Connective Tissue Proper

Connective tissue proper

- Also known as **general connective tissue**
- Widely distributed in body
- Connect tissues and organs to one another
- Components of internal architecture of some organs

Connective Tissue Proper

- **Cells of connective tissue proper – resident cells** permanently inhabit tissue; **migrant cells** migrate into different areas of body depending on situation; cells in connective tissue proper include:
  - **Fibroblasts**
  - **Adipocytes**
  - **Mast cells**
  - **Phagocytes**
  - **Other immune system cells**

Connective Tissue Proper

- **Cells of connective tissue proper** (continued):
  - **Fibroblasts** – most common resident cell
  - Mature cells that have properties of an immature "blast" cell
  - Make protein fibers and ground substance (components of ECM); continually produce collagen proteins

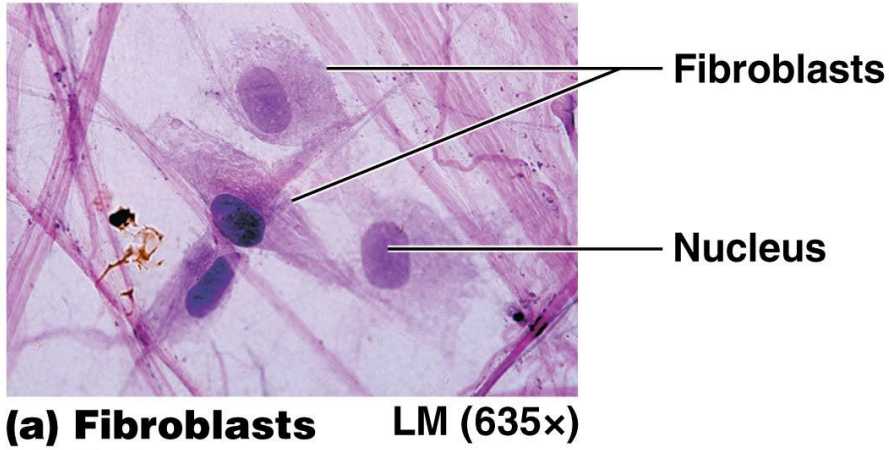


Figure 4.12a Cells of connective tissue proper.

Connective Tissue Proper

- **Cells of connective tissue proper** (continued):
  - **Adipocytes** (fat cells) – found in many different connective tissues; cytoplasm of each cell is filled with a single large *lipid inclusion*

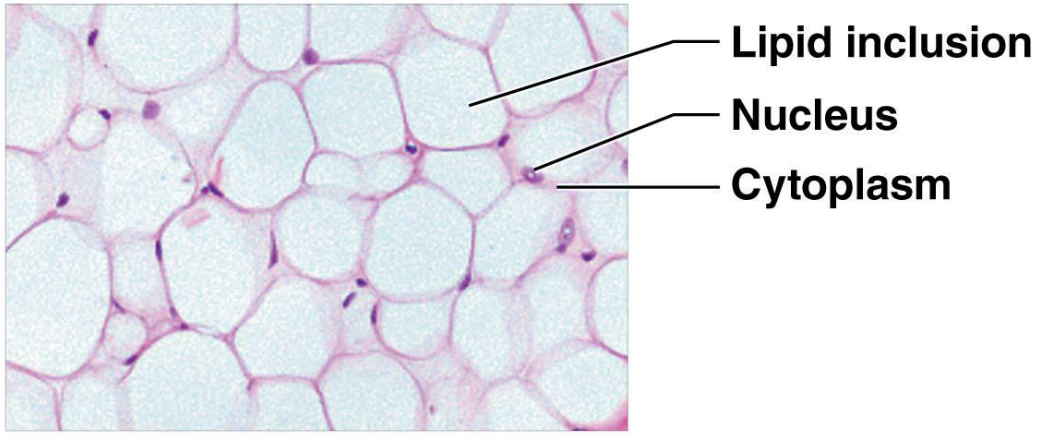


Figure 4.12b Cells of connective tissue proper.

Connective Tissue Proper

- **Cells of connective tissue proper** (continued):
  - **Mast cells** – largest resident cell
    - Immune system cells filled with cytosolic inclusions (**granules**) of inflammatory mediators such as **histamine**
    - Release mediators when stimulated, causing **inflammation** (protective response that *activates immune system*)

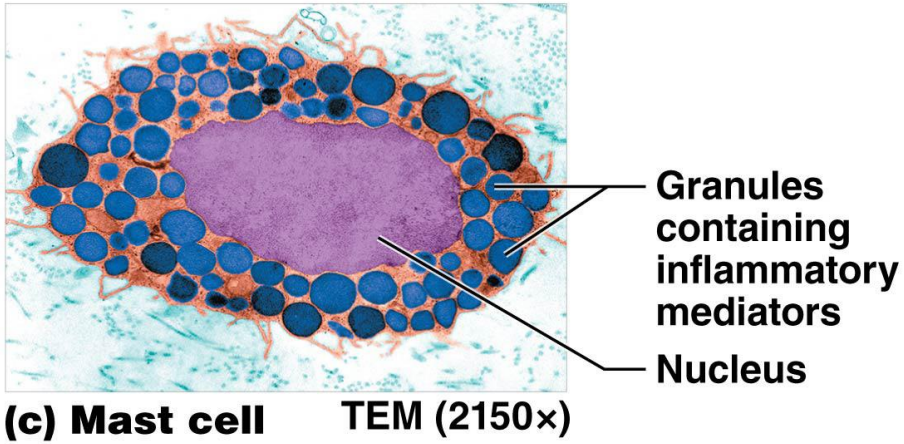


Figure 4.12c Cells of connective tissue proper.

Connective Tissue Proper

- **Cells of connective tissue proper** (continued):
  - **Phagocytes** – also immune system cells; can ingest foreign substances, microorganisms, and dead or damaged cells by **phagocytosis**; include **macrophages** (either resident or migrant) and **neutrophils** (migrant cells)
  - **Other immune system cells** can migrate in and out of connective tissues depending on body's needs

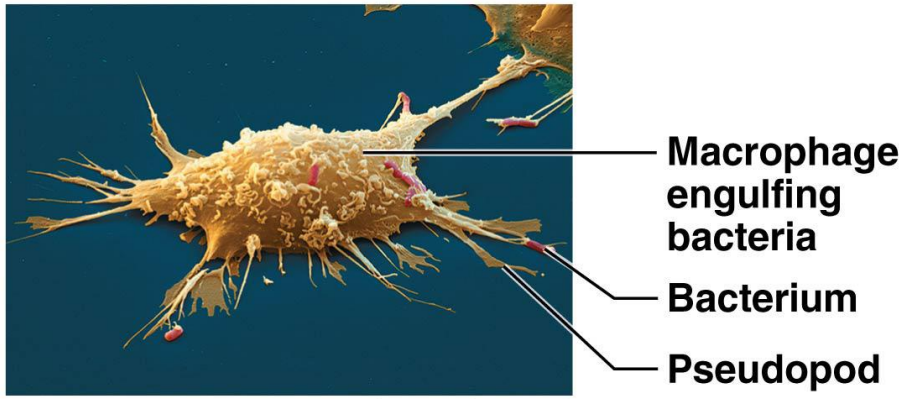


Figure 4.12d Cells of connective tissue proper.

Connective Tissue Proper

- Four basic **types of connective tissue proper**:
  - Loose connective tissue
  - Dense connective tissue
  - Reticular tissue
  - Adipose tissue

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Loose connective tissue** (**areolar** tissue) – mostly ground substance, with all three types of protein fibers, fibroblasts, and other cells such as adipocytes, suspended in ground substance (**Figure 4.13**):
    - Found beneath epithelium of skin, in membranes lining body cavities, and within walls of hollow organs
    - Contains and supports blood vessels vital to avascular epithelial tissues; houses immune system cells that protect body from microorganisms

Connective Tissue Proper

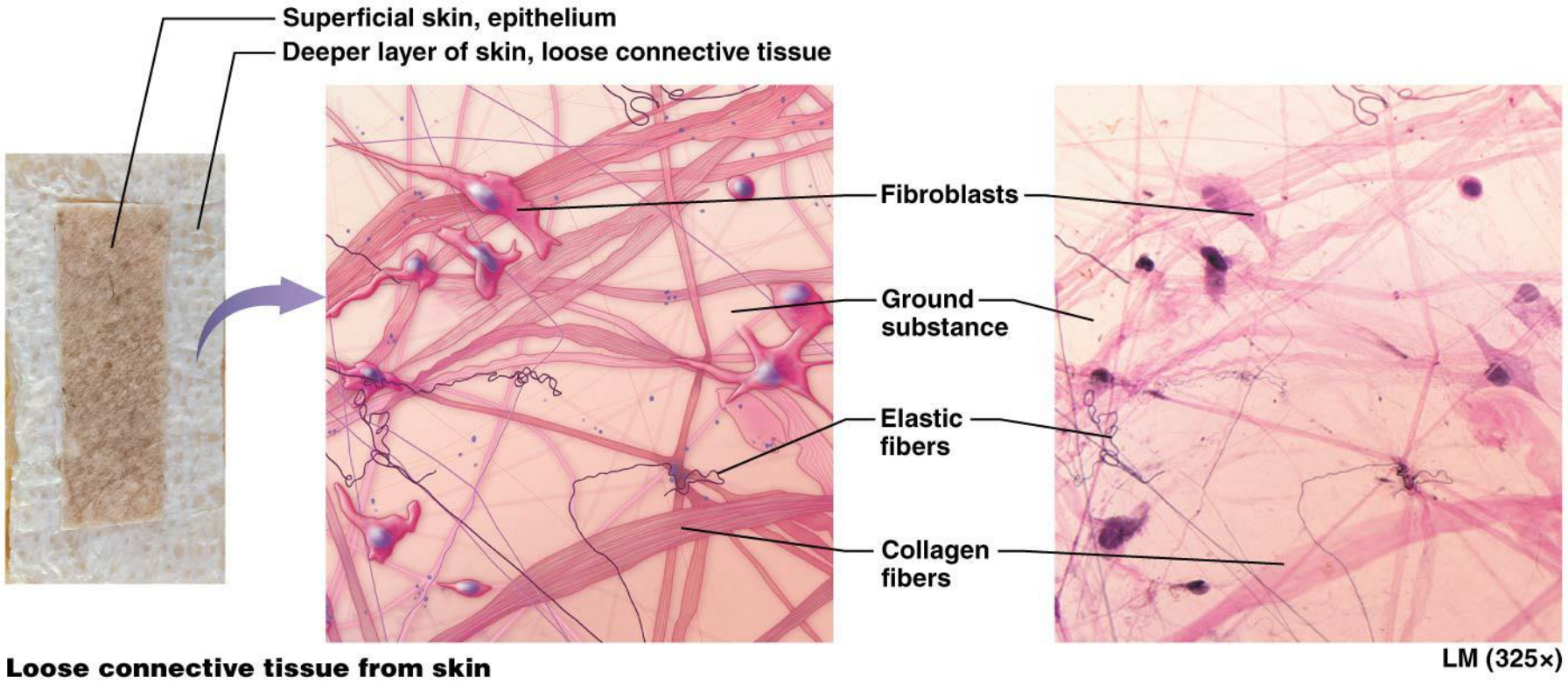


Figure 4.13 Structure of loose connective tissue.

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Dense connective tissue** (**fibrous connective tissue**) – mostly protein fibers; grouped into three classes:
    - **Dense irregular connective tissue** – predominantly *disorganized collagen bundles* (**Figure 4.14a**)
      - Strong and resists tension in *all three planes of movement*
      - Found in *high tension areas* like **dermis** (deep to skin) and surrounding organs and joints

Connective Tissue Proper

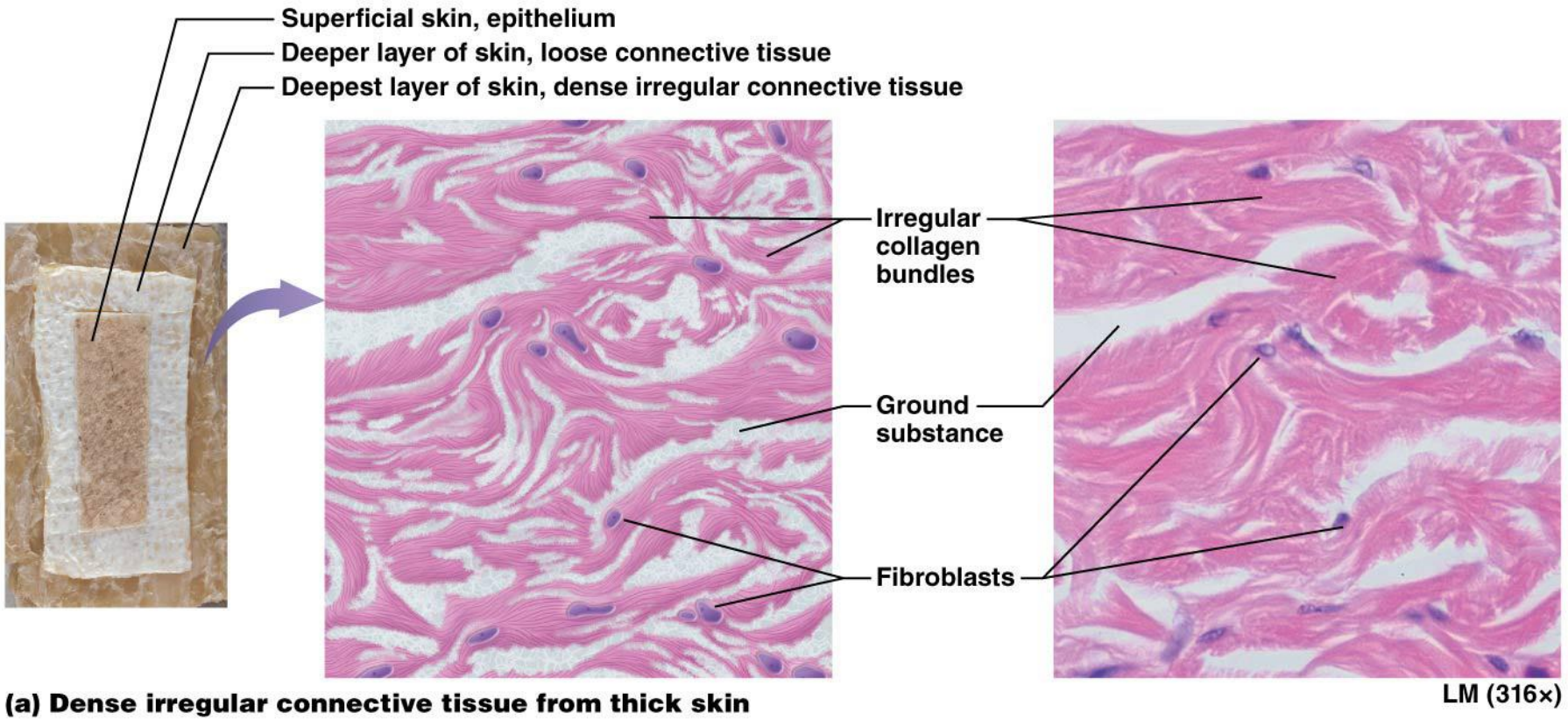


Figure 4.14a Structure of dense connective tissue.

