Connective Tissue
Part 2

Descriptive Histology 272

6/10/2019

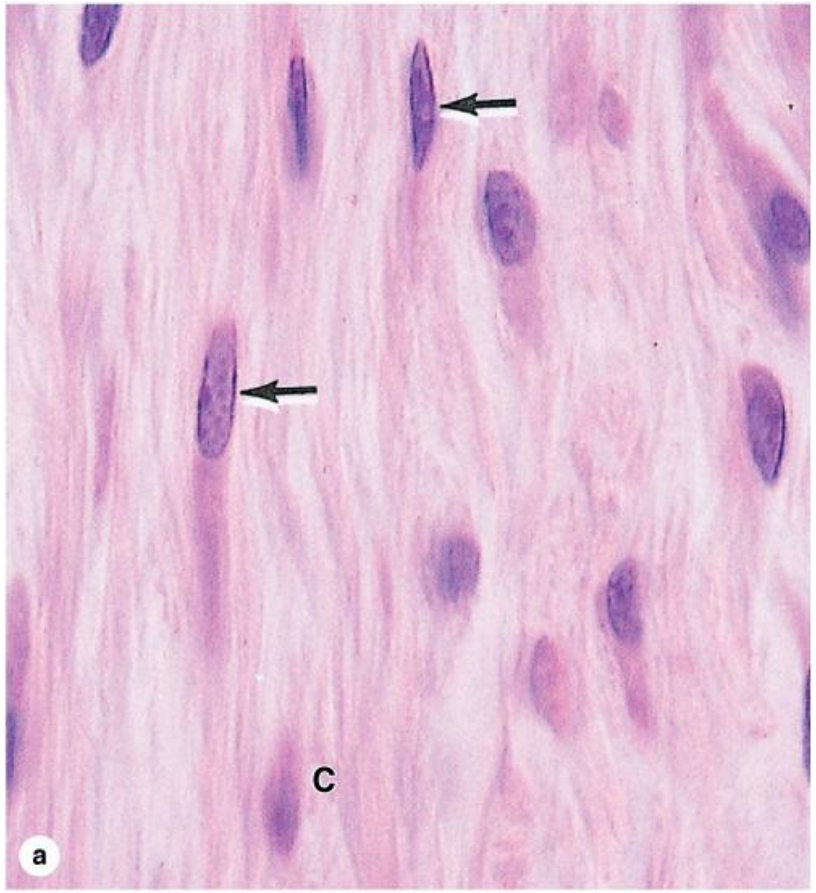
Cells of Connective Tissue

- Fibroblasts
- Adipocytes
- Macrophages
- Mast Cells
- Plasma Cells
- Leukocytes

Fibroblasts

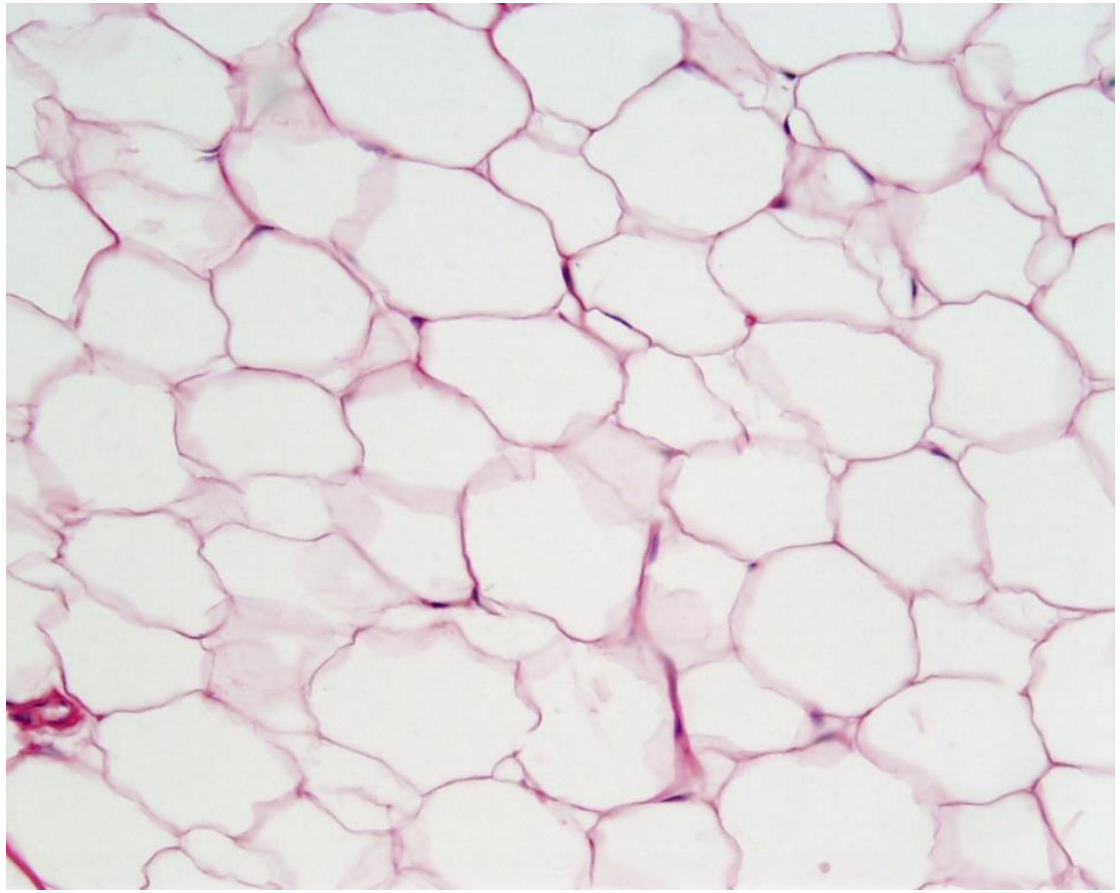
Fibroblasts synthesize

- Collagen,
- Elastin,
- Glycosaminoglycans,
- Proteoglycans
- Multiadhesive glycoproteins.



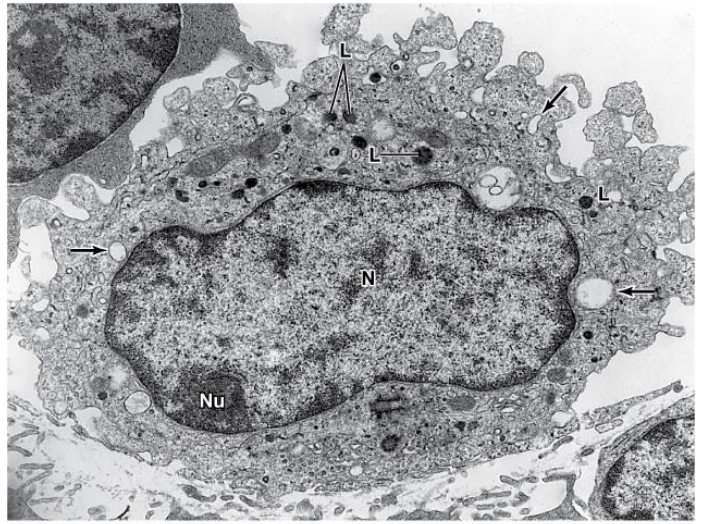
Adipocytes

Adipocytes are connective tissue cells that have become specialized for storage of neutral fats or for the production of heat, often called **fat cells**



Macrophages

- Macrophages derived from bone marrow precursor cells that divide, producing **monocytes** which circulate in the blood.
- Therefore, monocytes and macrophages are the same cell in different stages of maturation and location.
- Macrophages act as defense elements
- Macrophages are also antigen-presenting cells that participate in the processes of partial digestion and presentation of antigen to other cells

