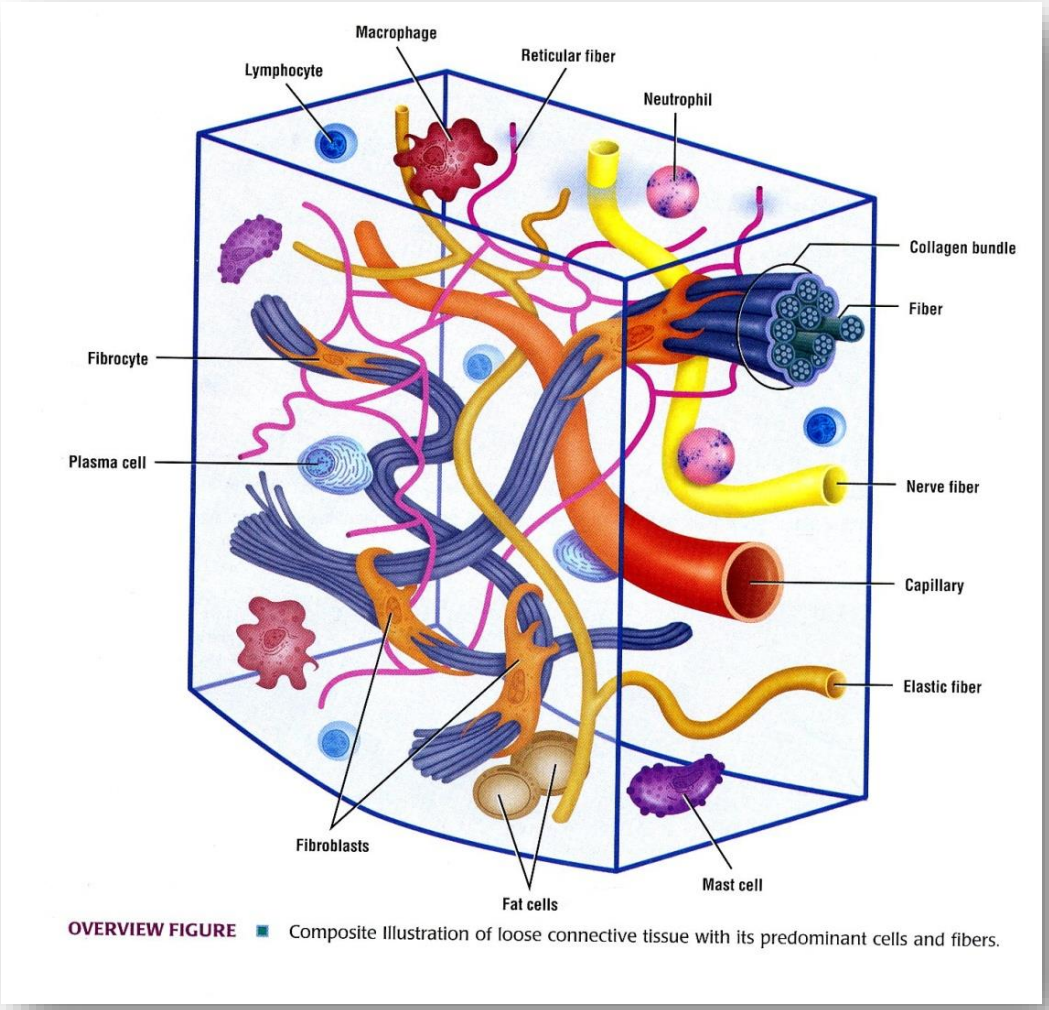
# Connective tissue



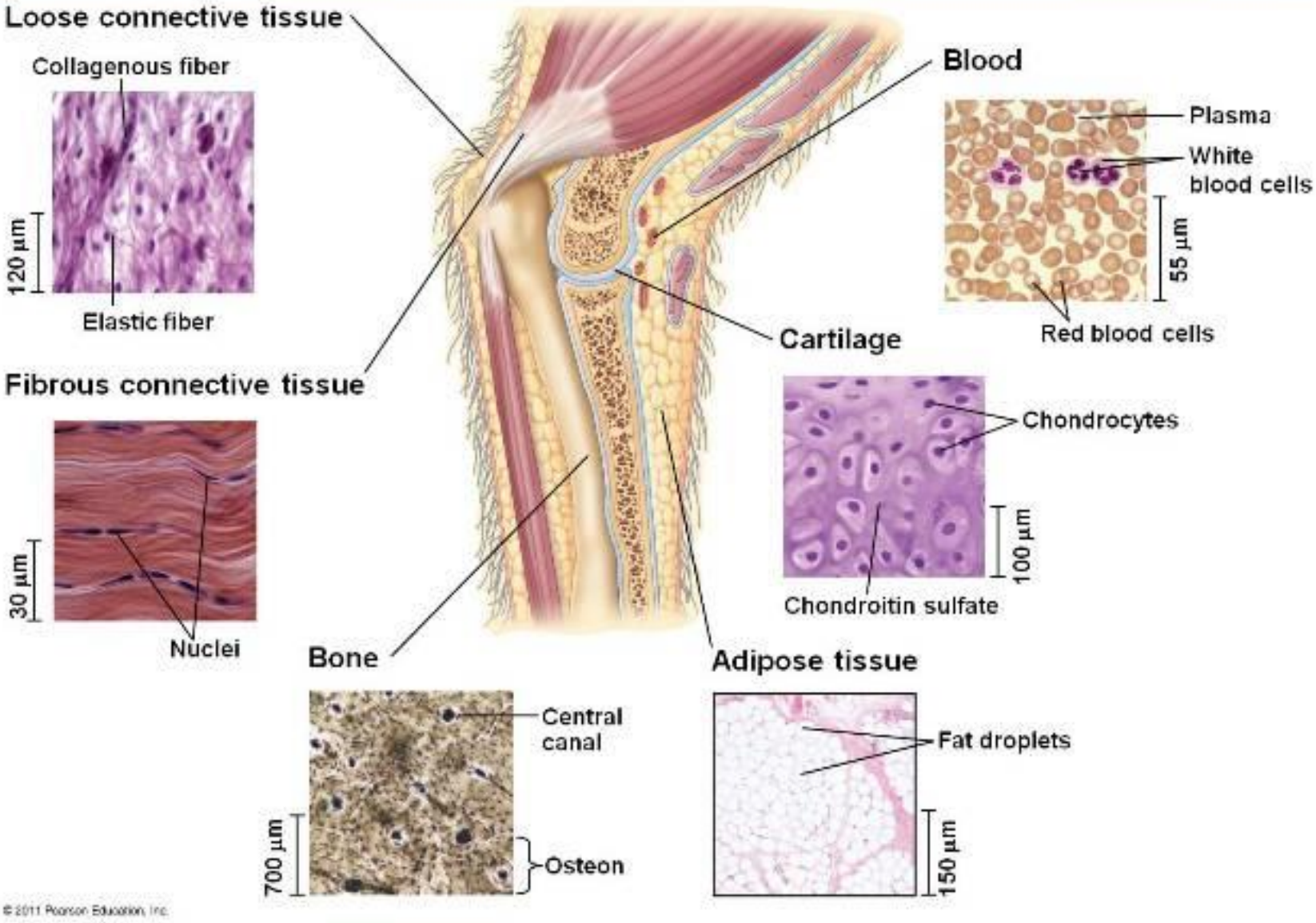

**OVERVIEW FIGURE** ■ Composite Illustration of loose connective tissue with its predominant cells and fibers.

# General properties of connective tissue

1. **One of the four basic types of tissues**

2. **Composition:**
   - cells (fibroblasts and others),
   - fibers
   - Ground substance (extracellular matrix)
3. **Functions:**
   - Architectural framework of the body
   - Bind together and provide mechanical support for other tissue (metabolic, defense, transport, storage)
   - Wound repair / inflammatory response

# Connective Tissue



# Ground substance

## Chondroitin sulfate:

**jellylike ground substance of cartilage, bone and skin.**

## Dermatin sulfate :

**Skin , Cardiovascular system .**

## Keratin sulfate :

**Fibrous cartilage**

## Heparine sulfate :

**Lung , Liver , Basal lamina , skin.**

# Ground substance

**Proteins in Matrix :**

**1.chondronectin**

**2.Laminin**

**3.Fibronectin**

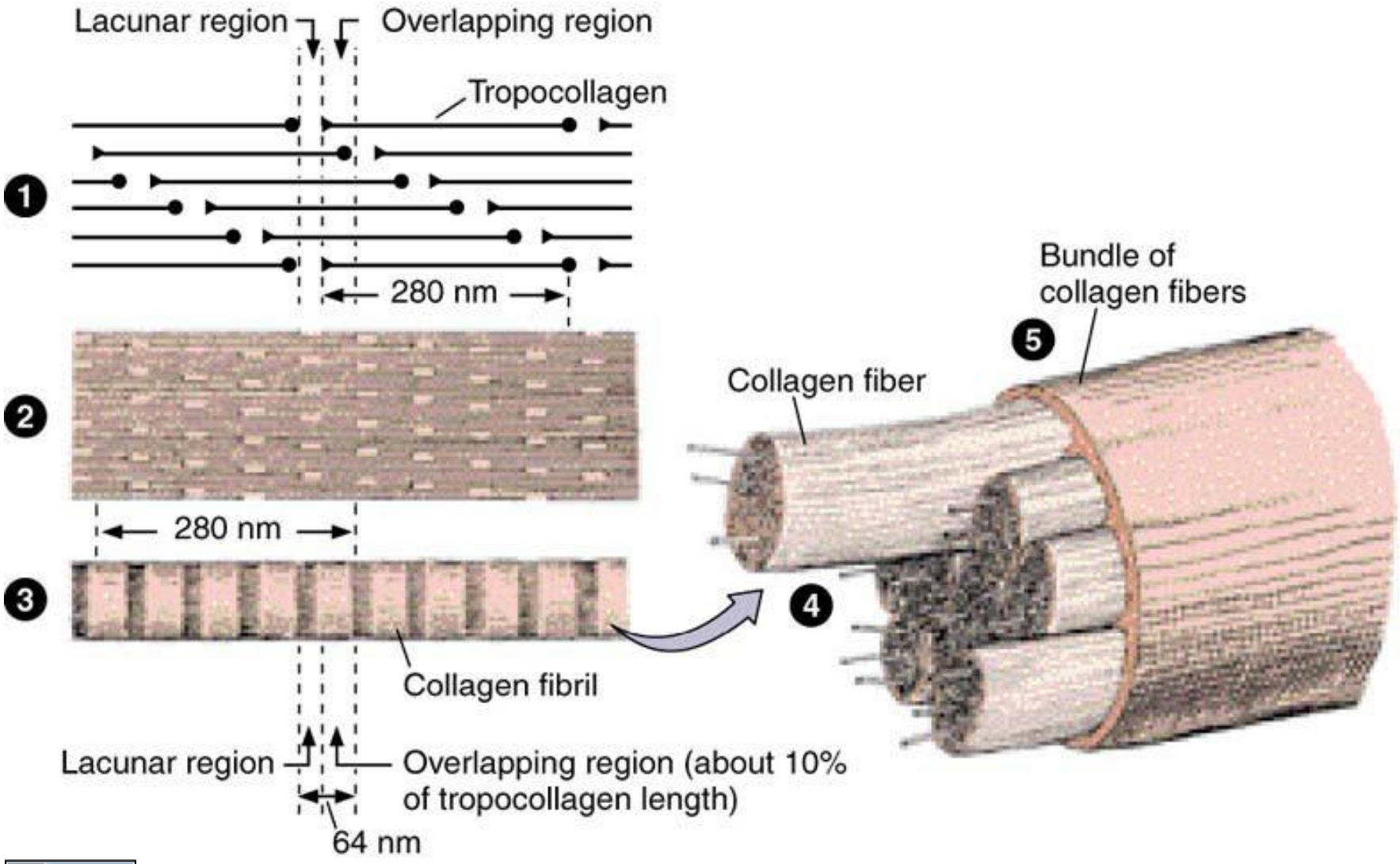
# Fibers in connective tissue

**Collagen**

**Reticular Fibers**

**Elastic Fibers**

# Assembly of collagen fiber bundles



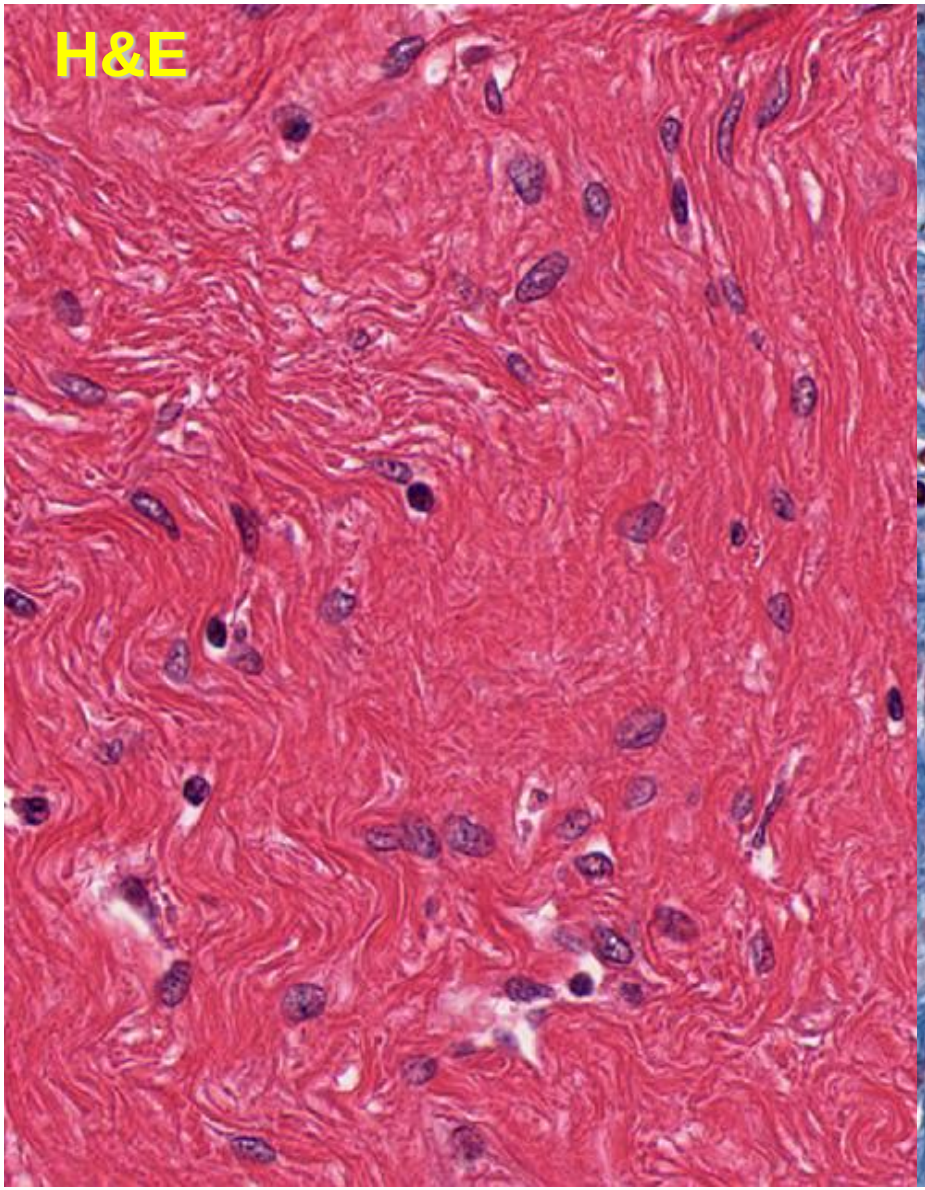



Junquiera and Carneiro. *Basic Histology*. Tenth Edition. 2003. Figure 5-19.

