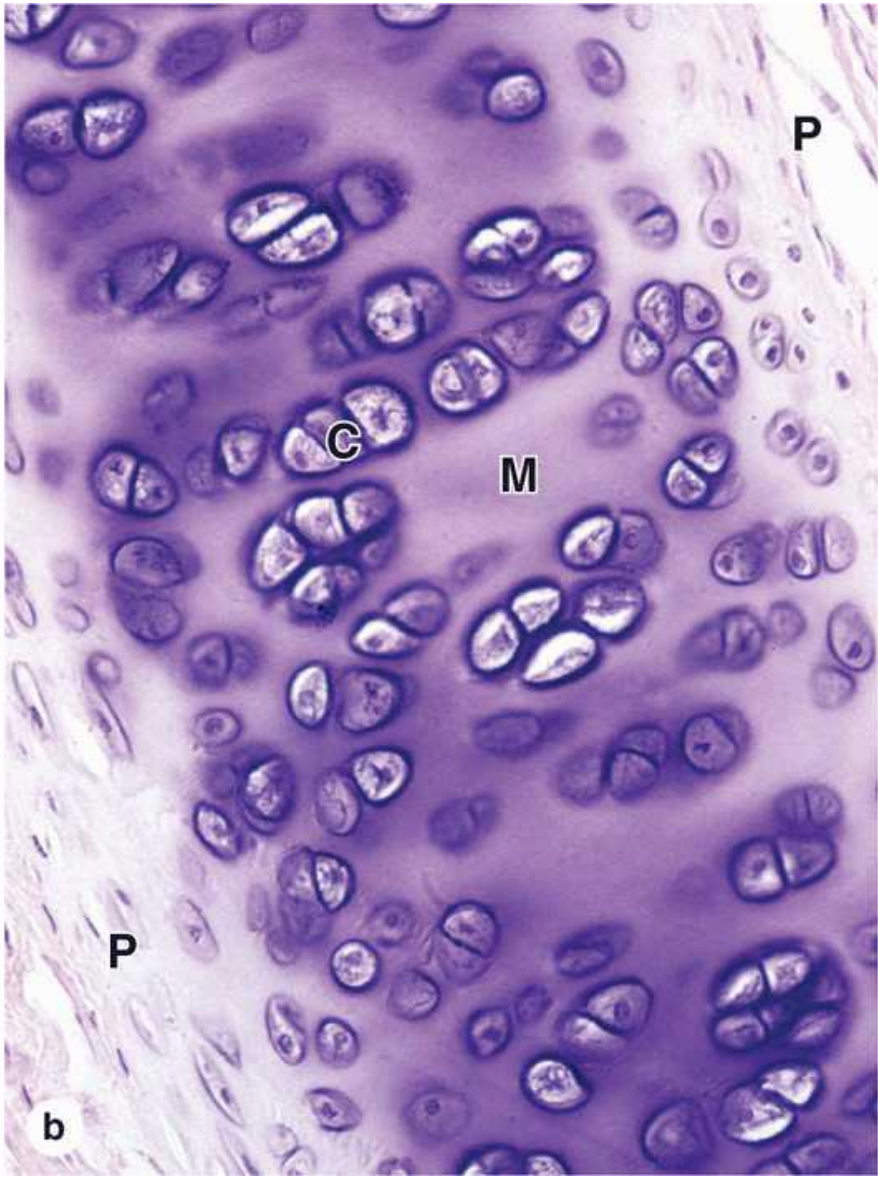
**Function:** Maintains the shape of a structure while allowing great flexibility.

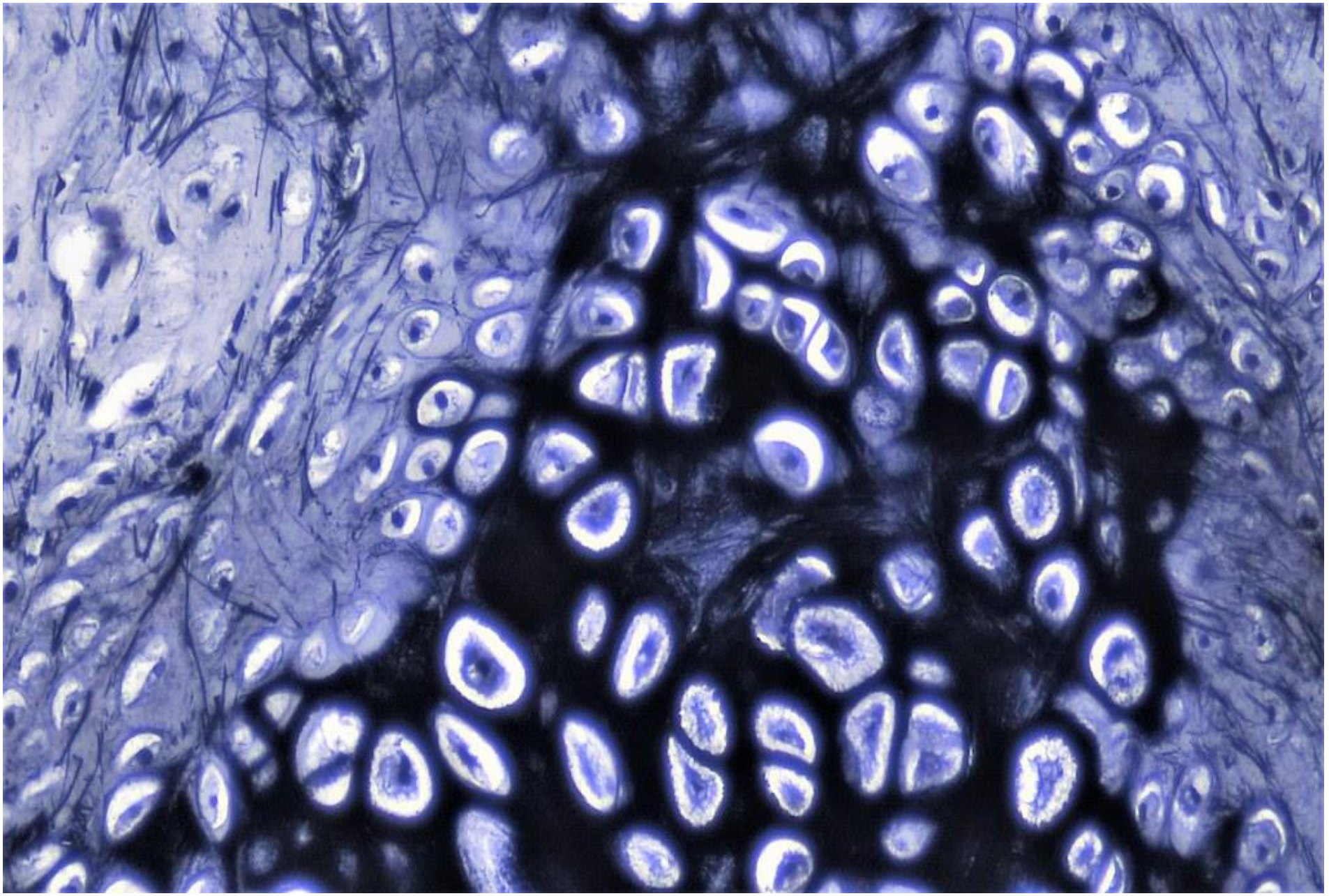
**Location:** Supports the external ear (pinna); epiglottis.

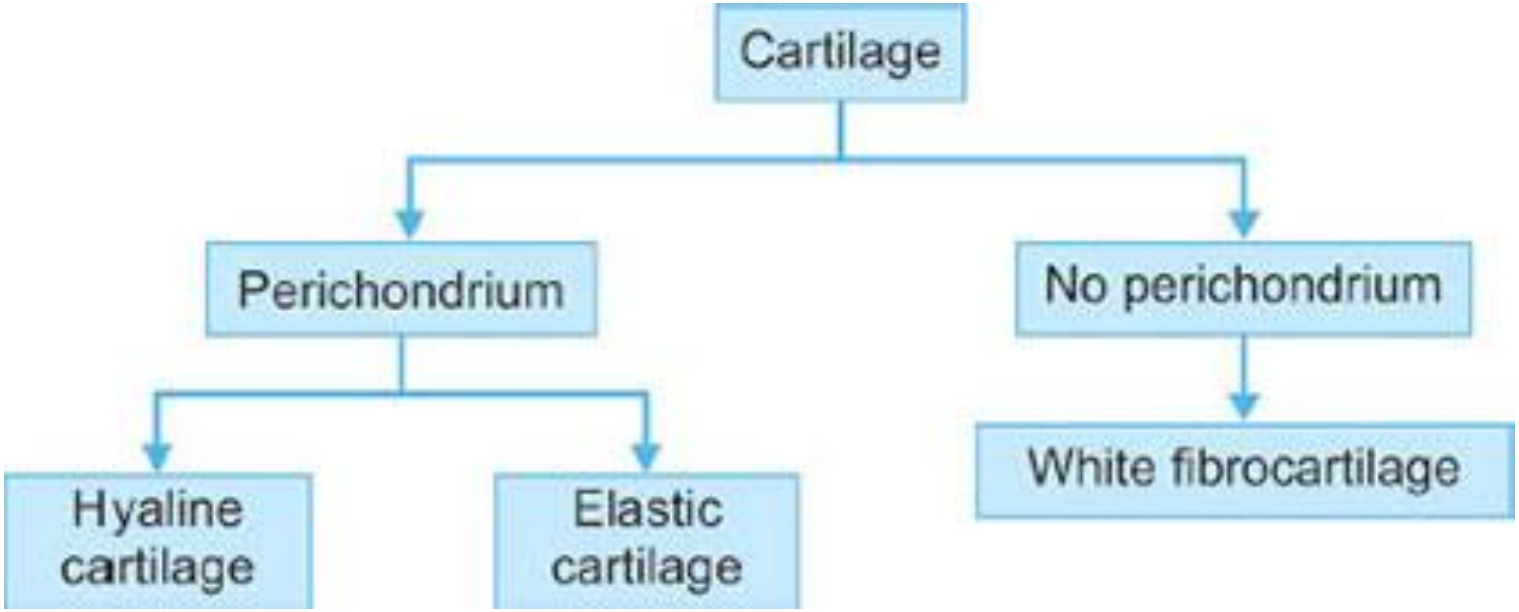



**Photomicrograph:** Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (400×).

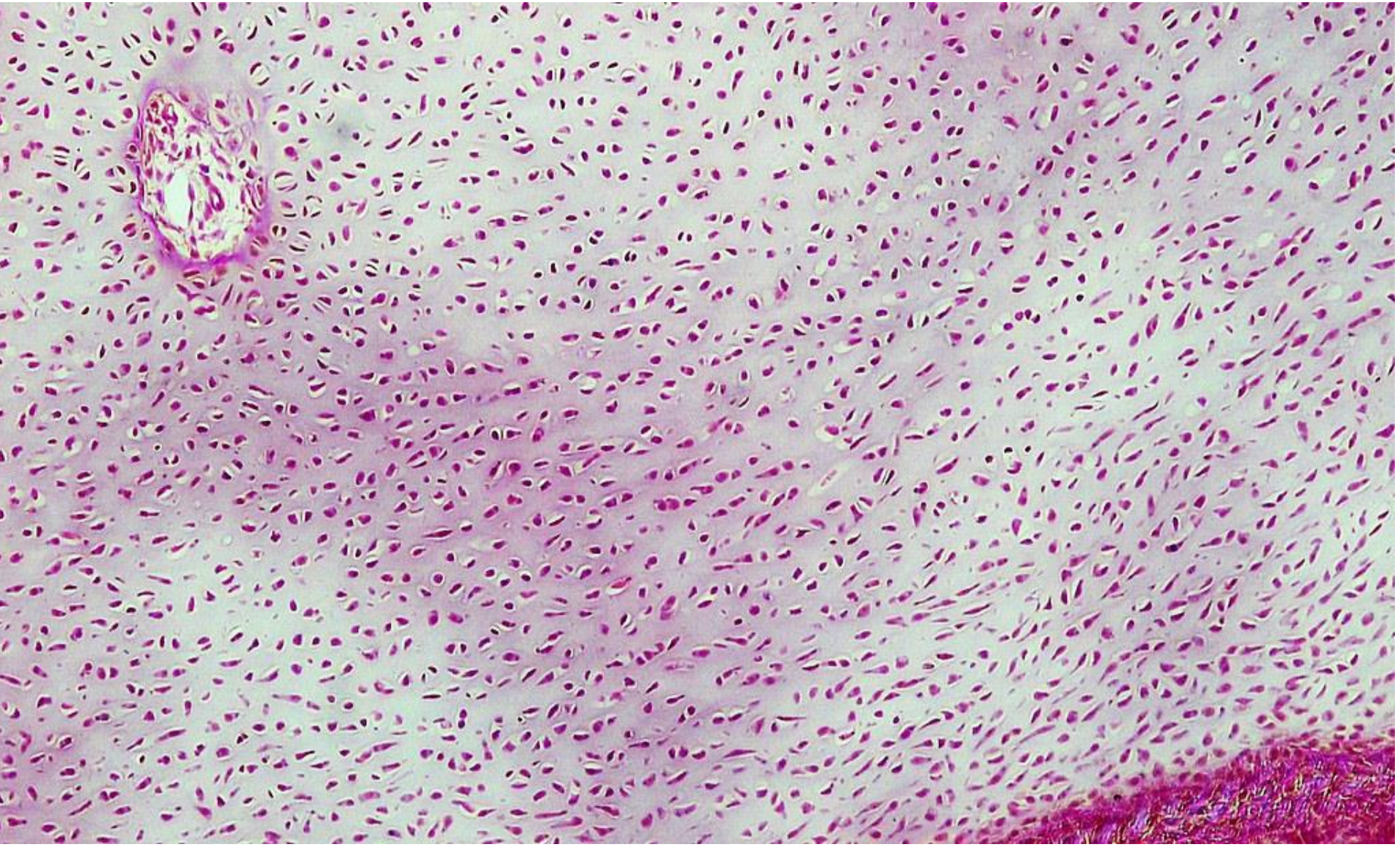

P
C
M
C

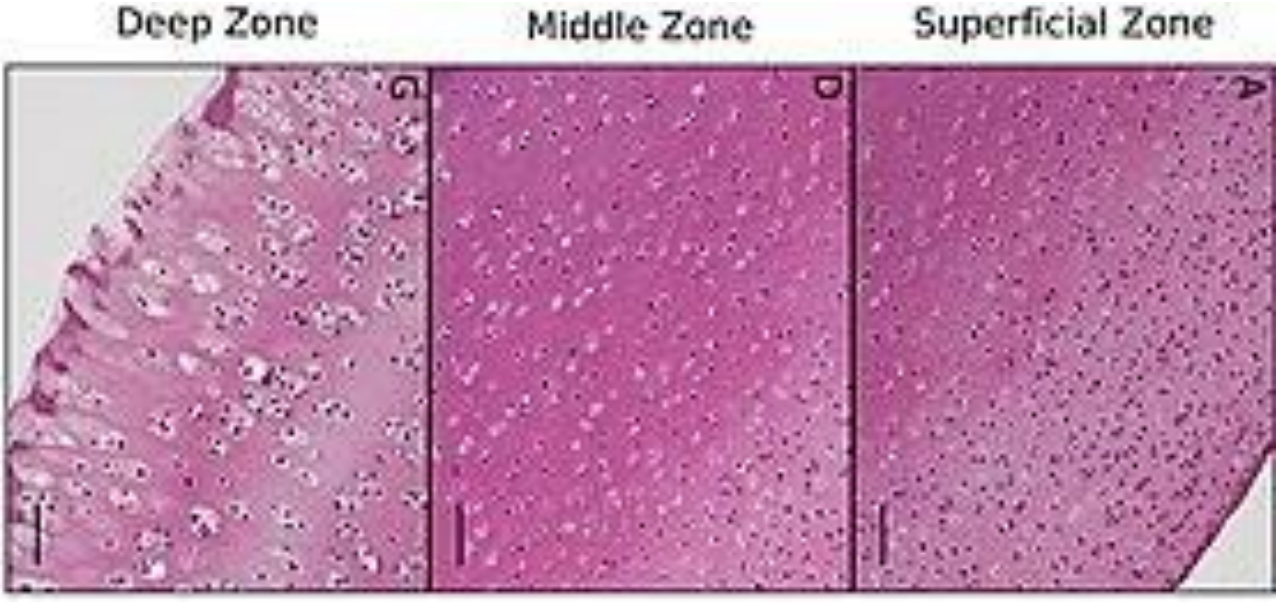

P
C
M
P
b

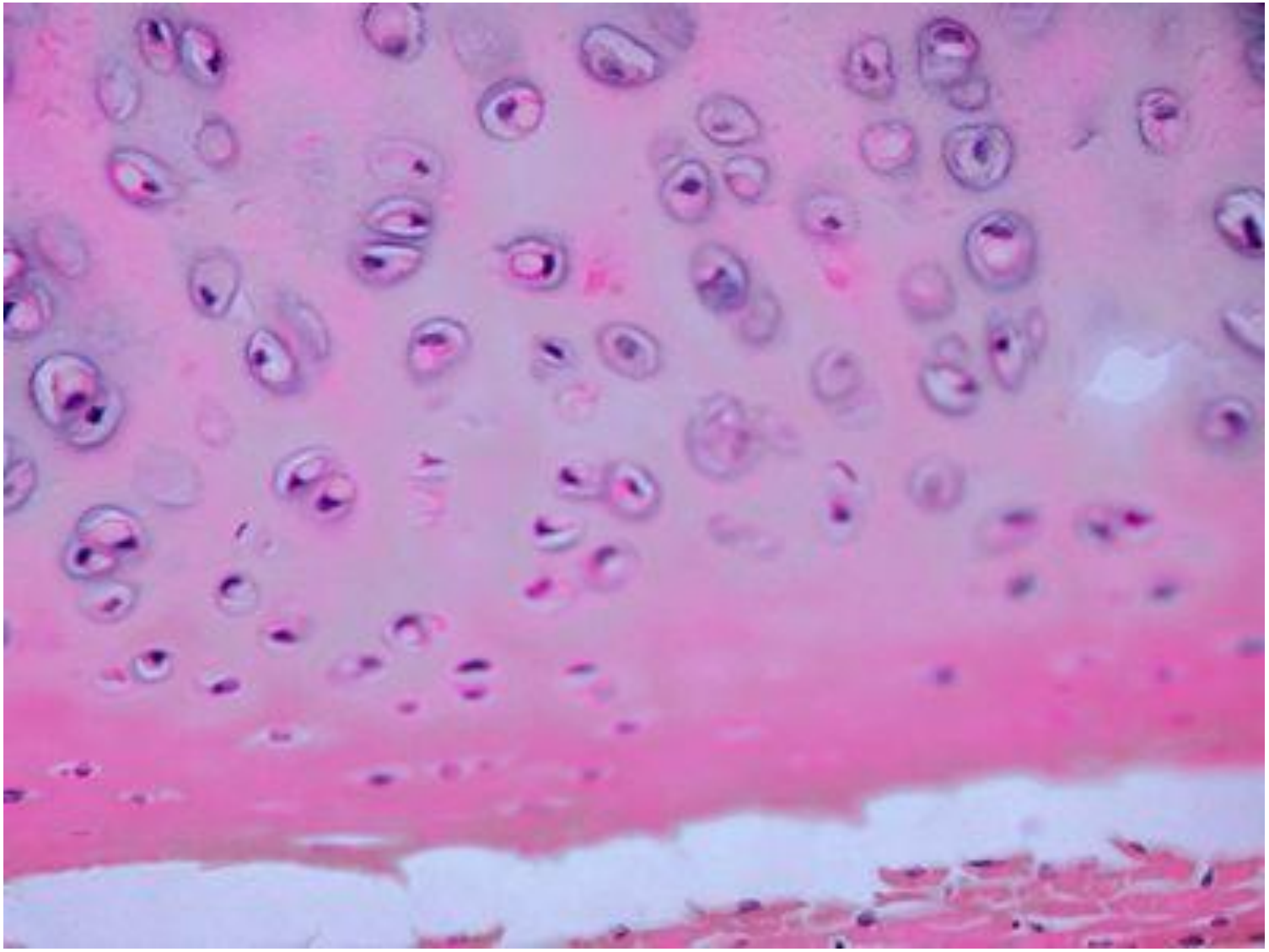


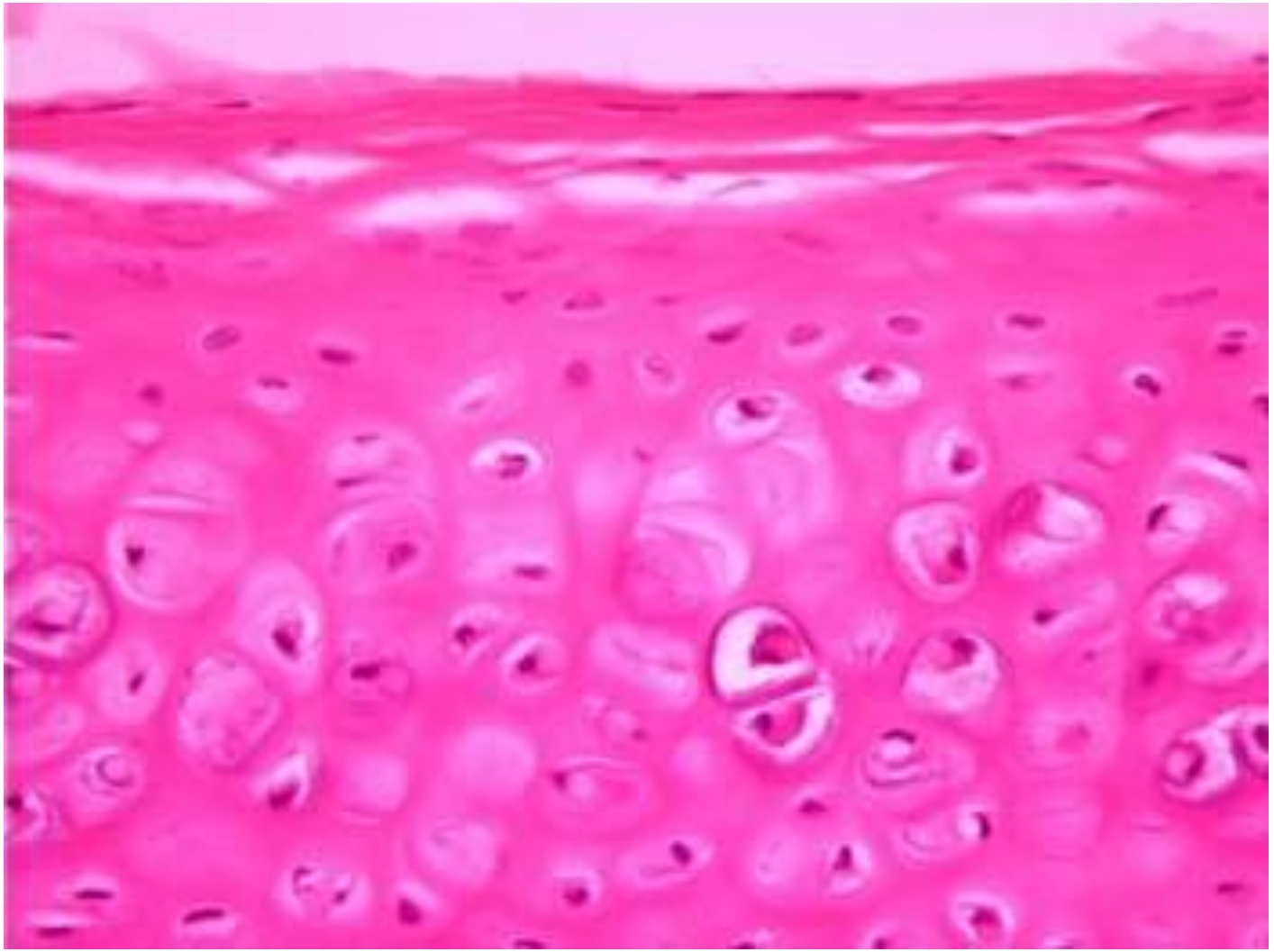

Cartilage
Perichondrium
No perichondrium
Hyaline cartilage
Elastic cartilage
White fibrocartilage

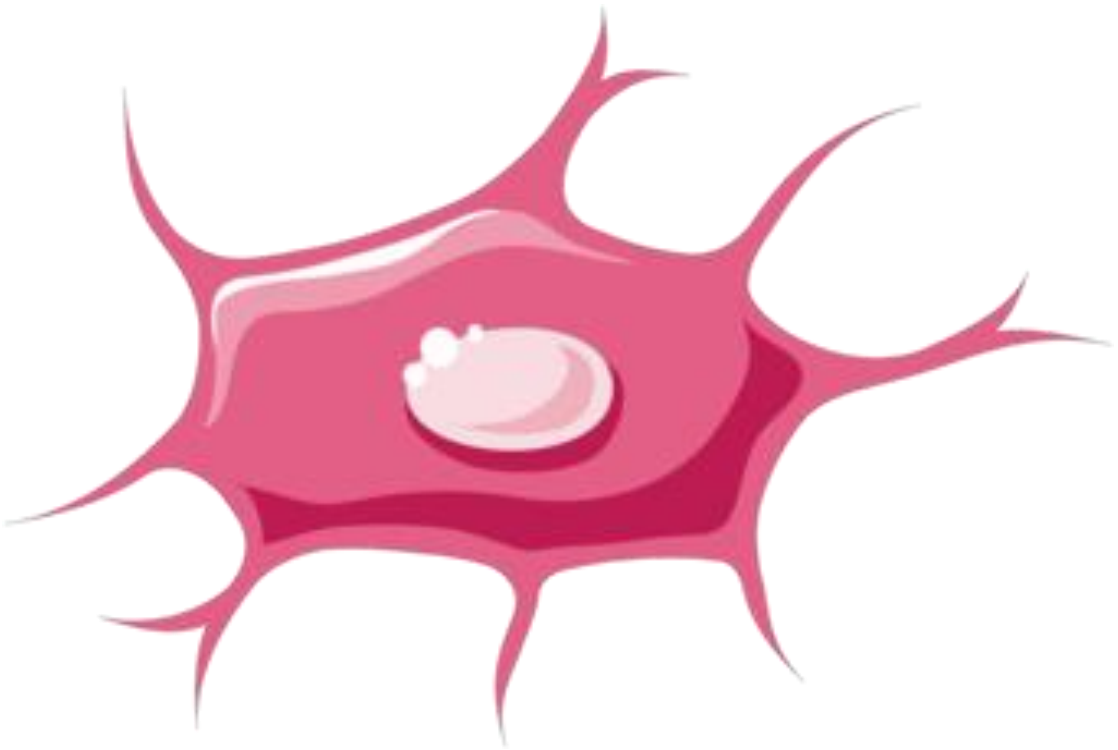

Sometimes you've gotta
fall before you fly

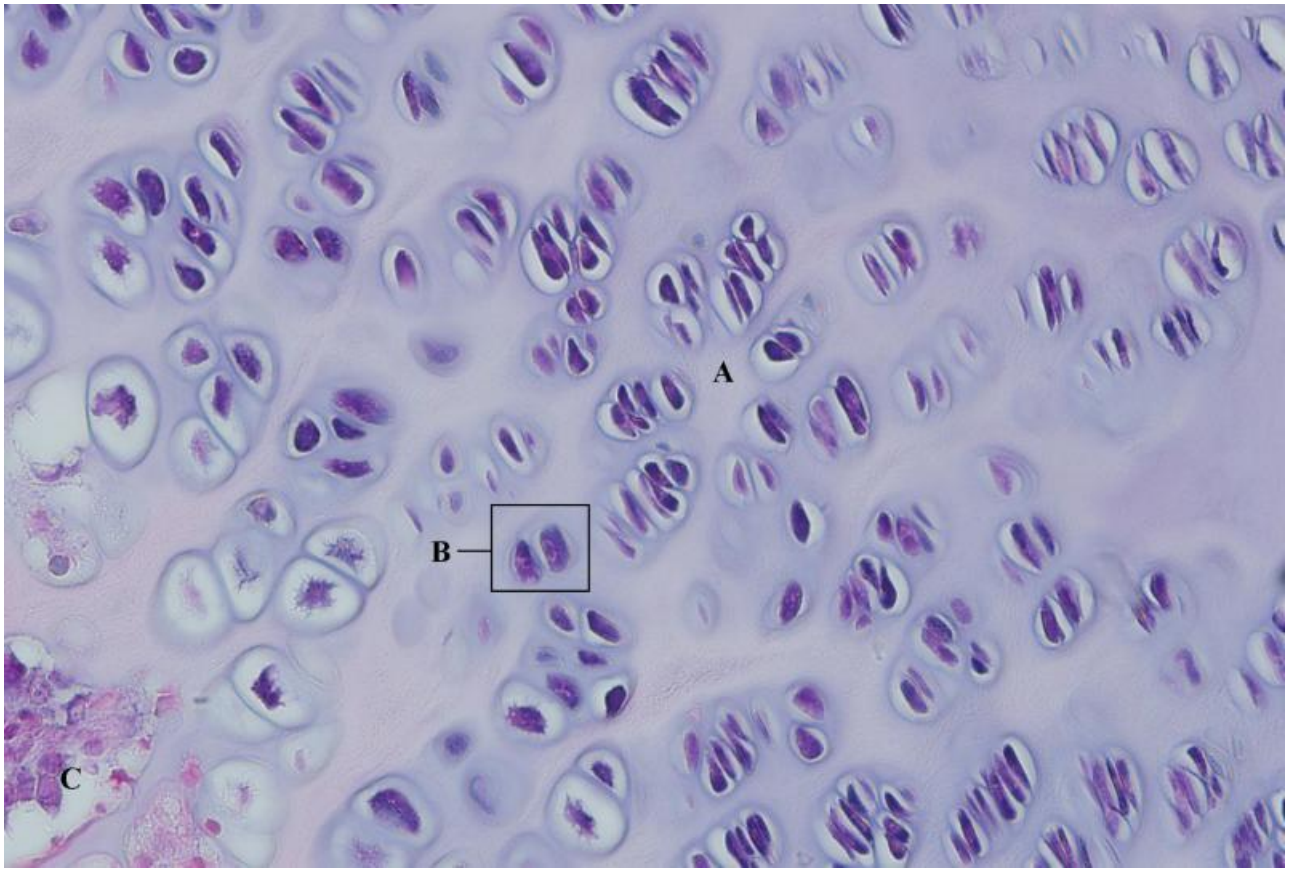


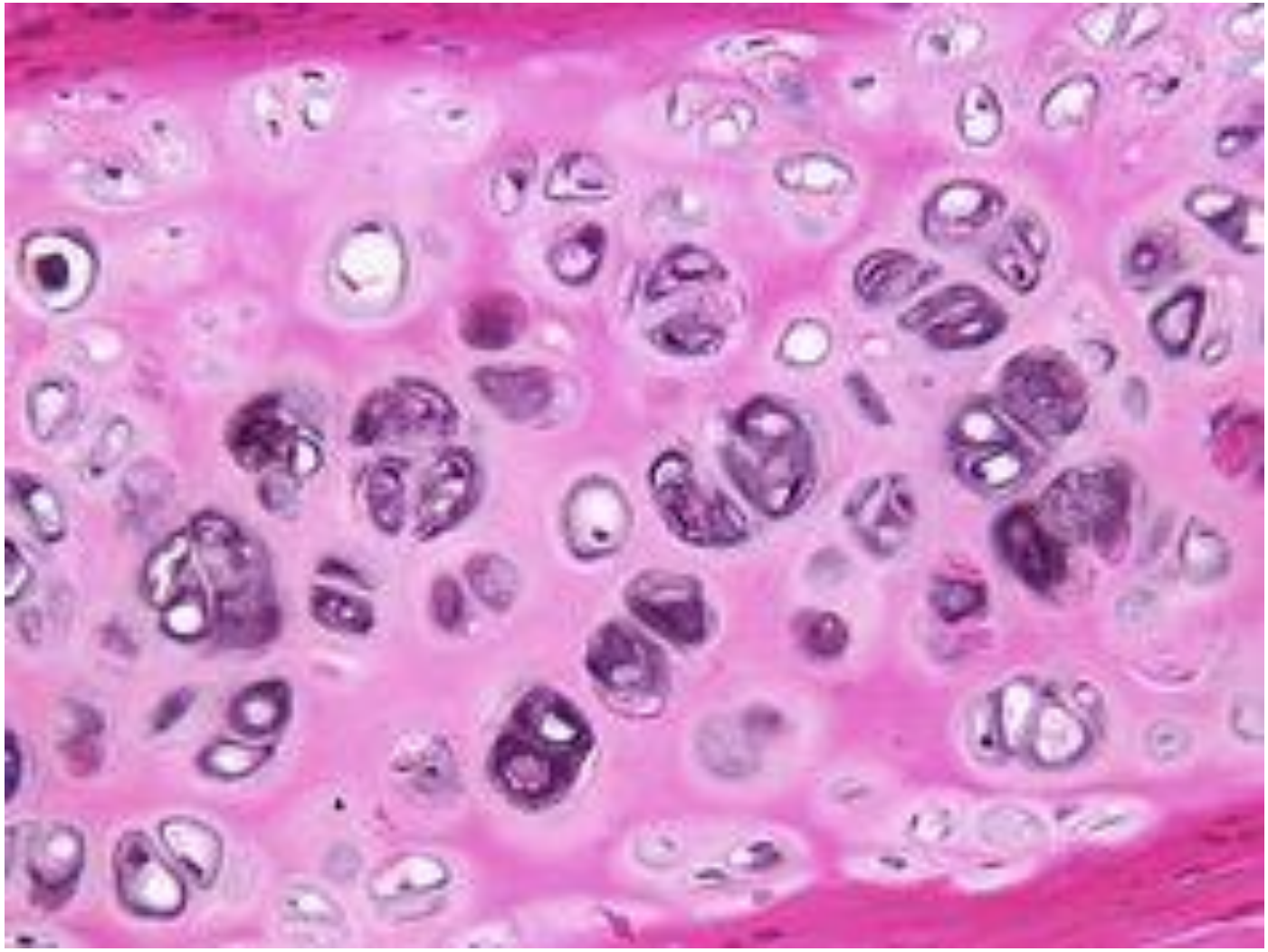

Deep Zone
Middle Zone
Superficial Zone



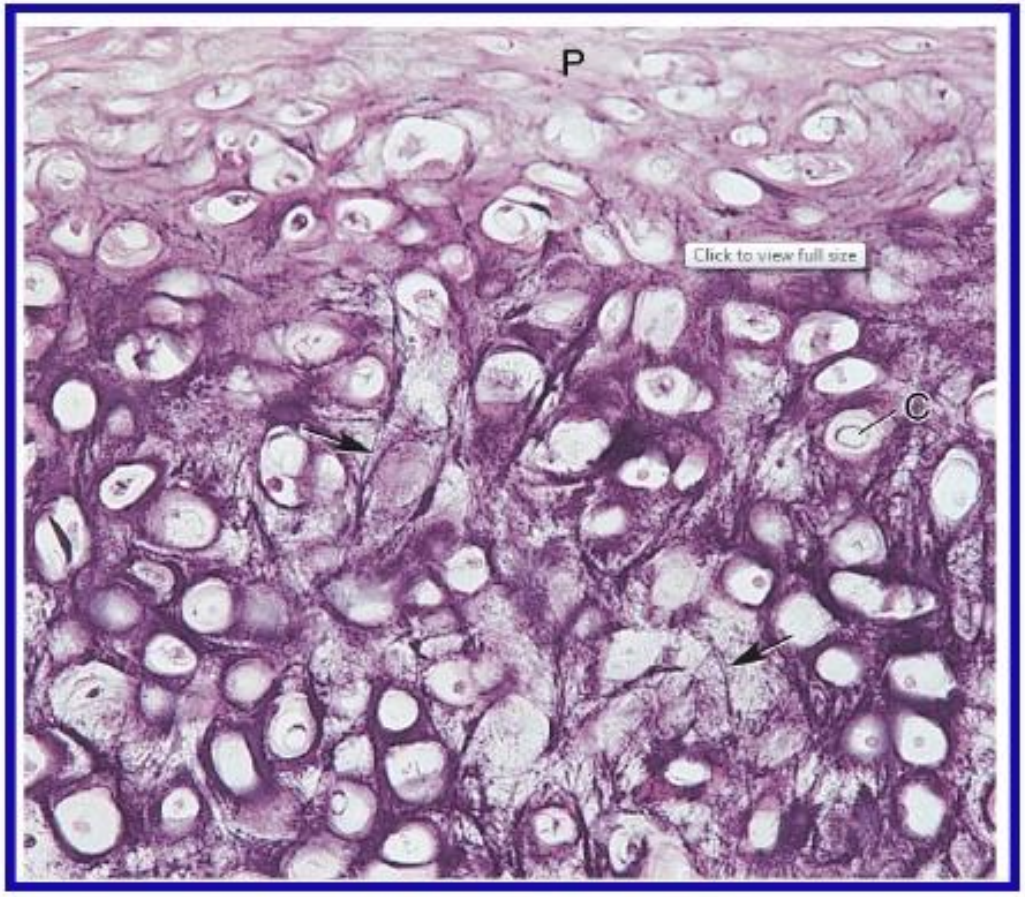


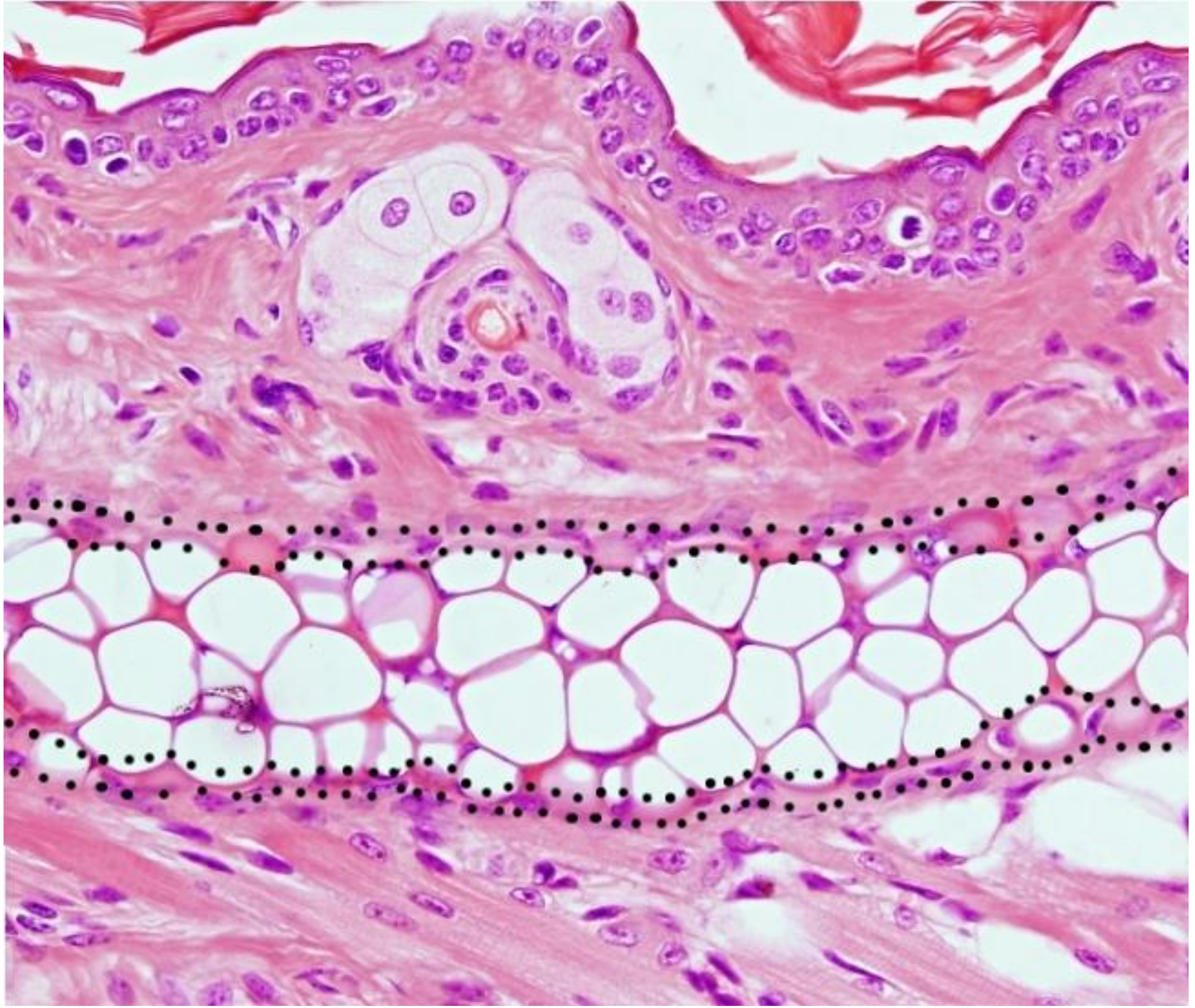


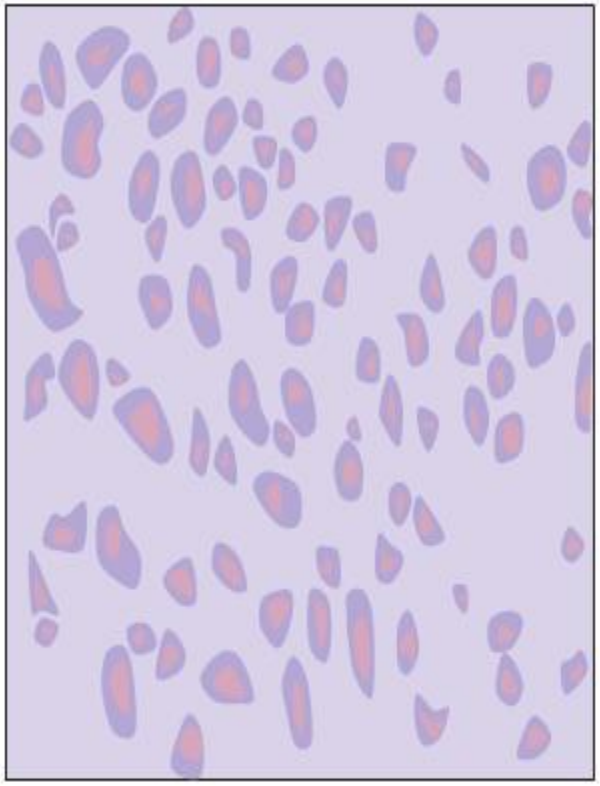

A
B
C



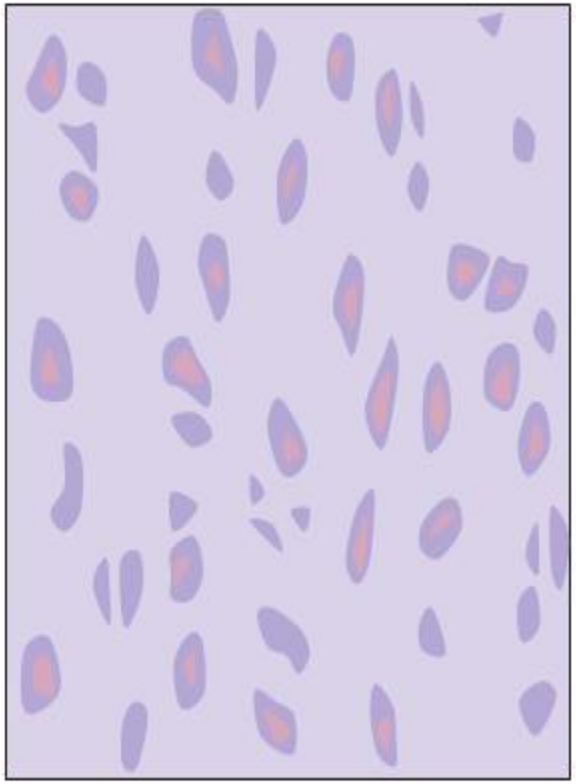
# ELASTIC CARTILAGE





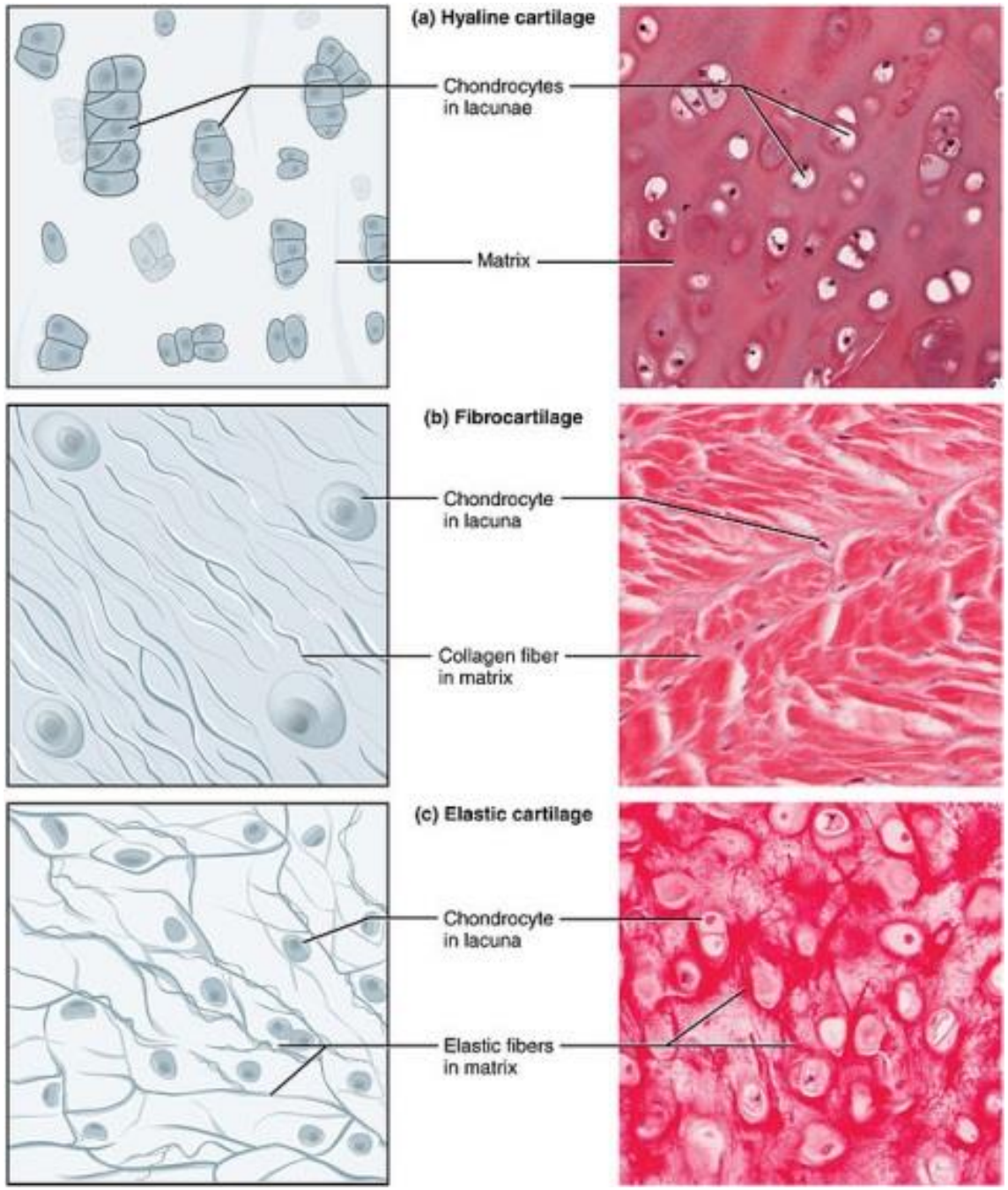


A. Elastic Cartilage

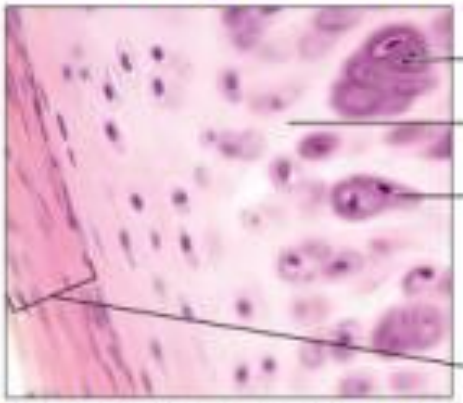


B. Hyaline Cartilage

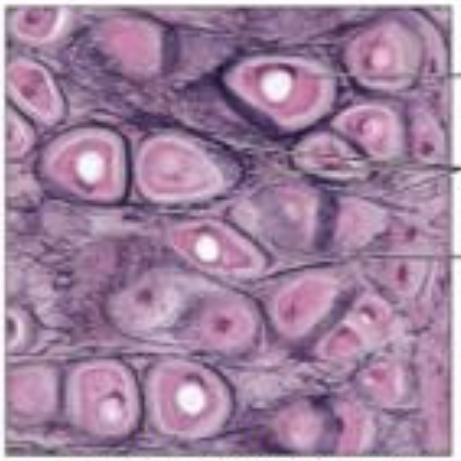
C. Fibrous Cartilage


(a) Hyaline cartilage
Chondrocytes in lacunae
Matrix
(b) Fibrocartilage
Chondrocyte in lacuna
Collagen fiber in matrix
(c) Elastic cartilage
Chondrocyte in lacuna
Elastic fibers in matrix

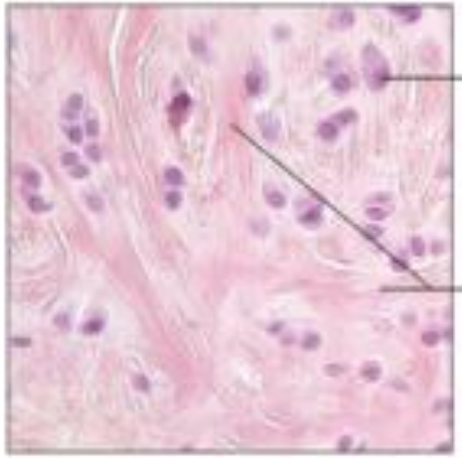
# Cartilages in the Adult Body




(a) Hyaline cartilage (180×)

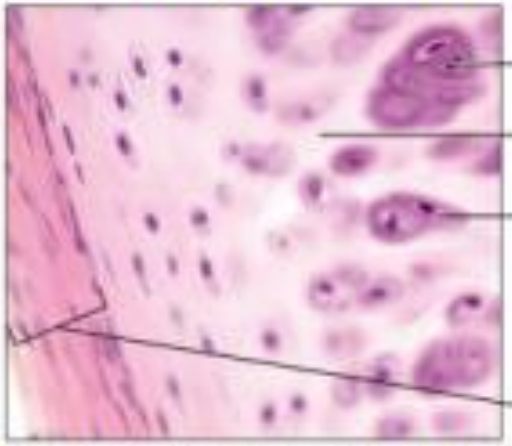



(b) Elastic cartilage (470×)

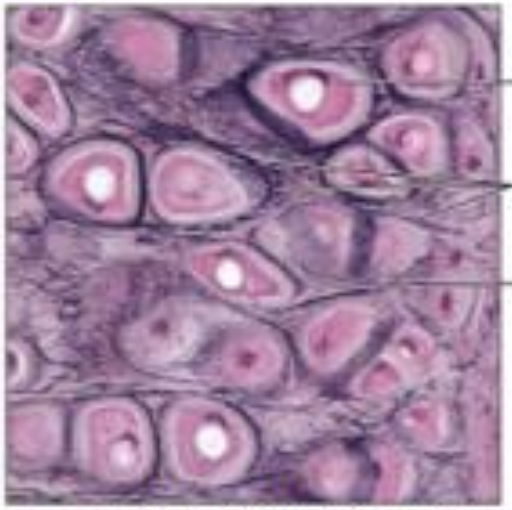



(c) Fibrocartilage (285×)

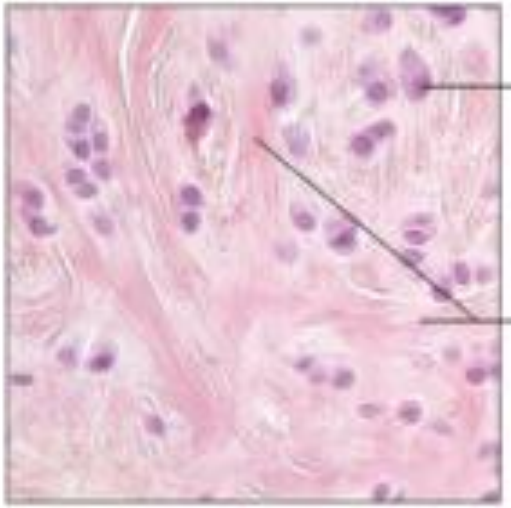
# Cartilages in the Adult Body




(a) Hyaline cartilage (180×)