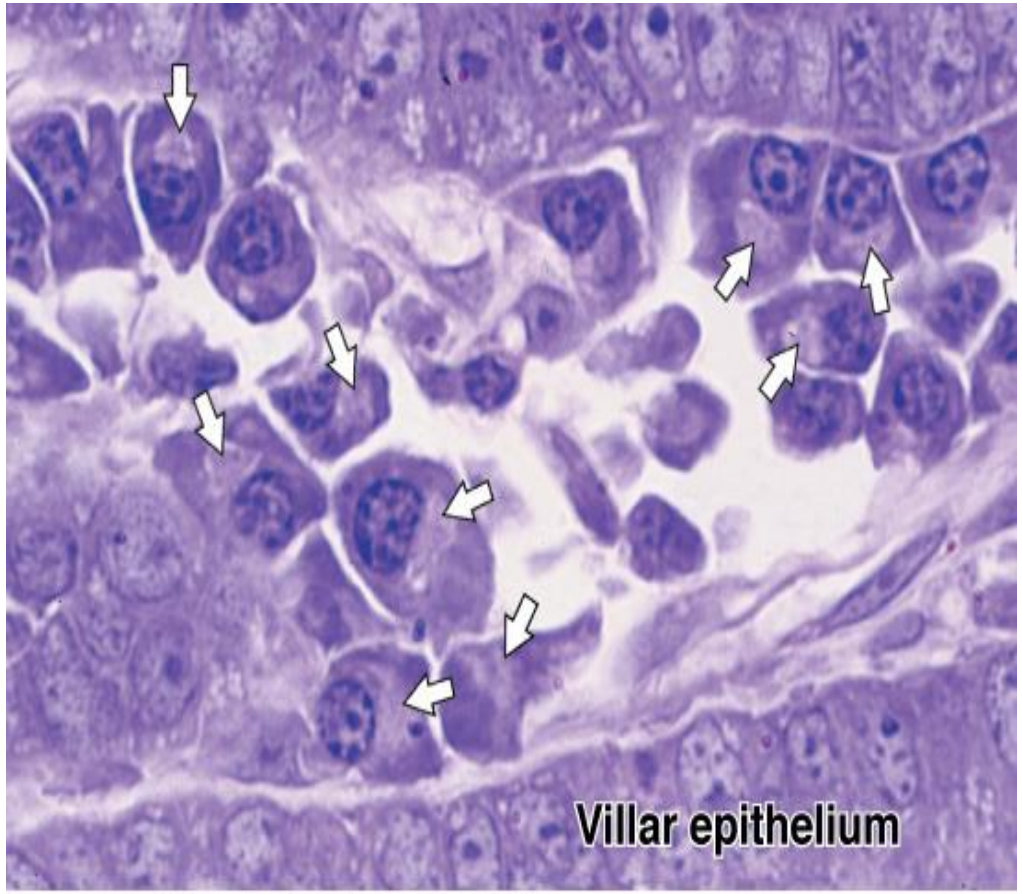


Mast Cells

- Mast cells function in the localized release of many bioactive substances with roles in the inflammatory response, innate immunity, and tissue repair.
- A partial list of important molecules released from these granules includes:
  - **Heparin**
  - **Histamine**
  - **Serine proteases**
  - **Eosinophil** and **neutrophil chemotactic factors**
  - **Leukotrienes C_4, D_4, and E_4**

Plasma Cells

- Plasma cells are derived from B lymphocytes and are responsible for the synthesis of antibodies.
- Plasma cells are large, ovoid cells, with basophilic cytoplasm.
- There are at least a few plasma cells in most connective tissues and often more abundant in infected tissues.
- Their average lifespan is only 10-20 days.



Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com

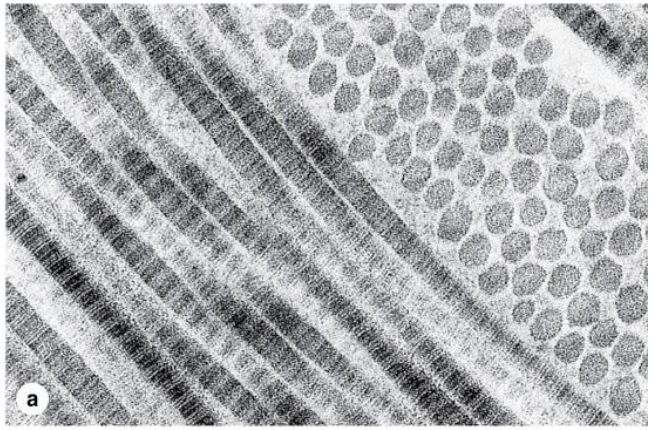
Cell Type	Major Product or Activity
Fibroblasts (fibrocytes)	Extracellular fibers and ground substance
Plasma cells	Antibodies
Lymphocytes (several types)	Various immune/defense functions
Eosinophilic leukocytes	Modulate allergic/vasoactive reactions and defense against parasites
Neutrophilic leukocytes	Phagocytosis of bacteria
Macrophages	Phagocytosis of ECM components and debris; antigen processing and presentation to immune cells; secretion of growth factors, cytokines, and other agents
Mast cells and basophilic leukocytes	Pharmacologically active molecules (eg, histamine)
Adipocytes	Storage of neutral fats

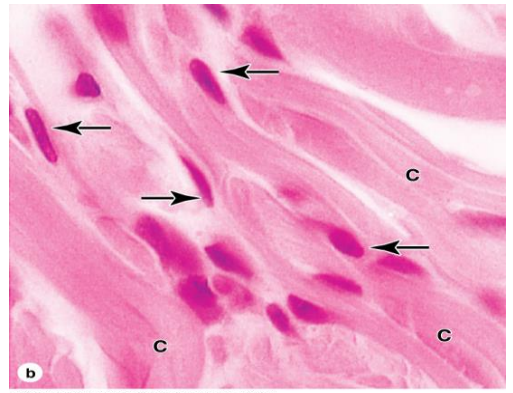
Fibers of connective tissue

- Collagen fibers present main tensile strength, and are the stuff of scars.
- Elastic fibers present elasticity.
- Reticular fibers (really, a special form of collagen) provide a delicate supporting framework for loose cells.

Collagen fibers

- Collagen types I, II and III are the major fibrous collagens
- Type I collagen is the most abundant structural component of skin, tendons and bones. It represents 90 % of the total collagen content.
- Type II collagen makes the structural framework of cartilage and intervertebral disks.





