

# 4

## Tissues, Glands, and Membranes

**FOCUS:** The cells of the body are specialized to form four basic types of tissues. Epithelial tissue covers free surfaces of the body or forms glands. Connective tissue joins cells and other tissues together, forms a supporting framework for the body (e.g., bone), and transports substances (e.g., blood). Connective tissue is characterized by large amounts of extracellular matrix that separates cells from each other. Muscle tissue has the ability to contract, making

body movement (skeletal muscle), blood movement (cardiac muscle), and movement through hollow organs (smooth muscle) possible. Nervous tissue is specialized for conducting electrical signals called action potentials. Inflammation is a process that isolates and destroys injurious agents. Tissues recover from injury by replacement or regeneration.

### CONTENT LEARNING ACTIVITY

#### Epithelial Tissue

“Epithelium covers surfaces of the body or forms glands.”

Match these terms with the correct statement or definition:

Basement membrane  
Free surface

free surface

1. Part of epithelial cells which is not in contact with other cells.

basement membrane

2. Attaches epithelial cells to underlying tissues.



A tissue is a group of cells with similar structure and functions as well as similar extracellular substances located between the cells. Histology is the microscopic study of tissue structure.

## Classification of Epithelium

“Epithelia are classified according to the number of cell layers and the shape of cells.”

A. Match these terms with the correct statement or definition:

Pseudostratified  
Simple columnar  
Simple cuboidal  
Simple squamous

Stratified columnar  
Stratified cuboidal  
Stratified squamous  
Transitional

simple cuboidal

stratified columnar

transitional

simple squamous

pseudostratified

stratified squamous

1. Epithelium with single layer of cube-shaped cells.
2. Epithelium with multiple layers of tall, thin cells.
3. Epithelium with layers of cells that appear cubelike when an organ is relaxed and flattened when the organ is distended by fluid.
4. Epithelium with single layer of flat, often hexagonal cells.
5. Epithelium with single layer of cells; some cells are tall and thin and reach the free surface, and others do not.
6. Epithelium with multiple layers of cells in which the deepest layers are cuboidal or columnar and becomes flattened at the surface.

B. Match these terms with the correct parts labeled in figure 4.1:

Pseudostratified epithelium  
Simple columnar epithelium

Simple squamous epithelium  
Transitional epithelium

1. transitional epithelium      3. simple columnar epithelium

2. pseudostratified epithelium      4. simple squamous epithelium

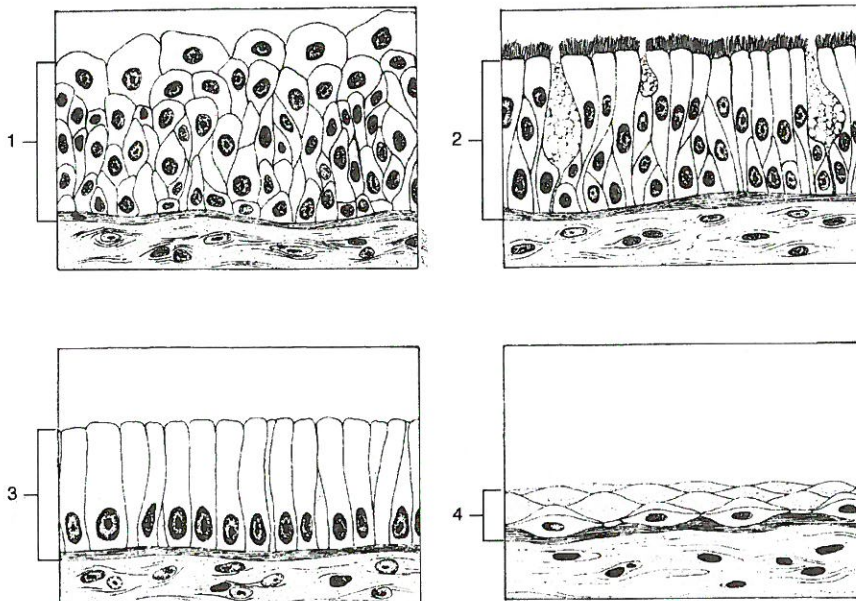


Figure 4.1

## Structure and Functional Relationships

“The number of cell layers and the shape of the cells in a specific type of epithelium reflect the function the epithelium performs.”

A. Match these terms with the correct statement or definition:

stratified epithelium

simple epithelium

Simple epithelium  
Stratified epithelium

1. Found in areas where protection is a major function, e.g., skin, anal canal, and vagina.
2. Found in organs where the principal functions are diffusion, filtration, secretion or absorption.