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Dense connective tissue** (continued):
    - **Dense regular connective tissue** (**Figure 4.14b**)
      - Predominantly organized into *parallel collagen bundles*; resistant to tension in <u>one</u> *plane*
      - Found in tendons and ligaments that are subject to tension in one plane of movement

Connective Tissue Proper

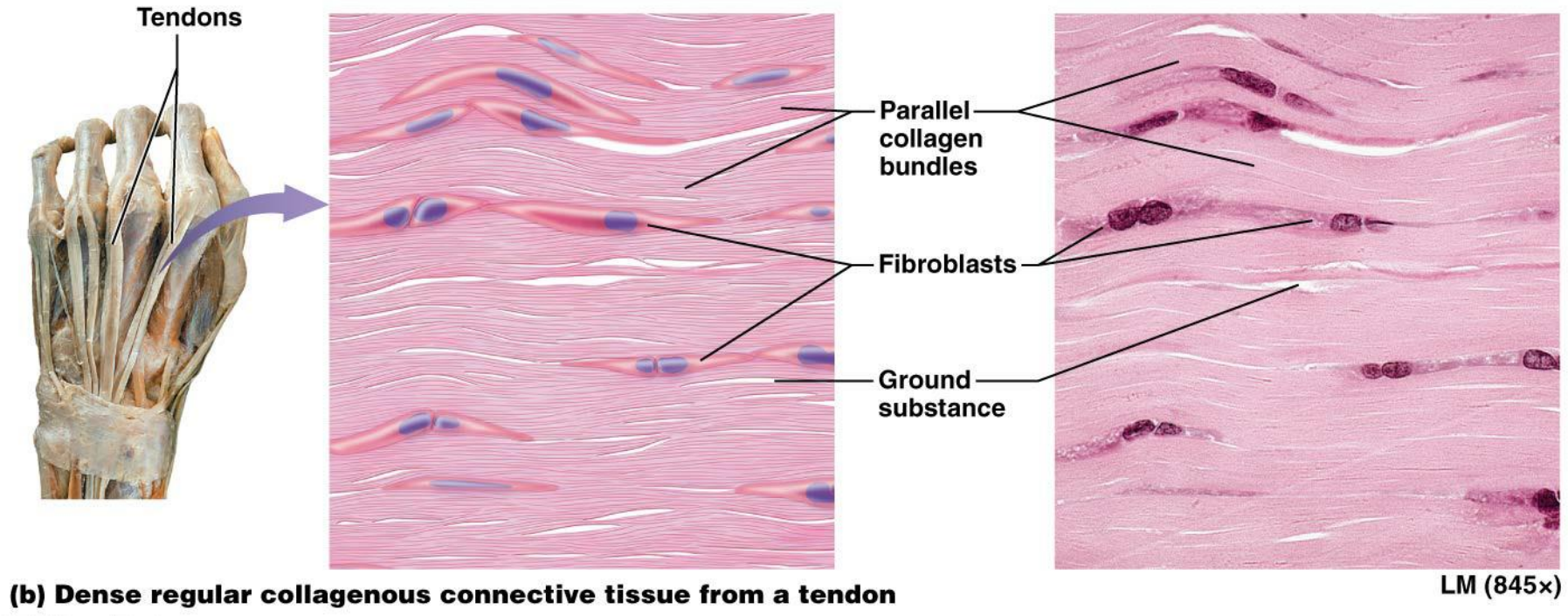


Figure 4.14b Structure of dense connective tissue.

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Dense connective tissue** (continued):
    - **Dense regular elastic connective tissue** (**elastic tissue**) (**Figure 4.14c**)
      - Mostly *parallel-oriented elastic fibers* with *randomly oriented collagen fibers*
      - Found in walls of organs that *stretch* to perform their function, such as large blood vessels and certain ligaments

Connective Tissue Proper

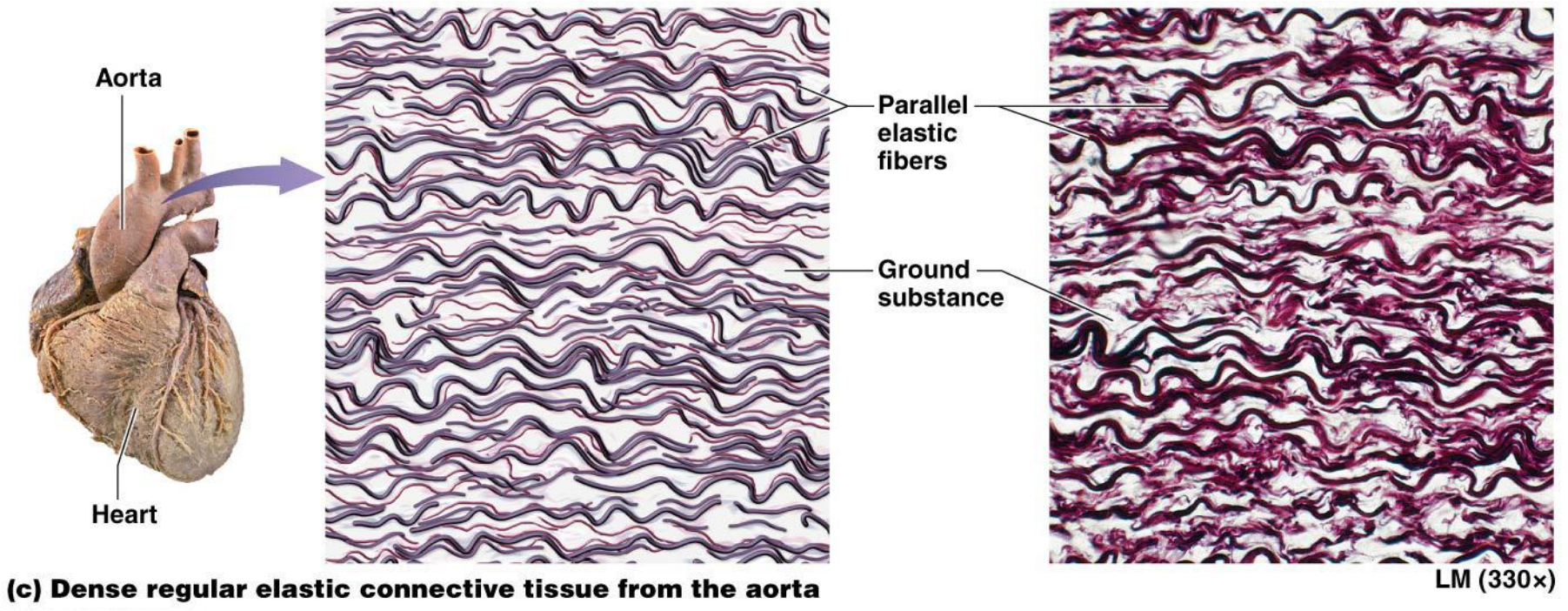


Figure 4.14c Structure of dense connective tissue.

Connective Tissue Proper

Note: *arrangement of fibers* in dense regular and irregular connective tissues is another example of the **Structure-Function Core Principle**

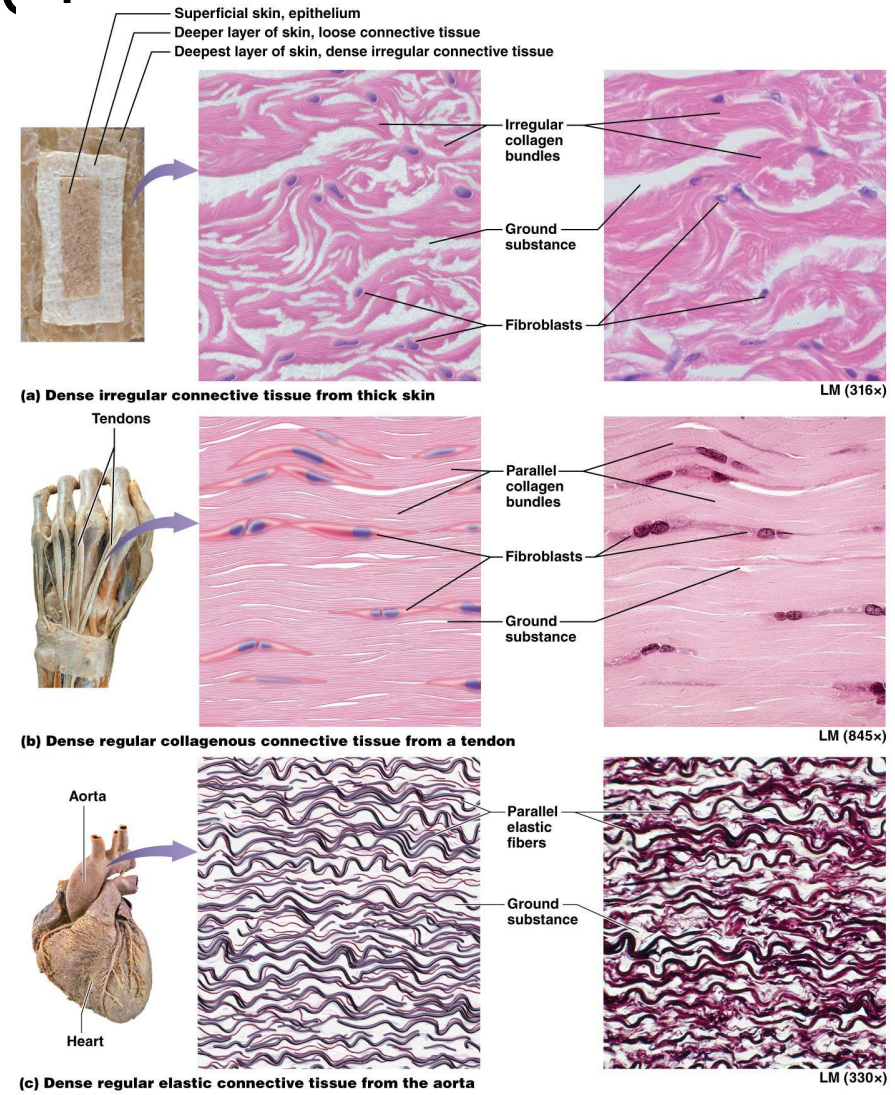


Figure 4.14 Structure of dense connective tissue.