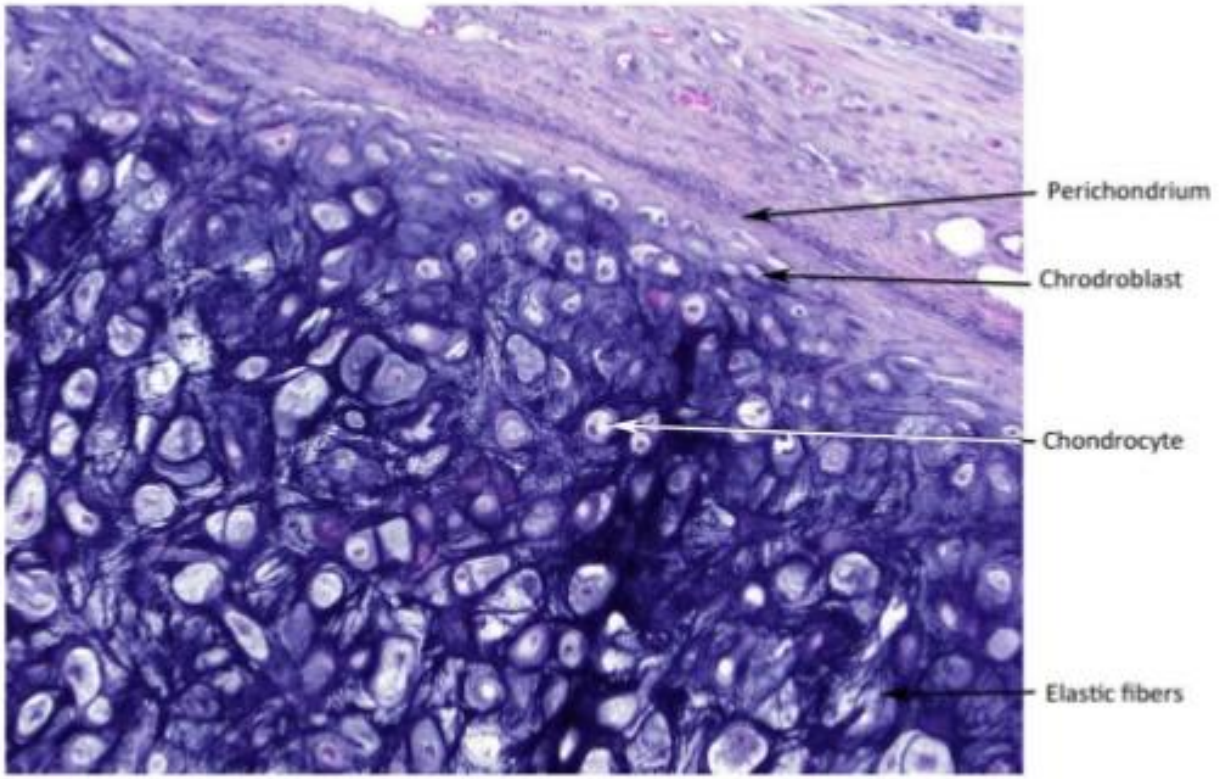


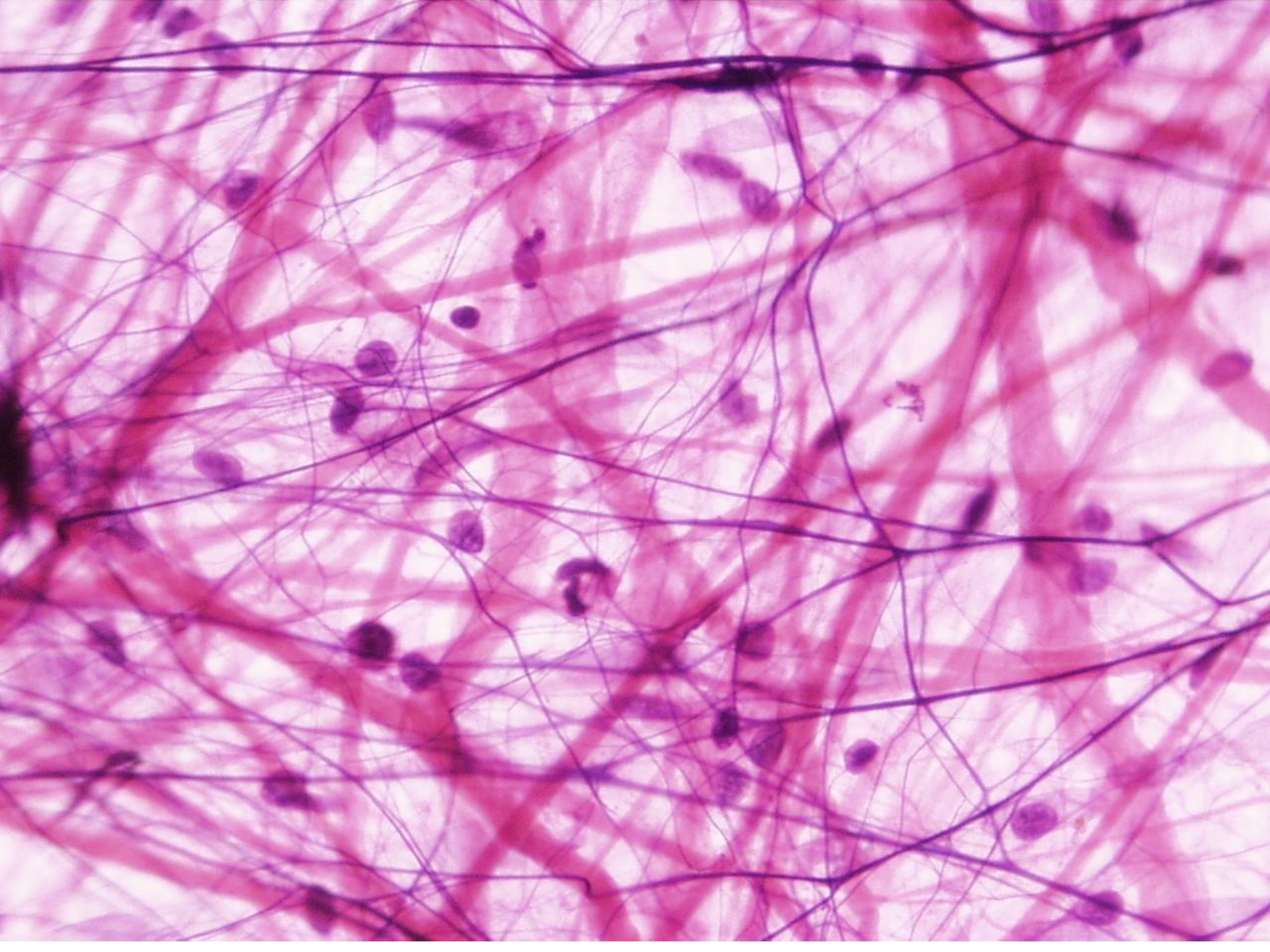

(b) Elastic cartilage (470×)

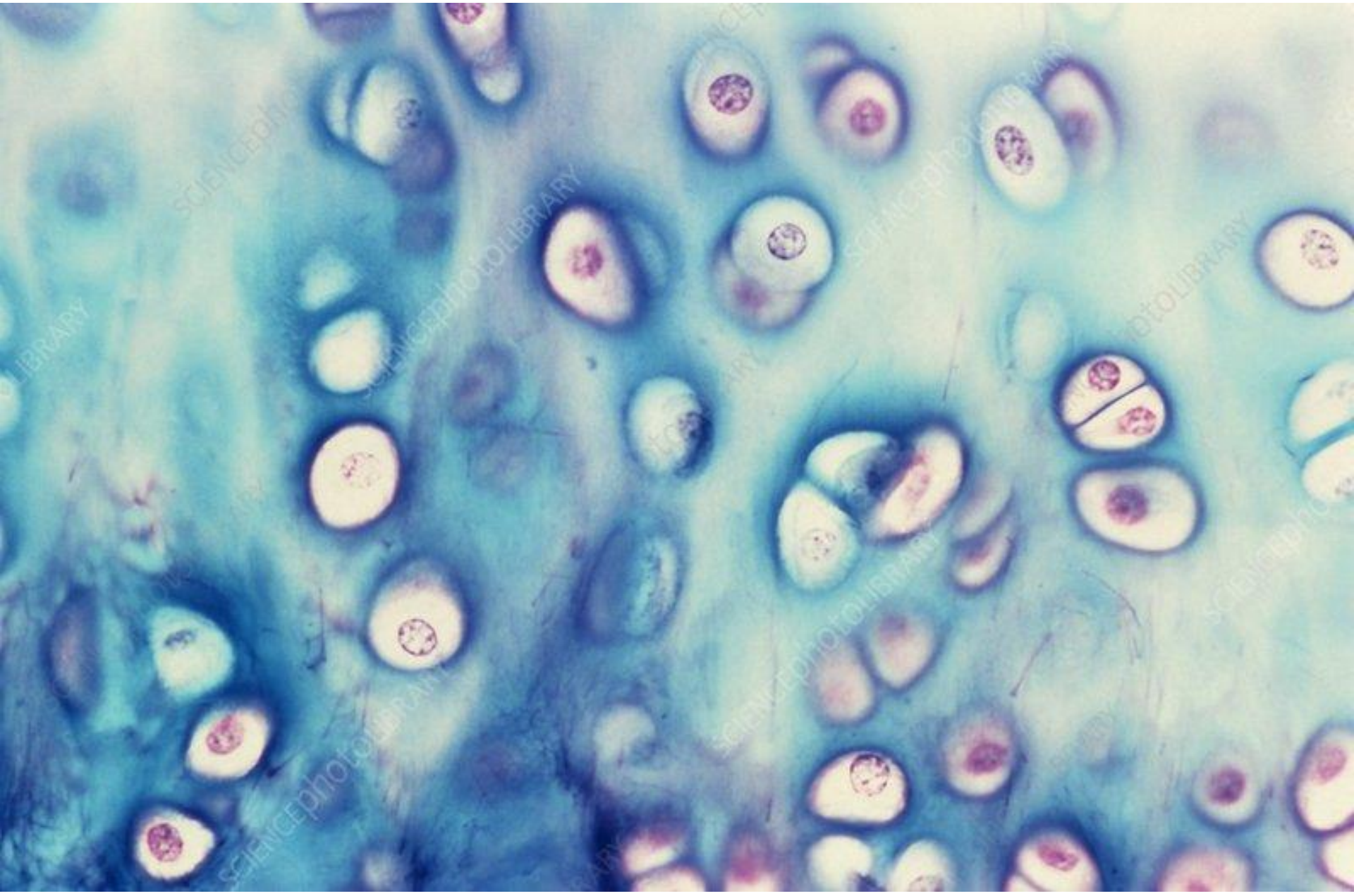


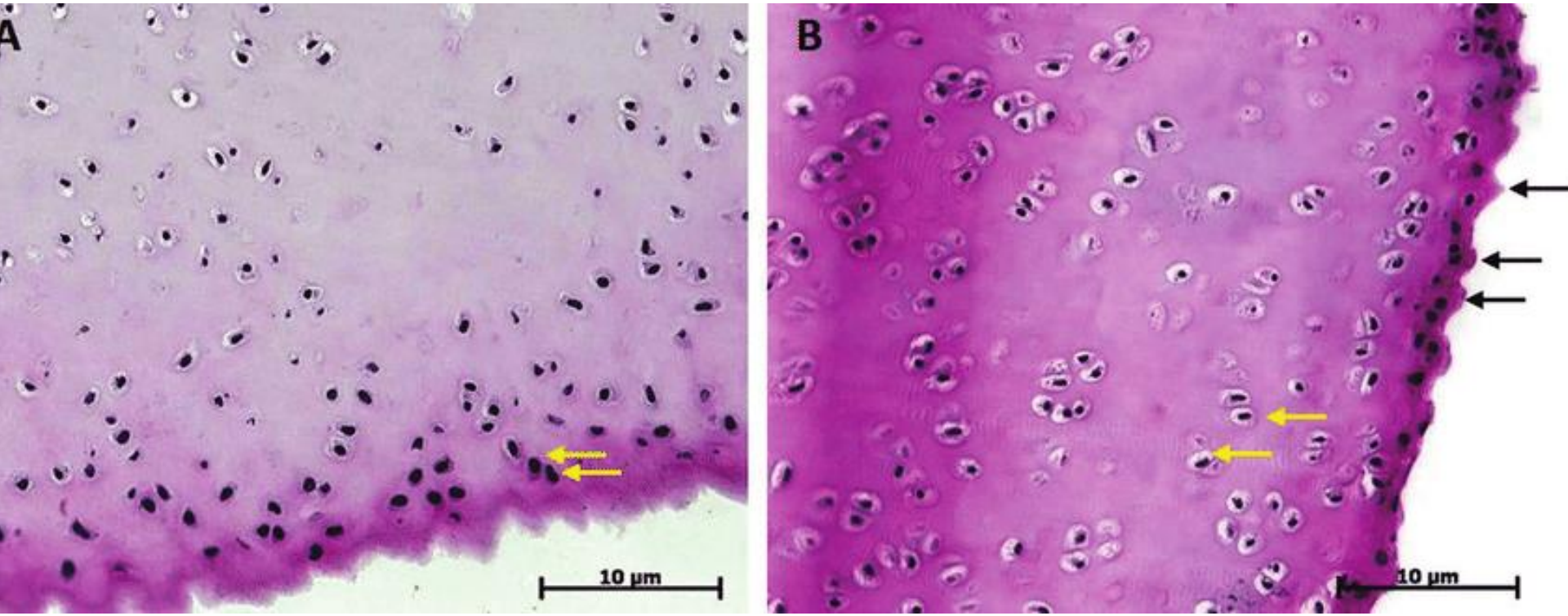

(c) Fibrocartilage (285×)

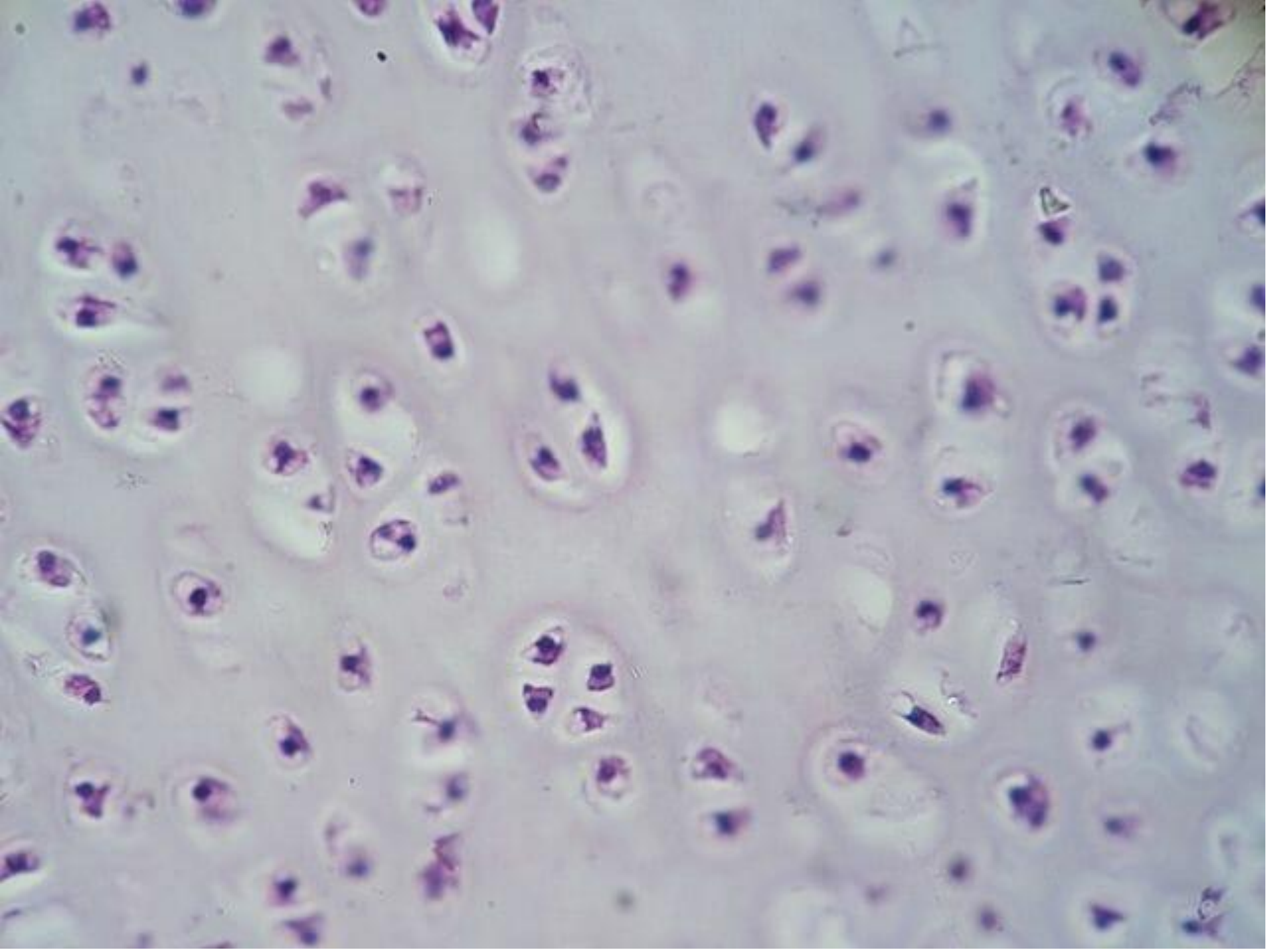
# ELASTIC CARTILAGE



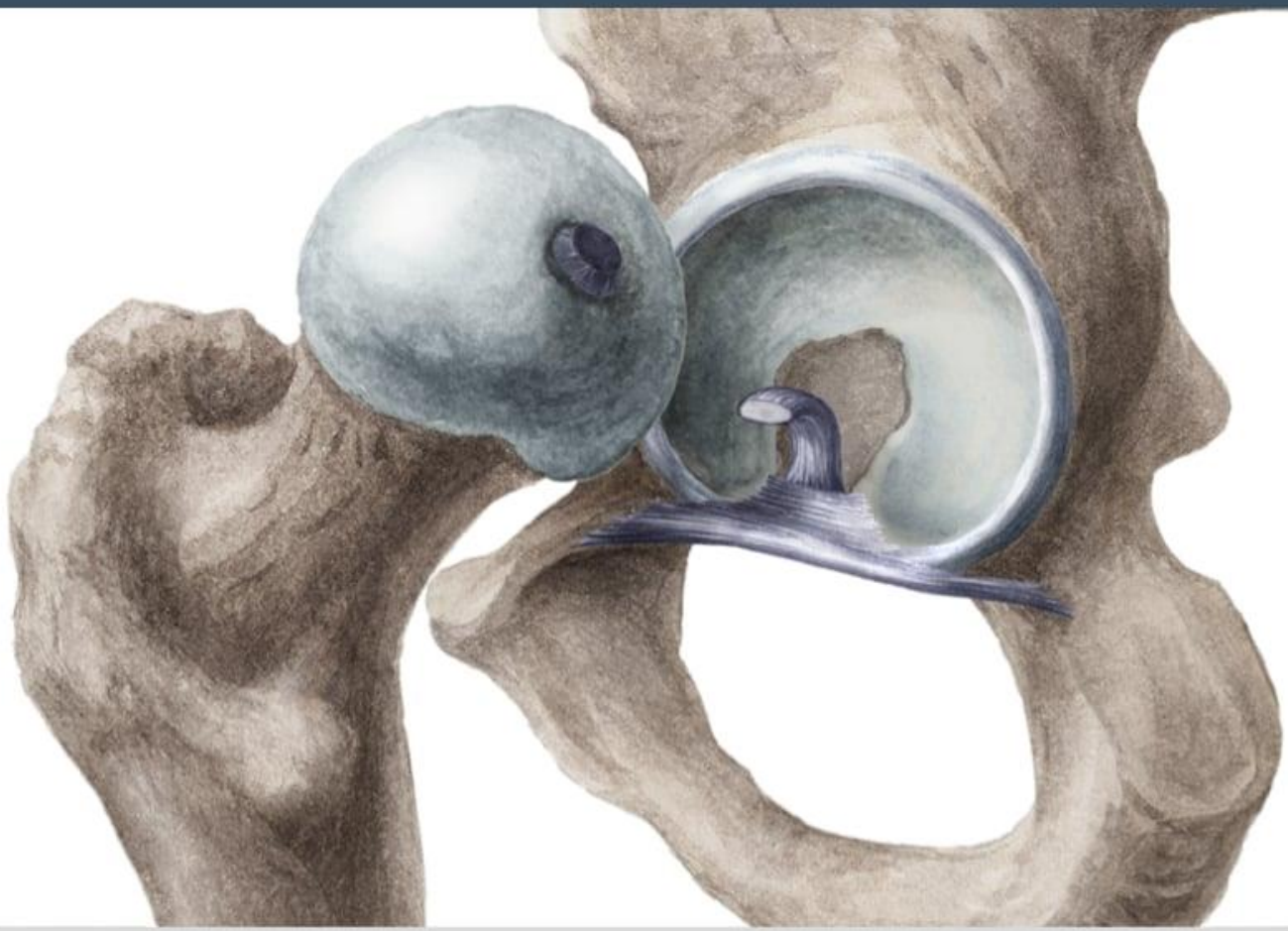




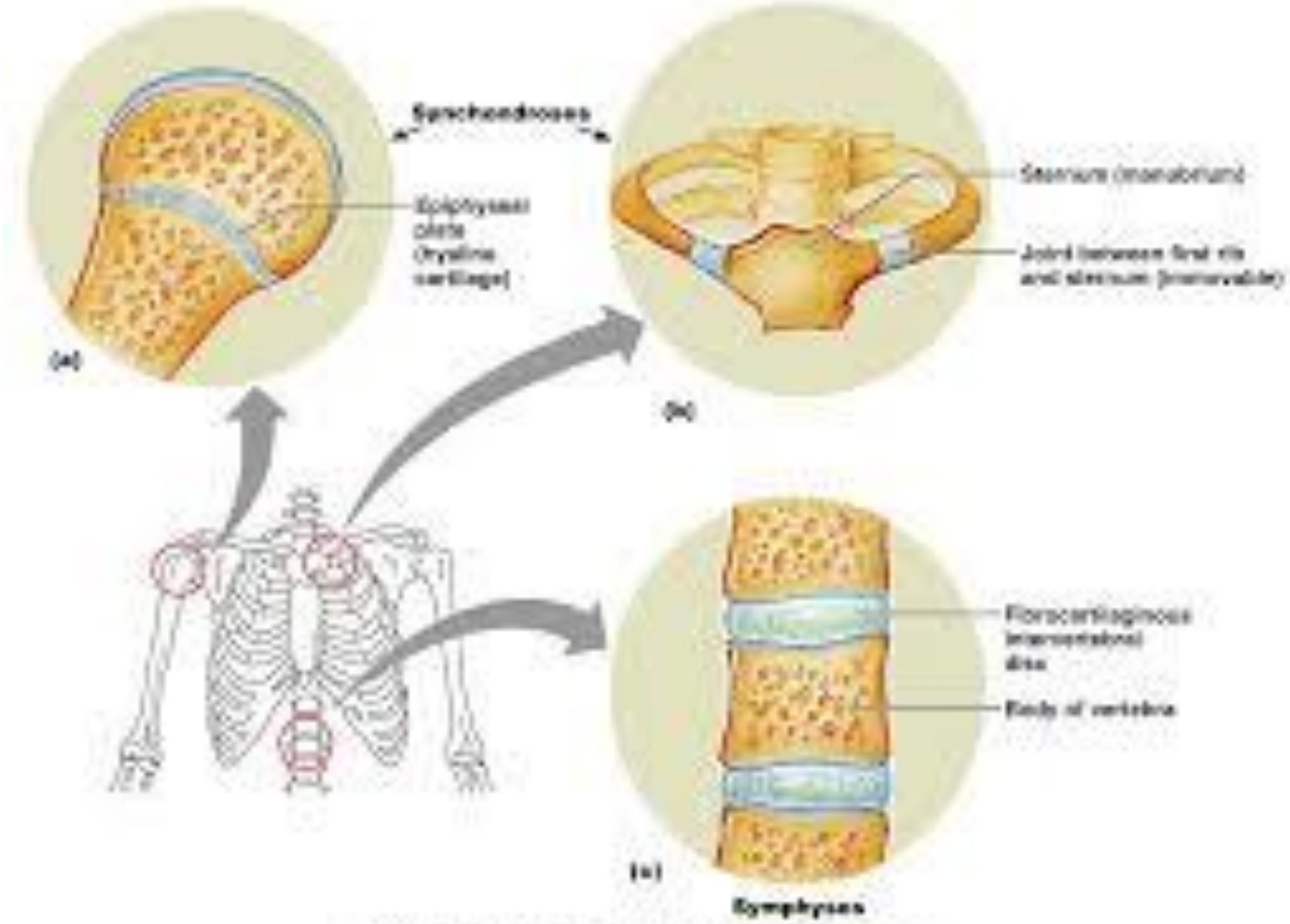

A
10 µm
B
10 µm

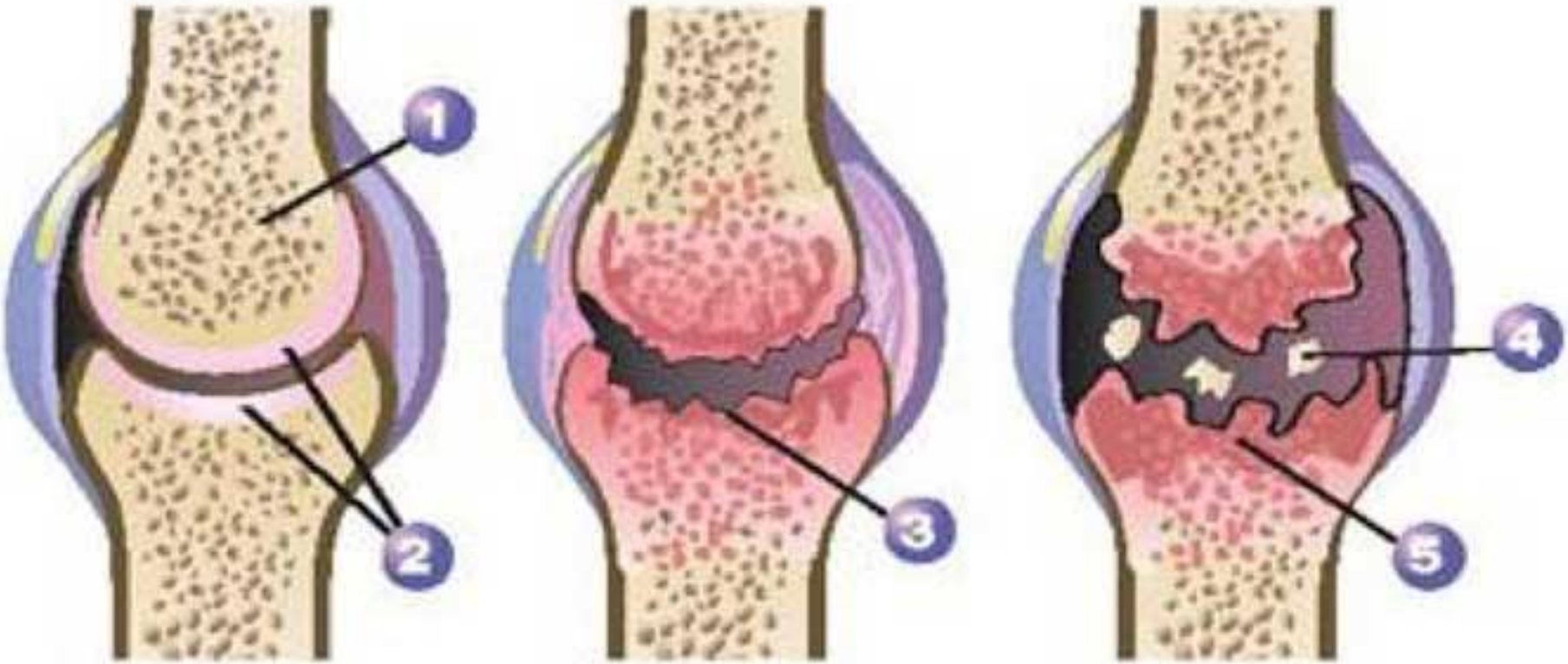


# What is cartilage

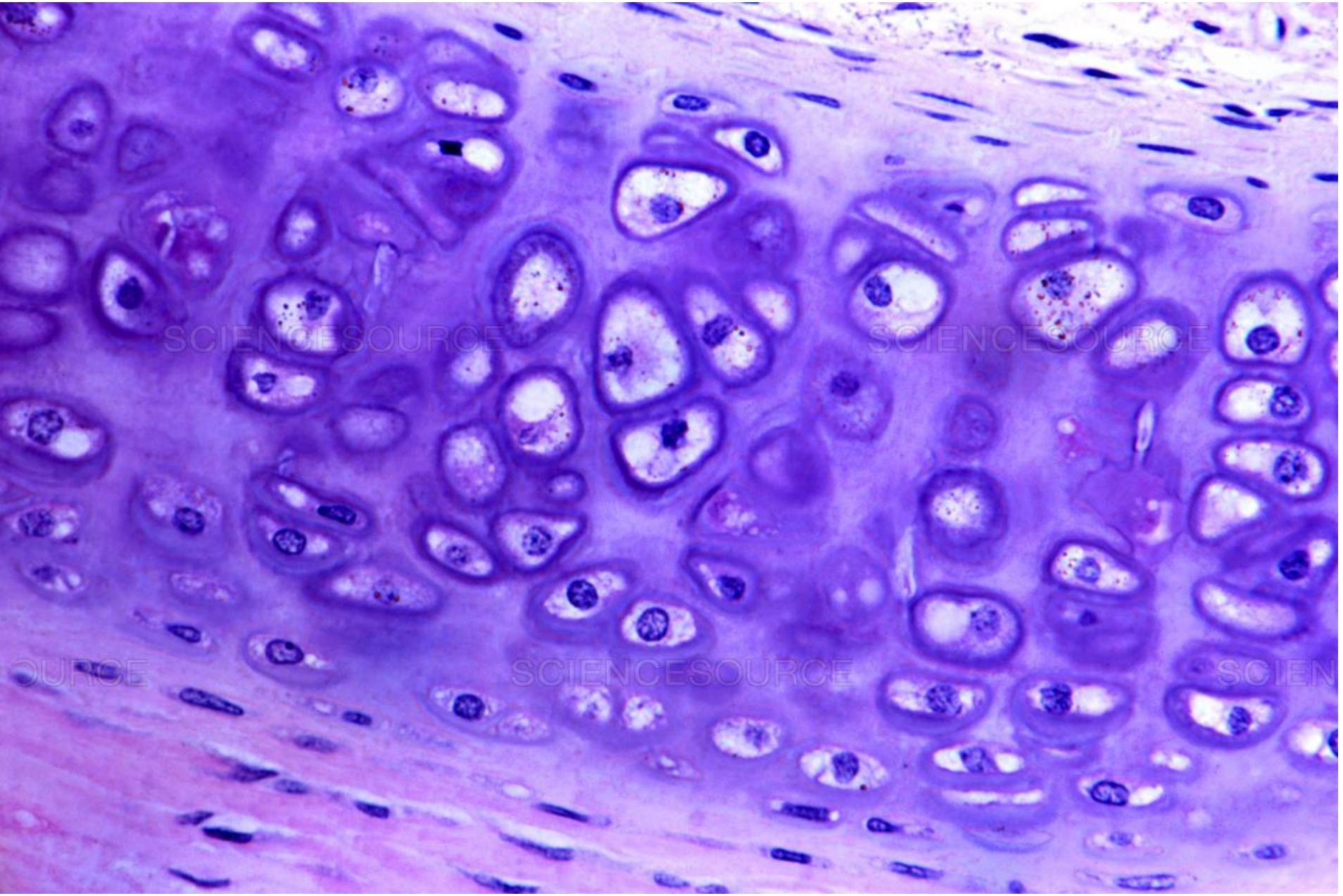


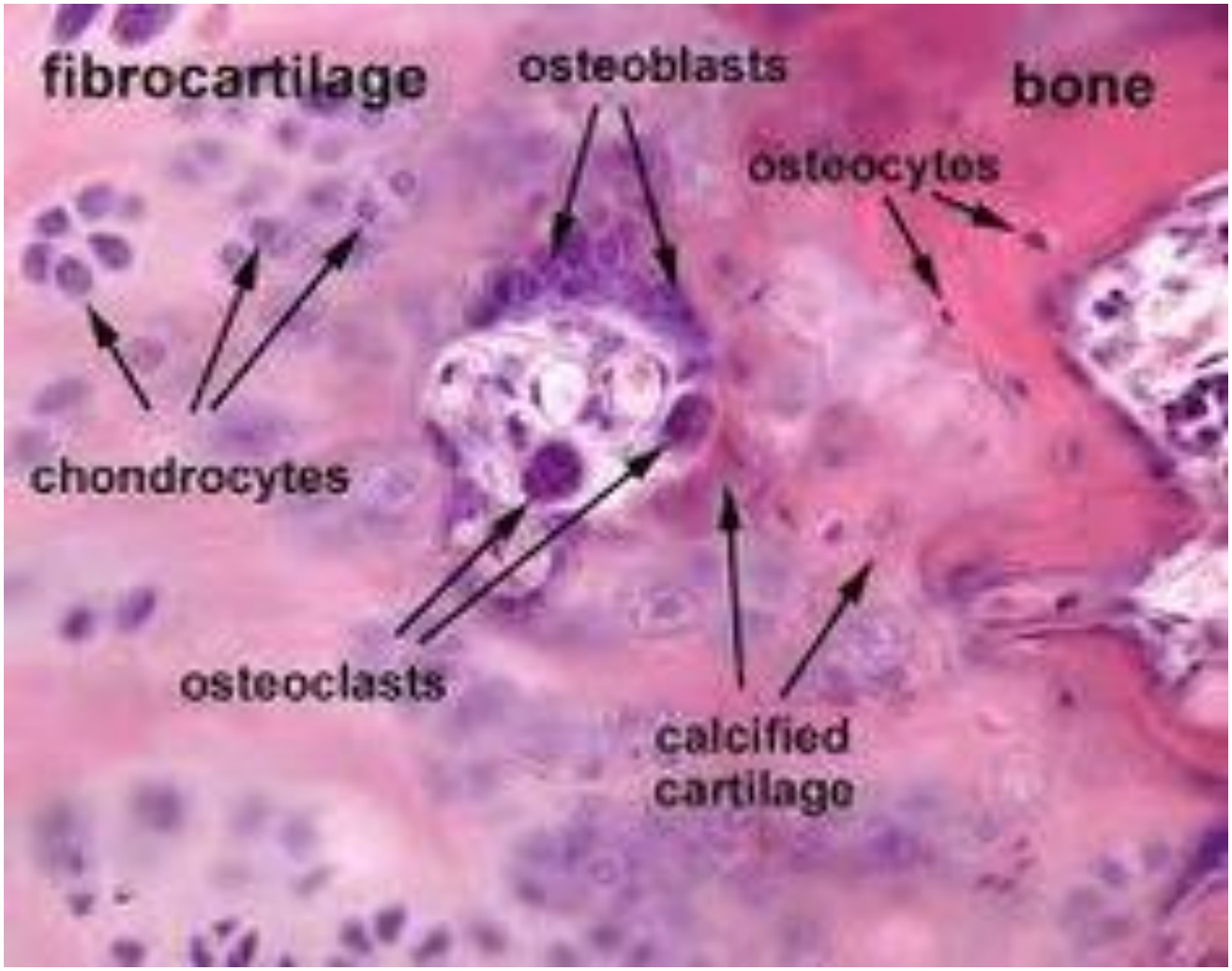
K


Synchondroses
(a)
(b)
(c)
Symphyses




1. Bone
2. Cartilage
3. Thinning of cartilage
4. Cartilage remnants
5. Destruction of cartilage




fibrocartilage
osteoblasts
bone
osteocytes
chondrocytes
osteoclasts
calcified
cartilage

# CARTILAGE TYPES

## Elastic Cartilage
*is the most flexible*

*Ear*

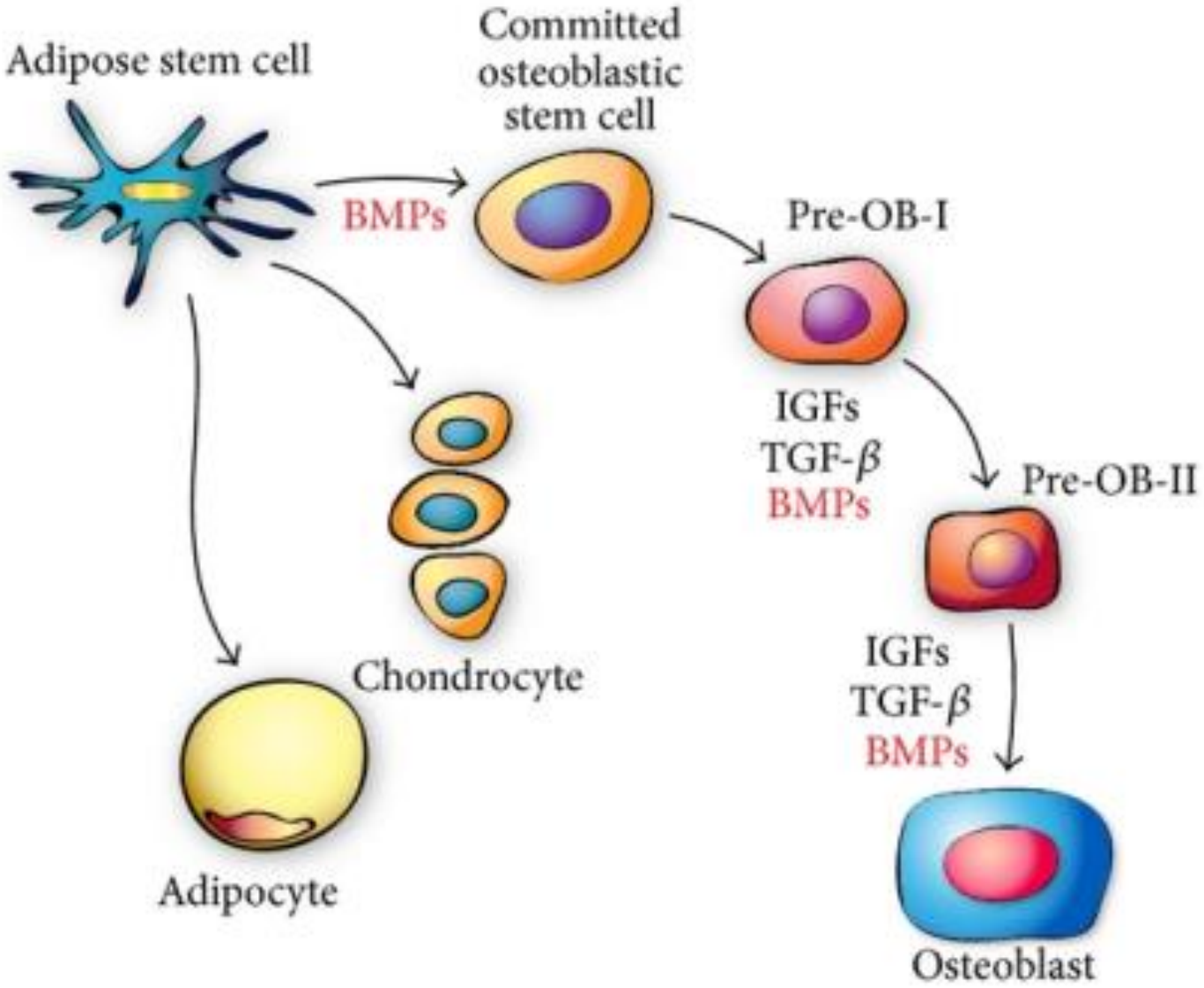
## Hyaline Cartilage
*is the 2nd most flexible*

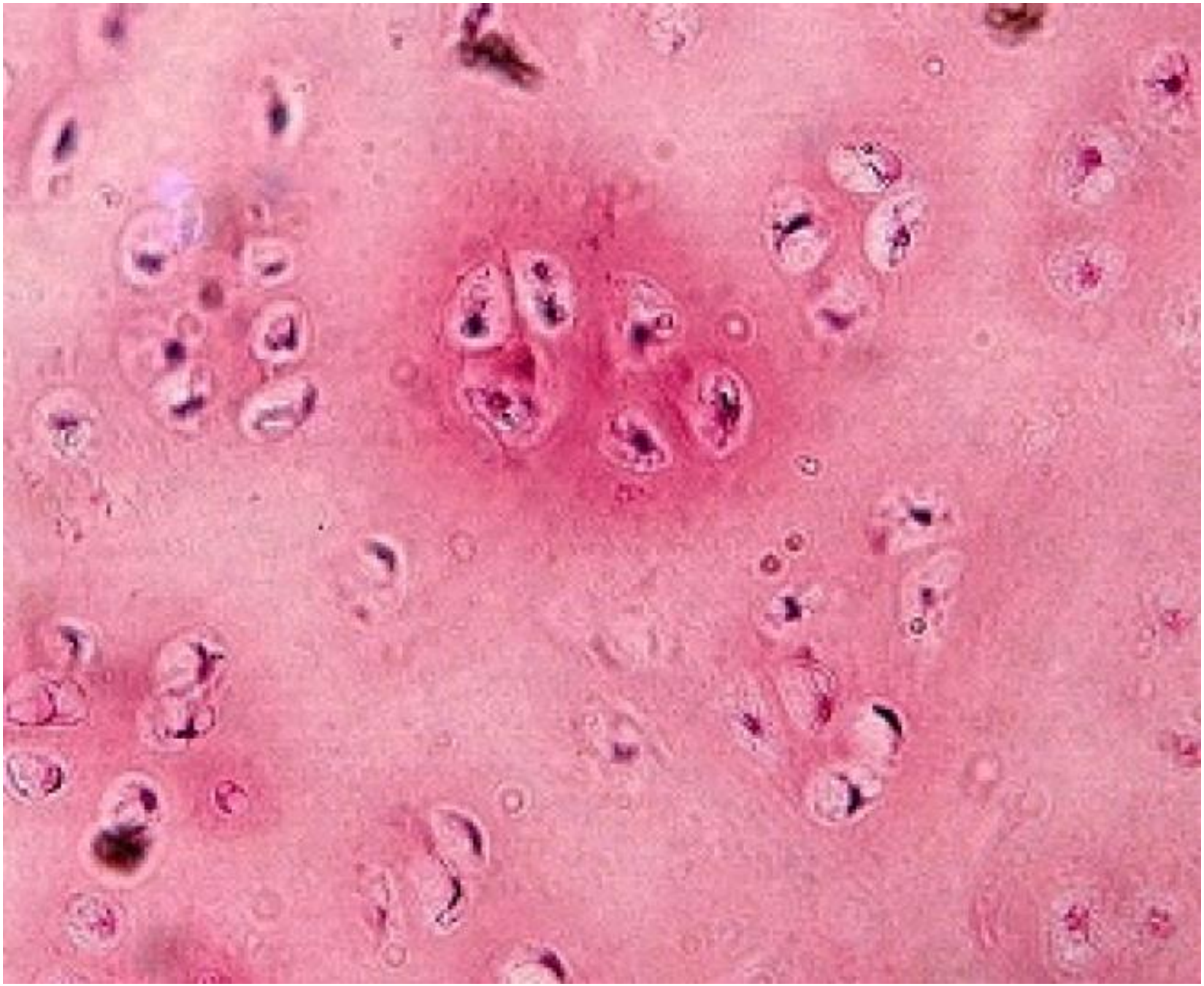
*Nose and Ribs*

## Fibro-Cartilage
*is the least flexible*

*Knee and Vertebrae*


MODBLOG.BMEZINE.COM


Adipose stem cell
Committed osteoblastic stem cell
BMPs
Pre-OB-I
IGFs
TGF-β
BMPs
Pre-OB-II
IGFs
TGF-β
BMPs
Chondrocyte
Adipocyte
Osteoblast



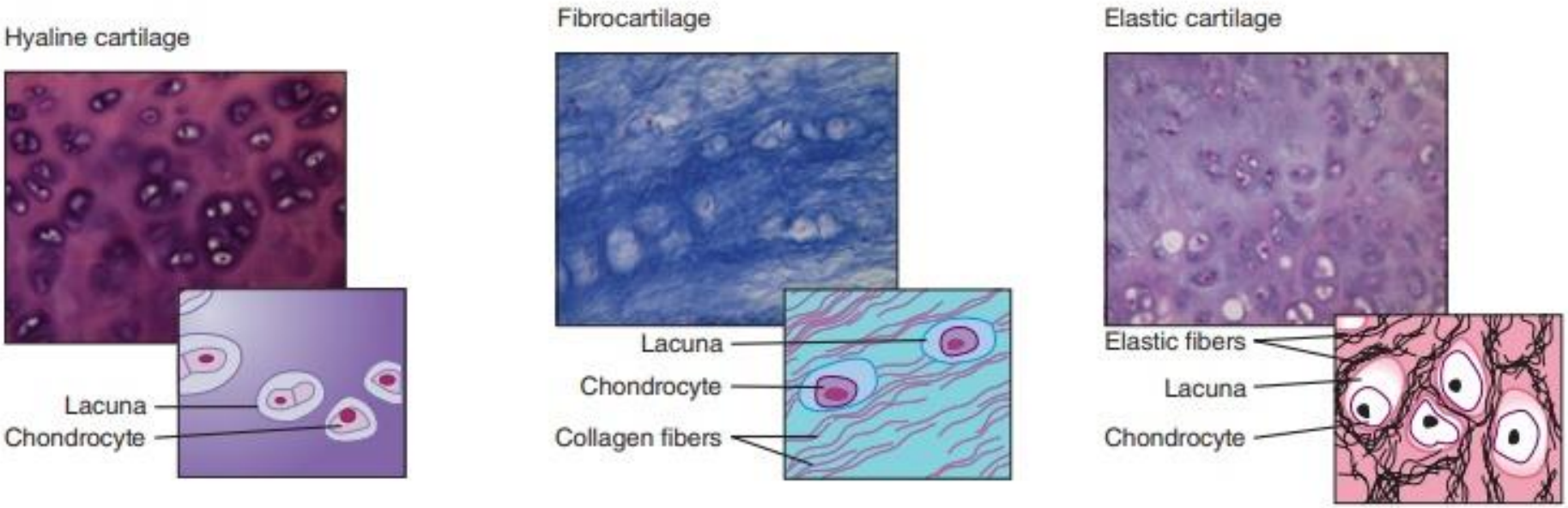
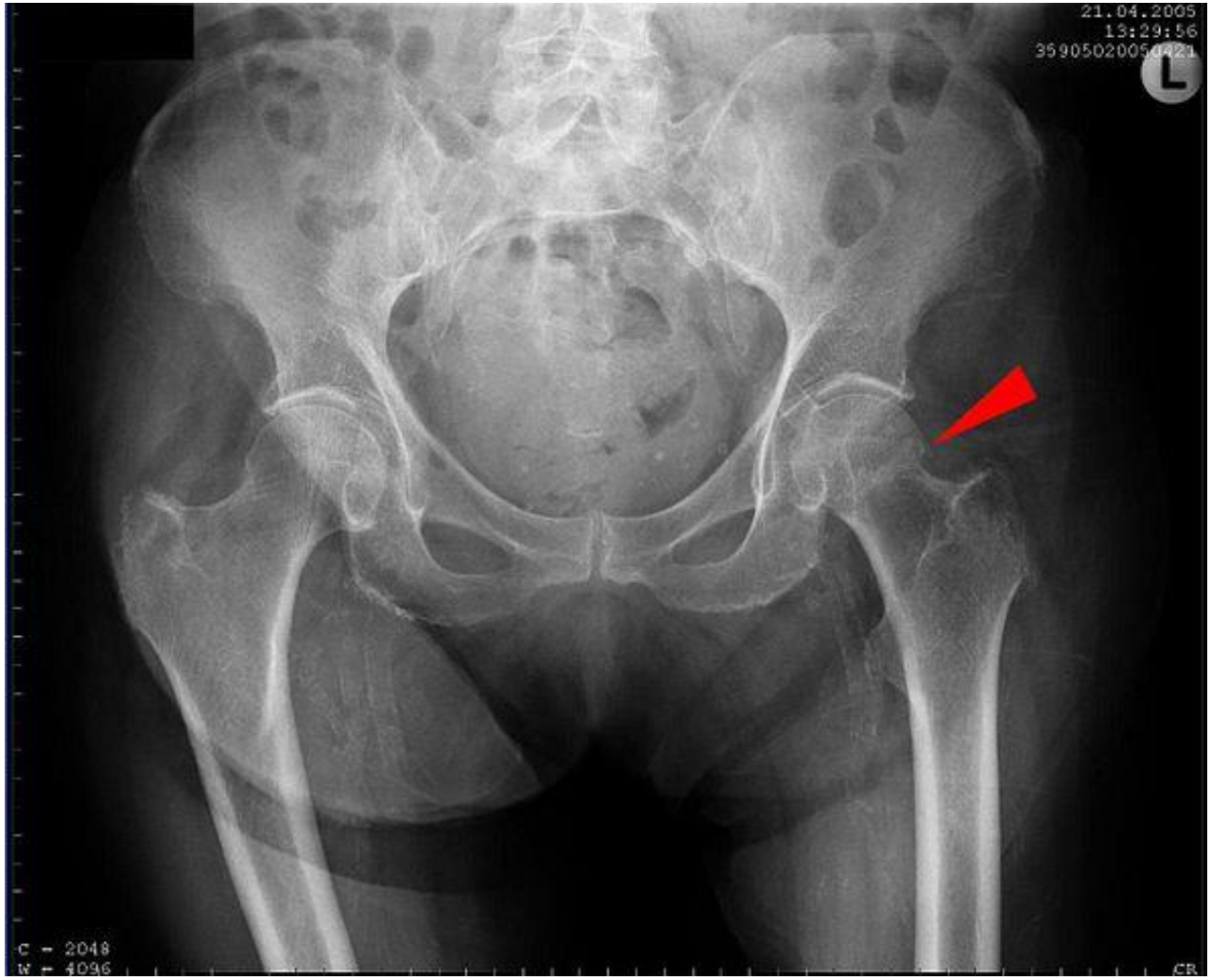



**FIGURE 5-7** Types of cartilage.

Photos: © Donna Beer Stolz, PhD, Center for Biologic Imaging, University of Pittsburgh Medical School.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13:29:56
L
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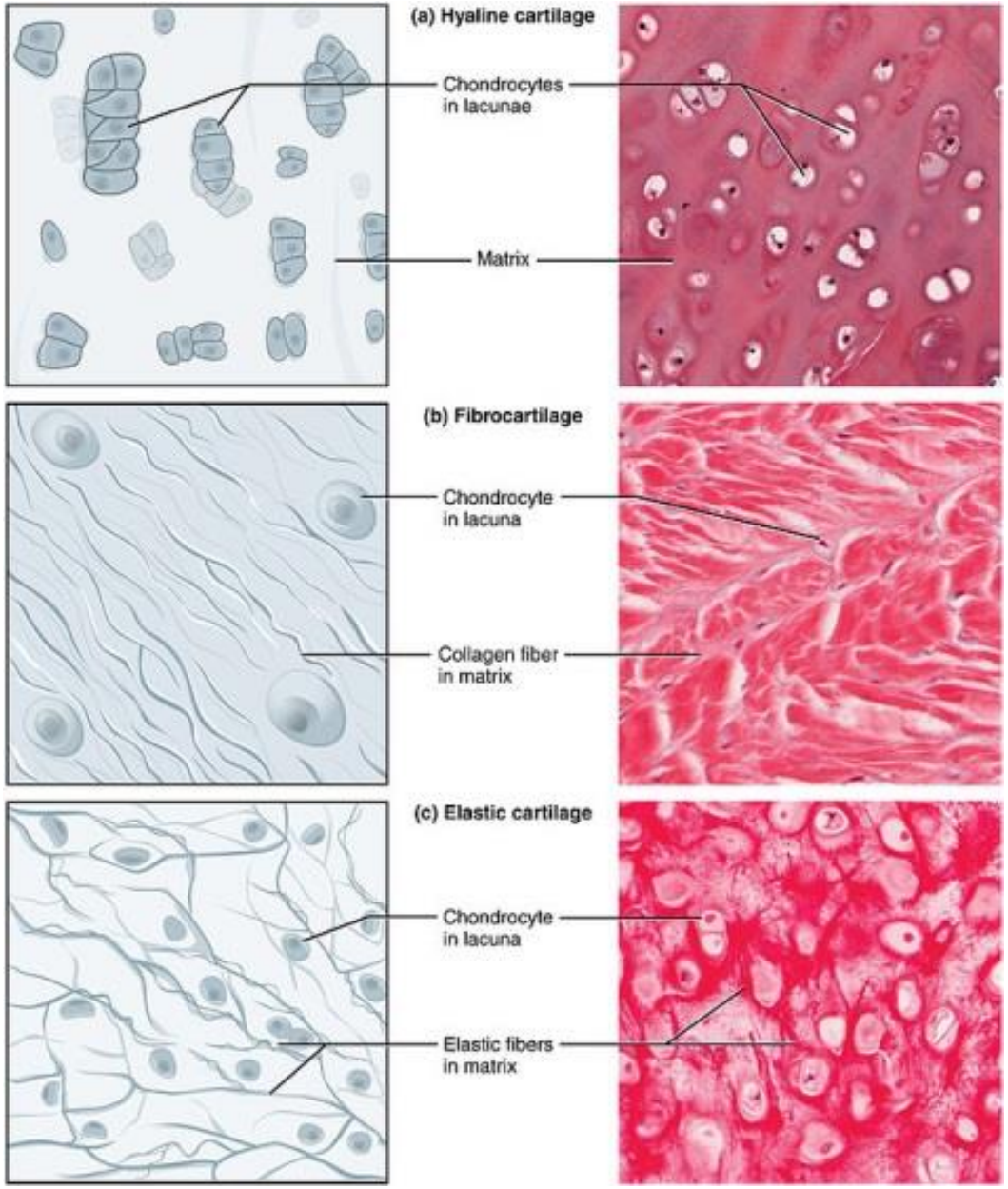
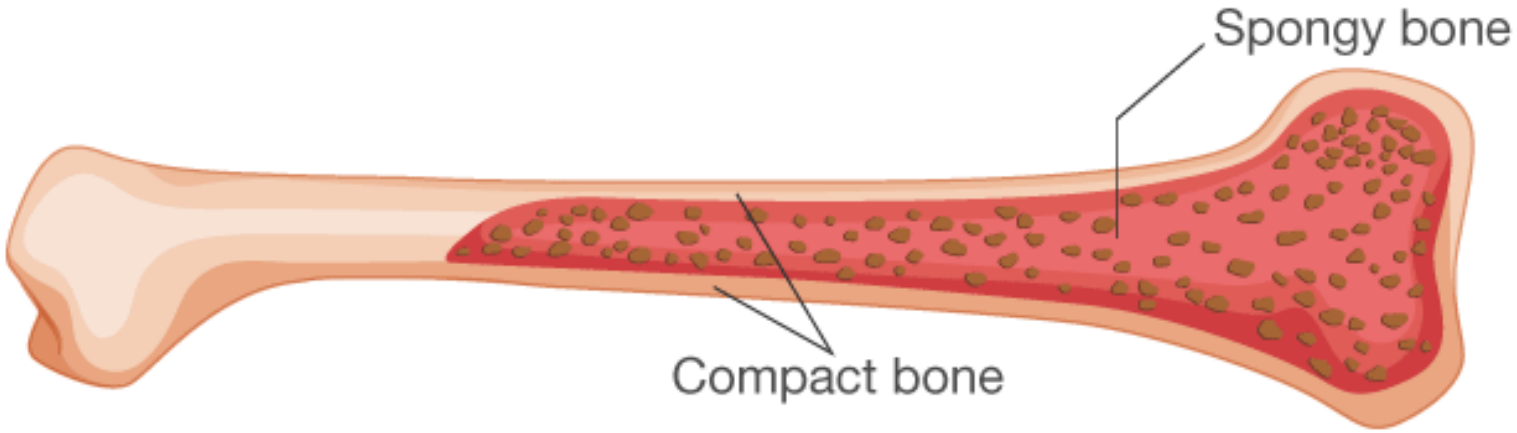
W = 4096
CR


(a) Hyaline cartilage
Chondrocytes in lacunae
Matrix
(b) Fibrocartilage
Chondrocyte in lacuna
Collagen fiber in matrix
(c) Elastic cartilage
Chondrocyte in lacuna
Elastic fibers in matrix

# BONE

# DIFFERENCE BETWEEN SPONGY AND COMPACT BONES



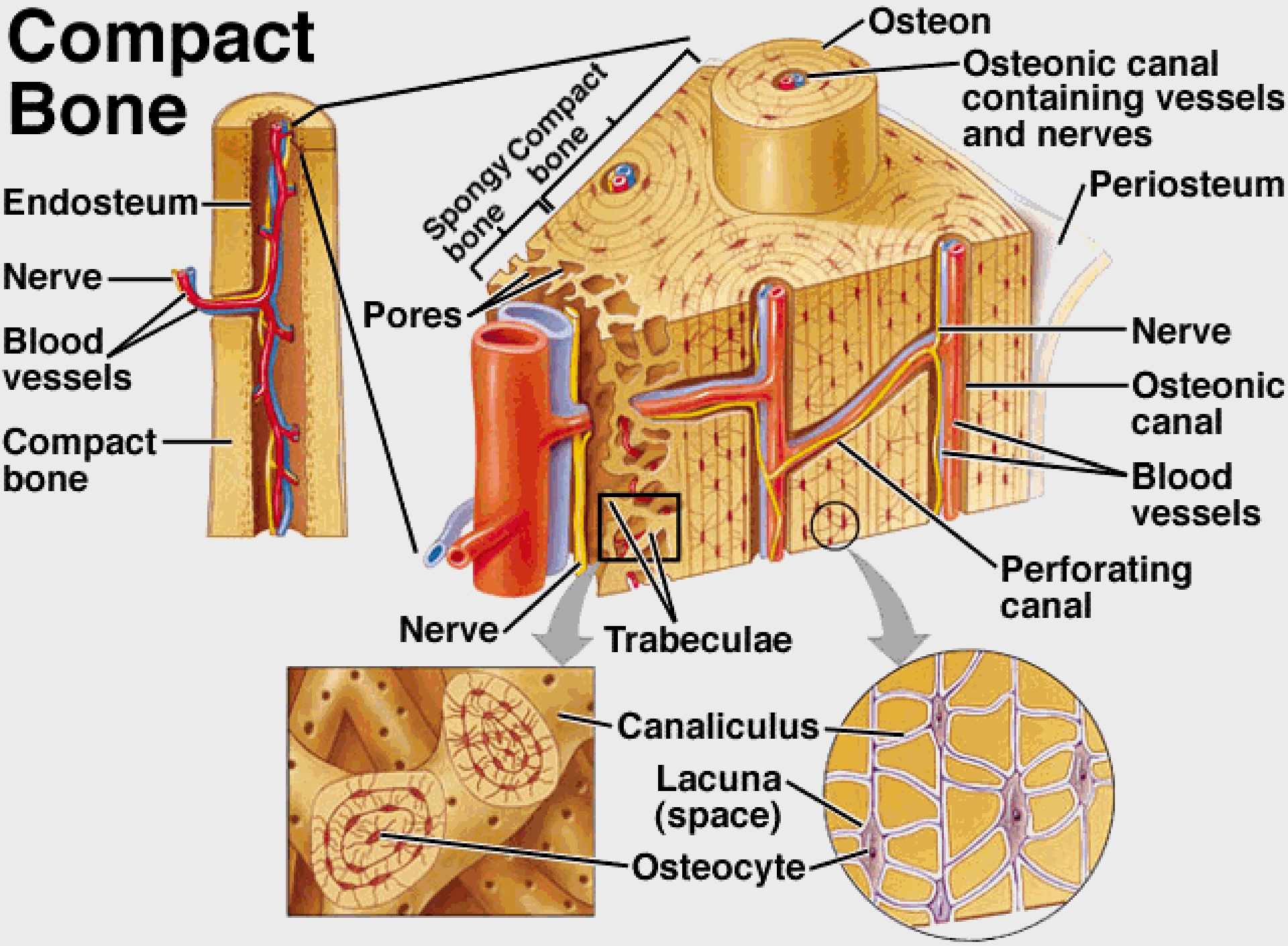

## SPONGY BONE

- Spongy bone is also called cancellous or trabecular bone. It is found in the long bones and it is surrounded by compact bone.

