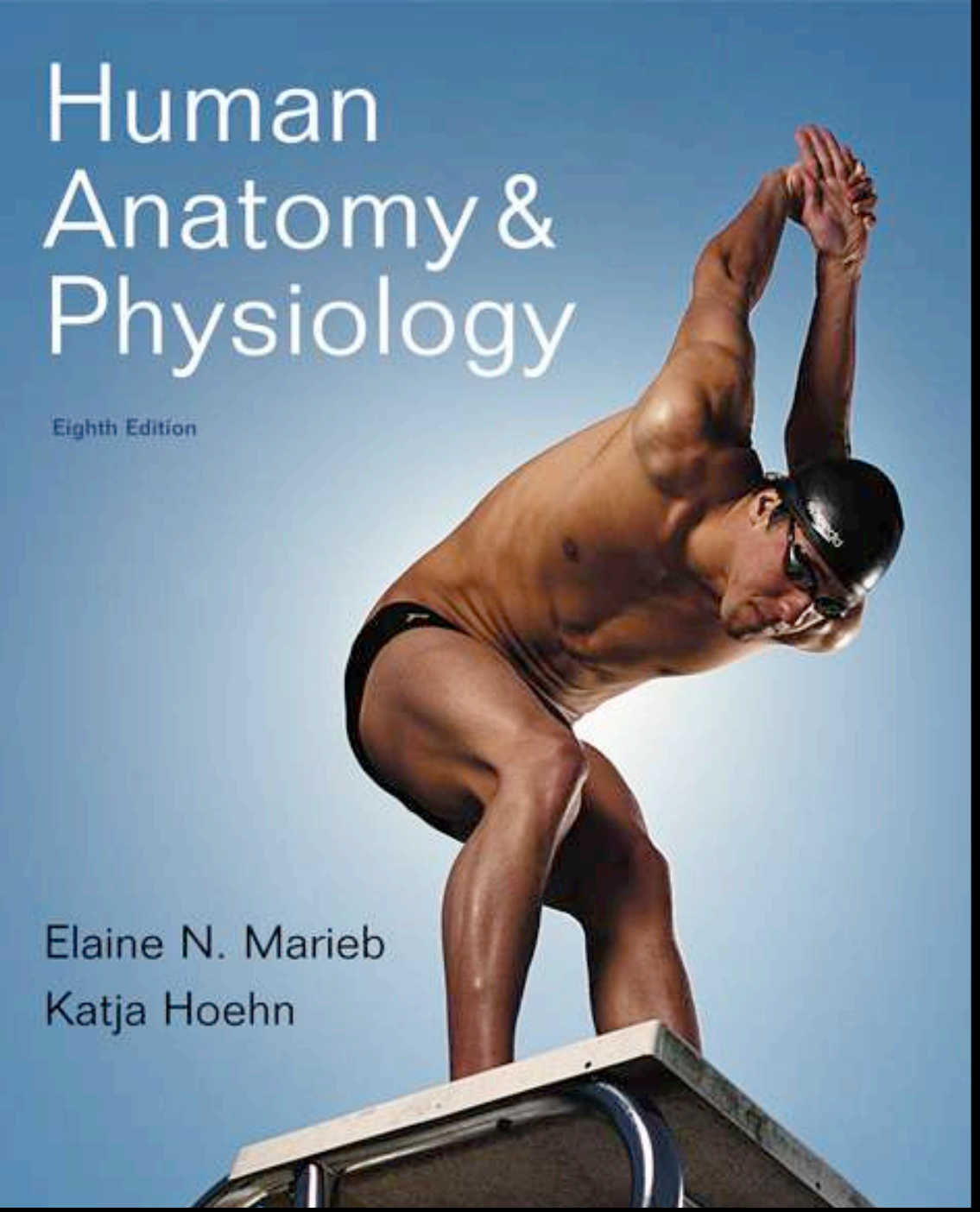


PowerPoint® Lecture Slides
prepared by
Janice Meeking,
Mount Royal College

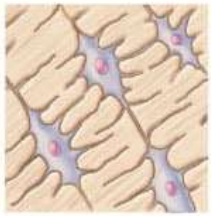
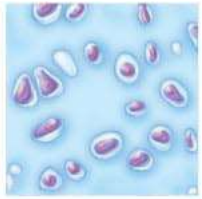
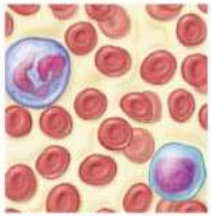
CHAPTER 4

Tissue: The Living Fabric: Part B

Connective Tissue

- Most abundant and widely distributed tissue type
- Four classes
  - Connective tissue proper (Fibrous)
  - Cartilage
  - Bone tissue
  - Blood

TABLE 4.1 Comparison of Classes of Connective Tissues

TISSUE CLASS AND EXAMPLE	SUBCLASSES	TISSUE CLASS AND EXAMPLE	SUBCLASSES
Connective Tissue Proper  *Dense regular connective tissue*	1. Loose connective tissue ▪ Areolar ▪ Adipose ▪ Reticular 2. Dense connective tissue ▪ Regular ▪ Irregular ▪ Elastic	**Bone Tissue**  *Compact bone*	1. Compact bone 2. Spongy bone
Cartilage  *Hyaline cartilage*	1. Hyaline cartilage 2. Elastic cartilage 3. Fibrocartilage	**Blood** 	Blood cell formation and differentiation are quite complex. Details are provided in Chapter 17.

Major Functions of Connective Tissue

- Binding and support
- Protection
- Insulation
- Transportation (blood)

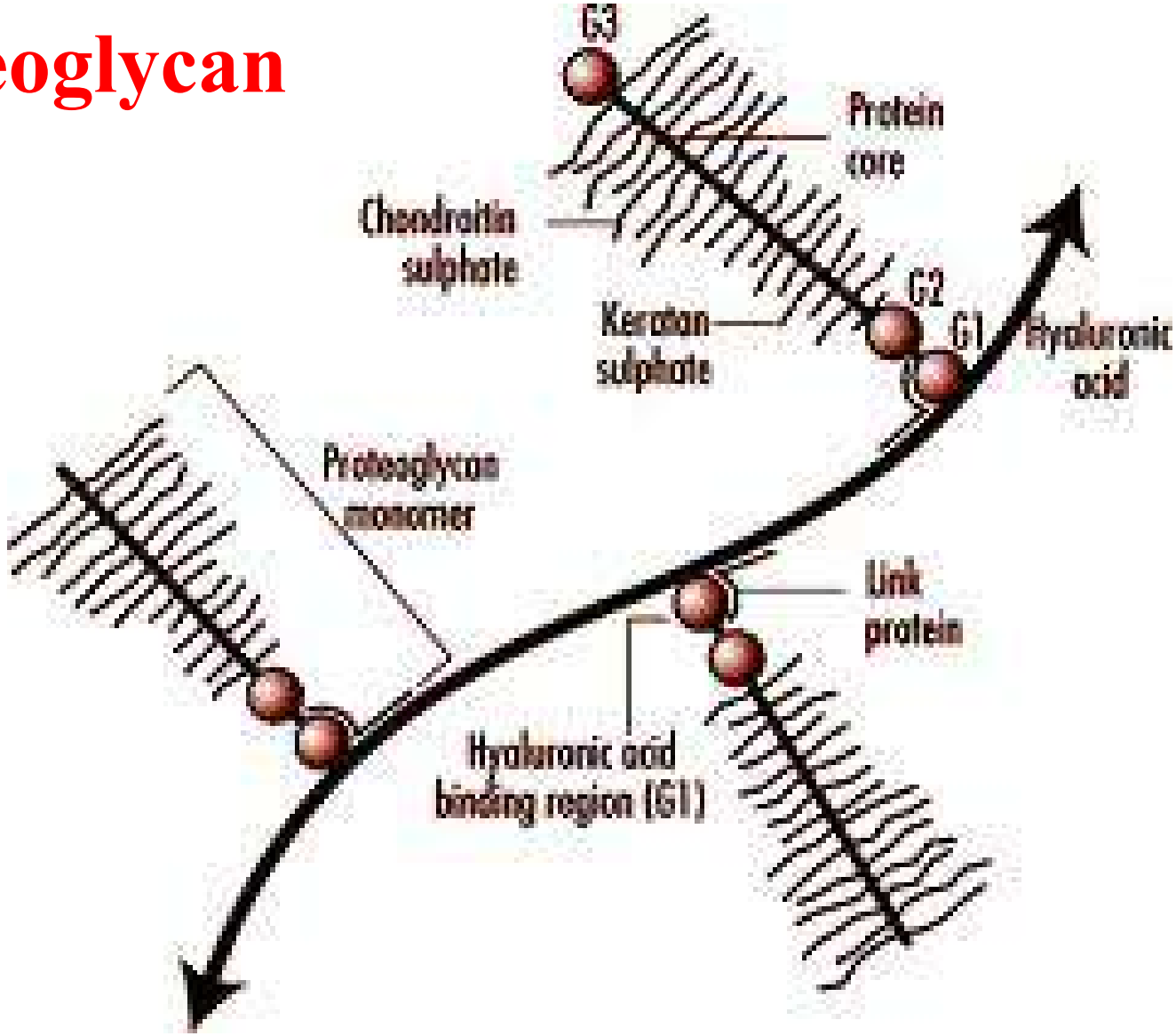
Characteristics of Connective Tissue

- Connective tissues have:
  - Mesenchyme (mesoderm) as their common tissue of origin
  - Varying degrees of vascularity
  - Cellular component
  - Matrix nonliving extracellular (ground substance and fibers)

Structural Elements of Connective Tissue

- Ground substance
  - Medium through which solutes diffuse between blood capillaries and cells
  - Components:
    - Interstitial fluid
    - Adhesion proteins ("glue")
    - Proteoglycans
      - Protein core + large polysaccharides (chrondroitin sulfate and hyaluronic acid)
      - Trap water in varying amounts, affecting the viscosity of the ground substance