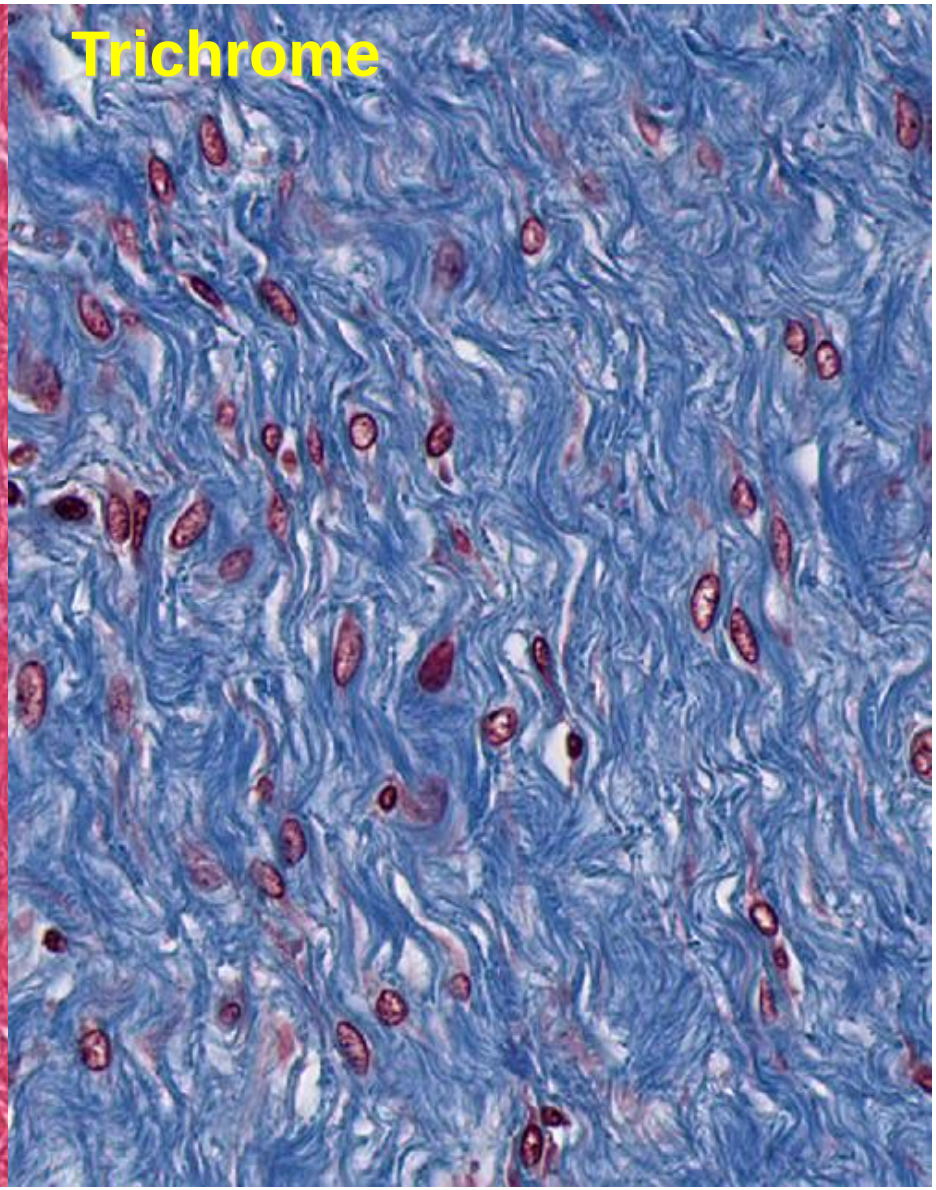
# Major collagen fiber types (out of at least 20)

| Collagen Type | Tissues | Function |
|---|---|---|
| **Fibril-forming collagens** (these are visible) | | |
| I (most abundant) | Skin, tendon, bone, dentin | Resistance to tension |
| II | Cartilage, vitreous of eye | Resistance to pressure |
| III (reticulin) | Skin, muscle, blood vessels, liver, etc. | Structural framework and stability |
| Network-forming collagens | | |
| IV | All basement membranes | Support and filtration |
| Fibril-associated collagens with interrupted triple helices (FACIT) | | |
| VI, IX | Assoc. w/ type I and II fibrils | Fibril-fibril / fibril-ECM binding |
| Anchoring filament collagens | | |
| VII | Epithelia | Epidermis to basal lamina |

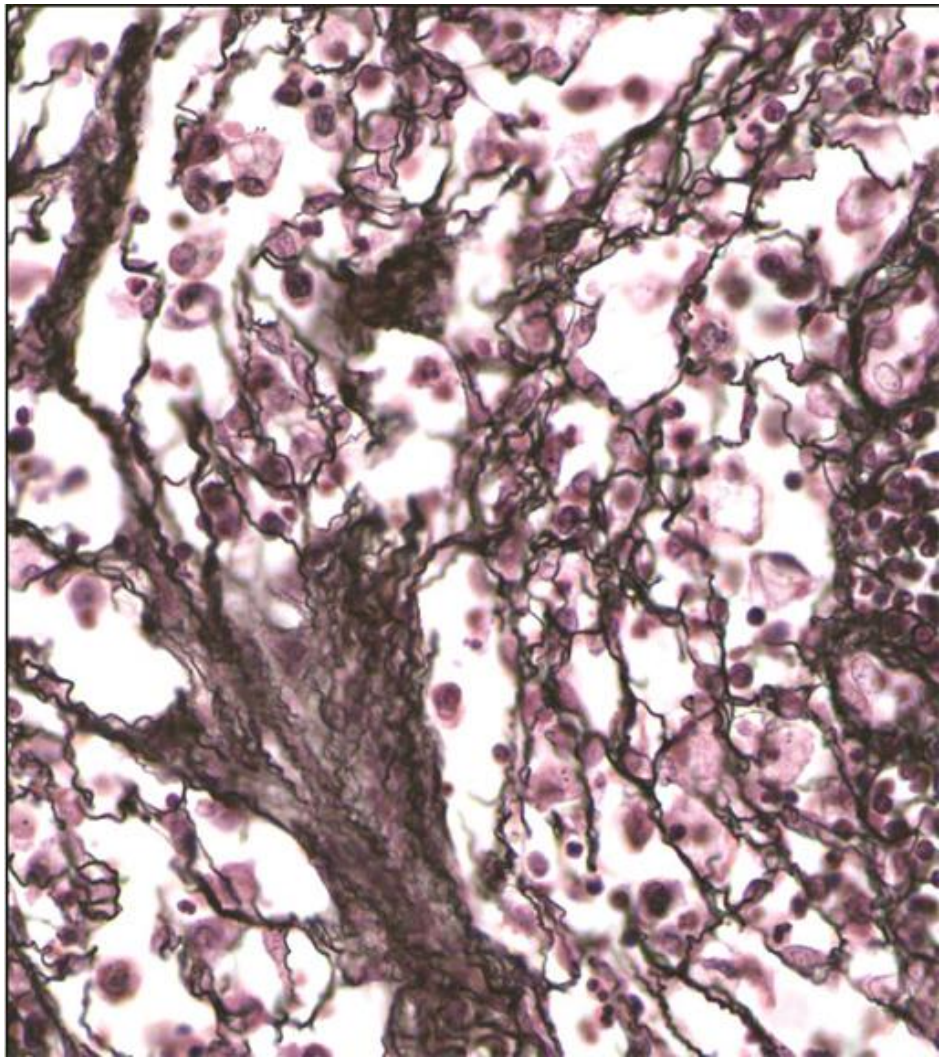
# Collagen fibers viewed by light microscopy





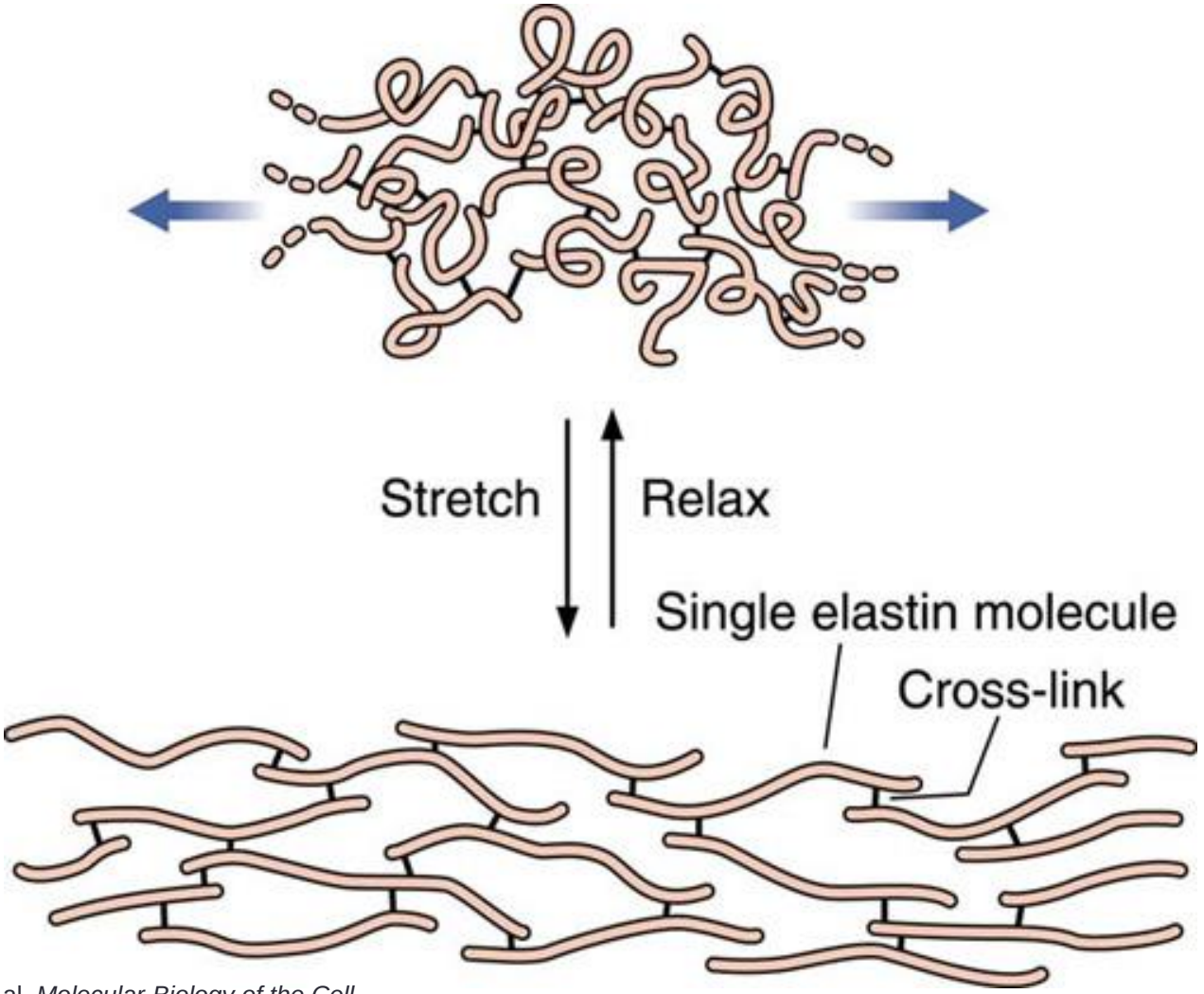
# Reticular (reticulin) fibers





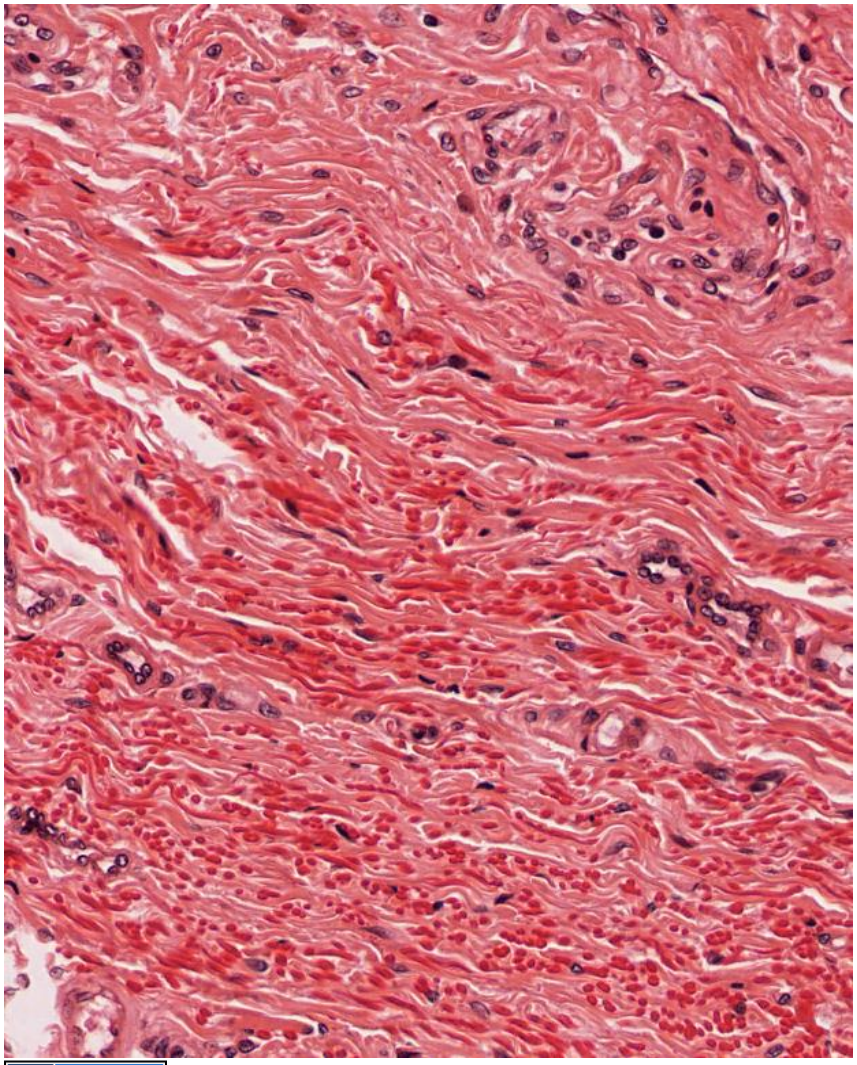
- Form a delicate supporting framework for highly cellular tissues (endocrine glands, lymph nodes, liver, bone marrow, spleen, smooth muscle).
- Composed mainly of Type III collagen, with a carbohydrate moiety that reduces Ag+ to metallic sliver = argyrophilic.
- Special stain: silver impregnation to visualize.
- Thinner than type I collagen
  (Type III fibrils are 30-40 nm diameter; type I fibrils are ~200 nm diameter)

# Network of elastin molecules can stretch and recoil like a rubber band



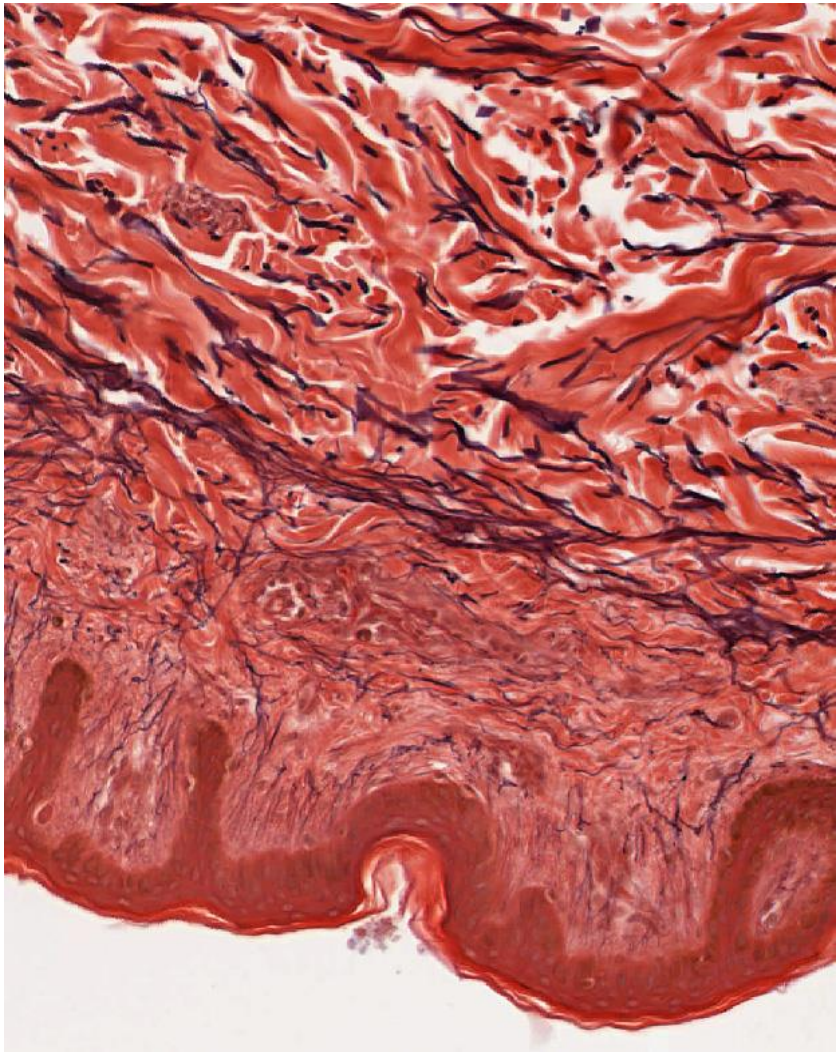

 Alberts et. al. *Molecular Biology of the Cell*.

