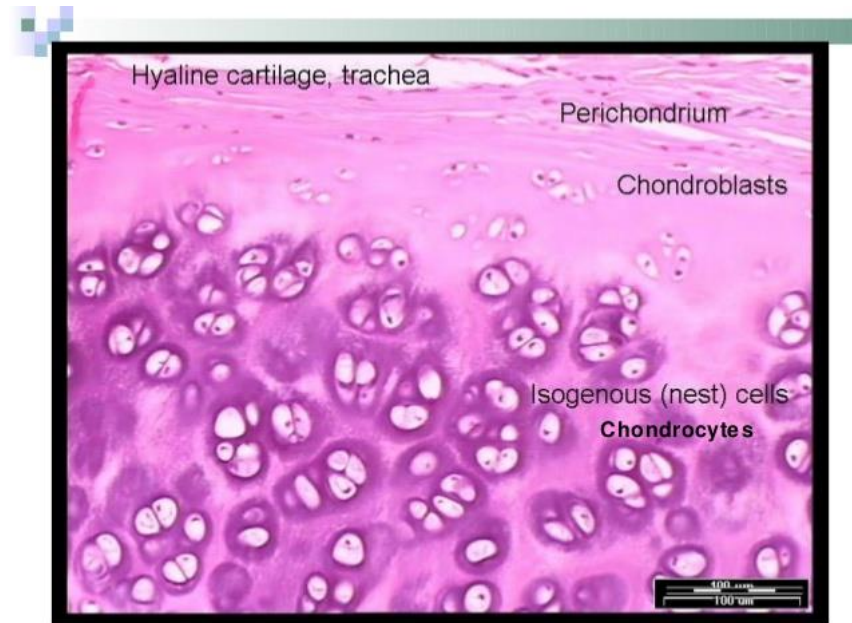
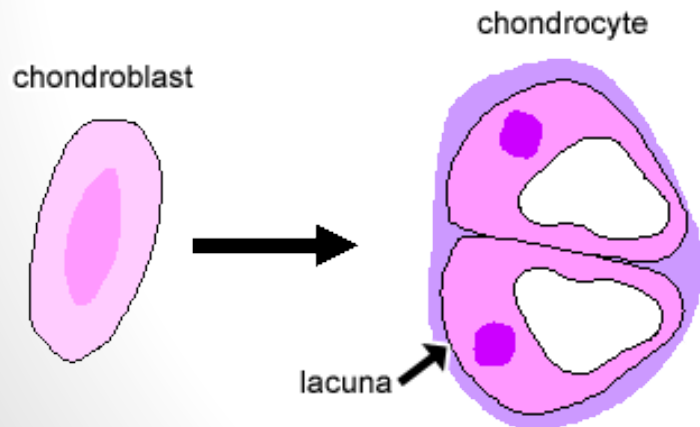


Cartilage and Bone tissues

Cartilage

Cartilage is a special form of connective tissue. It exhibits tensile strength, provides firm structural support for soft tissues, allows flexibility without distortion, and is resilient to compression. Cartilage consists mainly of cells called **chondrocytes** and **chondroblasts** that synthesize the extensive **extracellular matrix** (connective tissue fibers and ground substance). Three main types of cartilage are found in the body: hyaline, elastic, and fibrocartilage. Cartilage is classified based on the amount and types of fibers that are present in the extracellular matrix.

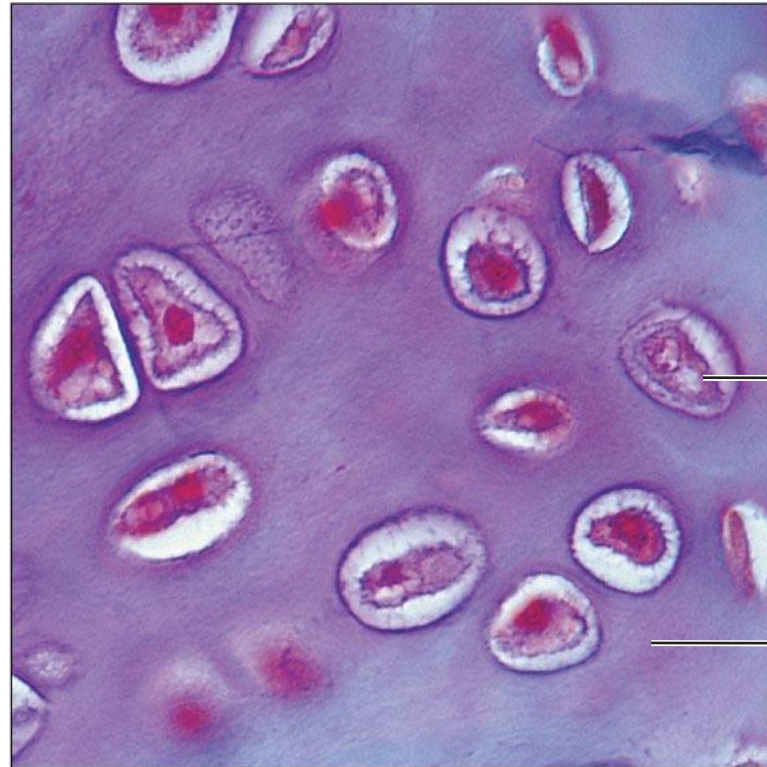
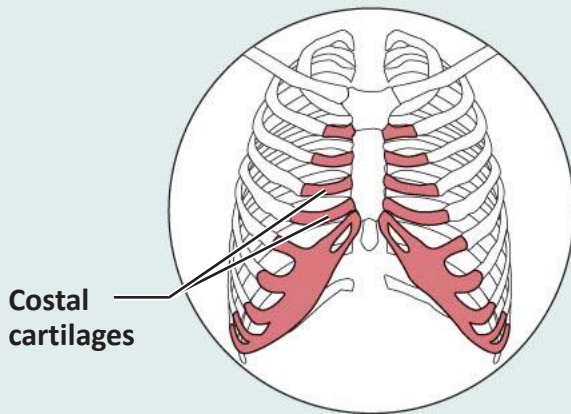


Cartilage: hyaline

Description: Amorphous but firm matrix; collagen fibers form an imperceptible network; chondroblasts produce the matrix and when mature (chondrocytes) lie in lacunae.

Function: Supports and reinforces; has resilient cushioning properties; resists compressive stress.

Location: Forms most of the embryonic skeleton; covers the ends of long bones in joint cavities; forms costal cartilages of the ribs; cartilages of the nose, trachea, and larynx.



Photomicrograph: Hyaline cartilage from the trachea (750x).

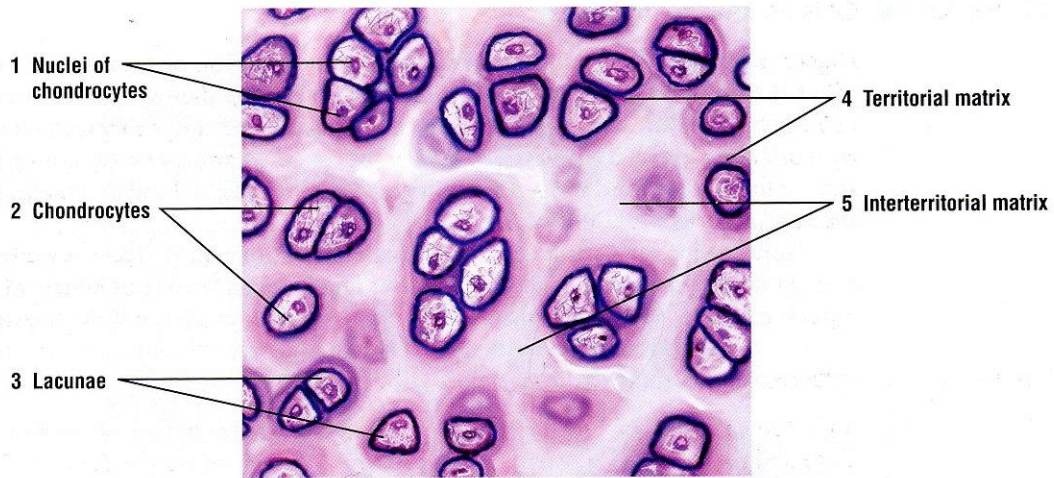


FIGURE 4.3 ■ Cells and matrix of mature hyaline cartilage. Stain: hematoxylin and eosin. High magnification.