## COMPACT BONE

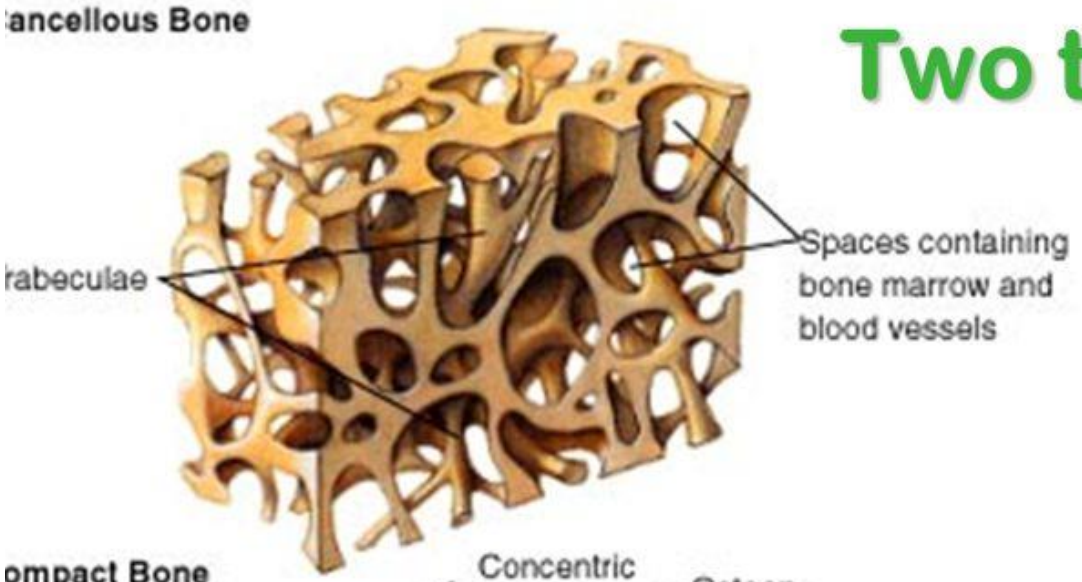
- Compact bone, also called cortical bone, surrounds spongy bone. They are heavy, tough and compact in nature

# Compact Bone

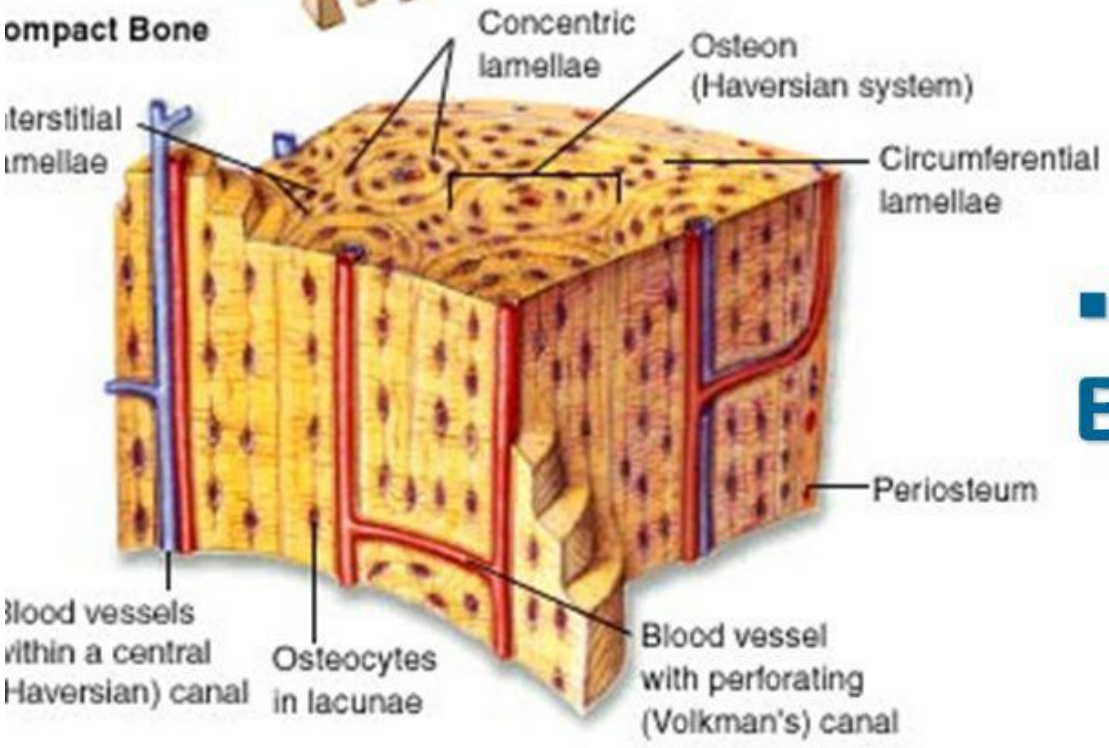


# Two types of Bone

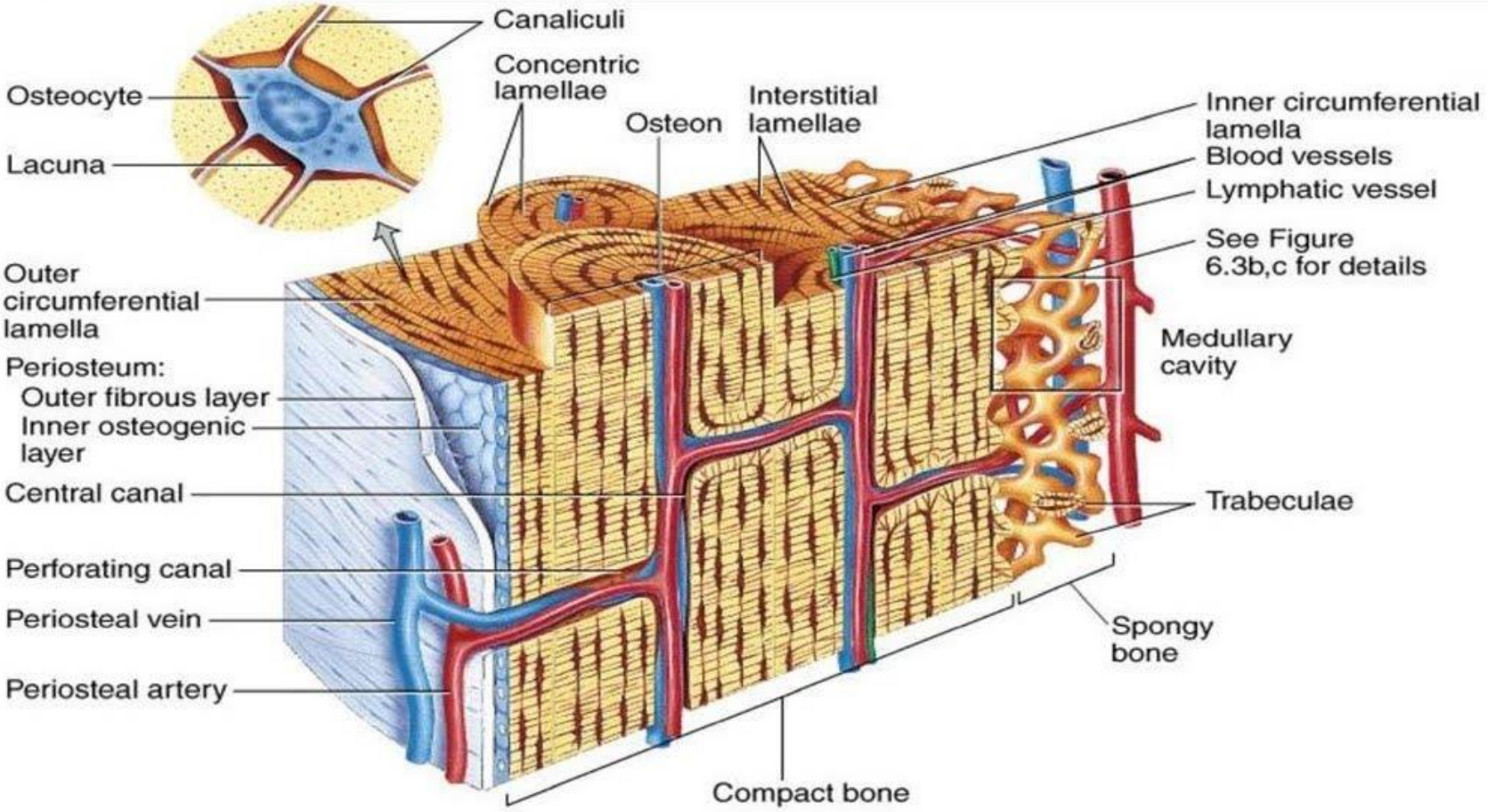
## Spongy (cancellous)

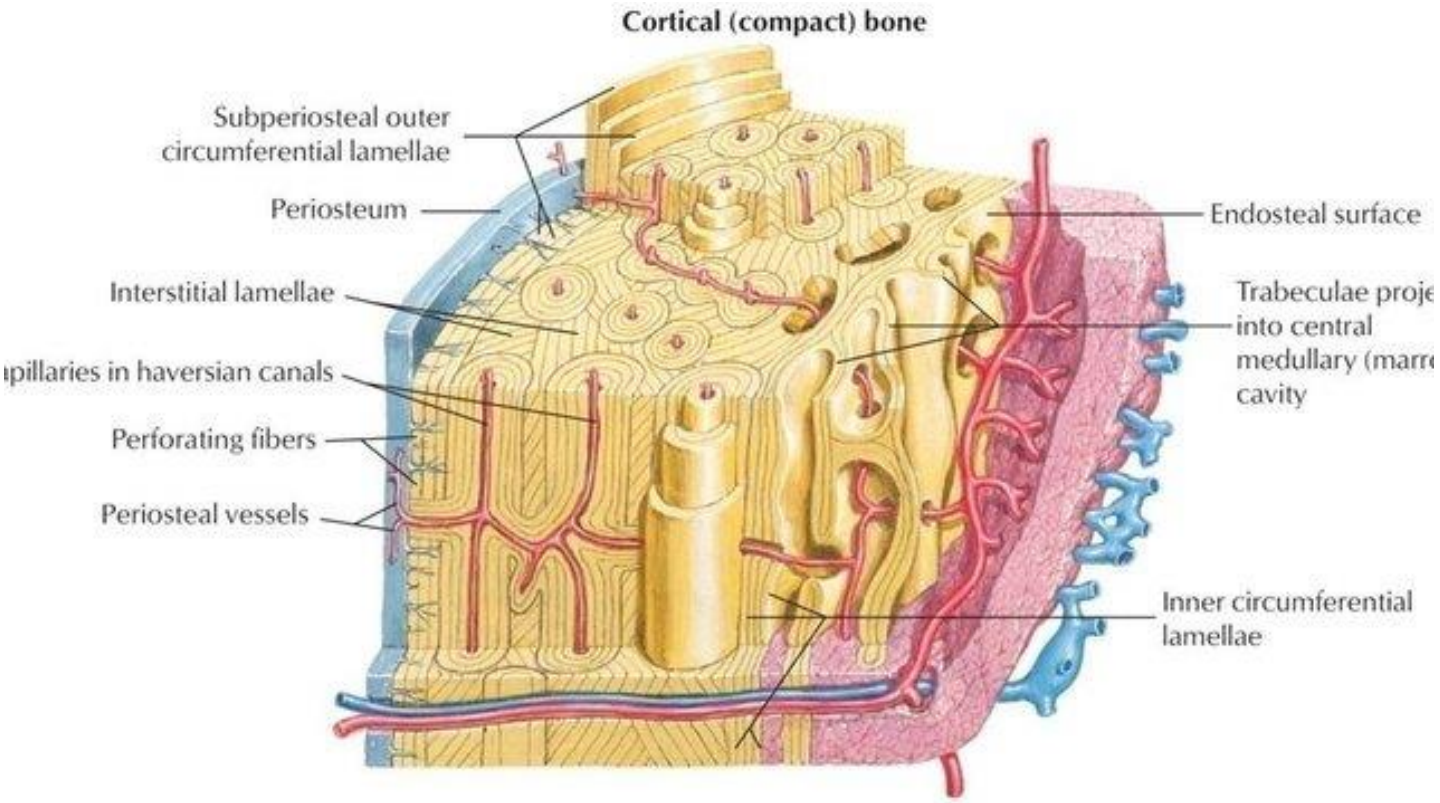


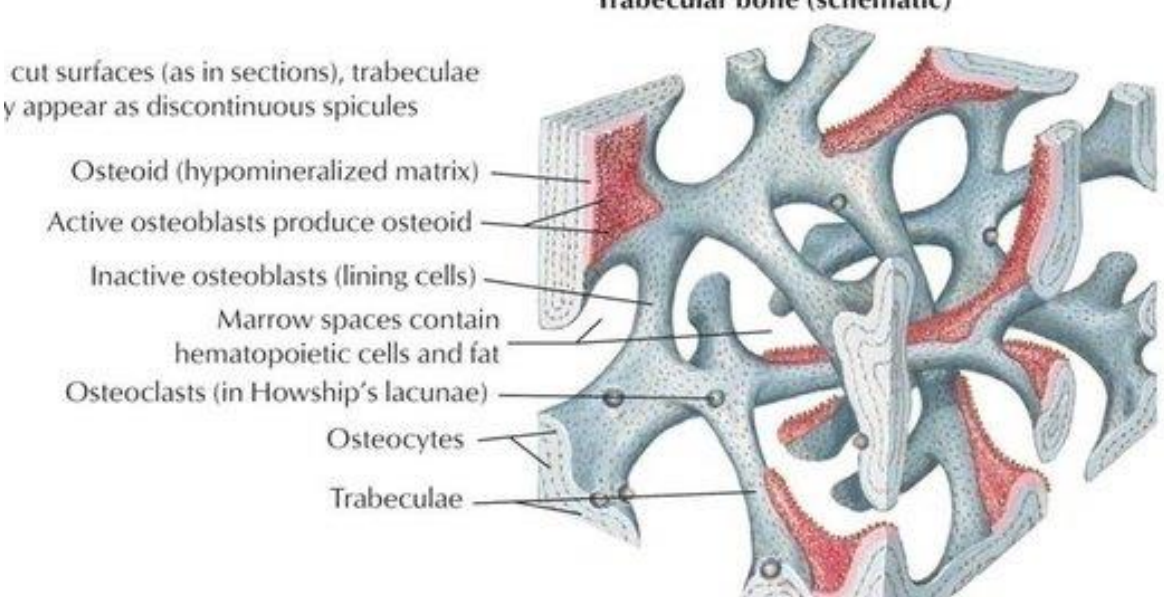

## ▪Compact Bone

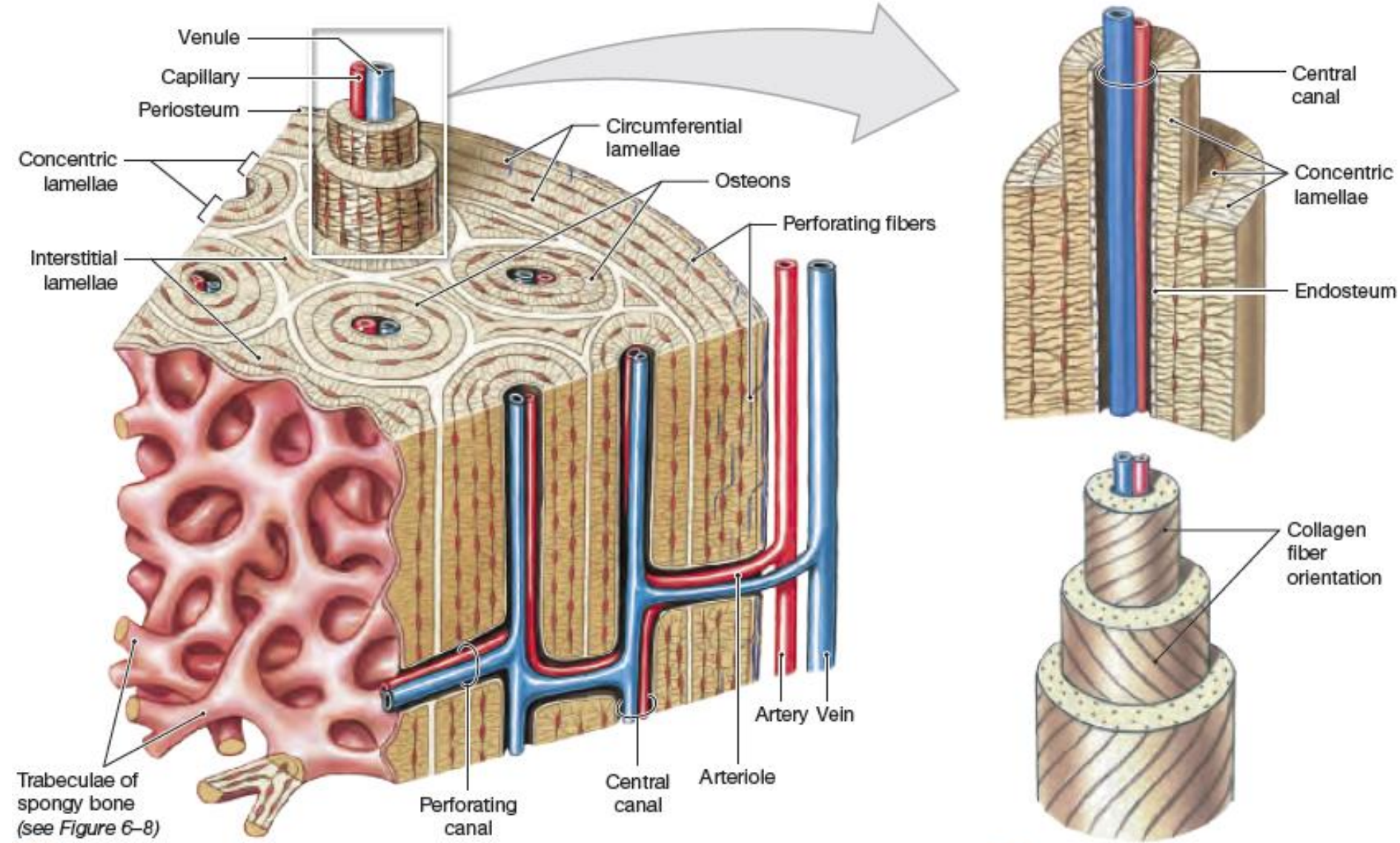


# Histology of Bone Tissue




Cortical (compact) bone
Subperiosteal outer circumferential lamellae
Periosteum
Interstitial lamellae
ıpillaries in haversian canals
Perforating fibers
Periosteal vessels
Endosteal surface
Trabeculae proje into central medullary (marr cavity
Inner circumferential lamellae

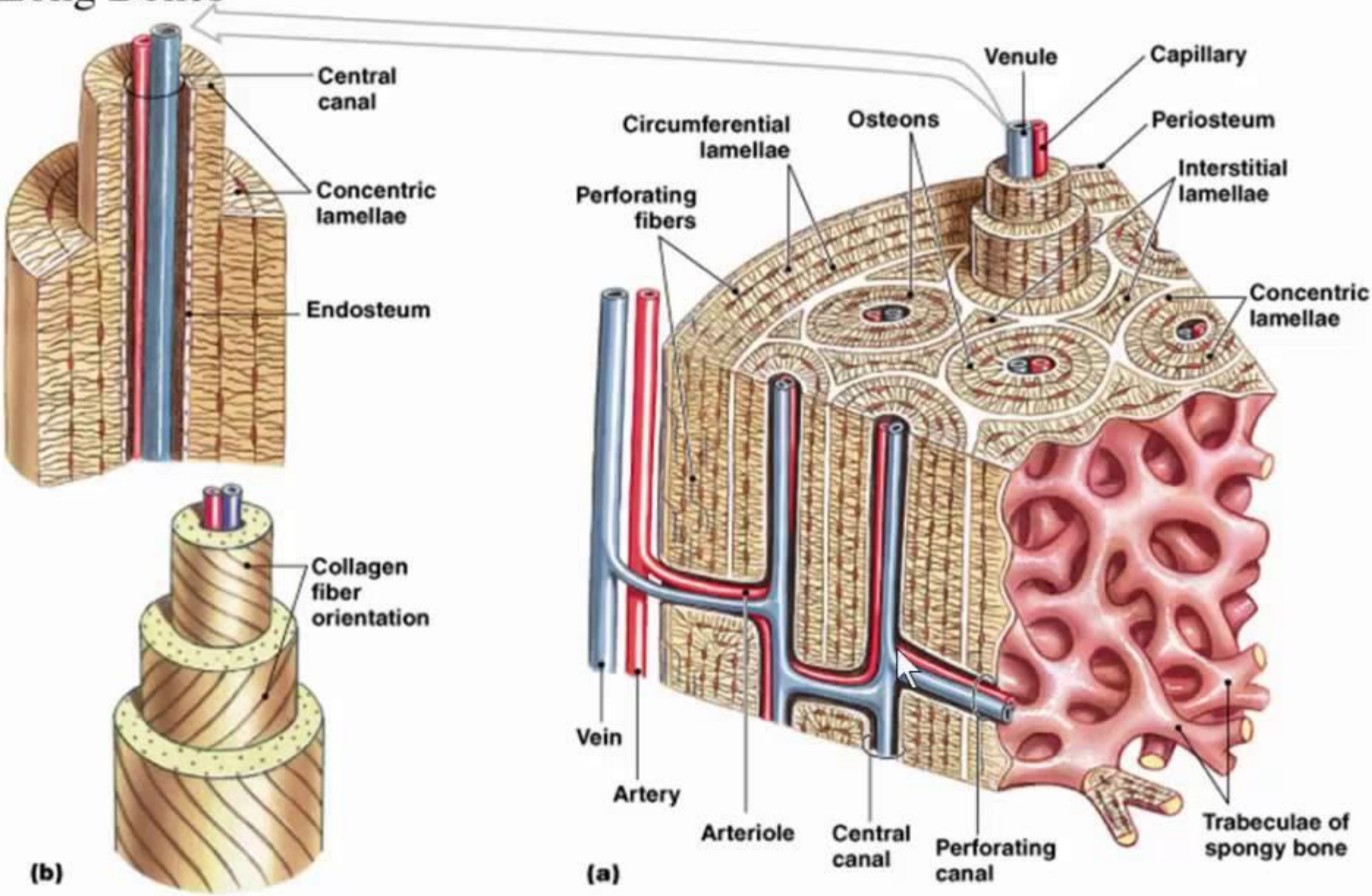

Trabecular bone (schematic)
cut surfaces (as in sections), trabeculae y appear as discontinuous spicules
Osteoid (hypomineralized matrix)
Active osteoblasts produce osteoid
Inactive osteoblasts (lining cells)
Marrow spaces contain hematopoietic cells and fat
Osteoclasts (in Howship's lacunae)
Osteocytes
Trabeculae

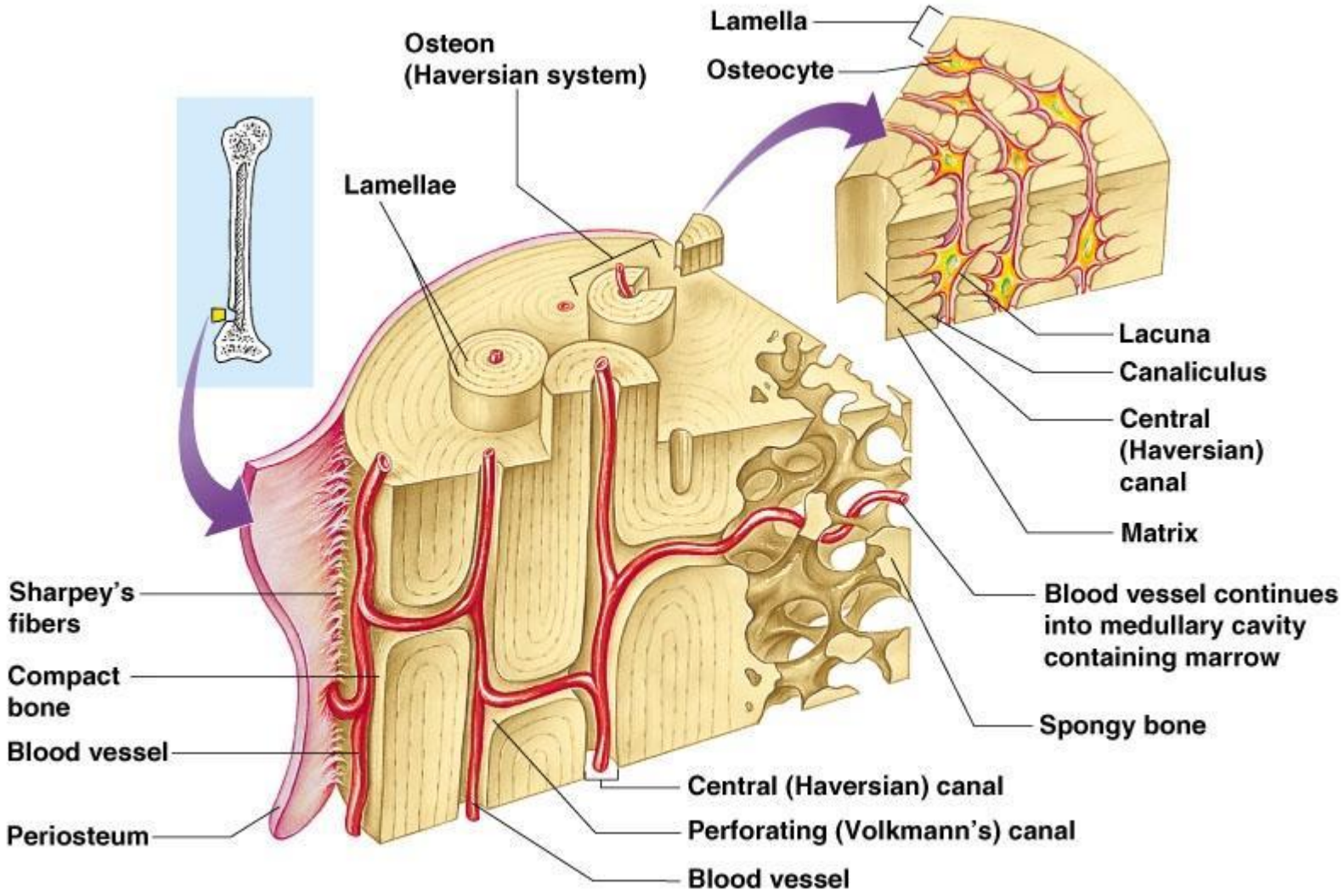


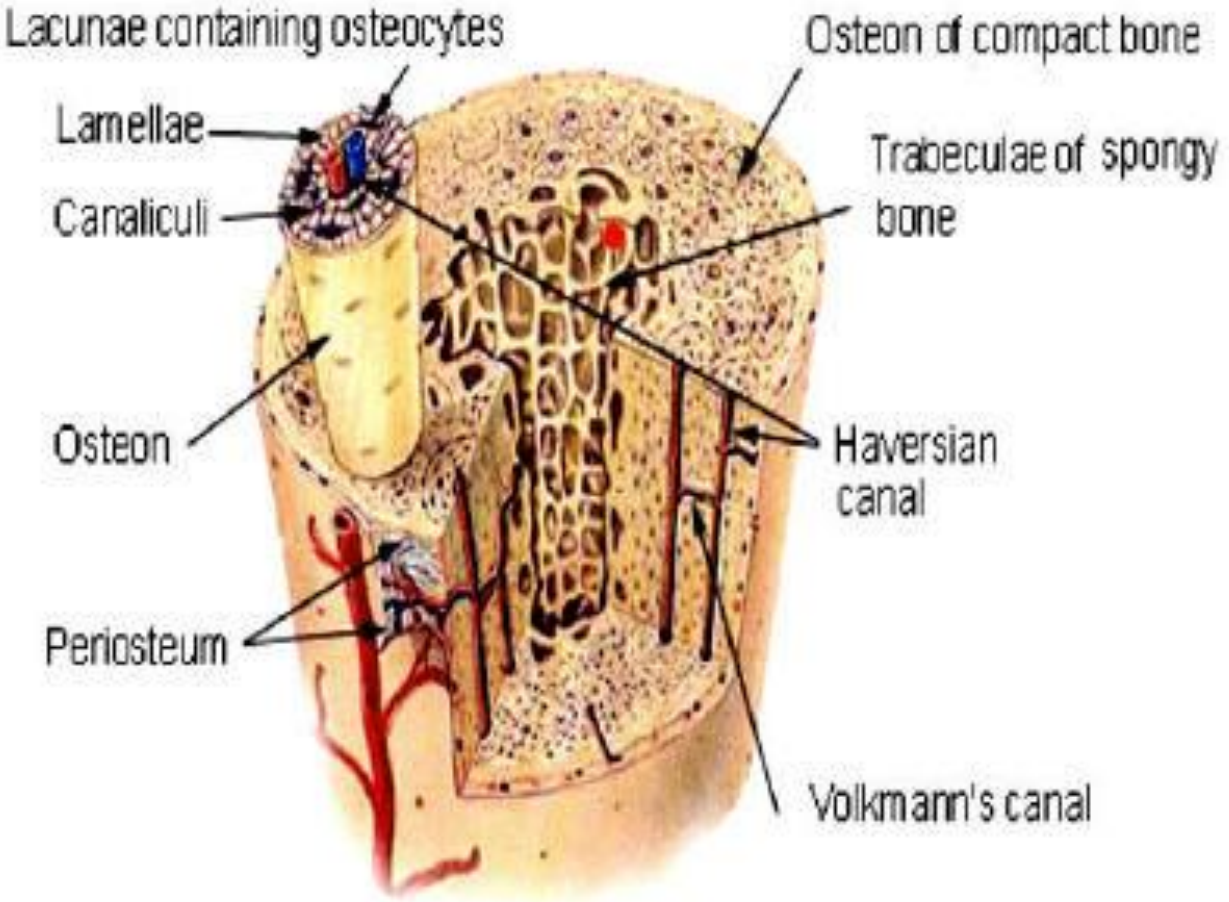

**a** The organization of osteons and lamellae in compact bone

**b** The orientation of collagen fibers in adjacent lamellae of an osteon

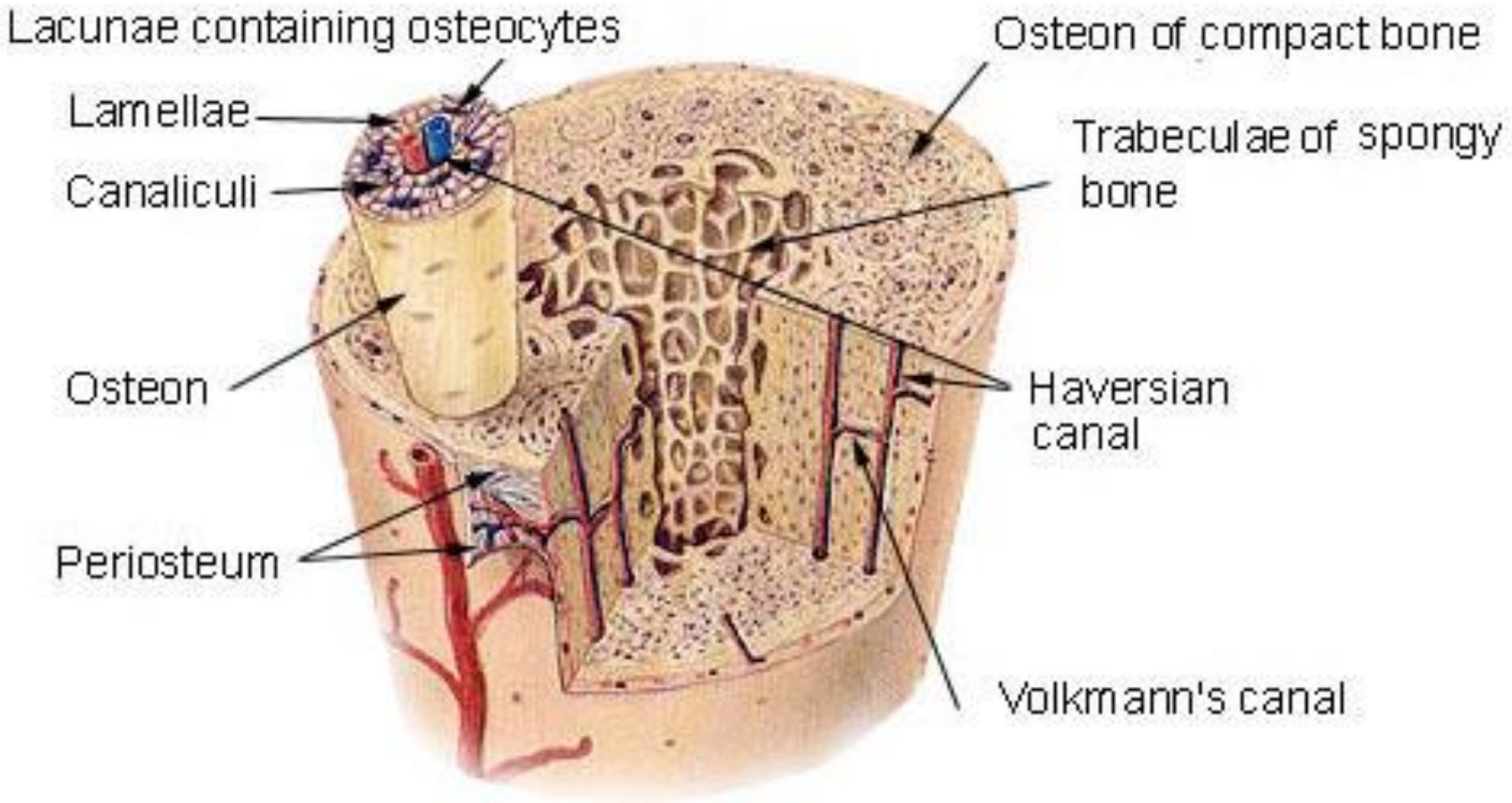
# Long Bones

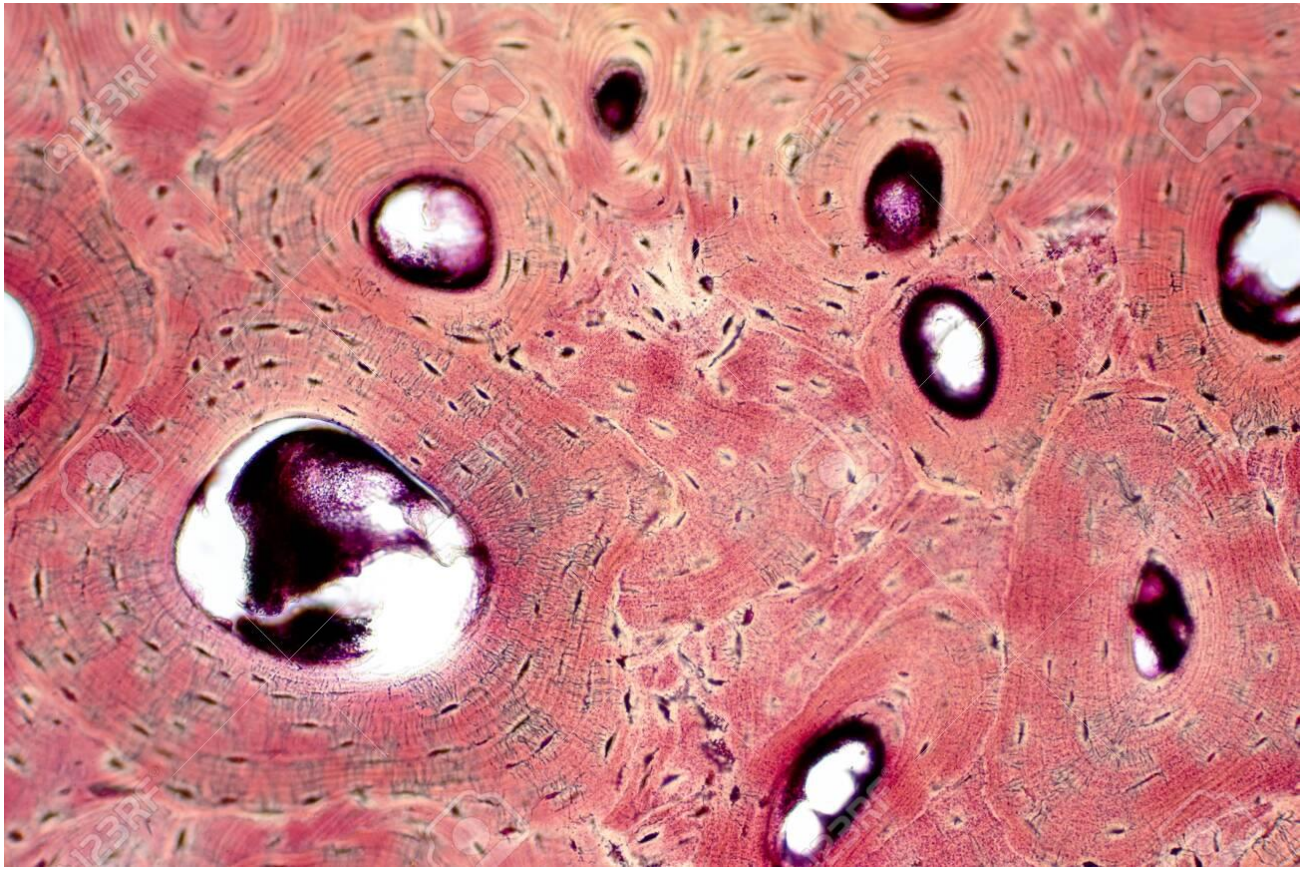

Central canal
Concentric lamellae
Endosteum
Collagen fiber orientation
(b)
Venule
Capillary
Circumferential lamellae
Osteons
Periosteum
Interstitial lamellae
Perforating fibers
Concentric lamellae
Vein
Artery
Arteriole
Central canal
Perforating canal
Trabeculae of spongy bone
(a)



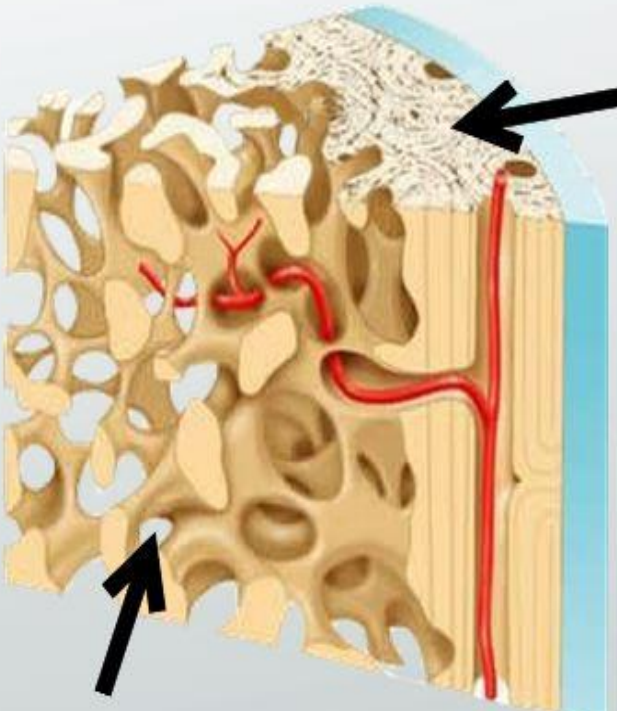

Lacunae containing osteocytes
Lamellae
Canaliculi
Osteon
Periosteum
Osteon of compact bone
Trabeculae of spongy bone
Haversian canal
Volkmann's canal

## Compact Bone & Spongy (Cancellous Bone)

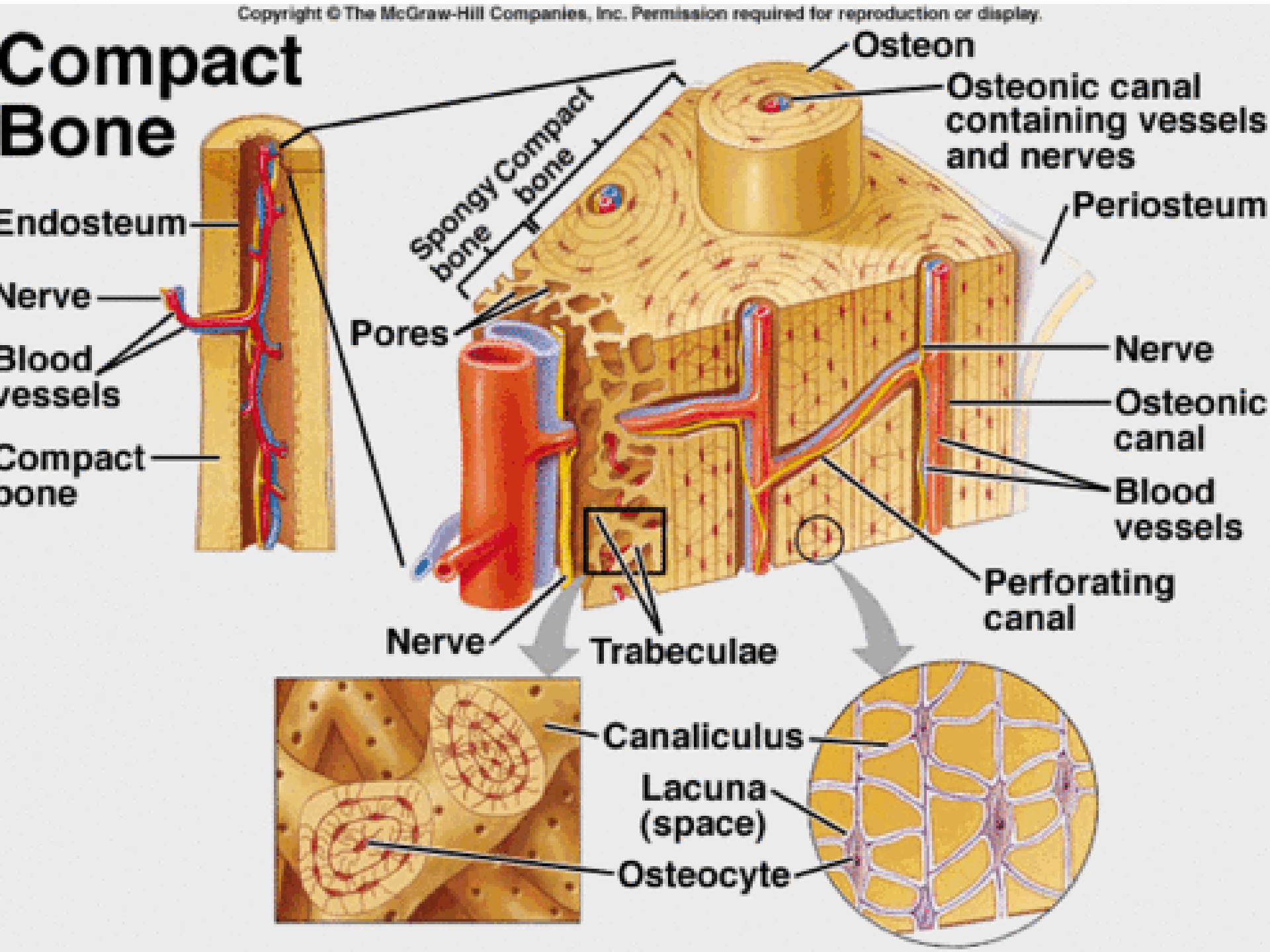


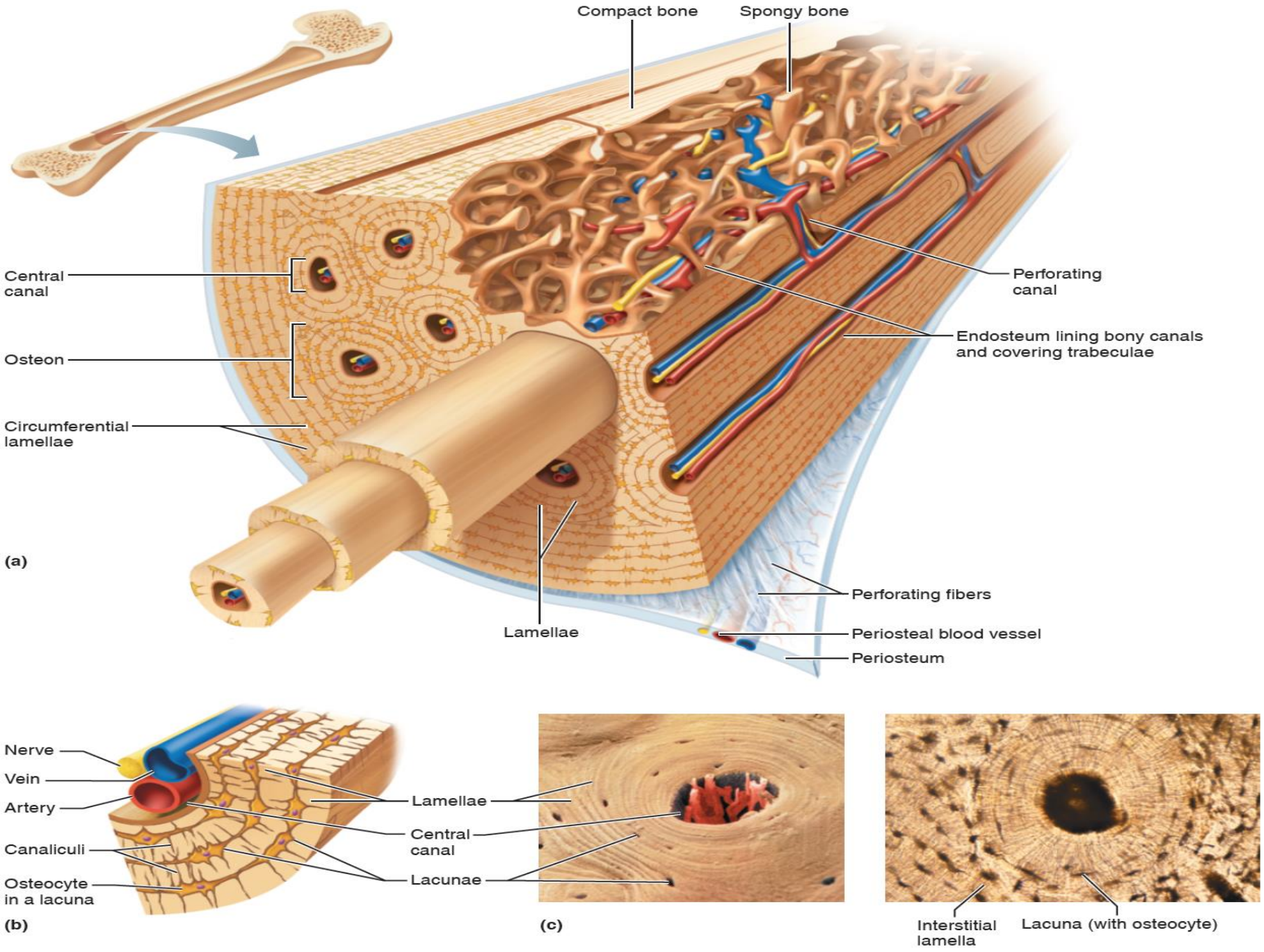


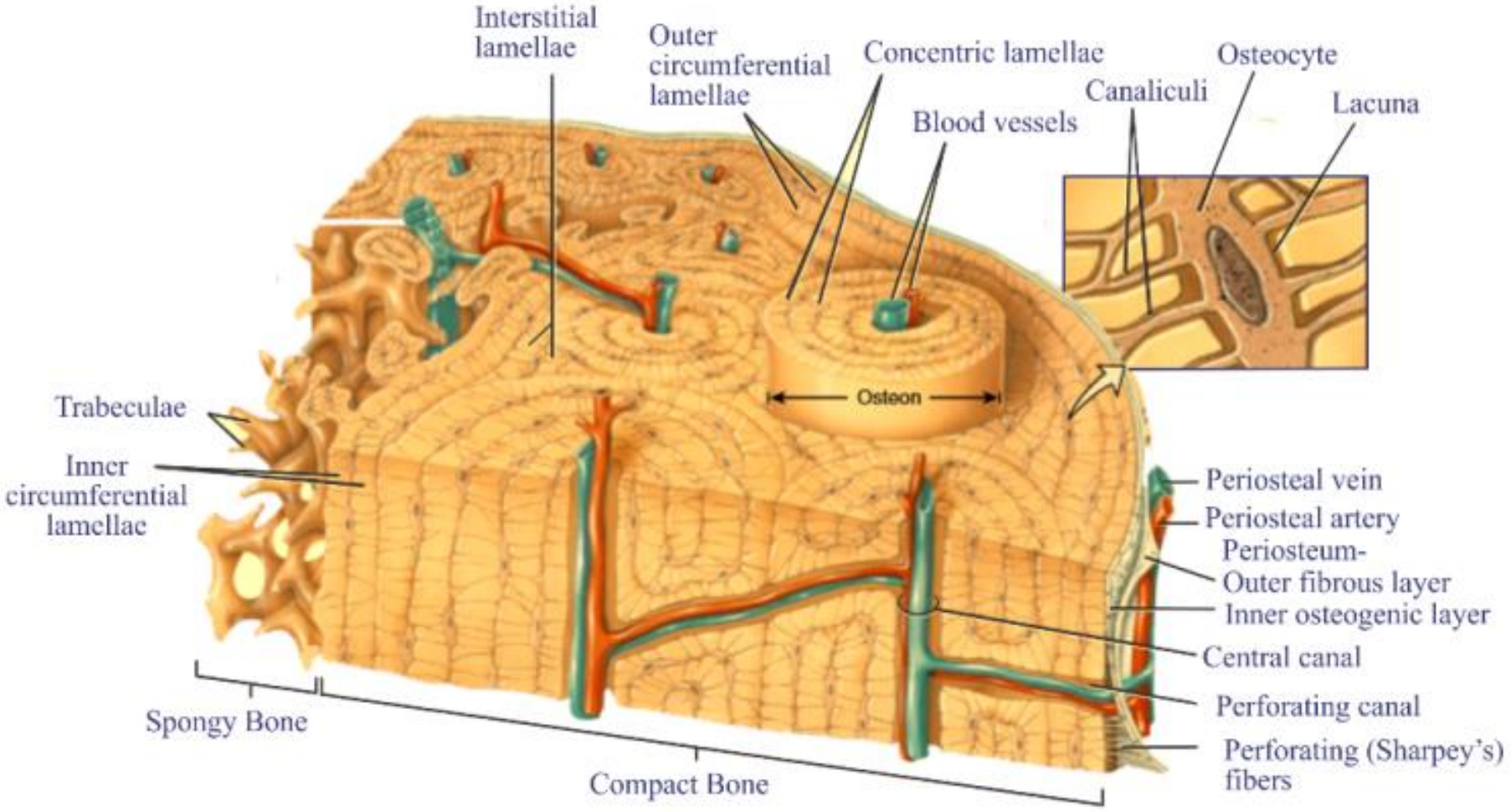
# S COMPACT BONE?