# Elastic and collagen fibers



PD-INEL University of Michigan Histology Collection

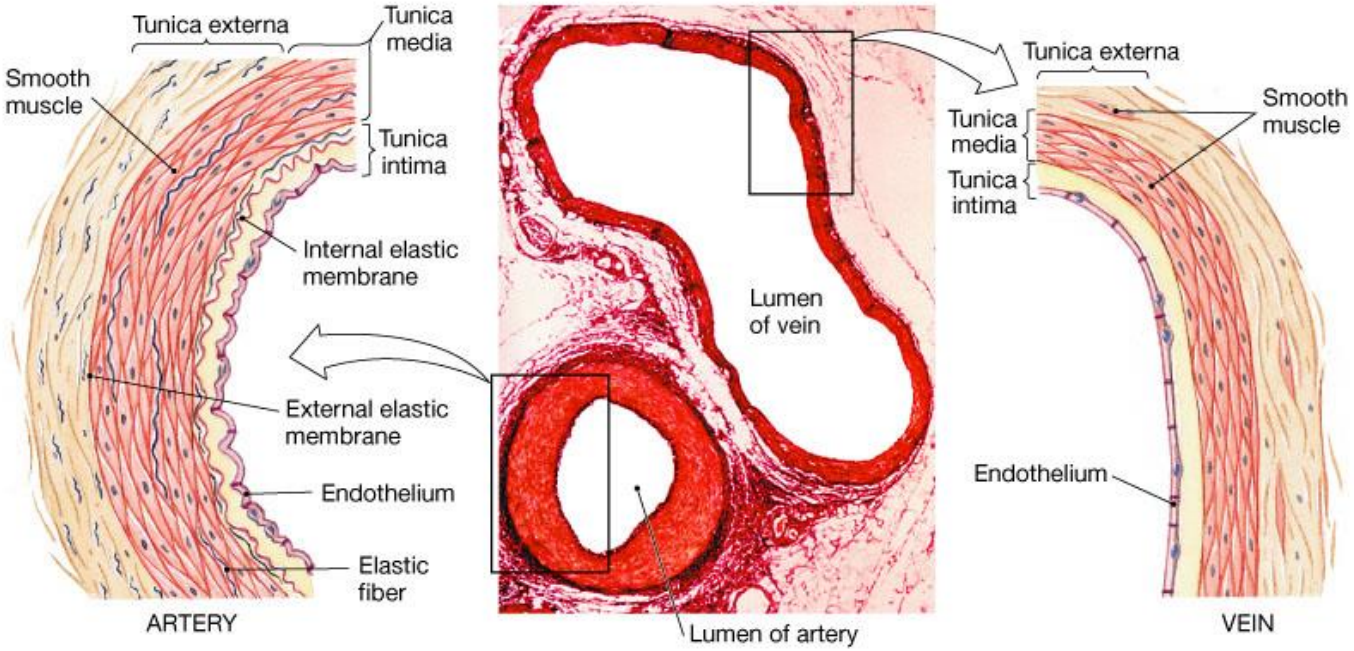
H&E stain: collagen stains ***orange/pink***; elastic fibers stain ***glassy red*** (generally only visible if in HIGH abundance)



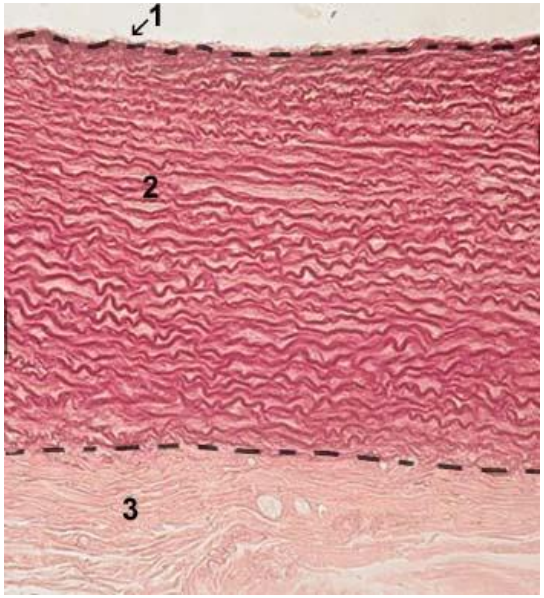
PD-INEL University of Michigan Histology Collection

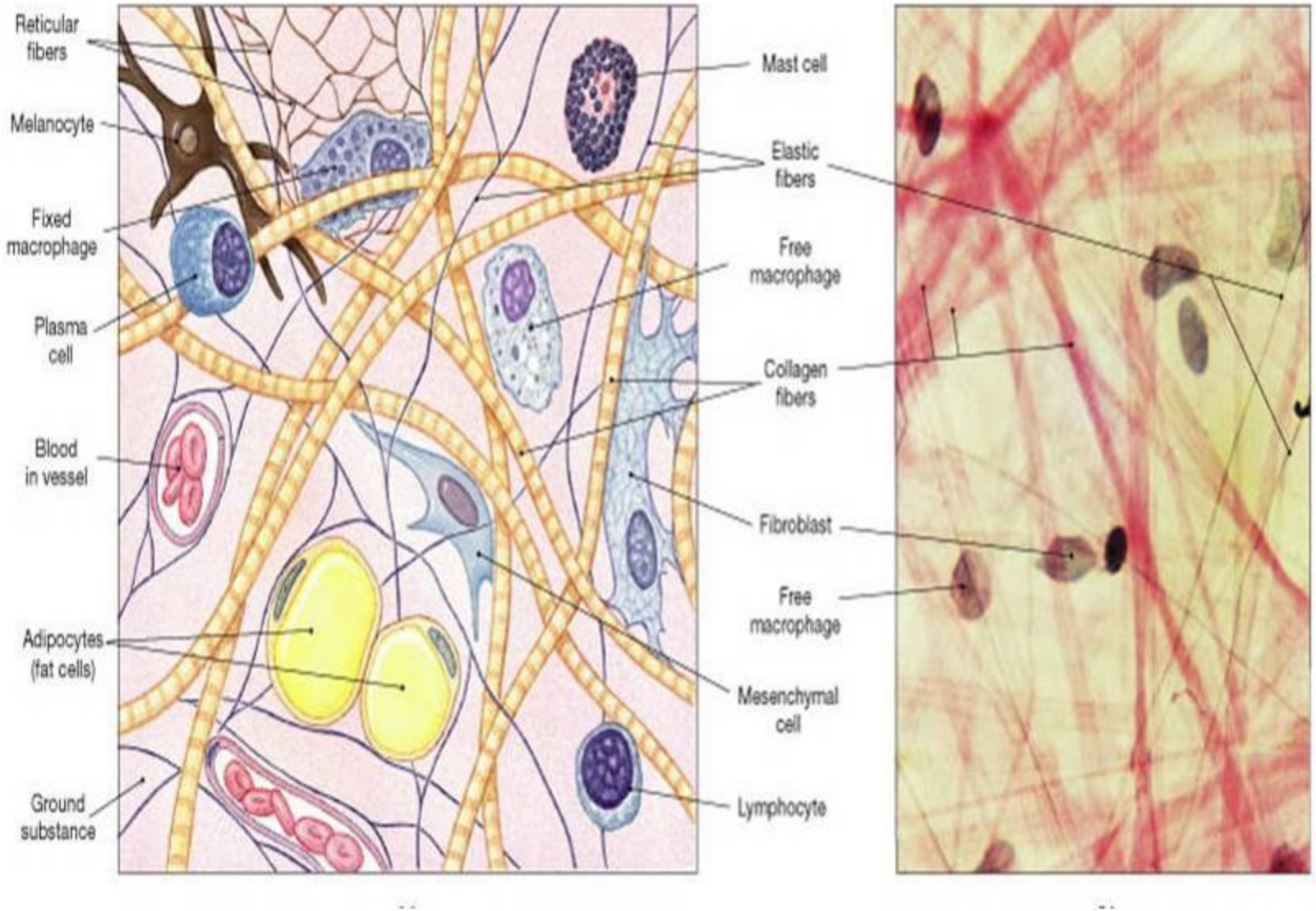
**elastin stain ("Weigert's", "aldehyde fuchsin", "Verhoeff"): elastic fibers are *purple/black***

**collagen fibers stain *orange/pink* or blue/green depending o other stains used (von Gieson's or trichrome, respectively)**






Reticular fibers
Melanocyte
Fixed macrophage
Plasma cell
Blood in vessel
Adipocytes (fat cells)
Ground substance
Mast cell
Elastic fibers
Free macrophage
Collagen fibers
Fibroblast
Free macrophage
Mesenchymal cell
Lymphocyte

# True connective tissue cells

**Mesenchymal**

**Fibroblasts: Secrete both fibers and ground substance of the matrix (wandering)**

**Fibrocyte**

**Reticular**

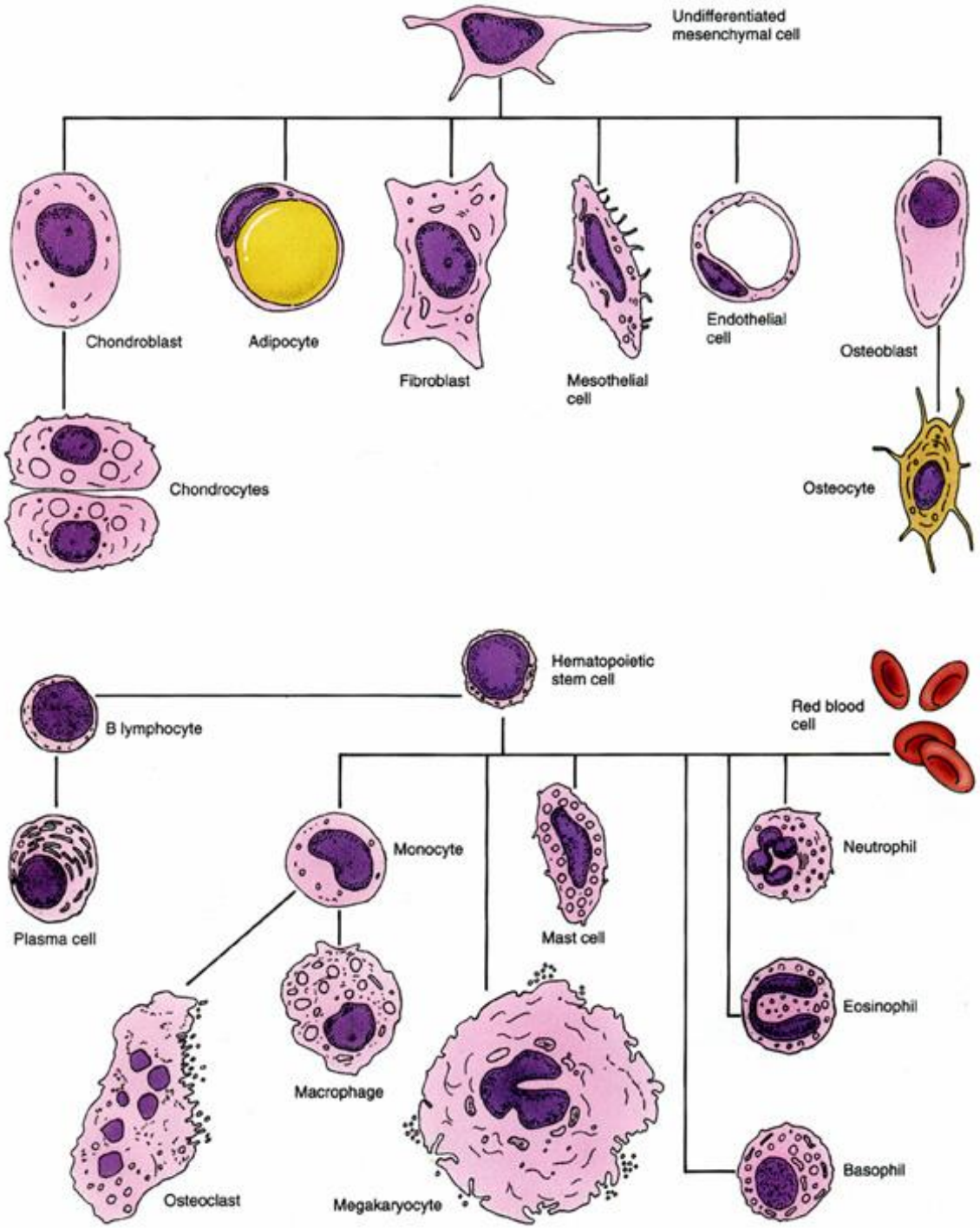
**Macrophages: Phagocytes that develop from monocytes (wandering or fixed)**

# True connective tissue cells

**Plasma Cells: Antibody secreting cells that develop from B Lymphocytes (wandering)**

**Mast Cells: Produce histamine that help dilate small blood vessels in reaction to injury (wandering)**

**Adipocytes: Fat cells that store triglycerides, support, protect and insulate (fixed)**


Undifferentiated mesenchymal cell
Chondroblast
Adipocyte
Fibroblast
Mesothelial cell
Endothelial cell
Osteoblast
Chondrocytes
Osteocyte
Hematopoietic stem cell
B lymphocyte
Red blood cell
Plasma cell
Monocyte
Mast cell
Neutrophil
Eosinophil
Macrophage
Osteoclast
Megakaryocyte
Basophil