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Reticular tissue** – composed mostly of **reticular fibers** produced by fibroblasts (**reticular cells**); form fine networks that can *support small structures* like blood and lymphatic vessels (**Figure 4.15**)
    - Also found in lymph nodes and spleen; form weblike nets that trap old and foreign cells
    - Forms part of basement membrane that supports all epithelia and internal structure of liver and bone marrow

Connective Tissue Proper

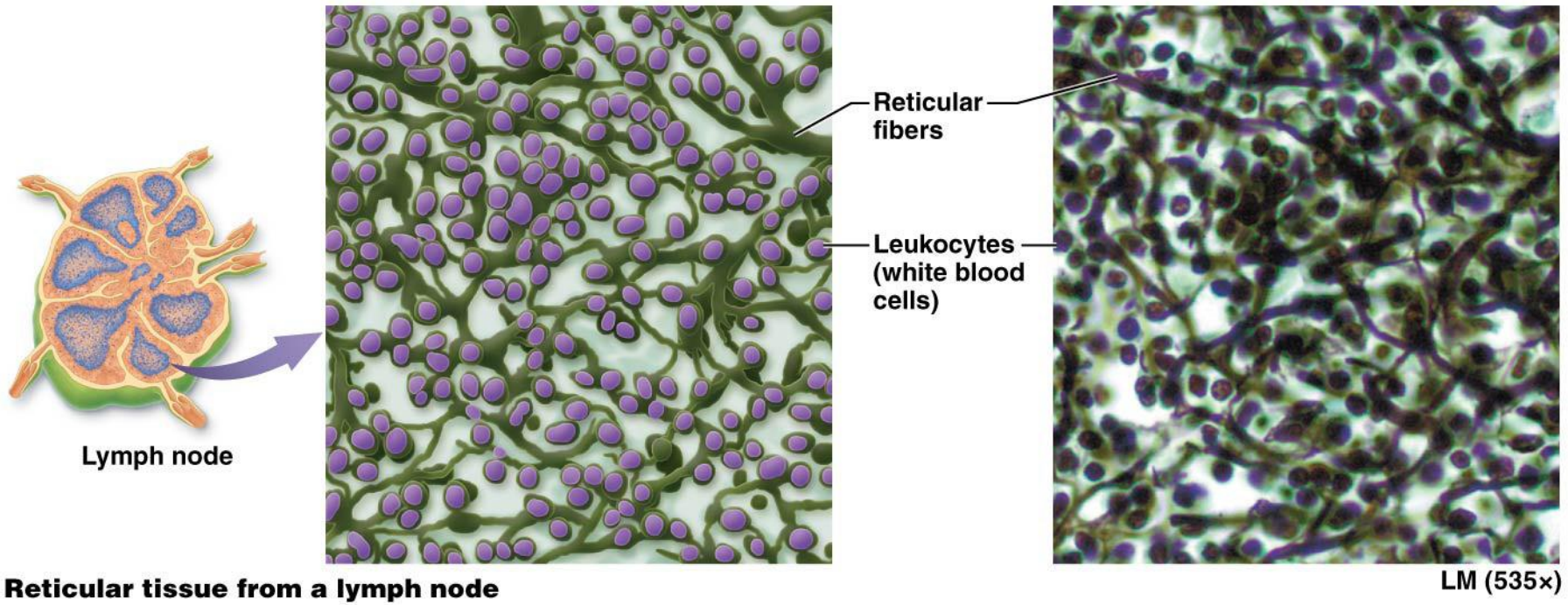


Figure 4.15 Structure of reticular tissue.

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Adipose tissue** (fat tissue) – consists of fat-storing **adipocytes** and surrounding fibroblasts and ECM; adipocytes can increase in size to point where fibroblasts and ECM are scarcely visible (**Figure 4.16**); functions include:
    - Fat storage (major energy reserve of body)
    - Insulation (retains warmth)
    - Shock absorption and protection

Connective Tissue Proper

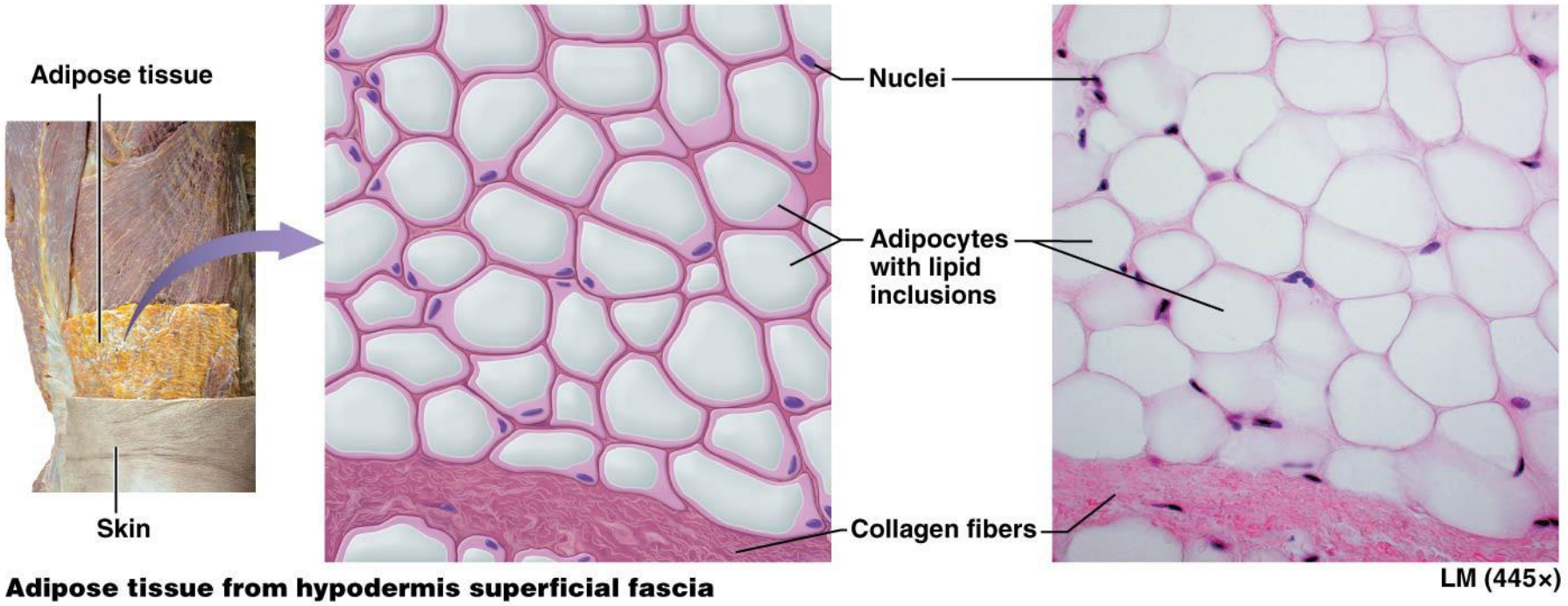


Figure 4.16 Structure of adipose tissue.

Connective Tissue Proper

- Four basic **types of connective tissue proper** (continued):
  - **Adipose tissue** (continued):
    - **White adipose tissue** – predominant fat tissue; appears white; consists of adipocytes with one *large lipid inclusion* in cytosol; found deep to skin as subcutaneous fat, and in abdomen, breasts, hips, buttocks, and thighs; white adipose surrounds heart and abdominal organs is known as **visceral fat**
    - **Brown adipose tissue** – less common; has a brown appearance due to *numerous mitochondria* in cytoplasm and a *vast blood supply*; contain multiple *lipid inclusions,* cells of brown adipose tissue can oxidize fatty acids about 20 times as fast as white adipose tissue, additional energy used to generate heat.

Adipose Tissue and Obesity

- **Obesity** – condition of having *excess adipose tissue* in proportion to lean body mass; two forms:
  - **Hypertrophic** – lipid inclusions accumulate excess fatty acids and increase in size up to 4× normal; *number of adipocytes* remains unchanged
  - **Hypercellular** – generally severe; *number of adipocytes* increases; correlates with development of obesity in infancy or early childhood; adult adipocytes *lack ability to divide* to form new cells
- Both forms increase risk for certain health problems; development of related disorders is *complex*; depends on *distribution of adipose tissue* and *genetic factors*

Specialized Connective Tissues

Specialized connective tissues have more specific functions and include the following three types of tissue (**Figures 4.17**, **4.18**, **4.19**):

- **Cartilage** – found in joints between bones, in ear, nose, and segments of respiratory tract
- **Bone tissue** (**osseous tissue**) – supports body; protects vital organs; provides attachments for muscles that allow for movement; stores calcium, and houses bone marrow (produces blood cells and stores fat)
- **Blood** – unique connective tissue with a liquid ECM called **plasma**; consists of mostly water, dissolved solutes, and proteins

Specialized Connective Tissues

Specialized connective tissues (continued):

- **Cartilage** – tough, flexible tissue; absorbs shock and resists tension, compression, and shearing forces; ECM consists of collagen and elastic fibers, glycosaminoglycans, and proteoglycans
  - Populated with two cell types:
    - **Chondroblasts** – immature cells that *divide by mitosis* and *make most of ECM*
    - Surround themselves in ECM gradually mature and become relatively *inactive* **chondrocytes,** which eventually inhabit small cavities in ECM called **lacunae.**

Specialized Connective Tissues

Specialized connective tissues (continued):

- **Cartilage** (continued):
  - One of few connective tissues that is essentially *avascular*, few if any blood vessels course through cartilage itself, blood supply to tissue is mostly limited to outer sheath (**perichondrium**)
  - Oxygen and nutrients must diffuse from blood vessels in perichondrium through ECM to supply chondroblasts and chondrocytes; limits *thickness* of living cartilage

Specialized Connective Tissues

Specialized connective tissues (continued):

- Cartilage can be further divided into three classes based on *ECM composition* (**Figure 4.17**):
  - **Hyaline cartilage** – most abundant cartilage
    - ECM mostly ground substance made of small bundles of fine collagen; give tissue a glassy appearance
    - Found on ends of bones in joints (**articular cartilage**), linking sternum to ribs, framing sections of respiratory tract, and in nose
    - Most of fetal skeleton begins as hyaline cartilage; replaced with bone during development

Specialized Connective Tissues

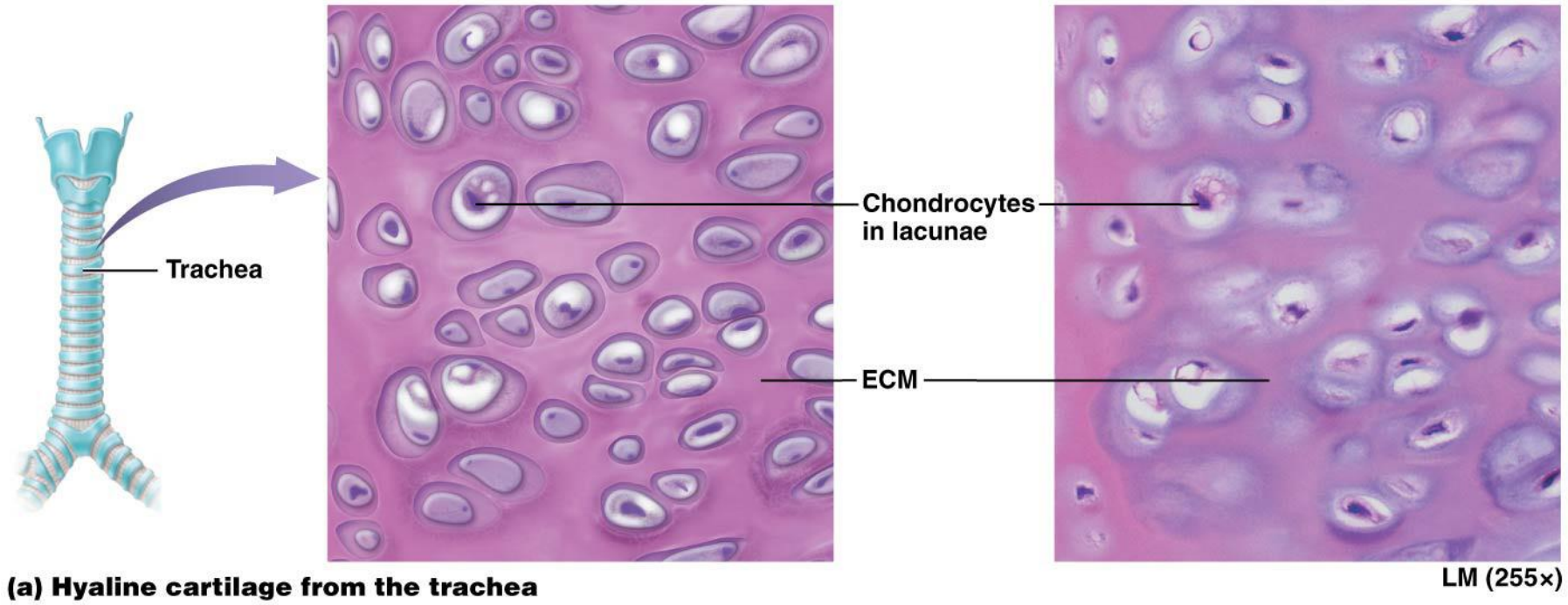


Figure 4.17a Structure of cartilage.