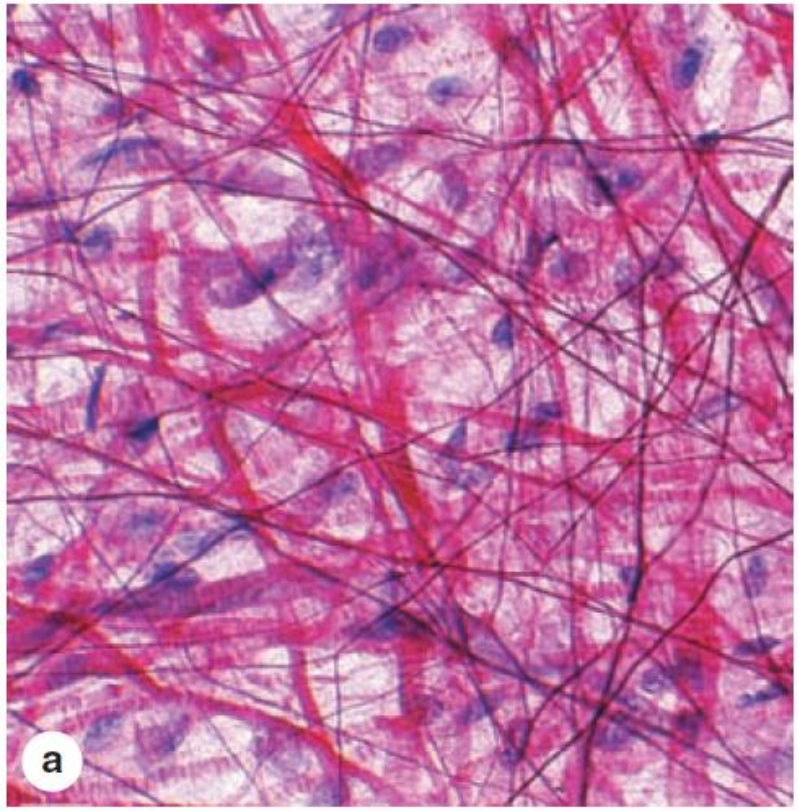
Collagen fibers

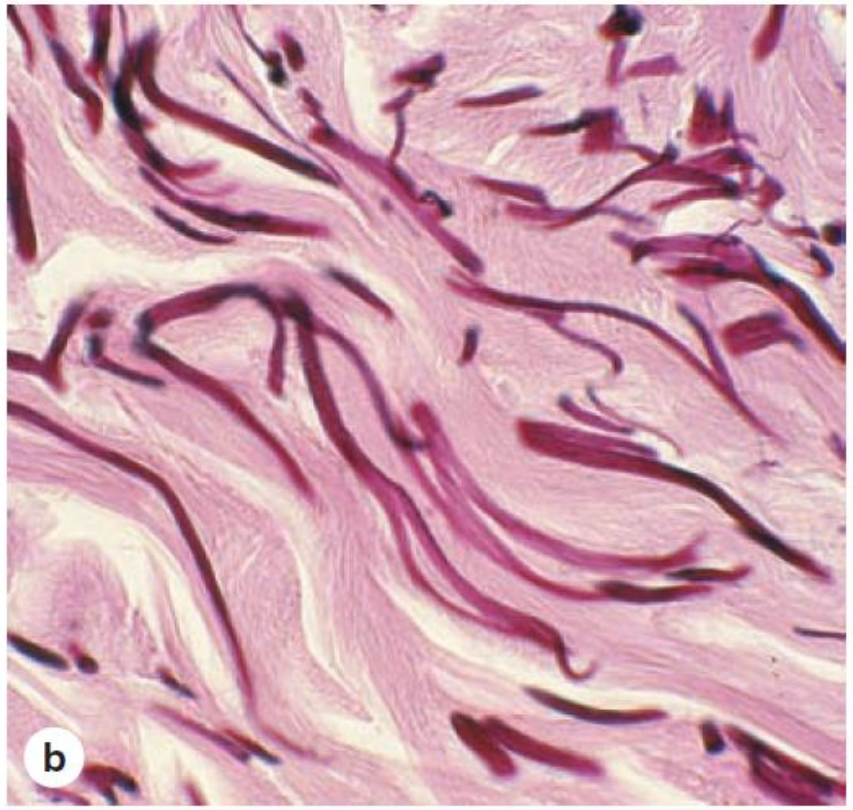
- Type III collagen is present in many tissues: 1 to 2 % in tendons, 10 % in the skin and even 50 % in the vascular system
- Type IV collagen is the structural framework of the non-fibrous basement membranes which act as an underlying support for epithelial and endothelial cells, a protective sheath for myofibrils and the filtration membrane of the glomeruli

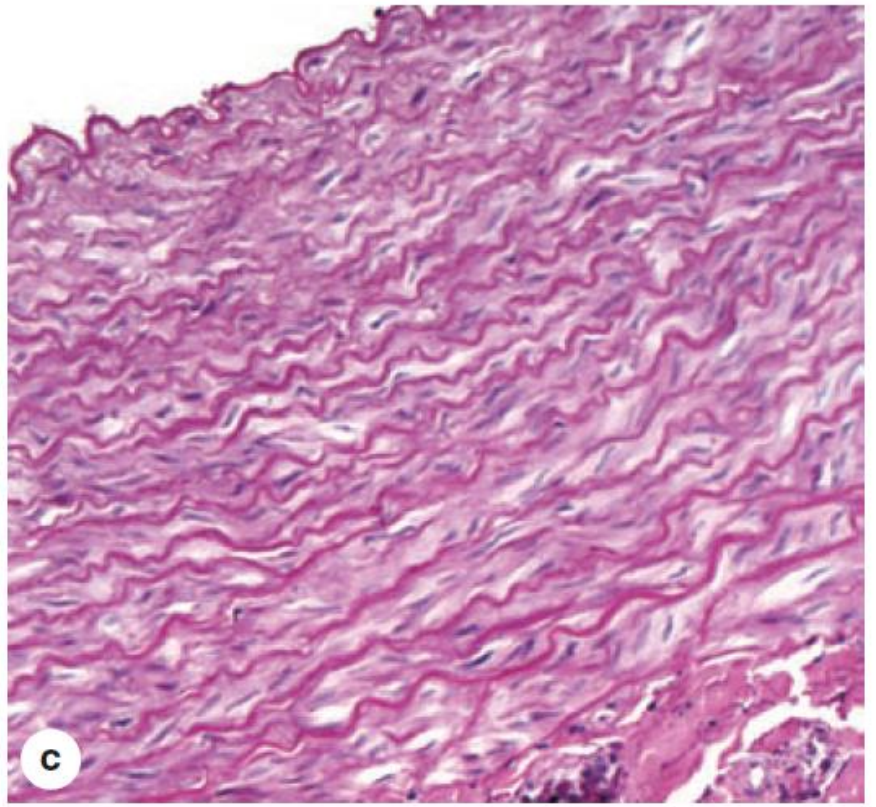
Elastic fibers

- **Elastin** is another fibrous protein.
- As the name implies, elastic fibers have physical properties similar to those of rubber, allowing tissues to be stretched or distended and return to their original shape
- In the wall of large blood vessels, especially arteries, elastin also occurs as fenestrated sheets called **elastic lamellae**.
- Elastic fibers can deteriorate with age and exposure to sun