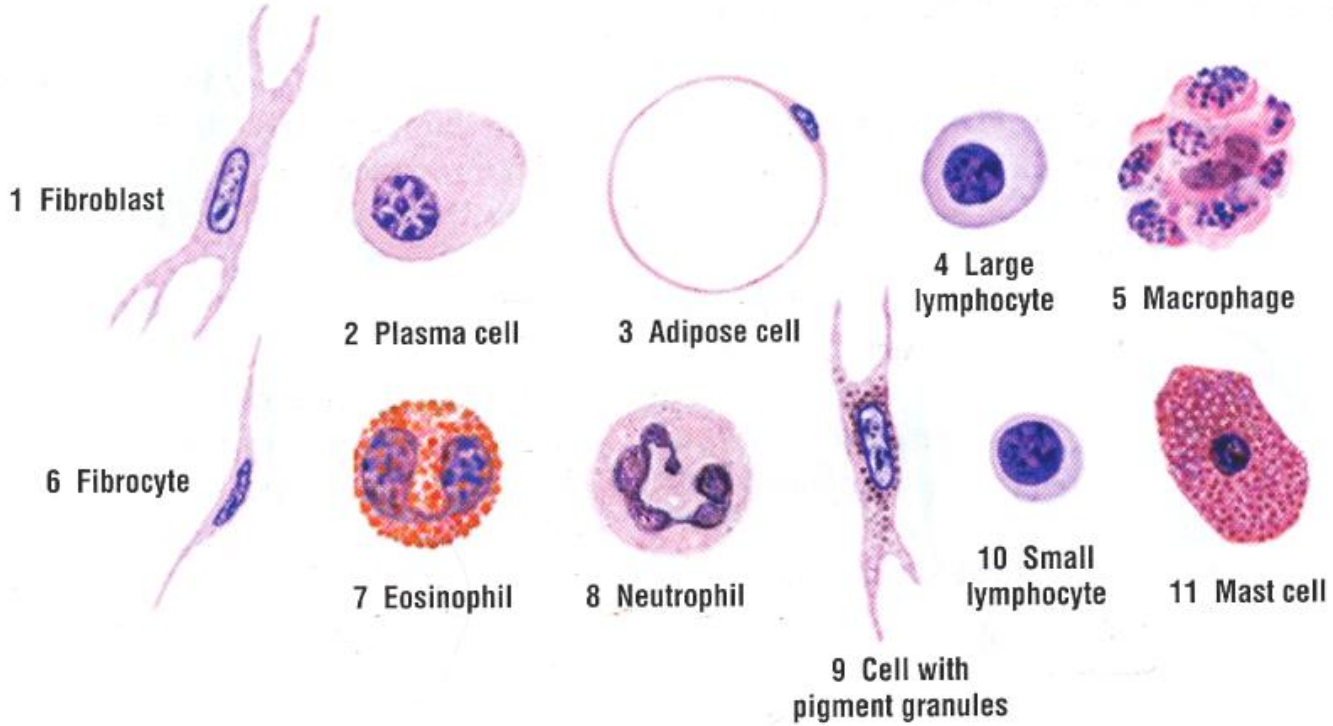
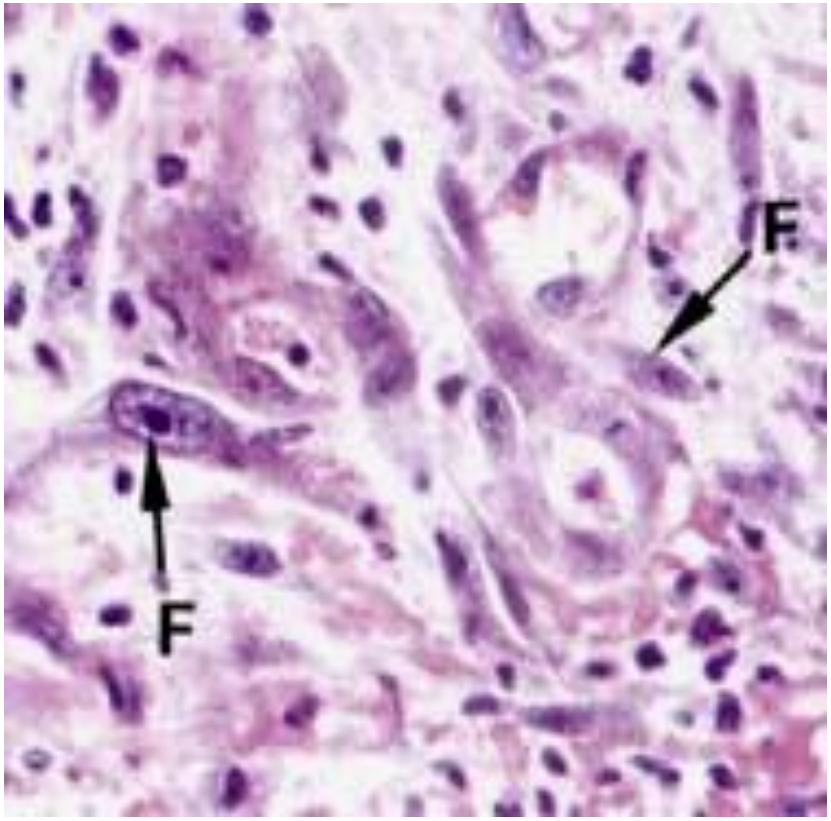
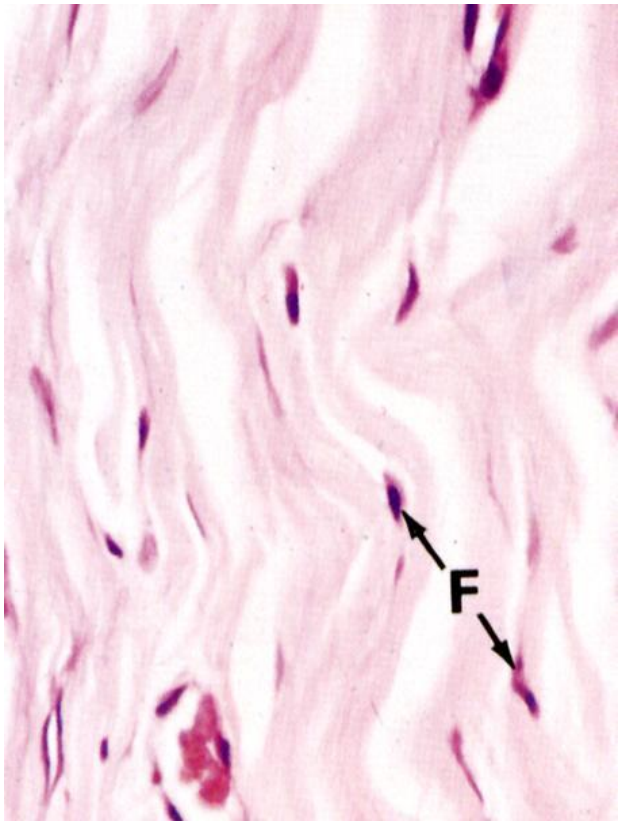



**FIGURE 3.2** ■ Cells of the connective tissue. Stain: hematoxylin and eosin. High magnification and/or oil immersion.

# Fibroblasts and Fibrocyte

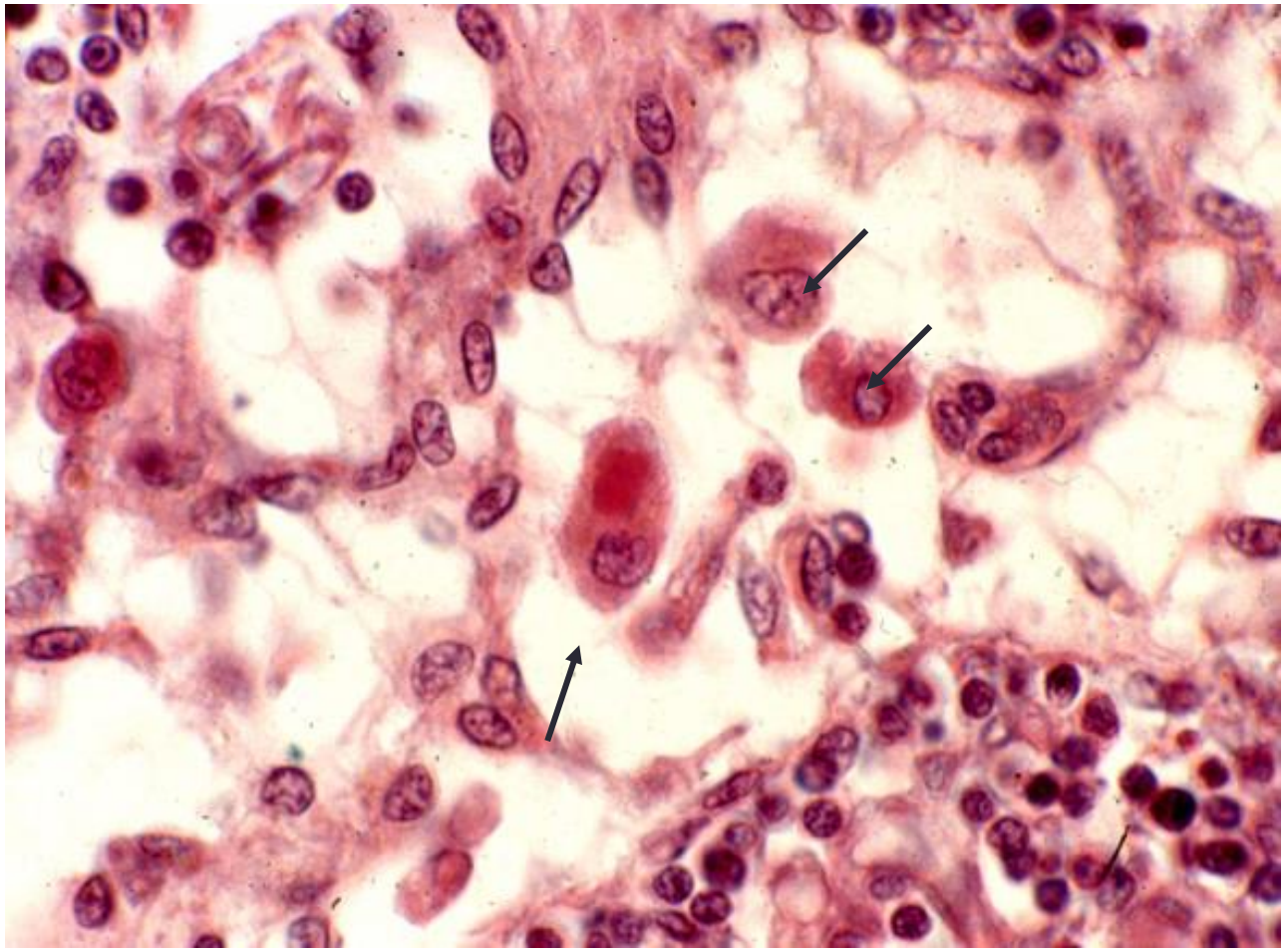




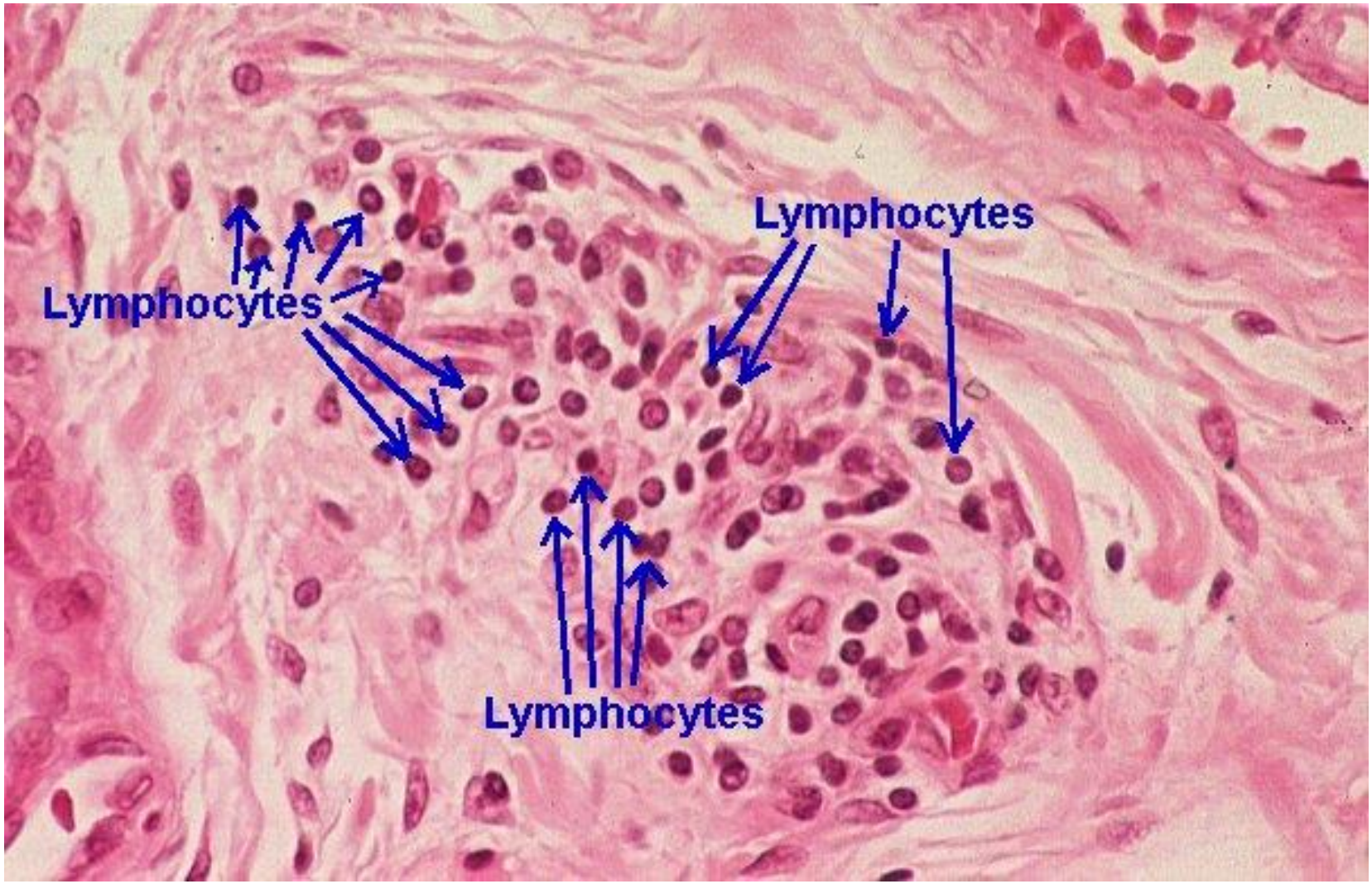

(Both images) Ross, M. Pawlina, W. *Wheater's Functional Histology: A Text and Atlas*. Fifth Edition. 2006.