Specialized Connective Tissues

Specialized connective tissues (continued):

- Cartilage can be further divided into three classes based on ECM composition (continued):
  - **Fibrocartilage** – filled with bundles of collagen fibers with little room for ground substance in ECM (**Figure 4.17b**)
    - Fibroblasts reside in tissue in addition to chondroblasts and chondrocytes; fill ECM with collagen and some elastic fibers
    - Tissue has great *tensile strength* with some degree of elasticity
    - Found in fibrous joints; intervertebral discs and forms **articular discs** that improve fit of bones in joints

Specialized Connective Tissues

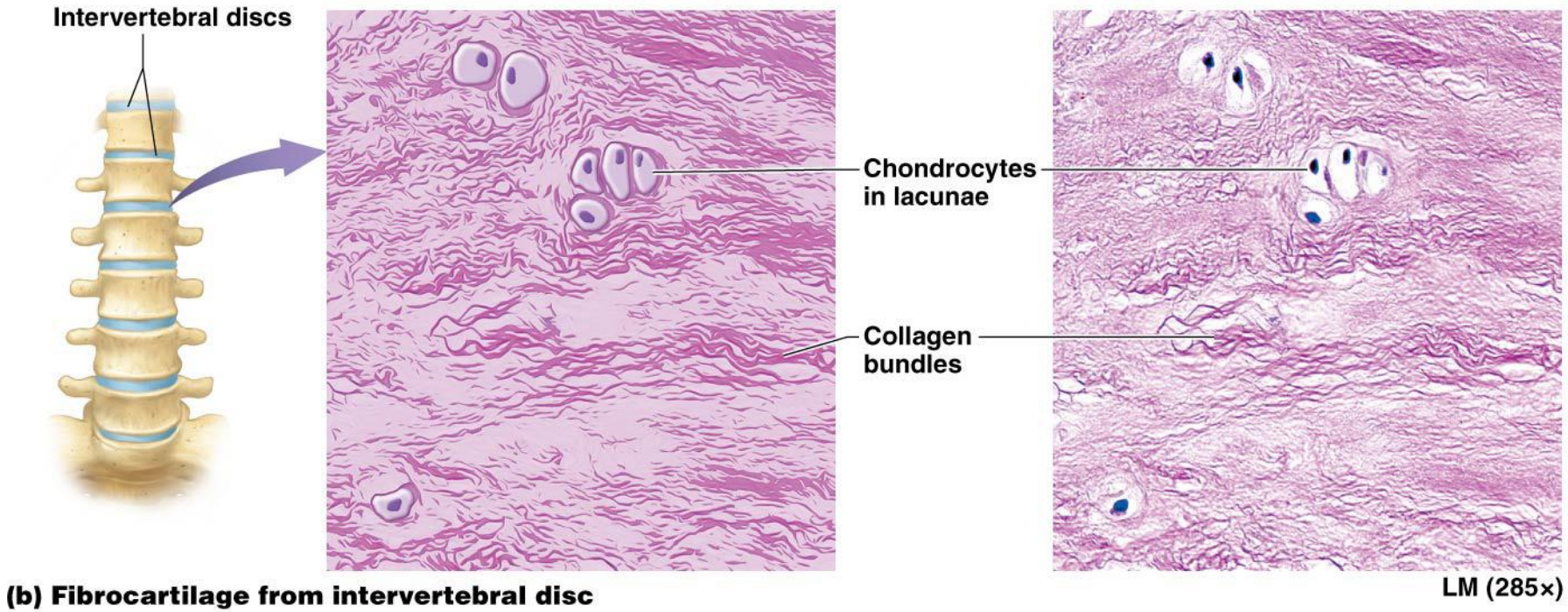


Figure 4.17b Structure of cartilage.

Specialized Connective Tissues

Specialized connective tissues (continued):

- Cartilage can be further divided into three classes based on ECM composition (continued):
  - **Elastic cartilage** –ECM is filled with elastic fibers (**Figure 4.17c**)
    - Allows this tissue to *vibrate*
    - Found in a limited number of structures; **external ear and** parts of **larynx** (“voice box”)

Specialized Connective Tissues

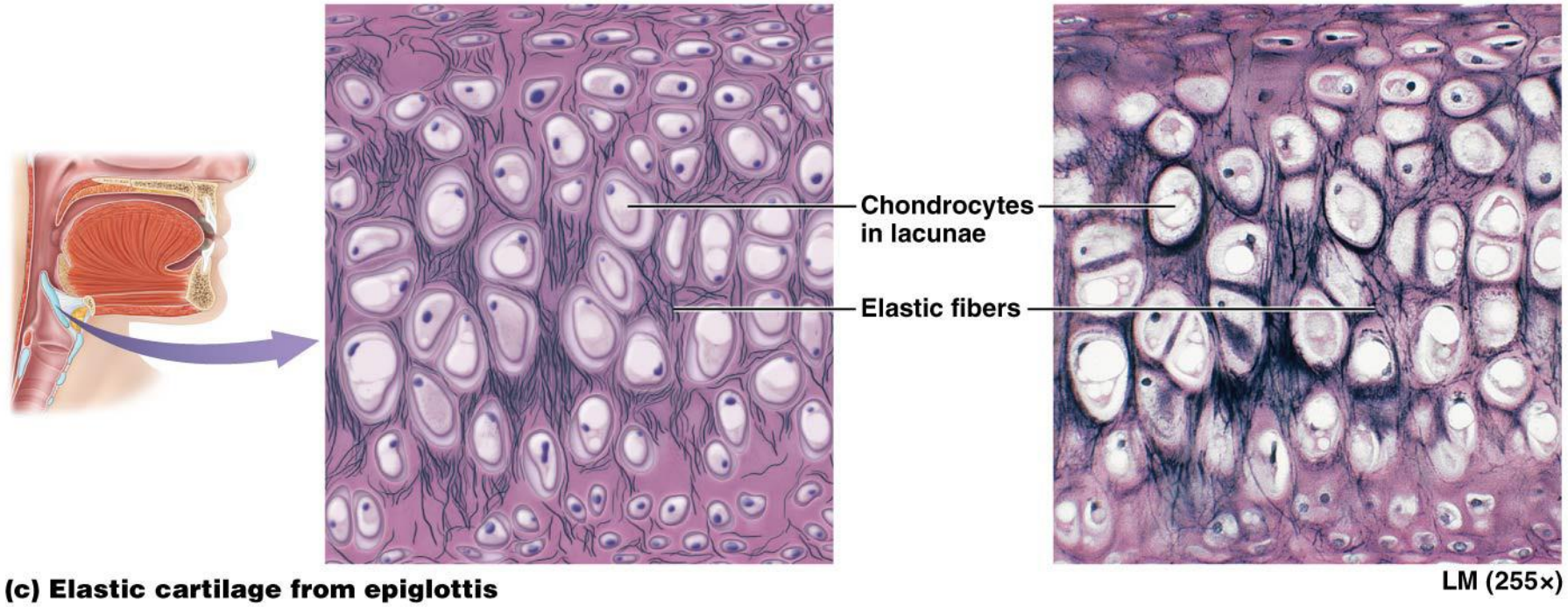


Figure 4.17c Elastic cartilage from epiglottis.

Specialized Connective Tissues

Specialized connective tissues (continued):

- **Bone**
  - Bone ECM is composed of about 35% organic components consisting of collagen fibers and ground substance called **osteoid**; remaining 65% of ECM is *inorganic portion composed of calcium phosphate crystals* making bone one of hardest substances in body (**Figure 4.18a**)
  - Bone is a *dynamic tissue* capable of *remodeling*; bone deposition and resorption is constantly occurring in healthy bone; tension increases *osteoblast activity* and bone *deposition*; pressure can increase *osteoclast activity* and bone *resorption*

Specialized Connective Tissues

Specialized connective tissues (continued):

- **Bone** (continued):
  - **Osteoblasts** (**Figure 4.18b**)
    - "Bone-builders" found on outer surface of bones; closely associated with dense irregular collagenous connective tissue covering called **periosteum**
    - Carry out process of bone *deposition*; synthesize and secrete *organic portion of ECM* and required chemicals for calcium to deposit within ECM.

Specialized Connective Tissues

Specialized connective tissues (continued):

- **Bone** (continued):
  - **Osteocytes** – osteoblasts that have *surrounded themselves with ECM* in lacunae; mature bone cells, *relatively inactive* but continue to make and secrete substances required for bone *maintenance*
  - **Osteoclasts** – large, *multinucleated* bone destroyers; carry out process of bone *resorption*; secrete hydrogen ions and enzymes that *break down components of ECM*

Specialized Connective Tissues

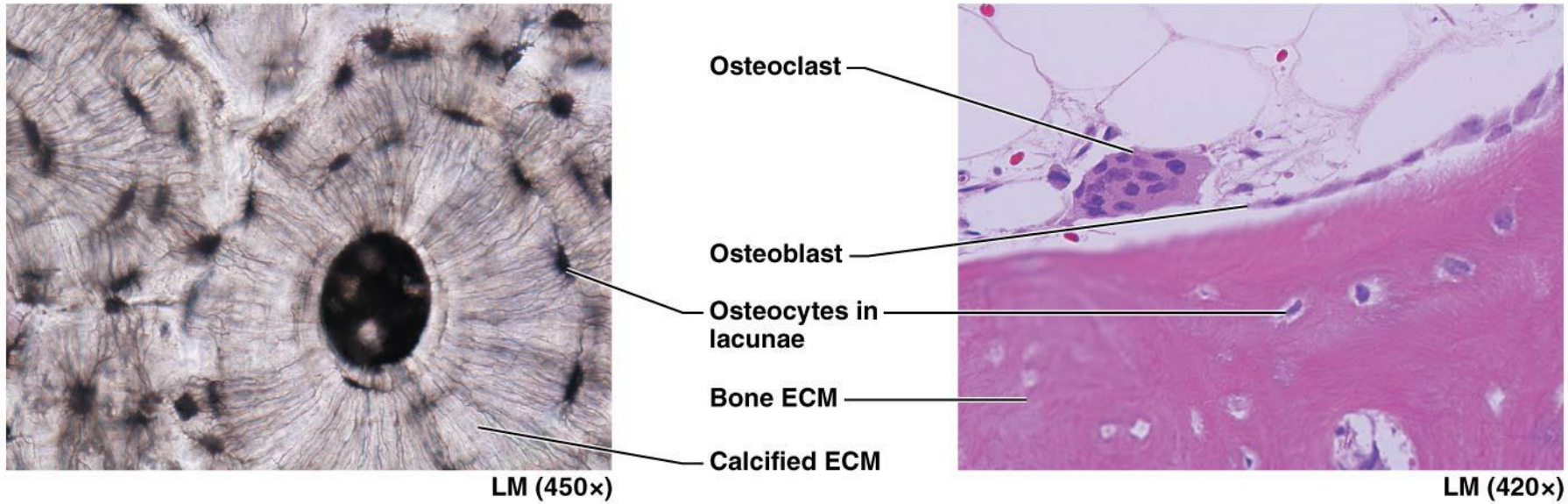


Figure 4.18 Structure of bone.

Specialized Connective Tissues

Specialized connective tissues (continued):

- **Blood** – unique in that ECM is *fluid* (**Figure 4.19**)
    - ECM of blood is called **plasma.**
    - **Plasma proteins** – not fibers, smaller proteins with a variety of functions including *transport* of substances and *blood clotting*
    - **Erythrocytes** (**red blood cells**) bind to and *transport oxygen* through body
    - **Leukocytes** (**white blood cells**) function in *immunity*
    - **Platelets** – cell fragments; major role in *blood clotting*

Specialized Connective Tissues

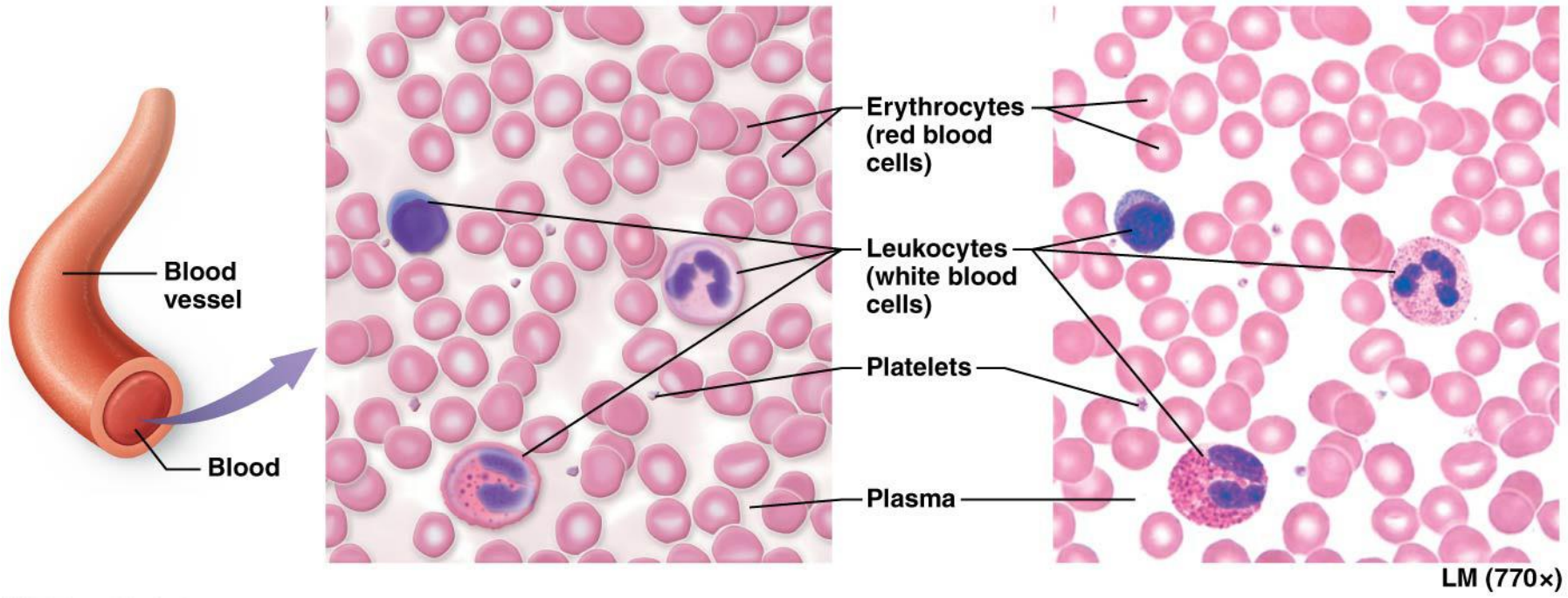


Figure 4.19 Components of blood.