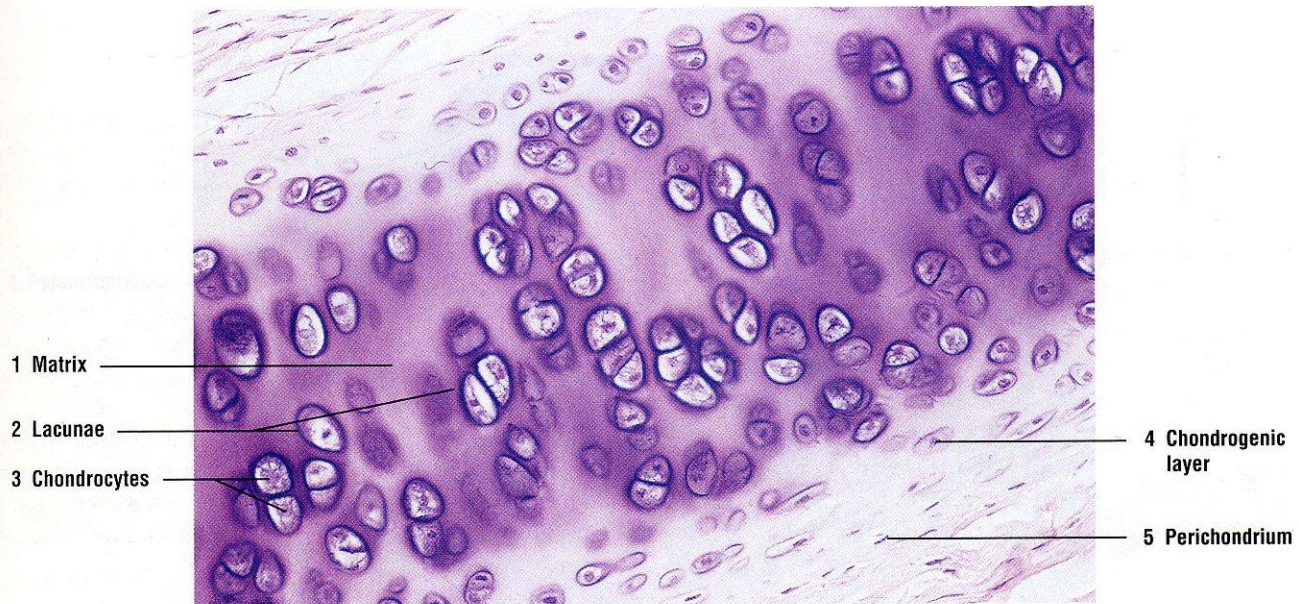


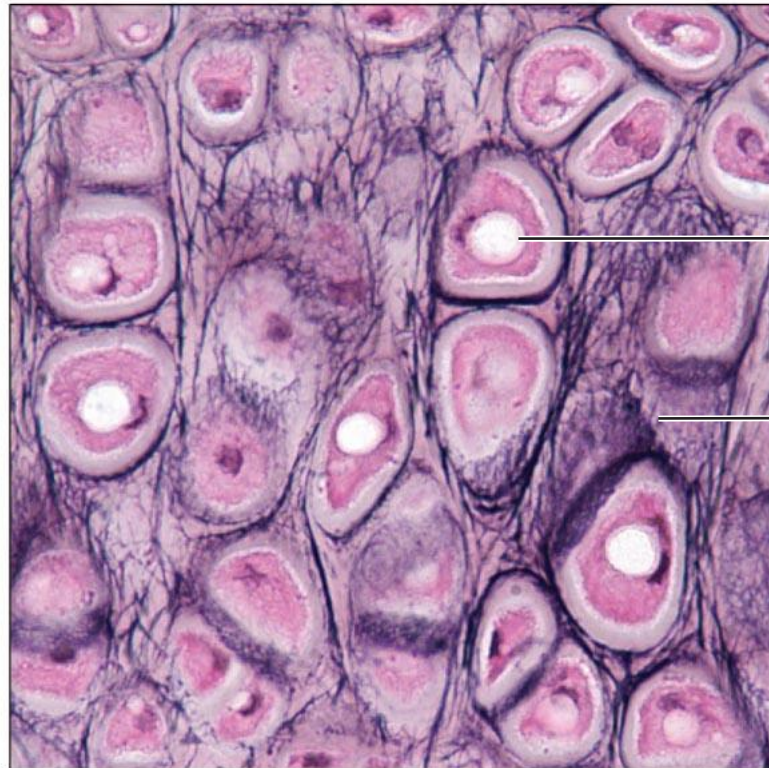
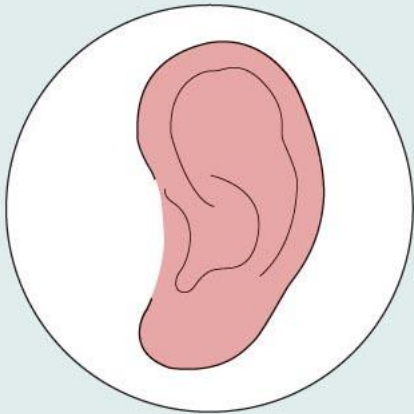
FIGURE 4.4 ■ Hyaline cartilage: developing bone. Stain: hematoxylin and eosin. 80×

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.



Chondrocyte
in lacuna

Matrix

Photomicrograph: Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (800x).

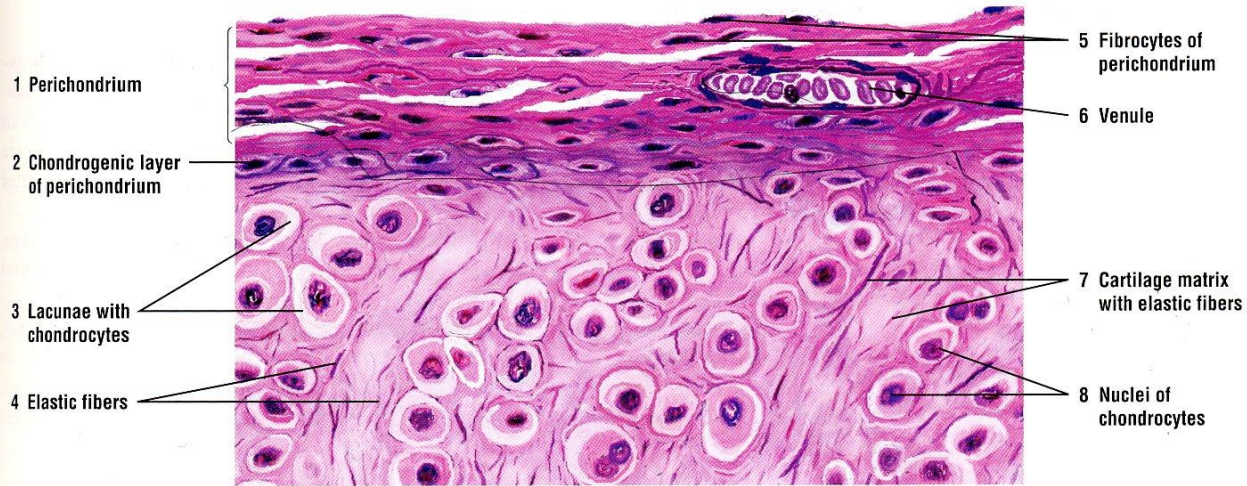


FIGURE 4.5 ■ Elastic cartilage: epiglottis. Stain: silver. High magnification.