B. Match these terms with the correct statement or definition:

squamous

cuboidal

Cuboidal or columnar  
Squamous

1. Epithelial cells involved in diffusion or filtration.
2. Epithelial cells with the major function of secretion or absorption.



The greater size of cuboidal and columnar epithelial cells enables them to contain organelles responsible for their function. The stomach, for example, is lined with columnar epithelial cells that contain many secretory vesicles filled with mucus.

C. Match these terms with the correct statement or definition:

smooth

cilia

microvilli

Cilia  
Smooth  
Microvilli

1. Cell surface that reduces friction.
2. Propel materials along the cell surface.
3. Greatly increase surface area; cylindrical extensions of the cell membrane.



Goblet cells, which are specialized mucus-producing cells, are intermixed with ciliated cells in the lining of the nasal cavity. Dust and other materials are trapped in the mucus, and moved into the throat by the movement of the cilia.

D. Match these terms with the correct statement or definition:

tight junctions

desmosomes

gap junctions

Desmosomes  
Gap junctions  
Tight junctions

1. Bind adjacent cells together and prevent the passage of materials between epithelial cells.
2. Mechanical links that function to bind cells together; found in areas subjected to stress such as skin epithelium.
3. Small channels that allow small molecules and ions to pass from one epithelial cell to another.

## Glands

“A gland is a single cell or a multicellular structure that secretes substances onto a surface, into a cavity, or into the blood.”

A. Match these terms with the correct statement or definition:

Endocrine  
Exocrine

exocrine  
endocrine

1. Glands with a duct (e.g., sweat glands).
2. Glands with no duct; secrete hormones (e.g. pituitary gland).

B. Match these terms with the correct part labeled in figure 4.2:

Compound acinar (alveolar)  
Compound tubular  
Simple acinar (alveolar)  
Simple straight tubular

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

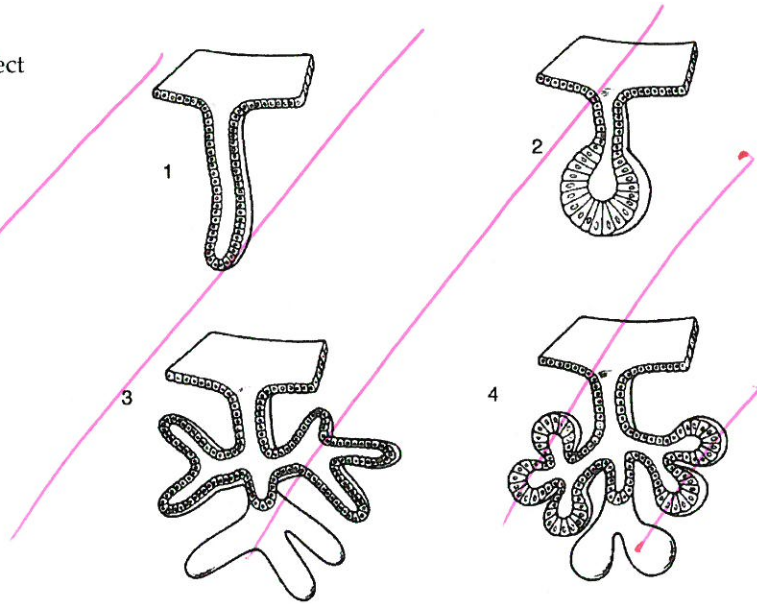


Figure 4.2

## Connective Tissue

“Connective tissue is characterized by large amounts of extracellular matrix that separates cells from each other.”

A. Match these terms with the correct statement or definition:

Collagen fibers  
Elastic fibers

Proteoglycans  
Reticular fibers

Collagen fibers  
reticular fibers  
elastic fibers  
proteoglycans

1. Protein fibers that resemble microscopic ropes; flexible, but resist stretching.
2. Fine short collagen fibers that branch.
3. Protein fibers with structure similar to a coiled bed spring.
4. Ground substance molecules that trap water; composed of proteins and polysaccharides.



Connective tissue functions to join together cells and other tissues, provides a supporting framework for the body, and transports substances.

B. Match these terms with the correct statement or definition:

Blast cells  
Clast cells  
Cyte cells

Macrophages  
Mast cells

blast cells  
cyte cells  
clast cells  
macrophages  
mast cells

1. Cells that produce the extracellular matrix.
2. Cells that maintain the extracellular matrix.
3. Cells that break down the extracellular matrix.
4. Cells that move about and ingest foreign substances.
5. Nonmotile cells; release chemicals promoting inflammation.