Osteoarthritis and Glucosamine Supplements

- **Osteoarthritis** – caused by a variety of factors including: age, joint trauma, genetic disorders, and infection
  - Develops as hyaline cartilage lining joints degenerates
  - Leads to destruction of proteoglycan and collagen fibers; may continue until bone is exposed
  - Bones grind painfully together as motion occurs
- Chondroblasts use **glucosamine** in synthesis of proteoglycans; further studies needed to determine if glucosamine supplementation can truly *slow osteoarthritic degeneration* of joints

Connective Tissues

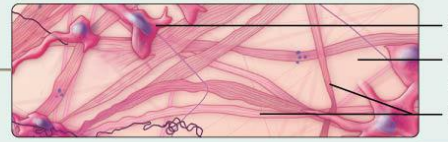
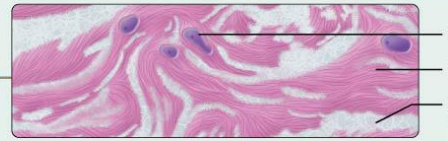
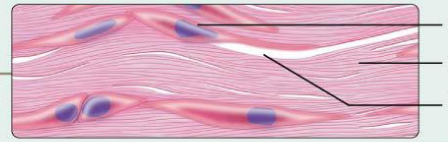
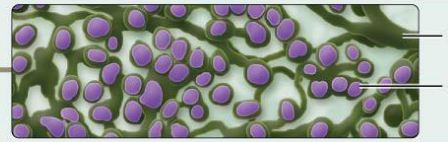
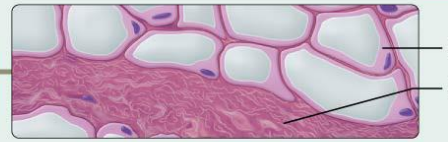
CONNECTIVE TISSUE PROPER		COMPONENTS	FUNCTION	LOCATION
Loose CT		Fibroblast Ground substance Protein fibers	• Support • Protection • Houses blood vessels supplying epithelium	• Deep to epidermis • Walls of hollow organs • Membranes lining body cavities
Dense CT				
Irregular		Fibroblast Collagen fibers Ground substance	• Strength • Resistance to stress in all three planes	• Deepest layer of skin • Around joints, organs
Regular collagenous		Fibroblast Collagen fibers Ground substance	• Strength • Resistance to stress in one plane	• Tendons, ligaments
Regular elastic		Elastic fibers Ground substance	• Allows tissue to stretch and recoil	• Large blood vessels • Certain ligaments
Reticular CT		Reticular fiber Leukocyte	• Forms internal structure of many organs • Supports smaller vessels and nerves	• Lymph nodes, spleen, bone marrow, liver • Basement membrane • Around vessels and nerves
Adipose CT		Adipocyte Protein fibers	• Warmth, insulation • Shock absorption, protection • Major energy reserve in the body	• Deep to the skin in characteristic areas • Surrounds the heart and abdominal organs

Figure 4.20 Summary of connective tissues.

Connective Tissues

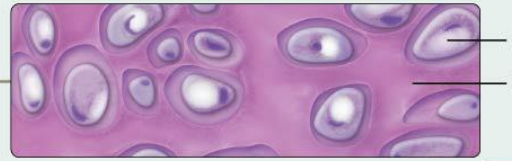
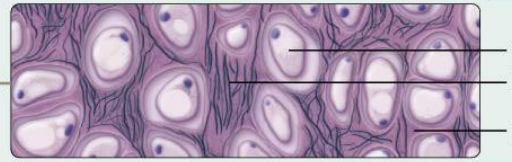
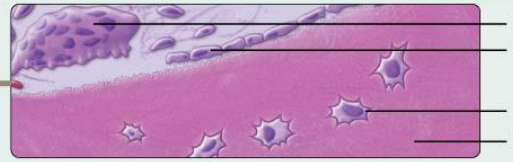
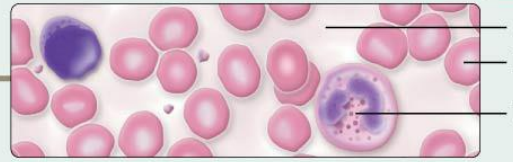
SPECIALIZED CONNECTIVE TISSUE	COMPONENTS	FUNCTION	LOCATION
Cartilage			
Hyaline 	Chondrocyte ECM	• Support • Protection • Resists compression	• Between bones in joints • Between sternum and ribs • Nose • Respiratory tract
Fibrocartilage 	Chondrocyte Collagen fibers ECM	• Support • Protection • Resists compression	• Intervertebral discs
Elastic 	Chondrocyte Elastic fibers ECM	• Involved in producing and detecting sound	• Ears • Epiglottis of larynx
Bone 	Osteoclast Osteoblast Osteocyte ECM	• Support • Protection • Provides leverage for movement • Stores calcium	• Bones
Blood 	Plasma Erythrocyte Leukocyte	• Transports nutrients, gases, wastes, immune cells	• Within blood vessels and chambers of the heart

Figure 4.20 Summary of connective tissues.

Module 4.4 Muscle Tissues

Muscle Tissues

- **Muscle tissues** are specialized for **contraction**
- Three muscle tissue types share common ability to turn *chemical energy* of ATP into mechanical *energy of movement*
- Walking, breathing, heart beating, and propulsion of substances through hollow organs all result from contractions of different muscle tissues
- Main component of muscle tissue is **muscle cell** or **myocyte**; **excitable** (ability to respond to electrical or chemical stimulation)

Components of Muscle Tissue

- Two forms of muscle cells based on arrangement of **myofilaments** (protein bundles) in cytoplasm:
  - **Striated muscle cells** – myofilaments are organized in such a way that there are regions where the myofilaments overlap and regions where they don't. This produces both dark and light areas called "bands", appear striped or striated under microscope **(striations)**
  - **Smooth muscle cells** – have myofilaments arranged in *irregular bundles* throughout cytoplasm, NO STRIATIONS visible
  - **Endomysium** – small amount of ECM that surrounds each muscle cell; helps to hold muscle cells together in tissue

Types of Muscle Tissue

- There are three *types of muscle tissue* that feature different structural and functional characteristics:
  - Skeletal muscle
  - Cardiac muscle
  - Smooth muscle
- Skeletal and cardiac muscle tissue are *striated* while smooth muscle tissue is not (**Figure 4.21**)

Types of Muscle Tissue

- **Skeletal muscle tissue** – found mostly attached to skeleton where its contraction produces *body movement* (**Figure 4.21a**):
  - Skeletal muscle must be *stimulated by the nervous system* to contract; generally under **voluntary** or conscious control
  - Most skeletal muscle cells are long, extending nearly length of whole muscle; often called **muscle fibers**
  - Form by *fusion* of embryonic **myoblasts** resulting in cells with more than one nucleus (**multinucleate**); useful for nearly constant synthesis of *enzymes*, *structural proteins*, and *contractile proteins*

Components of Muscle Tissue

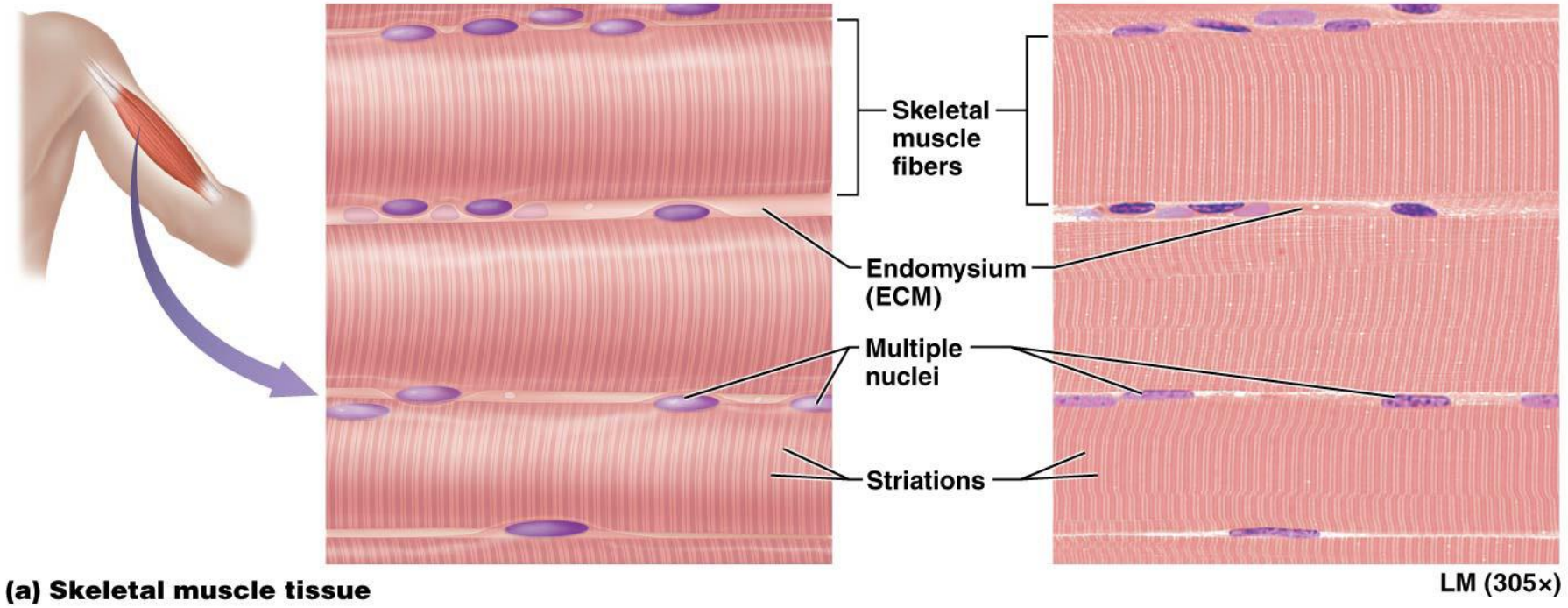


Figure 4.21a Summary of muscle tissues.

Types of Muscle Tissue

- **Cardiac muscle tissue** – found only in heart; composed of **cardiac muscle cells**; although these cells are striated like skeletal muscle cell, many differences can be seen (**Figure 4.21b**):
  - Cardiac muscle tissue is **involuntary**; brain does not have *conscious control* over its contraction
  - Cells are *short*, *branched*, and usually have only *one nucleus* (**uninucleate**)
  - **Intercalated disc** – dark line separating individual cardiac muscle cells; not seen in skeletal muscle; contain **gap junctions** and modified **tight junctions**; allow heart muscle to *contract as a unit*

Types of Muscle Tissue

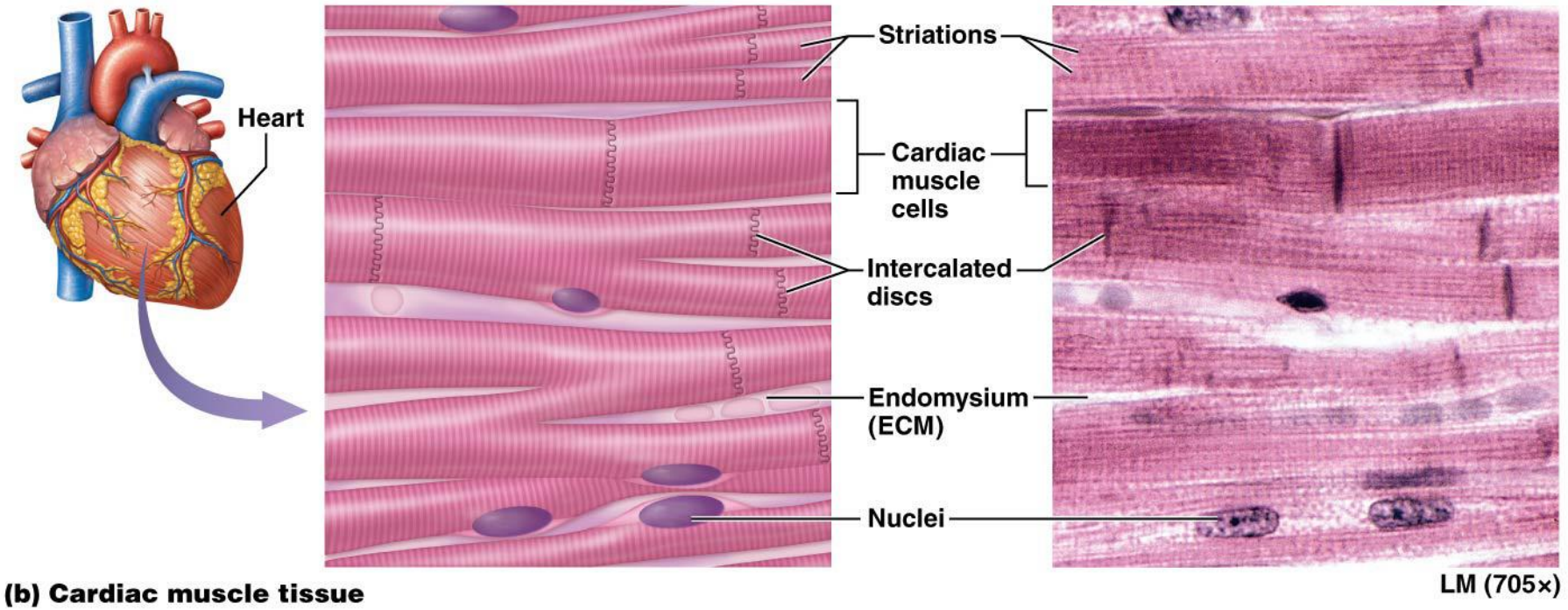


Figure 4.21b Summary of muscle tissues.

Types of Muscle Tissue

- **Smooth muscle tissue** – consists of smooth muscle cells whose contractions are *involuntary* like cardiac muscle cells (**Figure 4.21c**):
  - Found in walls of *nearly every hollow organ*, *blood vessels*, *eyes*, *skin*, and *ducts* of certain glands
  - Flattened cells with one centrally located ovoid nucleus
  - Most smooth muscle cells contain **gap junctions** in their plasma membranes that link them with other smooth muscle cells.