Elastic fibers





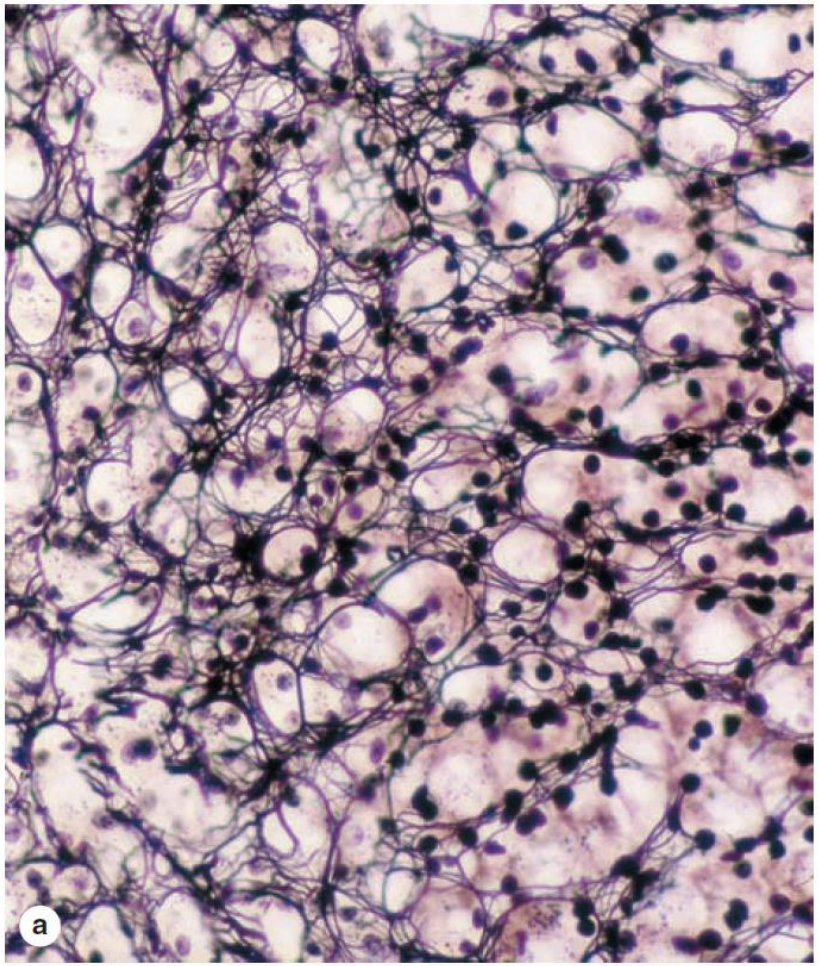


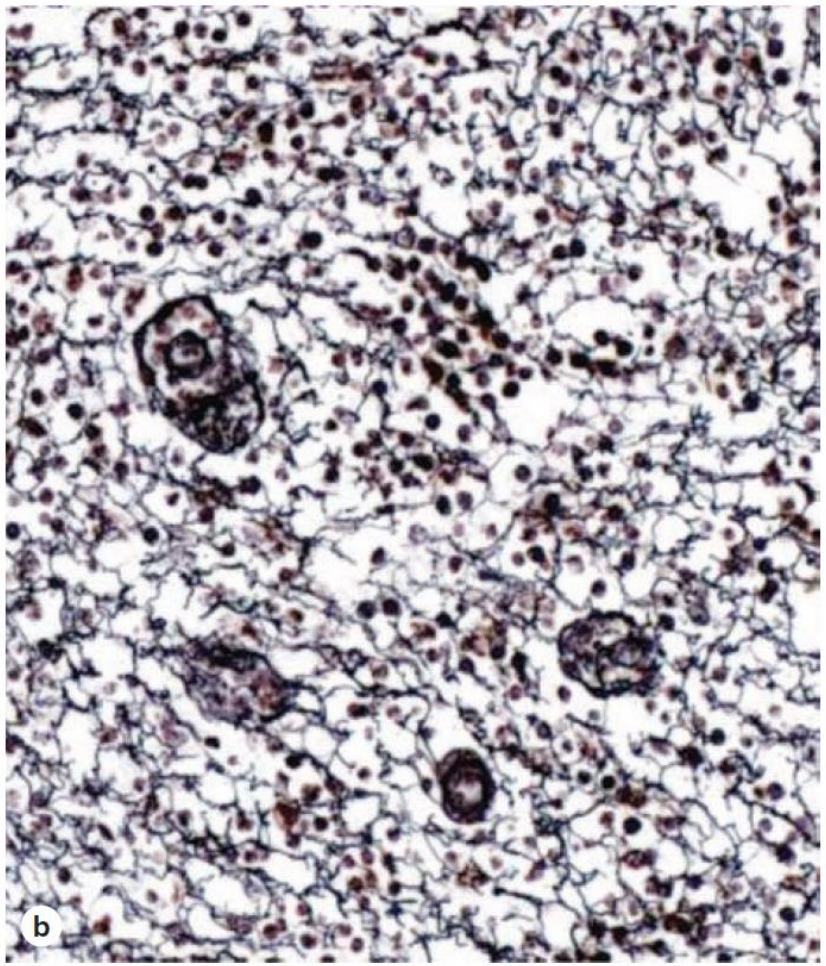
Elastic fibers or lamellae (sheets) add resiliency to connective tissue. Such fibers may be difficult to discern in H&E stained tissue, but elastin has a distinct, darker-staining appearance with other staining procedures.

Reticular fibers

- Made from type III collagen, provide a very delicate network (hence the name) supporting individual cells in certain organs (lymph nodes, spleen, liver).
- Reticular fibers do not show up in routine H&E stained specimens, but they can be demonstrated with silver salts.

Reticular fibers



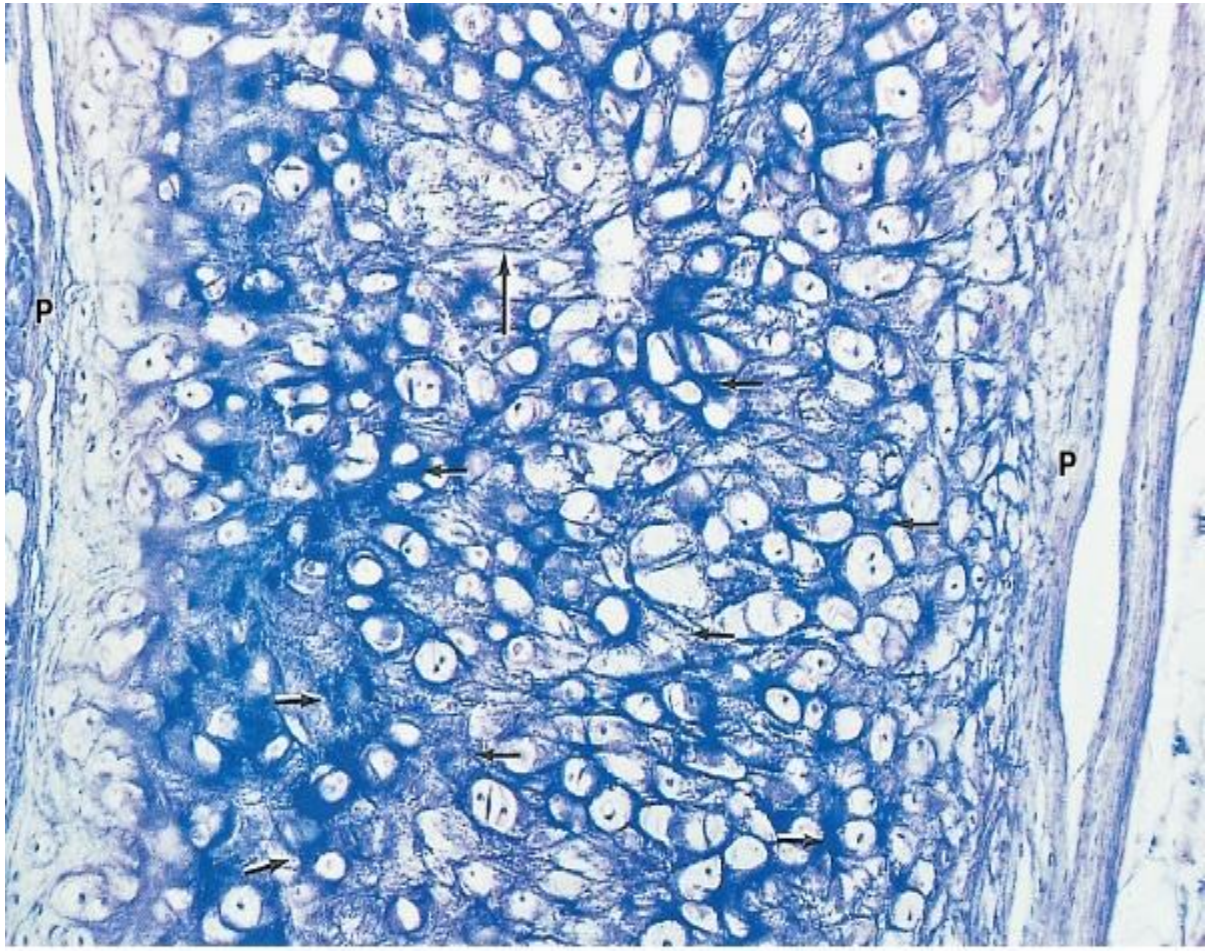


In these silver-stained sections of adrenal cortex (a) and lymph node (b), networks of delicate, black reticular fibers are prominent. These fibers serve as a supportive stroma in most lymphoid and hematopoietic organs and many endocrine glands.