Proteoglycan



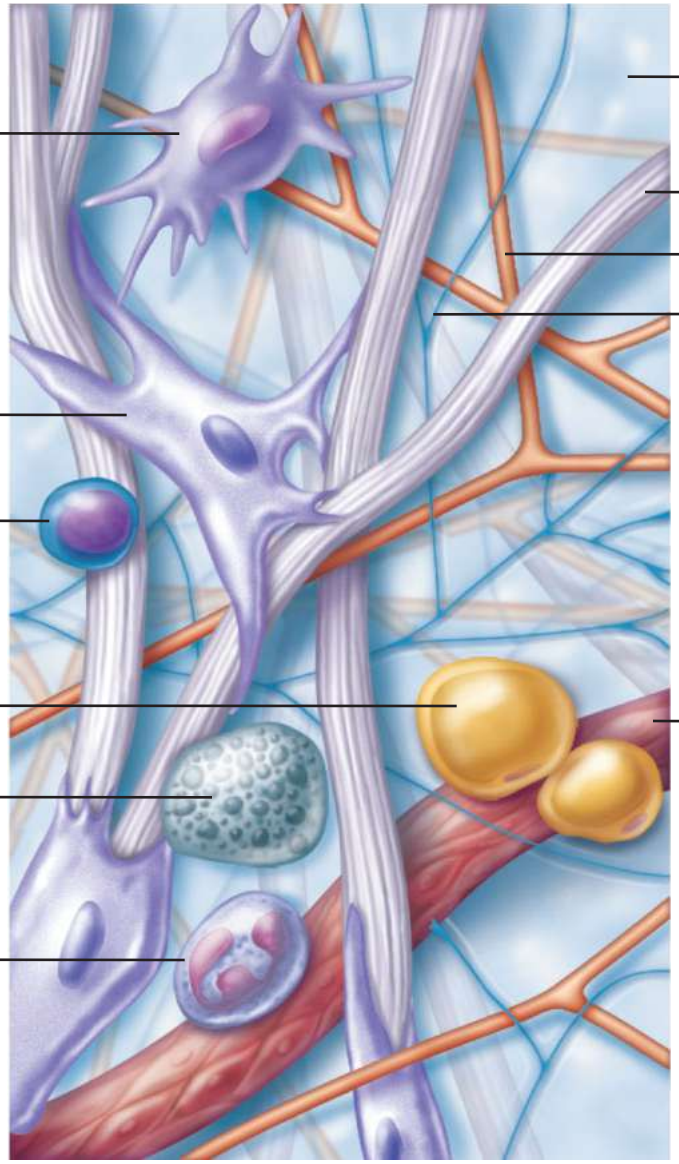
Structural Elements of Connective Tissue

- Fibers: Three types
  - Collagen (white fibers)
    - Strongest and most abundant type
    - Provides high tensile strength
  - Elastic
    - Networks of long, thin, elastin fibers that allow for stretch
  - Reticular
    - Short, fine, highly branched collagenous fibers

Structural Elements of Connective Tissue

- Cells
  - Mitotically active and secretory cells = "blasts"
  - Mature cells = "cytes" (less mitotically active)
    - Fibroblasts in connective tissue proper
    - Chondroblasts and chondrocytes in cartilage
    - Osteoblasts and osteocytes in bone
    - Hematopoietic stem cells in bone marrow
    - Fat cells, white blood cells, mast cells, and macrophages

Cell types (Areolar Connective Tissue)



Extracellular matrix
Ground substance
Fibers
• Collagen fiber
• Elastic fiber
• Reticular fiber
Macrophage
Fibroblast
Lymphocyte
Fat cell
Mast cell
Neutrophil
Capillary

Figure 4.7

Connective Tissue: Embryonic

- Mesenchyme (Mesoderm)
  embryonic connective tissue
  - Gives rise to all other connective tissues
  - Gel-like ground substance with fibers and star-shaped mesenchymal cells

Overview of Connective Tissues

- For each of the following examples of connective tissue, note:
  - Description
  - Function
  - Location

Connective Tissue Proper (Fibrous) Cell type & Matrix

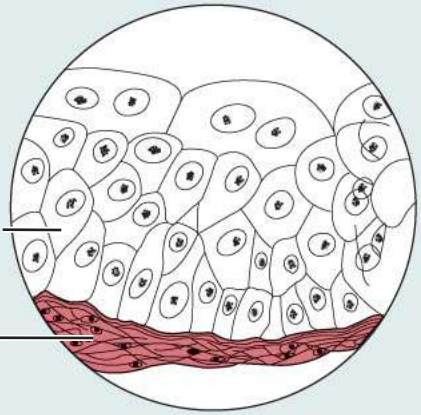
- Two Types:
  - Loose connective tissue
    - Areolar
    - Adipose
    - Reticular
  - Dense connective tissue
    - Dense regular
    - Dense irregular
    - Elastic

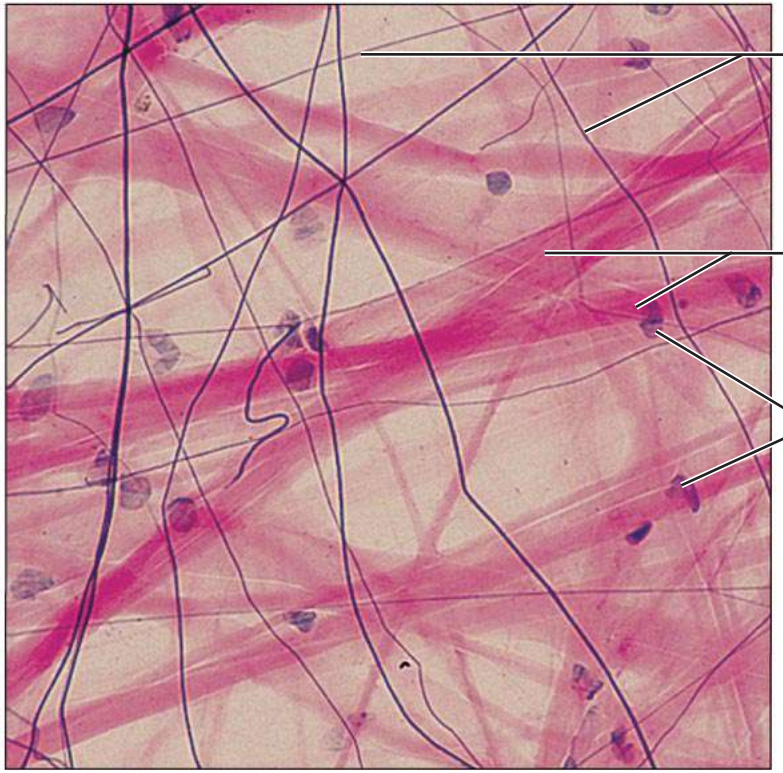
(a) Connective tissue proper (Fibrous): loose connective tissue, areolar

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.; vascular & heals well.

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).

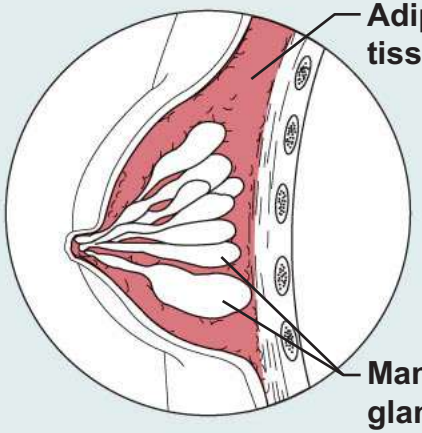
Figure 4.8a

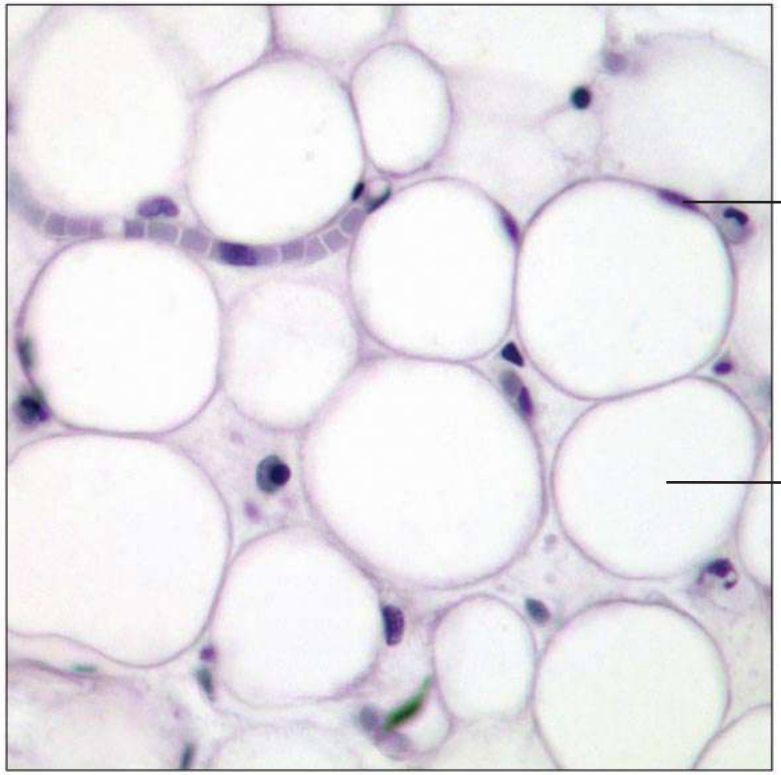
(b) Connective tissue proper (Fibrous): loose connective tissue, adipose

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

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).