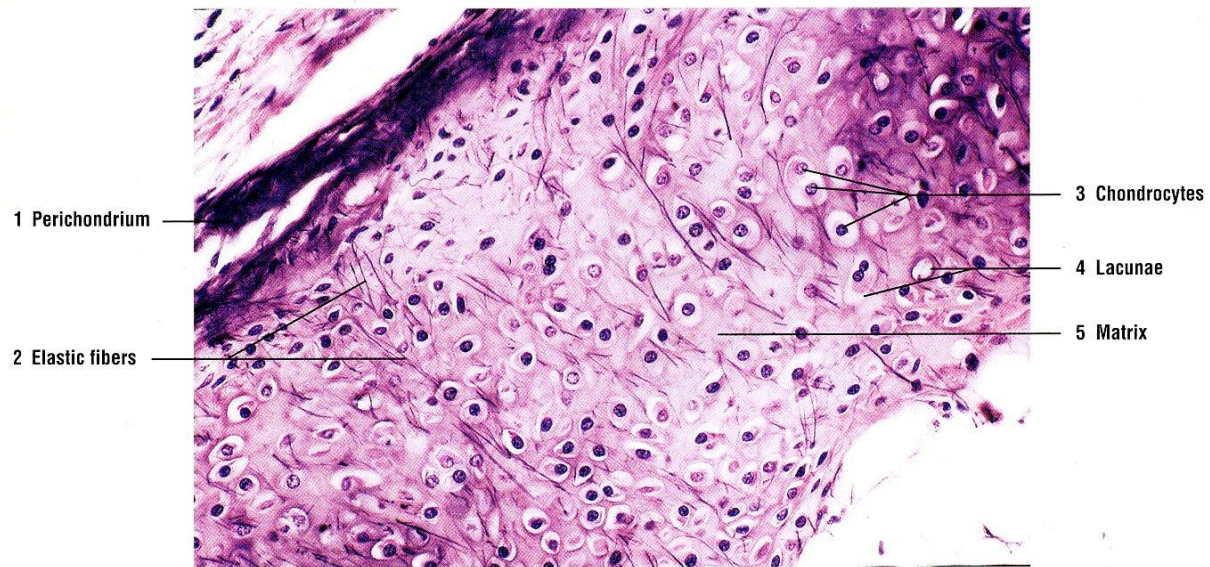


FIGURE 4.6 ■ Elastic cartilage: epiglottis. Stain: silver. 80×

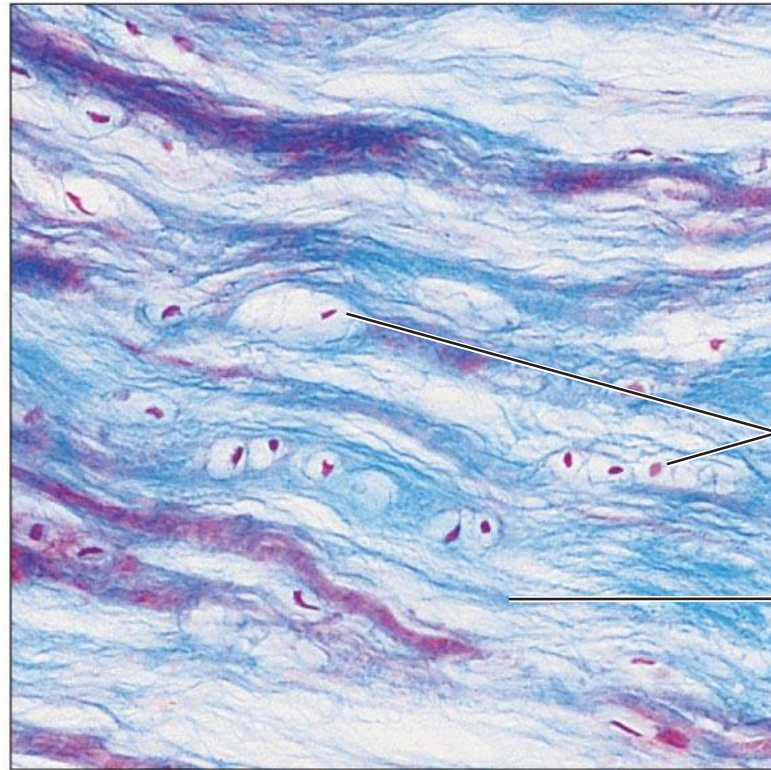
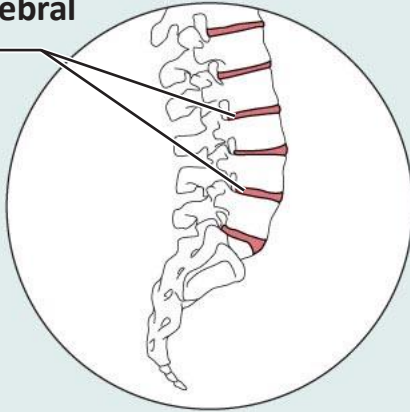
Cartilage: fibrocartilage

Description: Matrix similar to but less firm than that in hyaline cartilage; thick collagen fibers predominate.

Function: Tensile strength with the ability to absorb compressive shock.

Location: Intervertebral discs; pubic symphysis; discs of knee joint.

Intervertebral discs



Chondrocytes in lacunae

Collagen fiber

Photomicrograph: Fibrocartilage of an intervertebral disc (125x). Special staining produced the blue color seen.

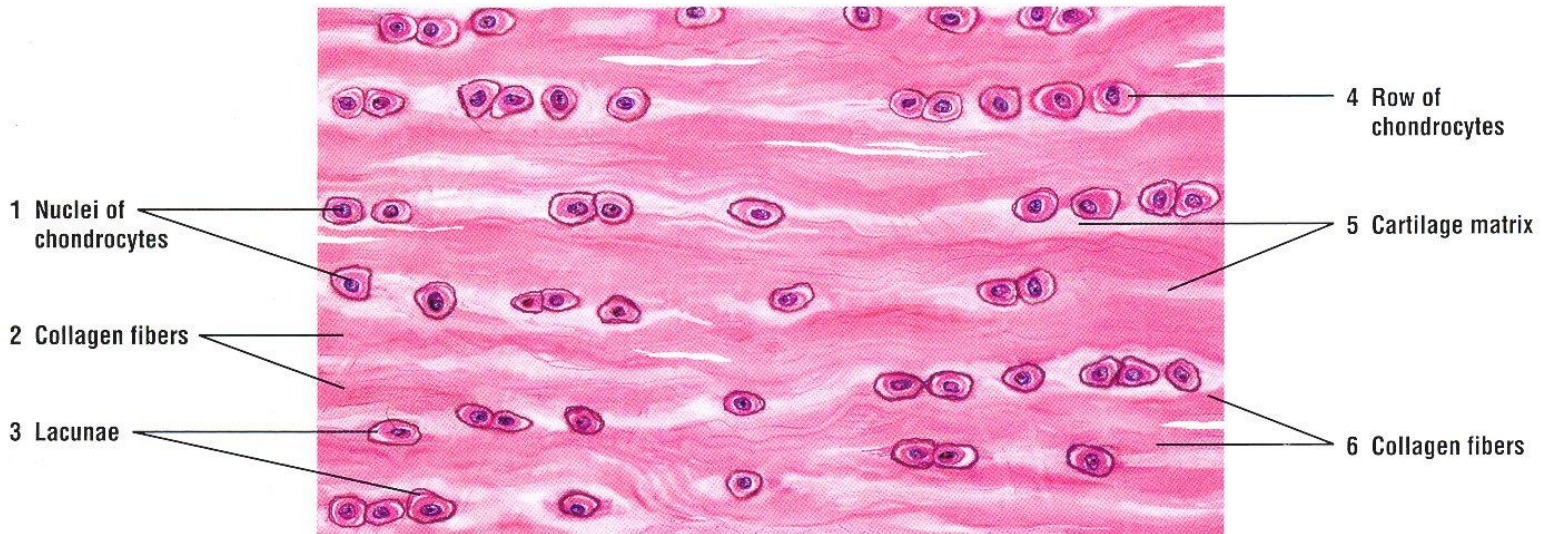
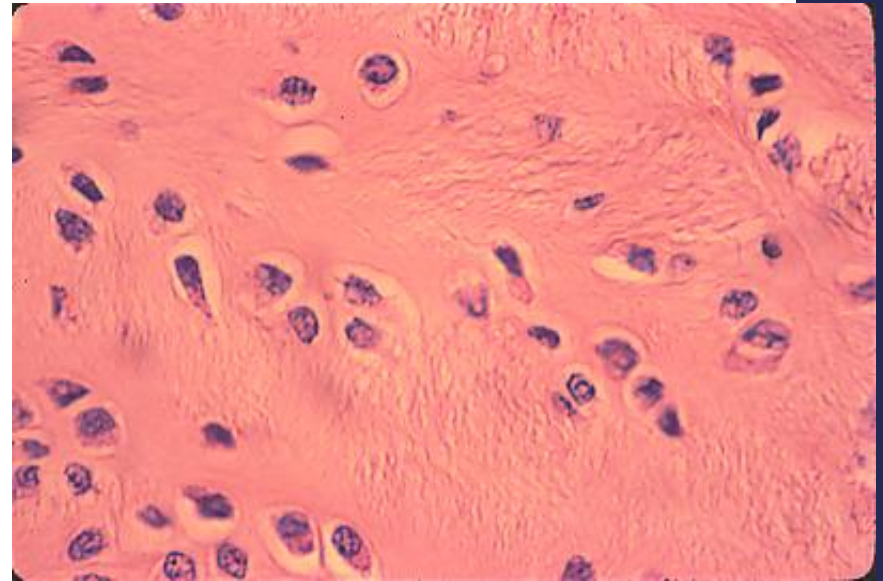


FIGURE 4.7 ■ Fibrous cartilage: intervertebral disk. Stain: hematoxylin and eosin. High magnification.