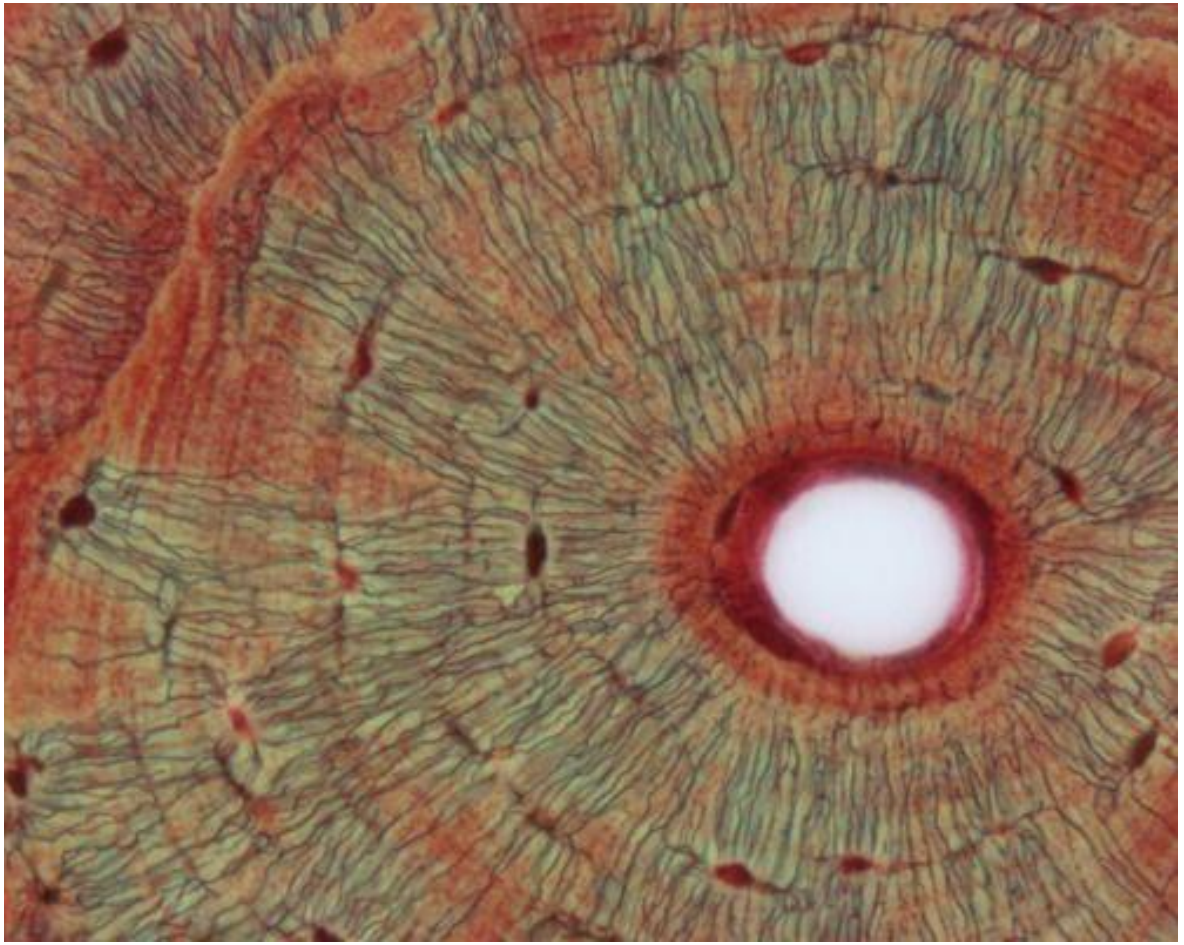


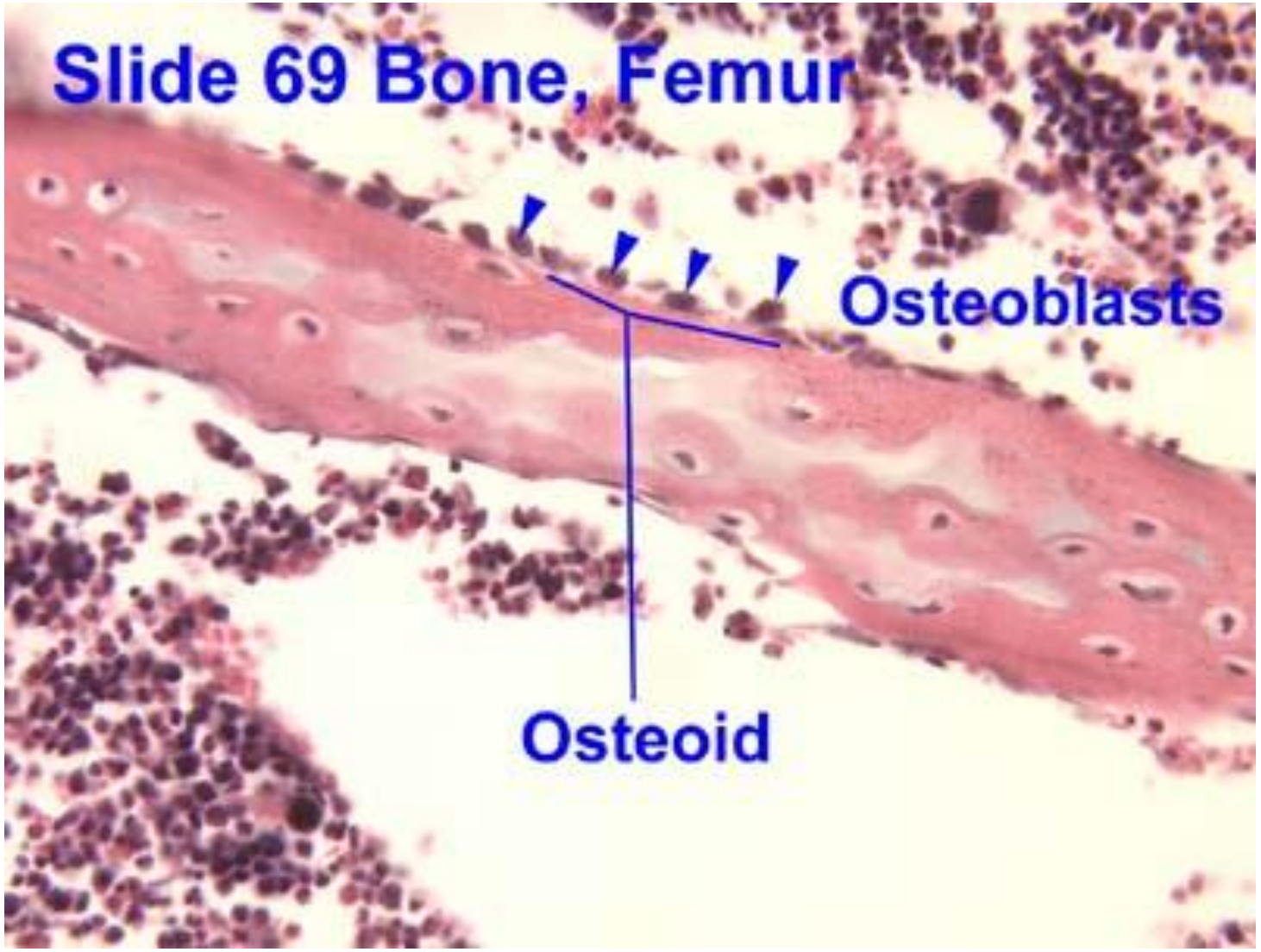
# Compact Bone

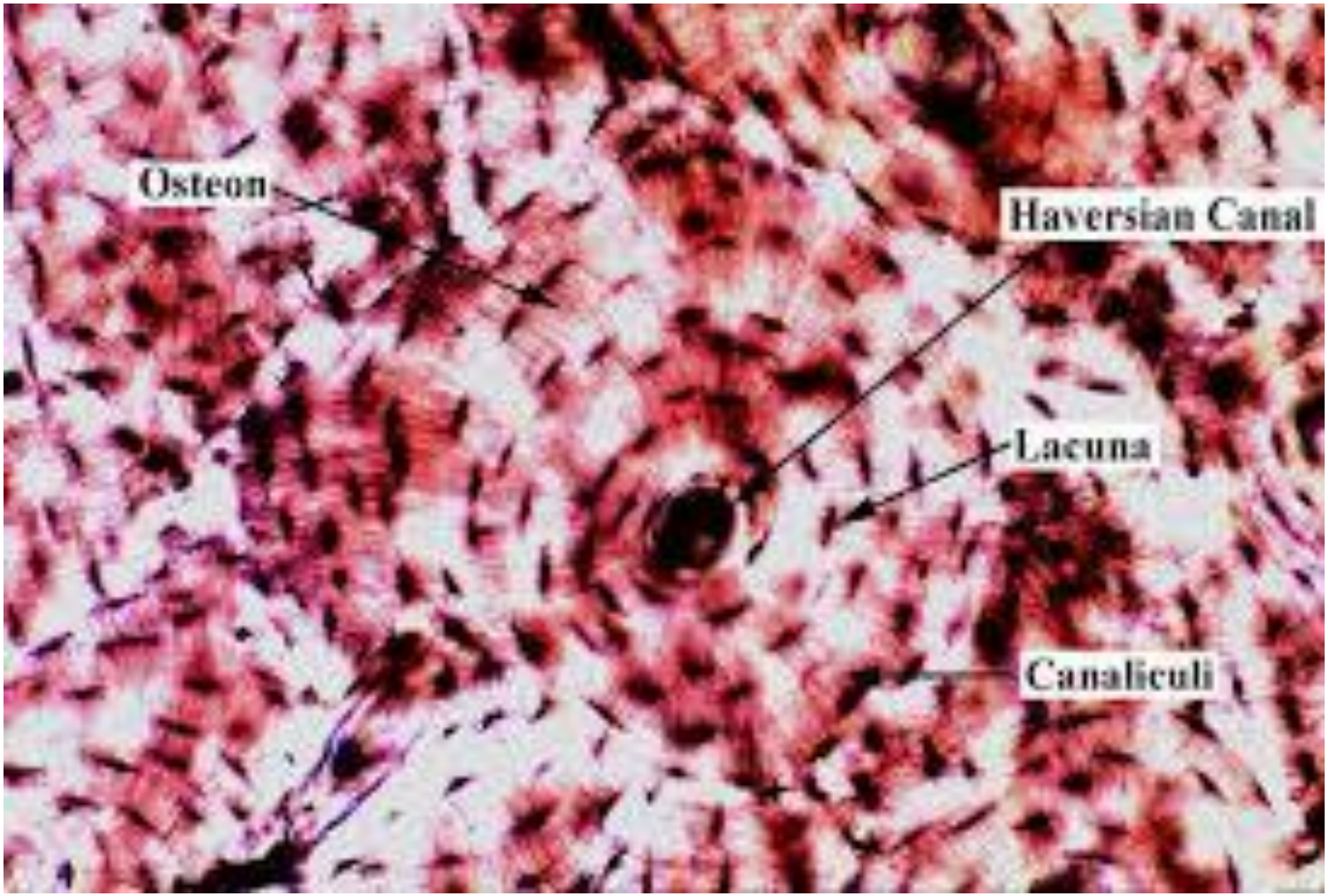


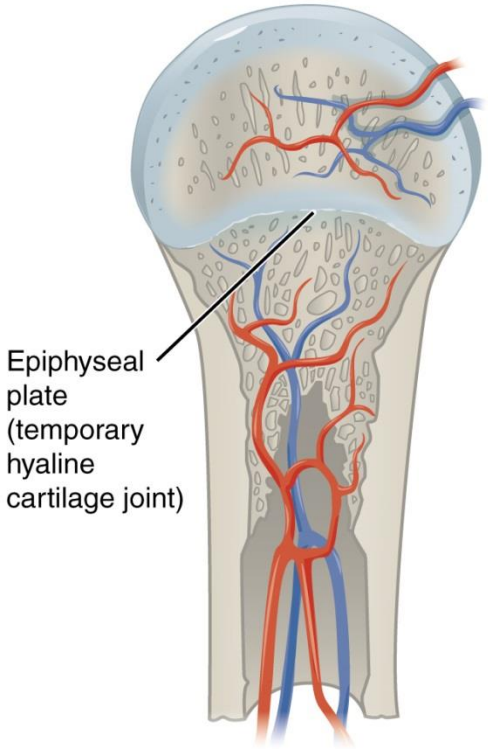

Compact bone
Spongy bone
Central canal
Osteon
Circumferential lamellae
Perforating canal
Endosteum lining bony canals and covering trabeculae
(a)
Lamellae
Perforating fibers
Periosteal blood vessel
Periosteum
Nerve
Vein
Artery
Canaliculi
Osteocyte in a lacuna
Lamellae
Central canal
Lacunae
(b)
(c)
Interstitial lamella
Lacuna (with osteocyte)


Interstitial lamellae
Outer circumferential lamellae
Concentric lamellae
Osteocyte
Canaliculi
Lacuna
Blood vessels
Osteon
Trabeculae
Inner circumferential lamellae
Periosteal vein
Periosteal artery
Periosteum-
Outer fibrous layer
Inner osteogenic layer
Central canal
Perforating canal
Perforating (Sharpey's) fibers
Spongy Bone
Compact Bone

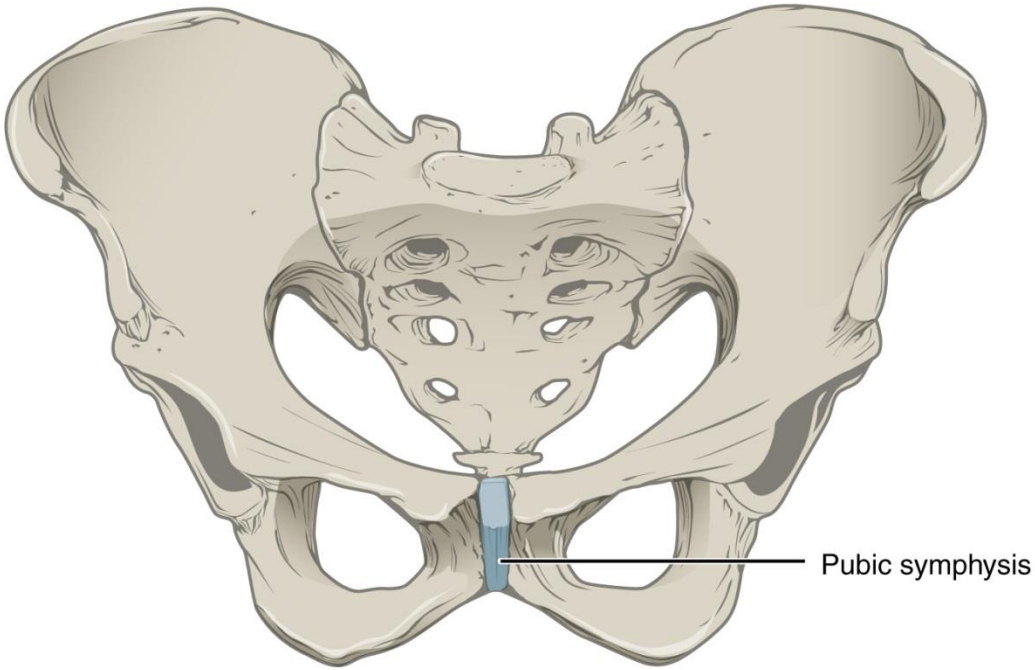



Slide 69 Bone, Femur
Osteoblasts
Osteoid

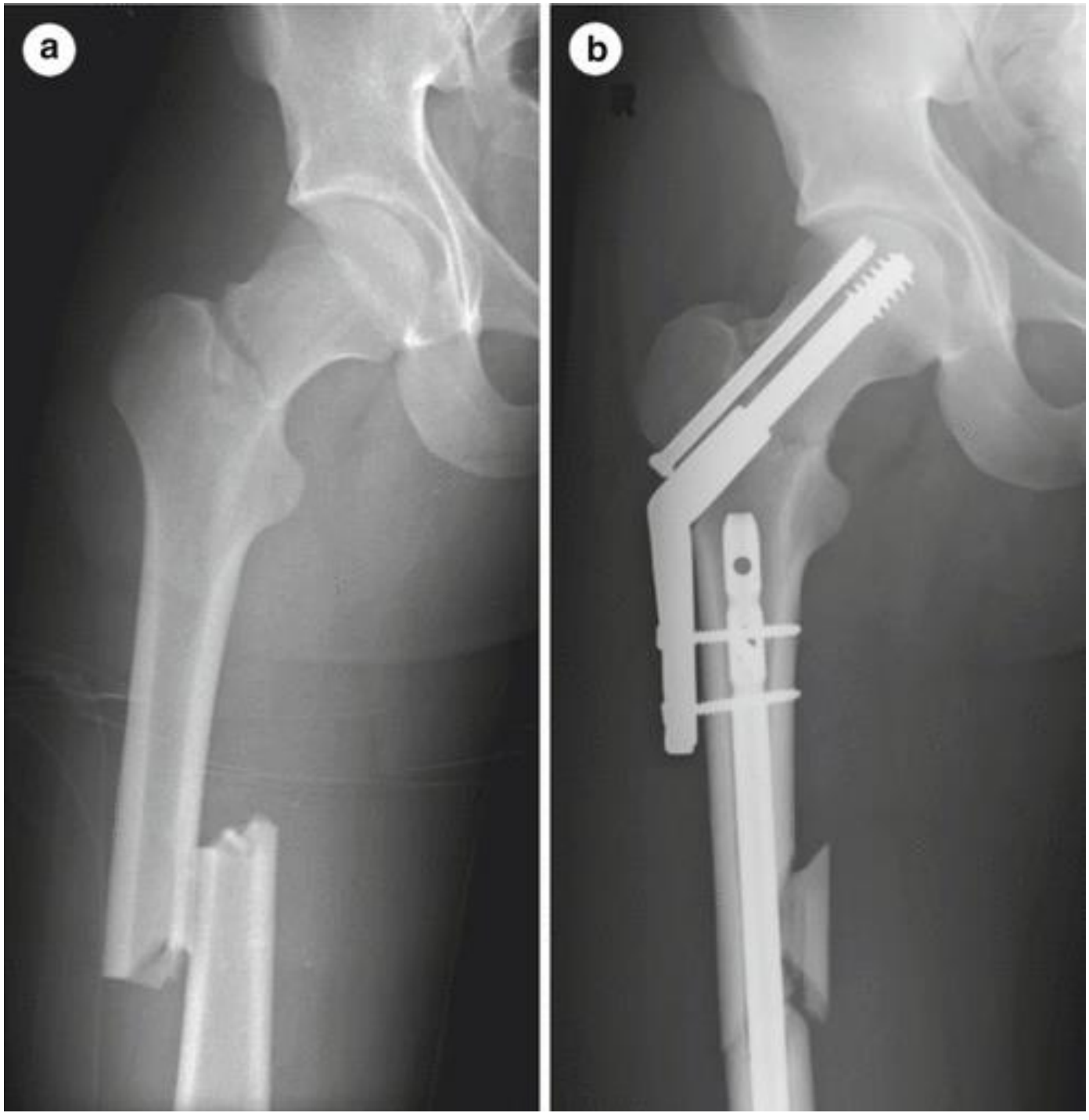

Osteon
Haversian Canal
Lacuna
Canaliculi

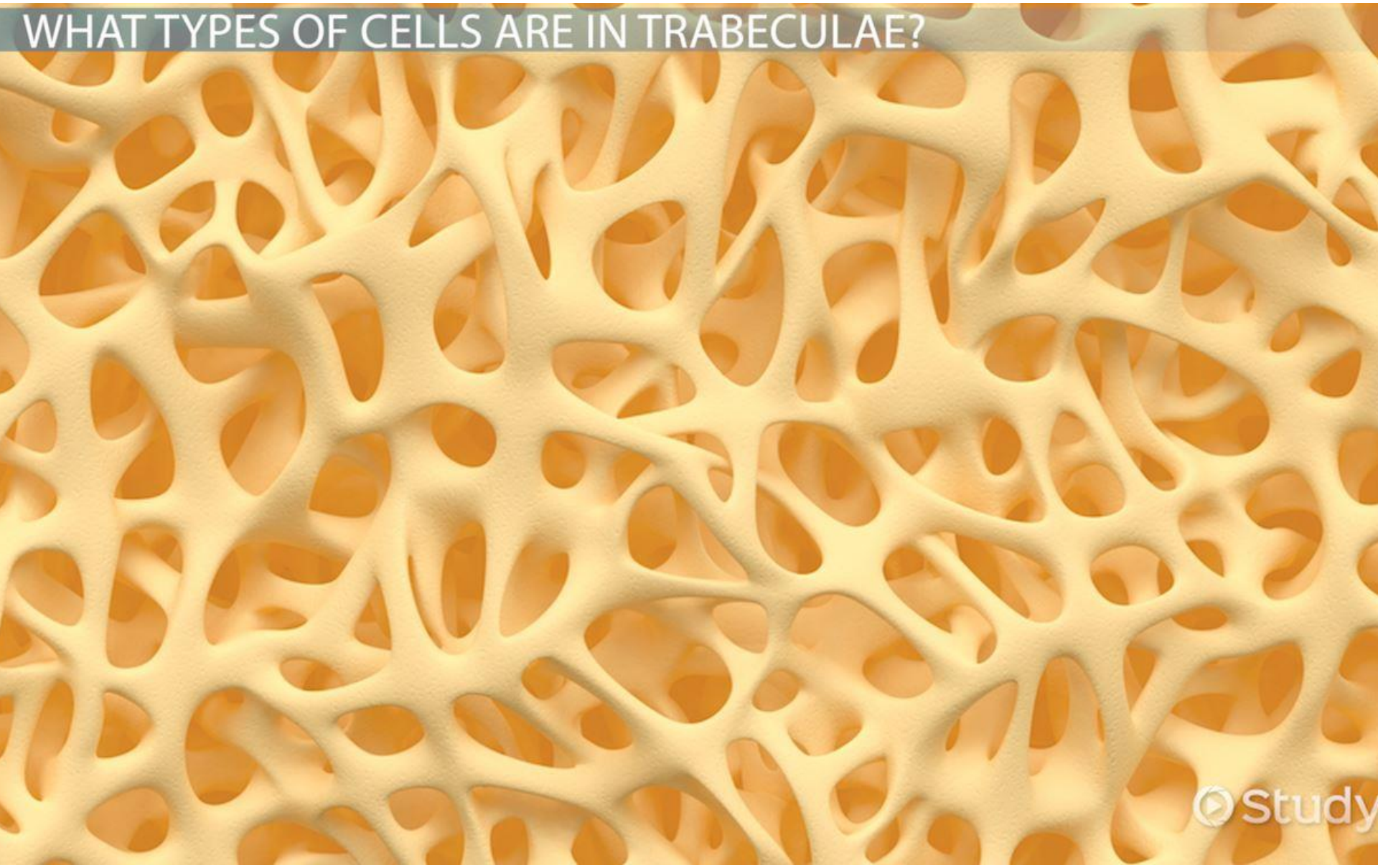

Epiphyseal plate (temporary hyaline cartilage joint)

(a)

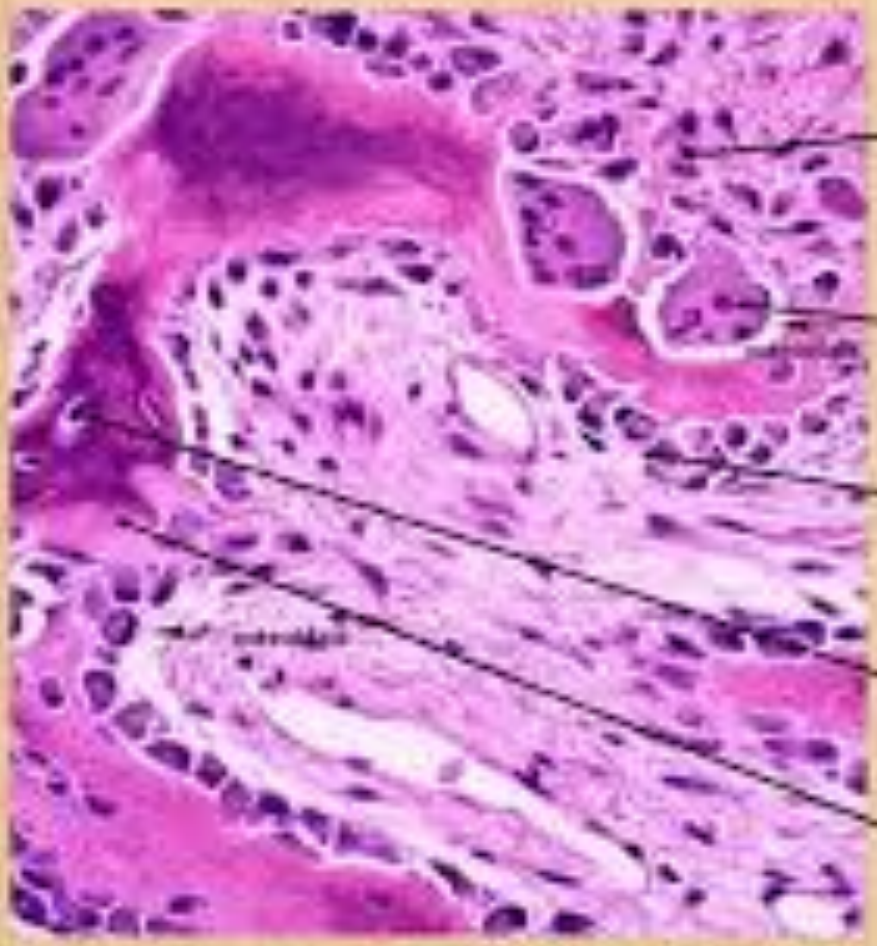

Pubic symphysis

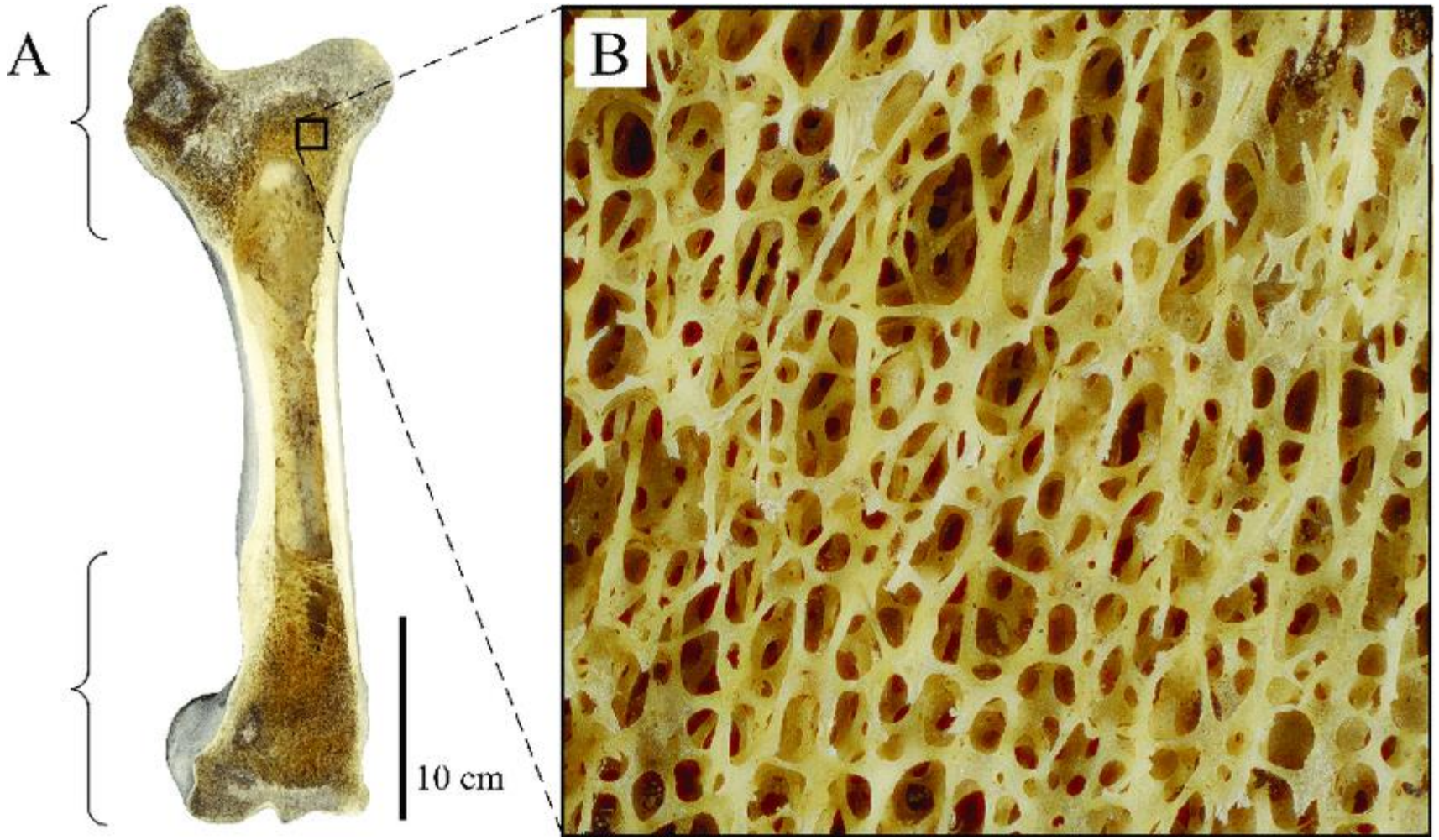
(b)


a
b

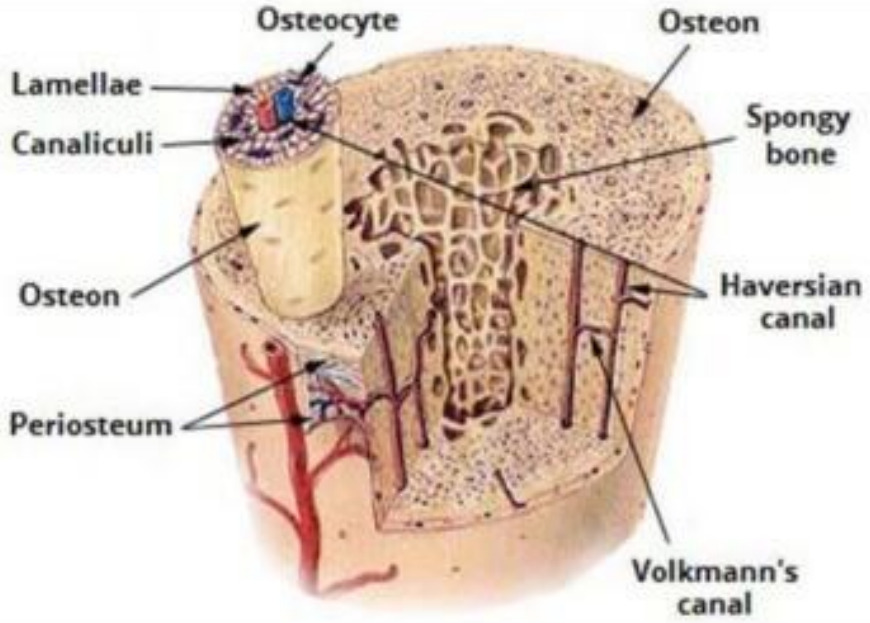

WHAT TYPES OF CELLS ARE IN TRABECULAE?
Study

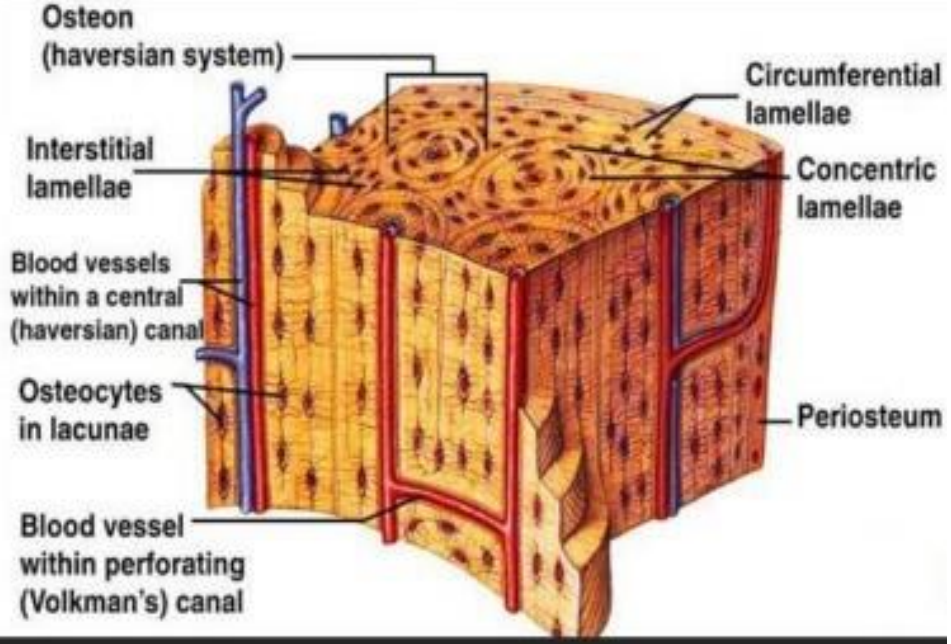
# Cells of Bone (Primary/Temporary)

