

Tissues and Membranes

Key Terms

adipose tissue (p. 82)

areolar tissue (p. 82)

chondrocytes (p. 84)

columnar epithelium (p. 78)

connective tissue (p. 81)

cuboidal epithelium (p. 78)

endocrine glands (p. 81)

epithelial tissue (p. 77)

exocrine glands (p. 81)

ligaments (p. 83)

mucous membranes (p. 88)

muscle tissue (p. 85)

nervous tissue (p. 85)

osseous tissue (p. 85)

parietal layer (p. 88)

serous membranes (p. 88)

squamous epithelium (p. 78)

tendons (p. 83)

visceral layer (p. 88)

Objectives

- List the four major types of tissues.
- Do the following regarding epithelial tissue:
 - Describe the characteristics and functions of epithelial tissue.
 - Explain how epithelial tissue is classified.
 - List the types of epithelial tissue membranes.
 - Differentiate between endocrine and exocrine glands.
- Describe the characteristics and functions of connective tissue, and list the types of connective tissue membranes.
- Describe the characteristics and functions of nervous and muscle tissues.
- Explain the process of tissue repair after an injury.
- Differentiate between mucous and serous membranes.

In Chapter 3, we studied a typical cell. We explained how it divides into millions of identical cells and how they differentiate into cells with unique shapes, sizes, and functions. In this chapter, we see how these cells are arranged to perform specific functions.

Tissues are groups of cells that are similar to each other in structure and function. Four major types of tissues are epithelial, connective, nervous, and muscular. The study of tissues is called *histology*.

EPITHELIAL TISSUE

WHERE IS IT FOUND?

Epithelial (ep-i-THÉE-lee-al) **tissue**, also called *epithelium*, forms large continuous sheets. Epithelial tissue helps form the skin and covers the entire outer surface of the body. Sheets of epithelium also line most of the inner cavities such as the mouth, respiratory tract, and reproductive tract. Types of epithelial tissue are listed in Table 6-1.

WHAT DOES IT DO?

Epithelial tissue is primarily concerned with protection, absorption, filtration, and secretion (see Table 6-1). The skin, for example, protects the body from

sunlight and from invasion by disease-producing bacteria. The epithelial tissue lining the respiratory passages helps clean inhaled air. The epithelium of the respiratory tract secretes mucus and is lined with cilia. The mucus traps the dust inhaled in the air, and the constantly waving cilia move the dust and mucus toward the throat. The dust and mucus are then either coughed up or swallowed and eliminated in the stools.

Epithelial tissue also functions in the transport of substances across membranes. Epithelium is abundant in organs like those in the digestive tract, which must absorb large amounts of water and digested food. Finally, epithelial tissue forms glands that secrete a variety of hormones and enzymes.

WHAT IS IT LIKE?

Epithelial tissue has the following characteristics:

- Epithelial tissue forms continuous sheets (Figure 6-1). The cells fit together snugly like tiles.
- Epithelial tissue has two surfaces. One surface is always unattached, like the surface of the outer skin or the inner lining of the mouth. The undersurface of the epithelium is attached to a basement membrane, which is a very thin material that anchors the epithelium to the underlying structure.

Table 6-1 Types of Epithelial Tissue

TYPE	LOCATION	FUNCTION
Simple		
Simple squamous	Walls of blood vessels (capillaries) Alveoli (air sacs in lungs) Kidneys	Permits the exchange of nutrients and wastes Allows diffusion of oxygen and carbon dioxide Filtration of water and electrolytes
Simple cuboidal	Lining of kidney tubules Various glands (thyroid, pancreas, salivary glands)	Absorption of water and electrolytes Secretion of enzymes and hormones
Simple columnar	Digestive tract	Protection, absorption, and secretion of digestive juice; often contains goblet cells (mucus)
Pseudostratified columnar	Lining of respiratory tract Lining of reproductive tubes (fallopian tubes)	Protection and secretion; cleans respiratory passages; sweeps egg toward uterus
Stratified		
Stratified squamous	Outer layer of skin Lining of mouth, esophagus, anus, and vagina	Protects body from invading microorganisms; withstands friction
Transitional	Urinary bladder	Permits expansion of an organ

- Epithelial tissue has no blood supply of its own; it is avascular. For its nourishment, it depends on the blood supply of underlying connective tissue.
- Because epithelial tissue is so well nourished from the underlying connective tissue, it is able to regenerate, or repair itself, quickly if injured.

? Re-Think

1. List four types of tissue.
2. List three words that describe epithelial tissue.

CLASSIFICATION

Epithelial tissue is classified according to its shape and the numbers of layers. It has three shapes: squamous,

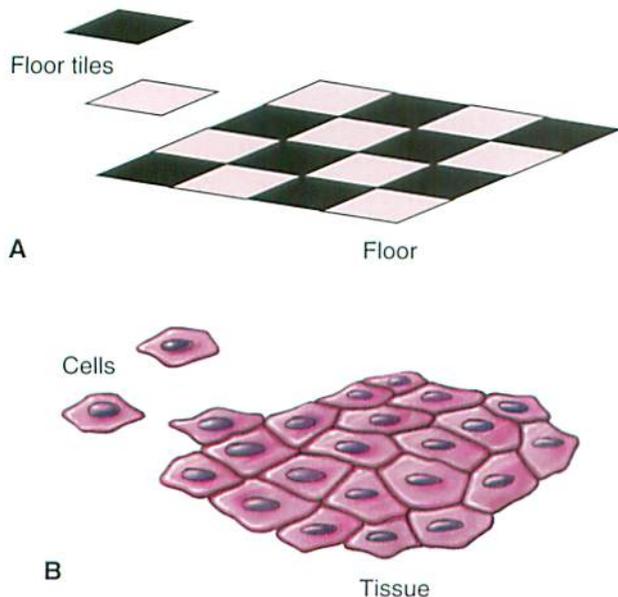


FIGURE 6-1 A, A tile floor. B, Tight-fitting cells of epithelial tissue.

cuboidal, and columnar (Figure 6-2 and Table 6-1). The **squamous** (SKWAY-muss) **epithelium** cells are thin and flat, like fish scales. (The word “squamous” comes from *squam*, meaning “scale.”) The **cuboidal epithelium** cells are cubelike and look like dice. The **columnar epithelium** cells are tall and narrow and look like columns.

Epithelial cells are arranged in a single layer or multiple layers (see Figure 6-2). One layer of cells is a simple epithelium. Two or more layers of cells are a stratified (STRAT-i-fyed) epithelium.

Both the shape and the number of layers describe the various types of epithelium. For example, simple squamous epithelium refers to a single layer of squamous cells. Stratified squamous epithelium contains multiple layers of squamous cells. Note that Figure 6-2 shows stratified squamous epithelium but not stratified cuboidal or columnar tissue. Stratified cuboidal and stratified columnar epithelia are found in very few organs.

SIMPLE EPITHELIA

Because simple epithelia are so thin, they are concerned primarily with the movement, or transport, of various substances across the membranes from one body compartment to another (Figure 6-3).