Supportive Connective Tissue

CARTILAGE

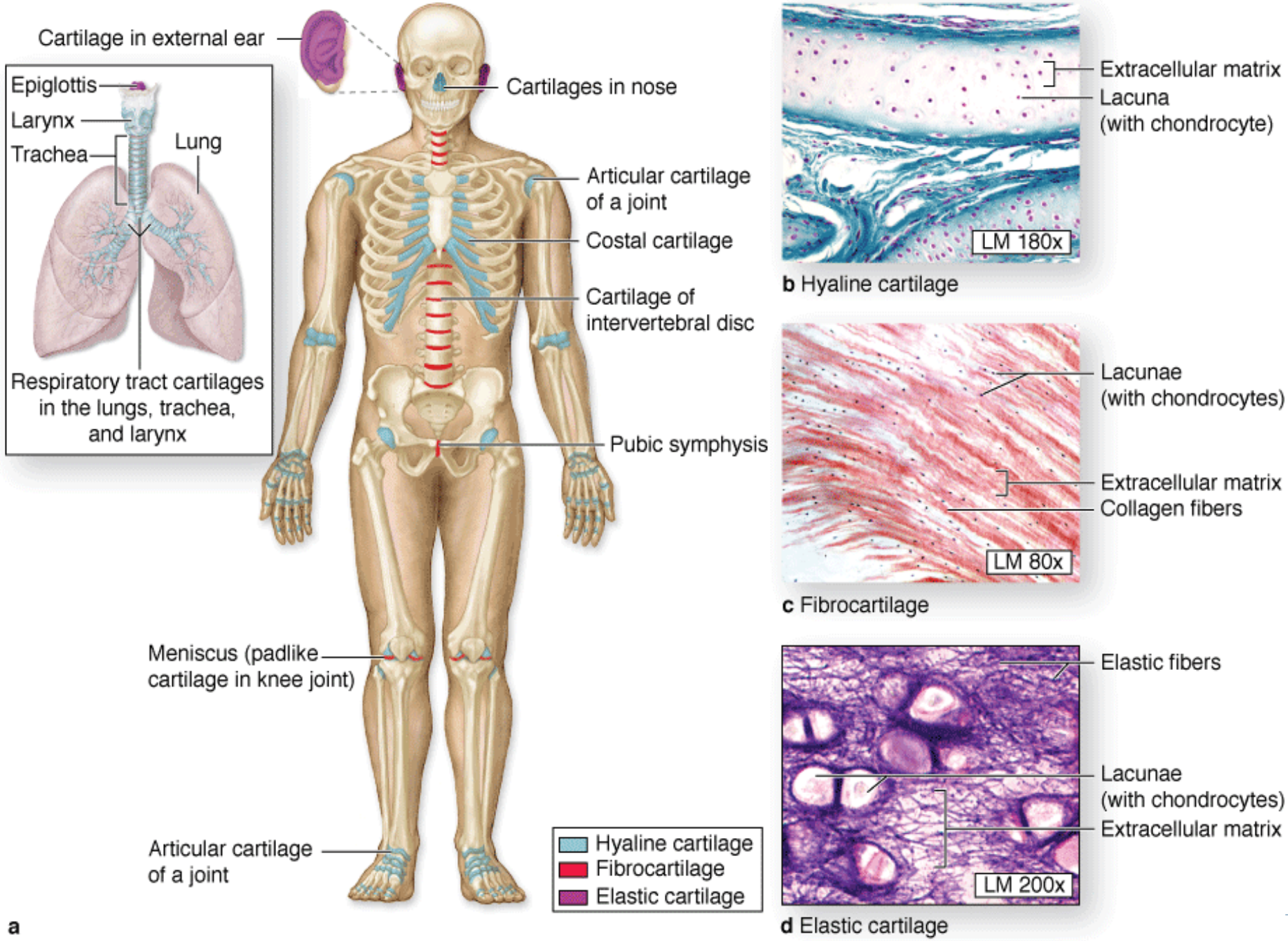
- Cartilage is a tough, flexible form of connective tissue, characterized by an extracellular matrix (ECM) with high concentrations of GAGs and proteoglycans, which interact with collagen and elastic fibers.
- Jelly-like matrix (chondroitin sulfate) containing collagen and elastic fibers and chondrocytes surrounded by a membrane called the perichondrium.
- Unlike other CT, cartilage avascular (has NO blood vessels) or nerves except in the perichondrium.
- The strength of cartilage is due to collagen fibers and the resilience is due to the presence of chondroitin sulfate.
- Chondrocytes occur within spaces in the matrix called lacunae.



perichondrium (P)

Type of cartilage

1. Hyaline cartilage
2. Fibrocartilage
3. Elastic cartilage

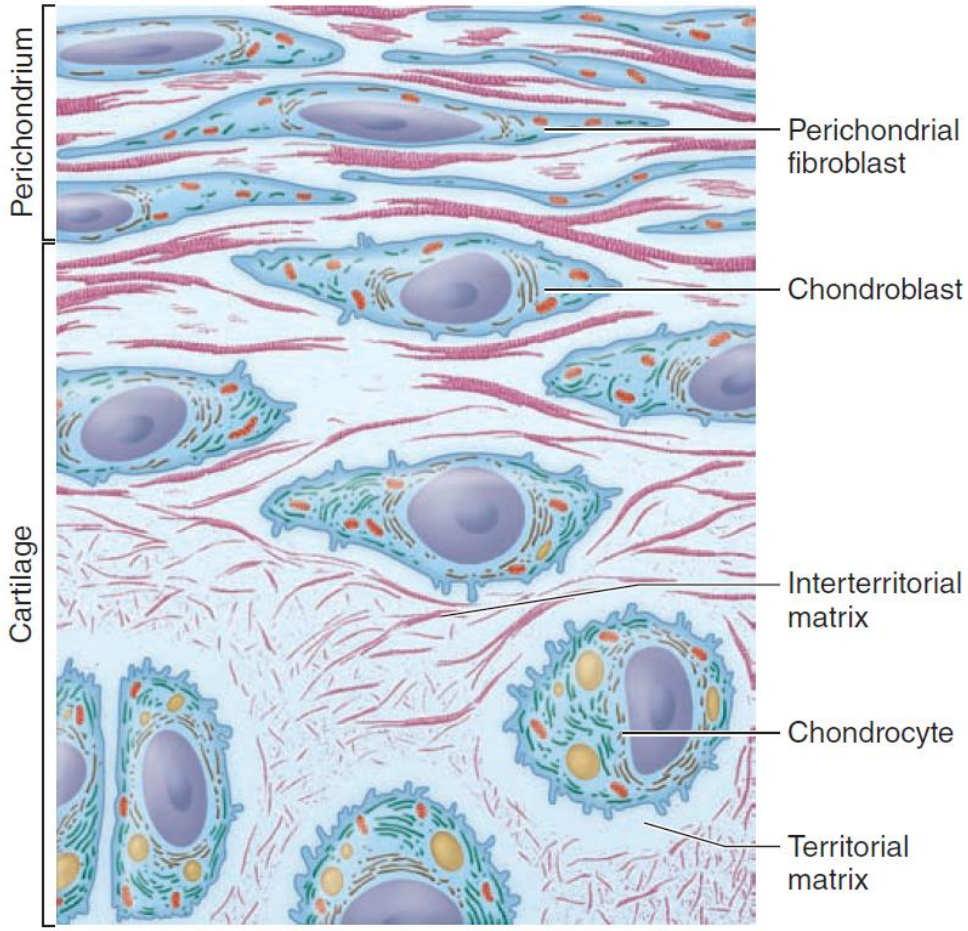

Cartilage in external ear
Epiglottis
Larynx
Trachea
Lung
Respiratory tract cartilages in the lungs, trachea, and larynx
Cartilages in nose
Articular cartilage of a joint
Costal cartilage
Cartilage of intervertebral disc
Pubic symphysis
Meniscus (padlike cartilage in knee joint)
Articular cartilage of a joint
Hyaline cartilage
Fibrocartilage
Elastic cartilage
a
Extracellular matrix
Lacuna (with chondrocyte)
LM 180x
b Hyaline cartilage
Lacunae (with chondrocytes)
Extracellular matrix
Collagen fibers
LM 80x
c Fibrocartilage
Elastic fibers
Lacunae (with chondrocytes)
Extracellular matrix
LM 200x
d Elastic cartilage