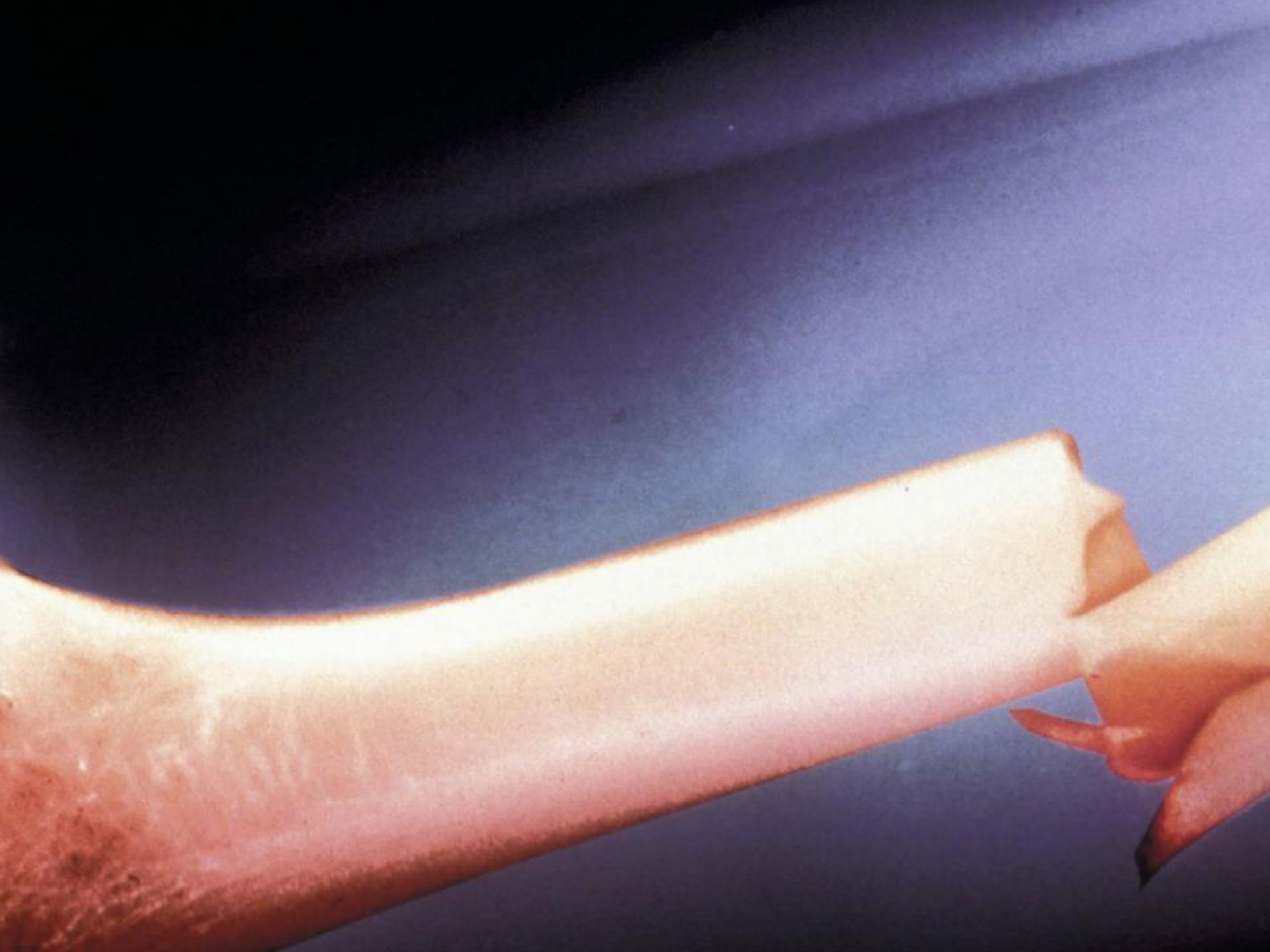


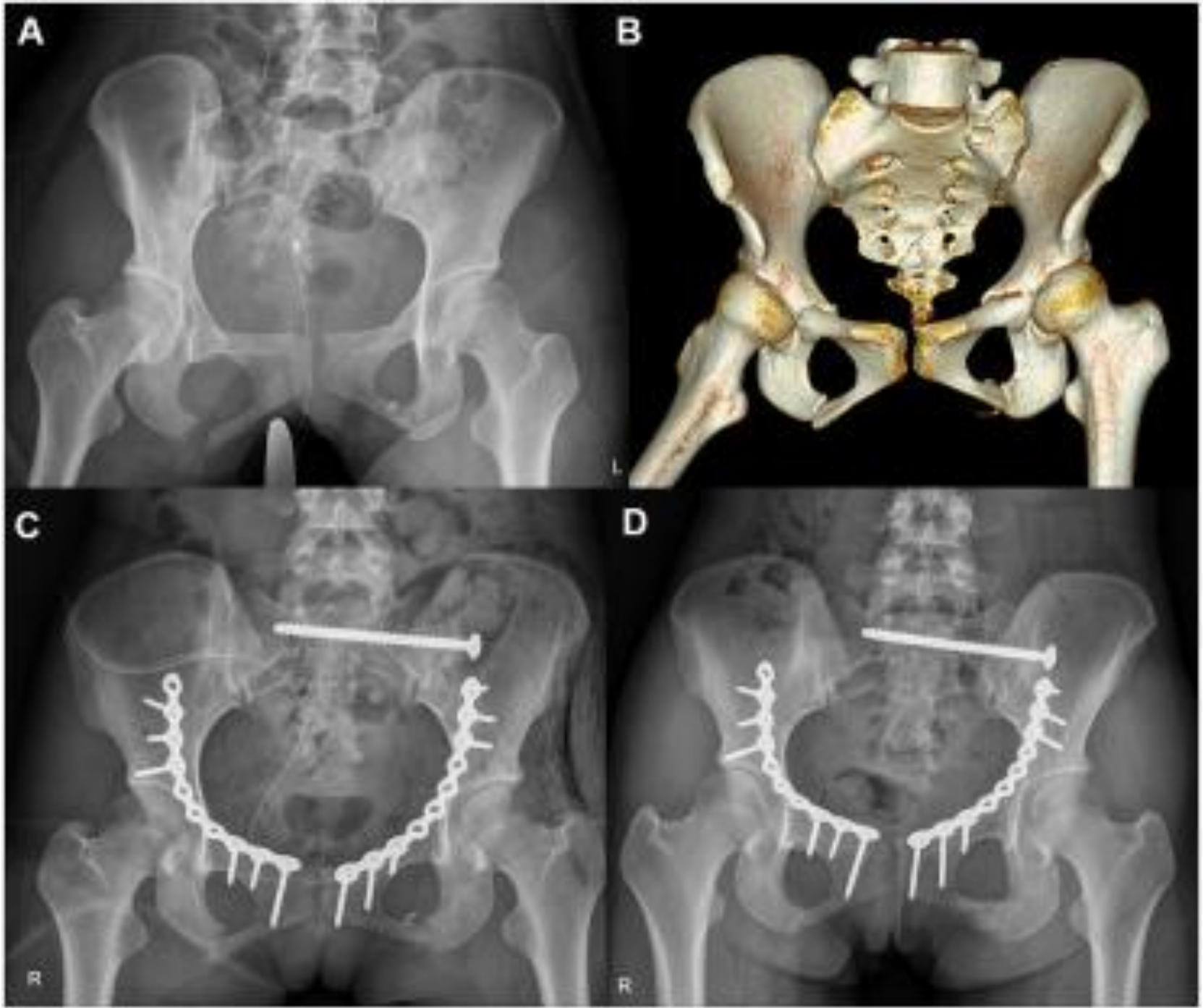

A
B
10 cm

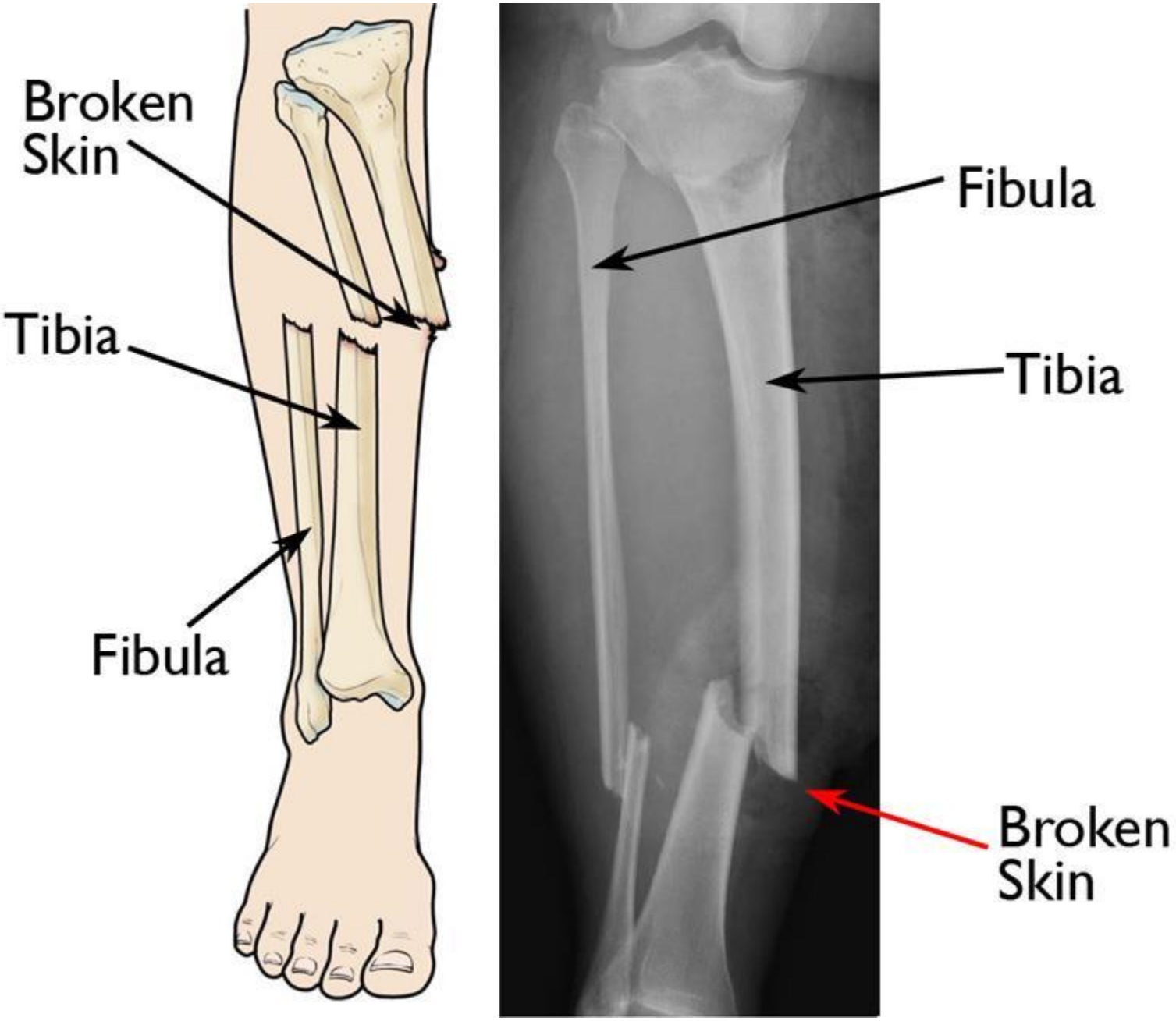
# SPONGY BONE VS COMPACT BONE

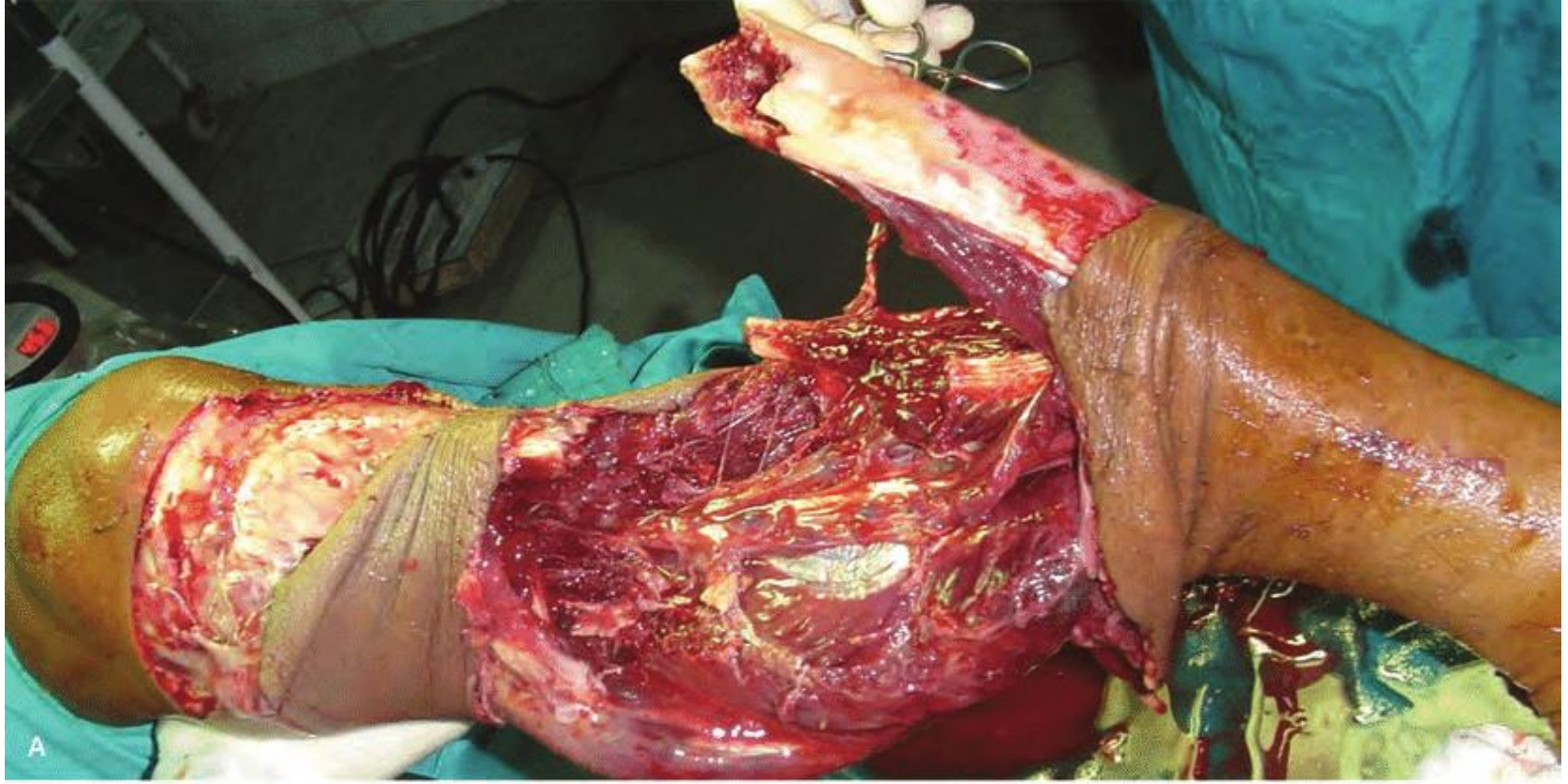




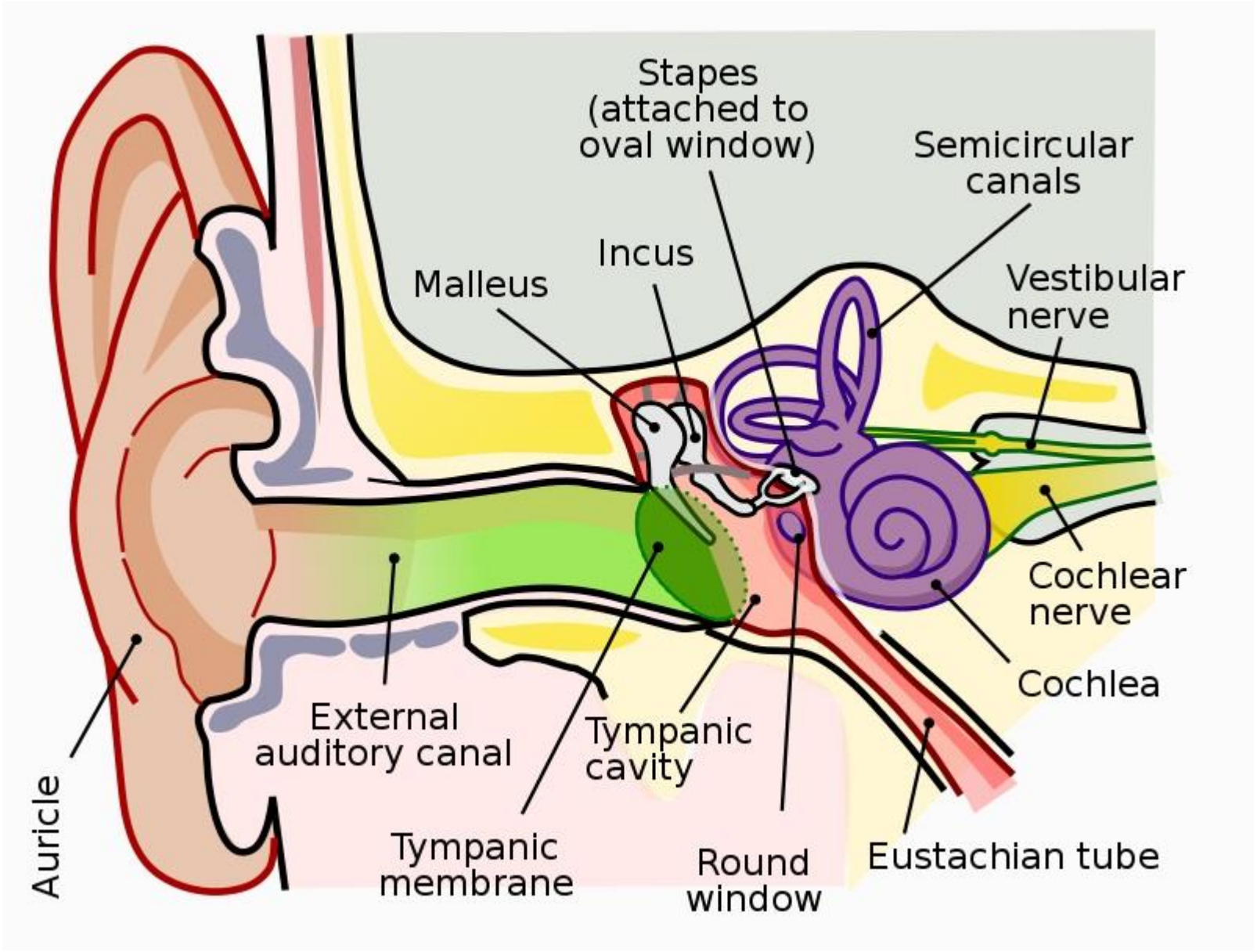

A
B
C
D
L
R
R

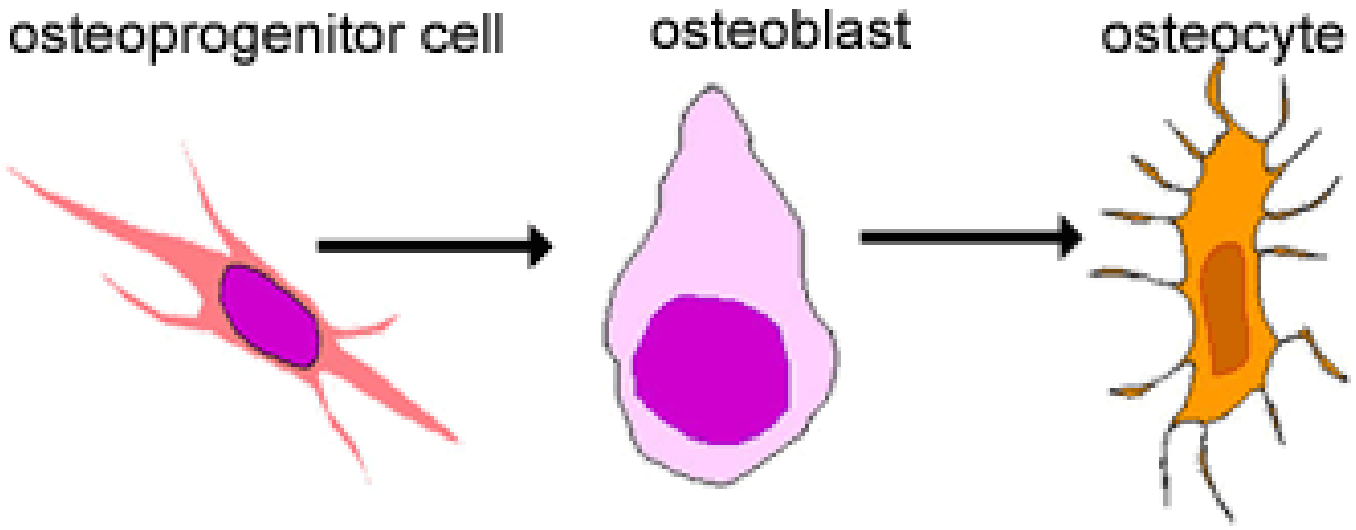

Broken
Skin
Tibia
Fibula
Fibula
Tibia
Broken
Skin

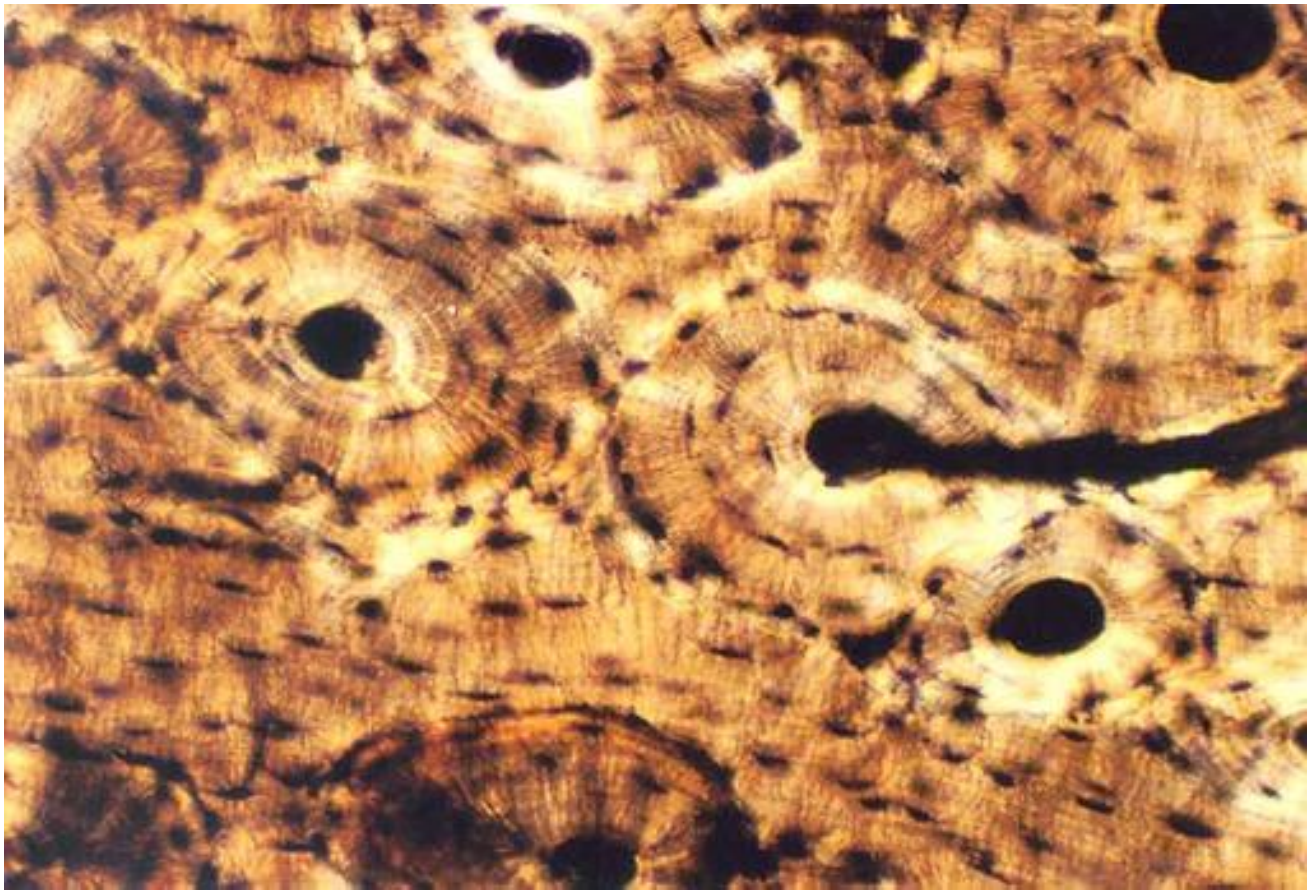

A

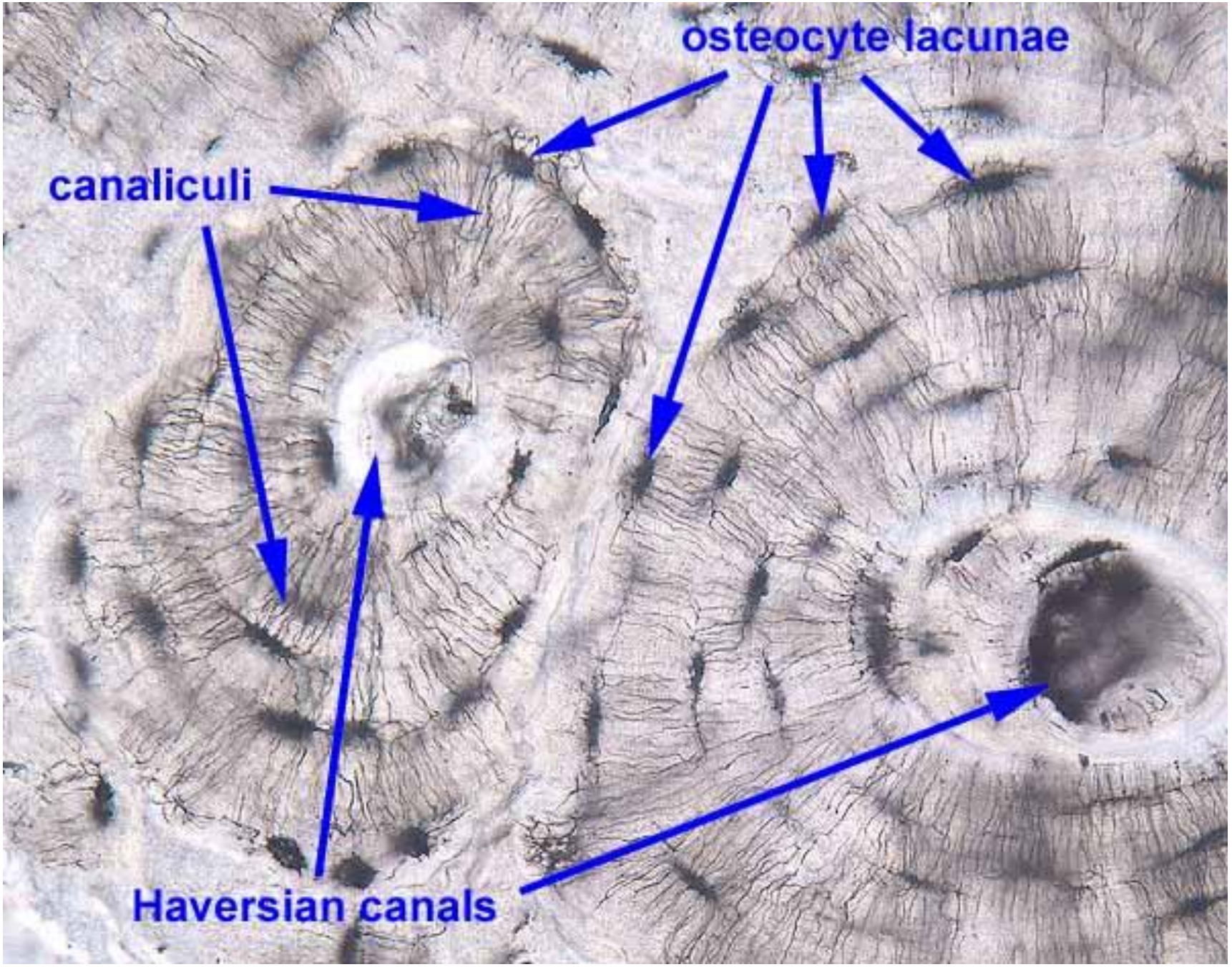

B
15 7:37

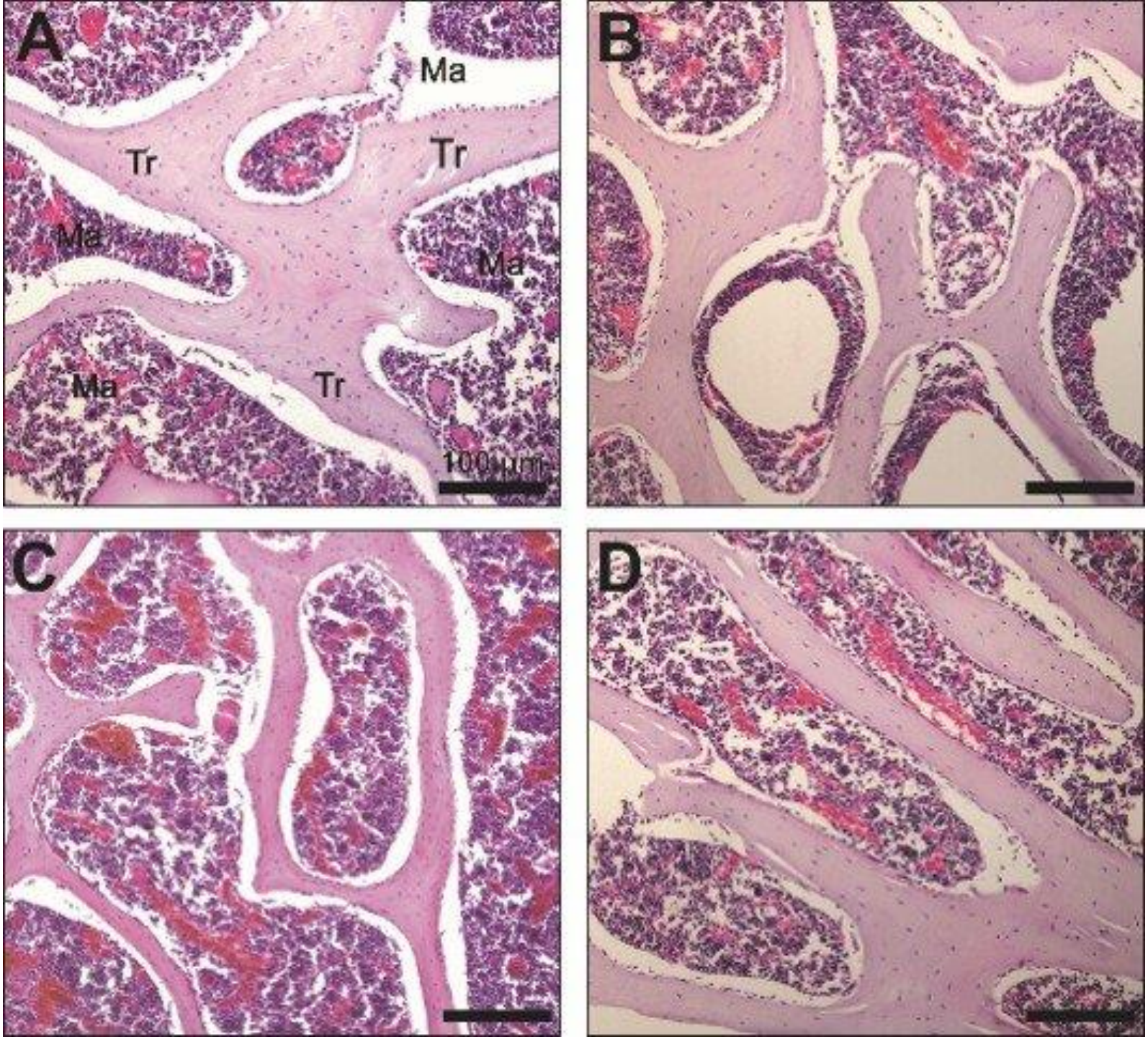

C

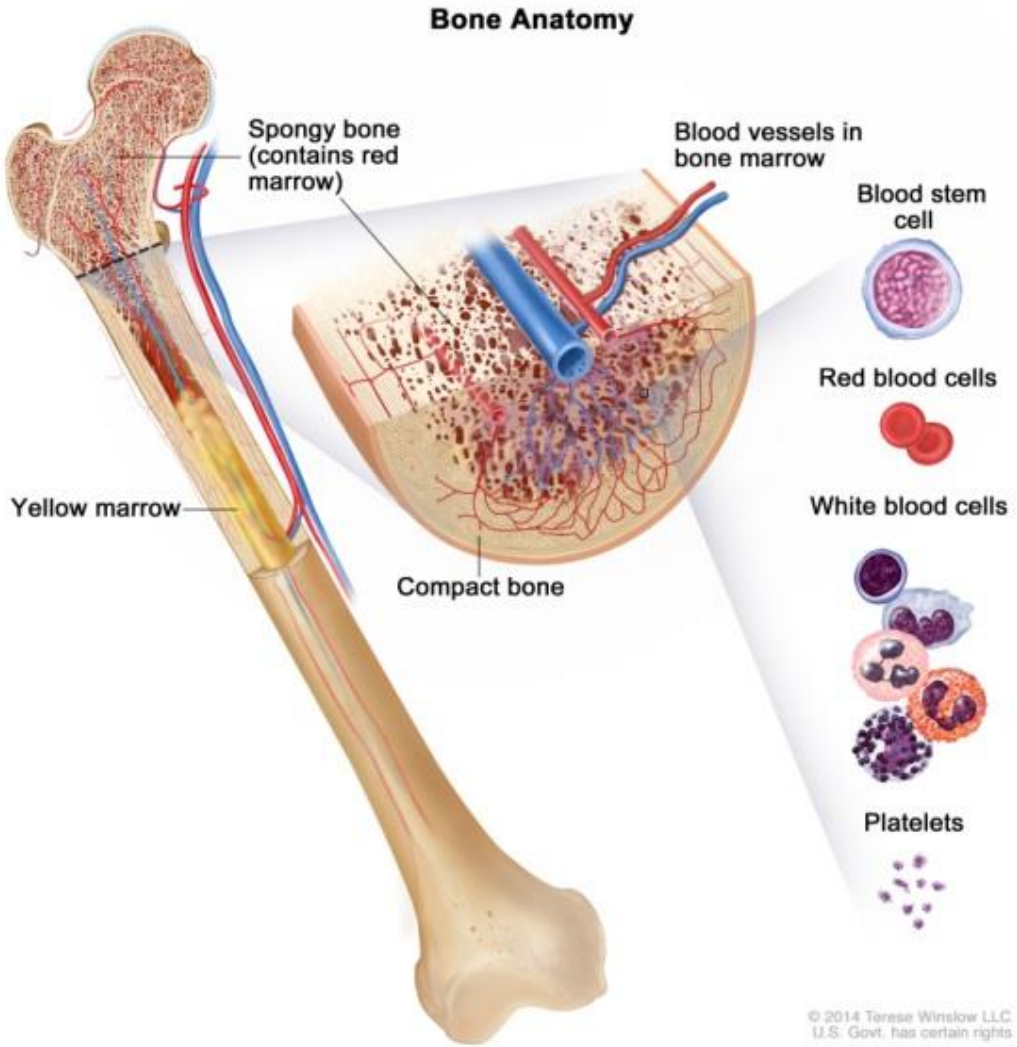

Stapes
(attached to
oval window)
Semicircular
canals
Incus
Malleus
Vestibular
nerve
Cochlear
nerve
Cochlea
External
auditory canal
Tympanic
cavity
Auricle
Tympanic
membrane
Round
window
Eustachian tube


osteoprogenitor cell
osteoblast
osteocyte




osteocyte lacunae
canaliculi
Haversian canals


A
Ma
Tr
Tr
Ma
Ma
Tr
Ma
100 µm
B
C
D


Bone Anatomy
Spongy bone (contains red marrow)
Blood vessels in bone marrow
Blood stem cell
Red blood cells
White blood cells
Platelets
Yellow marrow
Compact bone
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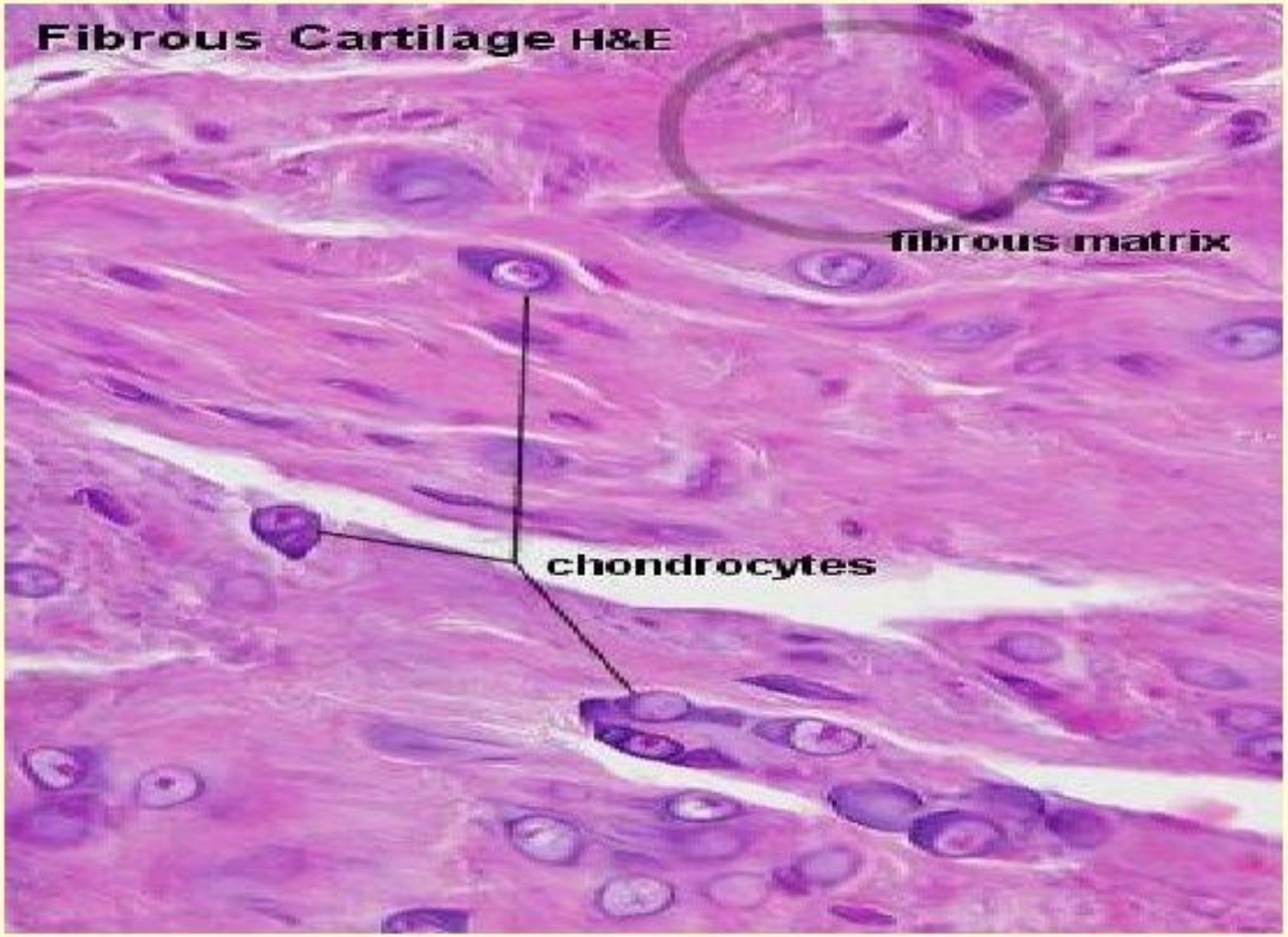
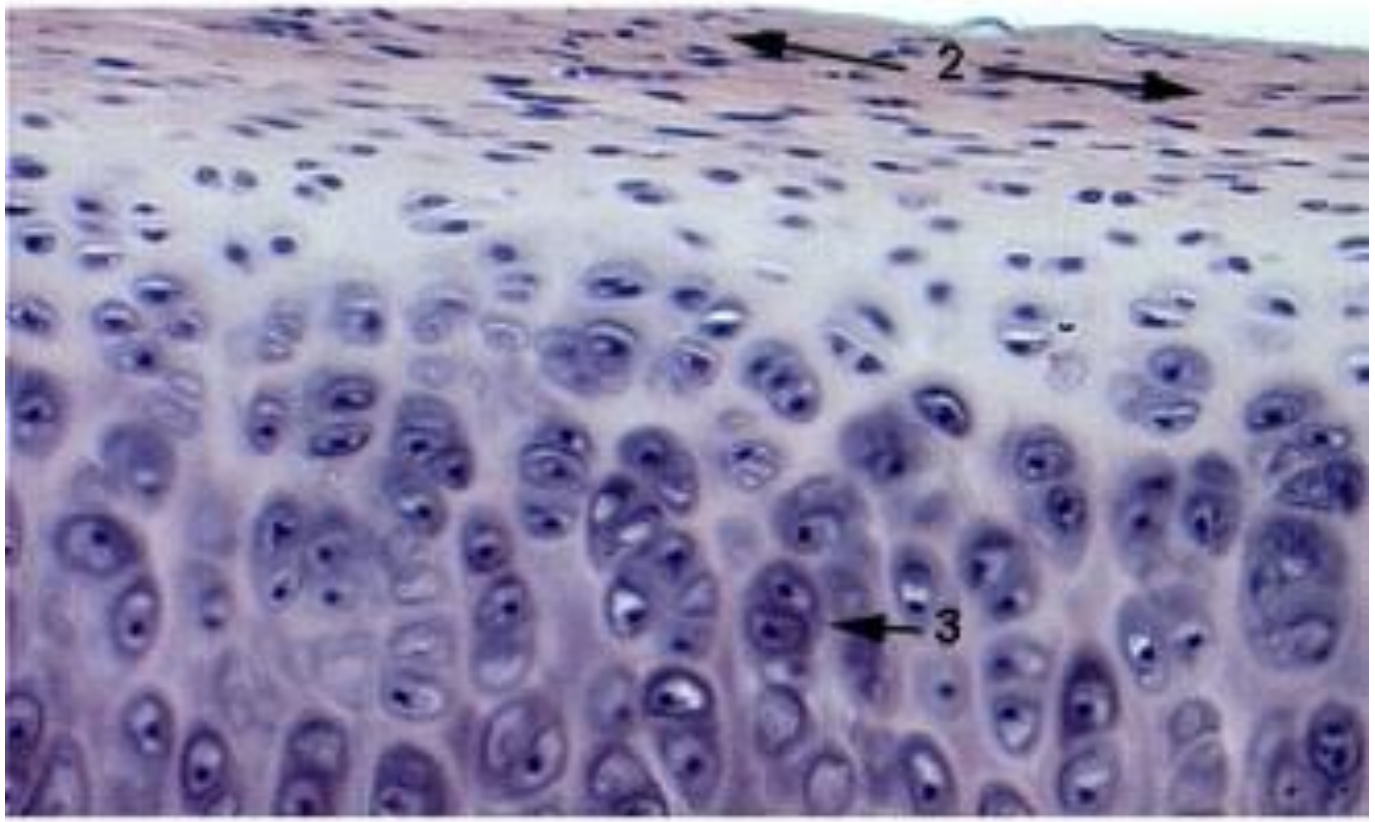
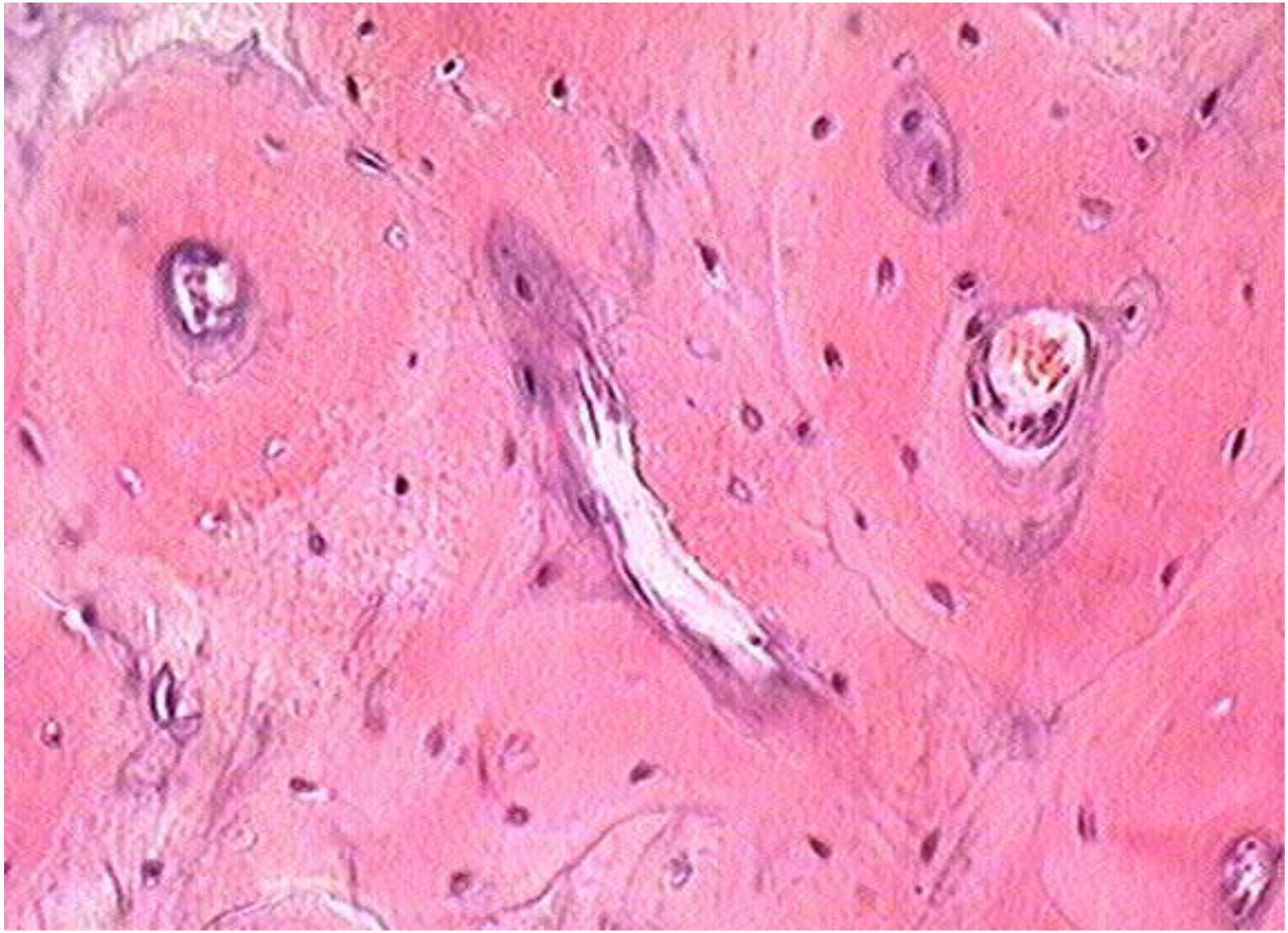
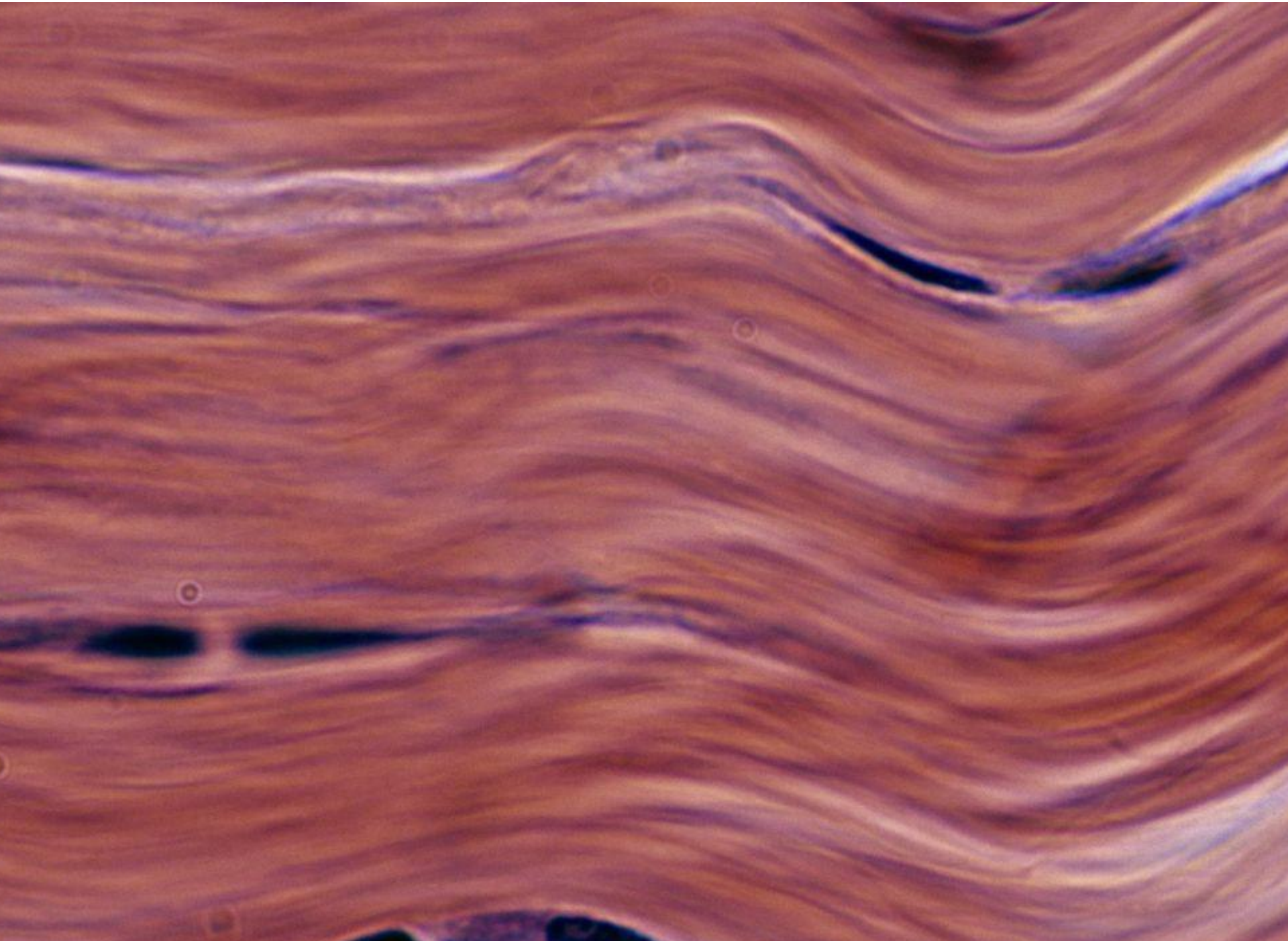
# Fibrocartilage

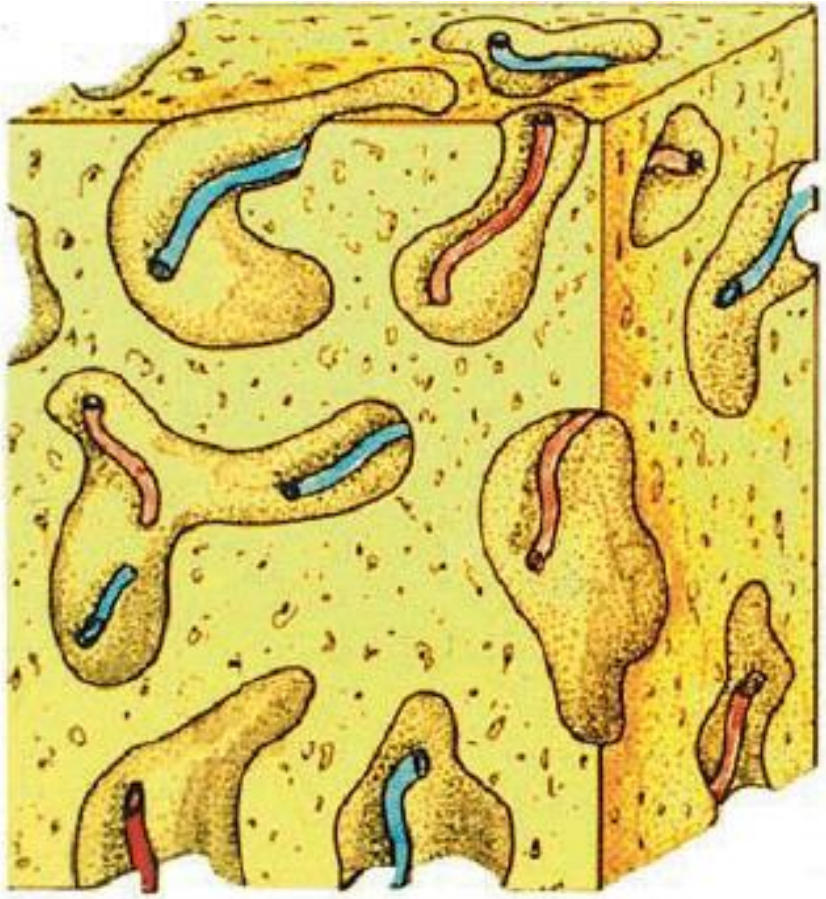




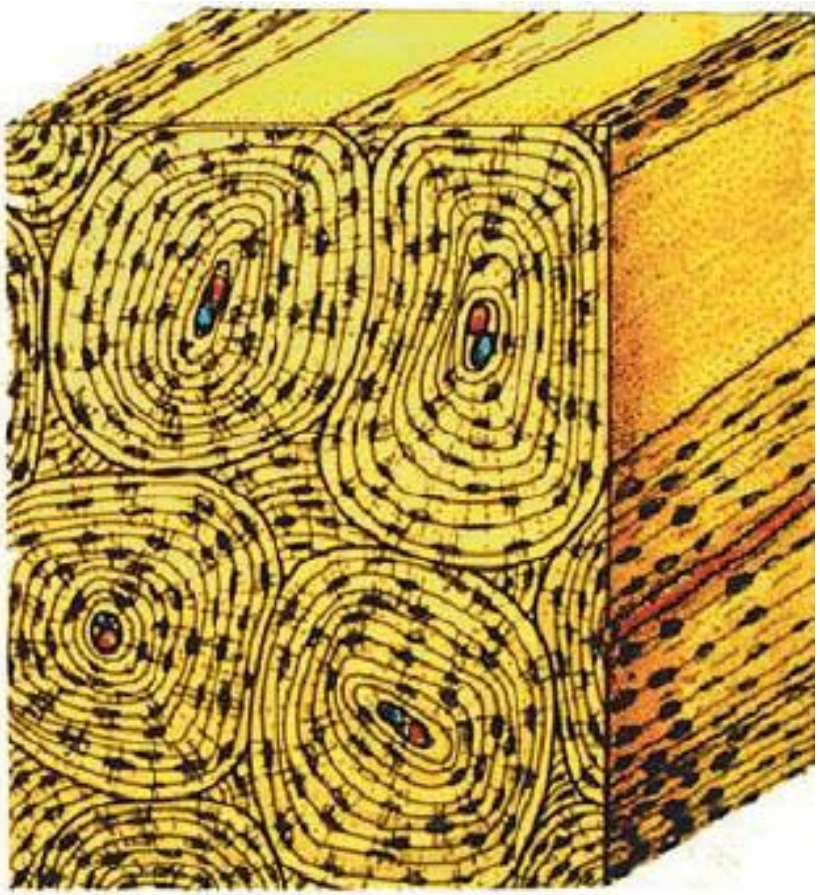

1) Identify this tissue
2) Identify the layer indicated by the arrow
3) Identify the structure indicated by the arrow
4) Idenitfy the cells which reside in this structure (#3)



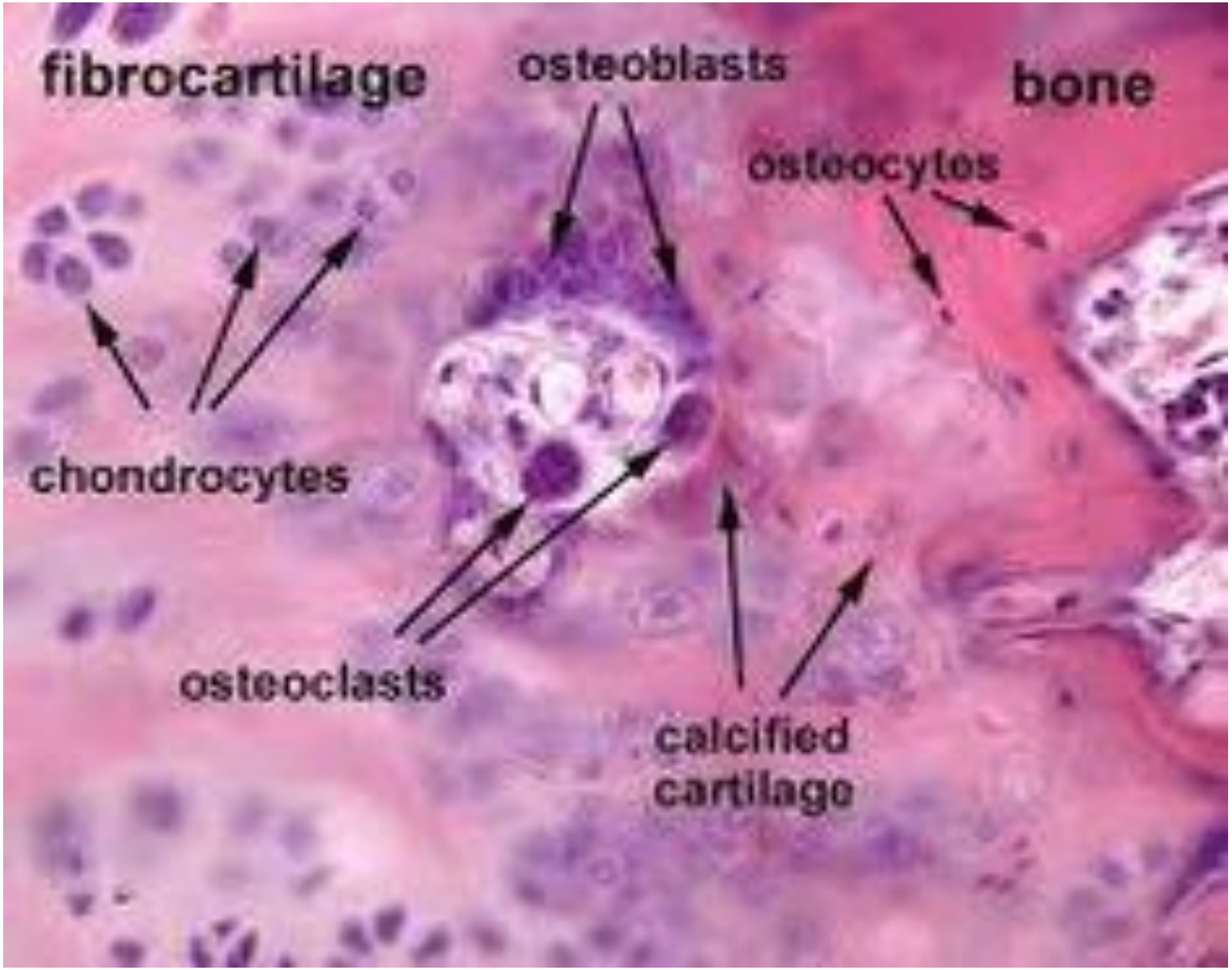


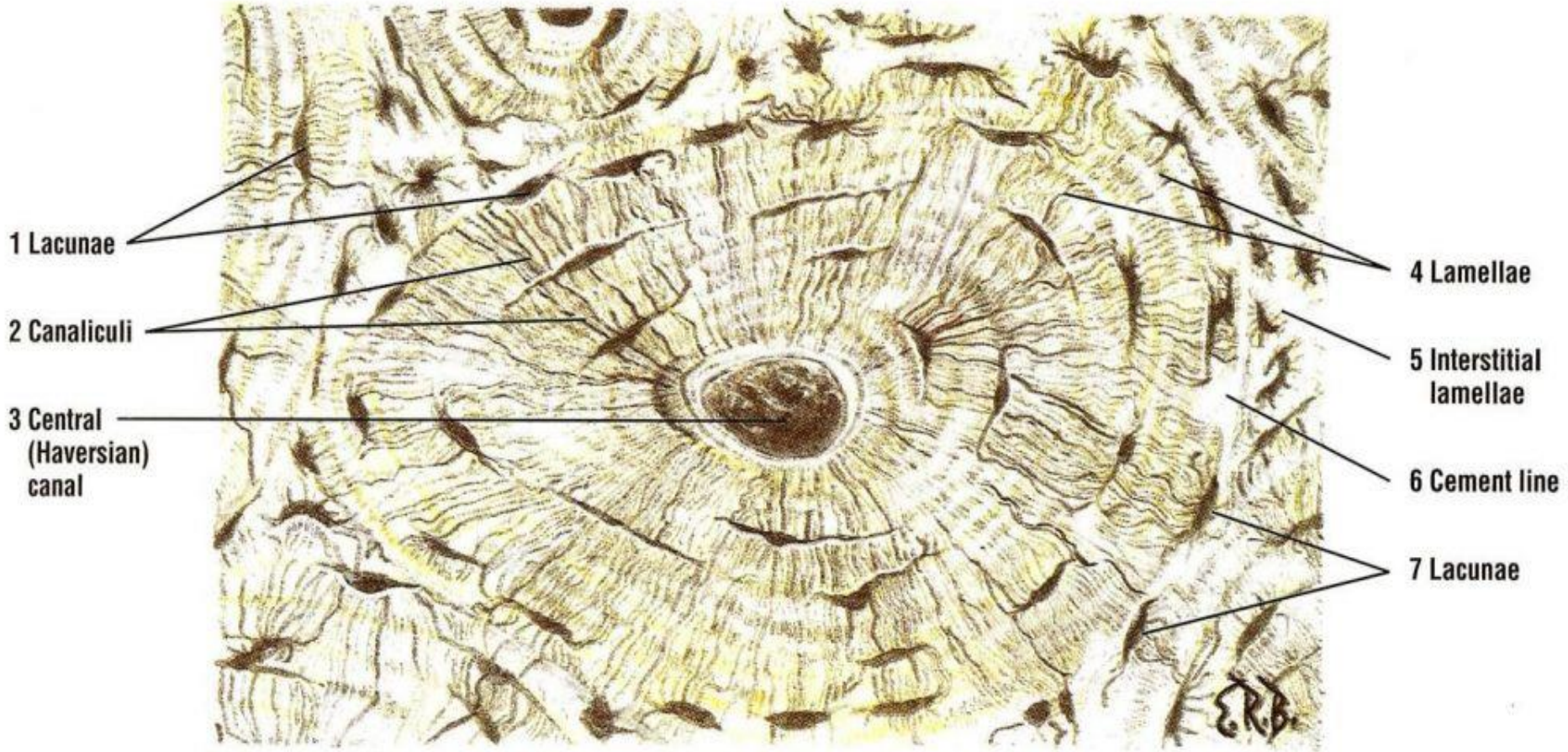


Woven

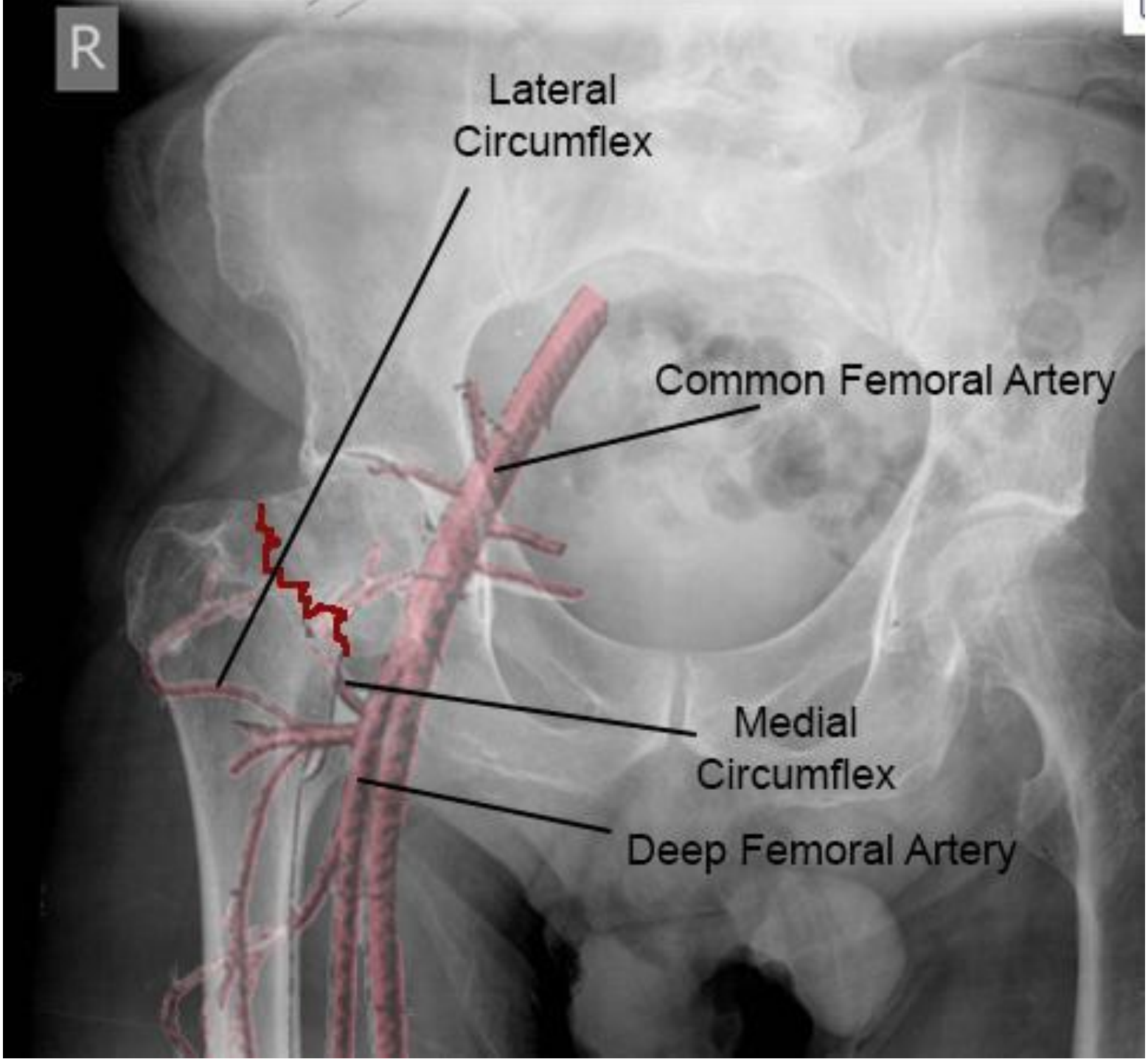


Lamellar


fibrocartilage
osteoblasts
bone
osteocytes
chondrocytes
osteoclasts
calcified
cartilage

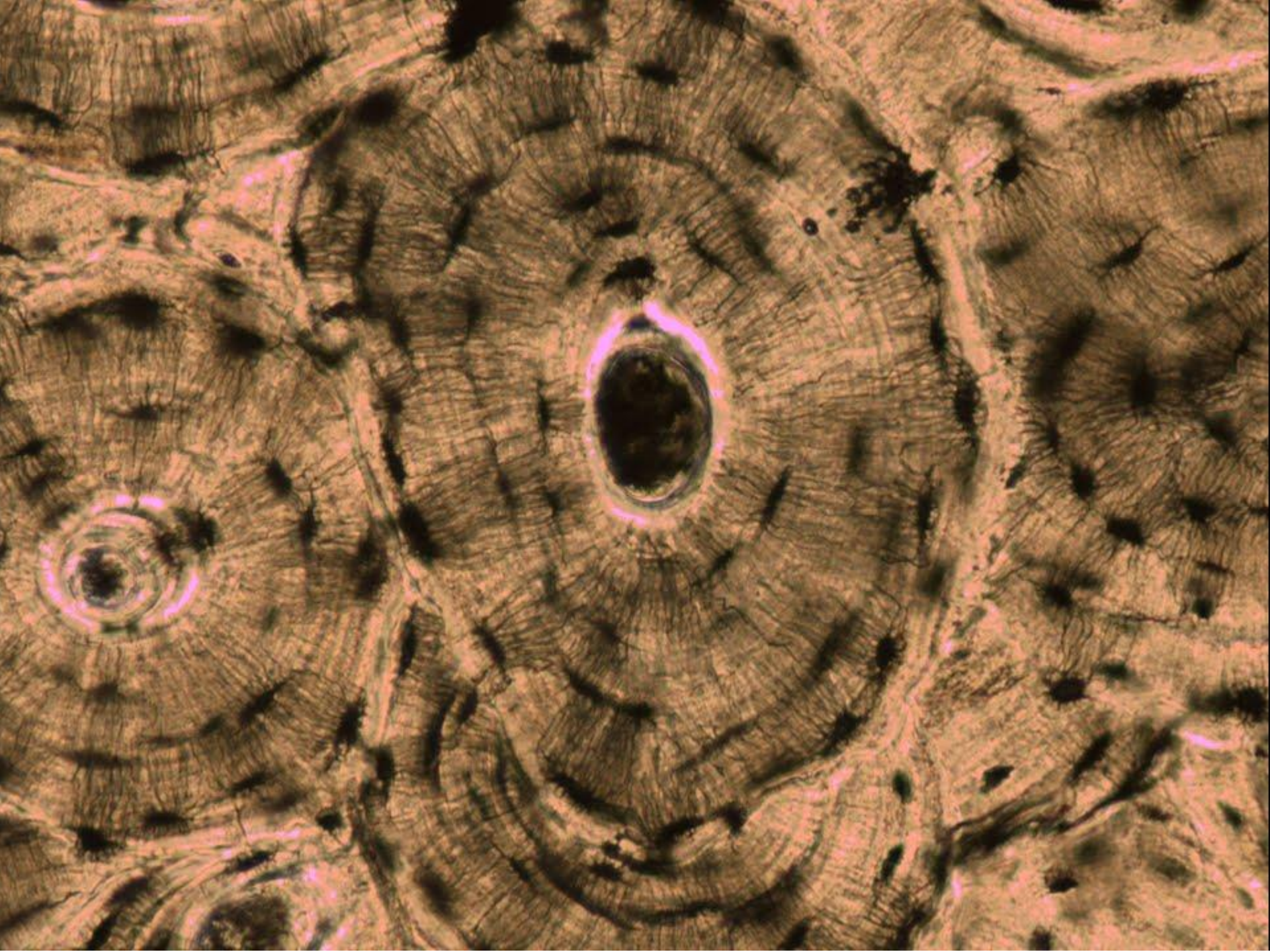


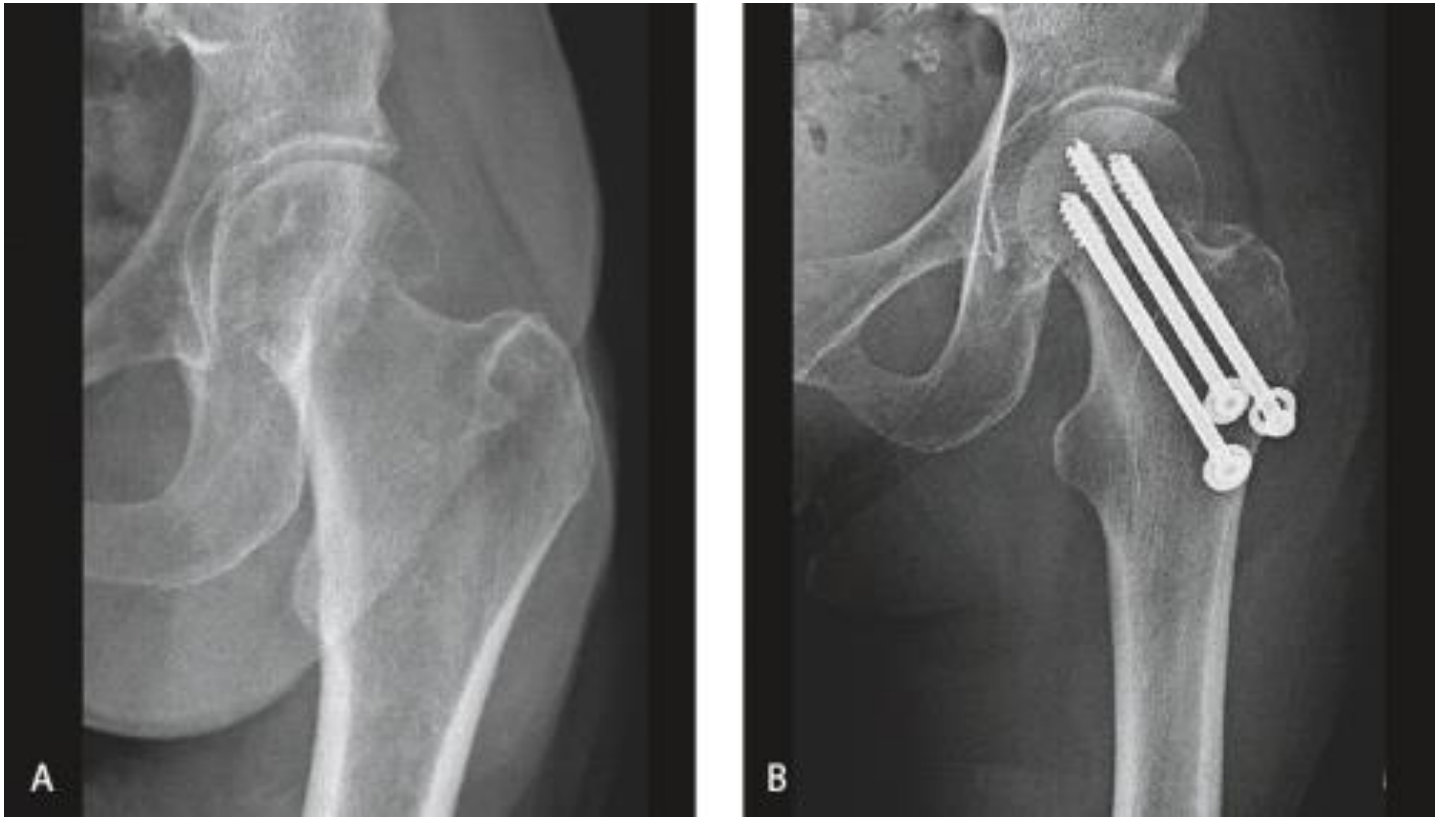

**Compact Bone, Dried: An Osteon (transverse section).** High magnification.


R
Lateral
Circumflex
Common Femoral Artery
Medial
Circumflex
Deep Femoral Artery


NEW PIERCING


FINERY29




A
B

# Classification of Primary Osteoporosis

- Idiopathic osteoporosis
  - affects children and adults

- Type I (or postmenopausal) osteoporosis
  - Usually affects females ages 51 to 75
  - Related to the loss of estrogen's protective effect on bone
  - Results in trabecular bone loss and some cortical bone loss
  - Vertebral and wrist fractures are common.