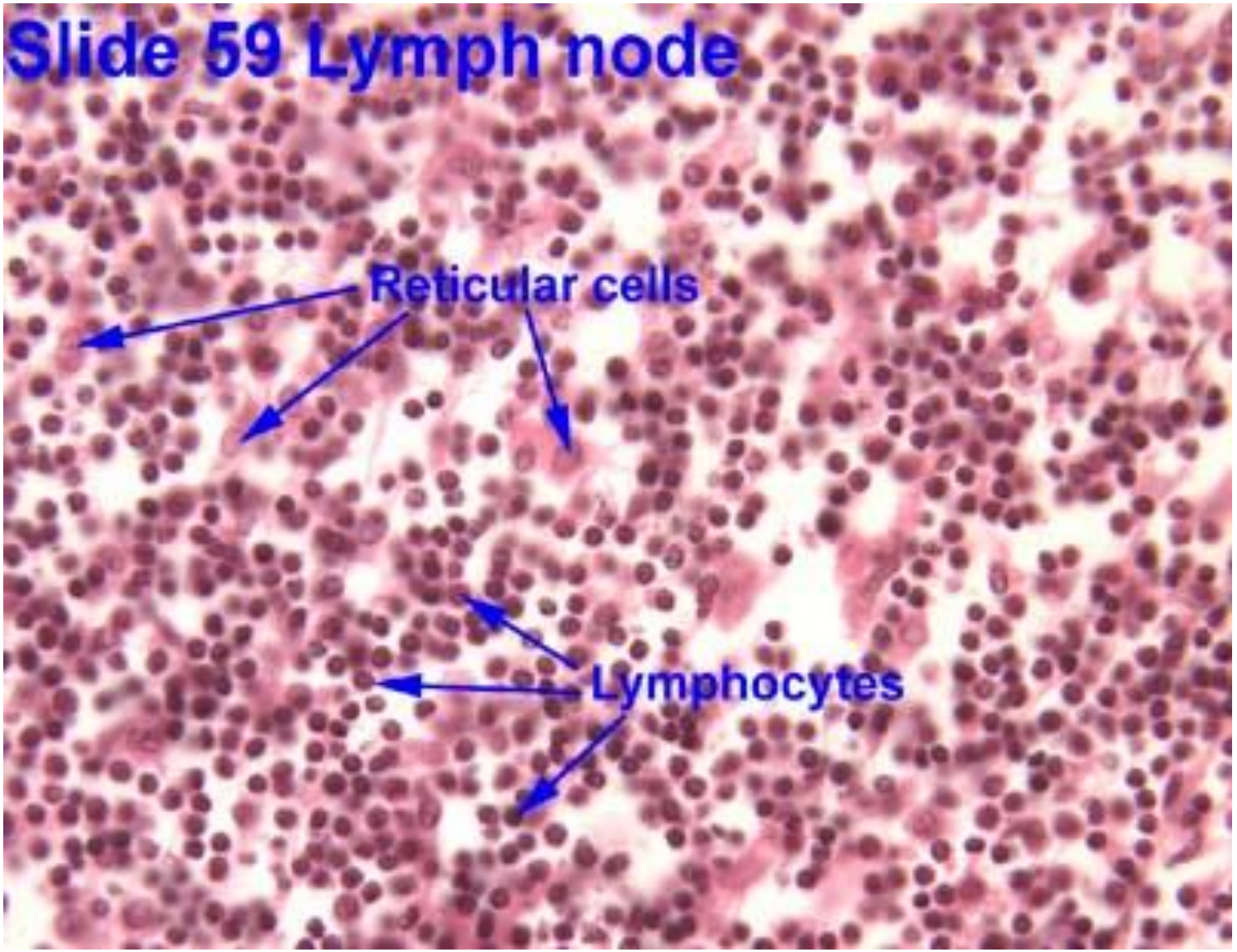
# Monocytes escape from blood vessels into connective tissue where they differentiate into macrophages



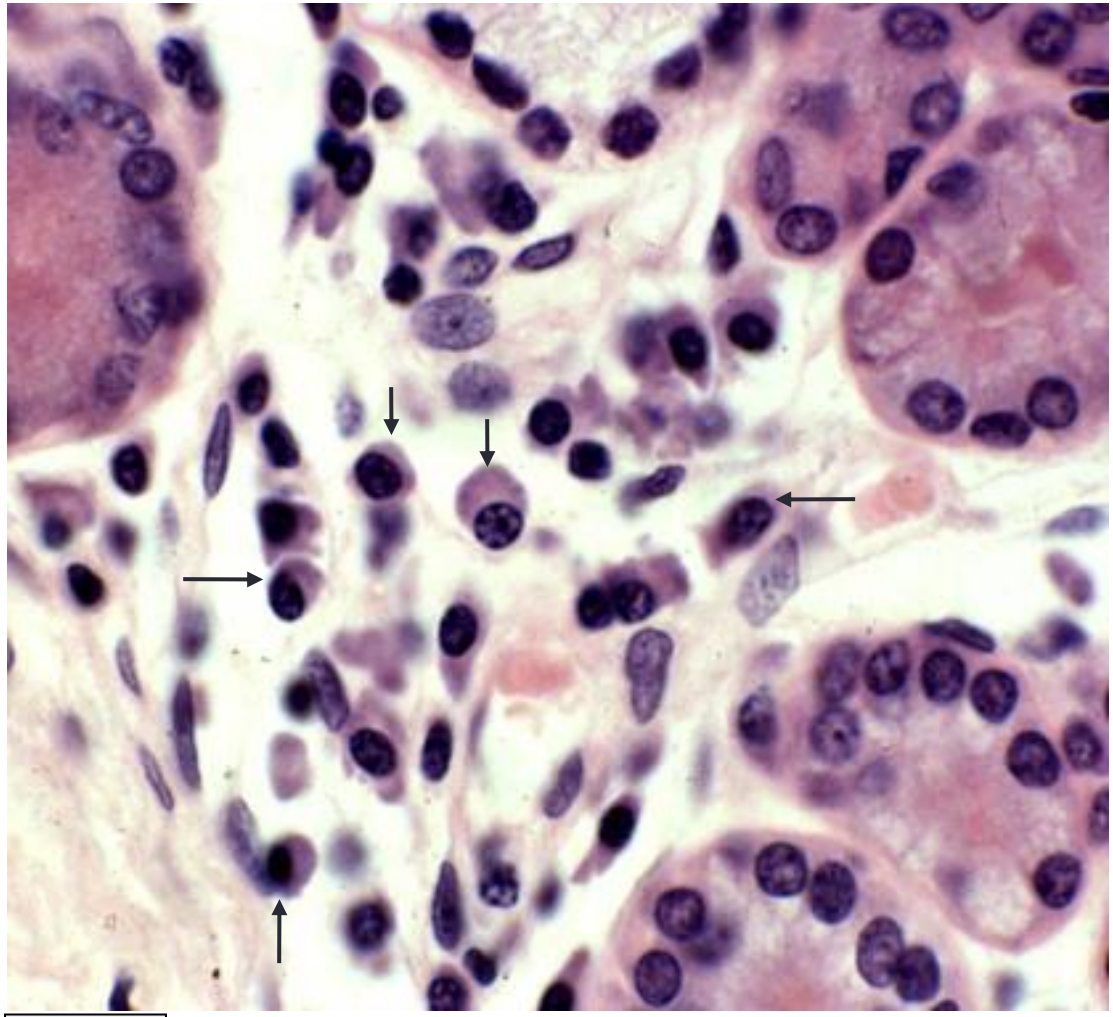


Primary function: phagocytosis and antigen presentation


Lymphocytes
Lymphocytes
Lymphocytes

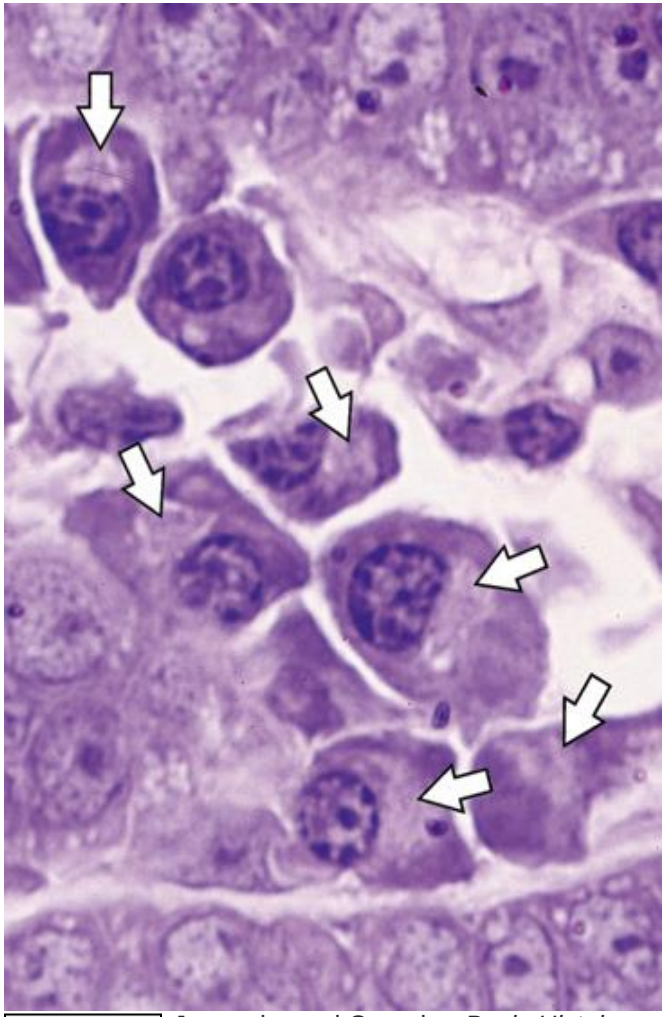

Slide 59 Lymph node
Reticular cells
Lymphocytes

# Plasma cells are mature B lymphocytes that constitutively secrete antibodies



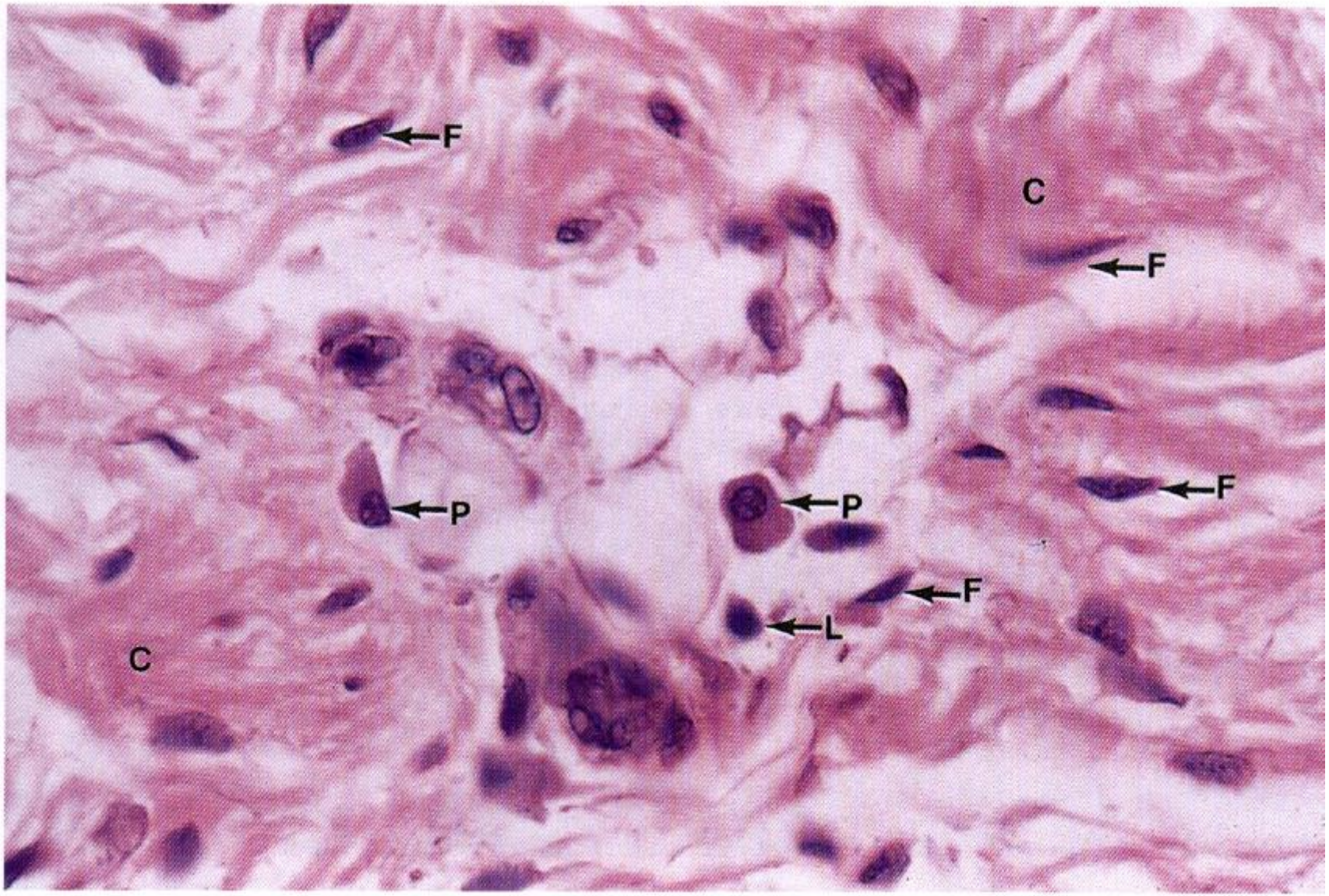
PD-INEL University of Michigan Histology Collection

Black arrows indicate several plasma cells



PD-INEL Junqueira and Carneiro. *Basic Histology*. Tenth Edition. 2003. Figure 6.5.

White arrows = Golgi regions


F
C
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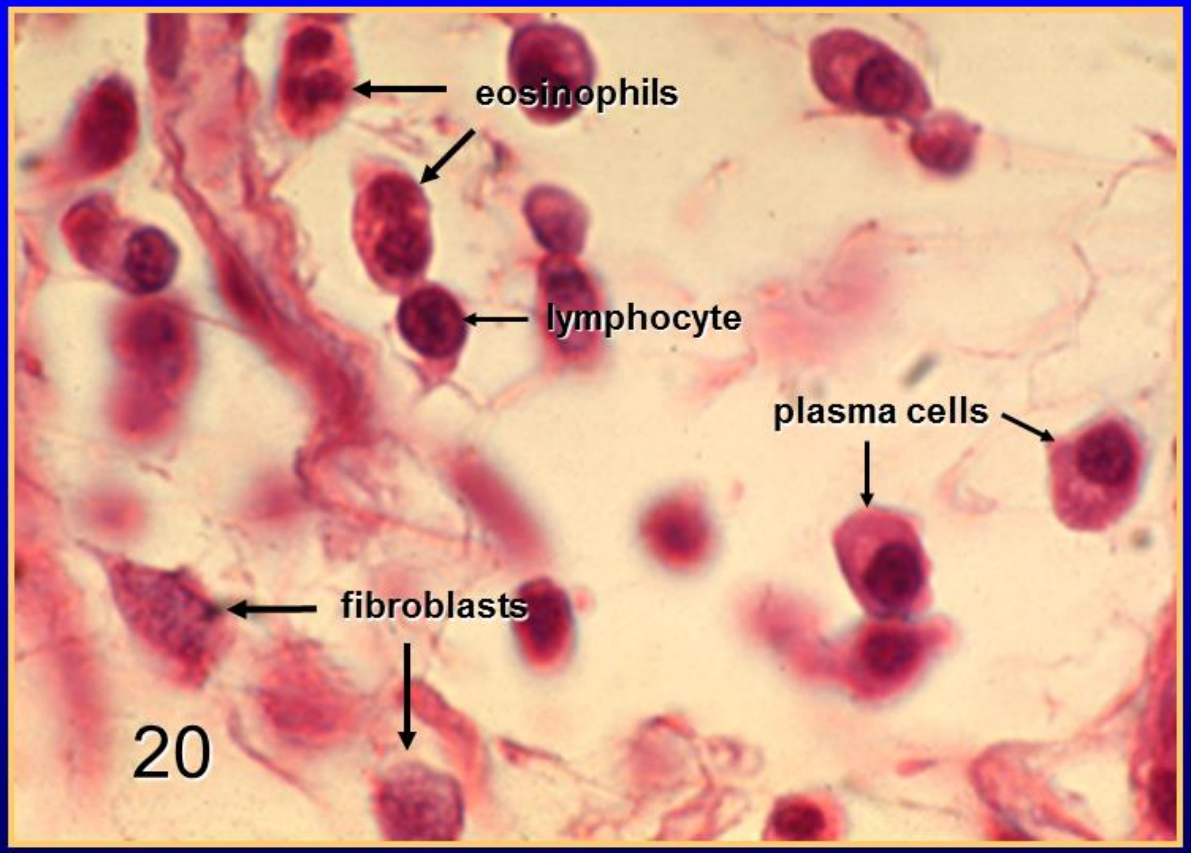
# Loose Connective Tissue