Type of Cartilage

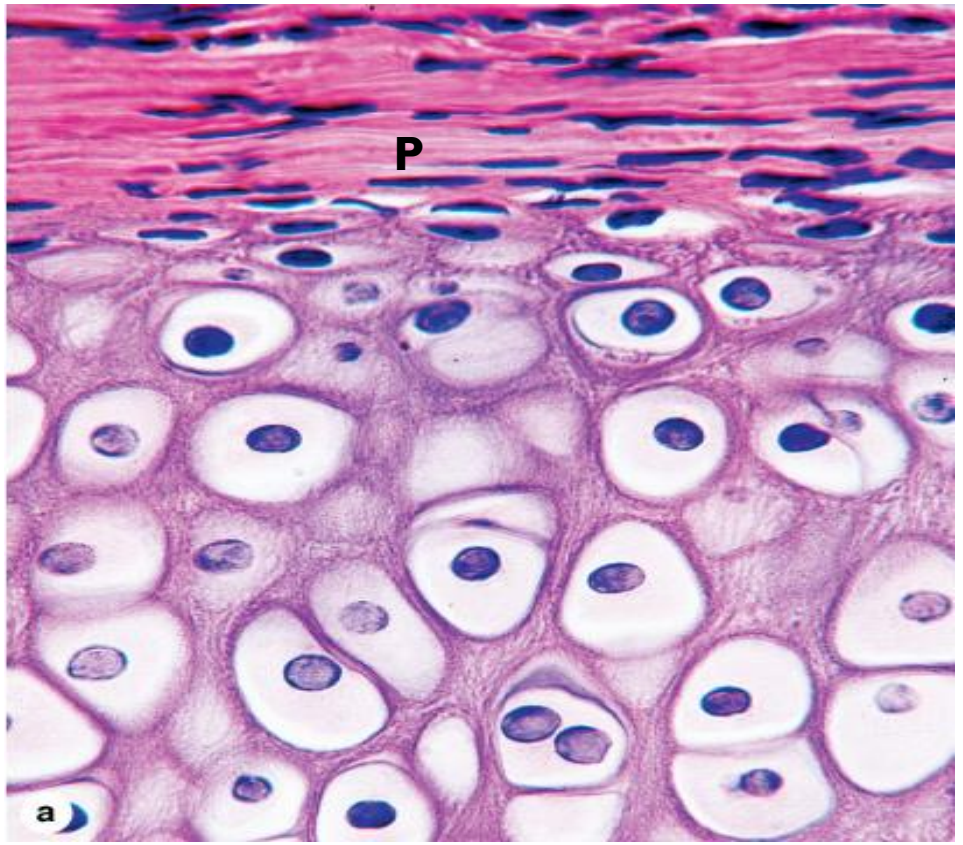
Hyaline Cartilage (most abundant type)

- Fine collagen fibers embedded in a gel-type matrix, occasional chondrocytes inside lacunae.
- Found in embryonic skeleton, at the ends of long bones, in the nose and in respiratory structures.
- Function: flexible, provides support, allows movement at joints

Hyaline Cartilage



A diagram of the transitional area between the perichondrium and the cartilage matrix.

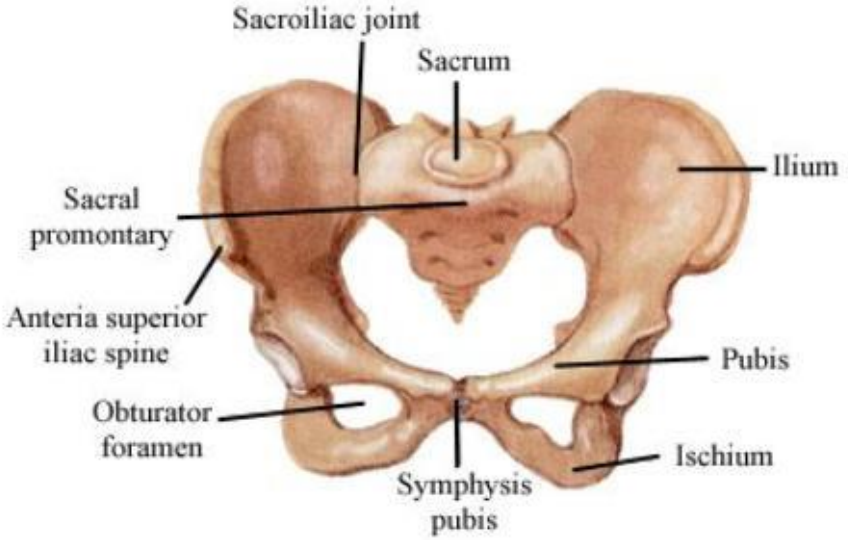


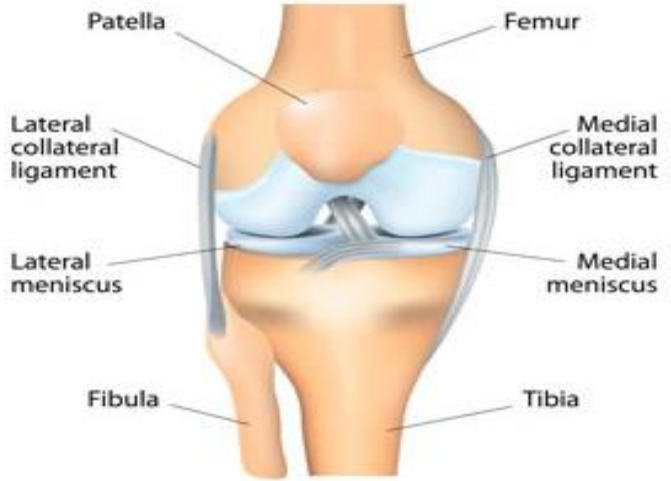
The upper part of the photo shows the more acidophilic perichondrium (P), an example of dense connective tissue consisting largely of type I collagen.

Type of Cartilage

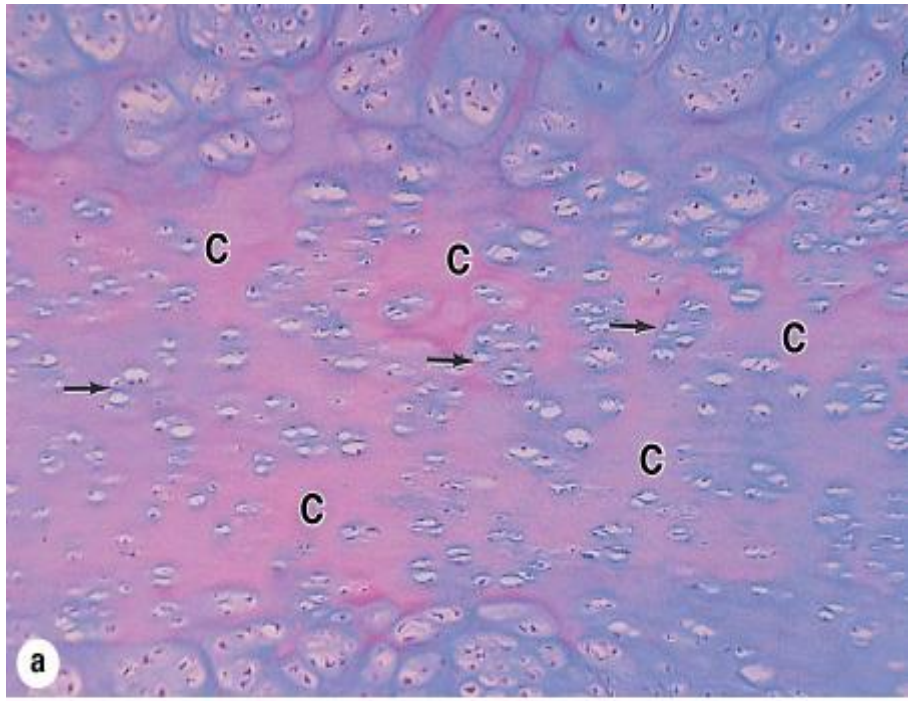
Fibrocartilage

- Contains bundles of collagen in the matrix that are usually more visible under microscopy.
- Found in the pubic symphysis, intervertebral discs, and knee meniscus.
- Function: support and fusion, and absorbs shocks.