- This shows a higher magnification view of **fibrocartilage** illustrating the collagen fibers within the matrix surrounding the chondrocytes. This type of cartilage is often found between hyaline cartilage and dense connective tissue.



BONE

- Bone is a specialized connective tissue with a mineralized extracellular matrix. Bone generally consists of three cell types including the osteoprogenitor cells, osteoblasts (osteocytes when differentiated) and osteoclasts. The following slides illustrate some of the features of bony tissue.

BONE FUNCTION

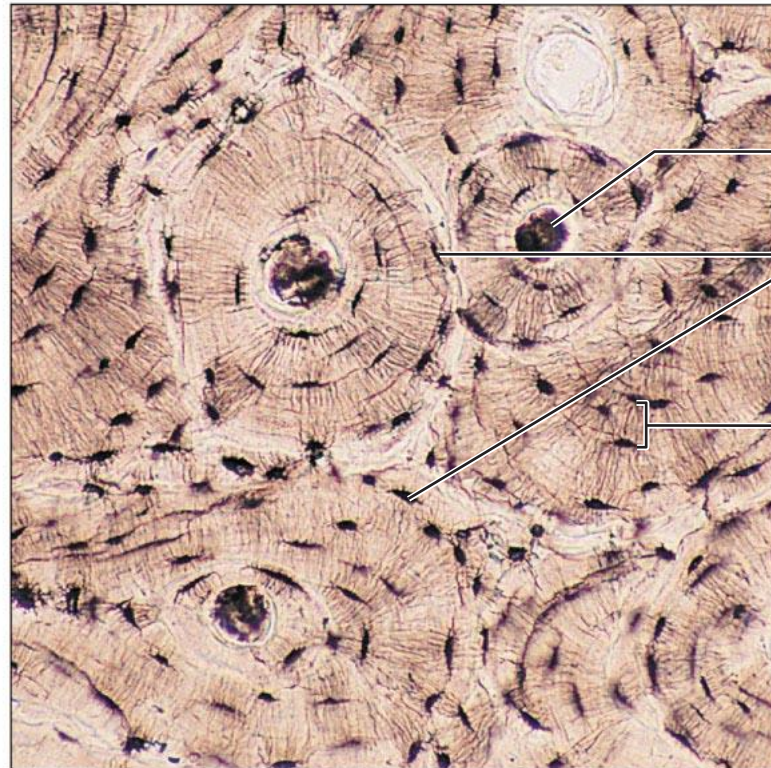
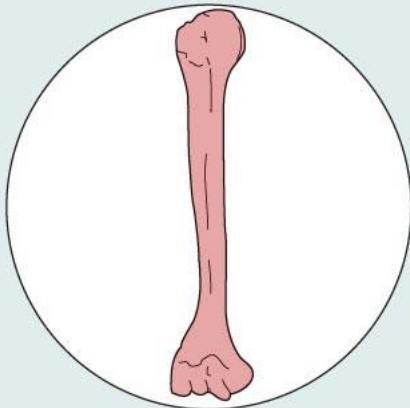
- Support
- Protection (protect internal organs)
- Movement (provide leverage system for skeletal muscles, tendons, ligaments and joints)
- Mineral homeostasis (bones act as reserves of minerals important for the body like calcium or phosphorus)
- Hematopoiesis: blood cell formation
- Storage of adipose tissue: yellow marrow

Osseous tissue

Description: Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. Very well vascularized.

Function: Bone supports and protects (by enclosing); provides levers for the muscles to act on; stores calcium and other minerals and fat; marrow inside bones is the site for blood cell formation (hematopoiesis).

Location: Bones



Central canal
Lacunae
Lamella

Photomicrograph: Cross-sectional view of bone (125x).

The Cells of Bone

There are different types of cells present in bone tissue, and each function differently.

Bone Cell Function

Osteogenic cells

Immature cells capable of differentiating (changing) into osteoblasts.

Osteoblasts

Cells capable of forming bone by secreting osteoid (proteins such as collagen) that form bone matrix, and eventually mineralized bone.

Osteocytes

Once an osteoblast is completely surrounded by bone matrix, it stops secreting osteoid and becomes an osteocyte. Osteocytes function in bone metabolism.

Osteoclasts

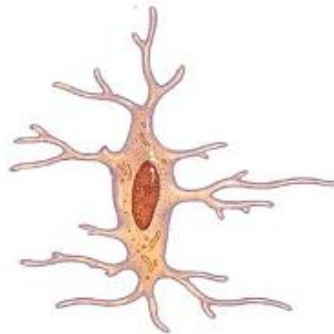
Cells that work opposite of osteoblasts and are capable of resorbing and breaking down bone structure. Osteoclasts use lysosomal enzymes and hydrochloric acid to break down bone.



Osteogenic cell
(develops into an osteoblast)



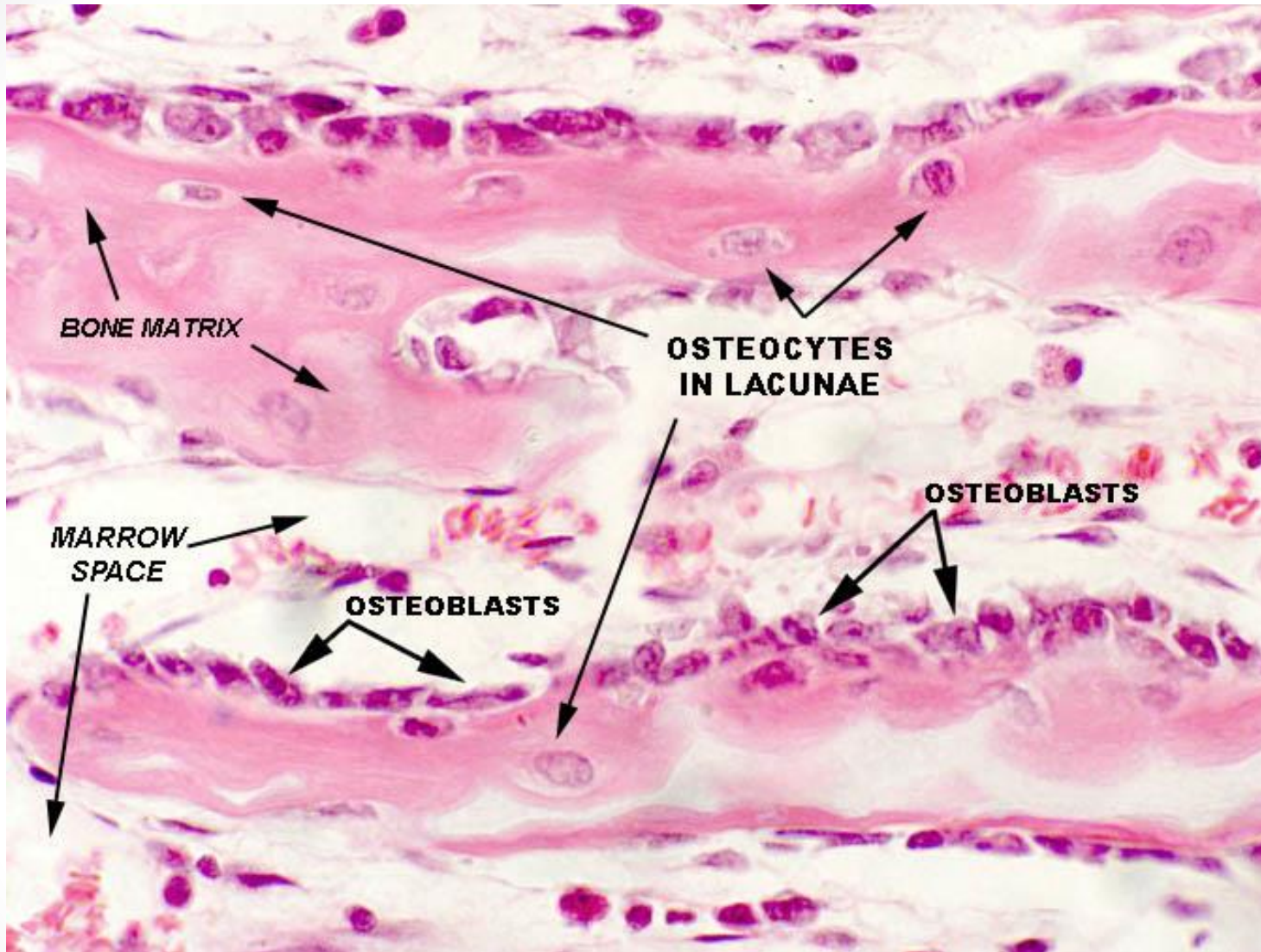
Osteoblast
(forms bone matrix)