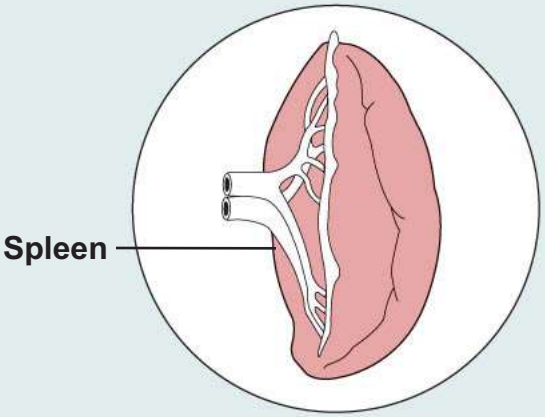
Figure 4.8b

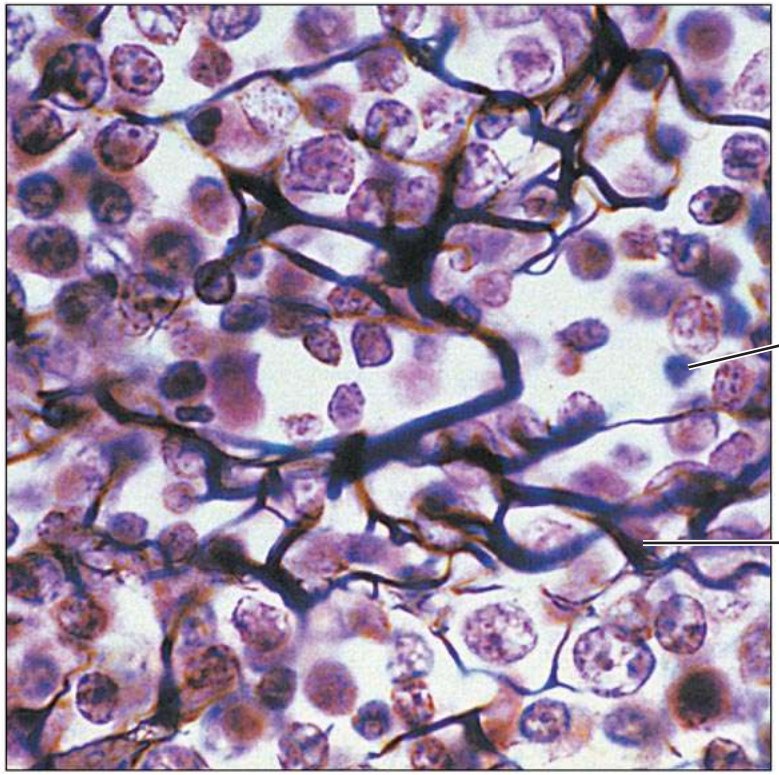
(c) Connective tissue proper (Fibrous): loose connective tissue, reticular

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 (immune response), highly vascularized

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).

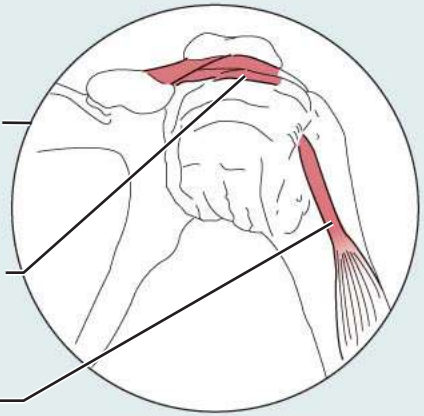
Figure 4.8c

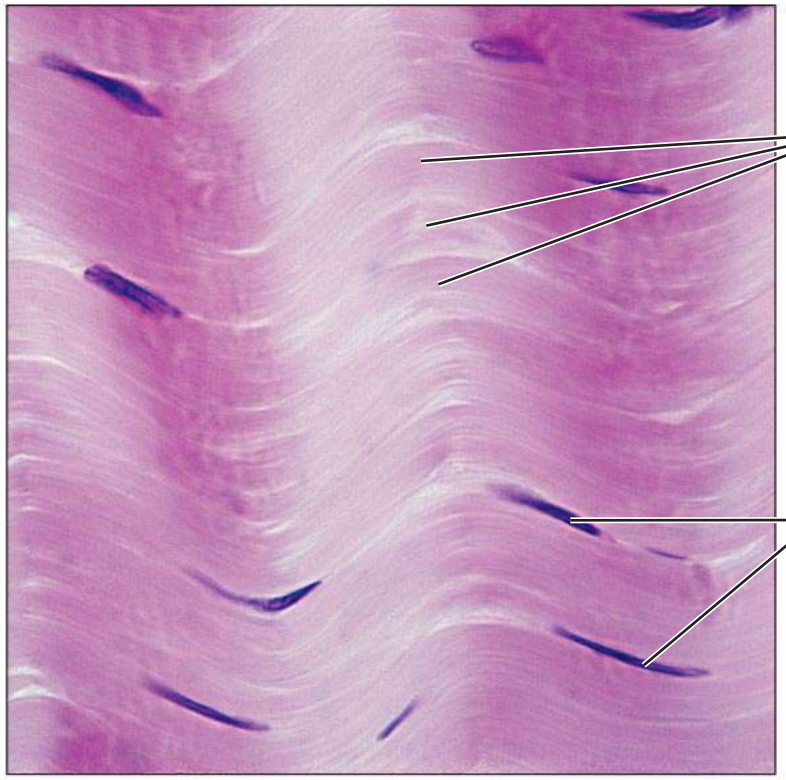
(d) Connective tissue proper (Fibrous): dense connective tissue, dense regular

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, poor to very poorly vascularized.

Location: Tendons, most ligaments, aponeuroses.





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

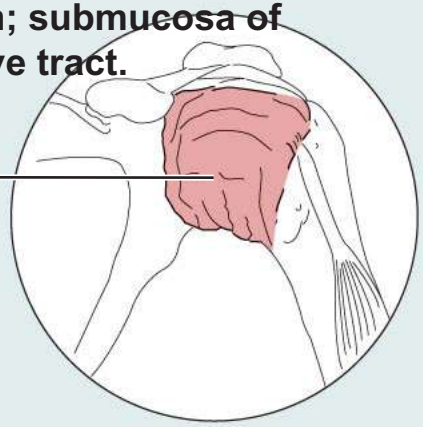
Figure 4.8d

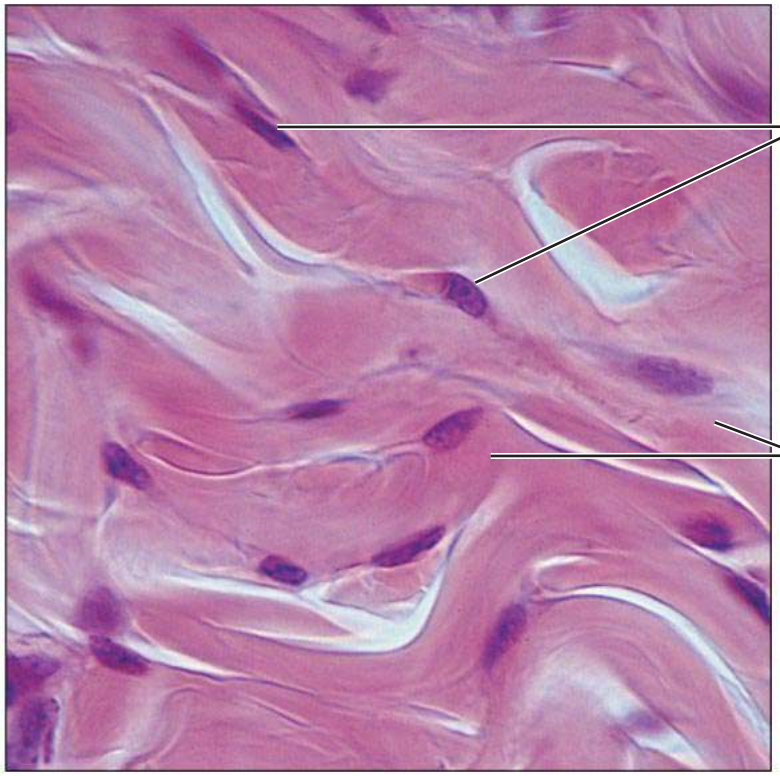
(e) Connective tissue proper (Fibrous): dense connective tissue, dense irregular

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, good to poor ly vascularized.

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).

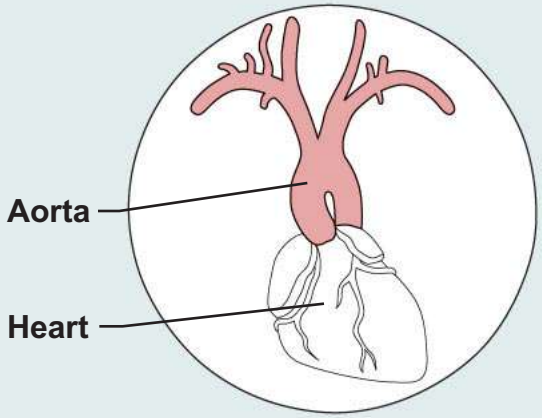
Figure 4.8e

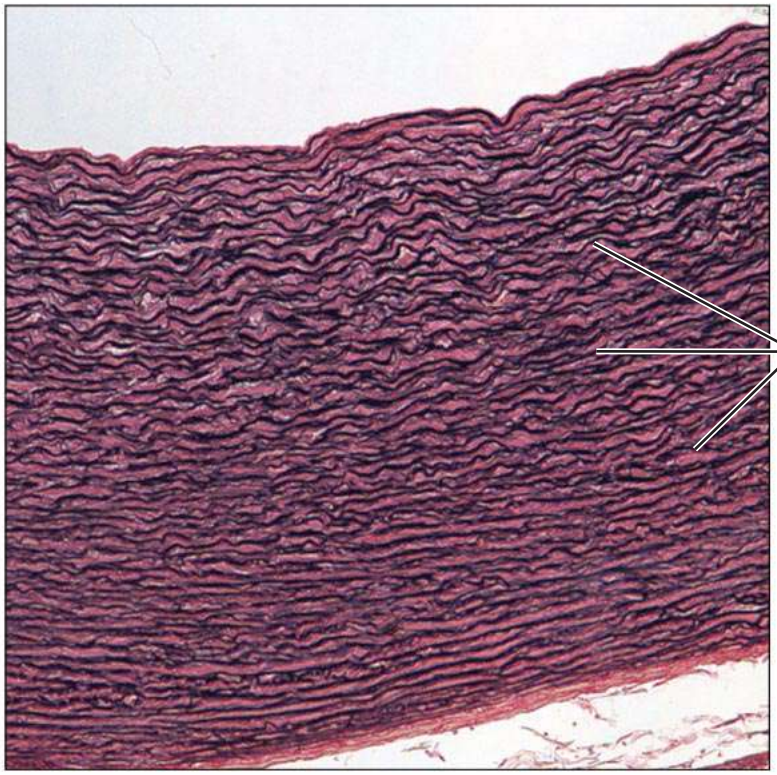
(f) Connective tissue proper (Fibrous): dense connective tissue, elastic

Description: Dense regular connective tissue containing a high proportion of elastic fibers.

Function: Allows recoil of tissue following stretching; maintains pulsatile flow of blood through arteries; aids passive recoil of lungs following inspiration.

Location: Walls of large arteries; within certain ligaments associated with the vertebral column; within the walls of the bronchial tubes; dermis





Photomicrograph: Elastic connective tissue in the wall of the aorta (250x).