Types of Muscle Tissue

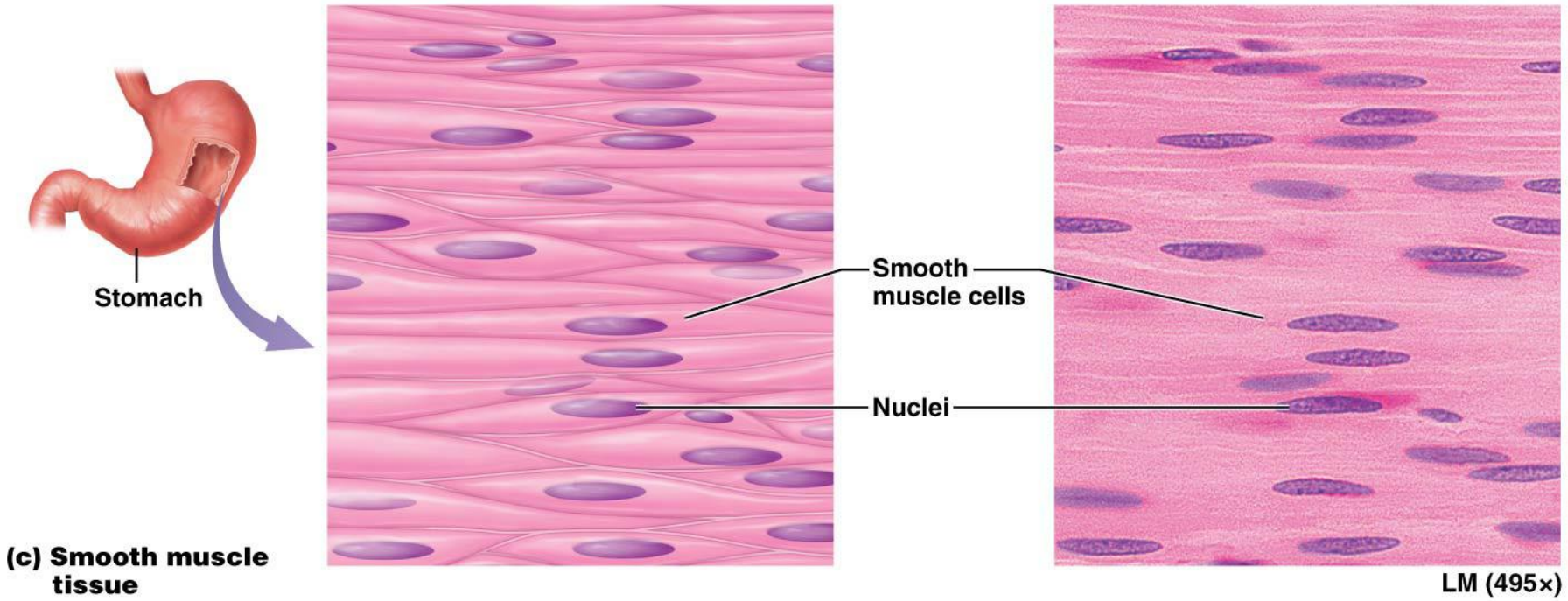


Figure 4.21c Summary of muscle tissues.

Module 4.5 Nervous Tissues

Nervous Tissues

- **Nervous tissue** makes up majority of brain, spinal cord, and nerves; composed of two main cell types and their surrounding ECM
  - **Neurons** – capable of sending and receiving messages
  - **Neuroglial cells** – perform various functions that *support* neurons
- ECM is unique; made up of ground substance with *unique proteoglycans* not found in other tissues of body; contains *few protein fibers*

Neurons

- **Neurons** (like muscle cells) are *excitable cells*; most mature neurons are amitotic (do not undergo mitosis); Neurons contain three main components (**Figure 4.22**):
  - **Cell body** or **soma** – *biosynthetic center* of neuron where nucleus and most organelles are found
  - Solitary **axon** extends from *one end of soma*; responsible for moving a **nerve impulse** from soma to a **target cell** (may be another neuron, muscle cell, or gland); axons illustrate **Cell-Cell Communication Core Principle**
  - **Dendrites** – other extensions protruding from soma; typically *short* with multiple branches; *receive impulses* from axons of neighboring neurons; *deliver impulses* to soma

Neurons

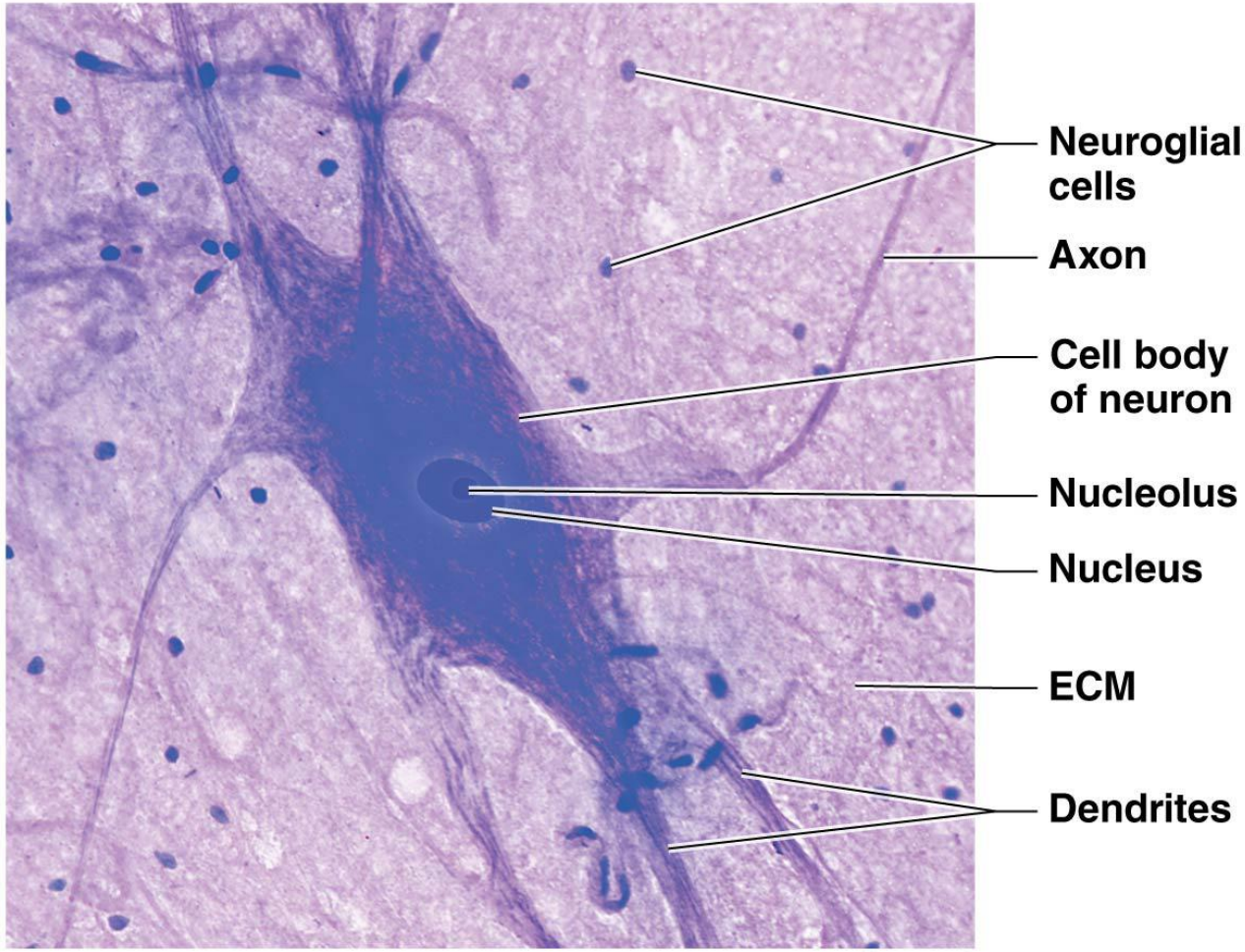


Figure 4.22 Structure of nervous tissue.

Neuroglial Cells

- **Neuroglial cells** – much smaller cells surrounding neurons; supportive cells:
  - Functions:
    - Anchoring neurons and blood vessels in place
    - Monitoring composition of extracellular fluid
    - Speeding up rate of nerve impulse transmission
    - Circulating fluid surrounding brain and spinal cord
  - Able to *divide by mitosis* (unlike neurons)

Concept Boost: But It All Looks Pink! Part 2

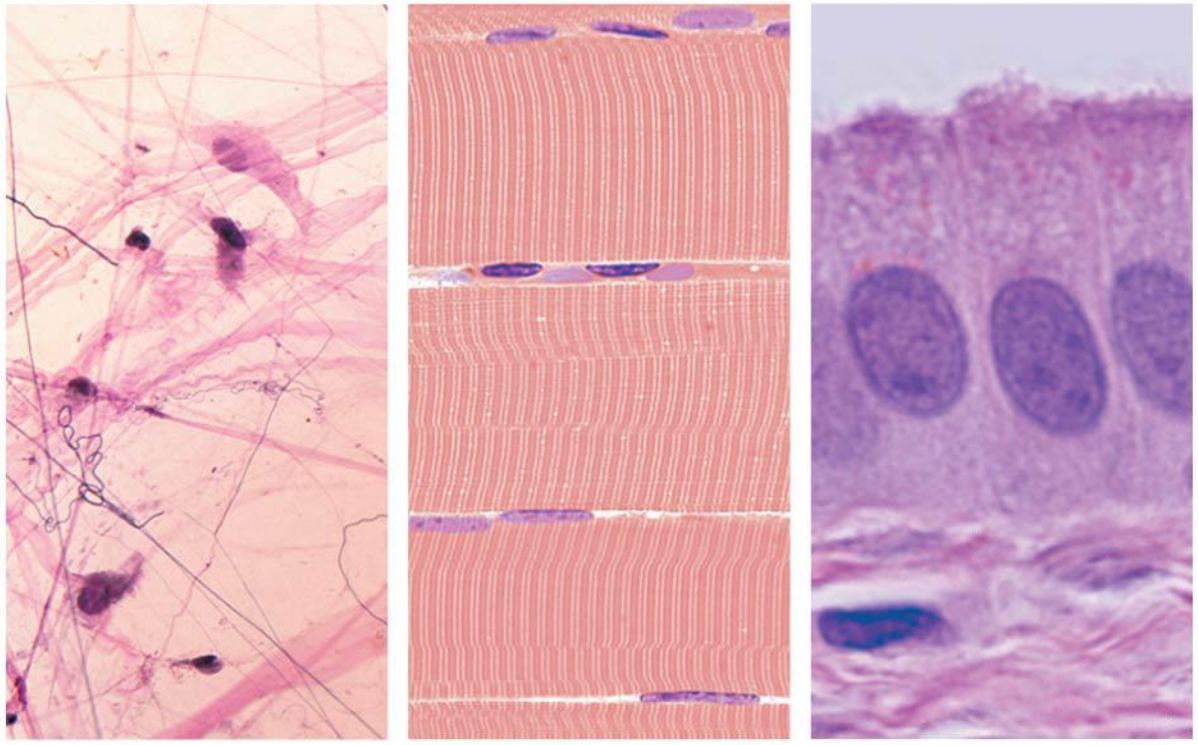
In Examples A, B, and C:

1. **Identify the cells and ECM**
   (review basics from Concept Boost Part 1 as needed)
2. **Notice how the cells are shaped and arranged:**
   - Are the cells packed tightly together, or are they widely spaced?
   - Do they form a continuous sheet, as in epithelial tissue—or do they seem to be surrounded by ECM, as in connective tissue?
   - Are the cells all identical, or are there clearly different types?
   - Do the cells have “arms” extending from a central body?