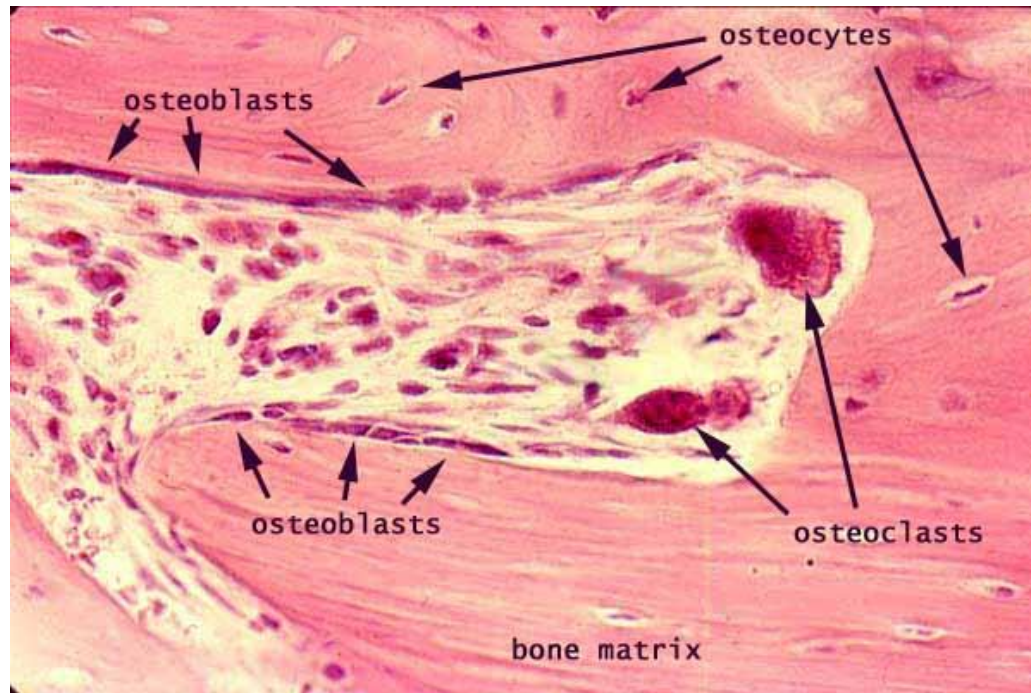
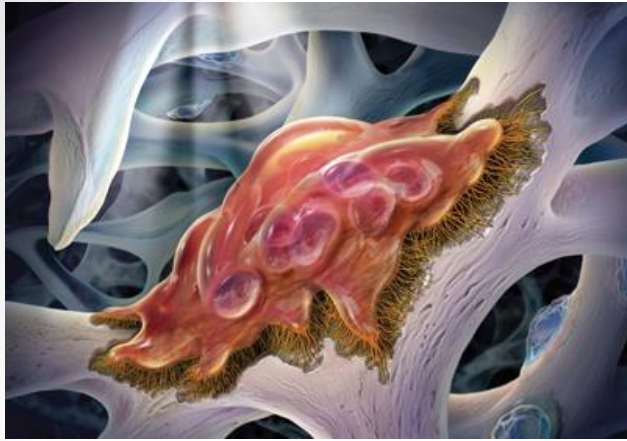


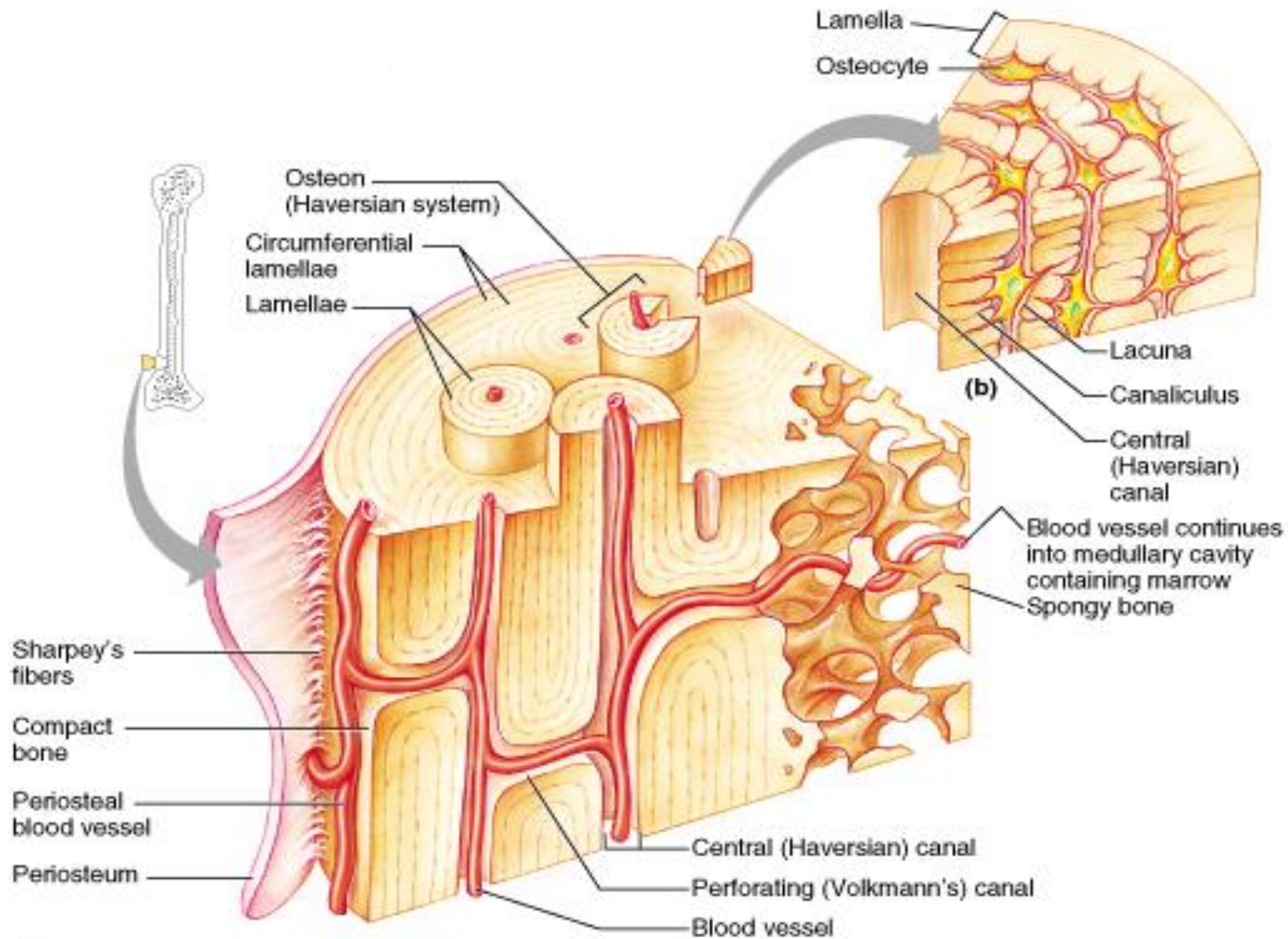
Osteocyte
(maintains bone tissue)