Simple squamous epithelium is a single layer of squamous cells with an underlying basement membrane. Because this tissue is so thin, simple squamous epithelium is found where substances move by rapid diffusion or filtration. For example, the walls of the capillaries (the smallest blood vessels) are composed of simple squamous epithelium. The walls of the alveoli (air sacs of the lungs) are also composed of simple squamous epithelium. This tissue allows the

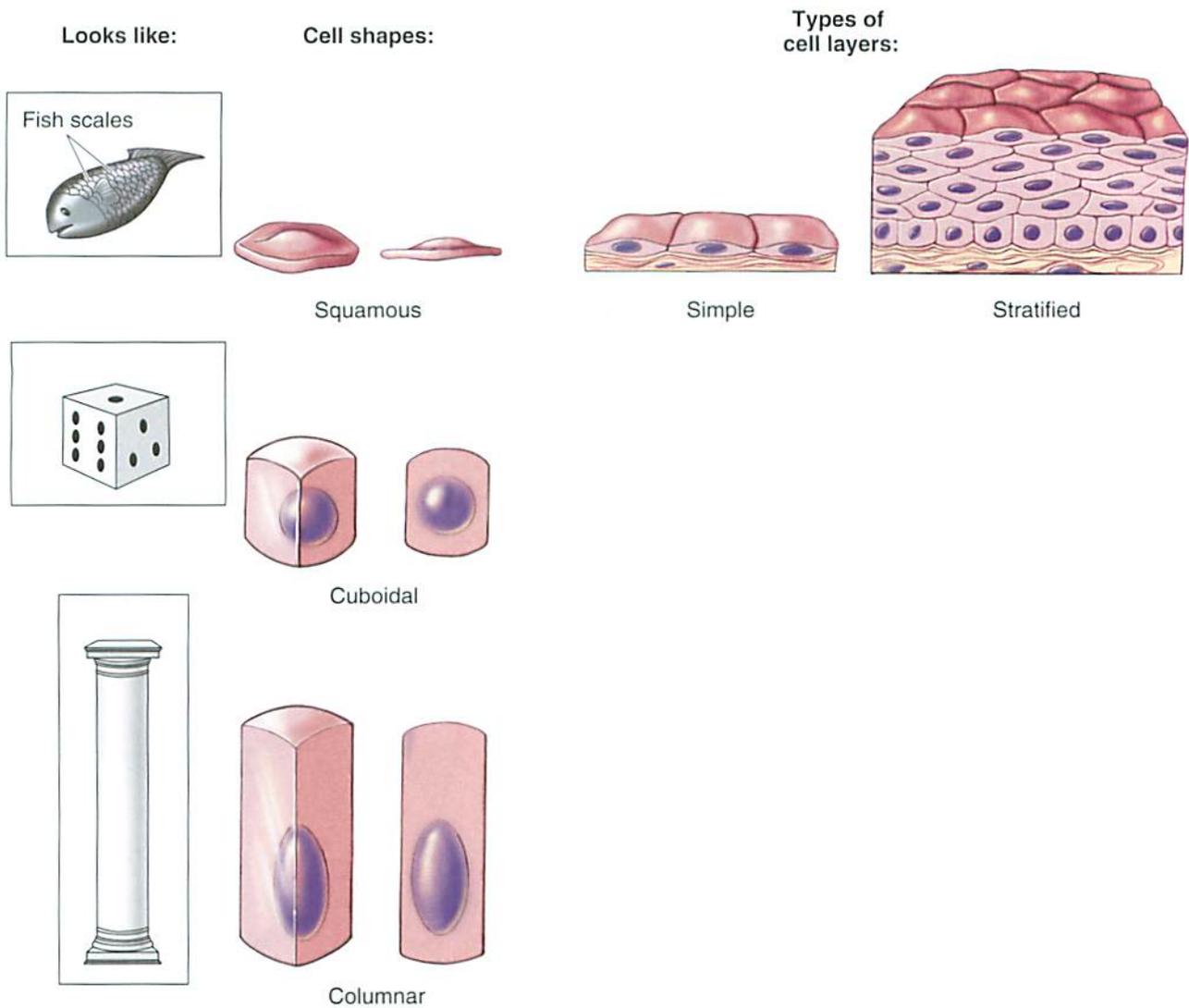


FIGURE 6-2 Classification of epithelial tissue: shapes and layers of cells.

rapid diffusion of oxygen from the alveoli into the blood.

Simple cuboidal epithelium is a single layer of cuboidal cells resting on a basement membrane. This epithelial layer is most often found in glands and in the kidney tubules, where it functions in the transport and secretion of various substances.

Simple columnar epithelium refers to a single layer of columnar cells resting on its basement membrane. These tall, tightly packed cells line the entire length of the digestive tract and play a major role in the absorption of the products of digestion. Lubricating mucus is produced by goblet cells, which are modified columnar cells.

Pseudostratified (SOOD-oh-STRAT-i-fyed) columnar epithelium is a single layer of columnar cells. Because the cells are so irregularly shaped, they appear multilayered; hence the term *pseudostratified*, meaning “falsely stratified.” Their function is similar to that of

simple columnar cells: They facilitate absorption and secretion.

STRATIFIED EPITHELIA

Stratified epithelia are multilayered (from 2 to 20 layers) and are therefore stronger than simple epithelia. They perform a protective function and are found in tissue exposed to everyday wear and tear, such as the mouth, esophagus, and skin. Stratified squamous epithelium is the most widespread of the epithelial tissue.

Transitional epithelium is found primarily in organs that need to stretch, such as the urinary bladder. This epithelium is called *transitional* because the cells slide past one another when the tissue is stretched. The cells appear stratified when the urinary bladder is empty (unstretched) and simple when the bladder is full (stretched).

Epithelial Tissue

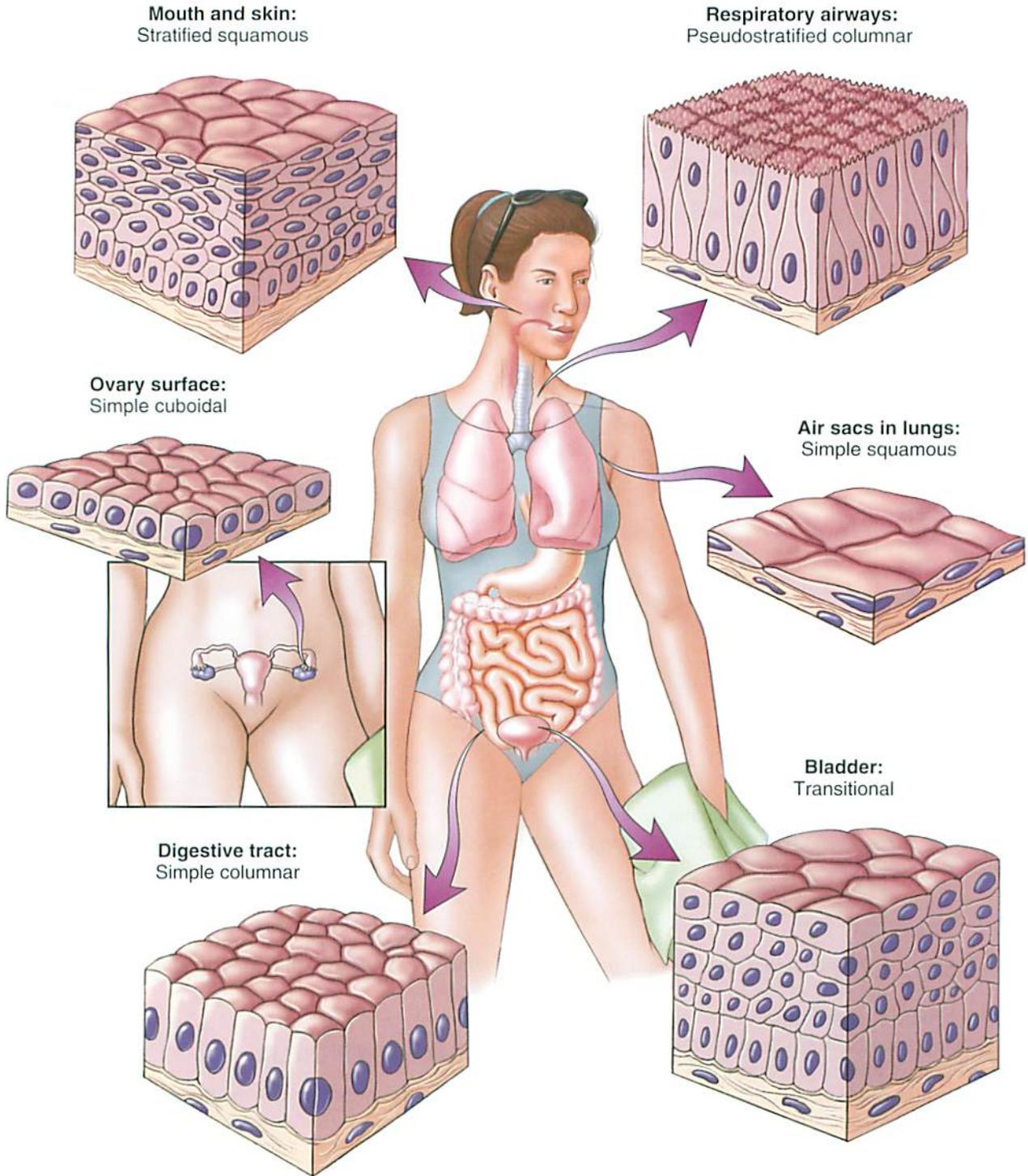


FIGURE 6-3 Types and location of epithelial tissue.