Concept Boost: But It All Looks Pink! Part 2

3. **Notice how the ECM is arranged:**
   - Is the ECM confined to one specific part of the tissue, or is it spaced evenly between the cells?
   - Does ground substance predominate, or are protein fibers the main elements?
   - What types of protein fibers can you see?
4. **Determine the class of tissue.** Using your analysis in the preceding steps, now you are ready to identify the class of tissue (answers are in text)

Concept Boost: But It All Looks Pink! Part 2



Example A Example B Example C

Module 4.6 Putting It All Together: The Big Picture of Tissues in Organs

The Big Picture of Tissues in Organs

Two or more tissues that combine structurally and functionally form an **organ**:

- Example,
- Skeletal muscle composed of 2 main tissues: skeletal muscle tissue and dense irregular collagenous connective tissue
  - Each has distinct functional role; skeletal muscle tissue allows it to contract; surrounding connective tissue binds muscle cells together and supports them so that their activity produces a contraction of *whole organ*

The Big Picture of Tissues in Organs

- More complex organ; consists of many different tissue types – *trachea*
  - Hollow organ; provides passageway through which air passes on its way into/out of lungs
  - **Figure 4.23** (next slide) – illustration of tissues of trachea from *superficial to deep* with list of their main functions
  - Each tissue layer serves an important role in overall function of trachea: *conducting air*

The Big Picture of Tissues in Organs

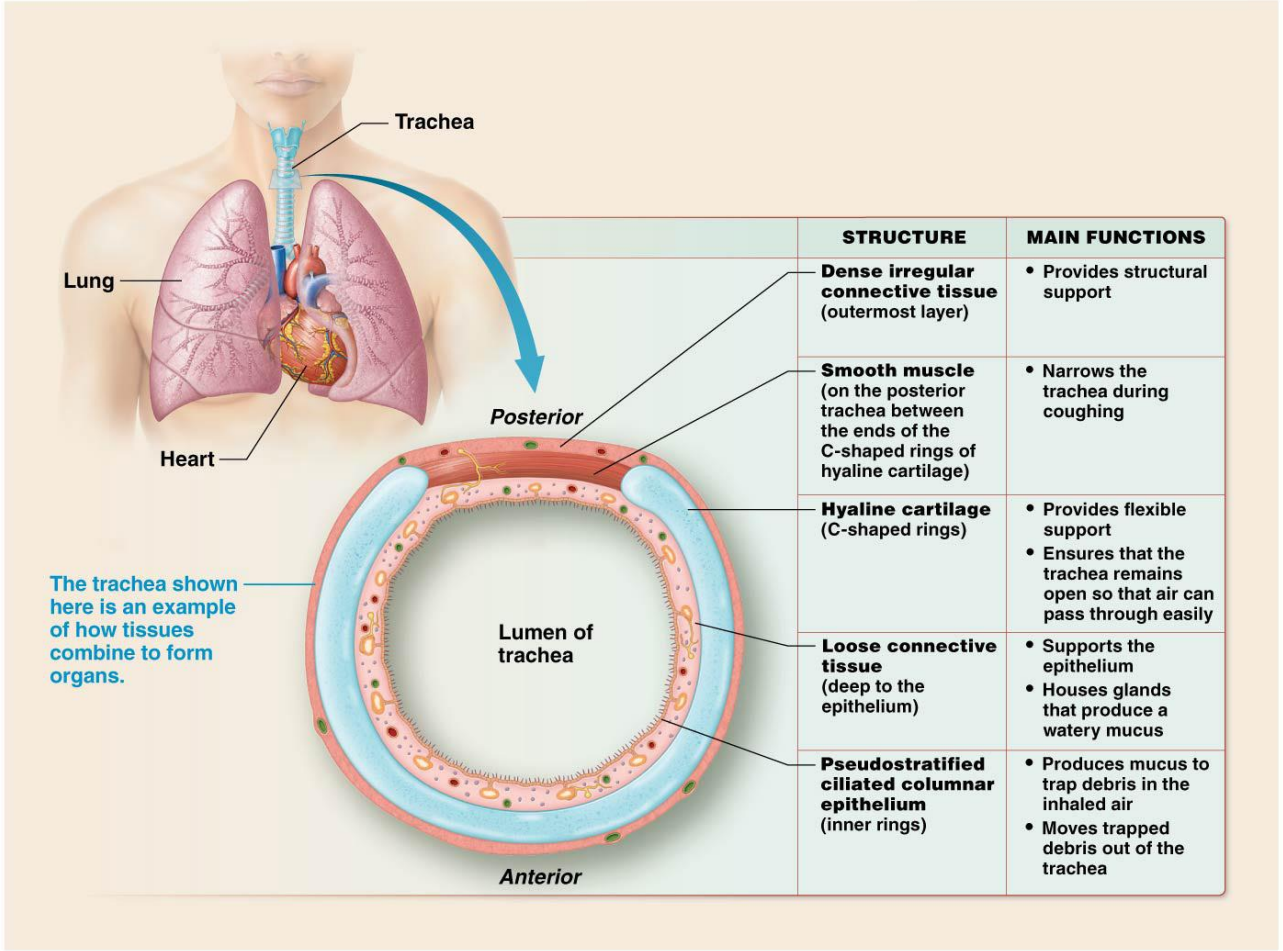


Figure 4.23 The Big Picture of Tissues in Organs.

Module 4.7 Membranes

Membranes

Membranes – thin sheets of one or more tissues that *line a body surface or cavity*:

- Most consist of a superficial *epithelial layer* resting on a *connective tissue layer*; sometimes contains smooth muscle
- Functions: anchor organs in place, serve as barriers, function in immunity, and secrete various substances
- **True membranes** – include **serous** and **synovial membranes**; fit above structural and functional definitions
- **Membrane-like structures** – include **mucous** and **cutaneous** membranes; don't fit above structural and functional definitions but perform many of same functions

True Membranes

True membranes do not open to outside of body; two examples:

- **Serous membranes** or **serosae** – line pericardial, peritoneal, and pleural body cavities; structural and functional features (**Figure 4.24a**):
  - Consist of a **mesothelium** (layer of simple squamous epithelium) associated basement membrane, and a layer of loose connective tissue

True Membranes

True membranes do not open to outside of body; two examples (continued):

- **Serous membranes** or **serosae** (continued):
  - Fold over themselves giving appearance of two layers; outer *parietal* layer *contact with body wall*; inner *visceral* layer *covers organ* within body cavity
  - Mesothelial cells produce a thin, watery **serous fluid**; fills space between parietal and visceral layers; reduces **friction** created when organs (like heart or lungs) move within respective membranes

True Membranes

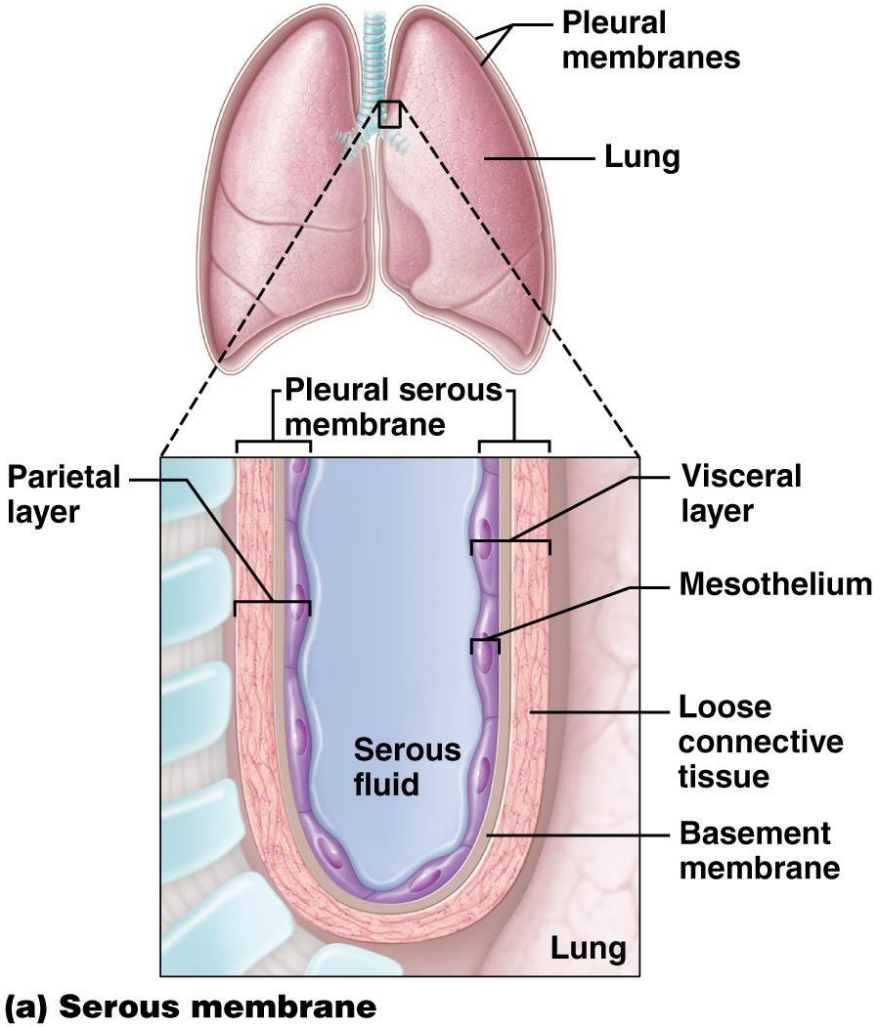


Figure 4.24a True membranes.

True Membranes

True membranes (continued):

- **Synovial membranes** – *line cavities* surrounding freely moveable joints like knee or shoulder; made up of two connective tissue layers without a layer of epithelial cells (**Figure 4.24b**):
  - *Outer layer* – usually composed of a mixture of loose and dense irregular connective tissue
  - *Inner layer* – **synoviocytes** (modified fibroblasts) secrete **synovial fluid**, a watery, slippery fluid; primarily functions to *lubricate* joint

True Membranes

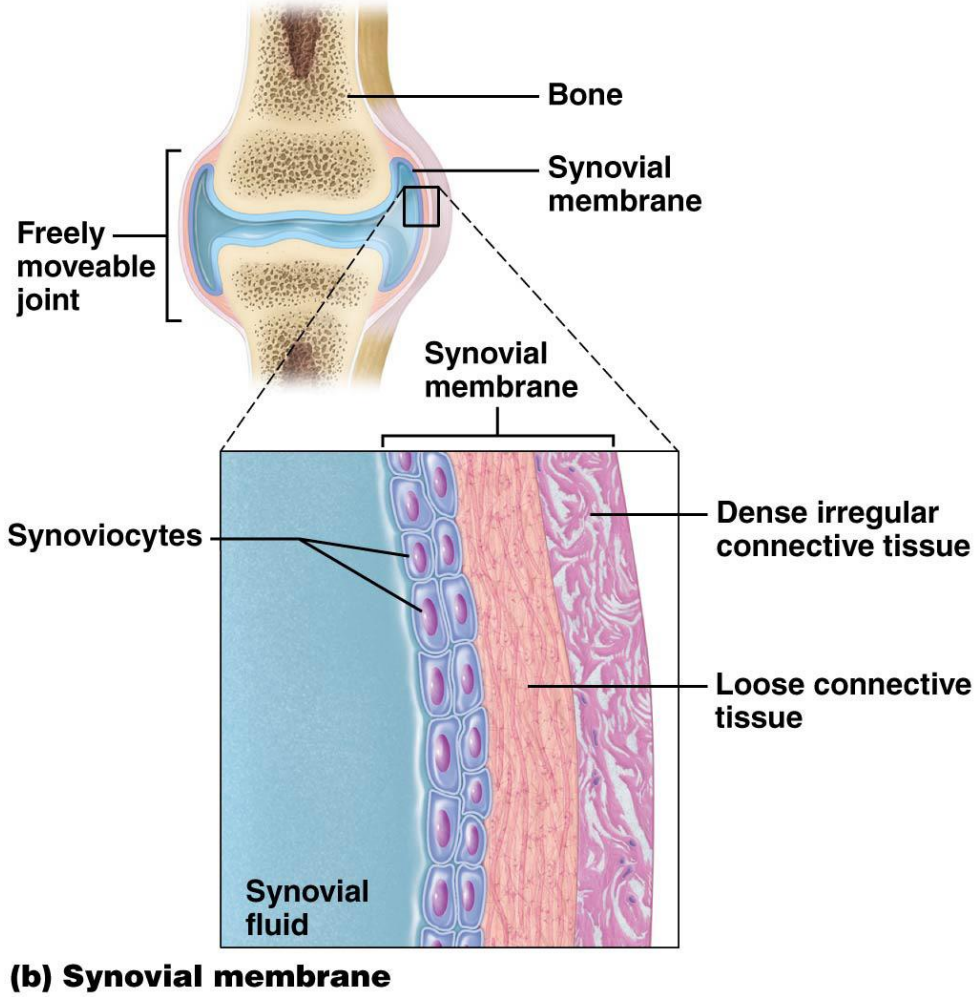


Figure 4.24b True membranes.

Membrane-like Structures

Cutaneous membranes and **mucous membranes** are **membrane-like structures** (do not fit full description of a true membrane):

- **Mucous Membranes** (**mucosae**) *line all body passages* as components of walls of hollow organs that *open to outside* of body; includes respiratory passages, mouth, nasal cavity, digestive tract, and male and female reproductive tracts (**Figure 4.25a**):
  - Consist of a layer of epithelium and its basement membrane (layer of connective tissue called the **lamina propria**) and occasionally a thin layer of smooth muscle
  - Contain glands with **goblet cells**; produce and secrete **mucus**; serves several functions, primarily protection

Membrane-like Structures

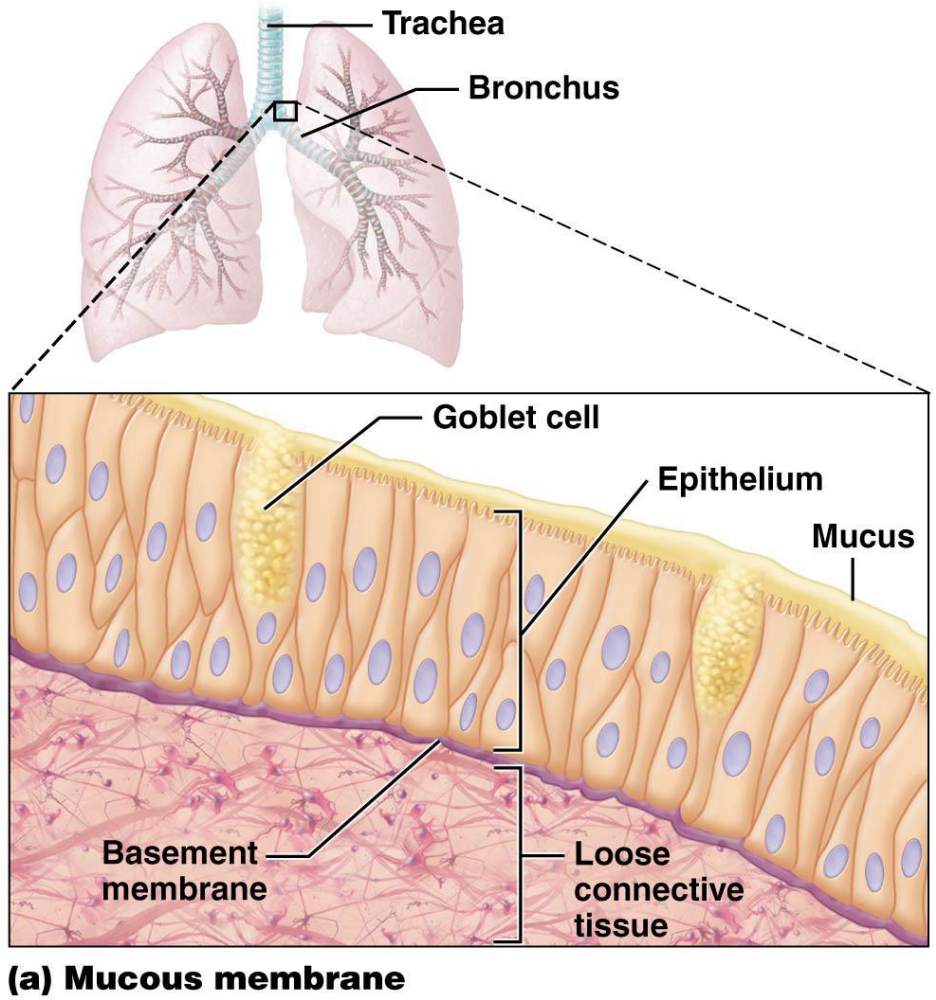


Figure 4.25a Membrane-like structures.