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



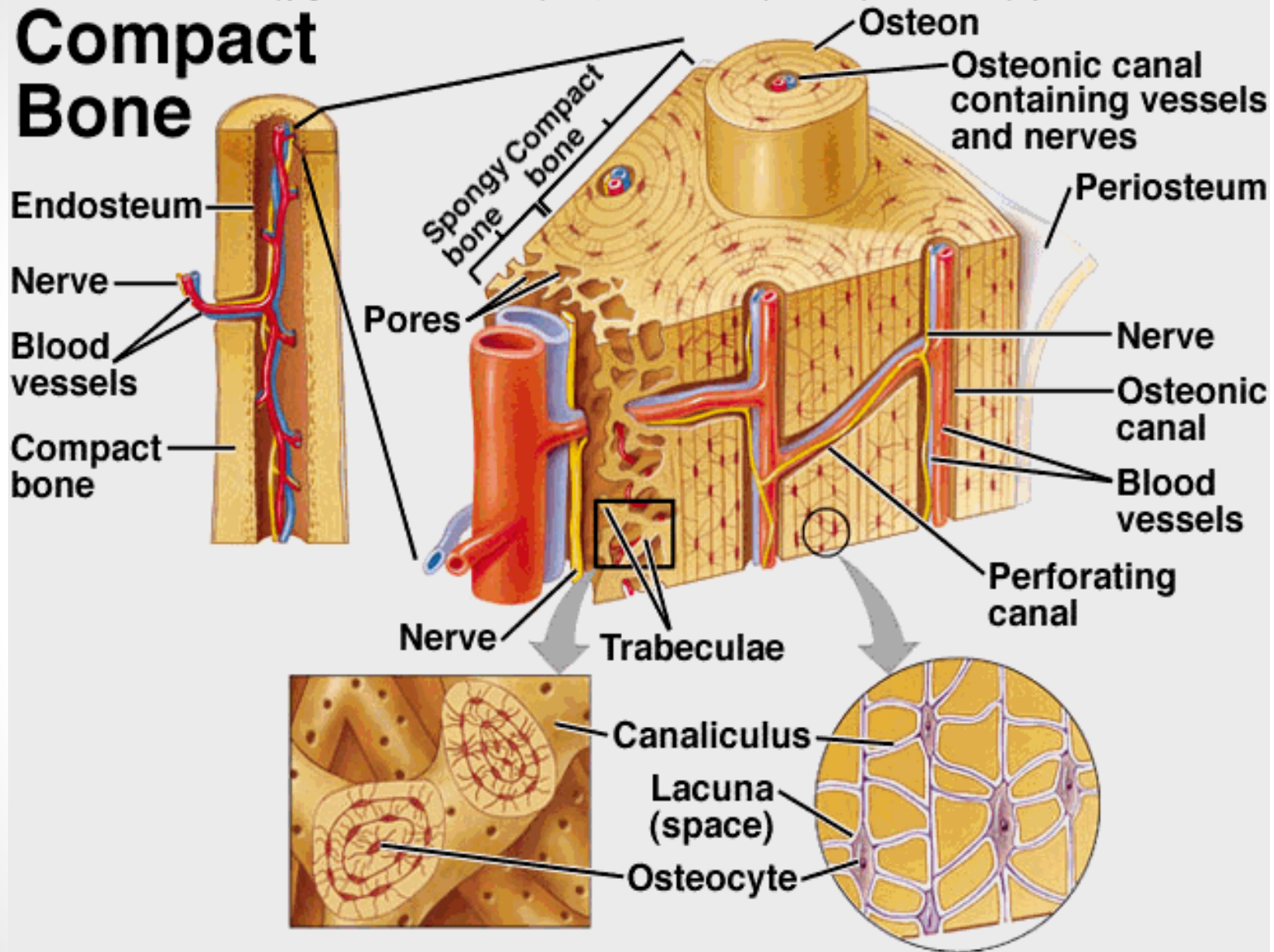




(a)

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Compact Bone



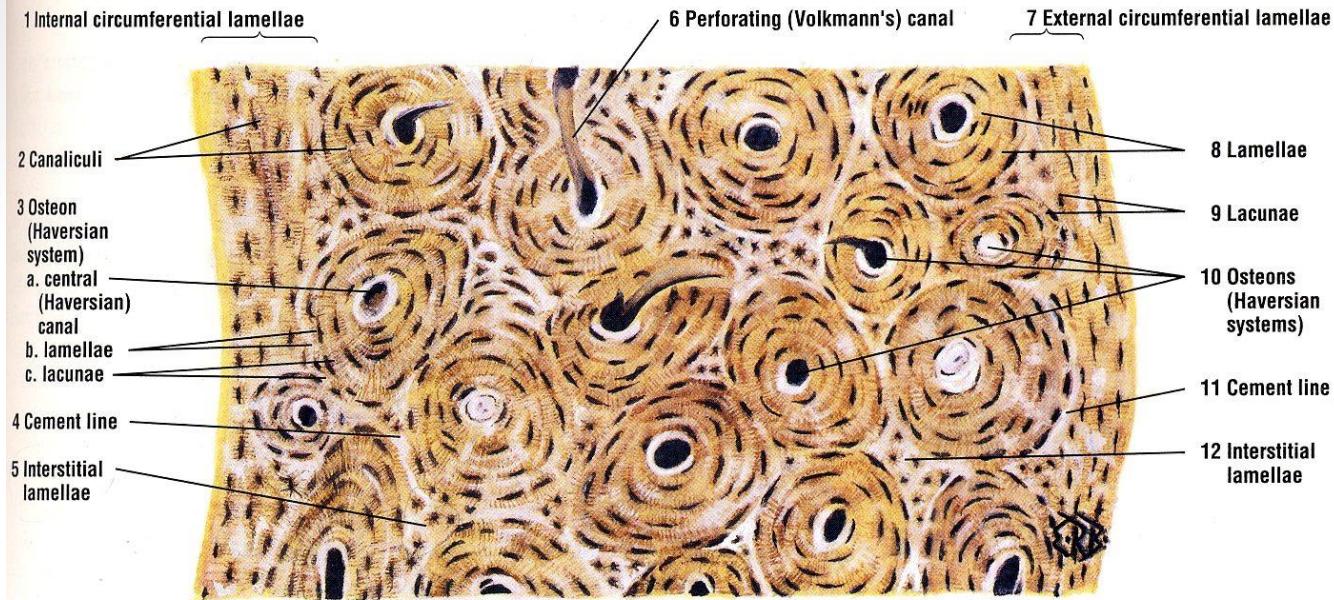


FIGURE 4.17 ■ Compact bone, dried (transverse section). Low magnification.

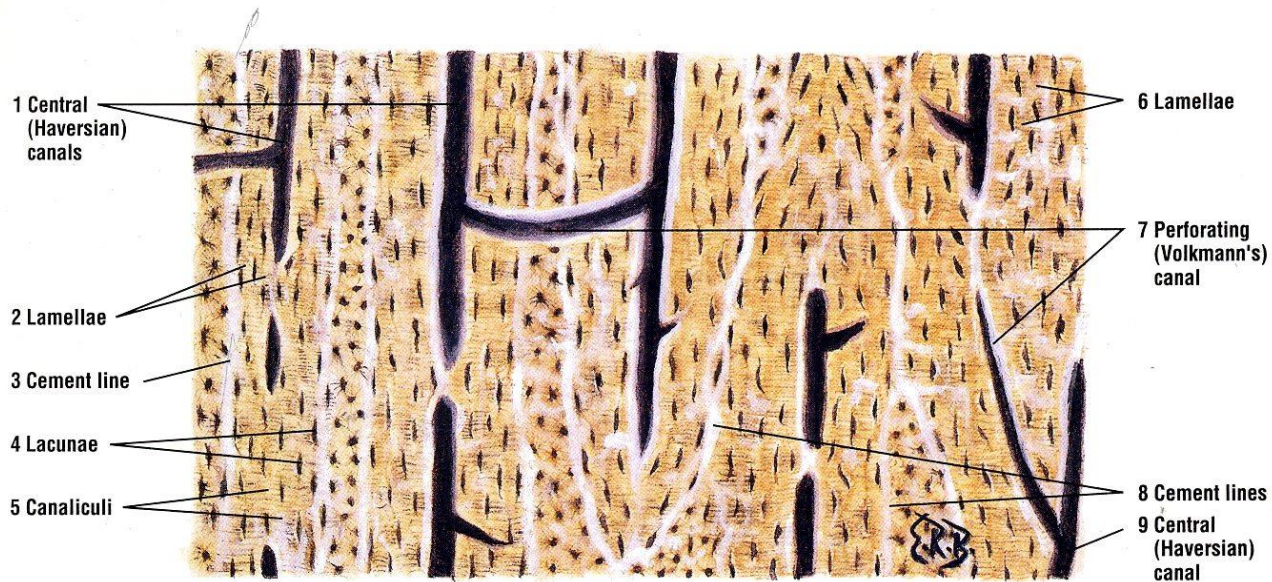


FIGURE 4.18 ■ Compact bone, dried (longitudinal section). Low magnification.