Do You Know...

What Causes a Pressure, or Decubitus ("Lying Down"), Ulcer?

A decubitus ulcer is another name for a bedsore or a pressure ulcer. The ulcer is caused by an interruption of the blood supply to a tissue. Decubitus ulcers often develop in patients who have been bedridden or confined to a wheelchair for long periods. Decubitus comes from a Latin word meaning to lie down. The ulcers are caused by the weight of the body on the skin overlying a bony area (e.g., elbow, heel, hip). The weight of the body compresses the blood vessels, cutting off the supply of blood to the tissues. Deprived of its blood supply, the tissue dies, forming an ulcer.

GLANDULAR EPITHELIA

The function of glandular epithelium is secretion. A gland is made up of one or more cells that secrete a particular substance. Much of the glandular tissue is composed of simple cuboidal epithelium.

Two types of glands are the exocrine glands and the endocrine glands. The **exocrine glands** have ducts, or tiny tubes, into which the exocrine secretions are released before reaching body surfaces or body cavities. The exocrine secretions include mucus, sweat, saliva, and digestive enzymes. The ducts carry the exocrine secretions outside the body. For example, sweat flows from the sweat glands through ducts onto the surface of the skin for evaporation (Figure 6-4).

The **endocrine glands** secrete hormones, such as insulin. Endocrine glands do not have ducts and are therefore called *ductless glands*. Because endocrine glands are ductless, the hormones are secreted directly into the blood. The blood then carries the hormones to their sites of action.

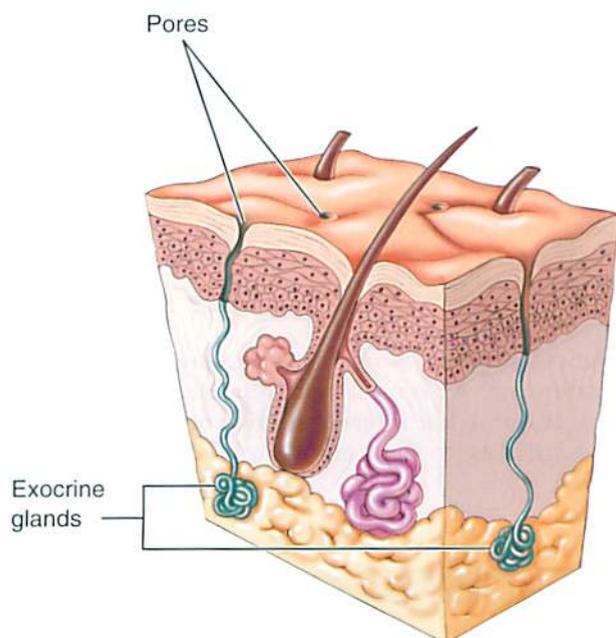


FIGURE 6-4 Exocrine gland, a sweat gland.



Re-Think

1. With regard to classification, what are two differences between simple columnar epithelial tissue and stratified squamous epithelial tissue?
2. What is the primary function of simple squamous epithelium?

2+2 Sum It Up!

Tissues are groups of cells that are similar to each other in structure and function. The four types of tissues are epithelial, connective, nervous, and muscle. Epithelial tissue covers the body (as the skin) and lines cavities that open to the outside; it is primarily concerned with protection, secretion, filtration, and absorption. The shape of epithelial tissue is described as squamous, cuboidal, and columnar. Depending on the number of layers, epithelial tissue is described as simple or stratified.

CONNECTIVE TISSUE

WHERE IS IT FOUND?

Connective tissue is the most abundant of the four tissue types and is widely distributed throughout the body. Connective tissue is found in blood, under the skin, in bone, and around many organs. As the name suggests, connective tissue connects, or binds together, the parts of the body. Other functions include support, protection, fat storage, and transport of substances.

WHAT DOES IT LOOK LIKE?

Although connective tissue types may not resemble each other very closely, they share two characteristics. First, most connective tissue, with the exception of ligaments, tendons, and cartilage, has a good blood supply. Ligaments, tendons, and cartilage have a poor blood supply. As any athlete knows, an injury to these structures usually heals very slowly. The second characteristic shared by most connective tissue is an abundance of intercellular matrix.

CONNECTIVE TISSUE CELLS

Each major type of connective tissue contains immature or "blast" cells. Fibroblasts are cells found in loose and dense fibrous tissue. Chondroblasts (KON-droh-blasts) are found in cartilage and osteoblasts are found in bone. Blast cells secrete matrix that is characteristic of the tissue. In addition to fibroblasts, connective tissue contains other types of cells, such as macrophages, adipocytes, and cells that fight infection and inflammation.

The intercellular matrix is what makes the various types of connective tissue so different. Matrix is composed of fibrous protein and ground substance. The hardness of the matrix varies from one cell type to the next. The intercellular matrix may be liquid as in blood,

gel-like as in fat tissue, rubbery as in cartilage, or hard as in bone. The amount of matrix also varies from one cell type to the next. In fat tissue, the cells are close together, with little intercellular matrix. Bone and cartilage, however, have few cells and large amounts of intercellular matrix.

Also found in the matrix of most connective tissue are protein fibers. These fibers are secreted by fibroblasts, and the fiber types include collagen, elastin, and reticular fibers (fine collagen). Collagen fibers are strong and flexible but are not easily stretched. Elastin fibers are not very strong, but they are stretchy, like a rubber band.

Injections of collagen are used cosmetically to remove unwanted lines and wrinkles. Collagen is obtained from cattle or, more often, from the patient's own hips, thighs, and abdomen. The collagen is then injected under the patient's skin. Acting as filler, the collagen smoothes out unwanted wrinkles, creating a surgical "fountain of youth." Tex, here, could use some collagen filler.



? Re-Think

Compare the amount of intercellular material of epithelial tissue with the amount of intercellular matrix of connective tissue.

TYPES OF CONNECTIVE TISSUE

The many types of connective tissue are loose connective tissue, dense fibrous connective tissue, cartilage, bone, and the "liquid" connective tissue (blood and lymph; Figure 6-5). Table 6-2 describes these types.

LOOSE CONNECTIVE TISSUE

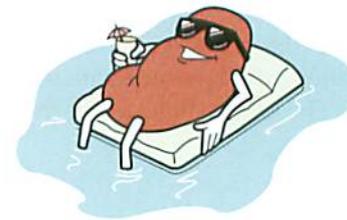
Loose connective tissue contains fibers that are loosely arranged around cells. There are three types of loose connective tissue: areolar tissue, adipose tissue, and reticular connective tissue (see Figure 6-5).

Areolar (ah-REE-oh-lar) **tissue** is made up of collagen and elastin fibers in a gel-like intercellular matrix. Areolar tissue is soft and surrounds, protects, and cushions many of the organs, acting as "tissue glue." It is the most widely distributed type of connective tissue.

Adipose (AD-i-pohs) **tissue** or fat is composed primarily of adipocytes, or cells that store fat (see Figure

6-5). The more fat that is stored, the larger the adipocyte. Fat performs several important functions:

- Fat serves as the body's reservoir of energy. When the body needs energy, the fat is broken down and the energy is released. Unfortunately, fat storage often exceeds energy requirements.
- Fat assists in body temperature regulation. Adipose tissue forms the tissue layer underlying the skin (the subcutaneous layer). Because of its location, adipose tissue can insulate the body from extremes of outside temperature. For example, in a cold environment, adipose tissue prevents the loss of heat from the body. This protection is best appreciated in observing the fat content of animals living in arctic conditions. The walrus, for example, has huge layers of fat tissue (blubber). Because of the insulating qualities of the blubber, the walrus can swim in deep cold waters without freezing to death. Think of how long you could sit on an iceberg, even if you had a few extra pounds.
- Fat acts as a cushion. For example, a pad of fat behind the eyeball protects the eye from the hard bones of the eye socket.
- Fat protects some organs by anchoring them in place. The kidney, for example, has a layer of fat tissue that helps hold it in place. In extremely thin individuals, this fat tissue may be absent, allowing the kidney to move around (a "floating kidney").