Figure 4.8f

Connective Tissue: Cartilage
Cell Type & Matrix

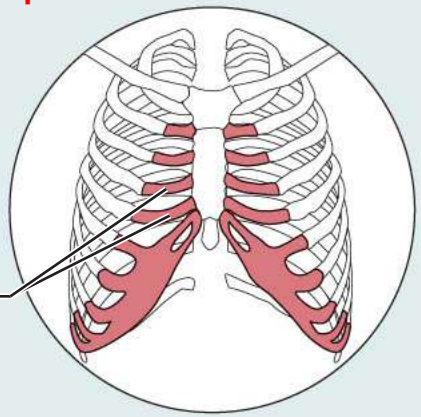
- **Three types of cartilage:**
  - Hyaline cartilage
  - Elastic cartilage
  - Fibrocartilage
  - **Cell Type**
    Chondrocyte & chondroblast
    nonvascularized; mitoticly inactive
    lacunae
  - **Matrix**
    Glycosaminoglycans (GAG)
    Chrondrotin sulfate
    Collagen & elastic fibers

(g) 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 (articulat); forms costal cartilages of the ribs; cartilages of the nose, trachea, and larynx; epiphyseal plate



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

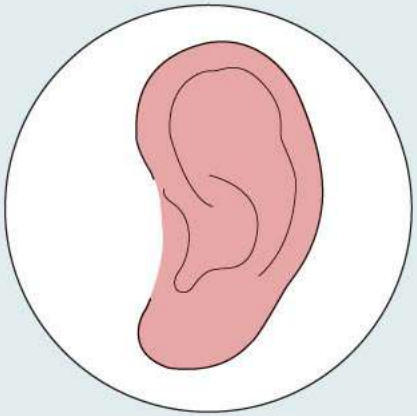
Figure 4.8g

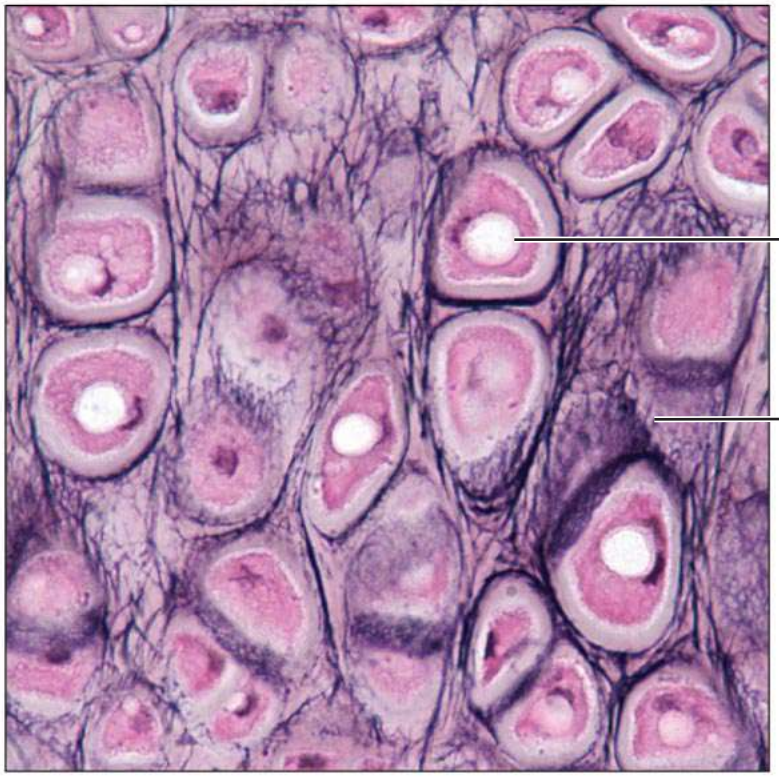
(h) Cartilage: elastic

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 (800x).

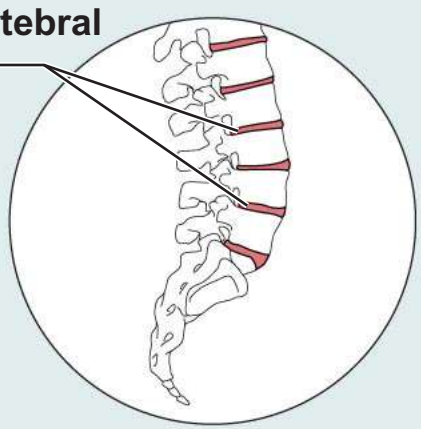
Figure 4.8h

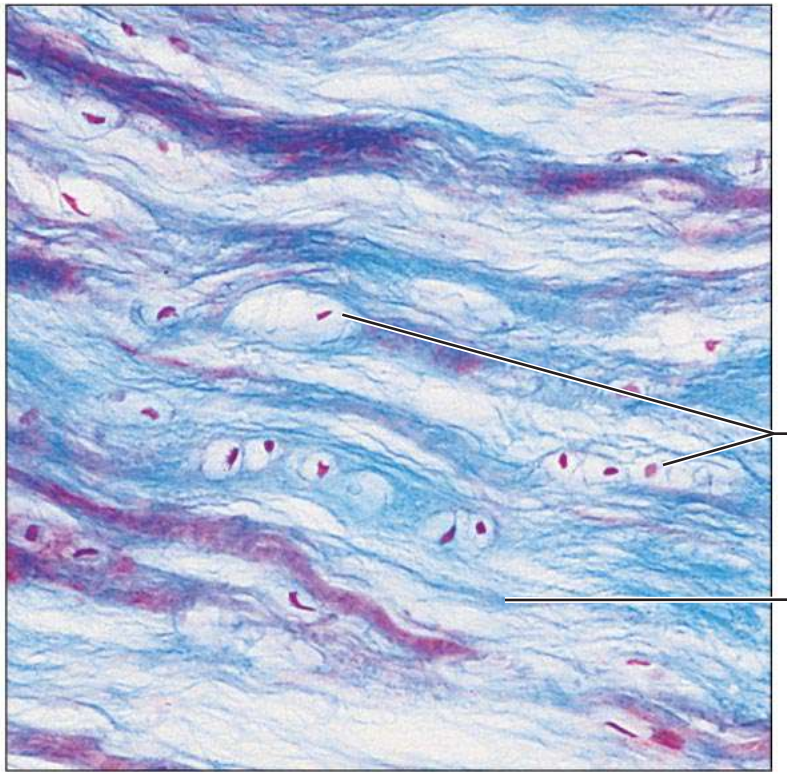
(i) Cartilage: fibrocartilage

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 (menisci).





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

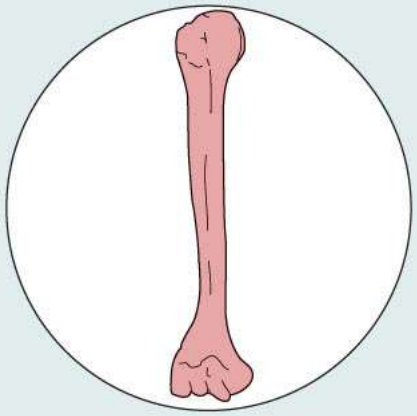
Figure 4.8i

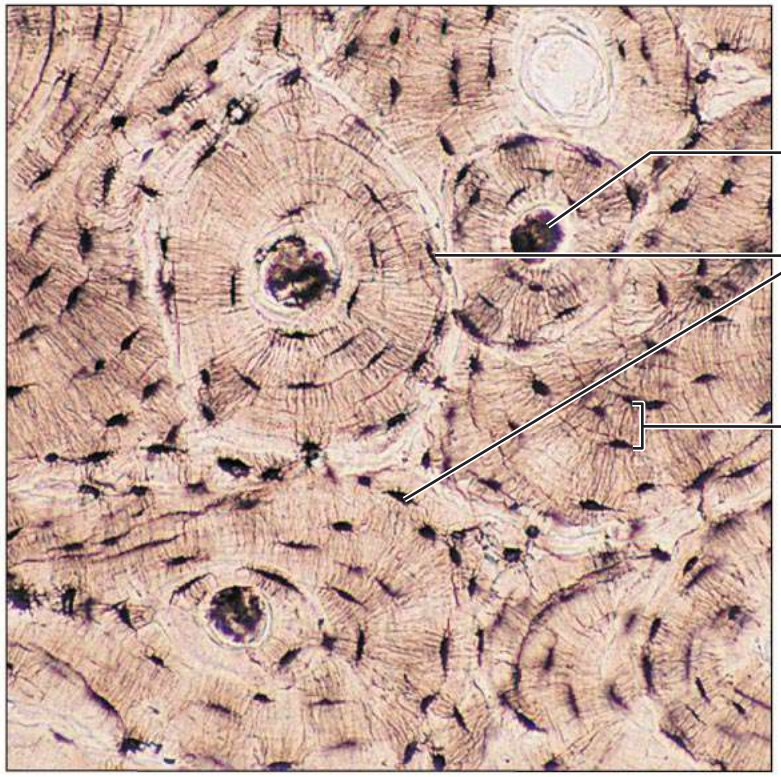
(j) Others: bone (osseous tissue)

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





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

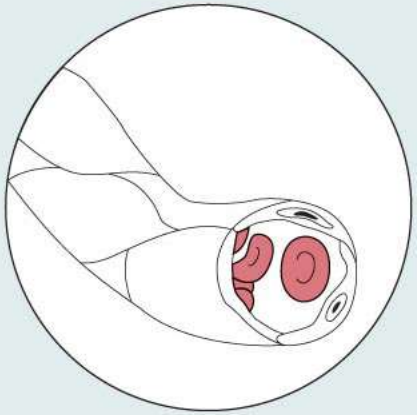
Figure 4.8j

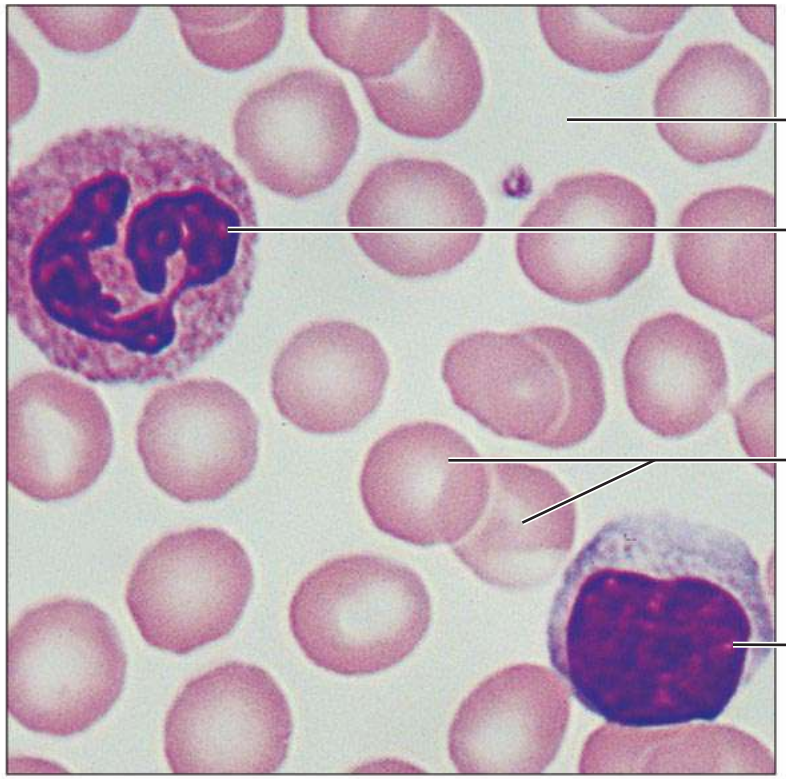
(k) Others: blood

Description: Red (erythrocytes) and white (lymphocytes) blood cells in a fluid matrix (plasma). Platelets (thrombocytes)

Function: Transport of respiratory gases, nutrients, wastes, and other substances.