SPONGY BONE (ANCELLOUS BONE): INTERNAL LAYER

- trabecular bone tissue (haphazard arrangement).
- filled with red and yellow bone marrow
- osteocytes get nutrients directly from circulating blood.
- short, flat and irregular bone is made up of mostly spongy bone

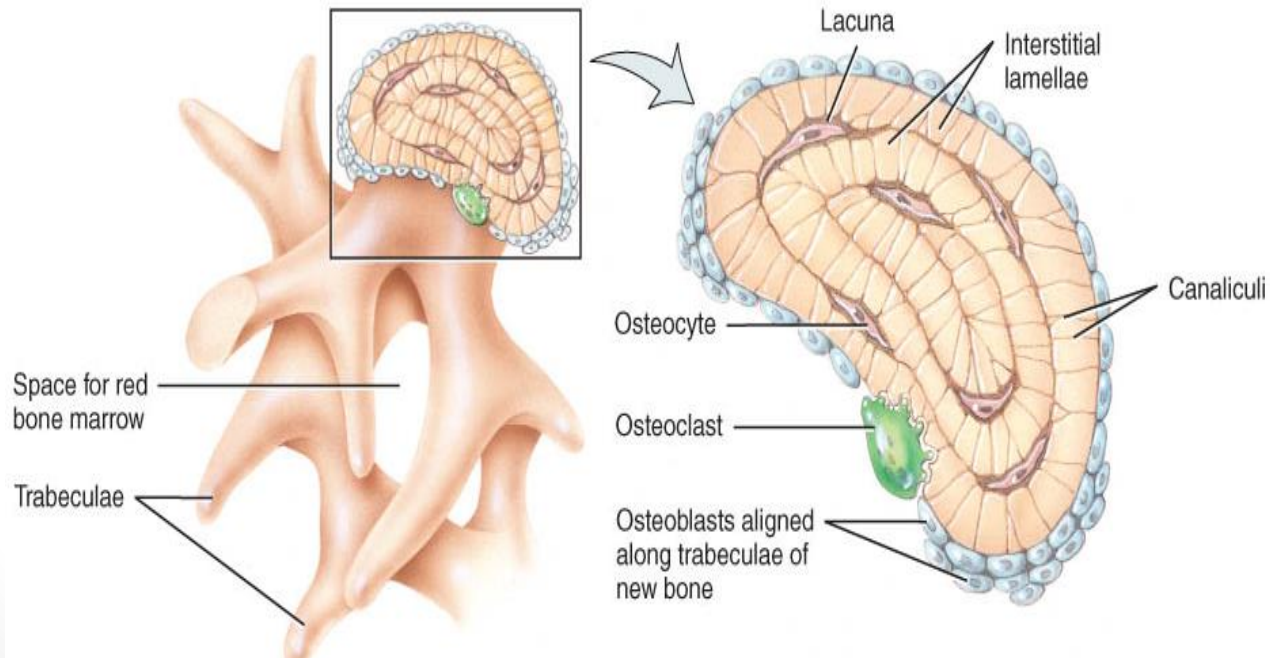




FIGURE 4.15 ■ Cancellous bone with trabeculae and marrow cavities: sternum (decalcified bone, transverse section). Stain: hematoxylin and eosin. Low magnification.

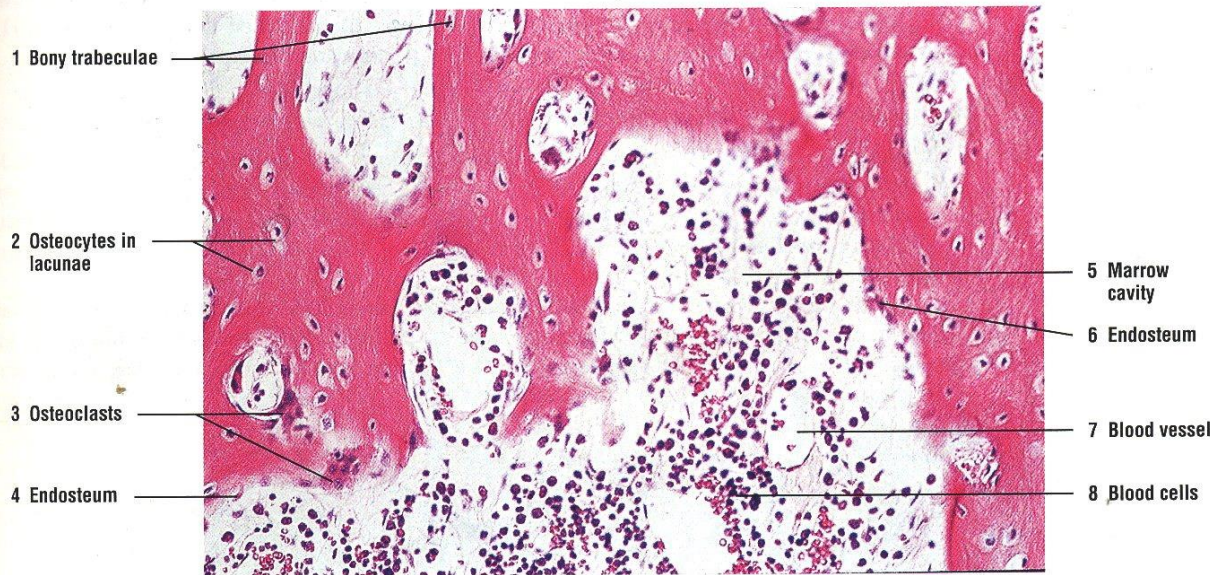
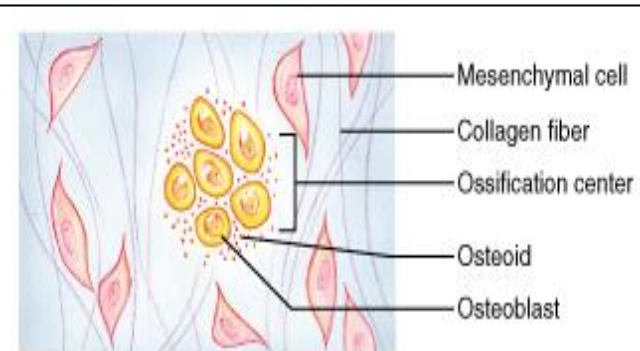


FIGURE 4.16 ■ Cancellous bone: sternum (decalcified bone, transverse section). Stain: hematoxylin and eosin. 64×

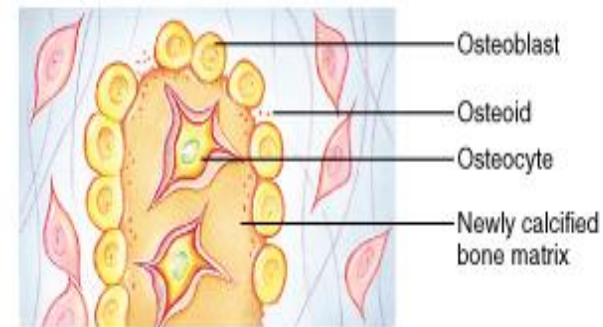
Intramembranous Ossification

- An ossification center appears in the fibrous connective tissue membrane
- Osteoblasts secrete bone matrix within the fibrous membrane
- Osteoblasts mature into osteocytes



① An ossification center appears in the fibrous connective tissue membrane.