? Do You Know...

Why a Too-Tight Tourniquet Is "Bad News"?

A too-tight tourniquet can cut off the flow of blood to a limb. If the blood supply to an area is stopped for too long, the tissue distal to the tourniquet is deprived of oxygen and dies. Tissue damage caused by diminished blood supply, called *ischemia*, often results in gangrene and necrosis.

Reticular tissue is characterized by a network of delicately interwoven cells and reticular (fine collagen) fibers. It forms the internal framework for lymphoid tissue such as the spleen, lymph nodes, and bone marrow.

? Re-Think

1. List the three types of loose connective tissue.
2. Describe four functions of adipose tissue.

Connective Tissue

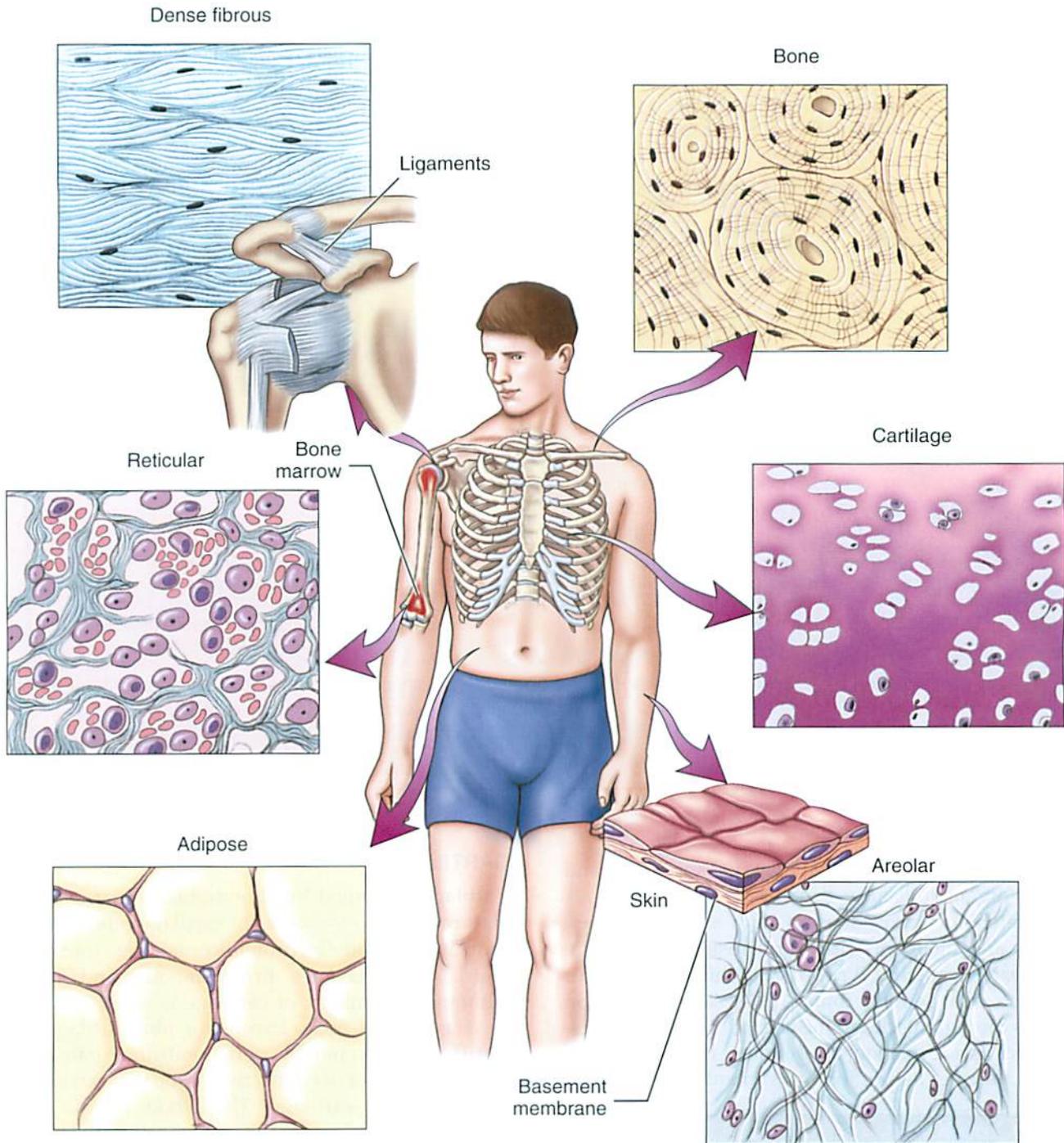


FIGURE 6-5 Types and location of connective tissue. (Blood and lymph are not shown.)

DENSE FIBROUS CONNECTIVE TISSUE

Dense fibrous connective tissue is composed of fibroblasts and an intercellular matrix that contains many collagen and elastic fibers. Collagen is the main type of fiber in dense fibrous tissue. The fibers form strong, supporting structures such as tendons, ligaments, capsules, fascia, and the dermal layer of skin.

Tendons are cordlike structures that attach muscles to bones. **Ligaments** cross joints and attach bones to each other. Because ligaments contain more elastic fibers than tendons, they stretch more easily. The ability to stretch is important; it prevents tearing of the ligaments when the joints bend. Dense fibrous connective tissue also forms tough capsules around certain organs (kidney and liver) and forms sheets of tissue

Table 6-2 Types of Connective Tissue

TYPE	LOCATION	FUNCTION
Loose Connective		
<i>Areolar</i>	Beneath skin and most epithelial layers; between muscles	Binds together, protects, cushions; "tissue glue"
Adipose	Beneath skin (subcutaneous) Around kidneys and heart Behind eyeballs	Cushions, insulates, stores fat
Reticular	Lymphoid tissue such as lymph nodes, spleen, and bone marrow	Forms internal framework of lymphoid organs
Dense Fibrous Connective		
	Tendons, ligaments, capsules, and fascia Skin (dermis)	Binds structures together
Cartilage		
Hyaline	Ends of long bone at joints Connects ribs to sternum Rings in trachea of respiratory tract Nose Fetal skeleton	Supports, protects, provides framework
Fibrocartilage	Intervertebral discs (in backbone) Pads in knee joint Pad between pubic bones (symphysis pubis)	Cushions, protects
Elastic cartilage	External ear and part of larynx	Supports, provides framework
Bone		
	Bones of the skeleton	Supports, protects, provides framework
Blood		
	Blood vessels throughout the body	Transports nutrients, hormones, respiratory gases (oxygen and carbon dioxide), waste
Lymph		
	Lymphatic vessels throughout the body	Drains interstitial fluid; involved in immune response

called *fascia* (FASH-uh) that covers, supports, and anchors organs to nearby structures.

If stretching is excessive, as with athletic injuries, tendons and ligaments can tear, causing severe pain and impaired mobility. A ruptured Achilles tendon, for example, is a serious injury. The Achilles tendon attaches the leg muscles to the heel of the foot. If excessive force is exerted on the tendon, it may snap or rupture, causing loss of foot movement.



Do You Know...

About Cooper's Droop?

As we age, the effects of gravity take over and some parts of the anatomy "head south." Breast tissue is anchored to the underlying structures by strands of connective tissue called *suspensory ligaments* (Cooper's ligaments). As we age, the tissue weakens and, sadly, sagging happens. The sorry saga of the sagging breasts is called *Cooper's Droop*.



Re-Think

What is the difference between a tendon and a ligament? Between fascia and a capsule?

CARTILAGE

Cartilage is formed by chondroblasts that eventually mature into **chondrocytes**, or cartilage cells. The chondroblasts secrete a protein-containing intercellular matrix that becomes firm, smooth, and rubbery. Although the matrix of cartilage is solid, it is not as hard as that of bone. Except for fibrocartilage, most cartilage is covered by perichondrium (pair-i-KON-dree-um), a layer of connective tissue that carries blood vessels to the cartilage. The blood vessels supply oxygen and nutrients to the cartilage. Located between the perichondrium and the cartilage is a storage supply of chondroblasts. The stored chondroblasts provide for cartilage growth throughout life.