**Figure 1:** Plain radiograph of the pelvis with both the hips showing bilateral neck of femur fracture.

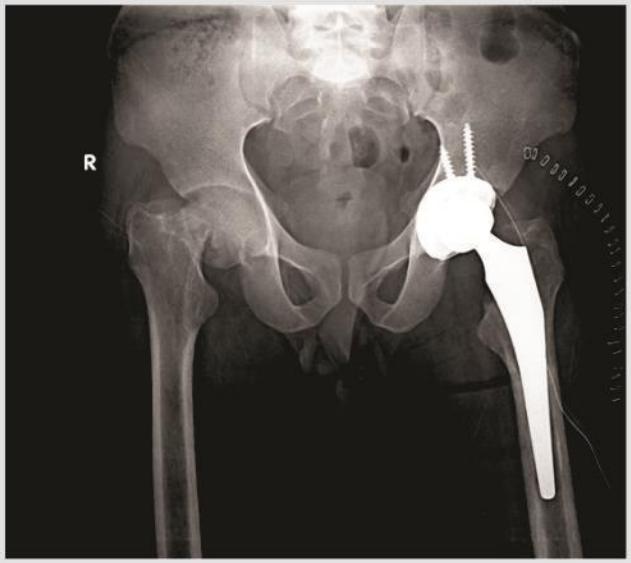
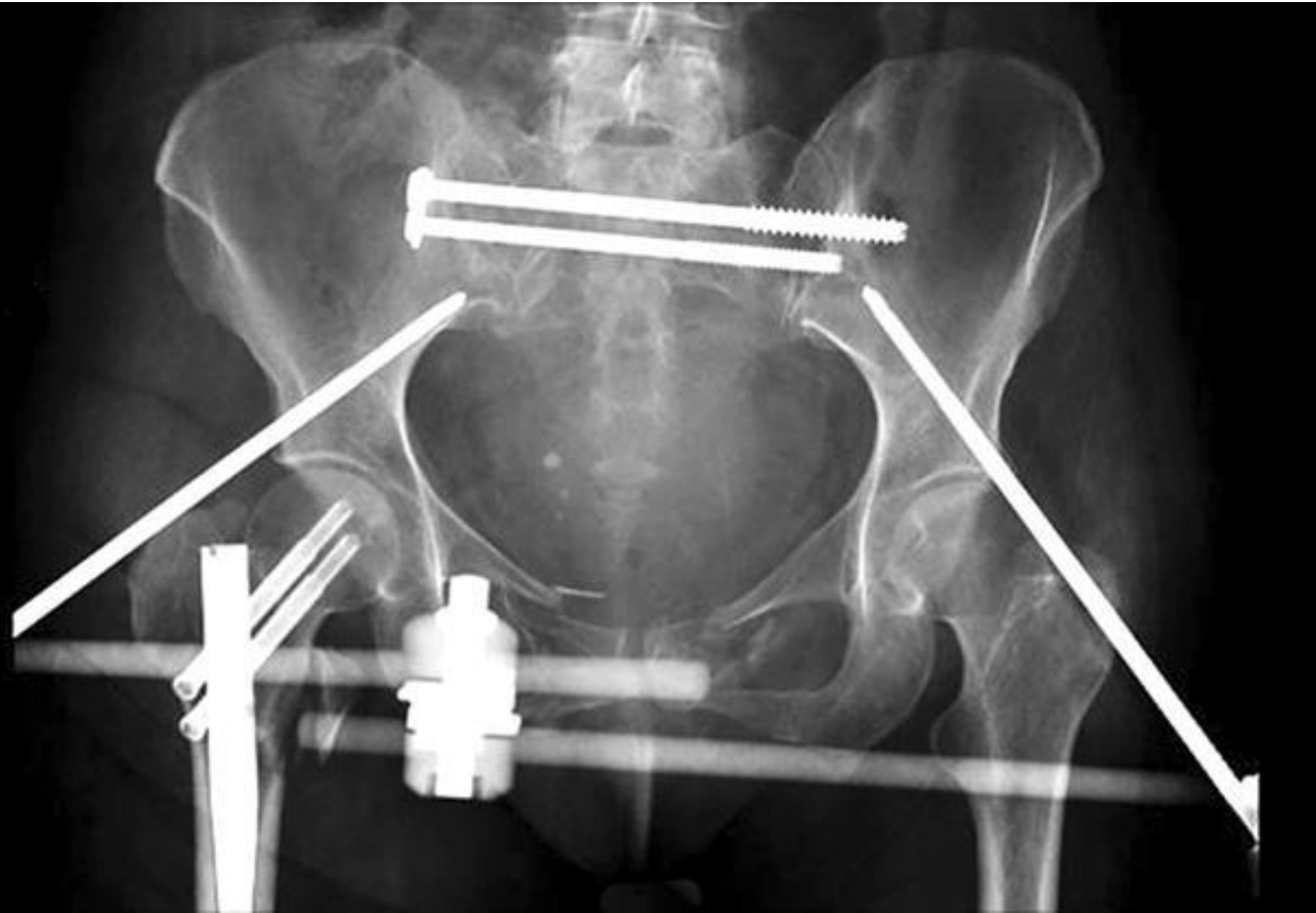
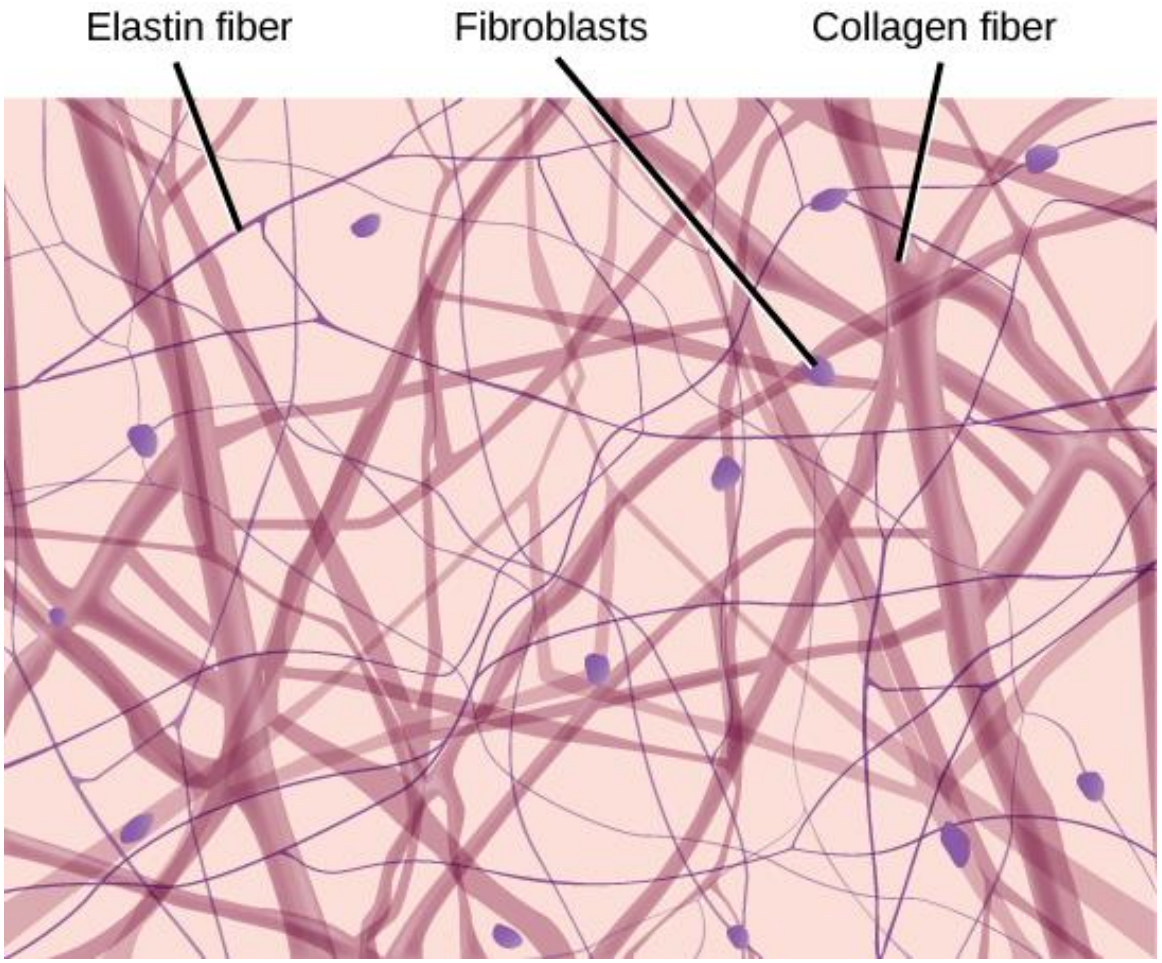


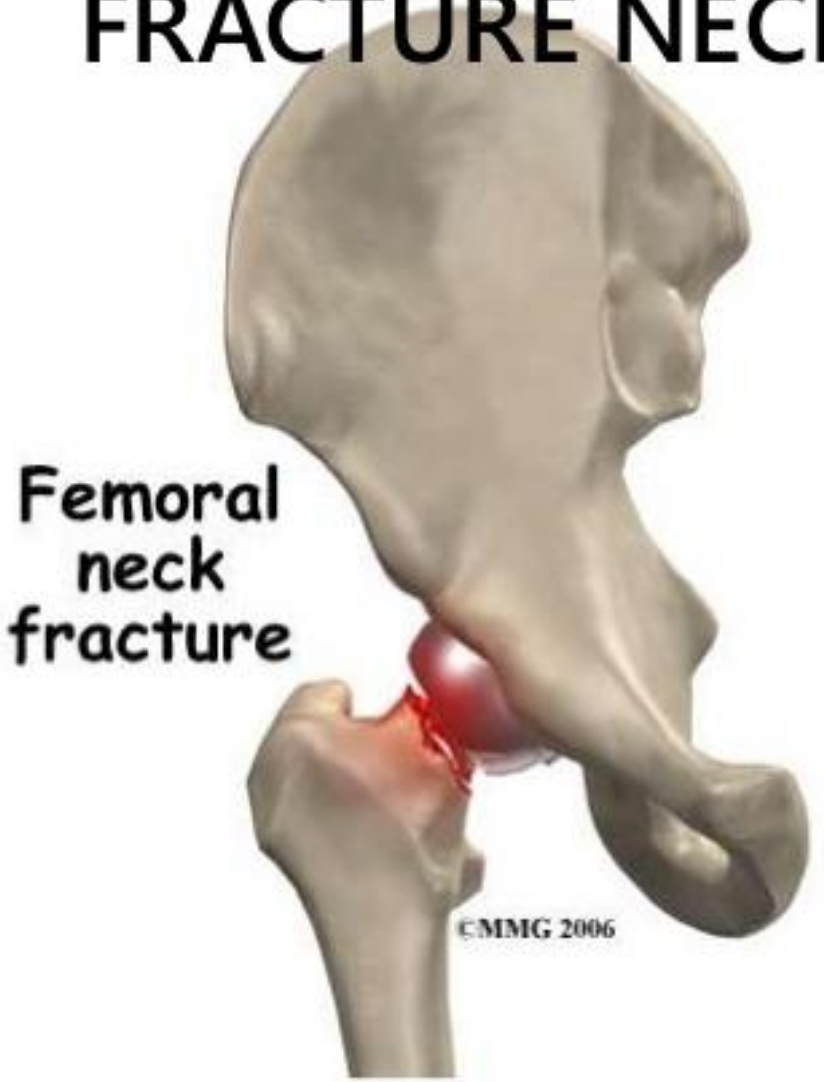

**Figure 2:** Left total hip replacement was done first as the left hip was more symptomatic.


7A




Elastin fiber
Fibroblasts
Collagen fiber

# FRACTURE NECK OF FEMUR




Hip fracture or Broken hip or Fracture Neck of Femur all mean the same type of fracture.

CLINICAL PRESENTATION


13
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Fotosearch
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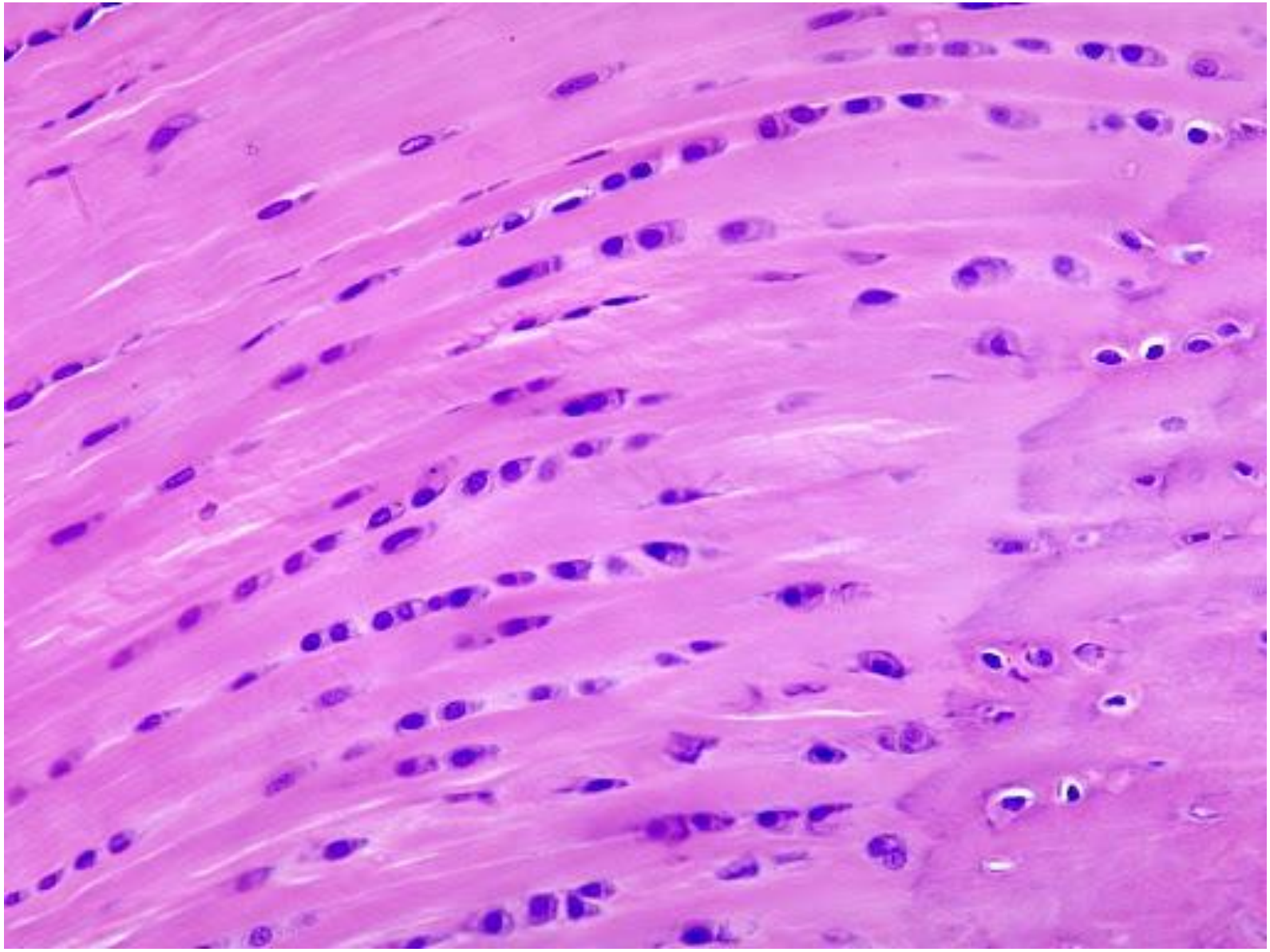


gettyimages
xia yuan
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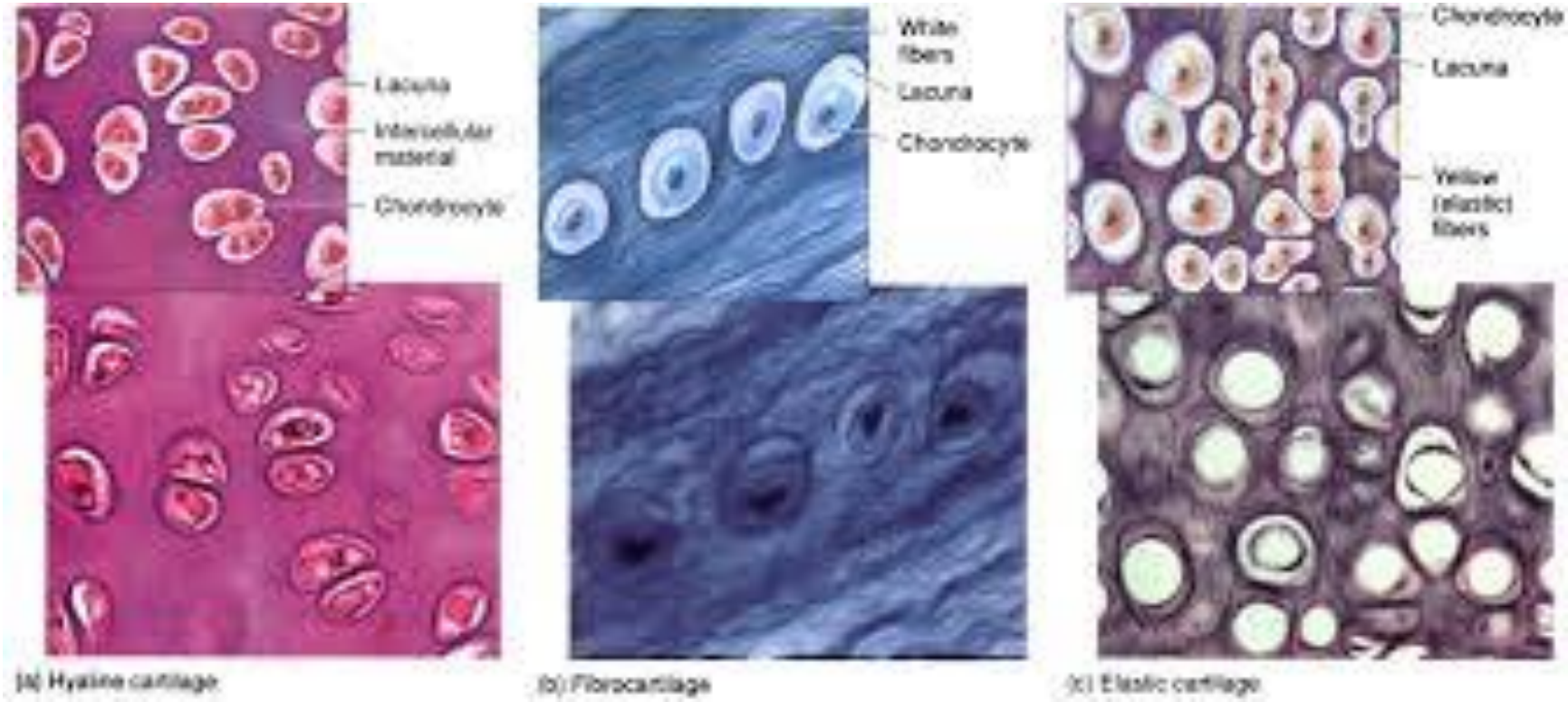
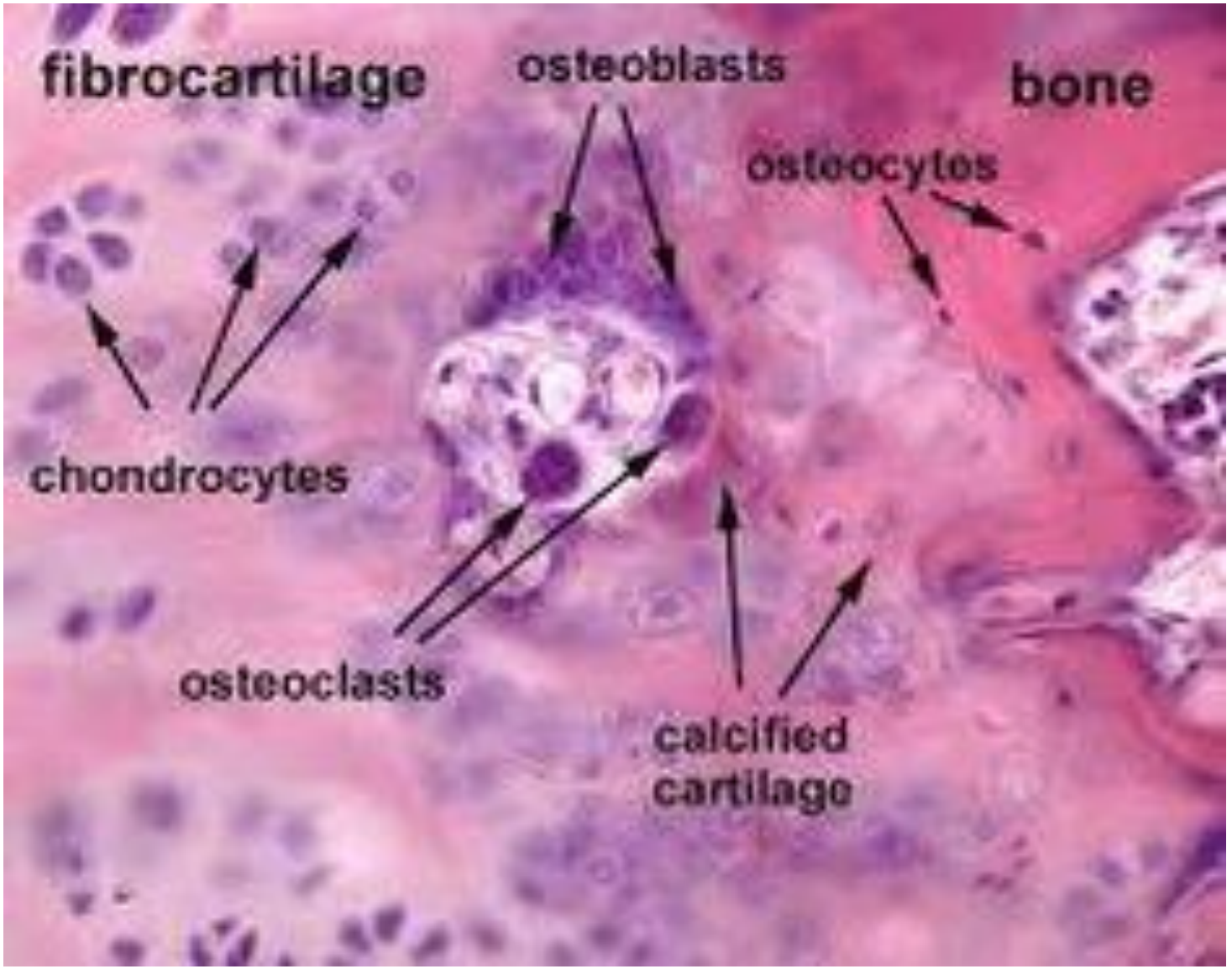
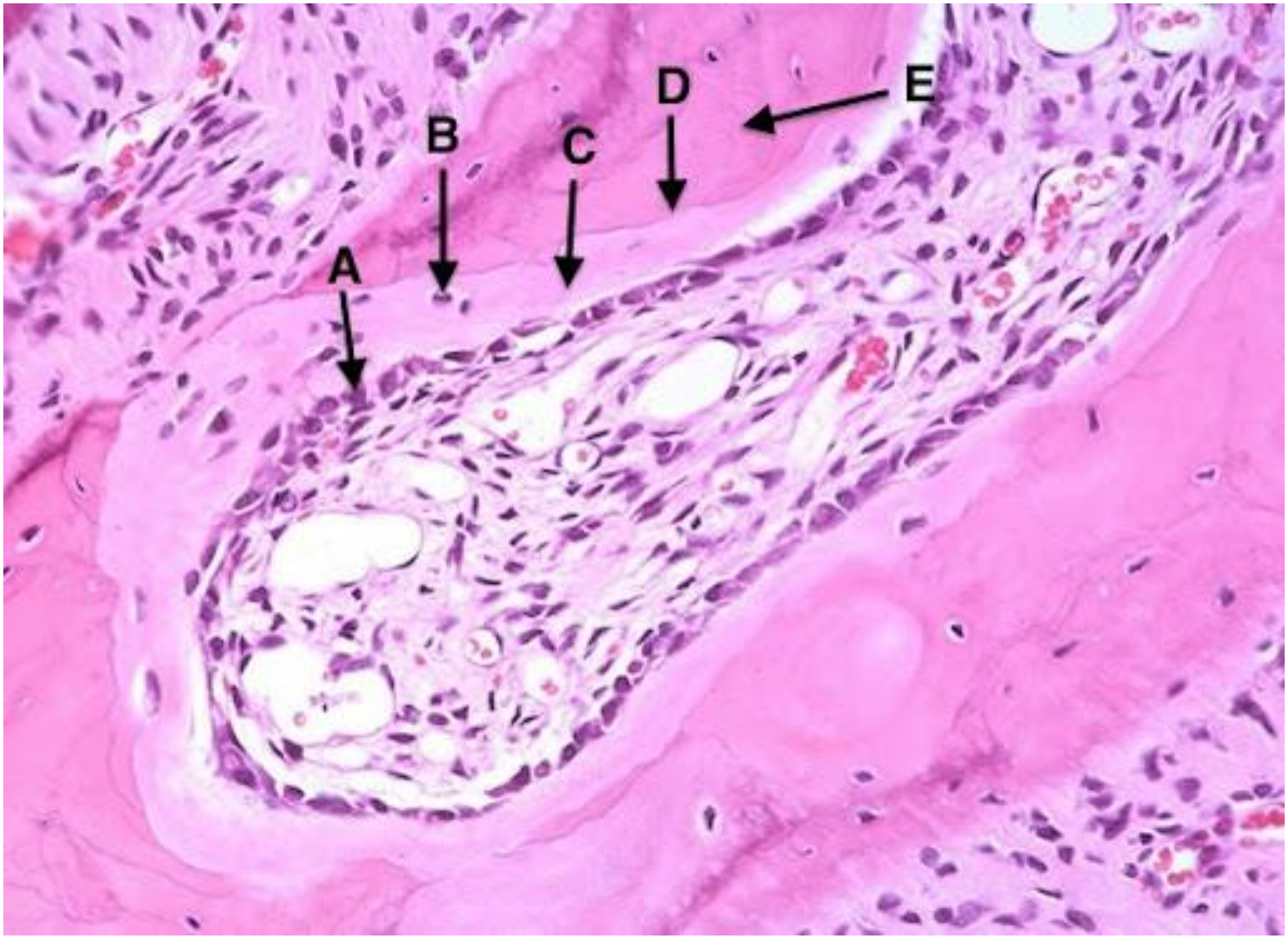
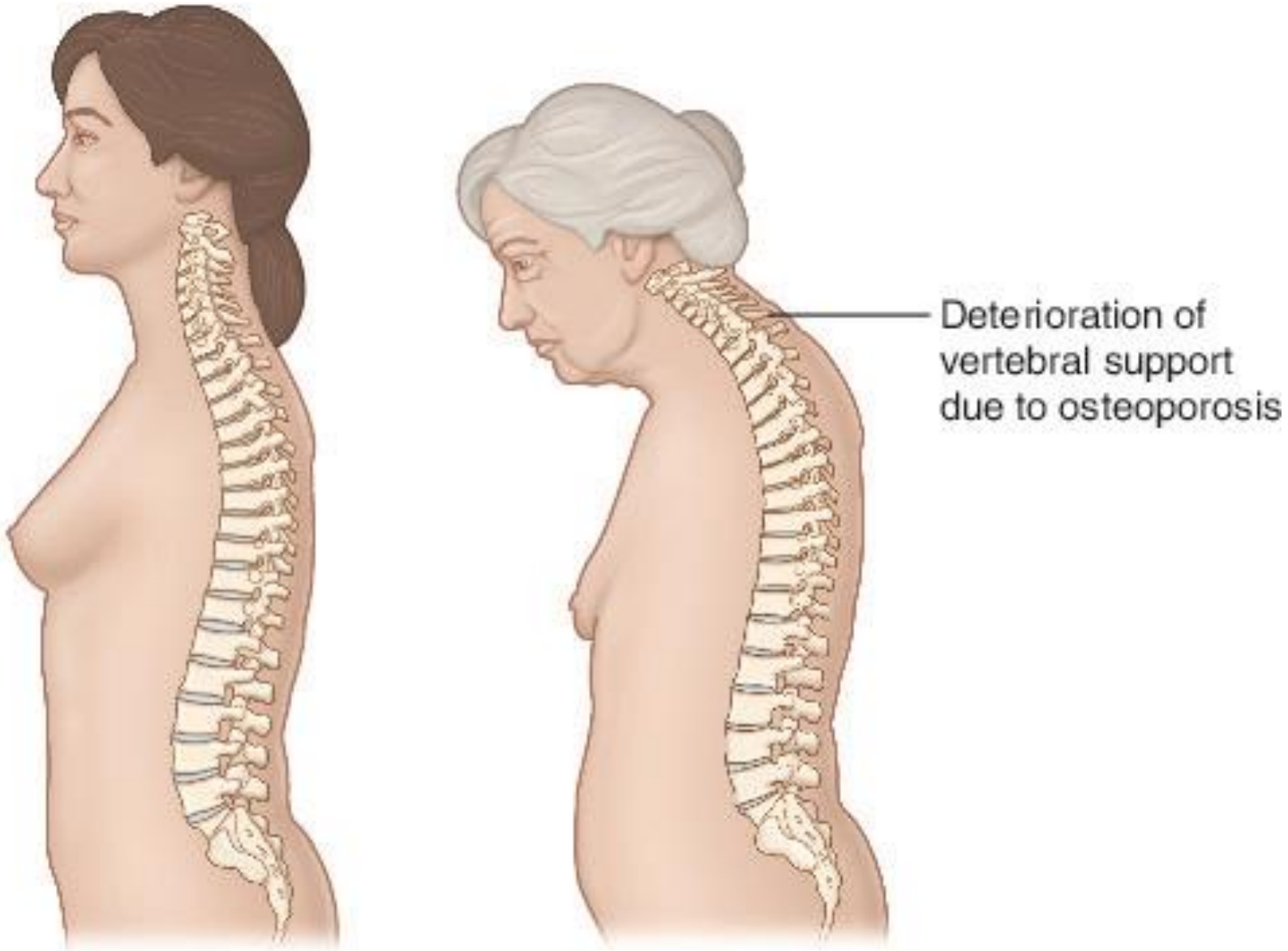


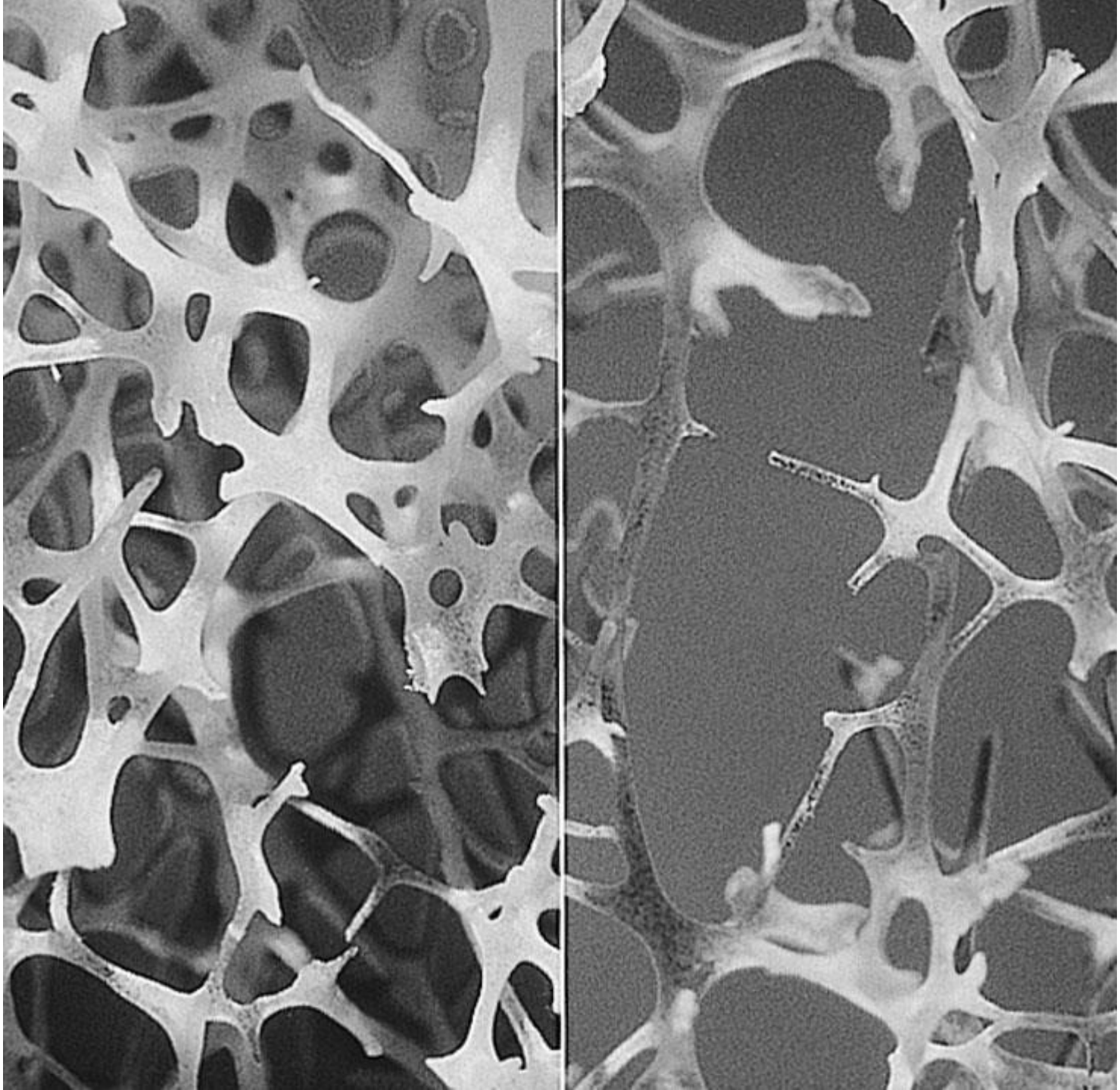

(a) Hyaline cartilage (b) Fibrocartilage (c) Elastic cartilage


fibrocartilage
osteoblasts
bone
osteocytes
chondrocytes
osteoclasts
calcified
cartilage


A
B
C
D
E


a
b
c

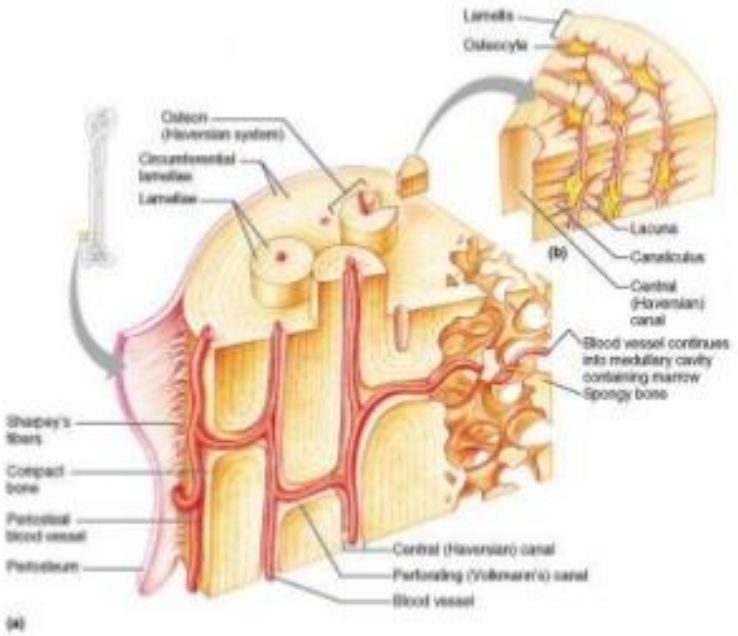

Deterioration of
vertebral support
due to osteoporosis

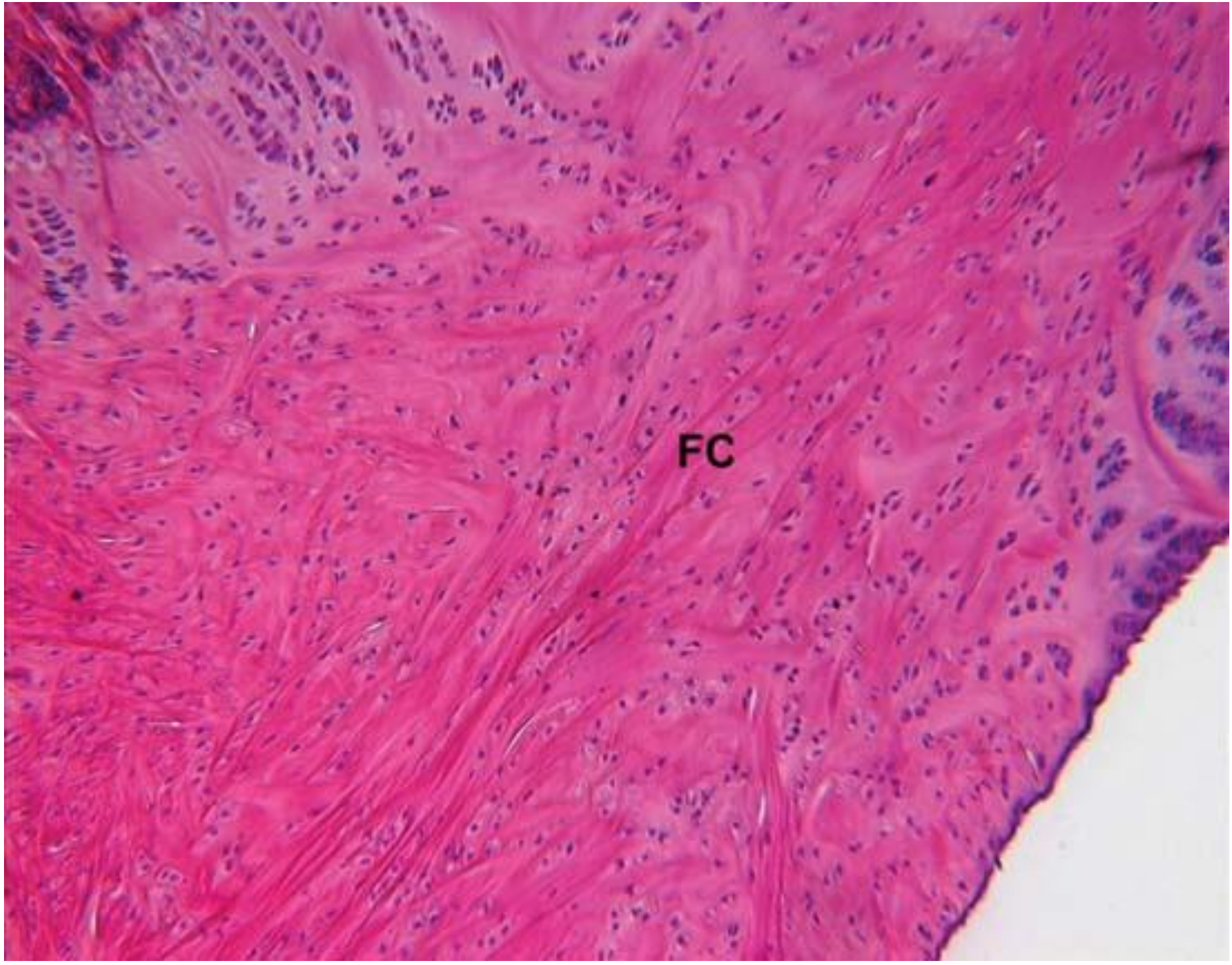


# Microscopic structure of compact bone

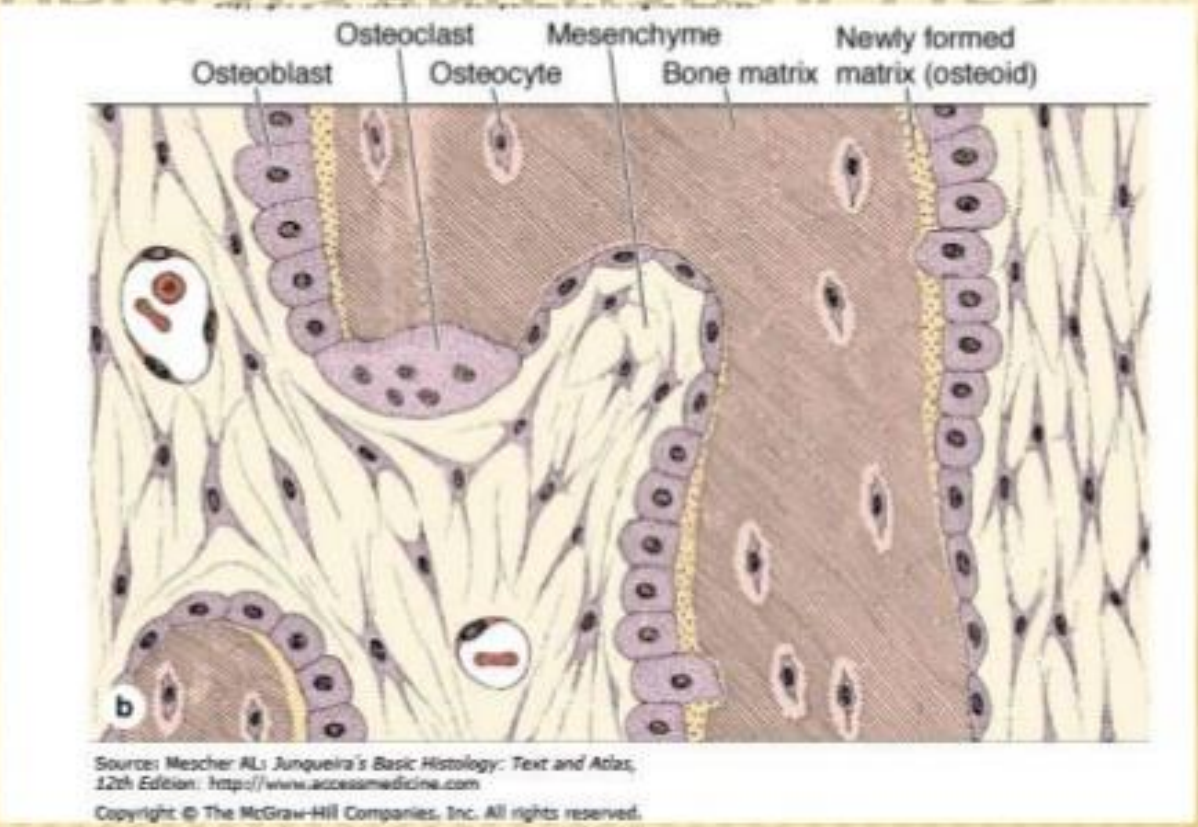
**Osteon System**:

- A **central** (**Haversian) canal** with concentric rings (**lamellae**) of bone matrix running lengthwise.
- Very strong!

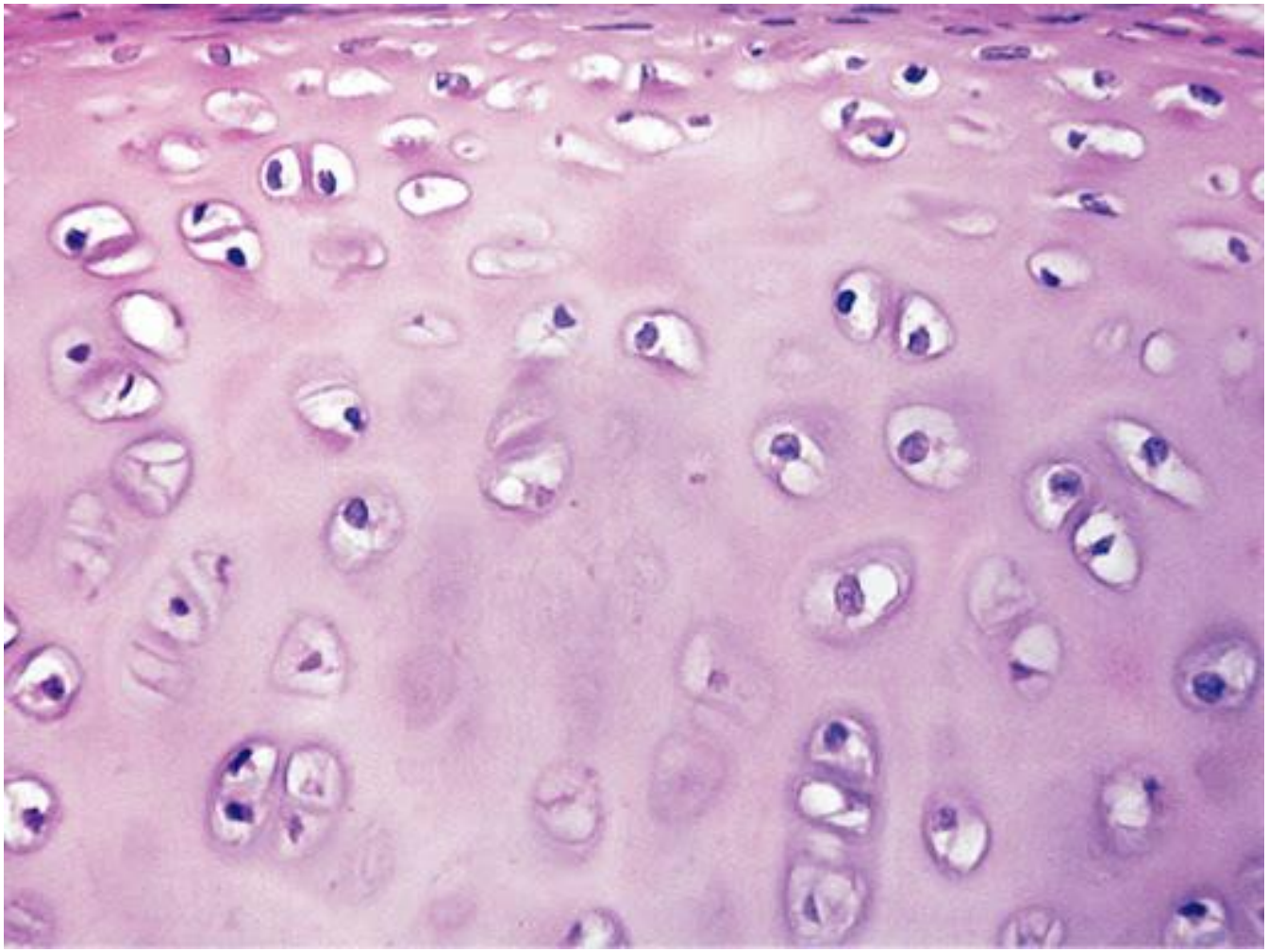


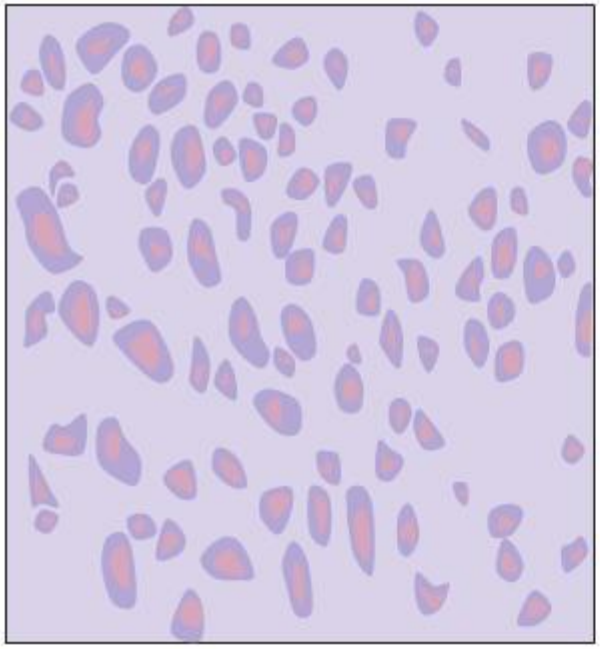

FC

# OSTEOBLASTS AND OSTEOCYTES

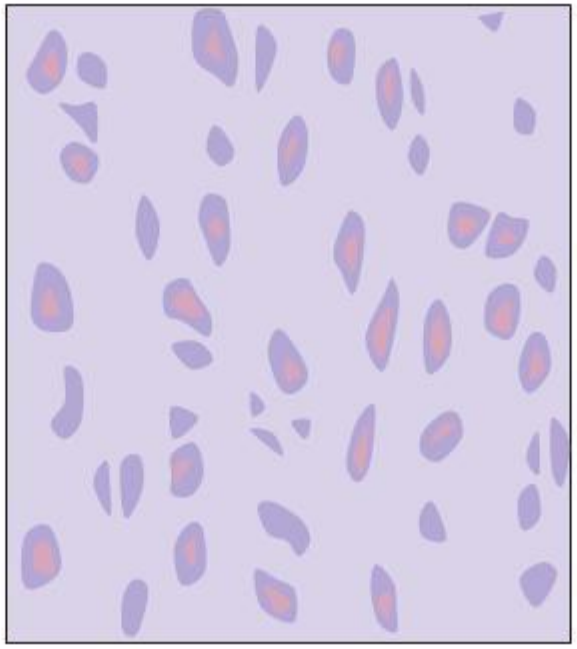



Schematic diagram shows the relationship of osteoblasts to osteoid, bone matrix, and osteocytes.