Location: Contained within blood vessels.





Photomicrograph: Smear of human blood (1860x); two white blood cells (neutrophil in upper left and lymphocyte in lower right) are seen surrounded by red blood cells.

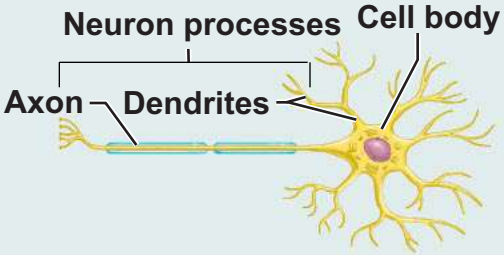
Figure 4.8k

Nervous Tissue

- Nervous tissue will be discussed in more detail with the Nervous System.

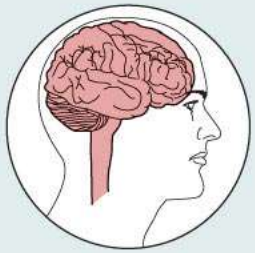
Nervous tissue

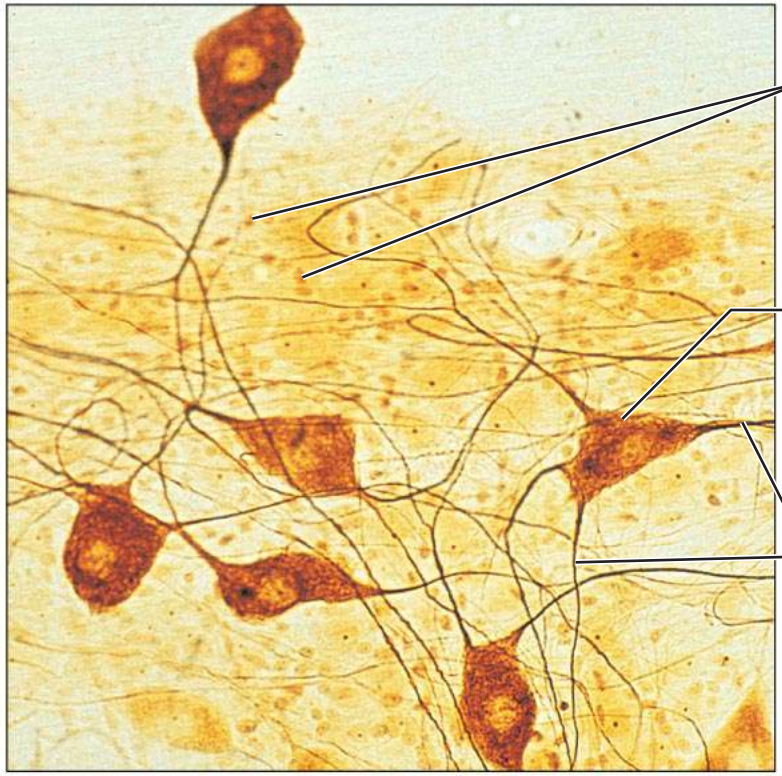
Description: Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body; also contributing to nervous tissue are nonirritable supporting cells (not illustrated).



Function: Transmit electrical signals from sensory receptors and to effectors (muscles and glands) which control their activity.

Location: Brain, spinal cord, and nerves.





Photomicrograph: Neurons (350x)

Figure 4.9

Muscle Tissue

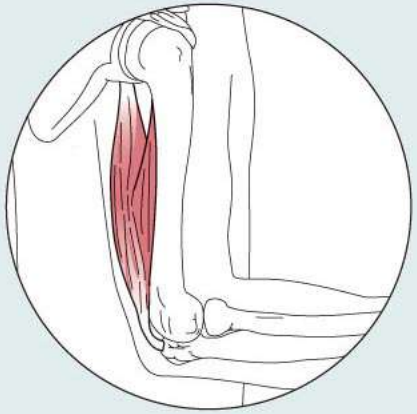
- Muscle tissue will be discussed in more detail with the Muscular System10.
- Three types
  skeletal (voluntary)
  cardiac (involuntary)
  smooth (involuntary)

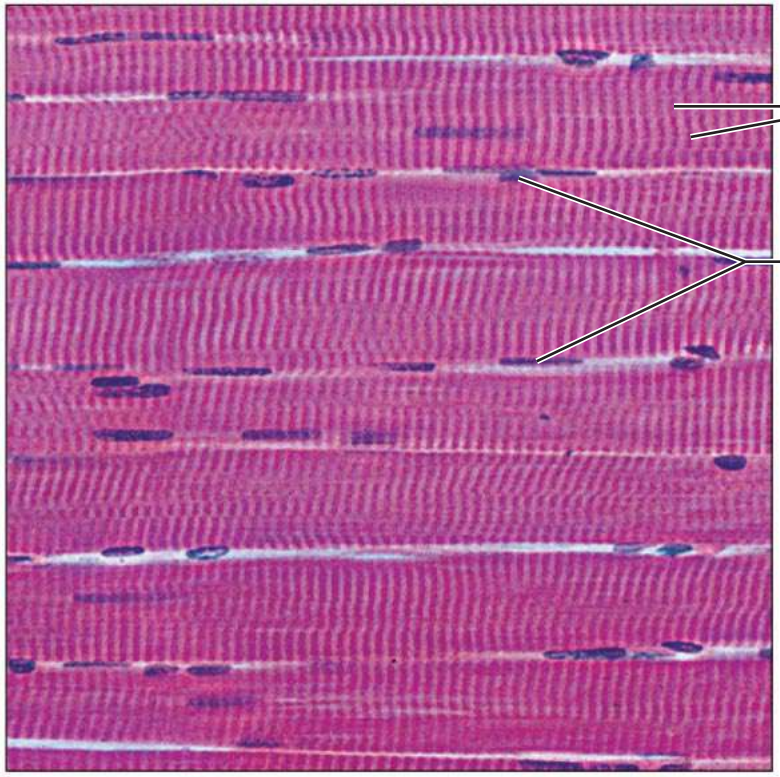
(a) Skeletal muscle

Description: Long, cylindrical, multinucleate cells; obvious striations.

Function: Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

Location: In skeletal muscles attached to bones or occasionally to skin.





Photomicrograph: Skeletal muscle (approx. 460x). Notice the obvious banding pattern and the fact that these large cells are multinucleate.

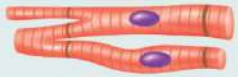
Figure 4.10a

Muscle Tissue

- Cardiac muscle tissue will be discussed in more detail with the Cardiovascular System.

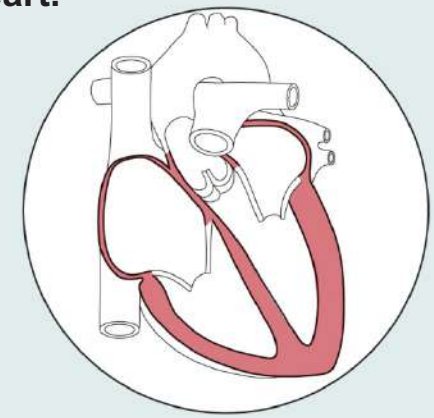
(b) Cardiac muscle

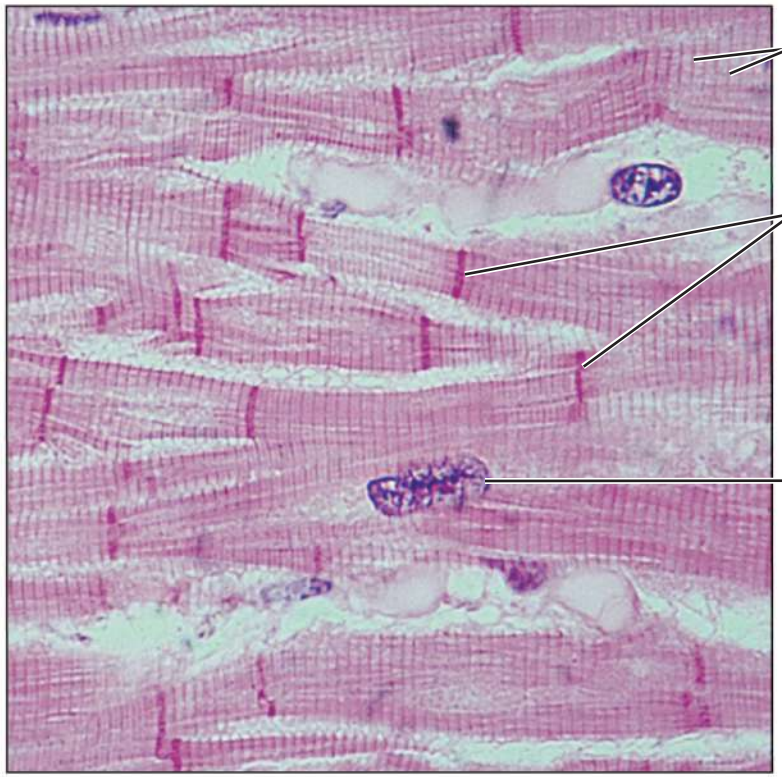
Description: Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).