Types of Cartilage

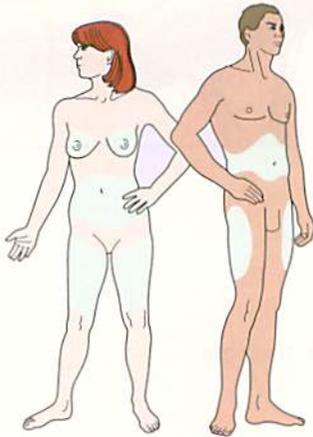
Three types of cartilage are hyaline cartilage, elastic cartilage, and fibrocartilage. Hyaline cartilage is found in (1) the larynx, or voicebox, (2) the ends of long bones at joints, (3) the nose, and (4) the area between the breastbone and the ribs. Figure 6-5 illustrates the attachment of the ribs to the breastbone by hyaline cartilage. Hyaline cartilage is found in larger quantities

in the fetal skeleton. As the fetus matures, however, most of the cartilage is converted to bone.

Do You Know...

Why Overweight Men and Women “Round Out” into Different Shapes?

Overeating results in the storage of fat in adipose tissue. Because fat metabolism is affected by the sex hormones estrogen and testosterone, storage sites differ for males and females. In the male, excess fat is stored primarily in the abdominal region, whereas in the female, excess fat is stored around the breasts and hips. Excess adipose tissue, especially that which deposits in the abdominal region, becomes metabolically active and secretes hormones that adversely affect metabolism. The “spare tire” hormones increase blood glucose, increase resistance to insulin, and increase blood pressure, none of which is healthy.



BONE

Bone tissue is also called **osseous** (OS-ee-us) **tissue**. Immature bone cells are called *osteoblasts*. Osteoblasts secrete an intercellular matrix that includes collagen, calcium salts, and other minerals. The collagen provides flexibility and strength; the mineral-containing matrix as a whole makes the bone tissue hard. The hardness of the bone enables it to protect organs such as the brain and to support the weight of the body for standing and moving. Bone also acts as a storage site for mineral salts, especially calcium (see Chapter 8). Osteoblasts mature into osteocytes.



When mineralization of bone tissue is diminished, as in osteoporosis, the bone is weakened and tends to break easily. Adequate dietary intake of calcium is essential for strong bones. Calcium is needed throughout the life cycle but is especially important during childhood and pregnancy, when bones are growing, and after menopause, when estrogen levels in women decline. Estrogen normally encourages the deposition of calcium in bone tissue, as does exercise and weight-bearing activity.

BLOOD AND LYMPH

Blood and lymph are two types of connective tissue that have a liquid intercellular matrix. Blood consists of blood cells surrounded by a fluid intercellular matrix called *plasma*. Unlike other connective tissues, which contain collagen and elastin fibers in the intercellular matrix, plasma contains nonfibrous plasma proteins (see Chapter 15). Lymph is the fluid that is found in lymphatic vessels (see Chapter 20).

? Re-Think

What is the difference in the intercellular matrix of cartilage, bone, and blood?

NERVOUS TISSUE

Nervous tissue makes up the brain, spinal cord, and nerves. Nervous tissue consists of two types of cells: neurons and neuroglia (Figure 6-6).

NEURONS

Neurons are nerve cells that transmit electrical signals to and from the brain and spinal cord. The neuron has three parts: (1) the dendrites, which receive information from other neurons; (2) the cell body, which contains the nucleus and is essential to the life of the cell; and (3) the axon, which transmits information away from the cell body.

Neuroglia (noo-ROG-lee-ah), or glia, are cells that support and take care of the neurons. The word *glial* means “gluelike” and refers to the ability of these cells to support, or bind together, the vast network of neurons. (Nervous tissue is described more fully in Chapters 10 to 13.)

MUSCLE TISSUE

Muscle tissue is composed of cells that shorten, or contract. In doing so, they cause movement of a body part. Because the cells are long and slender, they are called *fibers* rather than *cells*. The three types of muscle are skeletal, smooth, and cardiac (Figure 6-7).

Nervous Tissue

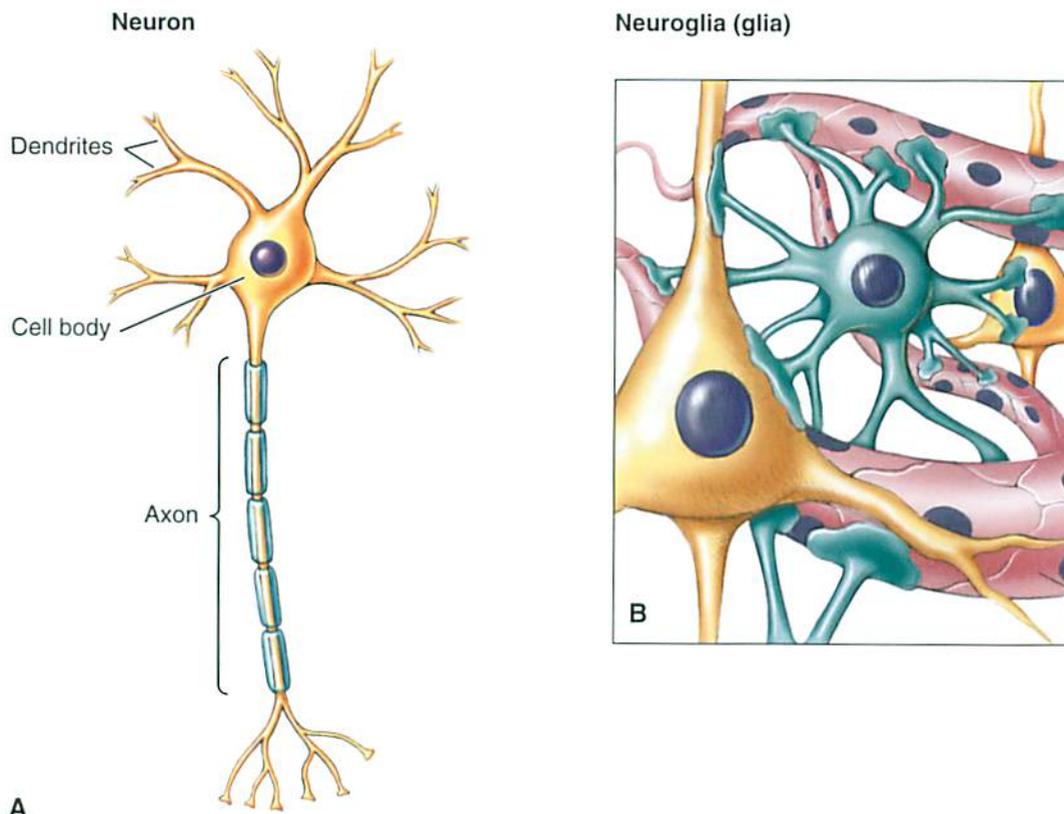


FIGURE 6-6 Two types of nervous tissue. **A**, Neuron. **B**, Neuroglia.

SKELETAL MUSCLE

Skeletal muscle is generally attached to bone (the skeletal system). Because of the appearance of striations (*STRYE-ay-shuns*) or stripes, *skeletal muscle* is also called *striated muscle*. Skeletal muscles move the skeleton, maintain posture, and stabilize joints.

SMOOTH MUSCLE

Smooth muscle, also called *visceral muscle*, is generally found in the walls of the viscera, or organs, such as the stomach, intestines, and urinary bladder. It is also found in tubes such as the bronchioles (breathing passages) and blood vessels. The function of smooth muscle is related to the organ in which it is found. For example, smooth muscle in the stomach helps mash and churn food, whereas the smooth muscle in the urinary bladder helps expel urine.

CARDIAC MUSCLE

Cardiac muscle is found only in the heart, where it functions to pump blood into a vast network of blood vessels. Cardiac muscle fibers are long branching cells

that fit together tightly at junctions; this arrangement promotes rapid conduction of coordinated electrical signals throughout the heart.

? Re-Think

List the four types of tissue and state the general function of each type.

2+2 Sum It Up!