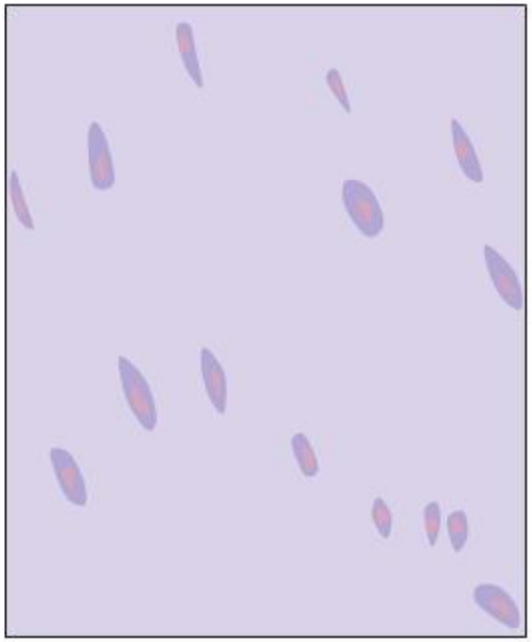




A. Elastic Cartilage

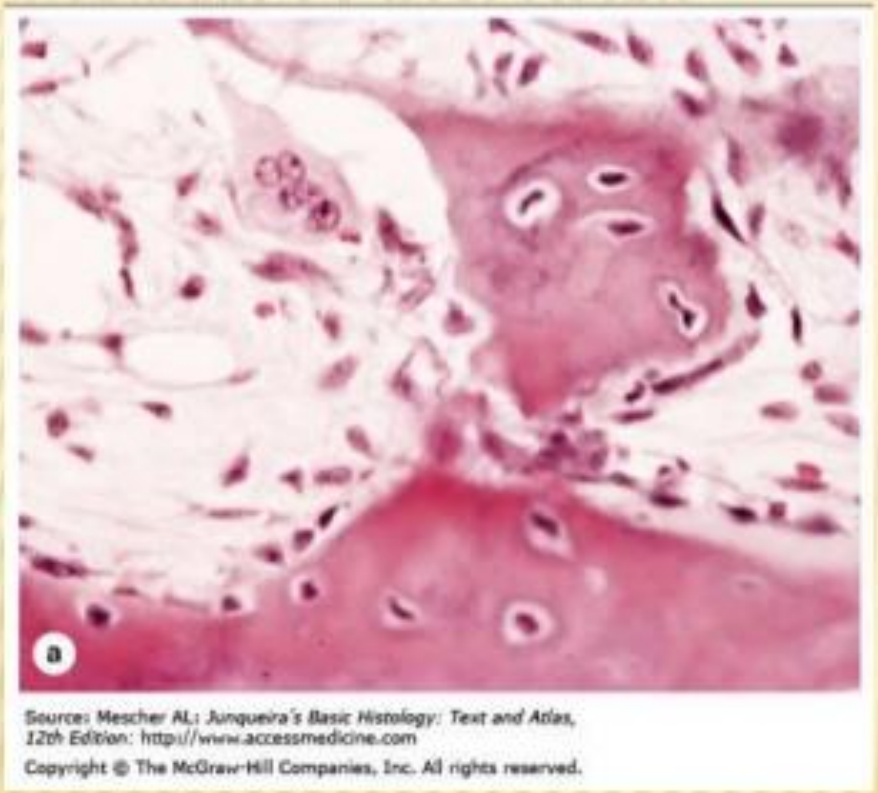


B. Hyaline Cartilage



C. Fibrous Cartilage

# PRIMARY (WOVEN) BONE AND SECONDARY (LAMELLAR) BONE

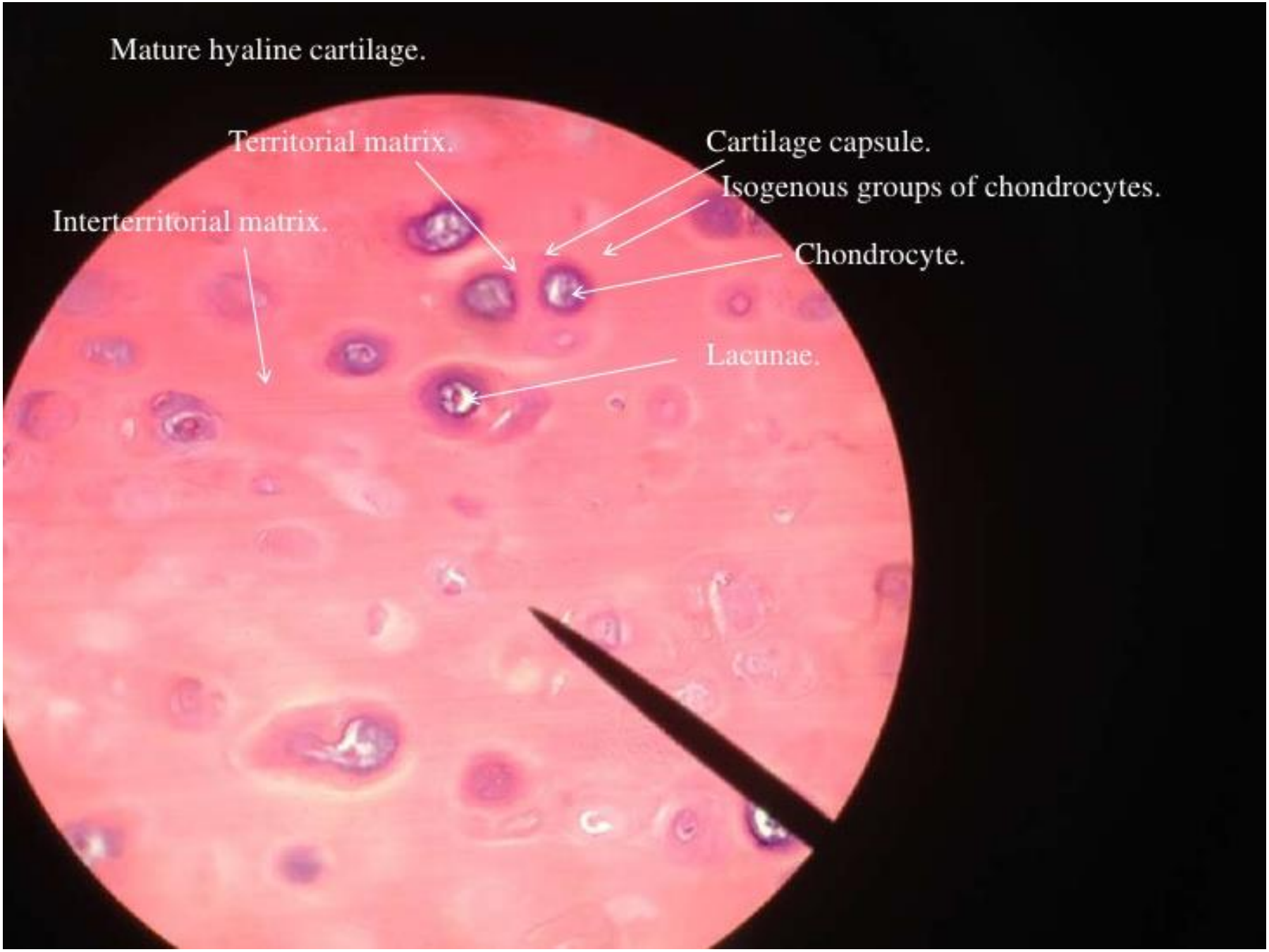


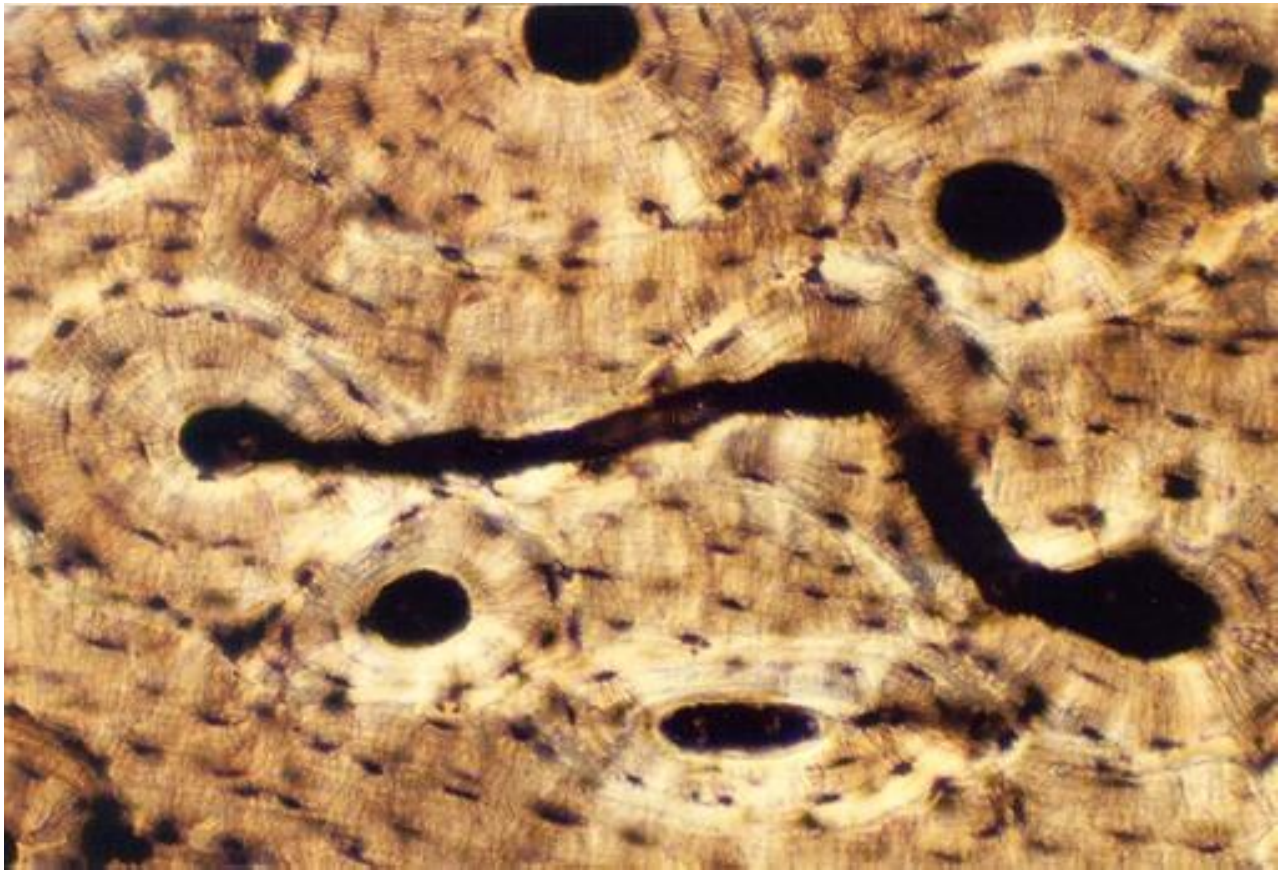


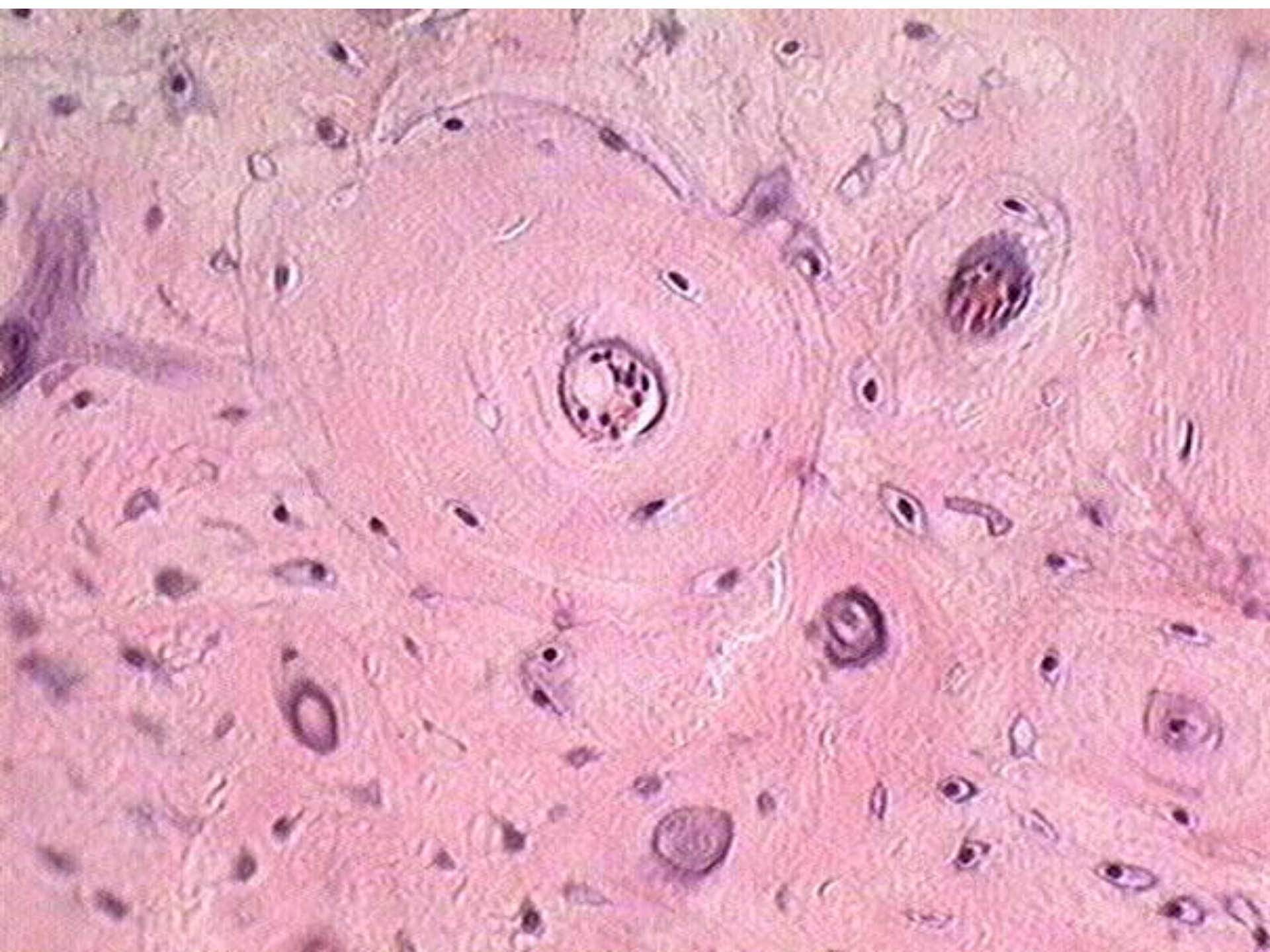

Micrograph of a fractured bone undergoing repair. Primary bone is newly formed, immature bone, rich in osteocytes, with randomly arranged bundles of calcified collagen. Osteoclasts and osteoblasts are numerous in the surrounding endosteum.

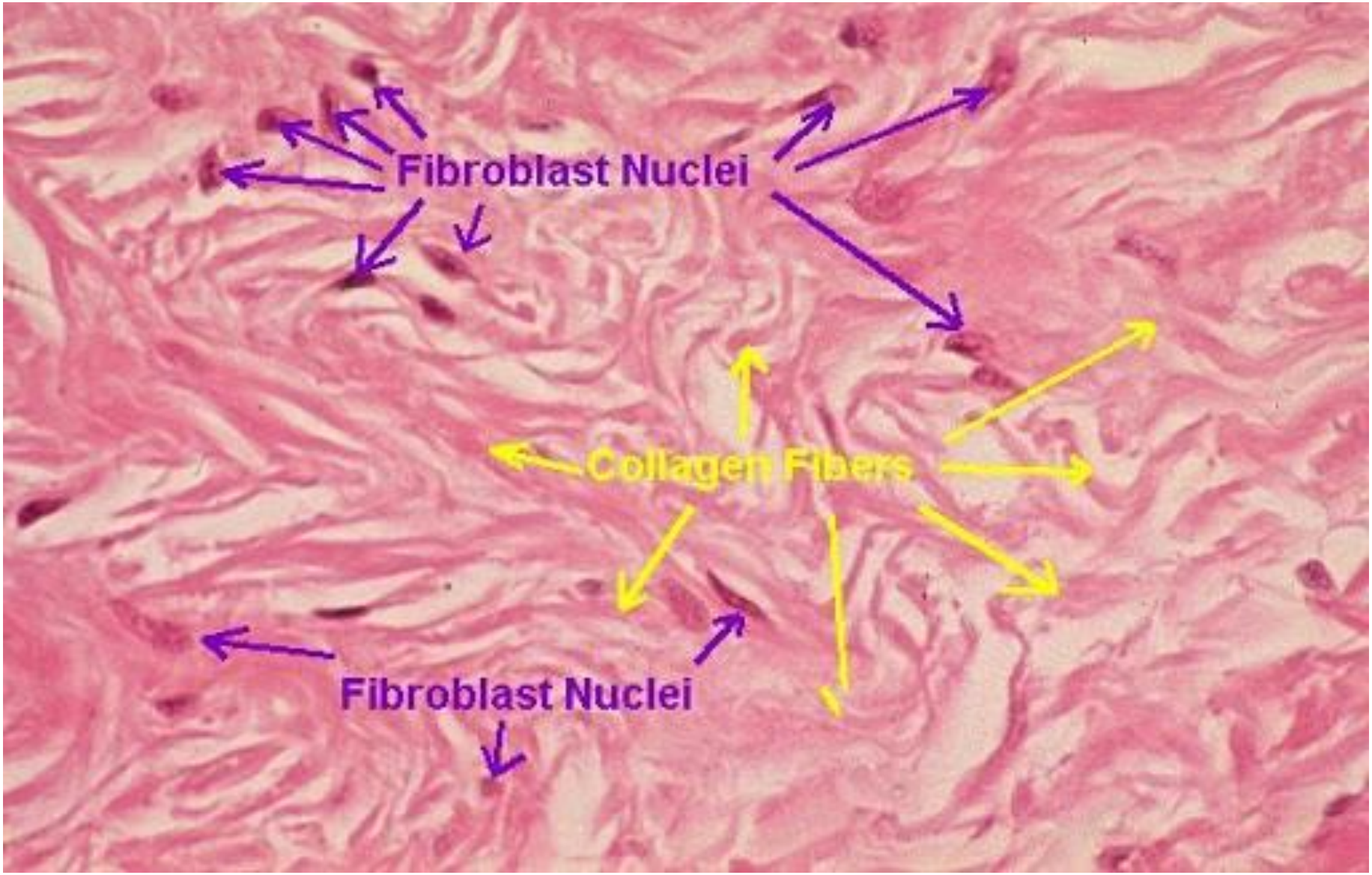


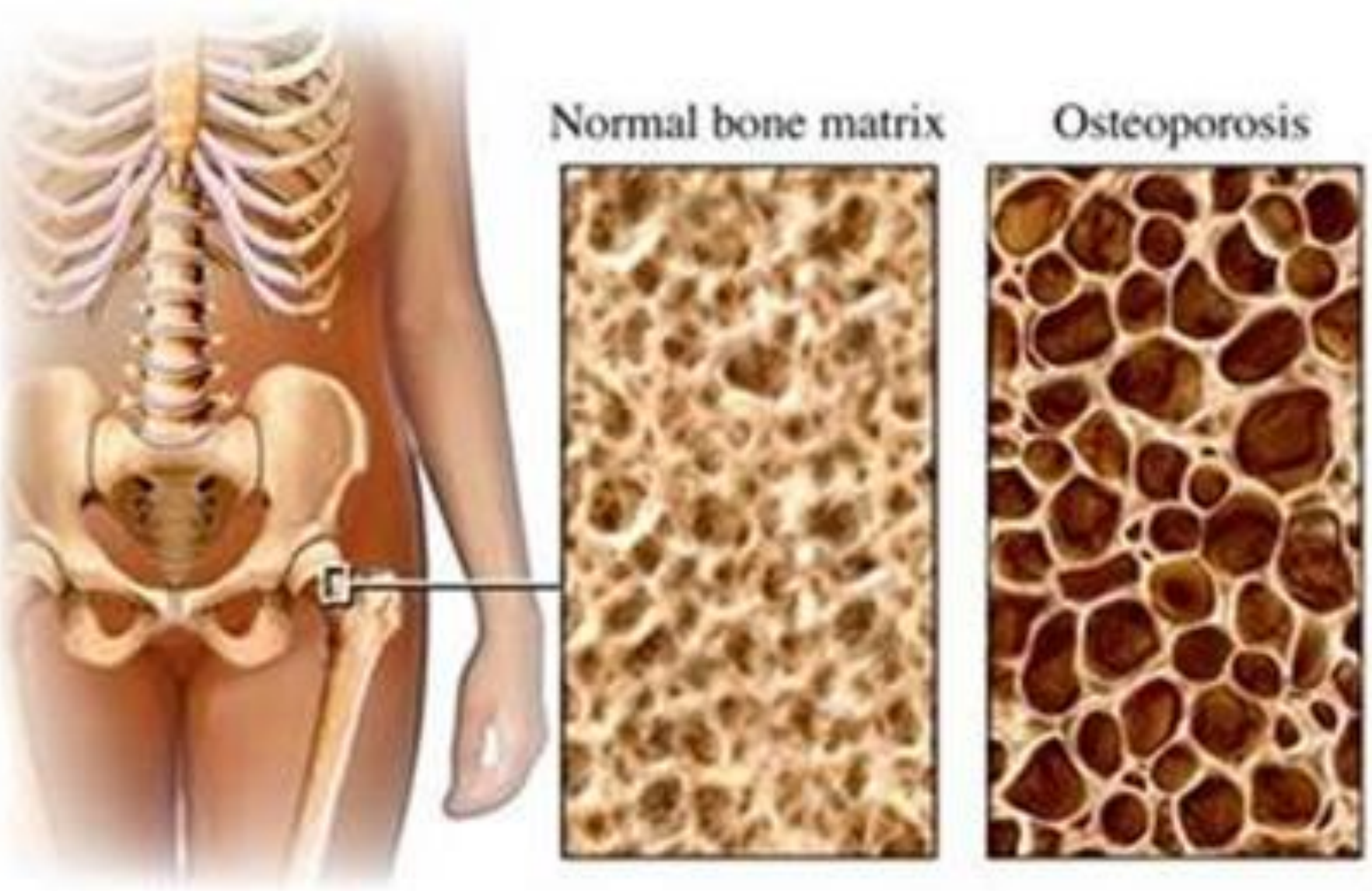

Secondary or mature bone shows matrix organized as lamellae, seen faintly here as concentric lines surrounding osteonic canals.

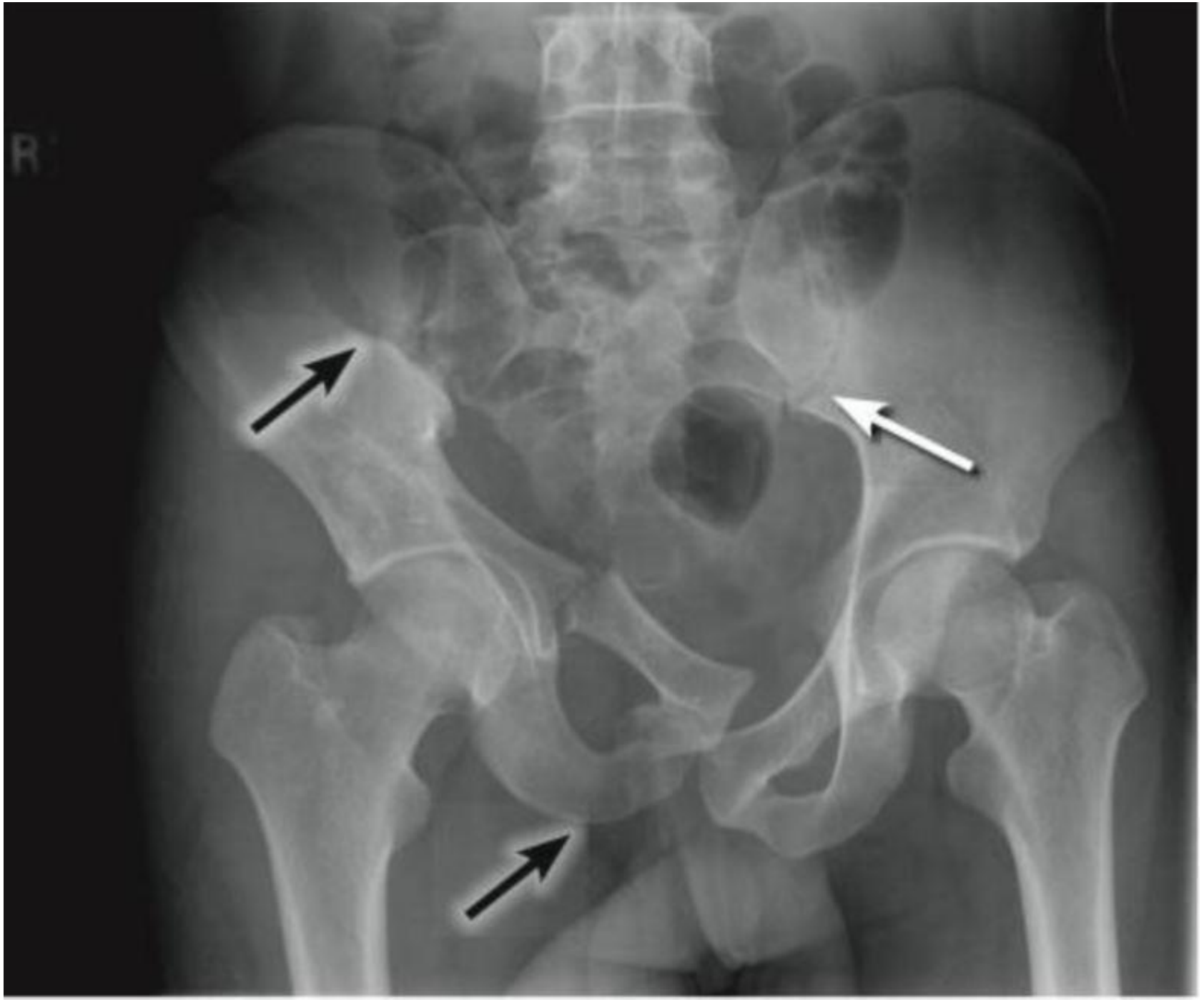

Mature hyaline cartilage.
Territorial matrix.
Cartilage capsule.
Isogenous groups of chondrocytes.
Interterritorial matrix.
Chondrocyte.
Lacunae.