Function: As it contracts, it propels blood into the circulation; involuntary control.

Location: The walls of the heart.





Photomicrograph: Cardiac muscle (500X); notice the striations, branching of cells, and the intercalated discs.

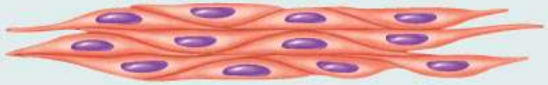
Figure 4.10b

Muscle Tissue

- Smooth muscle tissue will be discussed in more detail with the Muscular System.

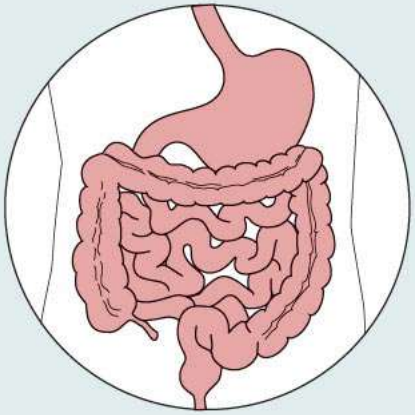
(c) Smooth muscle

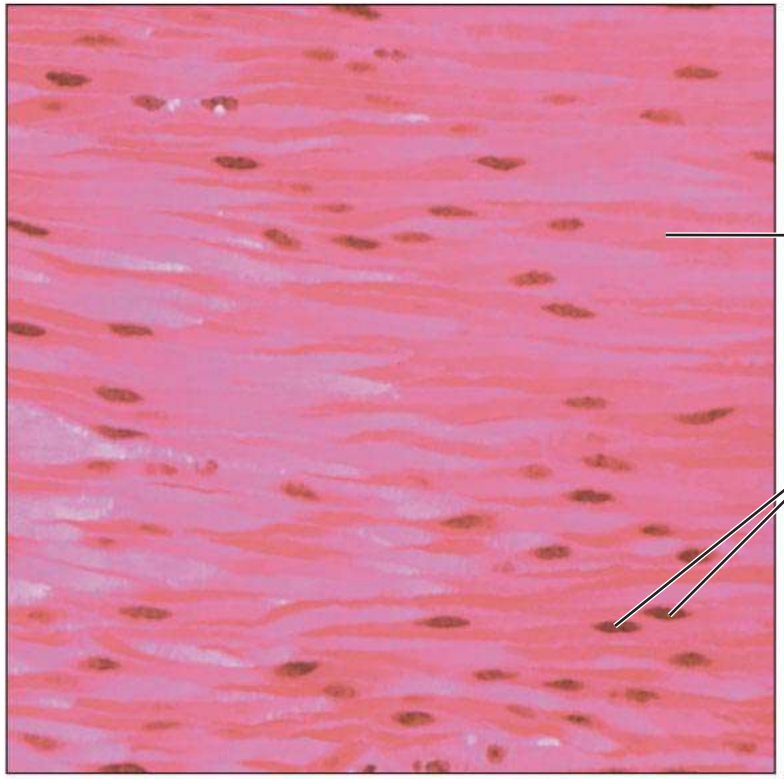
Description: Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.



Function: Propels substances or objects (foodstuffs, urine, a baby) along internal passageways; involuntary control.

Location: Mostly in the walls of hollow organs; arector pili.



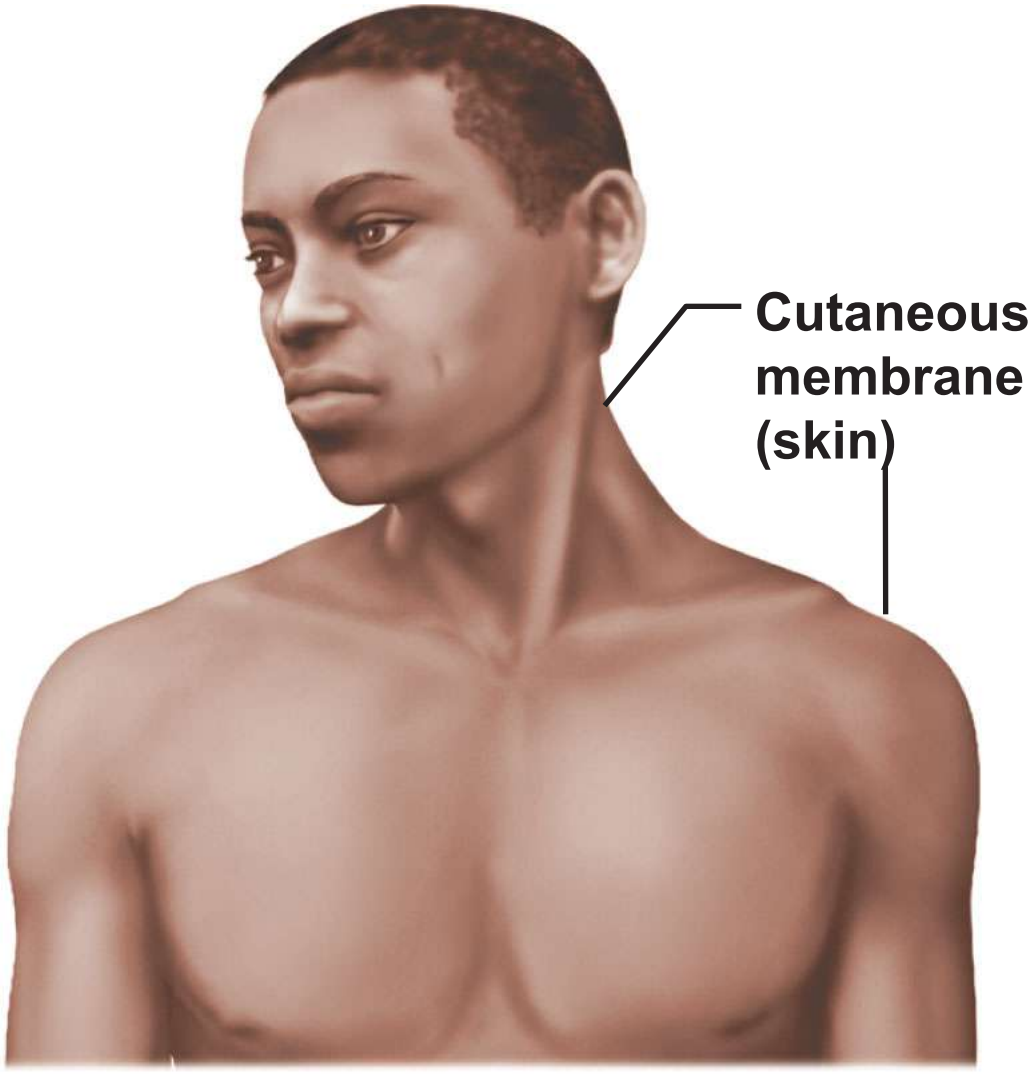


Photomicrograph: Sheet of smooth muscle (200x).

Figure 4.10c

Epithelial Membranes

- Cutaneous membrane (skin)

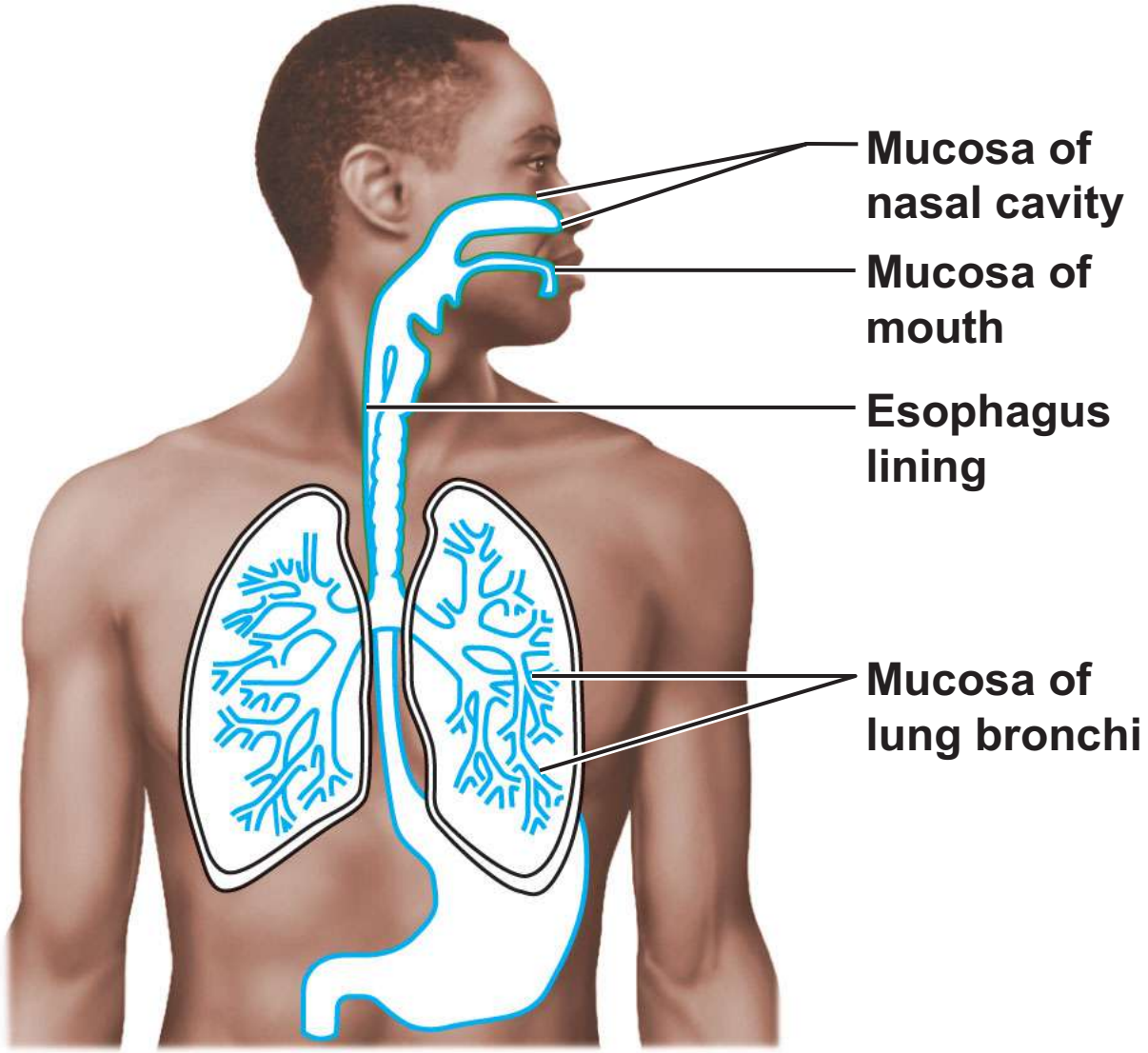


(a) Cutaneous membrane (the skin) covers the body surface.