Connective tissue is the most widespread and diverse of the tissue types; its abundant intercellular matrix can be solid, rubbery, gel-like, or liquid. Connective tissue generally connects and binds together parts of the body. Nervous tissue is found in the brain, spinal cord, and nerves and is concerned with the transmission of information throughout the entire body. Muscle tissue is composed of cells that can contract and thus produce movement of body parts. The three types of muscle are skeletal, smooth, and cardiac.

TISSUE REPAIR

How does tissue repair itself after an injury? Two types of tissue repair are regeneration and fibrosis. Regeneration refers to the replacement of tissue by cells that

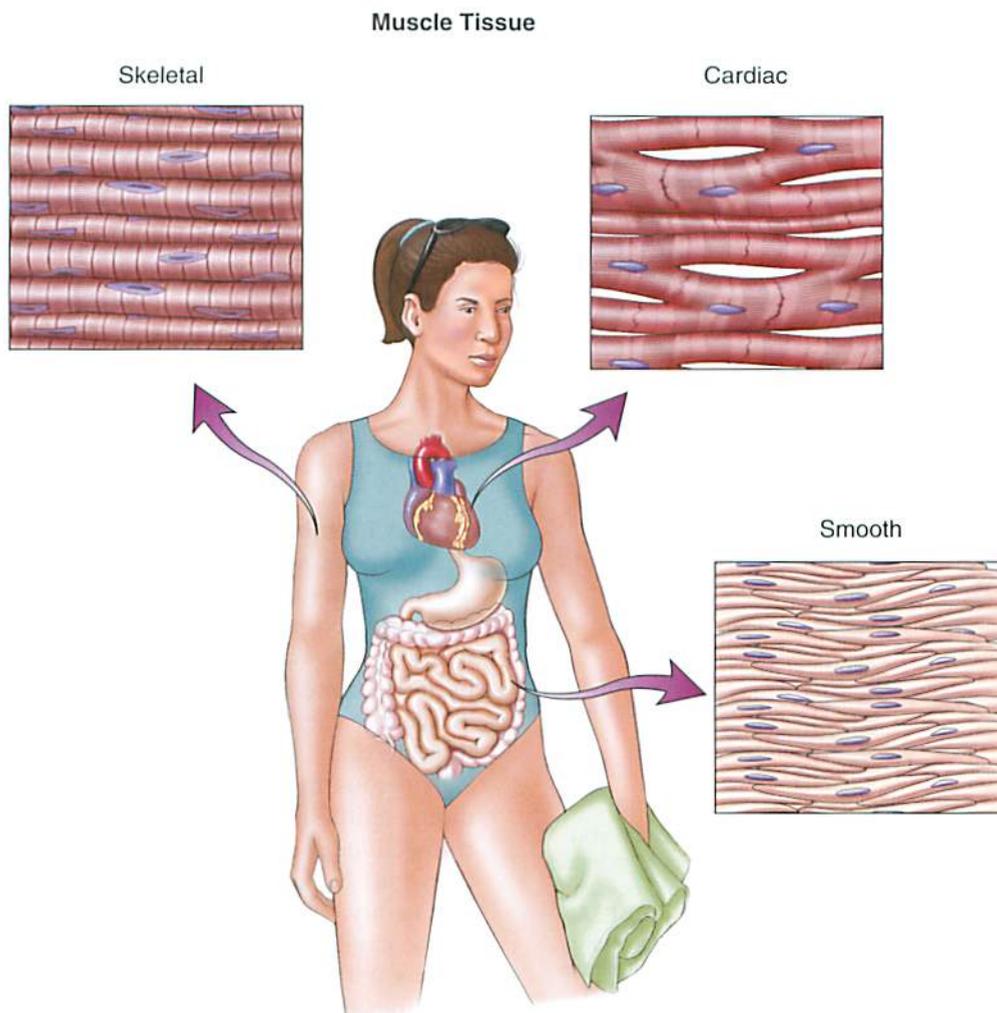


FIGURE 6-7 Types of muscle tissue: skeletal, cardiac, and smooth.

are identical to the original cells. Regeneration occurs only in tissues whose cells undergo mitosis, such as the skin.

Fibrosis is the replacement of injured tissue by the formation of fibrous connective tissue, or scar tissue. The fibers of scar tissue pull the edges of the wound together and strengthen the area. Damaged skeletal muscle, cardiac muscle, and nervous tissue do not undergo mitosis and must be replaced by scar tissue. The steps involved in tissue repair are illustrated and described in Figure 6-8. The injured skin of some persons exhibits excessive fibrosis, leading to the formation of keloids. Keloid (KEE-loyd) scars develop most often on the upper trunk and earlobes and are of concern cosmetically. Unfortunately, they tend to recur when surgically removed. Some tribespeople practice scarification during which the skin is sliced in hopes of inducing keloid scar formation. The keloid scar pattern reflects a significant event or rite of passage in the person's life.



Do You Know...

What a Confederate Medical Officer Observed about a Maggot-Infested Battle Wound?

He observed that the wound was "cleaner" than wounds not infested with maggots. The incidence of septicemia (blood poisoning) was also lower in patients with maggot-infested wounds. Maggots are fly larvae; in the battlefield, the infected wound attracted flies that promptly laid their eggs, producing the larvae. Hungry maggots feasted on dead and infected tissue, thereby débriding the wound. (Débridement is the process of removing necrotic tissue from a wound to promote growth of healthy tissue.) Despite our disgust at such dining practices, maggots have recently been re-employed in the hospital setting to clean up infected wounds. Maggots, hatched and dispatched under sterile conditions, perform their duties under a new fancy name: biodébridement. Maggots are placed in the infected wound and allowed to "do their thing." New name, same old maggot.

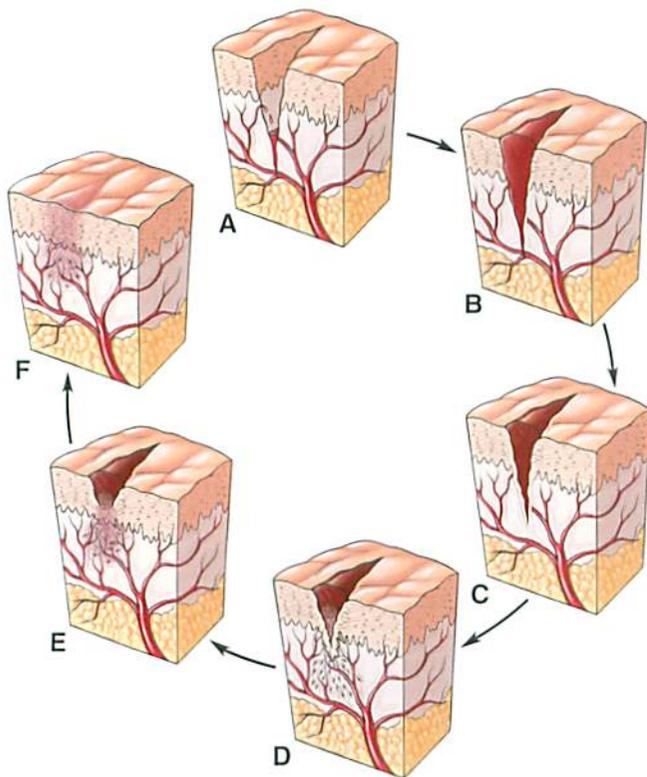


FIGURE 6-8 Steps in tissue repair. **A**, A deep wound to the skin severs blood vessels, causing blood to fill the wound. **B**, A blood clot forms and, as it dries, it forms a scab. **C, D**, The process of tissue repair begins. Scar tissue forms in the deep layers. **E**, At the same time, surface epithelial cells multiply and fill the area between the scar tissue and the scab. **F**, When the epithelium is complete, the scab detaches. The result is a fully regenerated layer of epithelium over an underlying area of scar tissue.

MEMBRANES

CLASSIFICATION OF MEMBRANES

Membranes are thin sheets of tissue that cover surfaces, line body cavities, and surround organs. Membranes are classified as epithelial or connective tissue (Table 6-3). (The connective tissue membranes are described in Chapters 8 and 10.)

EPITHELIAL MEMBRANES

The epithelial membranes include the cutaneous membrane (skin), the mucous membranes, and the serous membranes (Figure 6-9). Although called *epithelial*, these membranes contain both an epithelial sheet and an underlying layer of connective tissue.