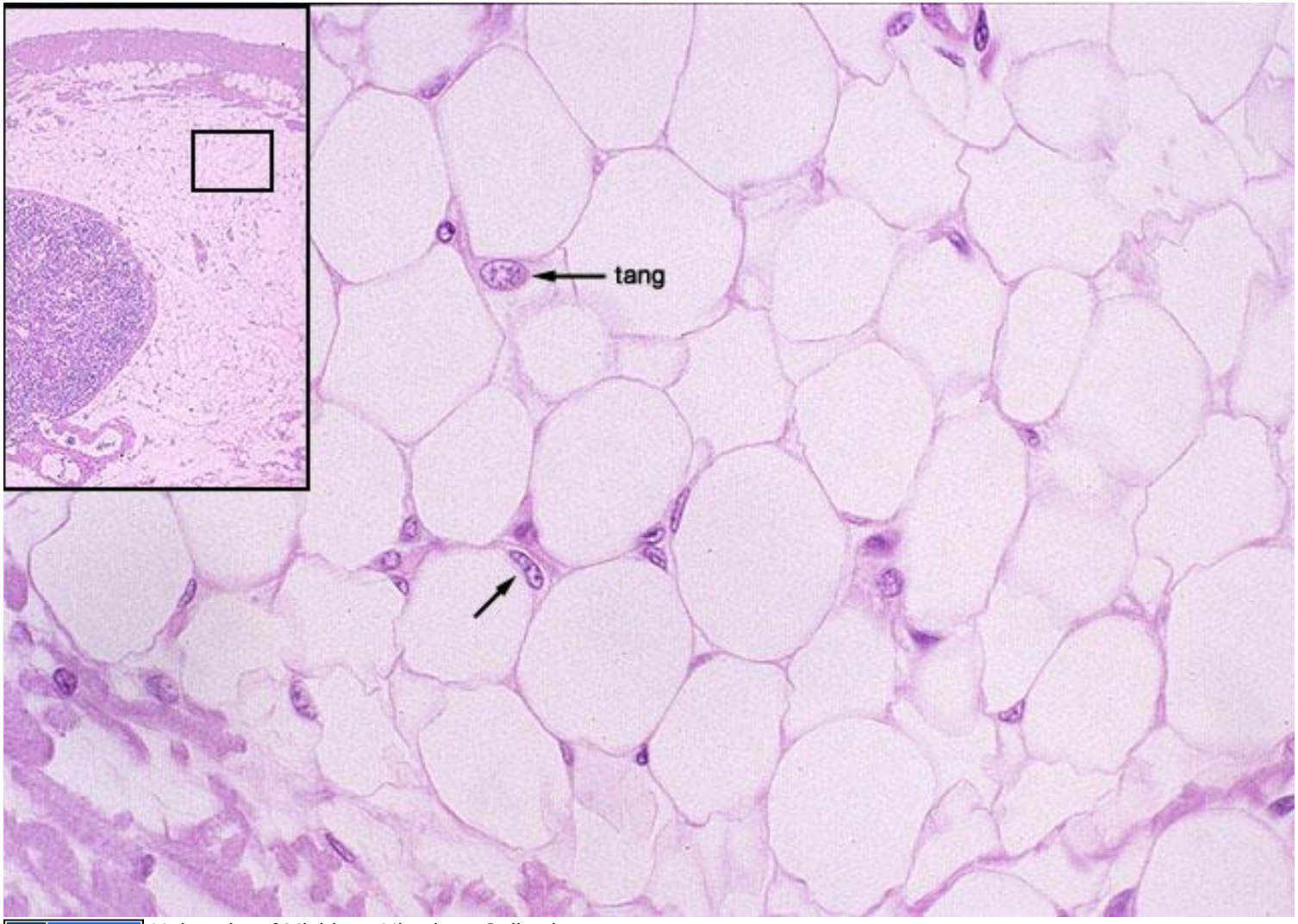



gure 20. Plasma cells and eosinophils. 400X. Plasma cells have an eccentrically ated and heterochromic nucleus and a basophilic cytoplasm with a pale staining ea (negative Golgi image) adjacent to the nucleus. Eosinophils have a lobated cleus and acidophilic granules in the cytoplasm. Two pale staining fibroblast clei are also shown in the lower left corner of the figure.

## Loose Connective Tissue


Figure 8. Mast cells in perivascular connective tissue. 160X.

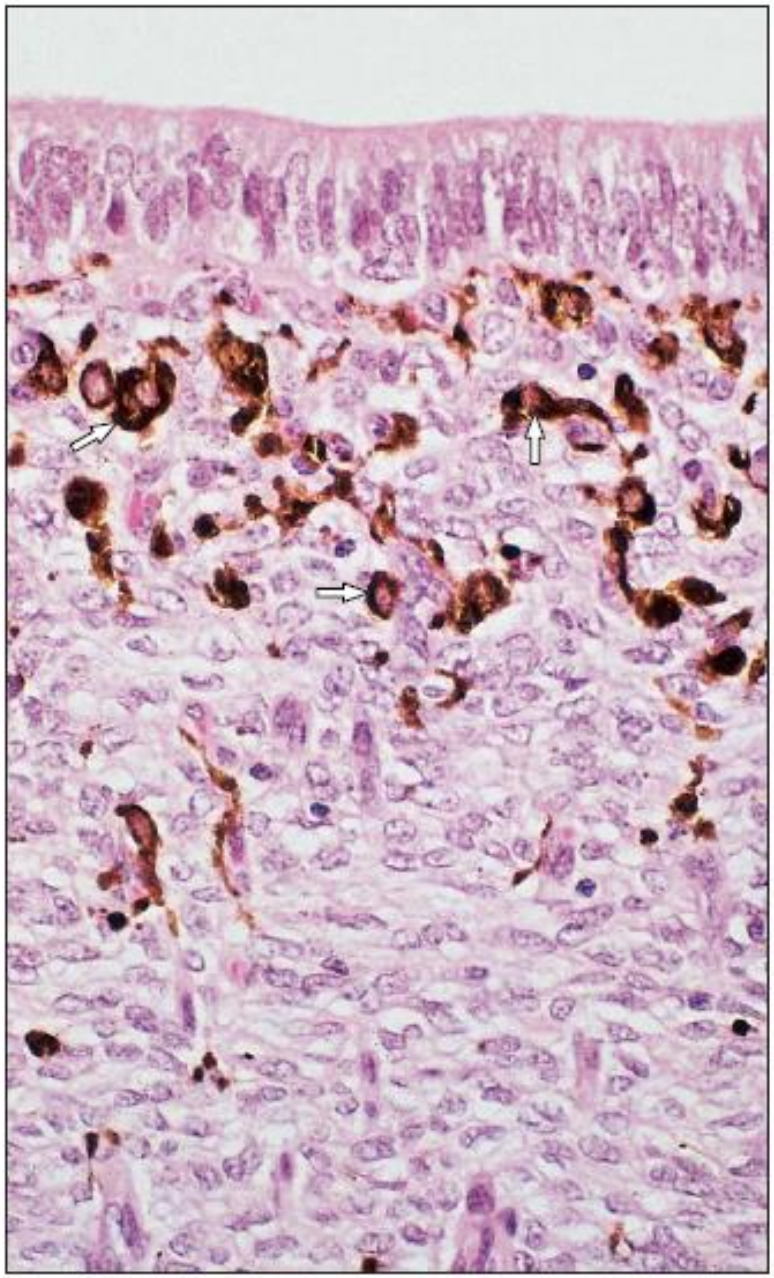
# Adipose tissue





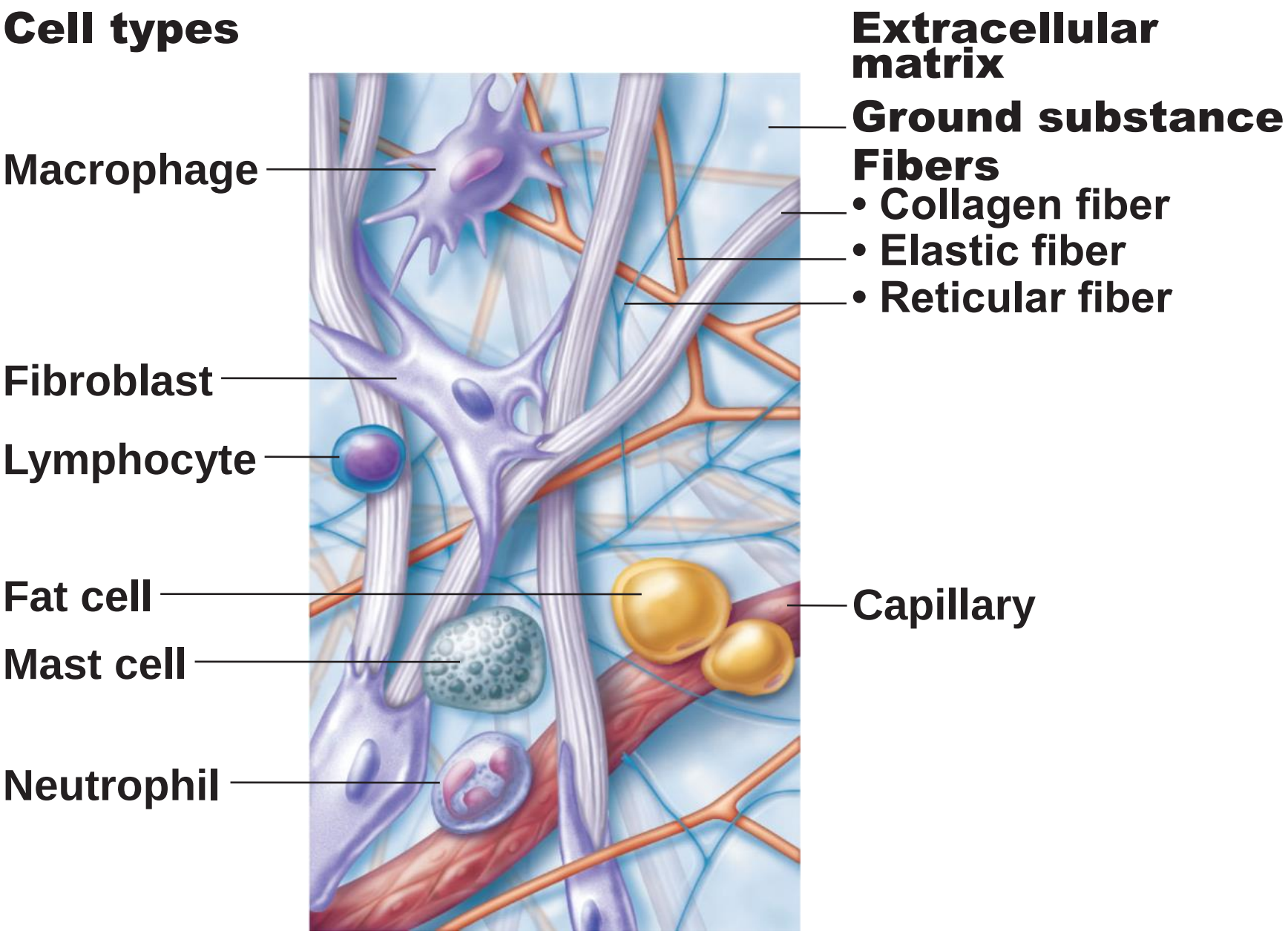

Adipose tissue in mesentery;

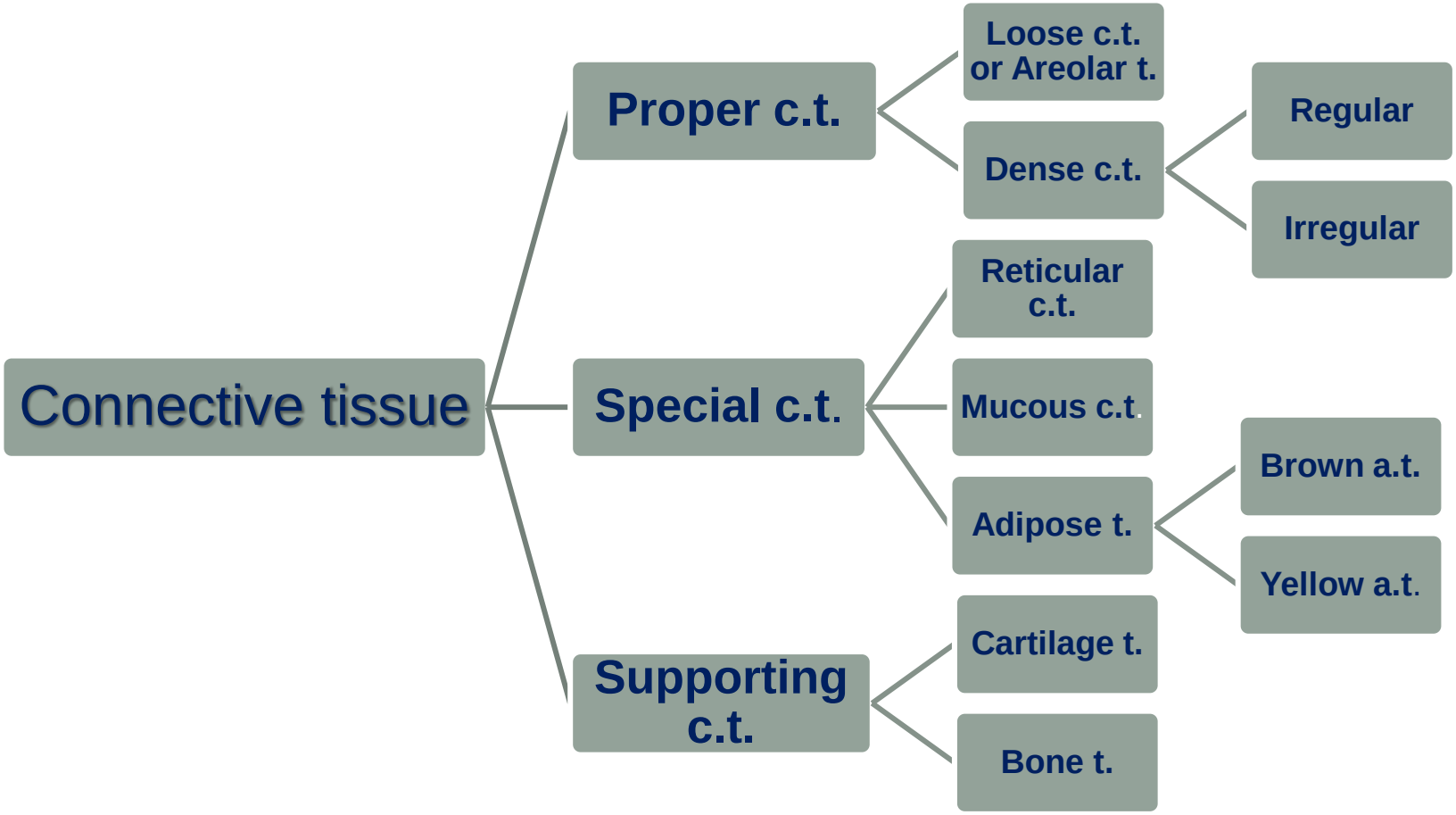
3.17



**3.17** Melanocytes. Uterus (ewe). The melanocytes are arrowed. H & E. ×200.

FIGURE 4.7 AREOLAR CONNECTIVE TISSUE: A PROTOTYPE (MODEL) CONNECTIVE TISSUE.