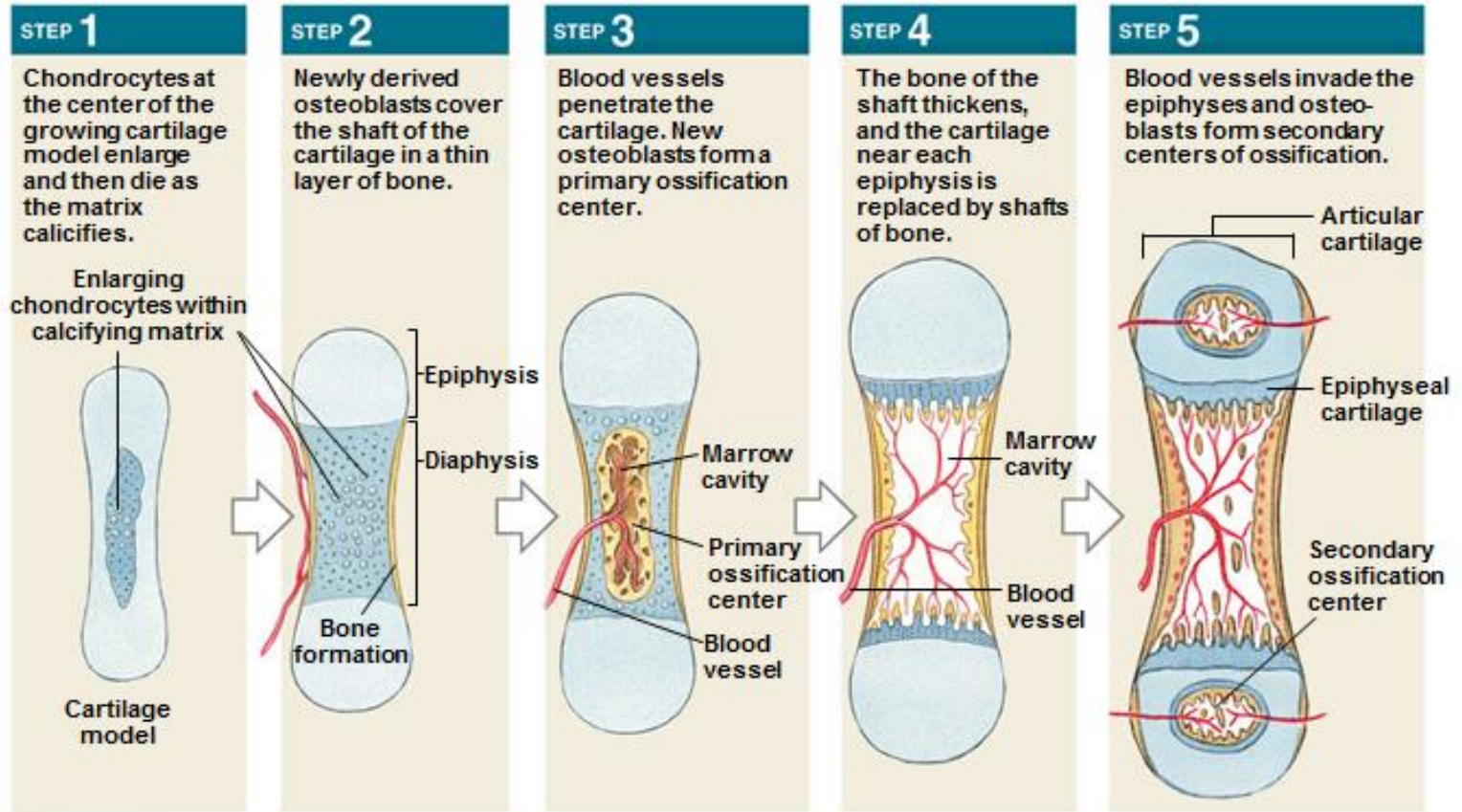
- Selected centrally located mesenchymal cells cluster and differentiate into osteoblasts, forming an ossification center.



② Bone matrix (osteoid) is secreted within the fibrous membrane.

- Osteoblasts begin to secrete osteoid, which is mineralized within a few days.
- Trapped osteoblasts become osteocytes.

Endochondral Ossification



Replacement of hyaline cartilage with bone
Most bones are formed this way (i.e. long bones).

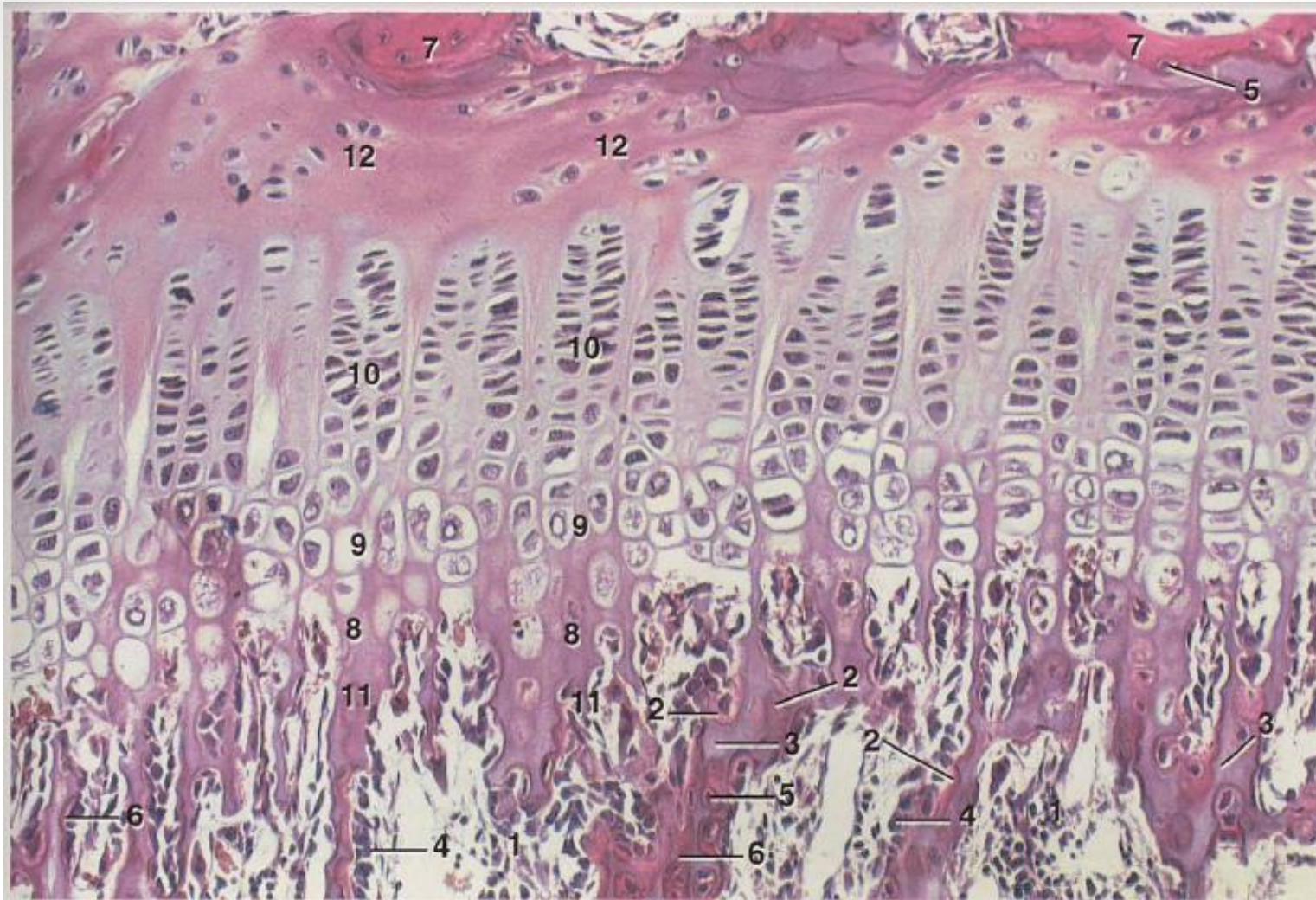


Figure 5.6

× 130

KEY

- | | |
|-------------------------------|-------------------------------|
| 1. Bone marrow | 7. Spongy bone, epiphysis |
| 2. Bone matrix | 8. Zone of calcification |
| 3. Calcified cartilage matrix | 9. Zone of hypertrophy |
| 4. Osteoblast | 10. Zone of multiplication |
| 5. Osteocyte | 11. Zone of ossification |
| 6. Spongy bone, diaphysis | 12. Zone of reserve cartilage |

- 1 Zone of reserve cartilage
- 2 Zone of proliferating chondrocytes
- 3 Zone of chondrocyte hypertrophy and calcification of cartilage
- 4 Zone of ossification
- 5 Outer periosteum
- 6 Inner periosteum
- 7 Periosteal bone collar
- 8 Osteoid and bone
- 9 Hair follicles
- 10 Blood vessels
- 11 Bony spicules
- 12 Megakaryocytes



- 13 Perichondrium
- 14 Chondrocytes in lacunae
- 15 Plates of calcified cartilage matrix
- 16 Red bone marrow cavity
- 17 Periosteum
- 18 Epidermis
- 19 Connective tissue of dermis
- 20 Blood sinusoids
- 21 Adipose cells
- 22 Bony spicules
- 23 Sweat glands in dermis

FIGURE 4.8 ■ Endochondral ossification: development of a long bone (panoramic view, longitudinal section). Stain: hematoxylin and eosin. Low magnification.