Fibroblast Nuclei
Collagen Fibers
Fibroblast Nuclei


Normal bone matrix
Osteoporosis

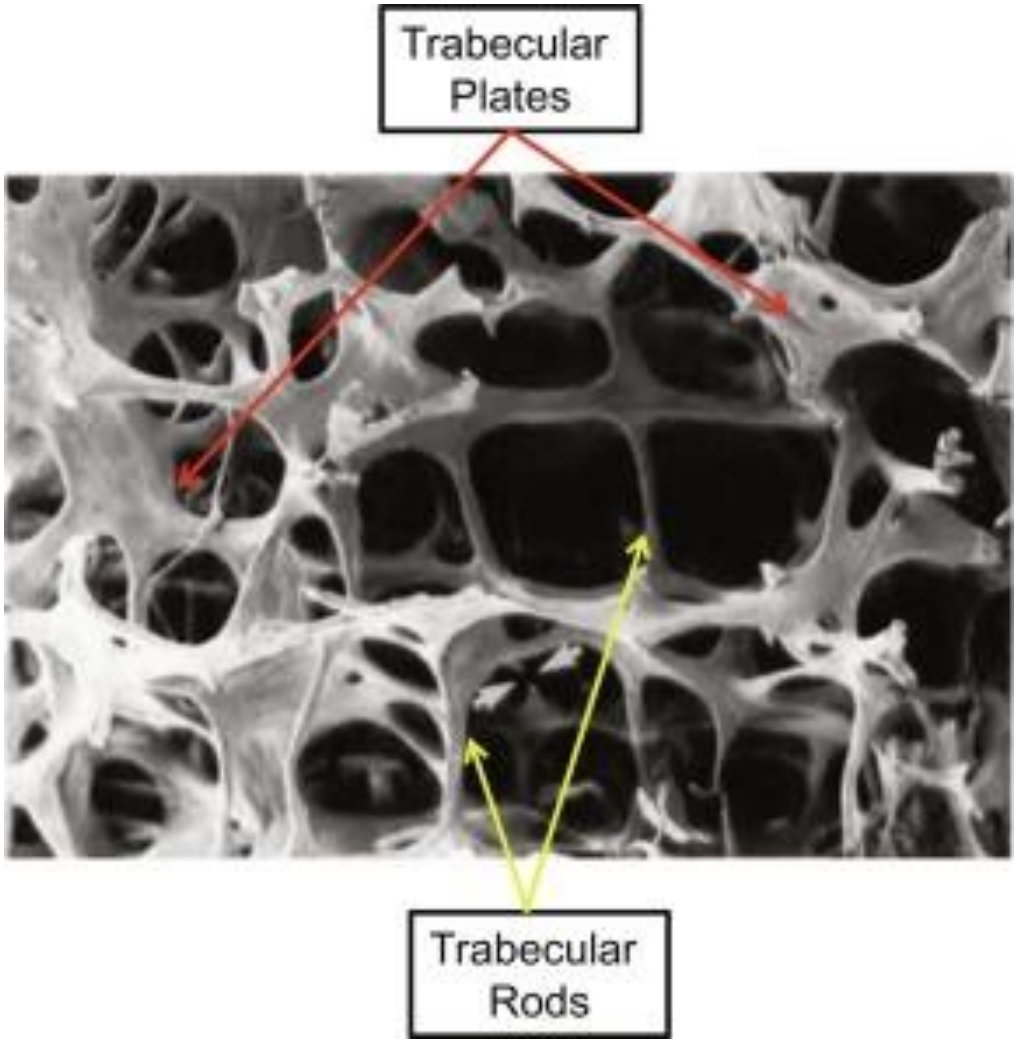


# STAGES OF OSTEOPOROSIS

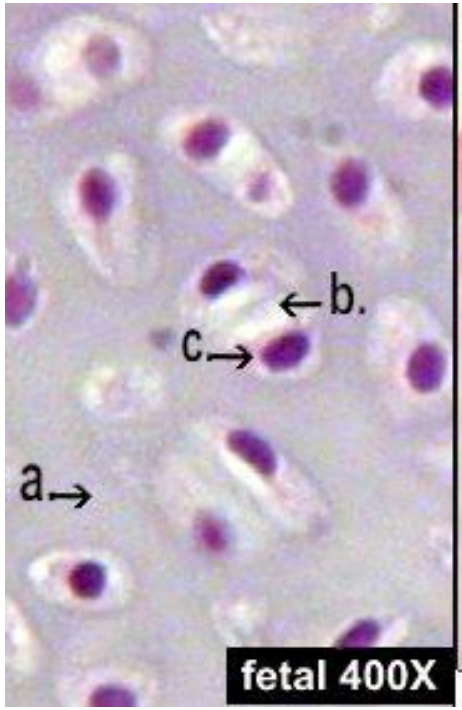
**NORMAL BONE**

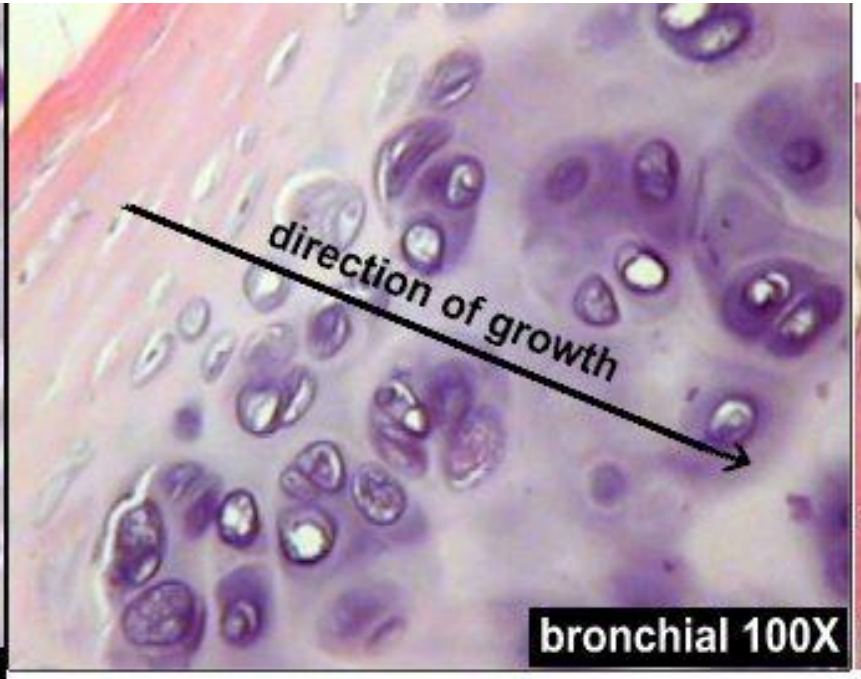
**OSTEOPOROSIS**

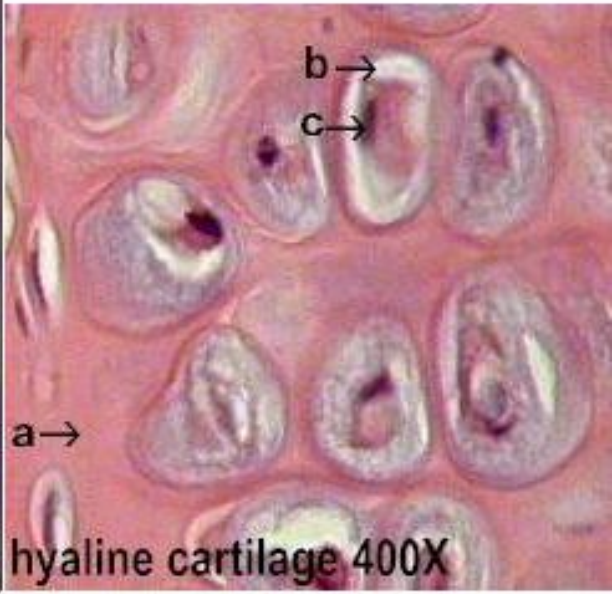
**SEVERE OSTEOPOROSIS**

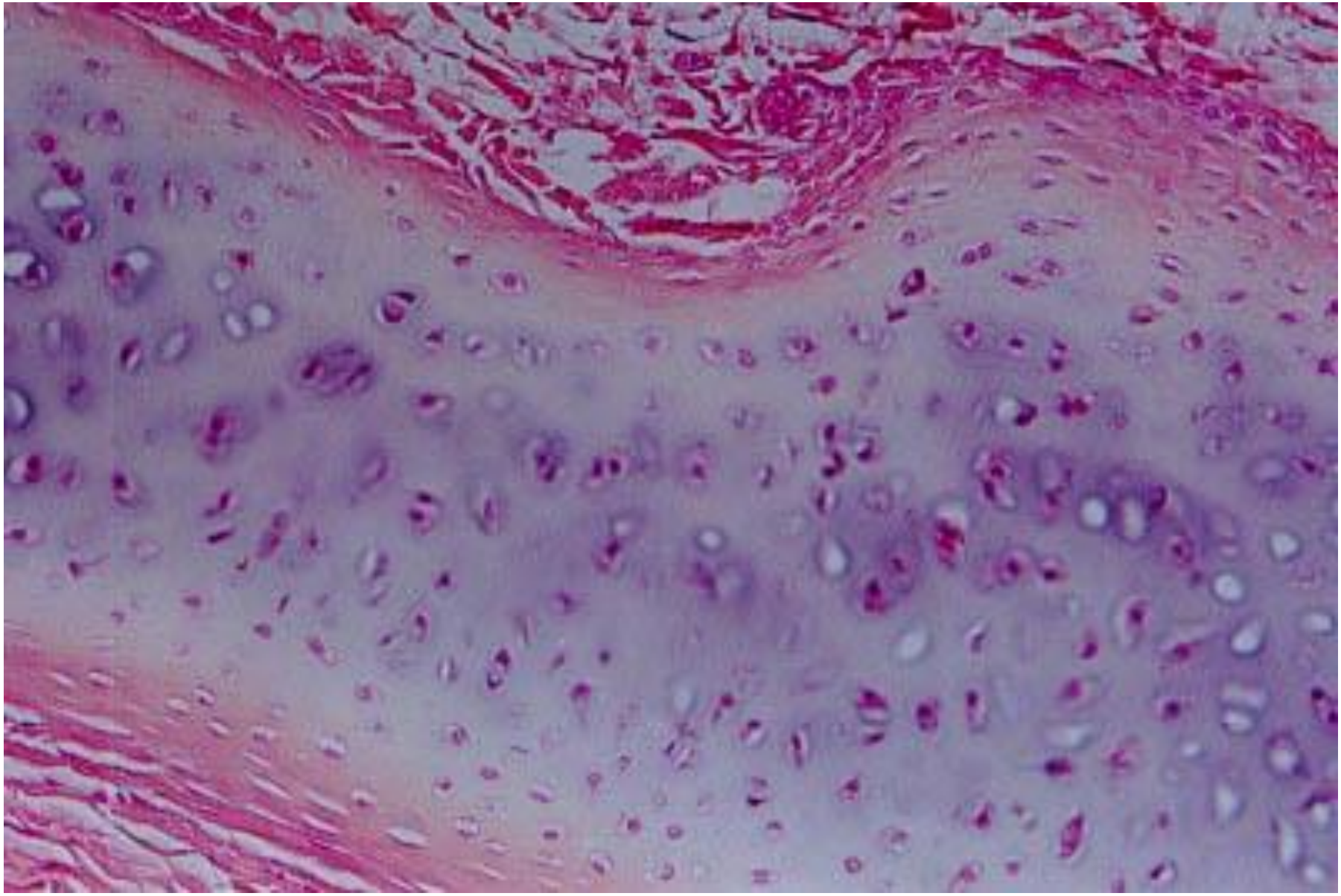

Trabecular Plates
Trabecular Rods

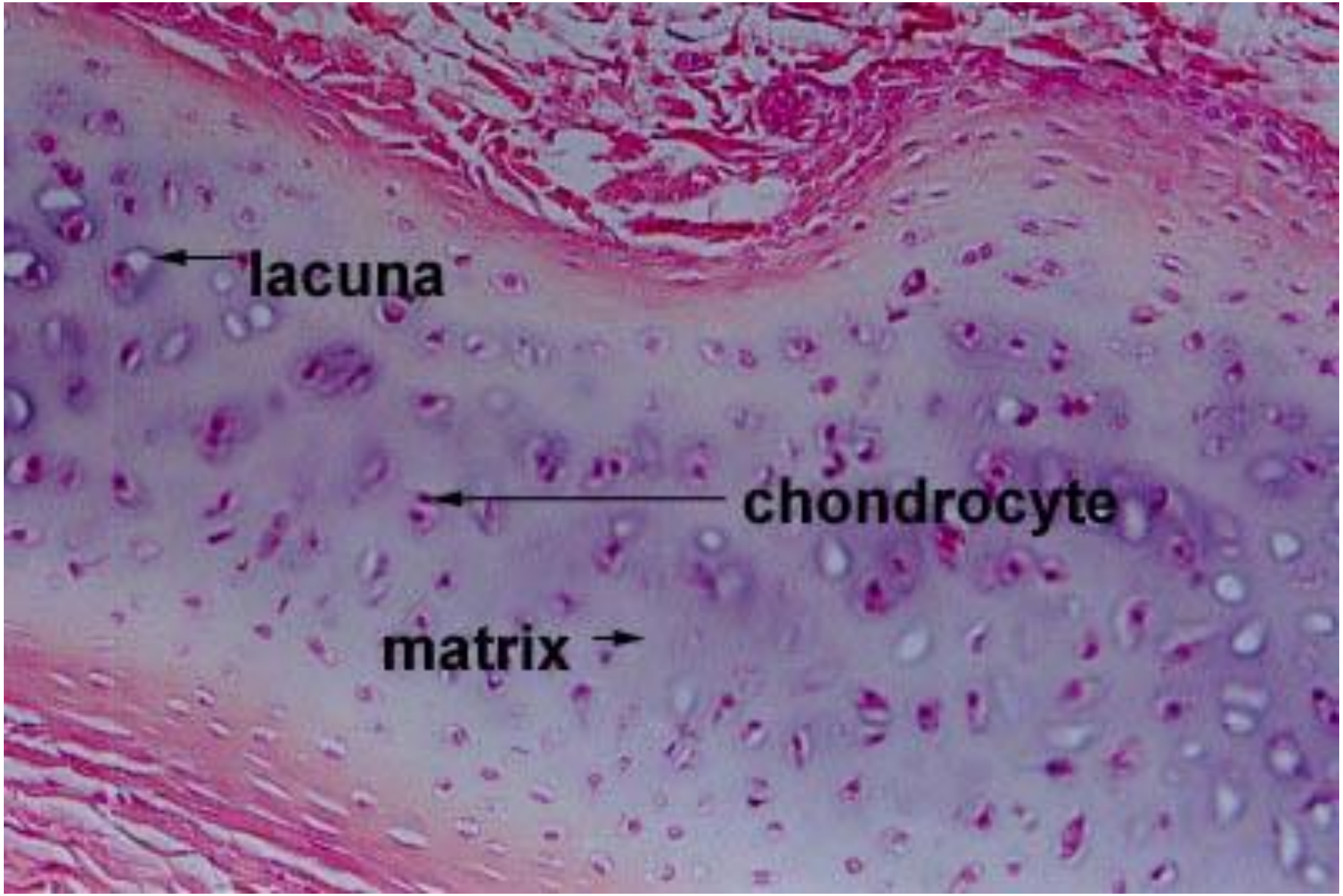

Normal
Osteoporosis

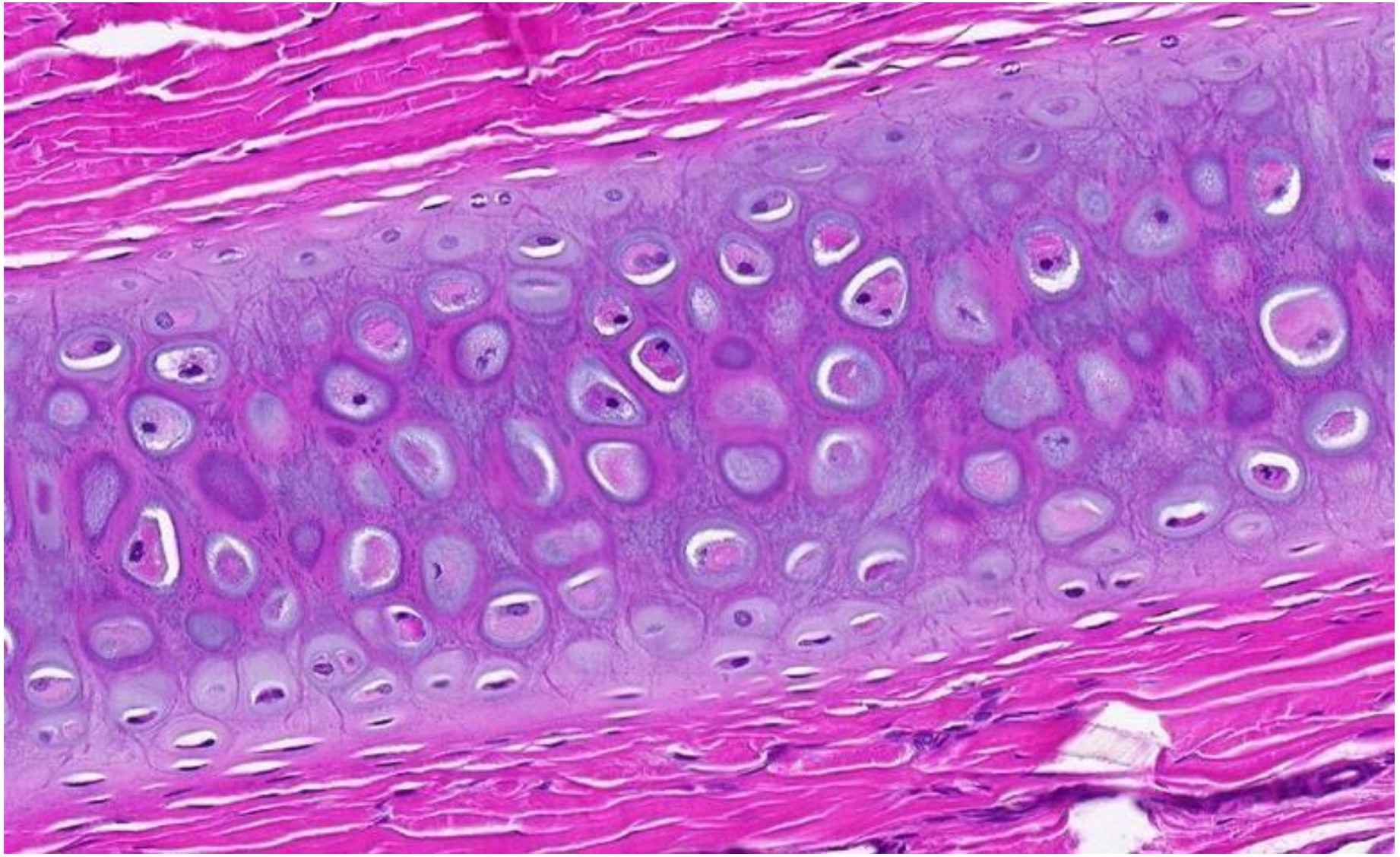

←b.
c→
a→
fetal 400X


direction of growth
bronchial 100X

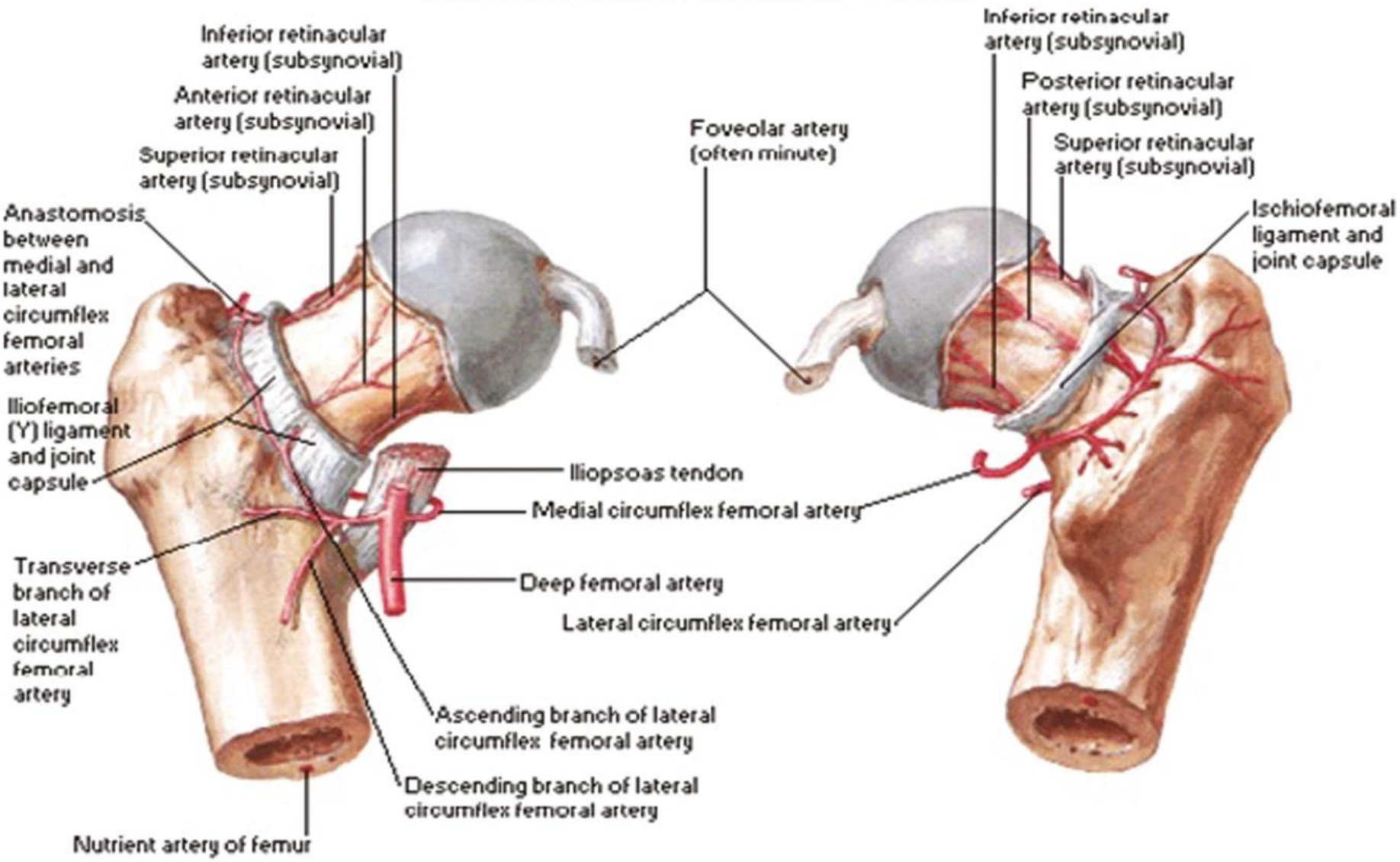

b→
c→
a→
hyaline cartilage 400X

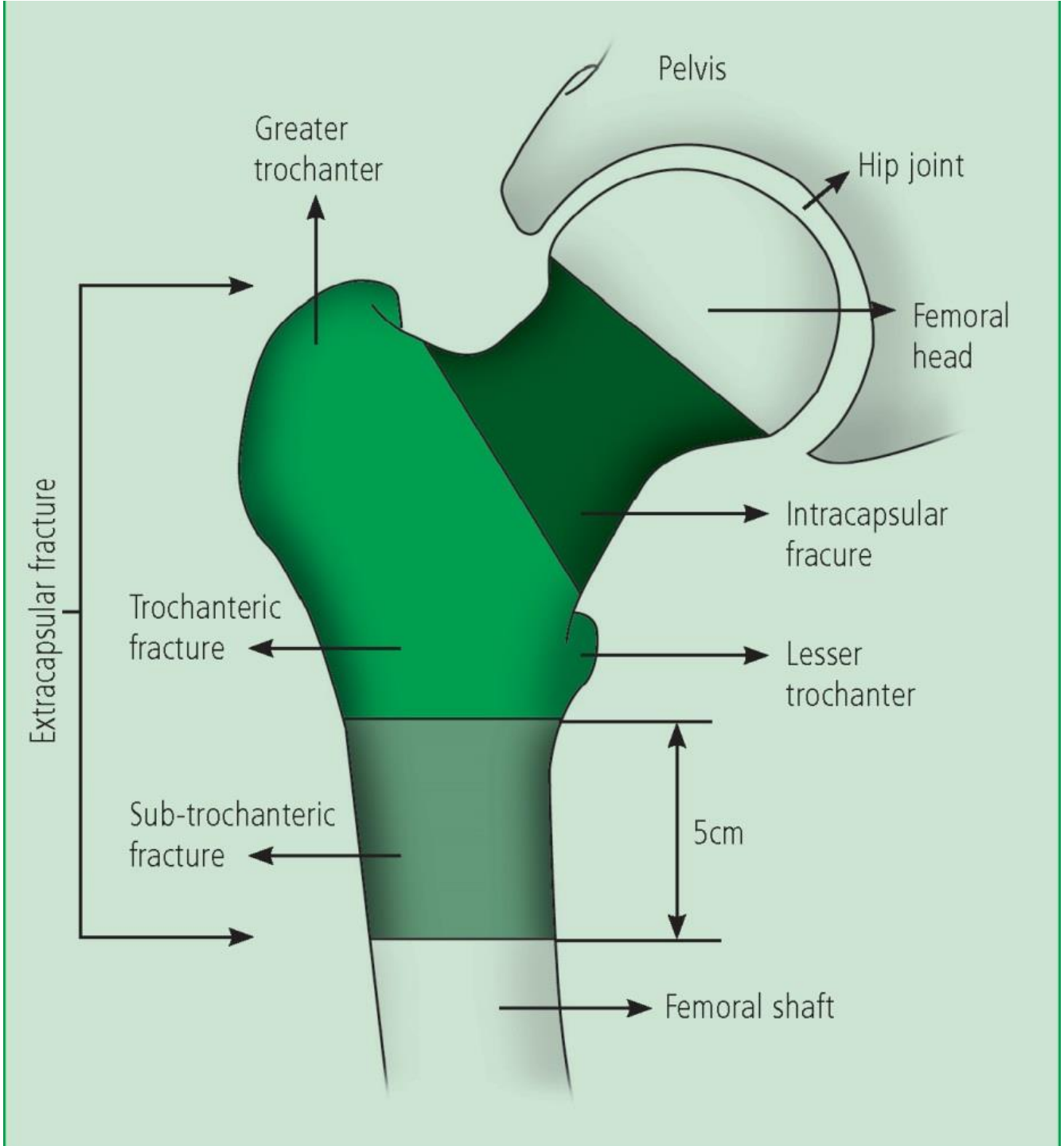


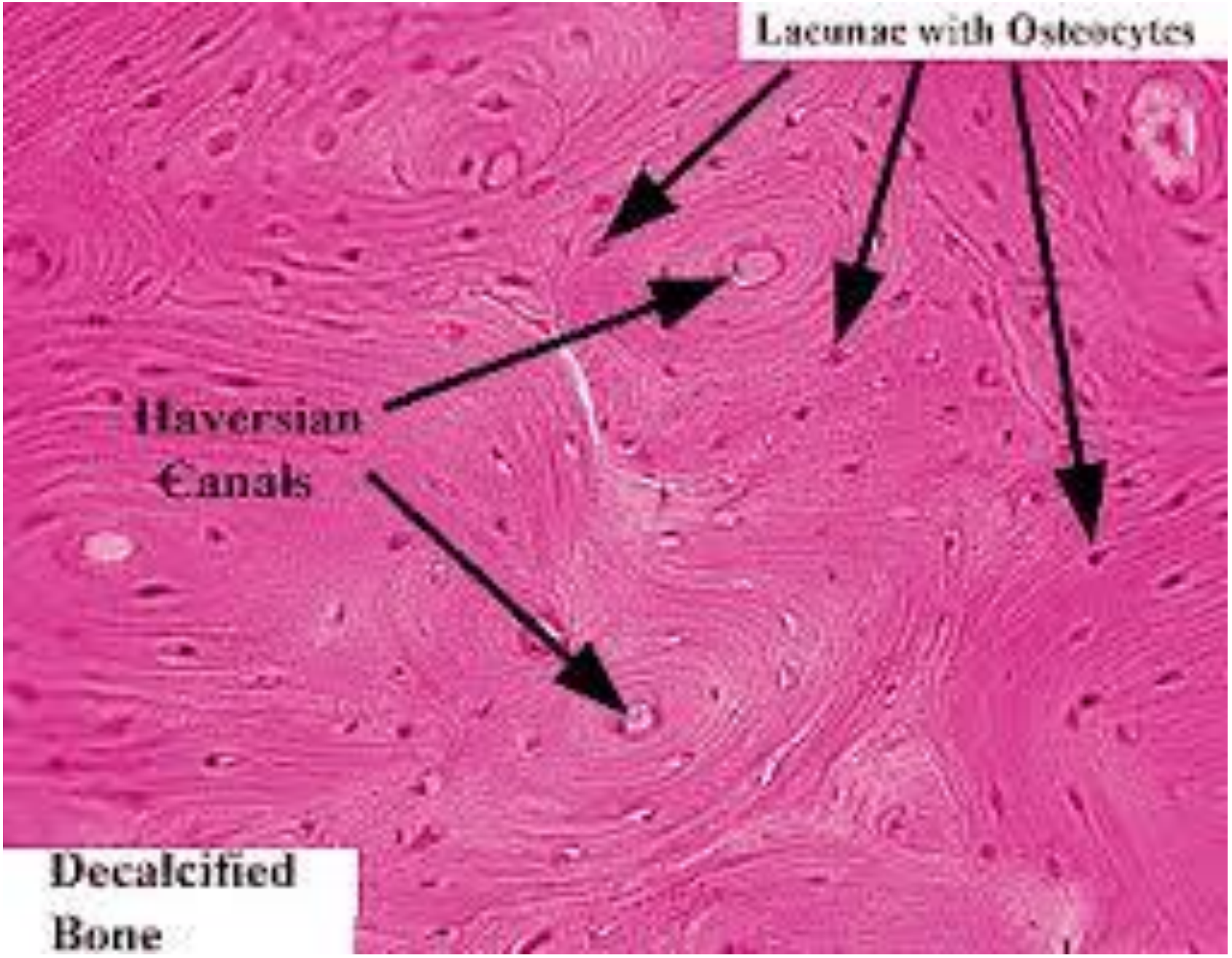

lacuna
chondrocyte
matrix

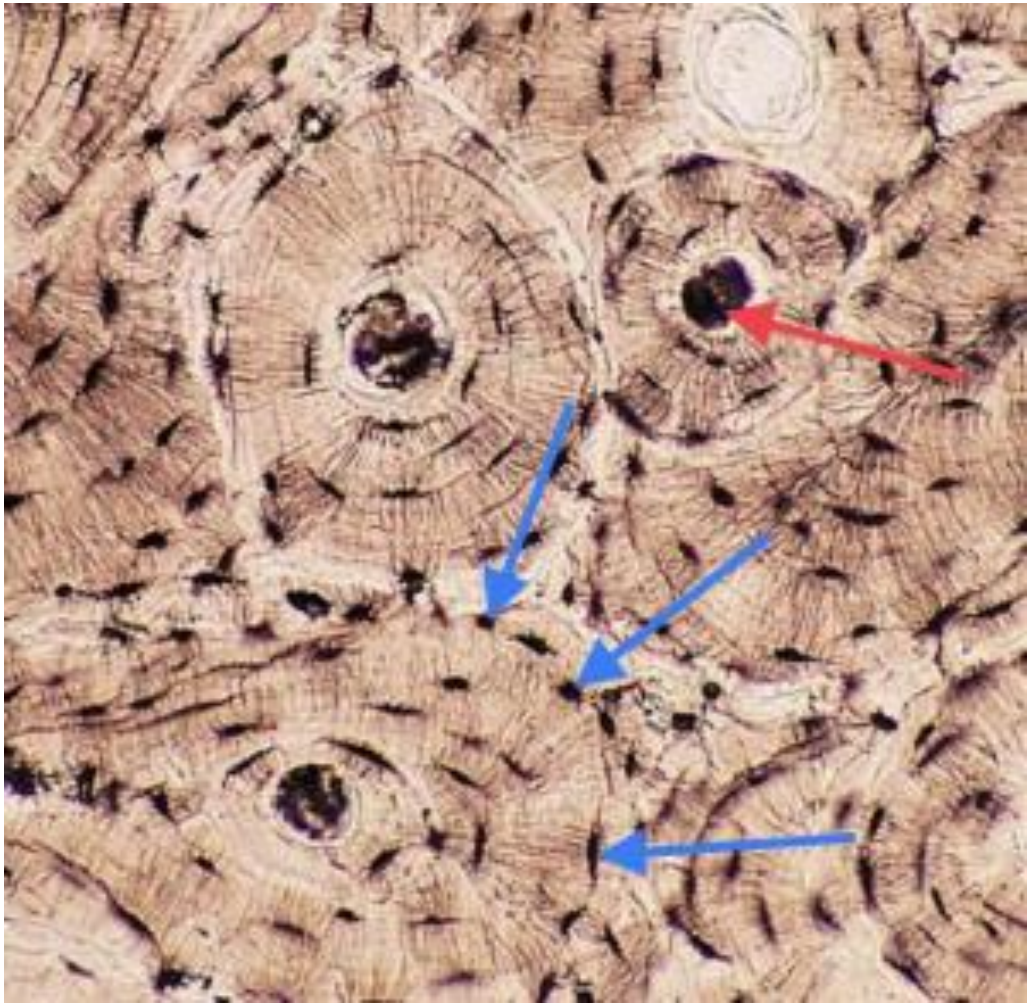


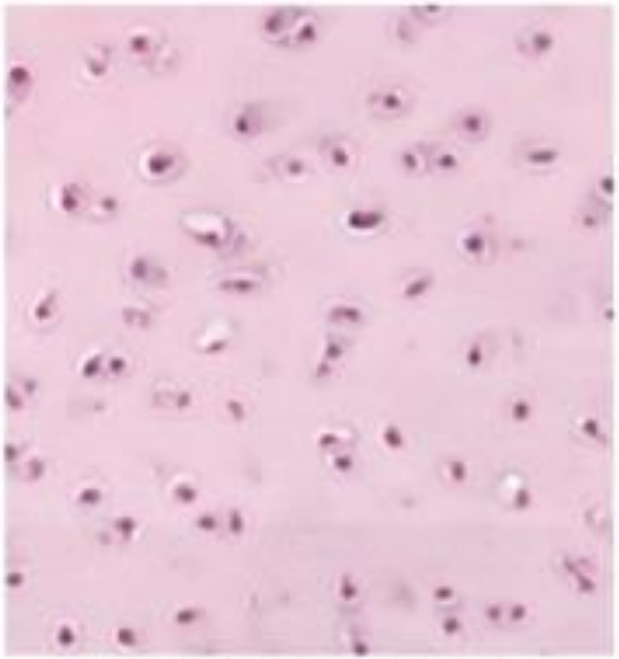
# Anterior and Posterior Views



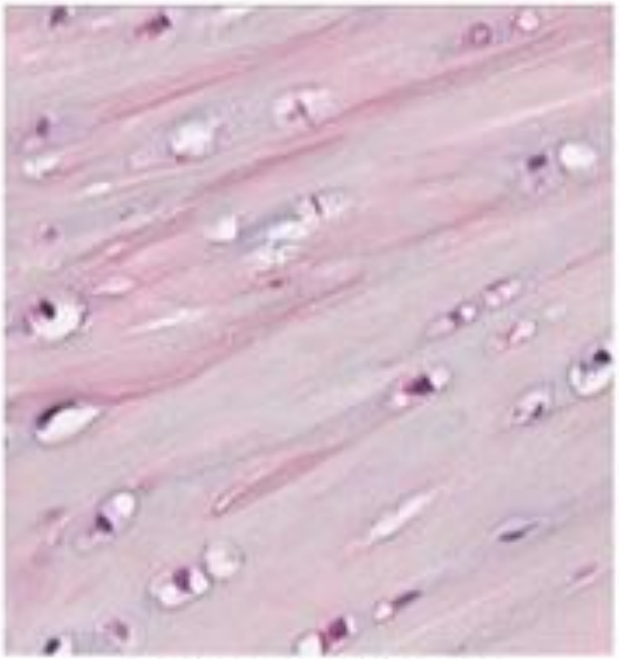

Pelvis
Greater trochanter
Hip joint
Femoral head
Extracapsular fracture
Intracapsular fracure
Trochanteric fracture
Lesser trochanter
5cm
Sub-trochanteric fracture
Femoral shaft


Lacunae with Osteocytes
Haversian Canals
Decalcified Bone

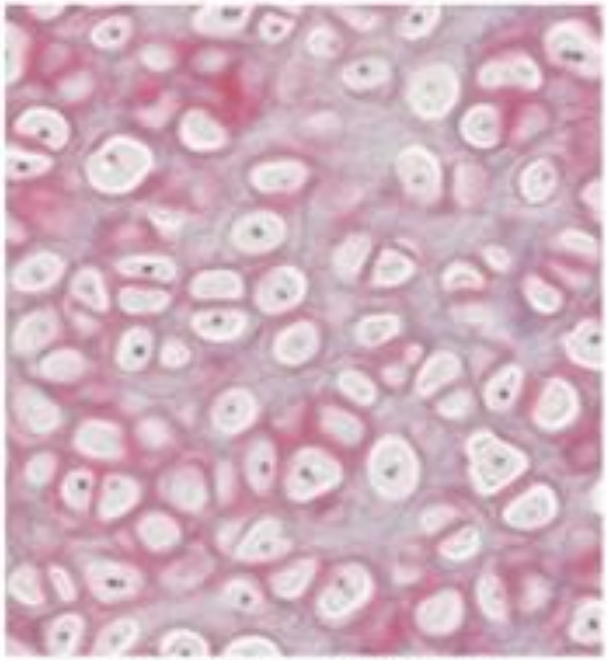




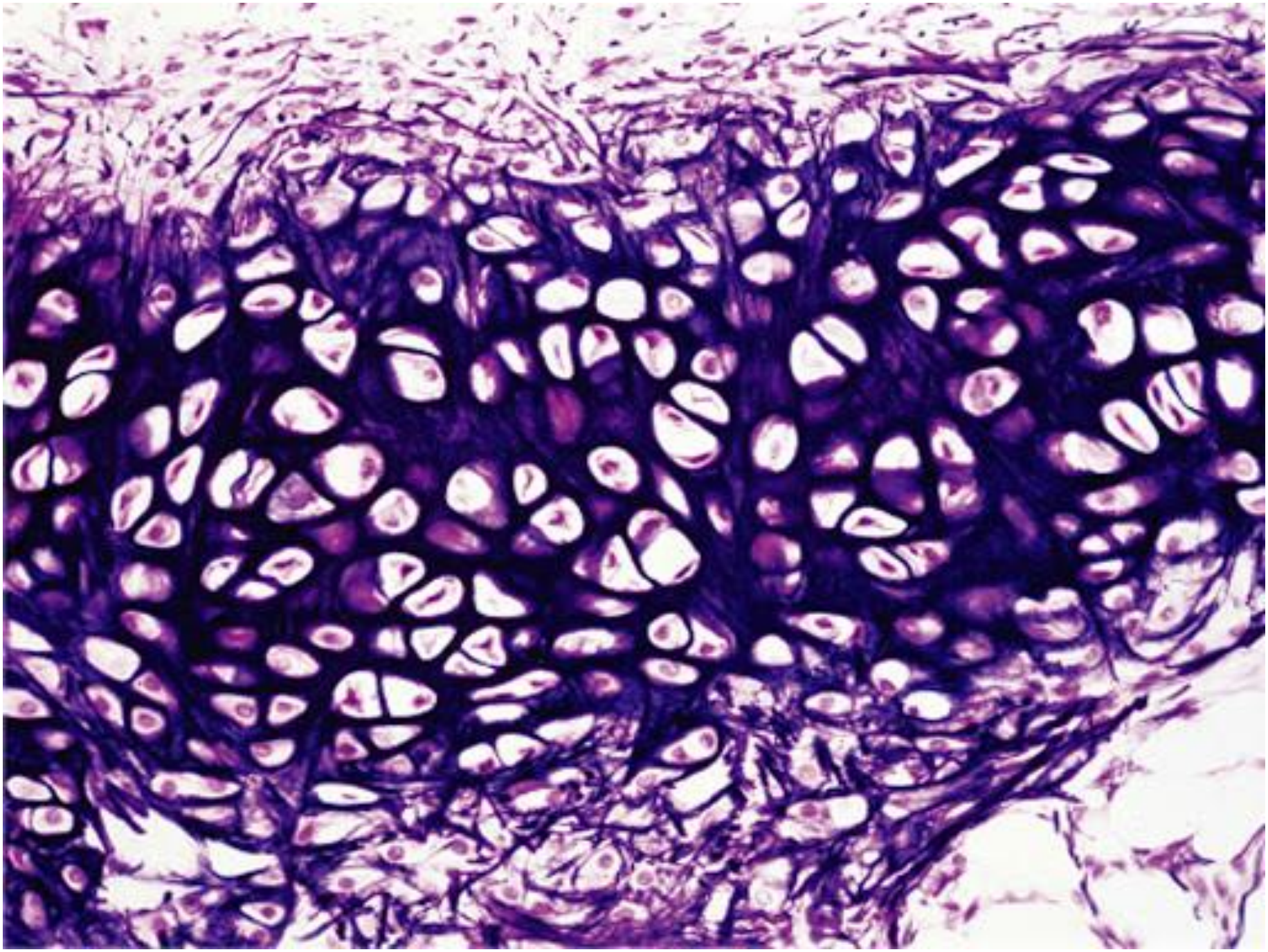
Hyaline cartilage

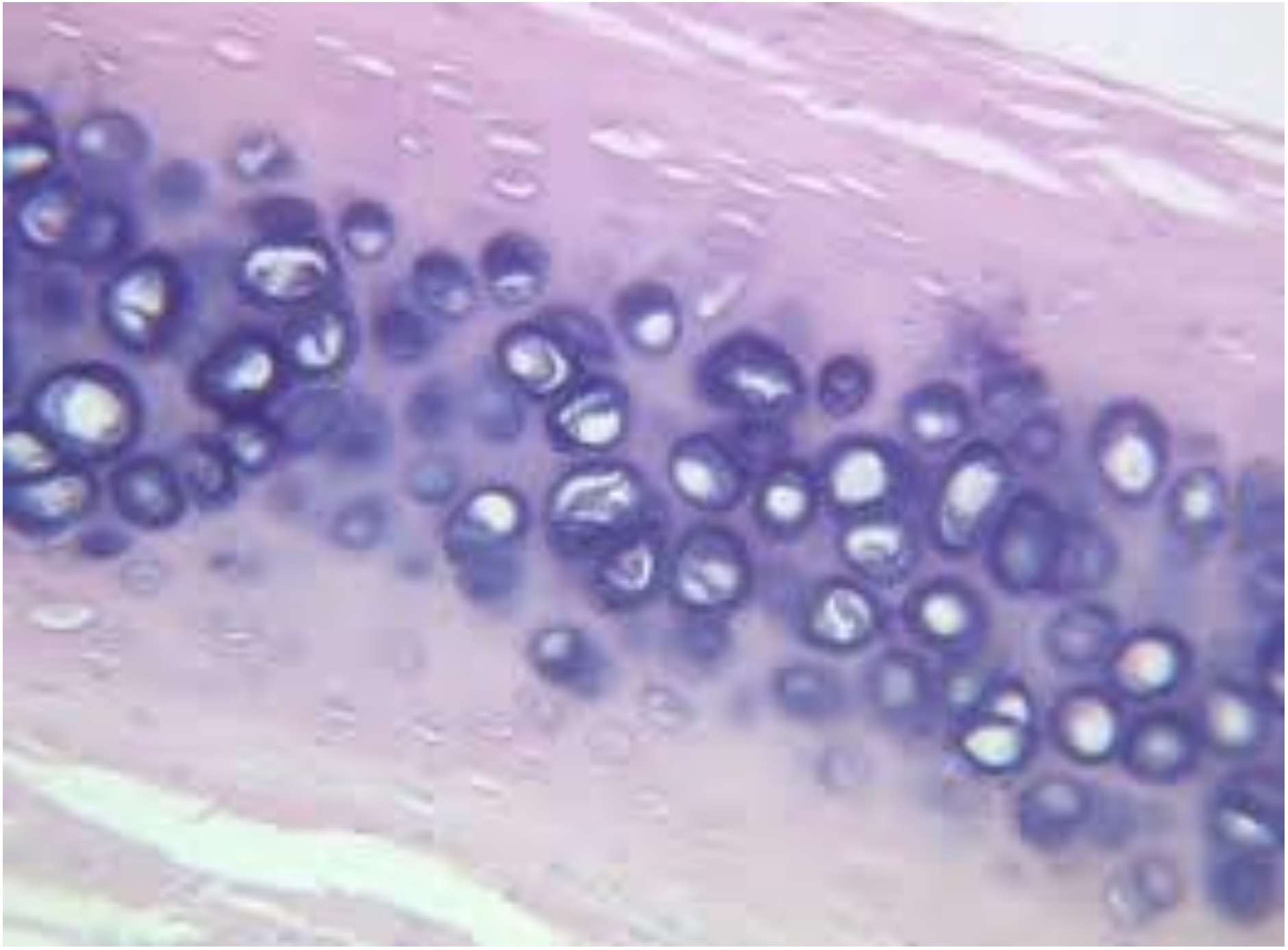


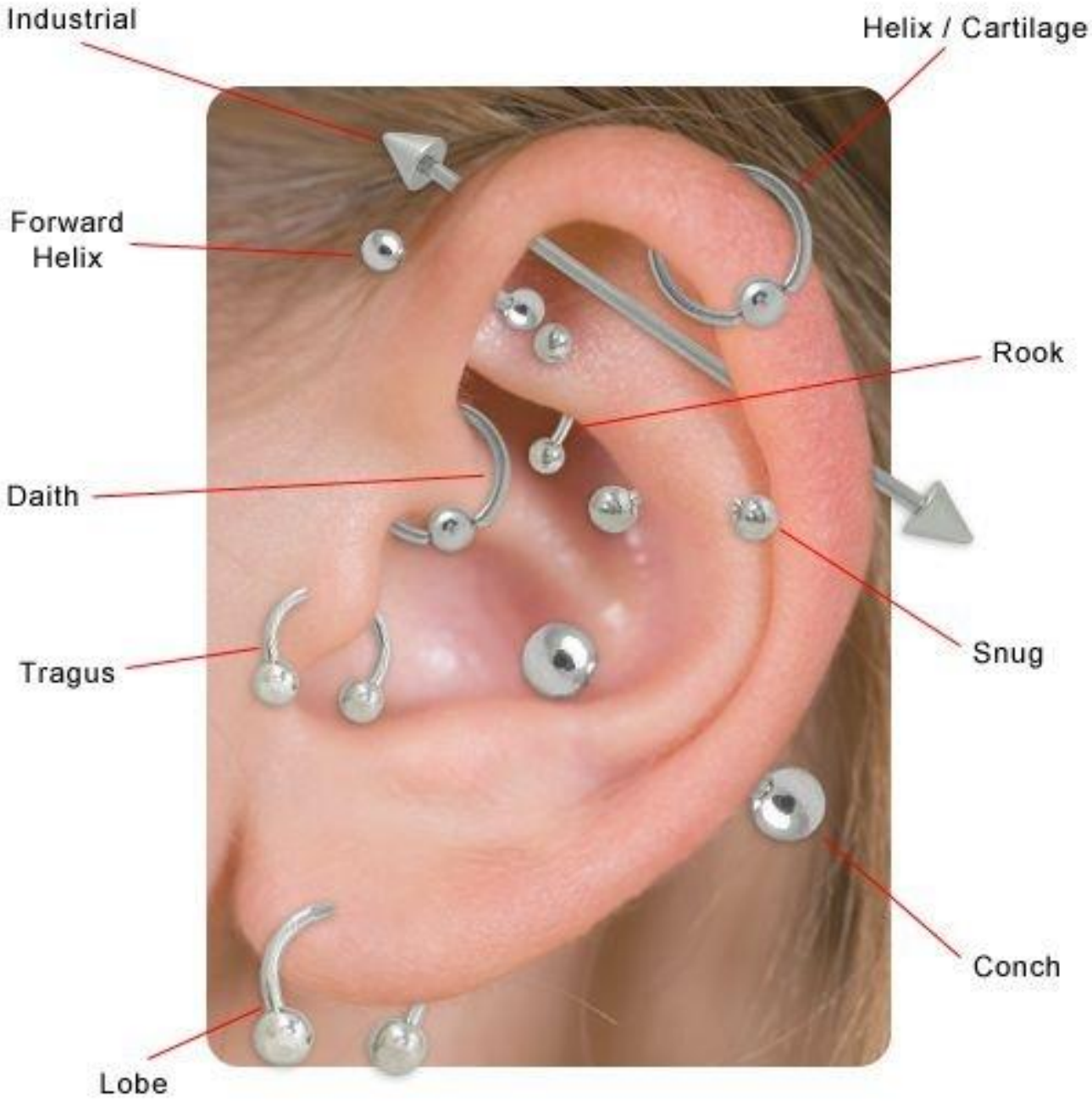
Fibrocartilage

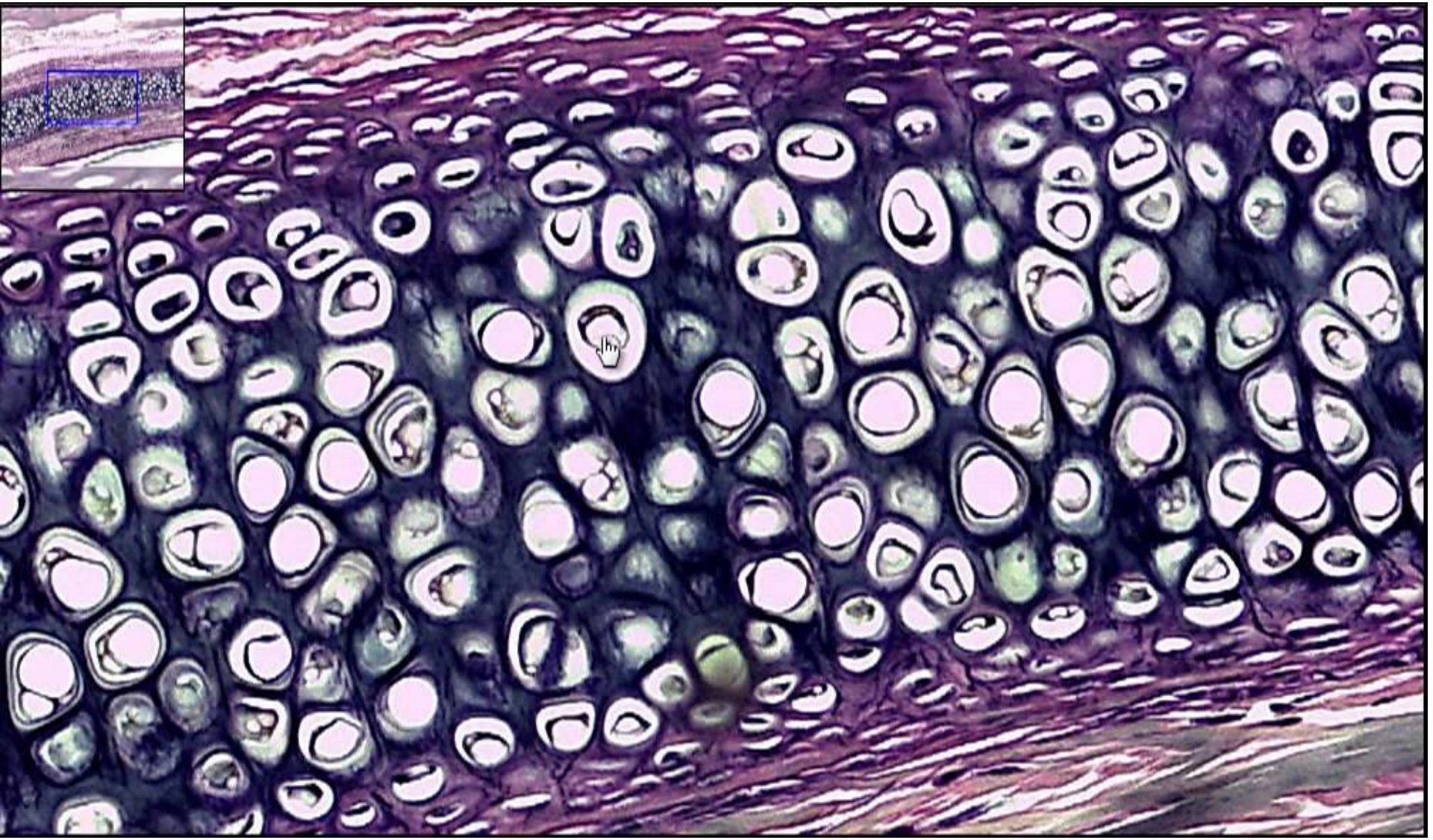


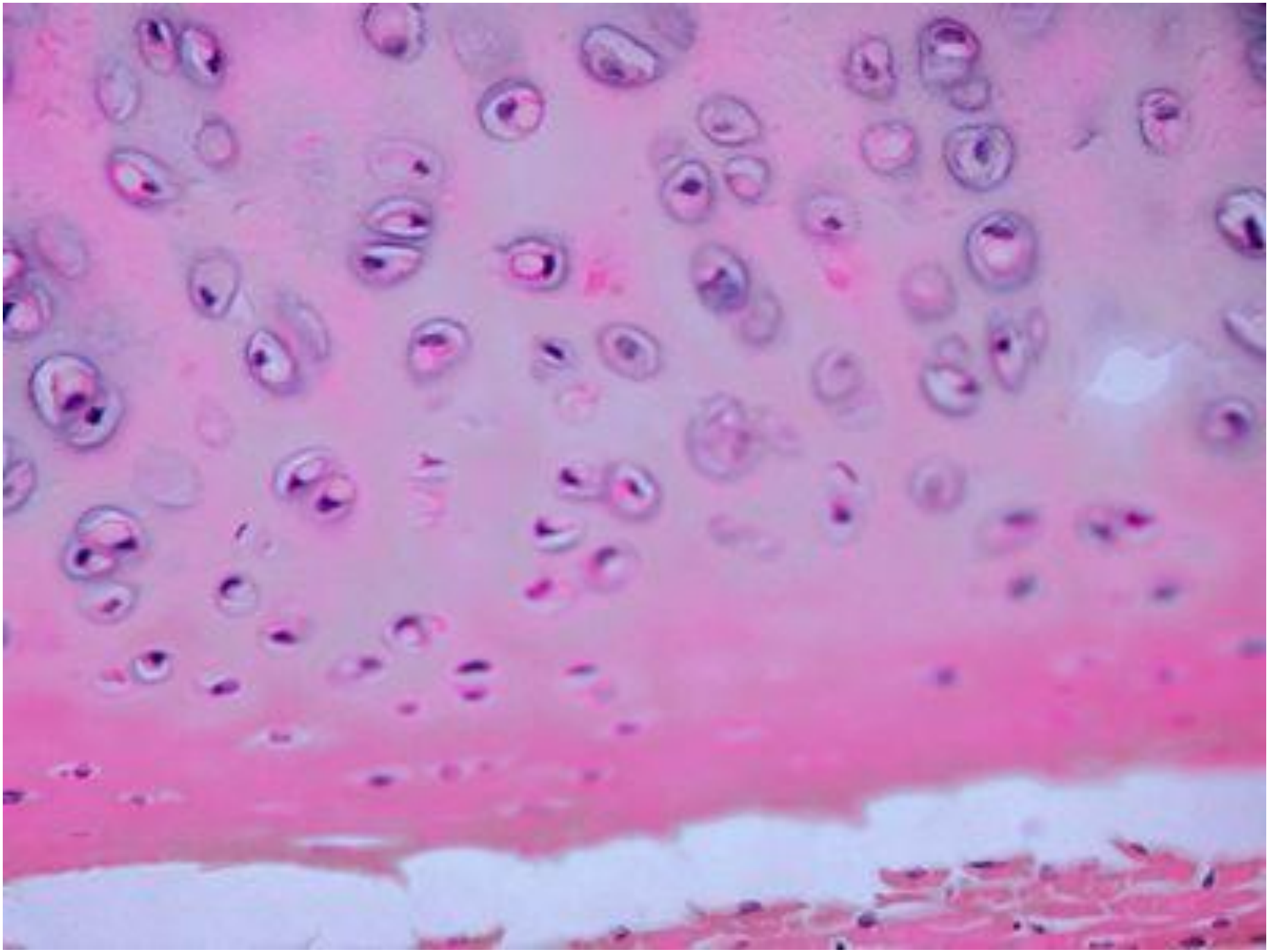
Elastic cartilage






Industrial
Helix / Cartilage
Forward Helix
Rook
Daith
Snug
Tragus
Conch
Lobe



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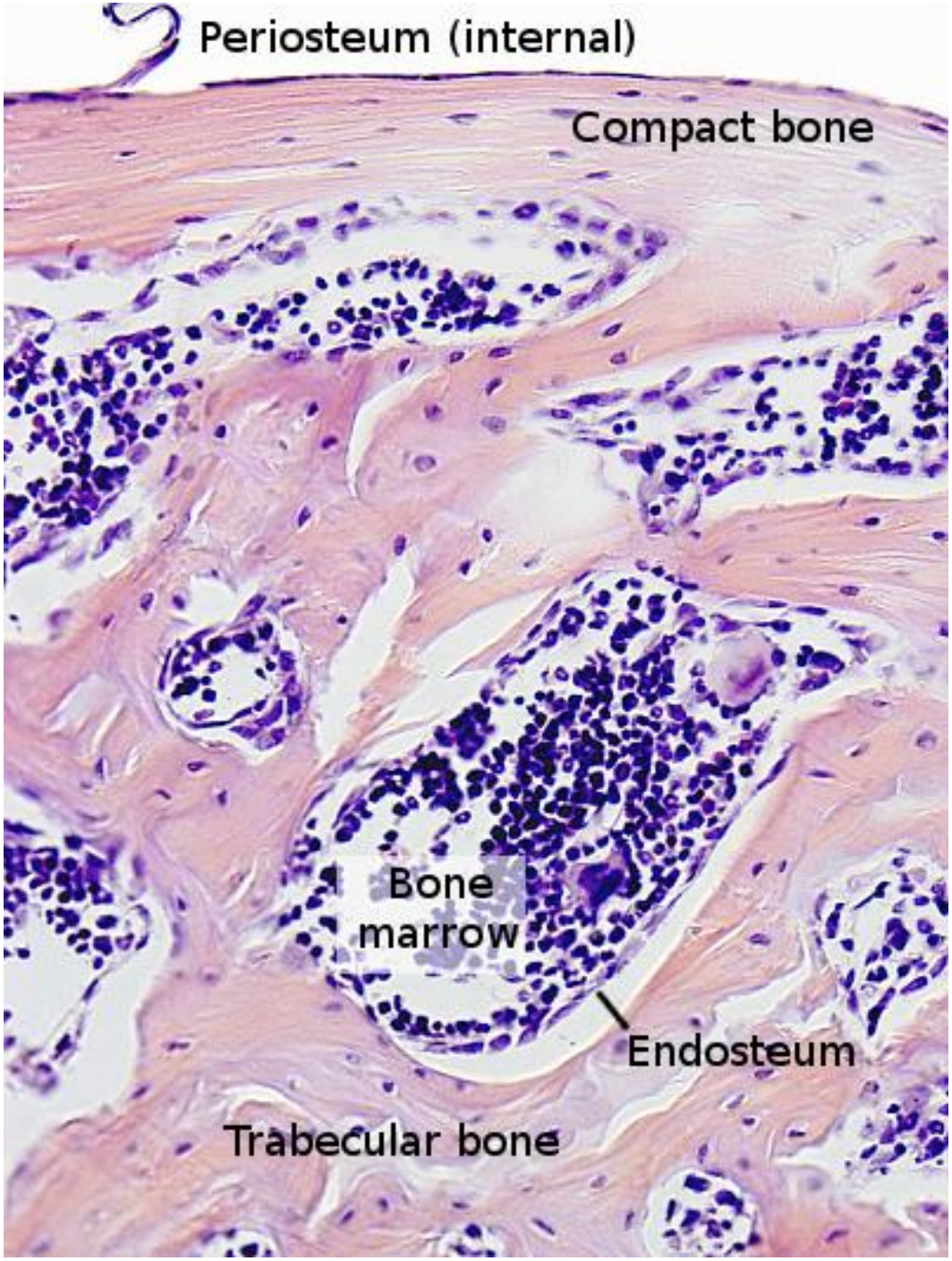
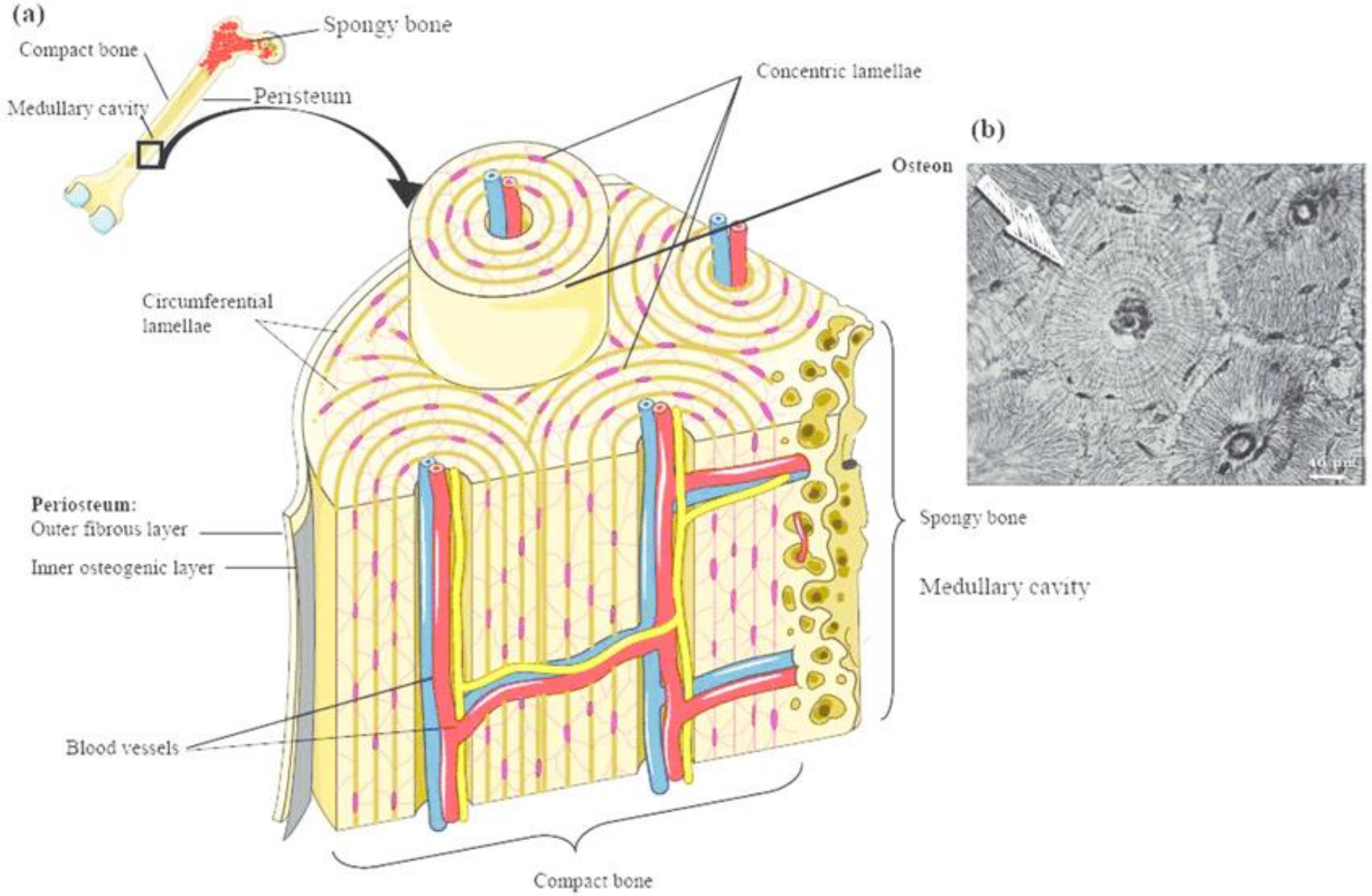
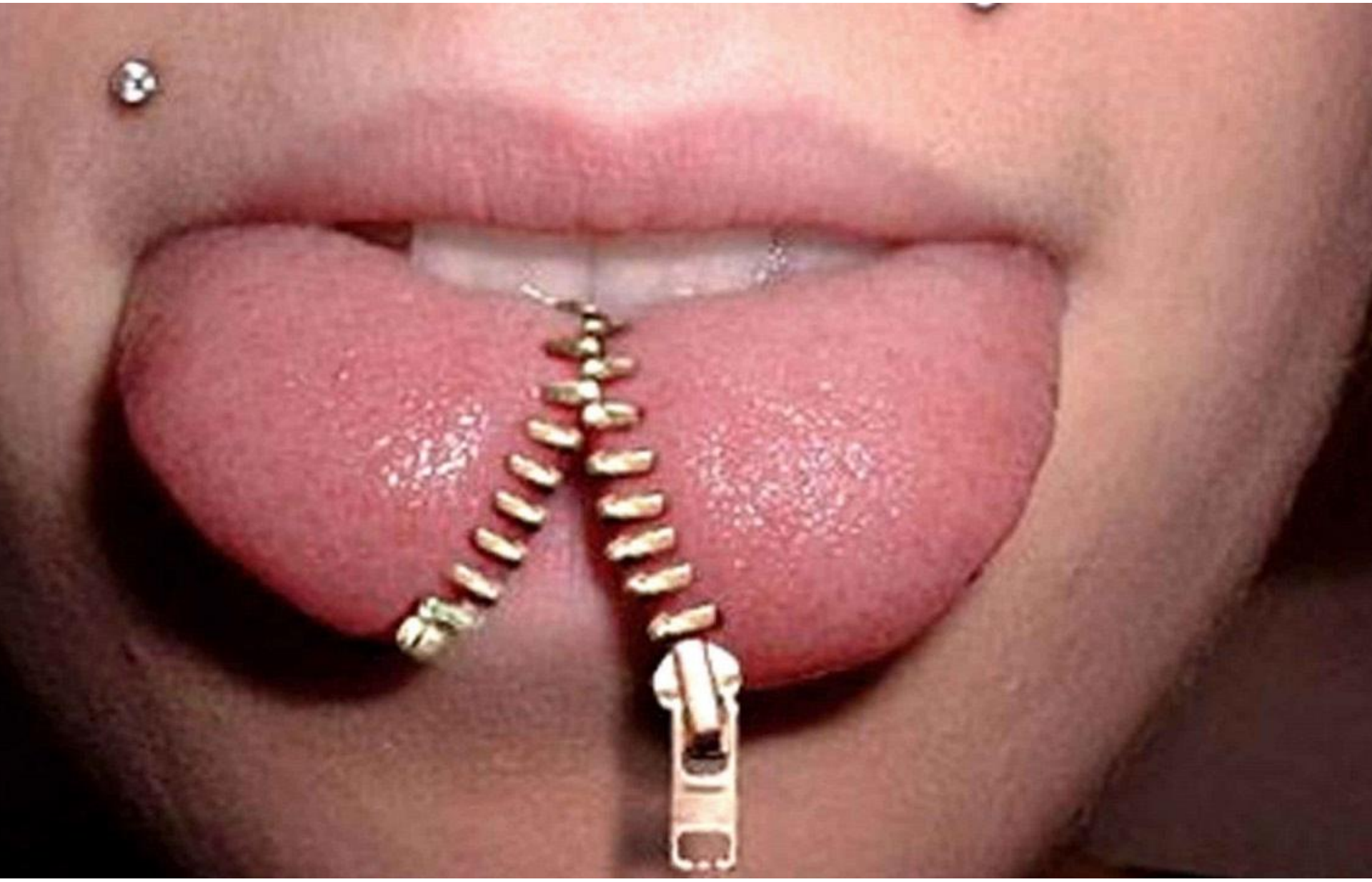

Periosteum (internal)
Compact bone
Bone marrow
Endosteum
Trabecular bone

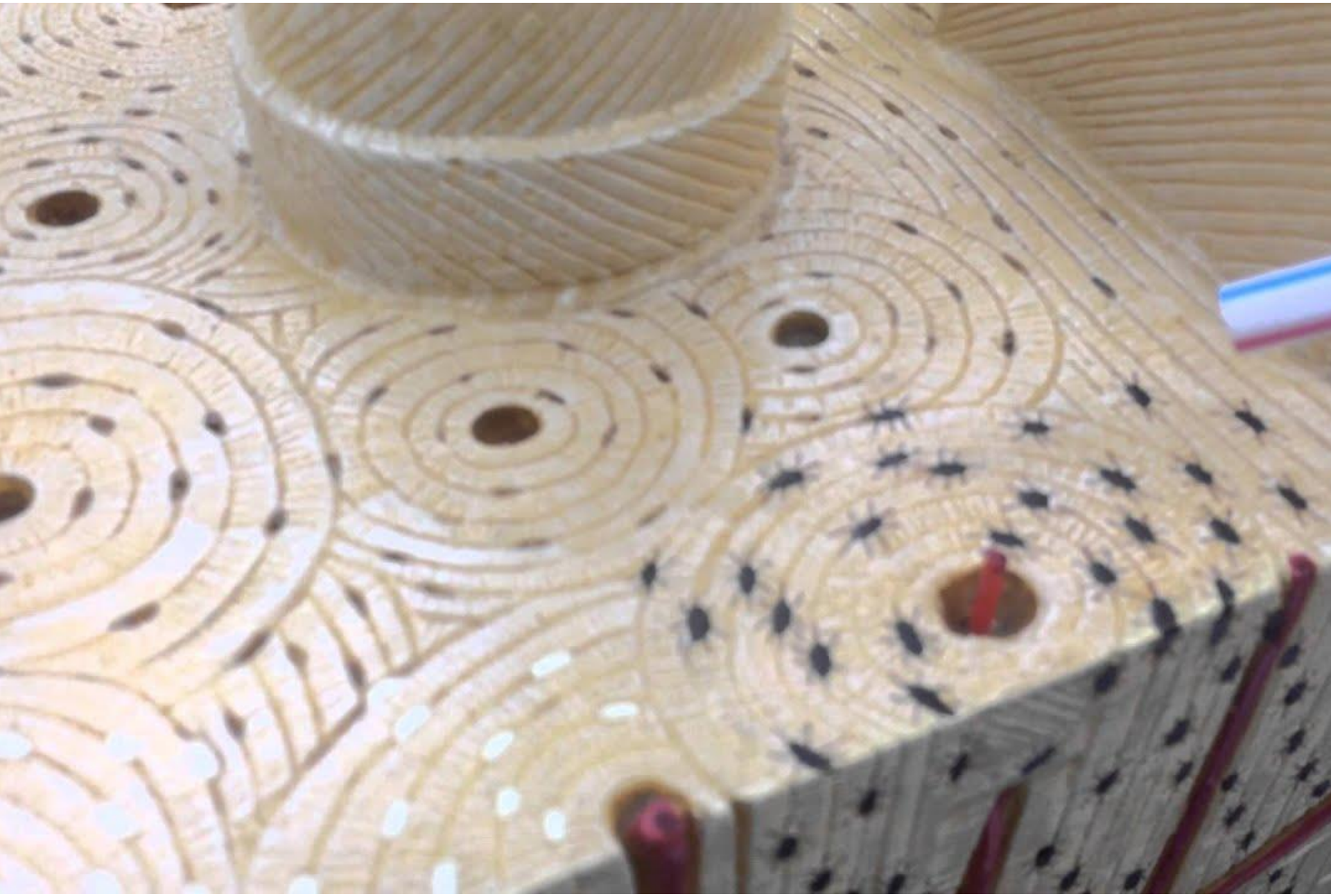

(a)
Compact bone
Spongy bone
Medullary cavity
Periosteum
Concentric lamellae
Osteon
(b)
Circumferential lamellae
Periosteum:
Outer fibrous layer
Inner osteogenic layer
Spongy bone
Medullary cavity
Blood vessels
Compact bone

# Summary of the Differences among the three main types of cartilage

| | Hyaline Cartilage | Elastic Cartilage | Fibrocartilage |
|---|---|---|---|
| Extracellular matrix | • Type II Collagen<br>• Aggrecan | • Type II Collagen<br>• Aggrecan<br>• Dark elastic fibres | • Dense connective tissue<br>• Type I collagen<br>• Type II collagen |
| Cells | • Chondrocytes<br>• Chrondroblasts | • Chondrocytes<br>• Chondroblasts | • Fibrochondrocytes |
| Cell Arrangement | • Isolated, Small<br>• Isogenous groups | • Small isogenous groups | • Axially arranged isogenous groups<br>• Isolated |
| Perichondrium | • Present | • Present | • Absent |
| Locations | • Epiphyseal plates of long bones<br>• Fetal skeleton<br>• Articular ends of long bones<br>• Throughout the upper respiratory tract | • External ear<br>• Auditory tube<br>• External acoustic meatus<br>• Epiglottis<br>• Laryngeal cartilage | • Intervertebral discs<br>• Symphysis pubis<br>• Menisci<br>• Tendinous insertions<br>• Glenohumeral/acet abular labra<br>• Tempormandibular joint |
| Functions | • Joint articulation<br>• Scaffold for osteogenesis | • Structural support | • Weight bearing<br>• Compression/ shear force resistance<br>• Tenacity |


resorption
bay
osteoclast
bone

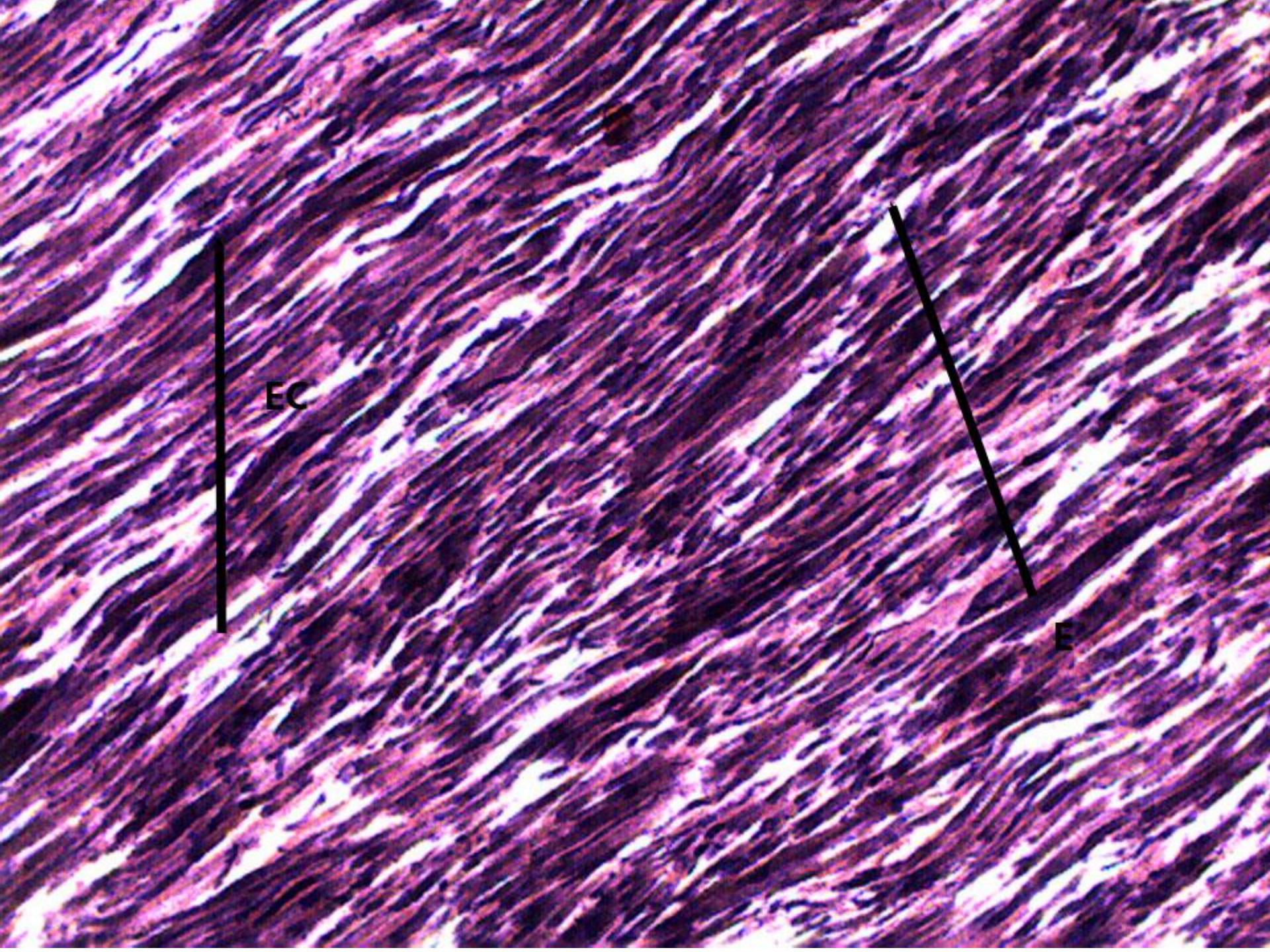


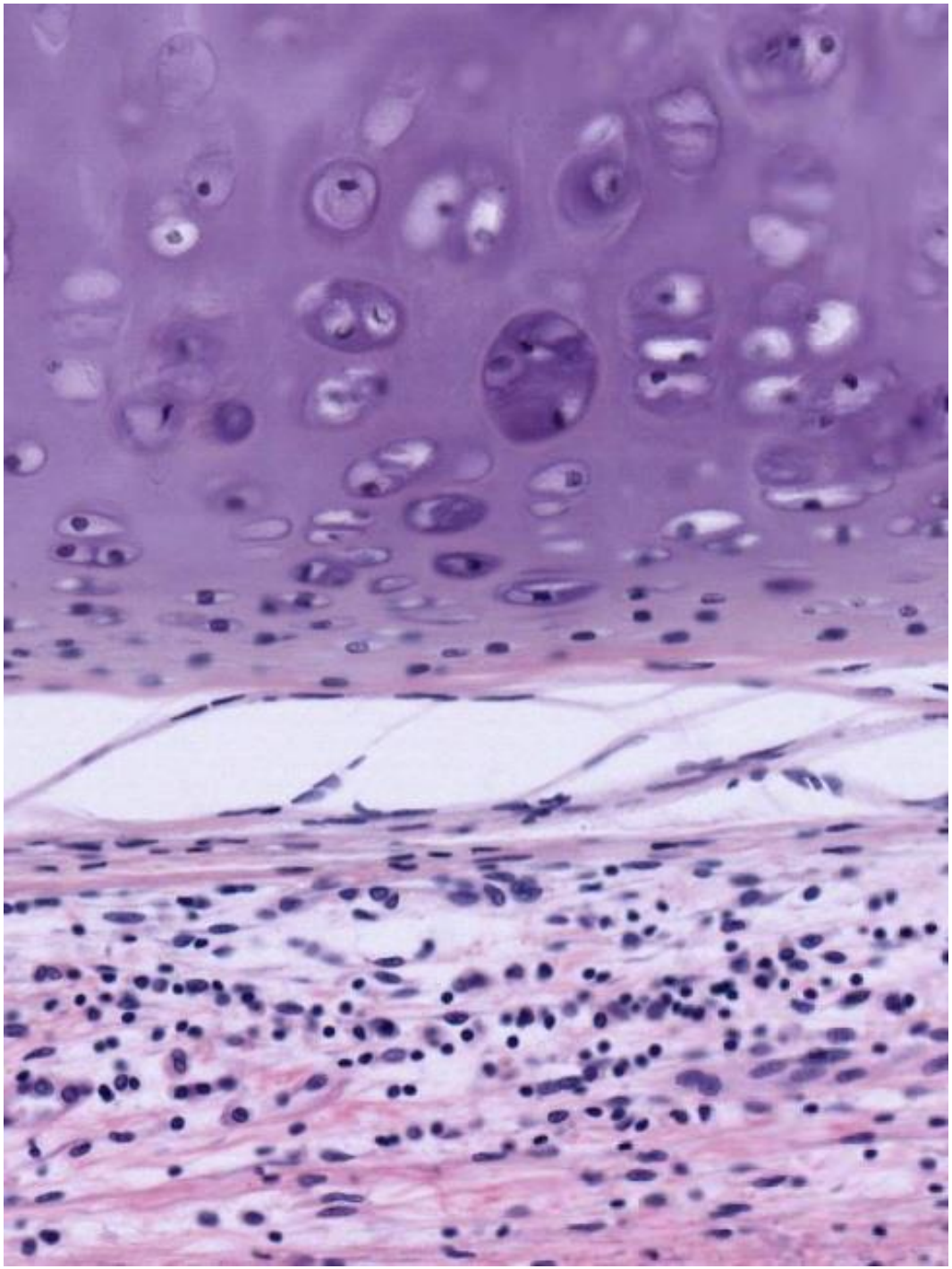



15


15 C


R


EC
E



# Compact bone structure