Membrane-like Structures

- **Cutaneous membrane** – refers to **skin**; largest organ of body (**Figure 4.25b**); consists of:
  - Outer layer of *keratinized stratified squamous epithelium* called **epidermis**; tough, continuous protective surface that protects structures deep to it
  - **Dermis**
    - Layer of *loose connective tissue* is found beneath epidermis plus even deeper layer of *dense irregular connective tissue*
    - Home to many blood vessels; provide a means for *oxygen and nutrients to diffuse* into **avascular** epidermis

Membrane-like Structures

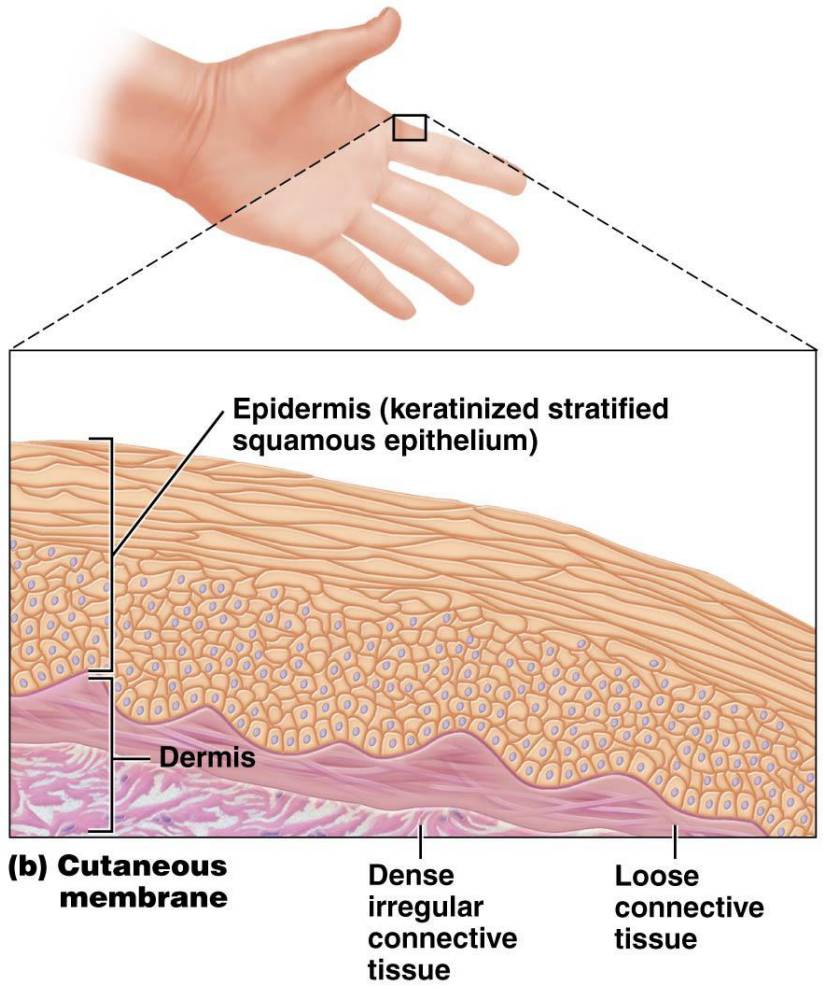


Figure 4.25b Membrane-like structures.

Friction Rubs

- *Certain viral or bacterial infection can cause inflammation of serous membranes of pleural and pericardial cavities*
- Serous fluid for lubrication becomes inadequate to reduce friction; layers *rub together* as organs contract and expand
- Resulting *grating sound* is termed a **friction rub**; can be heard with stethoscope
- Cause *chest pain*; worsens with inhalation, body movement, and swallowing
- Usually resolve with treatment of underlying condition

Module 4.7 Tissue Repair

Tissue Repair

- **Tissue repair** – process of *wound healing*; dead and damaged cells are removed and remaining gap is filled for maintenance of homeostasis; process differs with different tissues:
  - Some tissues are capable of **regeneration** where dead and damaged cells are replaced with cells of same *type*; when regeneration is complete, the function of the tissue is in general completely restored (**Figure 4.26a**)

Tissue Repair

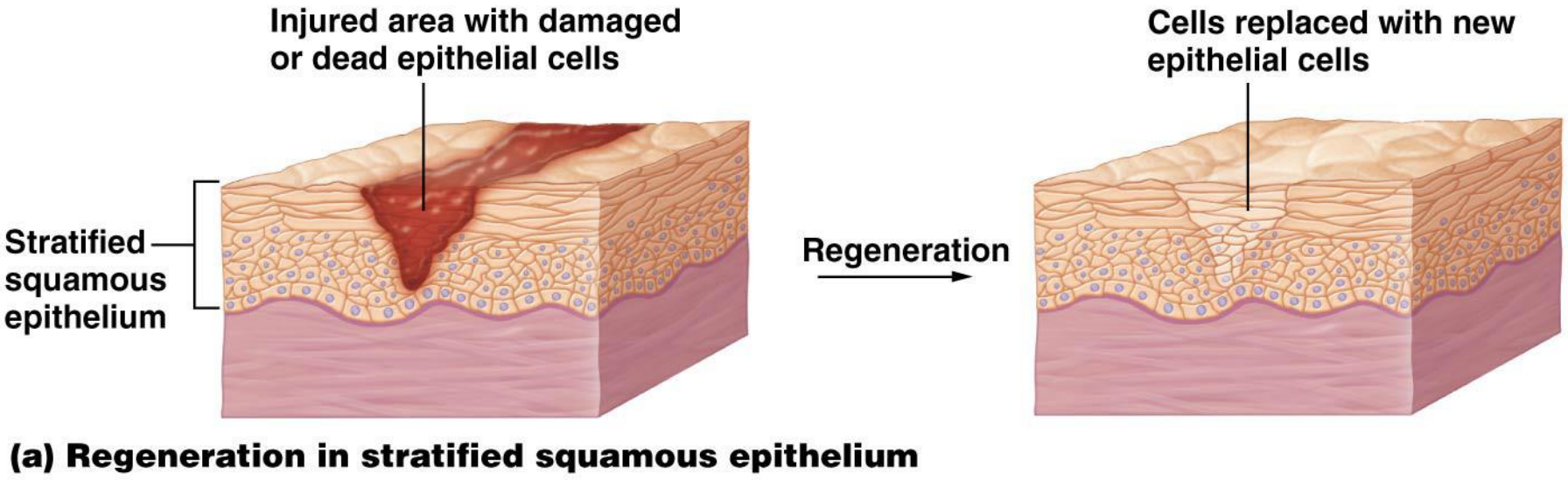


Figure 4.26a Tissue repair by regeneration or fibrosis.

Tissue Repair

- Other tissues are not capable of *full* regeneration; fibroblasts fill in gaps left from injury by a process called **fibrosis** (**Figure 4.26b**):
  - Fibroblasts divide by mitosis and produce *collagen* that fills in gap and tissue *loses* some level of *functional ability*
  - End result of fibrosis is development of **scar tissue** a type of *dense irregular connective tissue*

Tissue Repair

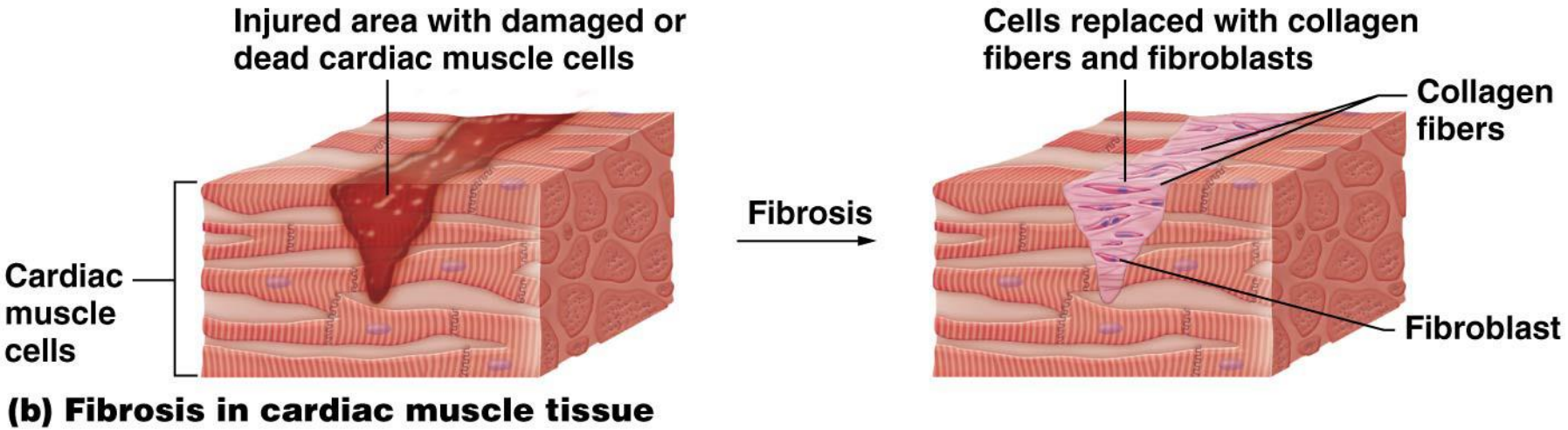


Figure 4.26b Tissue repair by regeneration or fibrosis.

Capacity for Tissue Repair

The extent to which regeneration or fibrosis takes place in a particular tissue type is largely determined by the degree to which the cells in that tissue can undergo mitosis.

- **Epithelial tissues typically undergo regeneration:**
  - Skin and digestive tract lining are subjected to a great deal of stress; must have a mechanism for *replacing dead, damaged or worn out cells*; Skin & Digestive tract contain immature cells called **stem cells** that divide to continually replace dead, injured, or worn out epithelial cells.
  - Other epithelial tissues (like liver and blood vessels) – mature cells divide to replace those that have been lost.

Capacity for Tissue Repair

Capacity of specific tissues for tissue repair (continued):

- **Most connective tissues heal by regeneration**:
  - Connective tissue proper, bone, and blood *regenerate easily* through division of immature cells
  - Cartilage is exception as cells have a limited capacity to divide; this tissue often *heals by fibrosis*

Capacity for Tissue Repair

Capacity of specific tissues for tissue repair (continued):

- **Smooth muscle tissue usually regenerates; cardiac and skeletal muscle tissues generally heal by fibrosis**
  - Smooth muscle cells largely retain ability to undergo mitosis; *heal by regeneration, HOWEVER…..*
  - Mature skeletal muscle fibers and cardiac muscle cells cannot undergo mitosis due to their large size and complicated cellular architecture.
  - **Satellite cells** in skeletal muscle tissue can divide and become skeletal muscle fibers, allowing a limited degree of regeneration.
  - No satellite cells associated with cardiac muscle tissue; injuries are *healed by fibrosis*

Capacity for Tissue Repair

Capacity of specific tissues for tissue repair (continued):

- **Nervous tissue generally undergoes fibrosis.** Neurons are generally unable to undergo mitosis
  - In general, damaged neurons in brain and spinal cord are replaced by neuroglial cells (remember they can divide) and produce a scar.
  - If the cell body of a neuron is intact and only the axon is damaged, there is some chance that the axon will regenerate, depending on location and nature of damage.

Other Factors Affecting Tissue Repair

- **Other factors affecting tissue repair** (beside ability to undergo mitosis) include **nutrition** and **blood supply**.
  - Tissue repair involves production of *proteins*, such as collagen; requires an adequate supply of amino acids to proceed
  - **Vitamin C** is needed by fibroblasts to *produce collagen*
  - Blood supply to injured region *must be adequate* to deliver much-needed oxygen and nutrients and cells of immune system needed for tissue repair

3 Important Determinants of Tissue Repair

1. Ability of cells to undergo mitosis
2. Nutrition-Adequate Protein (Amino Acid) intake and sufficient intake of Vitamin C (needed by fibroblasts to produce collagen)
3. Blood Supply-Blood brings in oxygen, nutrients, and cells of immune system