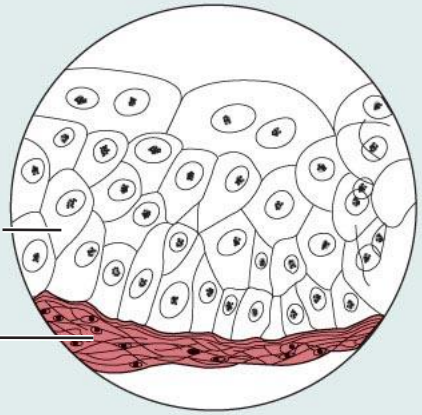

Connective tissue
Proper c.t.
Loose c.t. or Areolar t.
Dense c.t.
Regular
Irregular
Special c.t.
Reticular c.t.
Mucous c.t.
Adipose t.
Brown a.t.
Yellow a.t.
Supporting c.t.
Cartilage t.
Bone t.

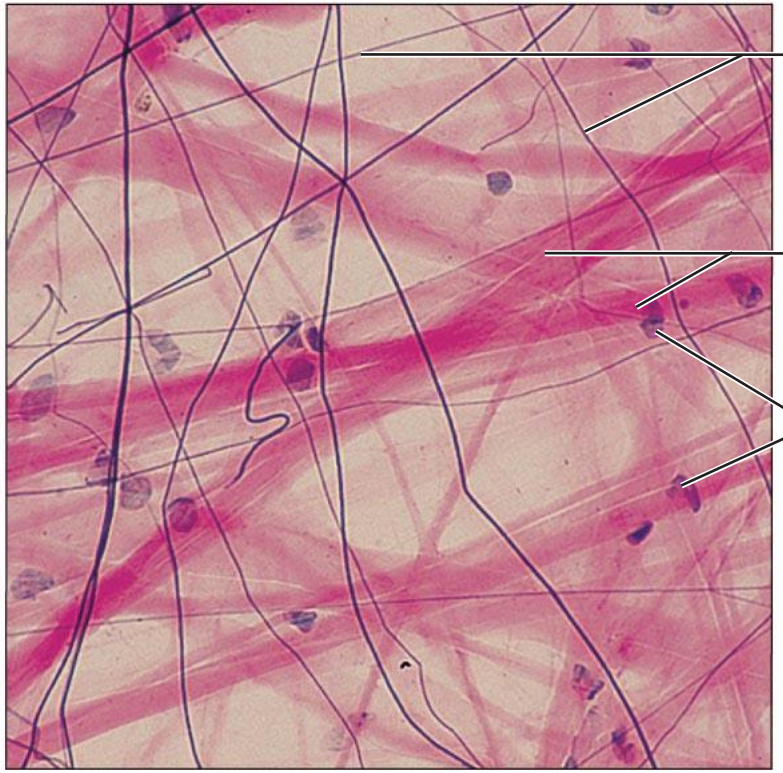
# Loose connective tissue, areolar

**Description:** Gel-like matrix with all three fiber types; cells: fibroblasts, macrophages, mast cells, and some white blood cells.

**Function:** Wraps and cushions organs; its macrophages phagocytize bacteria; plays important role in inflammation; holds and conveys tissue fluid.

**Location:** Widely distributed under epithelia of body, e.g., forms lamina propria of mucous membranes; packages organs; surrounds capillaries.



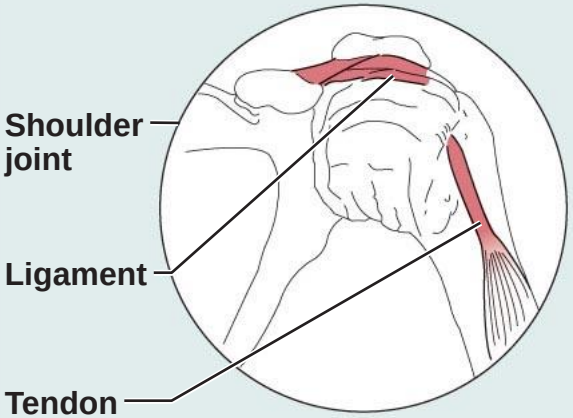

**Photomicrograph:** Areolar connective tissue, a soft packaging tissue of the body (300x).

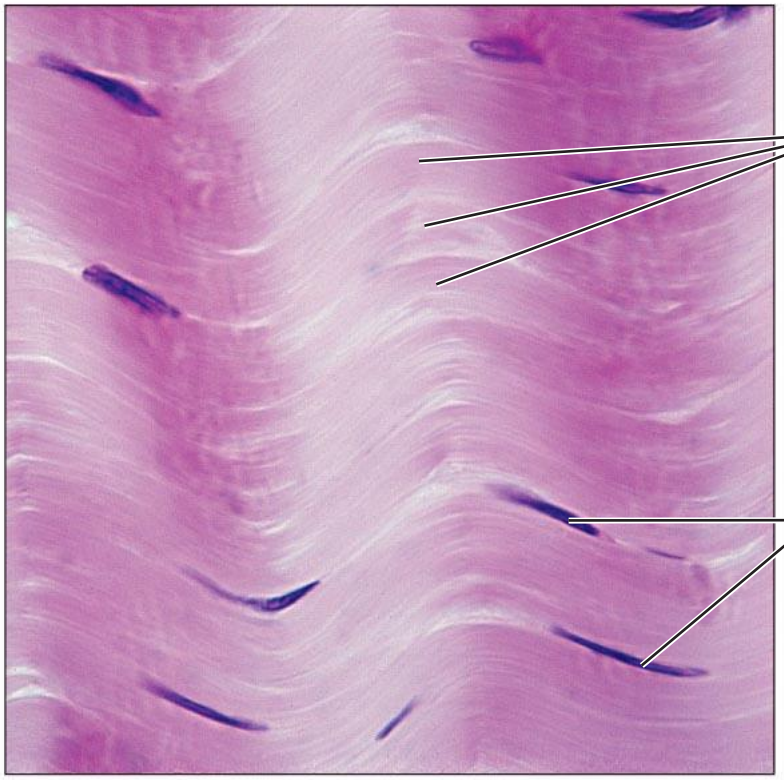
# Dense connective tissue, dense regular

**Description:** Primarily parallel collagen fibers; a few elastic fibers; major cell type is the fibroblast.

**Function:** Attaches muscles to bones or to muscles; attaches bones to bones; withstands great tensile stress when pulling force is applied in one direction.

**Location:** Tendons, most ligaments, aponeuroses.



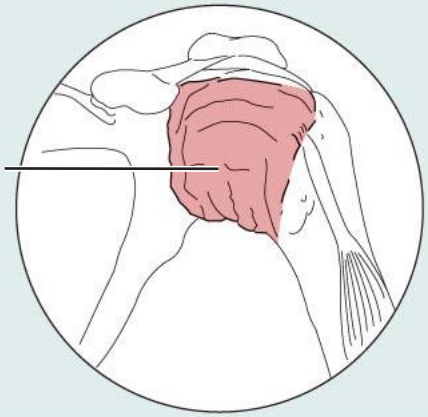

**Photomicrograph:** Dense regular connective tissue from a tendon (500x).

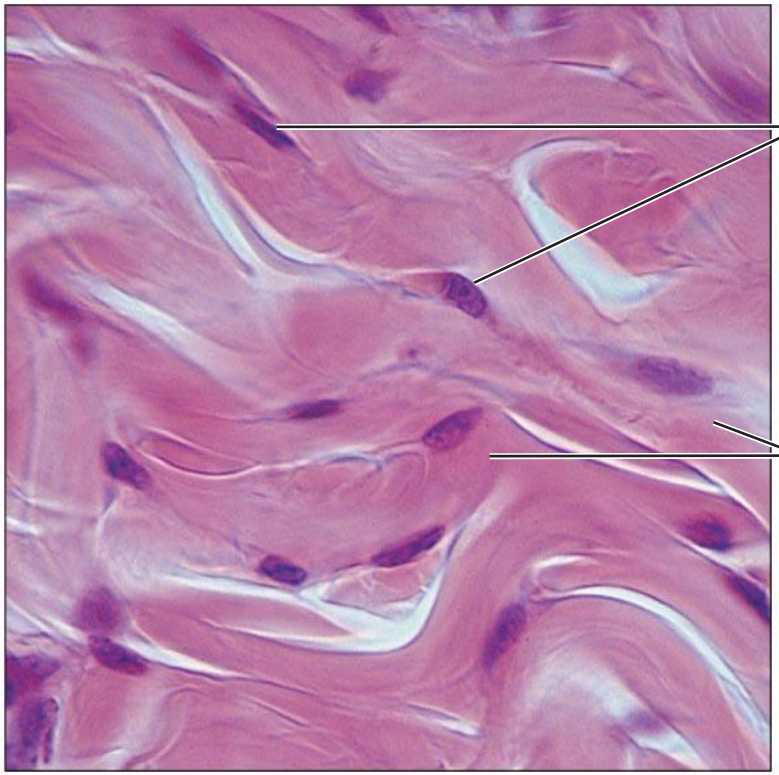
# Dense connective tissue, dense irregular

**Description:** Primarily irregularly arranged collagen fibers; some elastic fibers; major cell type is the fibroblast.

**Function:** Able to withstand tension exerted in many directions; provides structural strength.

**Location:** Fibrous capsules of organs and of joints; dermis of the skin; submucosa of digestive tract.




**Photomicrograph:** Dense irregular connective tissue from the dermis of the skin (400x).

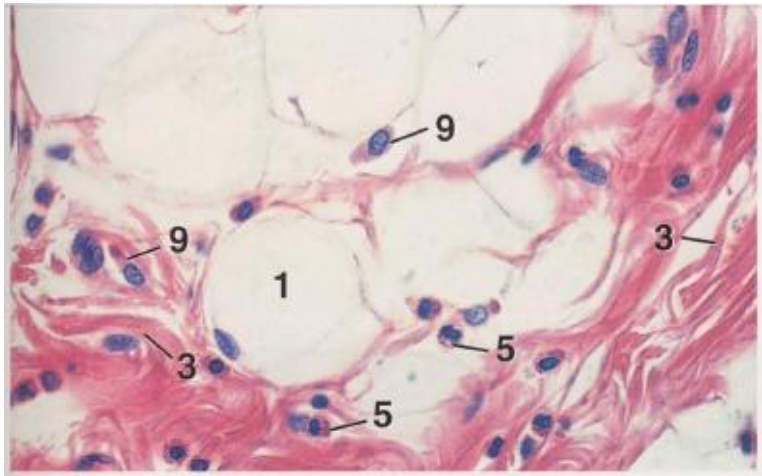



Figure 3.7 × 250

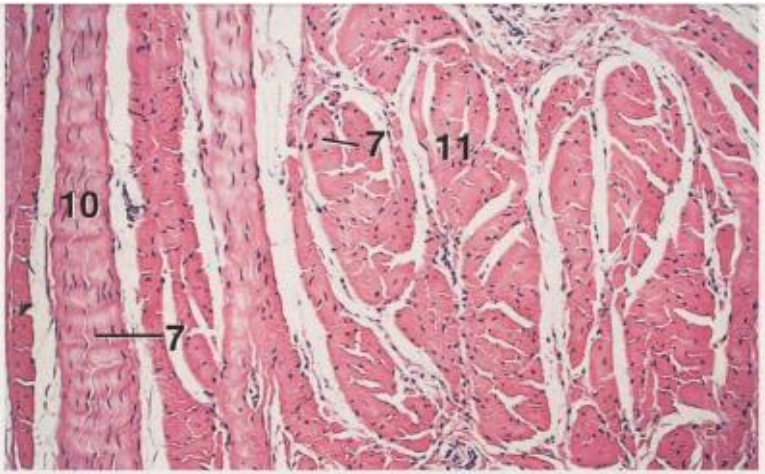
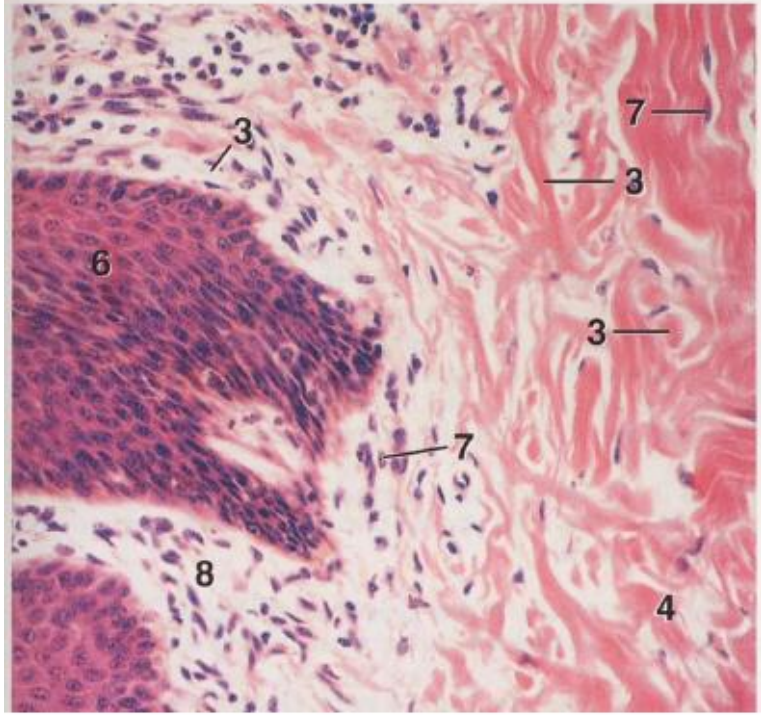



Figure 3.10 × 62.5




| KEY | |
|---|---|
| 1. Adipocyte | 7. Fibroblast nucleus |
| 2. Arteriole | 8. Loose connective tissue |
| 3. Collagenous fiber | 9. Macrophage |
| 4. Dense irregular connective tissue | 10. Tendon, l.s. |
| 5. Eosinophil | 11. Tendon, x.s. |
| 6. Epithelium, planum | |

**Figure 3.7. Macrophages, Loose Connective Tissue, Colon, Pig.** Wandering macrophages are characterized by their oval shape. The cytoplasm of these cells often contains ingested particles and appears dirty. Eosinophils of the pig contain oval or bilobed nuclei.

**Figure 3.8. Loose and Dense Irregular Connective Tissue, Dermis, Planum Nasolabiale, Cow.** Note that the loose connective tissue of the papillary layer of the dermis contains finer fibers and more cells than the dense irregular connective tissue of the reticular layer.

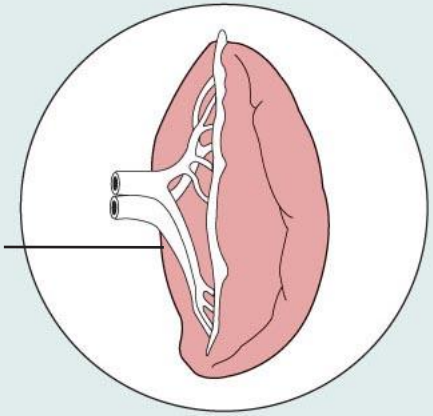
**Figure 3.9. Dense Irregular Connective Tissue, Dermis, Horse.** Note the coarse, interwoven, collagenous fibers.