## Connective Tissue Classification

“The nature of the extracellular matrix determines the functional characteristics of the connective tissue, and is used as a means of classifying the connective tissue.”

A. Match these terms with the correct statement or definition:

Liquid  
Protein fibers + ground substance  
Protein fibers

protein fibers  
protein fibers + ground substance  
liquid

1. Extracellular matrix for dense and areolar connective tissue.
2. Extracellular matrix for cartilage and bone.
3. Extracellular matrix for blood.

B. Match these terms with the correct statement or definition:

Adipose tissue  
Loose (areolar) connective tissue  
Dense connective tissue

dense connective tissue  
loose  
adipose

1. Closely packed collagen fibers running in the same direction; found in tendons, ligaments, and the dermis of the skin.
2. Widely separated collagen fibers running in random directions; attachment for organs, glands, muscles, nerves, and skin.
3. Very little matrix; cells filled with lipid for energy storage.

C. Match these terms with the correct statement or definition:

Bone  
Elastic cartilage  
Fibrocartilage  
Hyaline cartilage

Hyaline cartilage  
Fibrocartilage  
Elastic cartilage  
bone

1. Covers the ends of bones where bones come together to form joints.
2. Found in the disks between vertebrae.
3. Found in the external ear.
4. Hard connective tissue consisting of living cells and a mineralized matrix.

D. Match these terms with the correct statement or definition:

chondrocytes  
osteocytes  
lacunae

Chondrocytes  
 Lacunae

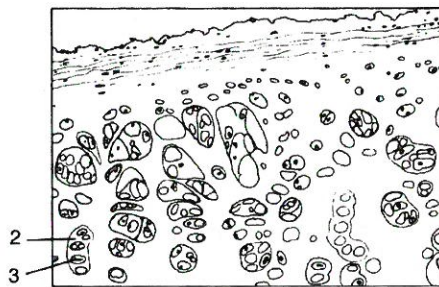
Osteocytes

1. Cartilage cells.
2. Bone cells.
3. Spaces containing cells within the matrix of bone or cartilage.

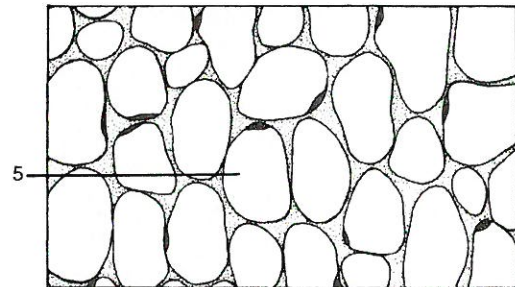
E. Match these terms with the correct parts labeled in figure 4.3:

Adipose  
 Bone  
 Cartilage  
 Chondrocyte

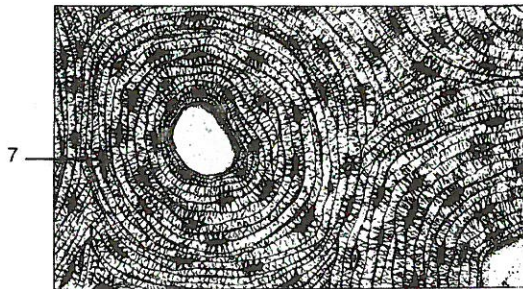
Dense connective tissue  
 Fat droplet  
 Fibroblast  
 Lacuna



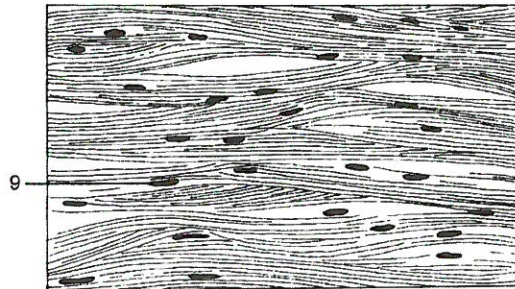
1. Type of tissue



4. Type of tissue



6. Type of tissue



8. Type of tissue

Figure 4.3

- |                       |                       |                                   |
|-----------------------|-----------------------|-----------------------------------|
| 1. <u>cartilage</u>   | 4. <u>adipose</u>     | 7. <u>lacuna</u>                  |
| 2. <u>lacunae</u>     | 5. <u>fat droplet</u> | 8. <u>dense connective tissue</u> |
| 3. <u>chondrocyte</u> | 6. <u>bone</u>        | 9. <u>fibroblast</u>              |

## Muscle Tissue

“The main characteristic of muscle tissue is its ability to contract or shorten, making movements possible.”