Figure 4.11a

Epithelial Membranes

- Mucous membranes
  - Mucosae
    - Line body cavities open to the exterior (e.g., digestive and respiratory tracts)

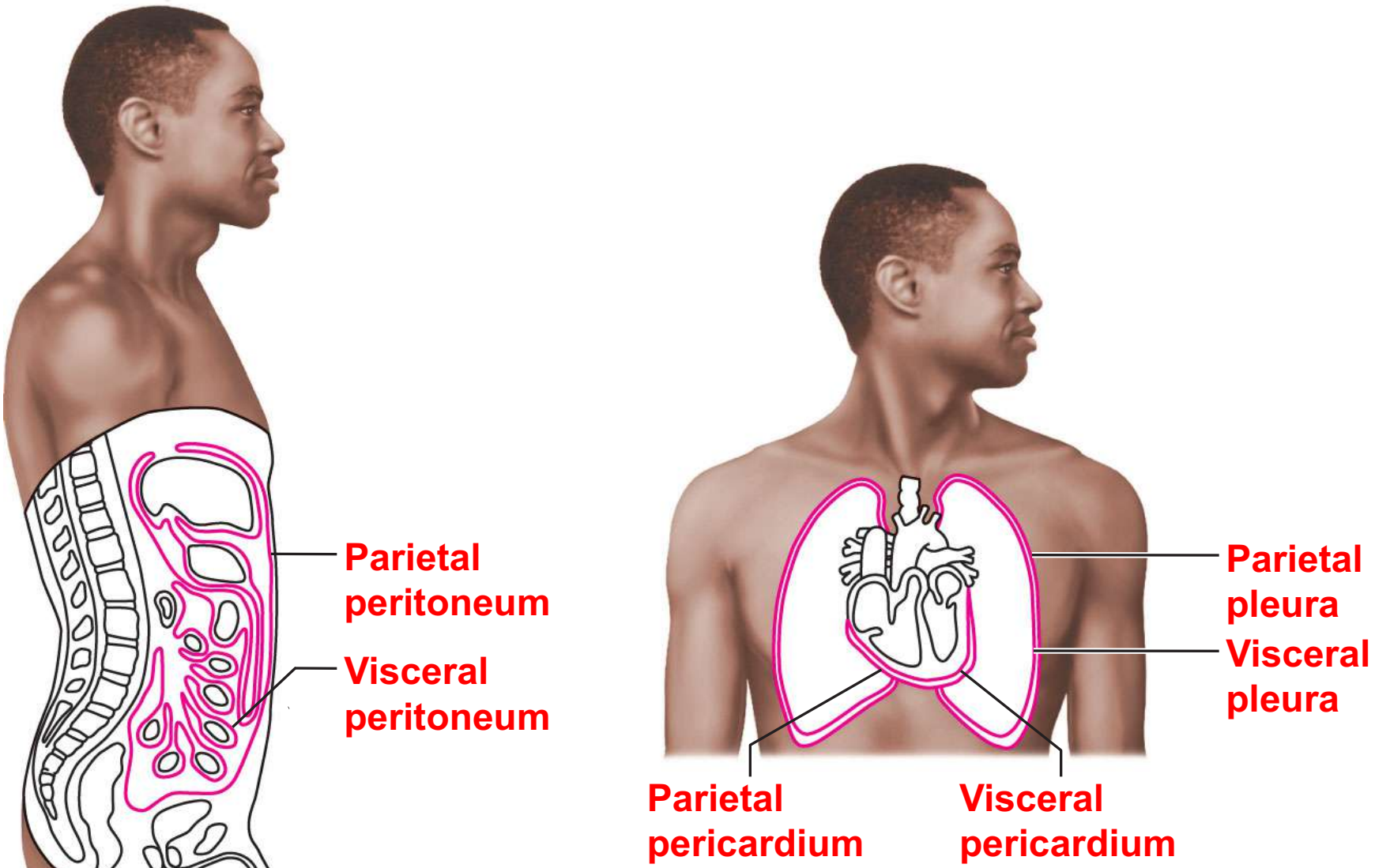


(b) Mucous membranes line body cavities open to the exterior.

Figure 4.11b

Epithelial Membranes

- Serous Membranes
  - Serosae—membranes (mesothelium + areolar tissue) in a closed ventral body cavity
  - Parietal serosae line internal body walls
  - Visceral serosae cover internal organs

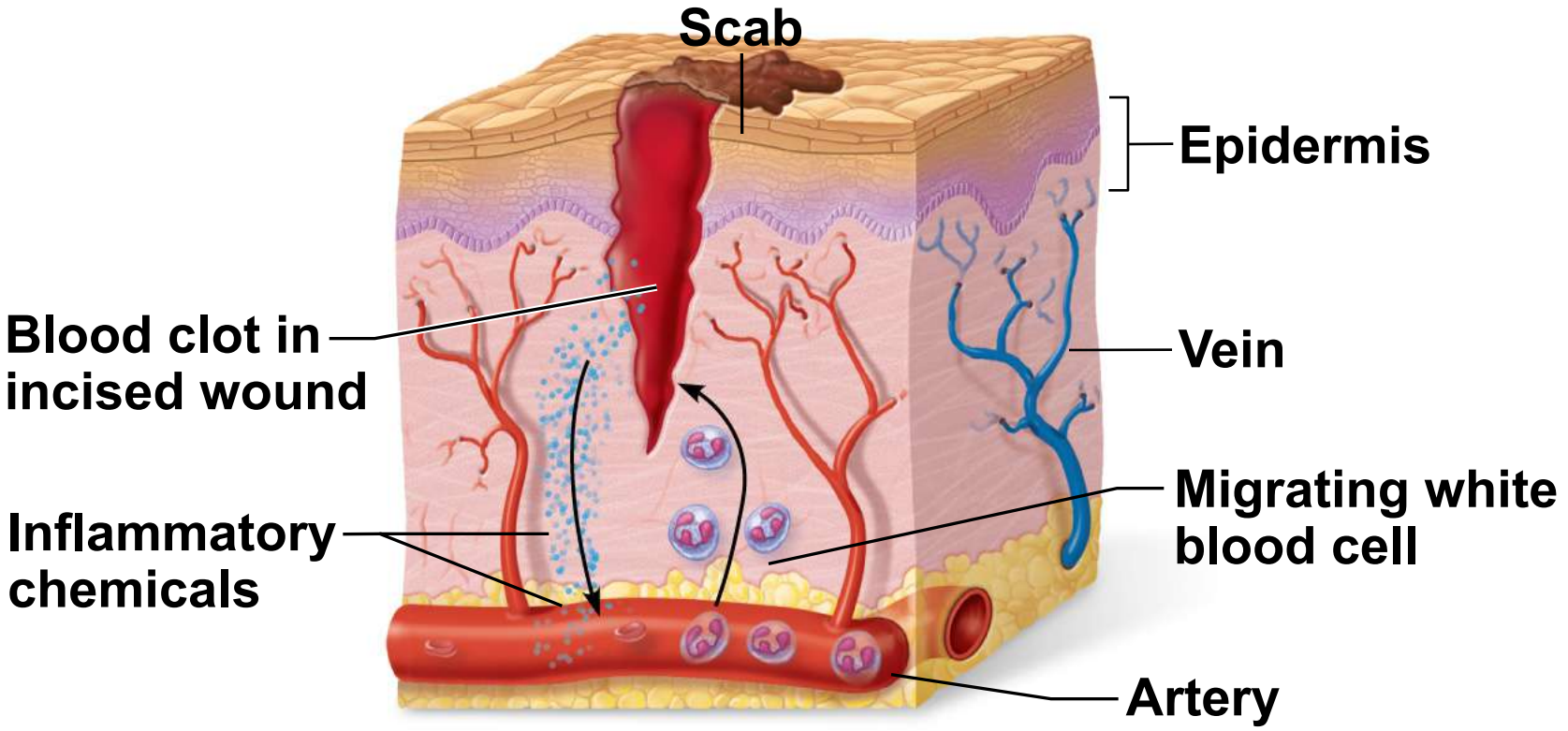


(c) Serous membranes line body cavities closed to the exterior.

Figure 4.11c

Steps in Tissue Repair

- Inflammation
  - Release of inflammatory chemicals
  - Dilation of blood vessels
  - Increase in vessel permeability
  - Clotting occurs