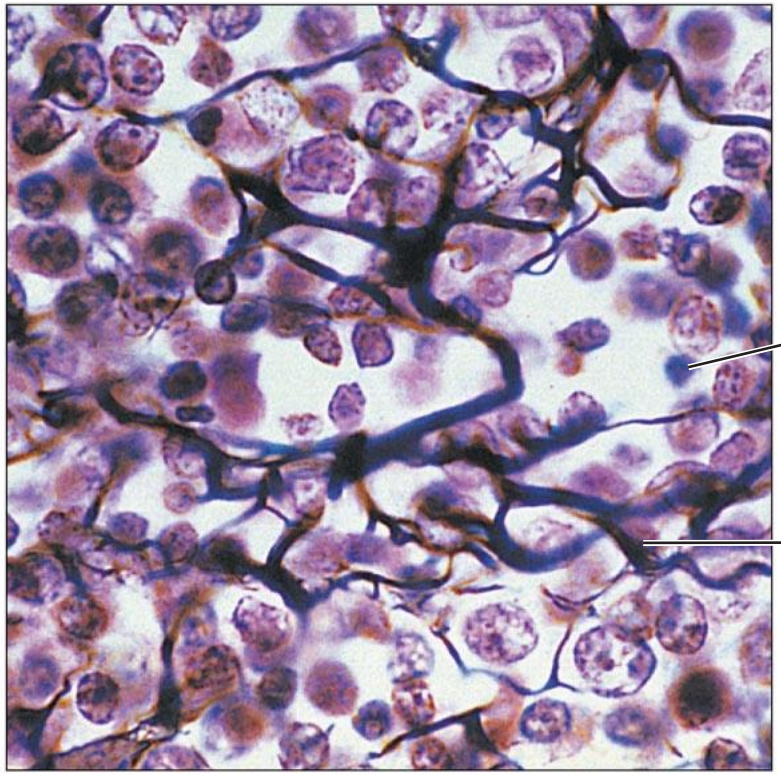
# Reticular tissue

**Description:** Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

**Function:** Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells, and macrophages.

**Location:** Lymphoid organs (lymph nodes, bone marrow, and spleen).




**Photomicrograph:** Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350x).

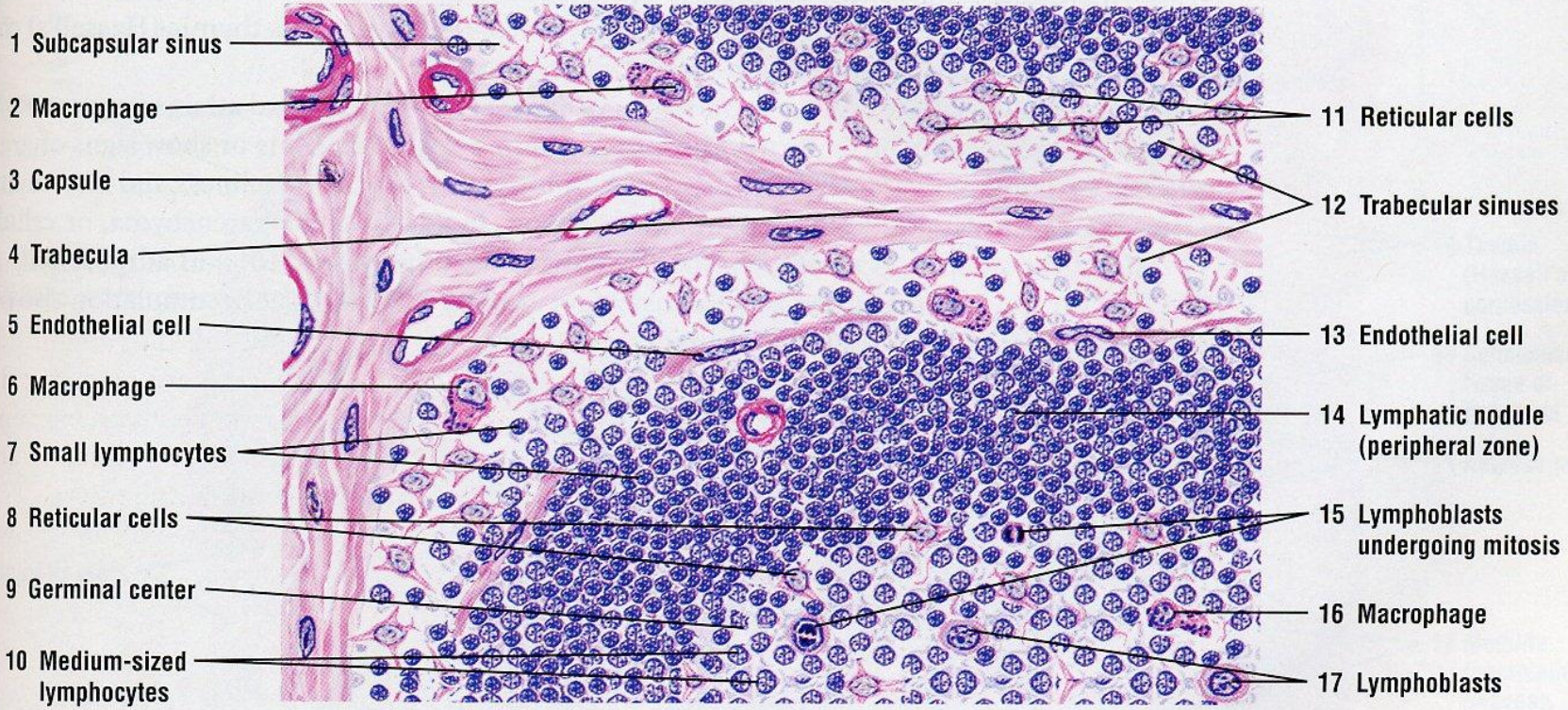



**FIGURE 9.4** ■ Lymph node: subcortical sinus and lymphatic nodule. Stain: hematoxylin and eosin. High magnification.

# Mucous connective tissue

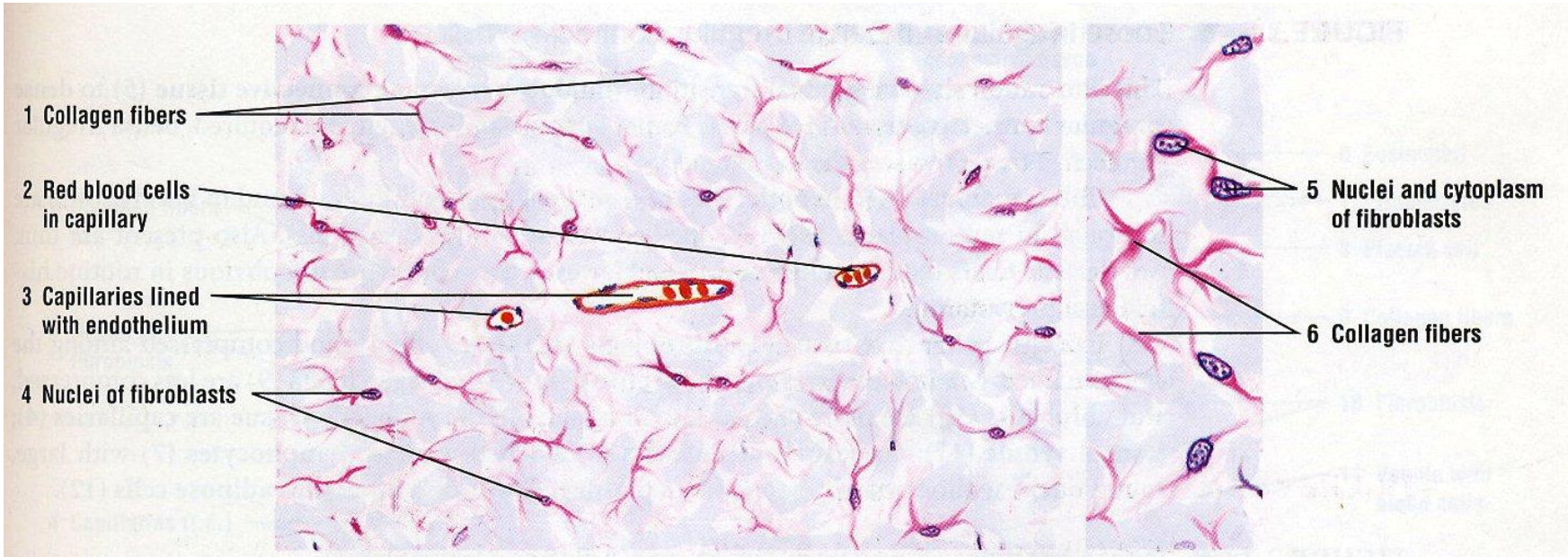


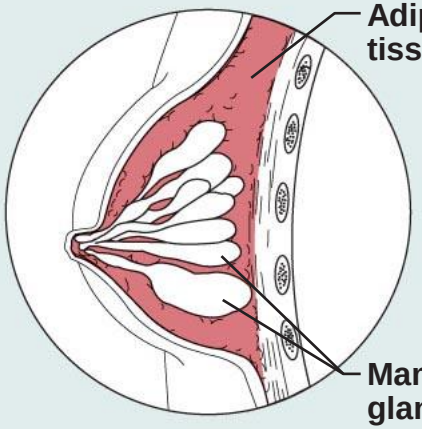

**FIGURE 3.3** ■ Embryonic connective tissue. Stain: hematoxylin and eosin. Left, low magnification; right, high magnification.

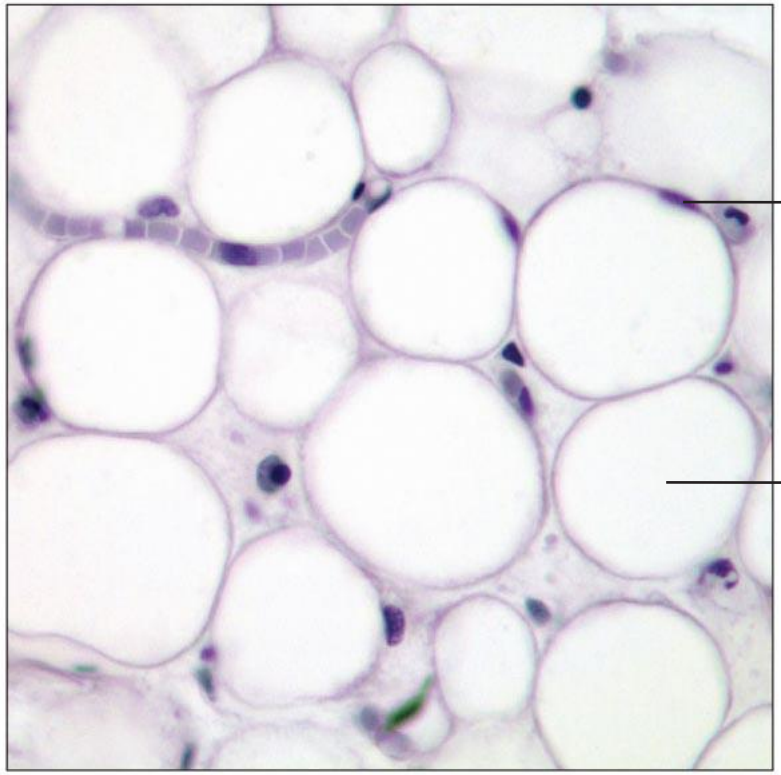
# Adipose tissue

**Description:** Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by large fat droplet.

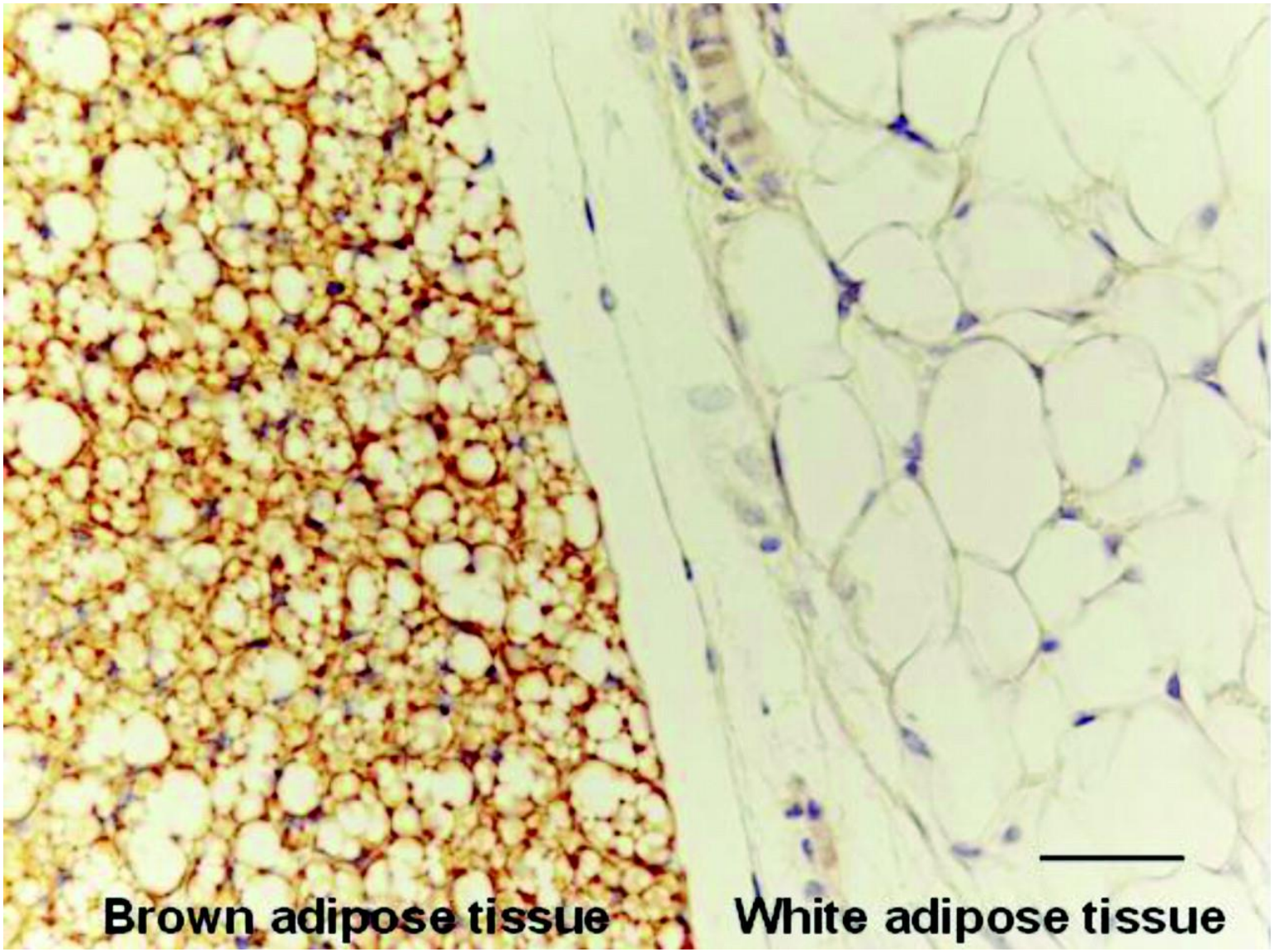
**Function:** Provides reserve food fuel; insulates against heat loss; supports and protects organs.

**Location:** Under skin in the hypodermis; around kidneys and eyeballs; within abdomen; in breasts.




**Photomicrograph:** Adipose tissue from the subcutaneous layer under the skin (350x).


Brown adipose tissue
White adipose tissue