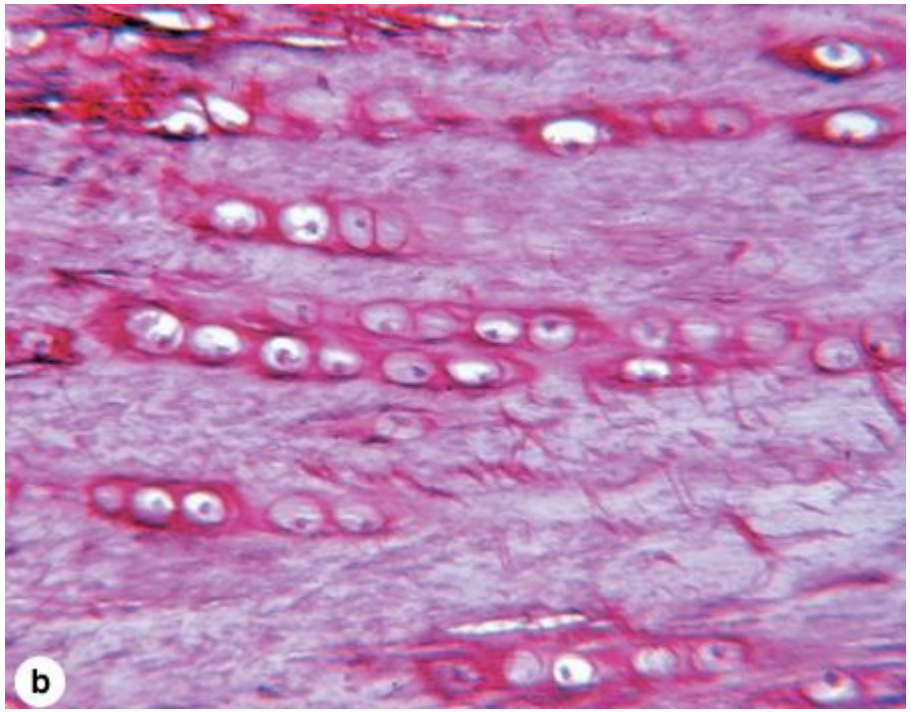




Fibrocartilage



(a) A section of pubic symphysis shows lacunae with isolated and grouped chondrocytes (C) surrounded by matrix (M) and separated in some areas by dense regions (D) containing more concentrated acidophilic type I collagen.

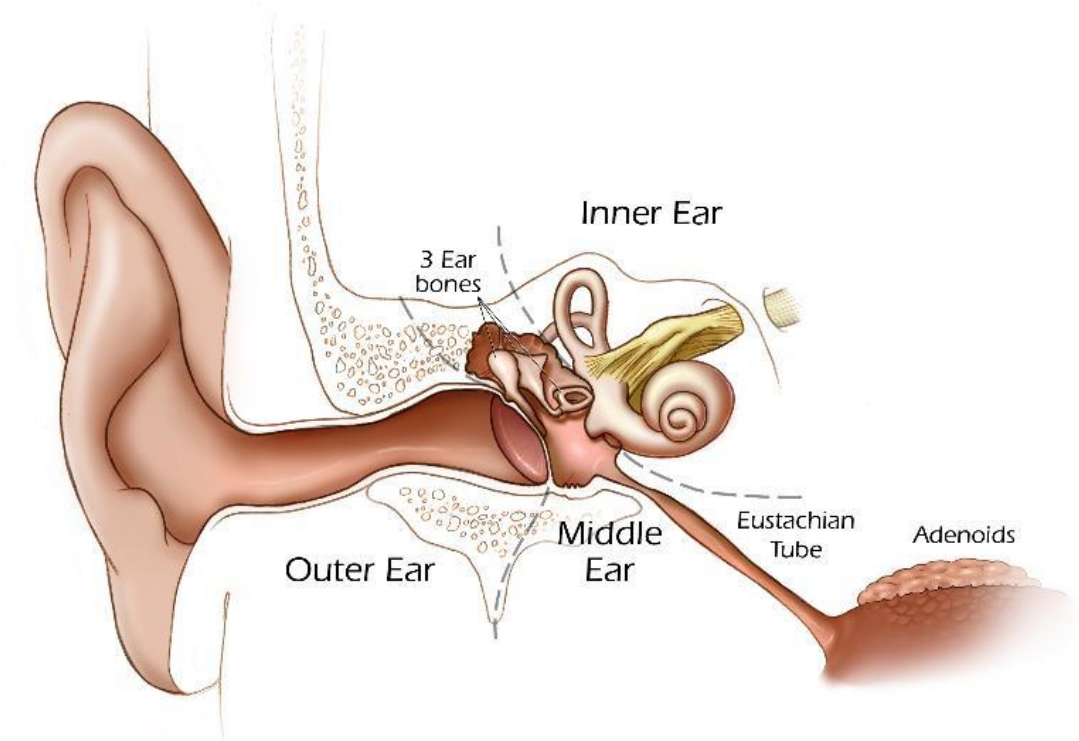


(b) At higher magnification in a small region of intervertebral disc, the axially arranged aggregates of chondrocytes (C) are seen to be surrounded by small amounts of matrix and separated by larger regions with dense collagen (D) and a small number of fibroblasts with elongated nuclei (arrows).