Cutaneous Membrane

The cutaneous membrane is the skin. The outer layer of skin (epidermis) is stratified squamous epithelium. The underlying layer (dermis) is composed of dense fibrous connective tissue (see Chapter 7).

Mucous Membranes

Mucous membranes line all body cavities that open to the exterior of the body (see Figure 6-9). They include the digestive, urinary, reproductive, and respiratory tracts. For example, the digestive tract opens to the exterior of the body at the mouth and anus, whereas the respiratory tract opens to the exterior at the nose and mouth. Mucous membranes usually contain stratified squamous epithelium or simple columnar epithelium. Most mucous membranes are adapted for absorption and secretion. Mucous membranes secrete mucus, which keeps the membrane moist and also lubricates it. For example, in the digestive tract, the mucus allows food to move through the tract with little friction.

Serous Membranes

Serous membranes line the ventral body cavities that are not open to the exterior of the body. If you were to enter the abdominal or thoracic cavity surgically, you would be looking at serous membranes. Serous membranes secrete a thin, watery, serous fluid. The fluid allows the membranes to slide past one another with little friction.

A serous membrane is composed of simple squamous epithelium resting on a thin layer of loose connective tissue. Serous membranes line a cavity and then fold back onto the surface of the organs within that cavity. Thus, part of the membrane lines the wall of the cavity, and the other part covers the organ or organs within that cavity. The part of the membrane that lines the walls of the cavity (like wallpaper) is the **parietal layer**, and the part of the membrane that covers the outside of an organ is the **visceral layer**.

The three serous membranes are the pleura, pericardium, and peritoneum (see Figure 6-9):

1. Pleurae are found in the thoracic cavity. The parietal pleurae line the wall of the thoracic cavity, and the visceral pleurae cover each lung. The space between the pleural layers is called the *pleural cavity*; the membranes are lubricated by pleural fluid. Why is pleurisy so painful? Pleurisy refers to an inflammation of the pleurae and a decrease in serous fluid. As the inflamed and “dry” pleural membranes slide past one another during breathing movements, the person experiences pain.
2. The pericardium is found in the thoracic cavity and partially surrounds the heart. There is a parietal and visceral pericardium that offers slinglike support to the heart. The space between the pericardial membranes is called the *pericardial cavity*; the membranes are lubricated by pericardial fluid. Pericardial structure is described further in Chapter 16.
3. The peritoneum is found within the abdominal cavity. The parietal peritoneum lines its walls, and the visceral peritoneum covers some of the abdominal organs (see Chapter 23).

Infection in the abdominal cavity often involves the peritoneum. For example, a ruptured appendix allows the escape of intestinal contents, loaded with bacteria, into the peritoneal cavity. This leakage causes a life-threatening infectious condition called *peritonitis*.

? Re-Think

1. List the two classifications of membranes.
2. List and locate three epithelial membranes.

2+2 Sum It Up!

Membranes are sheets of tissue. Membranes cover surfaces, line body cavities, and surround organs. Membranes are classified as epithelial membranes or connective tissue membranes. The epithelial membranes include cutaneous (skin), mucous, and serous membranes. The location and functions of the epithelial and connective tissue membranes are summarized in Table 6-3.

As You Age

1. Because tissues consist of cells, cellular aging alters the tissues formed by the cells. Alterations in tissues, in turn, affect organ function. For example, by age 85, lung capacity has decreased by 50%, muscle strength has decreased by about 45%, and kidney function has decreased by 30%.
2. Collagen and elastin decrease in connective tissue. Consequently, tissues become stiffer, less elastic, and less efficient in their functioning.
3. Lipid and fat content of tissues change. In men, a gradual increase in tissue lipids and fat occurs until age 60, and then a gradual decrease follows. In women, lipids and fats accumulate in the tissues continuously; no decline occurs as in men.
4. The total amount of water in the body gradually decreases. The change in body fat and the decrease in water are major reasons why older adults respond differently to drugs than the younger population.
5. Tissue atrophy causes a decrease in the mass of most organs.

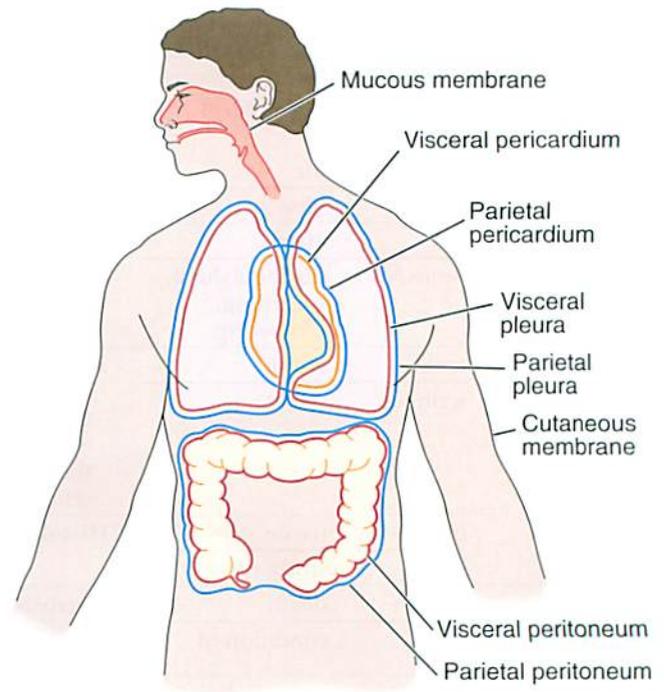


FIGURE 6-9 Epithelial membranes.

Table 6-3 Types of Membranes

TYPE	LOCATION
Epithelial Membranes	
Cutaneous membrane	Skin (outer layer)
Mucous membrane	Digestive tract lining Urinary tract lining Reproductive tract lining Respiratory tract lining
Serous membrane	
Pleurae	Thoracic cavity; pleural cavity
Pericardium	Thoracic cavity around the heart; pericardial cavity
Peritoneum	Abdominopelvic cavity
Connective Tissue Membranes	
Synovial	Lines joint cavities; secretes synovial fluid
Periosteum	Covers bone; contains the blood vessels that supply the bone
Perichondrium	Covers cartilage; contains capillaries that nourish the cartilage
Meninges	Covers brain and spinal cord
Fascia (various kinds)	Appears throughout body


MEDICAL TERMINOLOGY AND DISORDERS
Disorders of Tissues and Membranes

Medical Term	Word Parts	Word Part Meaning or Derivation	Description
Words			
biopsy	bi/o- -opsy	life view of	A biopsy is the removal and examination of tissue from a living body for diagnostic purposes.
diagnosis	dia- -gnos/o-	apart distinguishing, learning, knowing	Diagnosis is the process of identifying a disease or disorder by examination of the patient and all relevant data. A correct diagnosis allows the physician to give the patient his prognosis (pro = before; gnosis/o = knowing), a forecast of the probable course of the disease.
endocrine	endo- -crin/o-	within secrete	An endocrine gland secretes hormones that circulate through the blood and function within the body. For example, insulin is secreted by a gland called the <i>pancreas</i> and is carried throughout the body in the blood. An exocrine (exo = outside) gland secretes substances into ducts that carry the secretion to the outside of the body, as in sweat and sebum.
histology	hist/o- -logy	tissue study of	Histology is the study of tissues.
necrosis	necr/o- -osis	death condition of	Necrosis refers to the process of death of the cells or tissues, especially in a localized area. Tissue that is deprived of its blood supply necroses, or dies.
Disorders			
adhesions	ad- -hension	to, toward, or near From a Latin word meaning "sticking to"	Adhesions are bands of "internal scar tissue" that bind or constrict organs. Surgery and infection are common causes. As part of the healing process, fibrin and other tissue repair cells penetrate the fibrous bands, contributing to the formation of the adhesion. Adhesions are particularly common in the abdominopelvic cavity. An example of an adhesion-related consequence is intestinal obstruction.
connective tissue diseases			A group of diseases that attack the connective tissues of the body. The connective tissues are composed of two major structural proteins: collagen and elastin. Diseases that affect collagen specifically are also referred to as <i>collagen diseases</i> . Many connective tissue diseases are associated with abnormal immune system activity. A wide variety of symptoms occur depending on the location of the connective tissue. Systemic autoimmune connective tissue diseases include systemic lupus erythematosus (SLE) and scleroderma.
gangrene		From a Greek word meaning "to gnaw"	Gangrene is a condition in which an insufficient blood supply causes tissue necrosis. Two types of gangrene are dry and wet gangrene. Dry gangrene is caused by ischemia (poor blood supply). Wet gangrene involves infection of a wound that impairs both arterial and venous blood flow and cell function.
neoplasm	neo- -plasm	new formed material	A neoplasm is an abnormal proliferation of cells, the growth being excessive and uncoordinated with surrounding cells. The excessive growth most often forms a lump or a solid tumor. Neoplasms may be benign, premalignant, or malignant. Examples of benign (meaning "well," as opposed to malignant) neoplasms include fibromas, adenomas, lipomas, and skin moles. They are localized, do not become malignant, and do not metastasize. An example of a premalignant neoplasm is carcinoma-in-situ; it remains localized for a while but becomes cancerous, given enough time. Hence, the urgency for early diagnosis and treatment. Malignant (from a Latin word meaning "acting from malice") neoplasms are called <i>cancers</i> . Because they are invasive and metastatic (spreading), they eventually kill the host. The primary neoplasm is the original or first tumor; untreated, it spreads or metastasizes throughout the body. A secondary neoplasm refers to a cancerous tumor that is the result of metastasis (metastatic lesion). Carcinomas and sarcomas are malignant tumors. A carcinoma is a malignant tumor that arises from epithelial tissue. A sarcoma is a malignant tumor that arises from connective tissue.