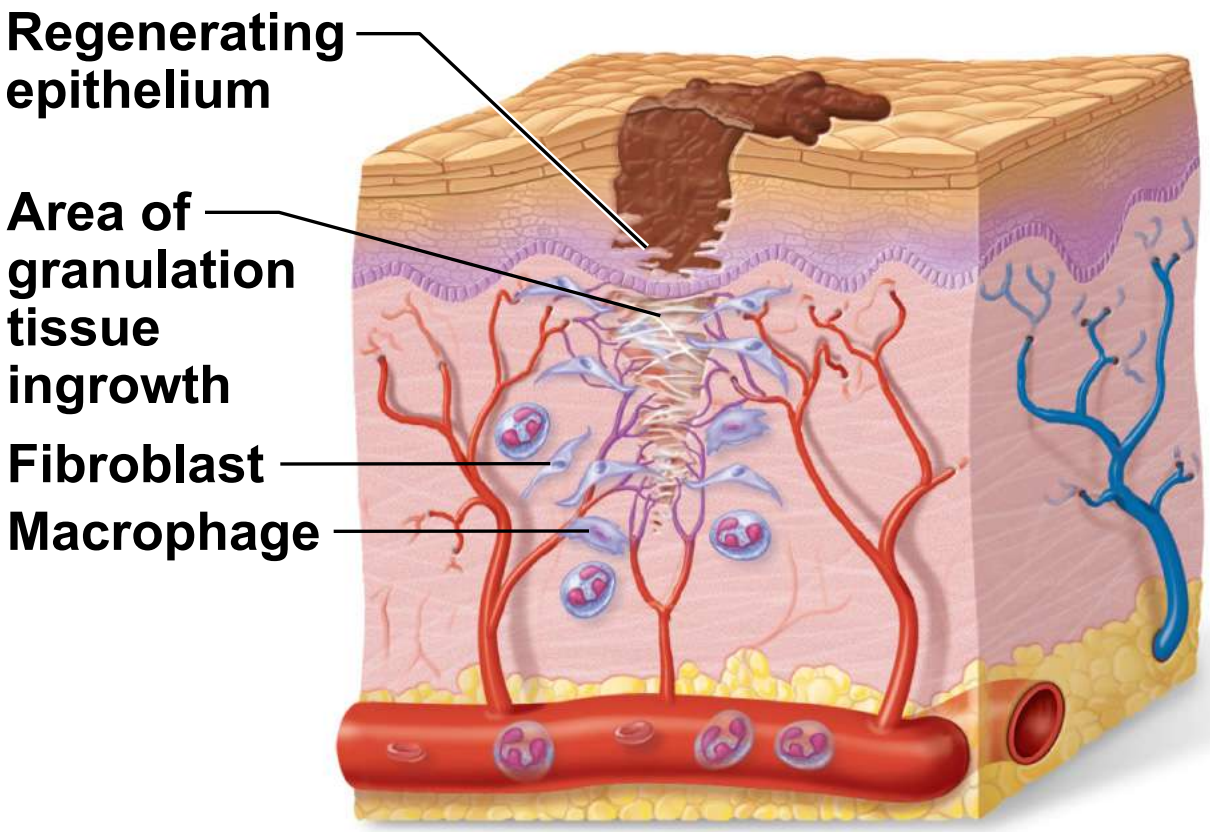
Inflammation sets the stage (edema):

1. • Severed blood vessels bleed and inflammatory chemicals (**histamine**) are released from **mast** cells.
   • Local blood vessels become more permeable, allowing white blood cells, fluid, clotting proteins and other plasma proteins to seep into the injured area.
   • Clotting occurs (thrombocytes plasma proteins); surface dries and forms a scab.

Figure 4.12, step 1

Steps in Tissue Repair

- Organization and restored blood supply
  - The blood clot is replaced with granulation tissue
  - Epithelium begins to regenerate
  - Fibroblasts produce collagen fibers to bridge the gap
  - Debris is phagocytized



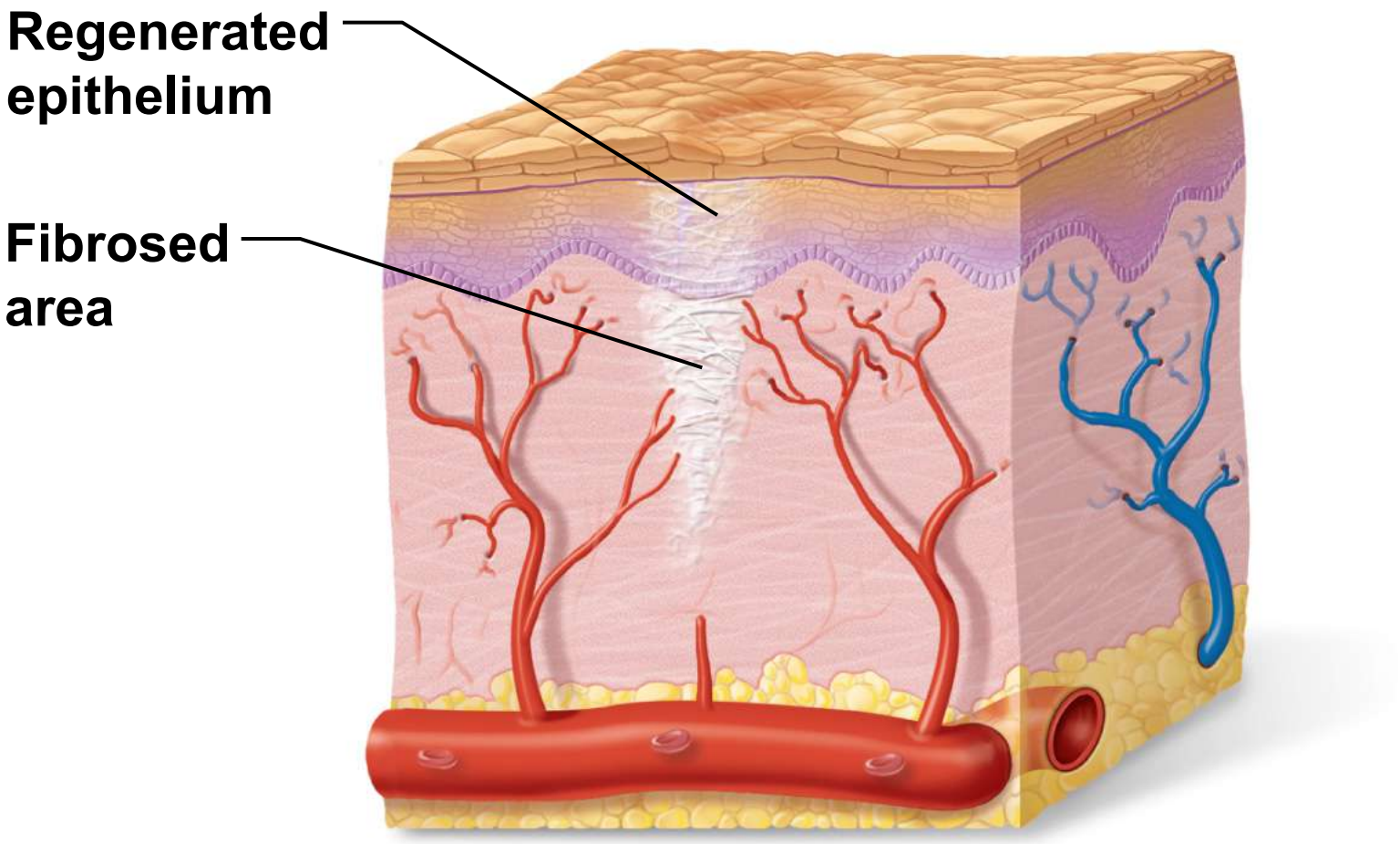
② Organization restores the blood supply:

- The clot is replaced by granulation tissue (fibrous connective tissue), which restores the vascular supply.
- Fibroblasts produce collagen fibers that bridge the gap.
- Macrophages phagocytize cell debris.
- Surface epithelial cells multiply and migrate over the granulation tissue.

Figure 4.12, step 2

Steps in Tissue Repair

- Regeneration and fibrosis
  - The scab detaches
  - Fibrous tissue matures; epithelium thickens and begins to resemble adjacent tissue
  - Results in a fully regenerated epithelium with underlying scar tissue



③ Regeneration and fibrosis effect permanent repair:

- The fibrosed area matures and contracts; the epithelium thickens.
- A fully regenerated epithelium with an underlying area of scar tissue results.

Figure 4.12, step 3

Developmental Aspects

- Primary germ layers: ectoderm, mesoderm, and endoderm
  - Formed early in embryonic development
  - Specialize to form the four primary tissues
    - Nerve tissue arises from ectoderm
    - Muscle and connective tissues arise from mesoderm
    - Epithelial tissues arise from all three germ layers

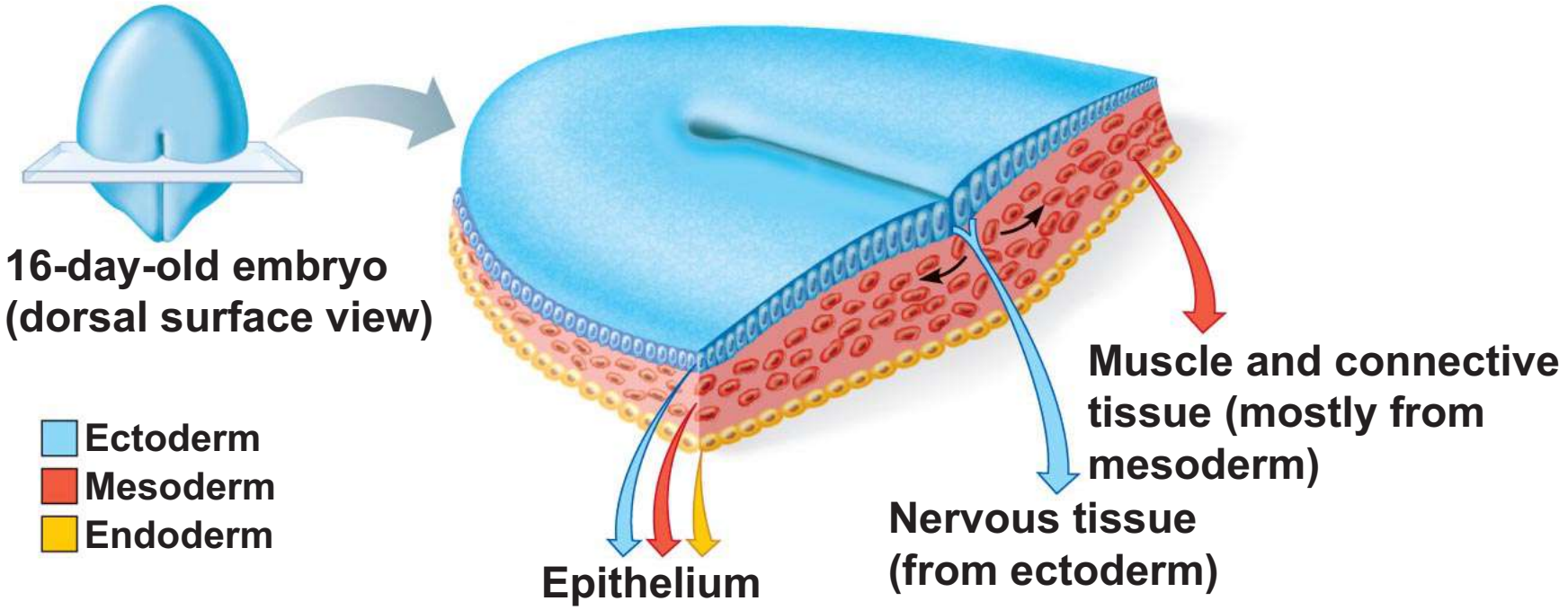


Figure 4.13