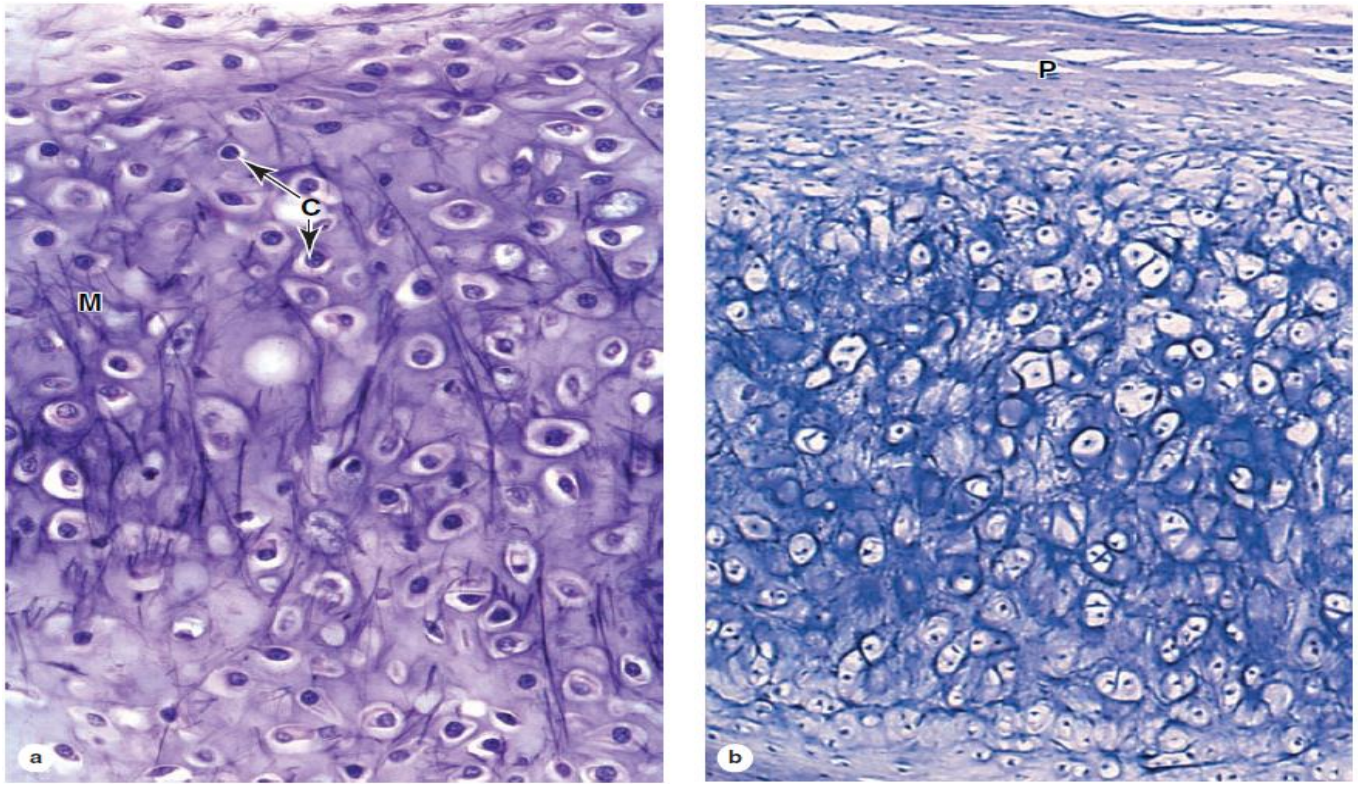
Type of Cartilage

Elastic Cartilage

- Threadlike network of elastic fibers within the matrix.
- Found in external ear, auditory tubes, epiglottis, and the cuneiform cartilage in the larynx.
- Function: gives support, maintains shape, allows flexibility



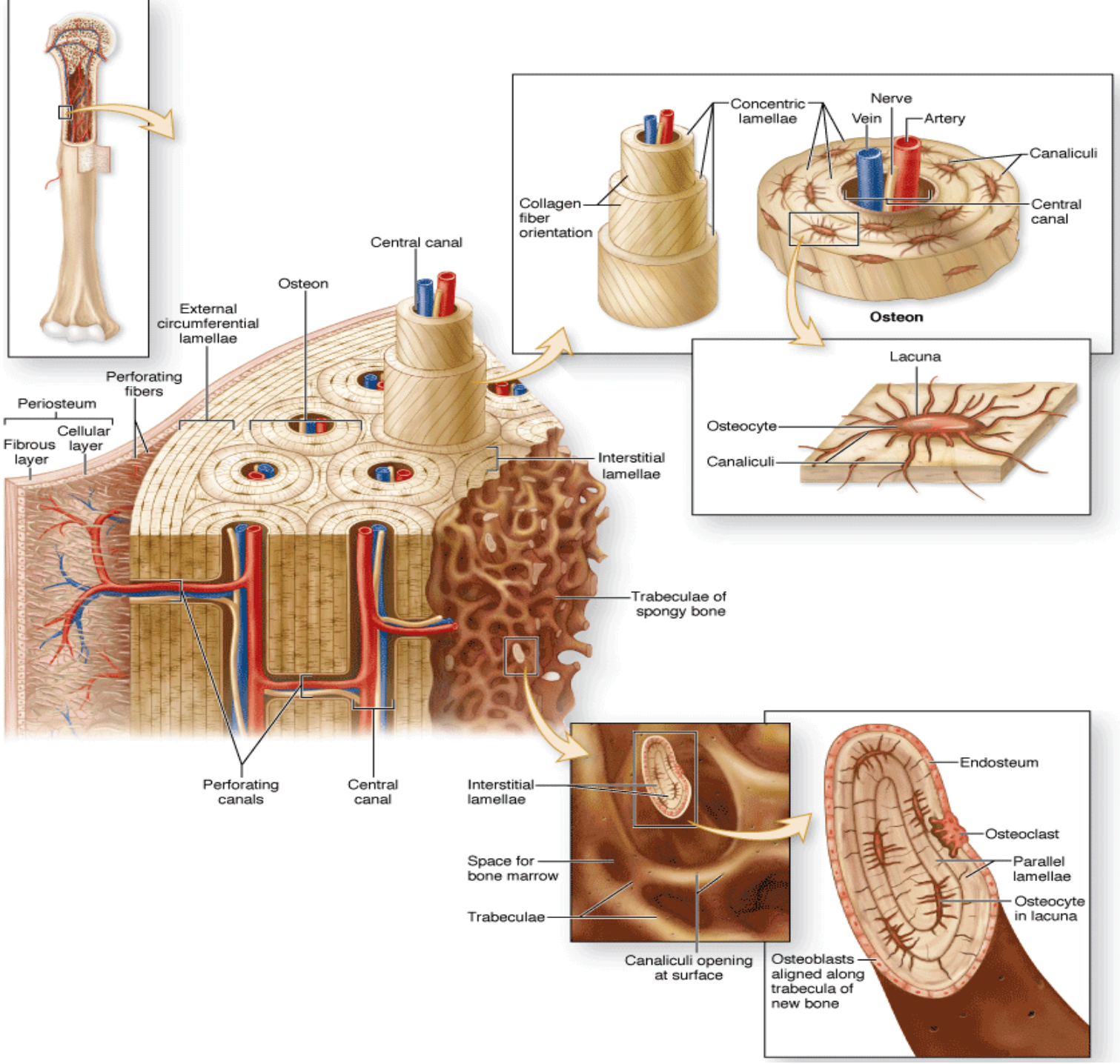
Elastic Cartilage



The chondrocytes (C) and overall organization of elastic cartilage are similar to those of hyaline cartilage. Stains for elastin, however, reveal many dark-staining elastic fibers in the matrix (M), in addition to the major components found in hyaline matrix. Elastic fibers provide greater flexibility to this form of cartilage. The section in part b includes perichondrium (P) that is also similar to that of hyaline cartilage. (a) X160. Hematoxylin and orcein. (b) X100. Weigert resorcin-fuchsin.

Bone

- **Osteocytes** (Gr. *osteon*, bone + *kytos*, cell), which are found in cavities (**lacunae**) between layers (lamellae) of bone matrix
- **Osteoblasts** (*osteon* + Gr. *blastos*, germ), which synthesize the organic components of the matrix
- **Osteoclasts** (*osteon* + Gr. *klastos*, broken), which are multi-nucleated giant cells involved in the resorption and remodeling of bone tissue.



A schematic overview of the basic features of bone, including the three key cell types: **osteocytes, osteoblasts, and osteoclasts**; their usual locations; and the typical **lamellar organization** of bone. Osteoblasts secrete the matrix that then hardens by calcification, trapping the differentiating cells now called **osteocytes** in individual **lacunae**. Osteocytes maintain the calcified matrix and receive nutrients from microvasculature in the central canals of the osteons via very small channels called **canaliculi** that interconnect the lacunae. Osteoclasts are monocyte-derived cells in bone required for bone remodeling.

The **periosteum** consists of dense connective tissue, with a primarily fibrous layer covering a more cellular layer. Bone is vascularized by small vessels that penetrate the matrix from the periosteum. **Endosteum** covers all **trabeculae** around the marrow cavities.

Bone matrix

- **Inorganic material** represents about 50% of the dry weight of bone matrix.
- Calcium hydroxyapatite is most abundant, but bicarbonate, citrate, magnesium, potassium, and sodium ions are also found.
- Significant quantities of amorphous (noncrystalline) calcium phosphate are also present.
- **The organic matter** embedded in the calcified matrix includes type I collagen, proteoglycan aggregates, and bonespecific multiadhesive glycoproteins such as osteonectin.
- Calcium-binding glycoproteins, notably osteocalcin, and the phosphatases released in matrix vesicles by osteoblasts promote calcification of the matrix.
- The association of minerals with collagen fibers during calcification is responsible for the hardness and resistance of bone tissue.

https://www.youtube.com/watch?v=8cIm_tN_qds

http://www.youtube.com/watch?v=Tkf8-xbWeHY

http://www.youtube.com/watch?v=RIuwQ7f8zSw