Get Ready for Exams!

Summary Outline

Tissues are groups of cells similar to each other in structure and function. Membranes are thin sheets of tissue that cover surfaces, line body cavities, and surround organs.

I. Types of Tissue

A. Epithelial tissue

1. Covers surfaces, lines cavities, and engages in secretion/absorption and protective functions
2. Classified according to cell shape (squamous, cuboidal, and columnar) and layers (simple and stratified)
3. Types and functions are summarized in Table 6-1.

B. Connective tissue

1. Primary function of connective tissue is to bind together the parts of the body. Other functions include support, protection, storage of fat, and transport of substances. See Table 6-2.
2. Has an abundant intercellular matrix that may be liquid, gel-like, or hard; often contains protein fibers that are secreted by the cells
3. Types of loose connective tissue: areolar, adipose, and reticular
4. Dense fibrous connective tissue forms tendons, ligaments, capsules, fascia, and the dermal layer of skin.
5. Types of cartilage: hyaline, elastic, and fibrocartilage
6. Bone (osseous tissue) has a hard intercellular matrix that includes collagen, calcium salts, and other minerals.
7. Blood and lymph have a watery intercellular matrix.

C. Nervous tissue

1. Nervous tissue: found in the nerves, brain, and spinal cord
2. Two types of nervous tissue: neurons (transmit electrical signals) and neuroglia (support and take care of the neurons)

D. Muscle tissue

1. Muscle cells contract, thereby causing movement.
2. Three types of muscle: skeletal, smooth, and cardiac

II. Tissue Repair

- A. Tissue repair by regeneration: replacement of tissue by cells that undergo mitosis
- B. Tissue repair by fibrosis: formation of scar tissue

III. Membranes

A. Epithelial membranes (see Table 6-3)

1. Cutaneous membrane: the skin
2. Mucous membrane: lines all body cavities that open to the exterior of the body
3. Serous membranes: line the ventral body cavities, which are not open to the exterior of the body
4. Layers of serous membranes: a parietal layer that lines the wall of the cavity and a visceral layer that covers the outside of an organ
5. Three serous membranes: pleurae, pericardium, and peritoneum

- B. Connective tissue membranes (see Table 6-3): includes synovial, periosteum, pericardium, meninges, and fascia

Review Your Knowledge

Matching: Tissues

Directions: Match the following words with their descriptions below. Some words may be used more than once.

- a. epithelial
 - b. connective
 - c. muscle
 - d. nervous
1. ___ Important functions: secretion, absorption, excretion, and protection
 2. ___ Blood, bone, cartilage, and adipose tissue
 3. ___ Classified as squamous, cuboidal, or columnar
 4. ___ Endocrine and exocrine glands arise from this type of tissue
 5. ___ Binds together parts of the body; examples include tendons, ligaments, and fascia
 6. ___ Skeletal, cardiac, and smooth
 7. ___ Has the greatest amount of intercellular matrix
 8. ___ Chondrocytes and osteocytes are included in this tissue
 9. ___ Intercellular matrix may be liquid, gel, or rigid
 10. ___ Dendrites, axons, and glia

Matching: Membranes

Directions: Match the following words with their descriptions below.

- a. visceral pleura
 - b. parietal peritoneum
 - c. connective tissue membranes
 - d. mucous membranes
 - e. parietal pleura
1. ___ Membranes lining all body cavities that open to the outside of the body
 2. ___ Serous membrane that lines the walls of the thoracic cavity
 3. ___ Serous membrane that lines the walls of the abdominopelvic cavity
 4. ___ Serous membrane that covers each lung
 5. ___ Synovial membranes: periosteum, perichondrium, and meninges

Multiple Choice

1. Which of the following is not characteristic of epithelial tissue?
 - a. Arranged like floor tiles
 - b. Simple, cuboidal, and columnar
 - c. Large amount of mineral-containing intercellular matrix
 - d. Gives rise to endocrine and exocrine glands
2. Adipose tissue is
 - a. a type of connective tissue that stores fat.
 - b. described as striated and voluntary.
 - c. classified as endocrine and exocrine.
 - d. classified as skeletal, cardiac, and smooth.

3. Osseous tissue
 - a. contains hard mineral-containing intercellular matrix.
 - b. contains osteocytes.
 - c. is a type of connective tissue.
 - d. All of the above.
4. With regard to the pleural membranes,
 - a. there is a visceral and parietal pleural membrane.
 - b. they are connective tissue membranes.
 - c. they are mucous membranes.
 - d. they are located in the dorsal cavity.
5. The pleurae and peritoneum
 - a. are serous membranes.
 - b. are located within the thoracic cavity.
 - c. are located within the abdominal cavity.
 - d. surround the lungs and the heart.
6. Epithelial tissue is avascular, meaning that it
 - a. is shaped like a fish scale.
 - b. contains no blood vessels.
 - c. has no intercellular matrix.
 - d. cannot repair itself.
7. The intercellular matrix of connective tissue
 - a. is less apparent than the intercellular matrix of epithelial tissue.
 - b. is absent in blood and lymph.
 - c. is classified as squamous, cuboidal, and columnar.
 - d. can be hard, liquid, or gel-like in consistency.
2. According to Figure 6-5 and Table 6-2
 - a. The air sacs in the lungs are lined with adipose tissue.
 - b. Cartilage, bone, and adipose tissue are classified as connective tissue.
 - c. All connective tissue has a hard intercellular matrix.
 - d. *Pseudostratified* and *transitional* are descriptive terms most associated with connective tissue.
3. According to Figures 6-6 and 6-7
 - a. Dendrites, cell bodies, and axons are parts of neuroglial cells.
 - b. *Skeletal*, *cardiac*, and *smooth* are terms that describe visceral muscle.
 - c. Both skeletal and cardiac muscle are striped or striated.
 - d. Smooth muscle is striped or striated, like skeletal muscle.
4. According to Figure 6-9
 - a. The terms *parietal* and *visceral* only refer to serous membranes located within the thoracic cavity.
 - b. Pleural membranes surround the lungs and heart.
 - c. The visceral and parietal peritoneal membranes are located in the abdominopelvic cavity.
 - d. The cutaneous membrane lines the mouth and digestive tract.

Go Figure

1. According to Figures 6-1, 6-2, and 6-3
 - a. Only squamous epithelial tissue forms large continuous sheets.
 - b. Epithelial tissue has a superabundance of intercellular matrix.
 - c. Epithelial tissue is confined to the thoracic cavity.
 - d. Epithelial tissue is described as squamous, cuboidal, columnar, simple, or stratified.