Match these terms with the correct statement or definition:

skeletal muscle

cardiac muscle

smooth muscle

Cardiac muscle  
Skeletal muscle

Smooth muscle

1. Cylindrical, striated, voluntary muscle cells with several nuclei per cell.
2. Striated, branching, involuntary cells with intercalated disks.
3. Cells tapered at each end, unstriated, involuntary, and with a single nucleus.

## Nervous Tissue

“Nervous tissue forms the brain, spinal cord and nerves; it is responsible for coordinating and controlling many of the body's activities.”

Match these terms with the correct statement or definition:

cell body

dendrites

axon

neuroglia

Axon  
Cell body

Dendrites  
Neuroglia

1. Part of the neuron (nerve cell) that contains the nucleus; site of general cell functions.
2. Receive action potentials and conduct them toward the cell body.
3. Conducts action potentials away from the cell body.
4. Support cells of the nervous system; function to nourish, protect and insulate the neurons.



Nervous tissue cells communicate with each other and cells of other tissues by electrical signals called action potentials.

## Membranes

“A membrane is a thin sheet or layer of tissue that covers a structure or lines a cavity.”

A. Match these terms with the correct statement or definition:

mucous membranes

serous membranes

other membranes

Mucous membranes  
Other membranes

Serous membranes

1. Line cavities that open to the outside of the body.
2. Line the trunk cavities and cover the organs located within the trunk cavities.
3. Includes skin, synovial membrane, and periosteum.

B. Match these terms with the correct statement or definition:

pleural  
pericardial  
peritoneal

Pericardial  
Peritoneal

Pleural

1. Serous membranes associated with the lungs.
2. Serous membranes associated with the heart.
3. Serous membranes associated with the abdominopelvic cavity.

### Inflammation

“The inflammatory response occurs when tissues are damaged.”

Match these terms with the correct statement or definition:

mediators of inflammation  
dilation, increased permeability  
edema  
neutrophils  
pain  
disturbance of function

Dilation  
Disturbance of function  
Edema  
Increased permeability

Mediators of inflammation  
Neutrophils  
Pain

1. Chemical substances that are released or activated in the injured tissues and adjacent blood vessels.
2. Two changes that occur in blood vessels that result in symptoms of redness, heat, and swelling.
3. Swelling of tissues when proteins and water from blood enter tissues.
4. Phagocytic white blood cells that fight infection; dead cells in pus.
5. Result of direct damage, mediators, and edema stimulating nerve cell endings.
6. Limitations produced by edema, tissue destruction, and pain.



The inflammatory response mobilizes the body's defenses and isolates and destroys microorganisms, foreign materials, and damaged cells so that tissue repair can proceed.



## Tissue Repair

“Tissue repair is the substitution of viable cells for dead cells, and it can occur by regeneration or replacement.”

A. Using the terms provided, complete these statements:

Labile	Replacement
Permanent	Stable
Regeneration	

In (1), the new cells are of the same type as those that were destroyed, whereas in (2), a new type of tissue develops that eventually causes scar production and the loss of some tissue function. (3) cells continue to divide throughout life; these cells can be completely repaired by regeneration. (4) cells do not actively divide after growth ceases, but they do retain the ability to divide after an injury, and are capable of regeneration. (5) cells cannot divide, and if killed, they are usually replaced by connective tissue.

1. regeneration
2. replacement
3. labile
4. stable
5. permanent

B. Using the terms provided, complete these statements:

Fibrin	Scab
Granulation tissue	Scar
Macrophage	Wound contracture

When the edges of a wound are close together, the wound fills with blood and a clot forms. The clot contains a threadlike protein, (1), which binds the edges of the wound together and stops any bleeding. The surface of the clot dries to form a (2), which seals the wound. Neutrophils enter the tissue from the blood. After the epithelium is repaired, the scab is shed, and a second type of phagocytic cell, called a (3) removes dead neutrophils, cellular debris, and the decomposing clot. The clot is replaced by a delicate connective tissue called (4), which consists of fibroblasts, collagen, and capillaries. Sometimes a large amount of granulation tissue persists as a (5), which at first is bright red because of the vascular-ization of the tissue. Repair takes longer if the wound edges are far apart. Much more granulation tissue forms, and (6) occurs when fibroblasts pull the edges of the wound closer together. This can lead to disfiguring and debilitating scars.

1. fibrin
2. scab
3. macrophage
4. granulation tissue
5. scar
6. wound contracture

## QUICK RECALL

1. List five major functions of epithelia.
2. List six kinds of epithelium based on the number of cell layers and the shape of cells.
3. Name three types of cell connections.
4. List two types of glands, based on whether or not a duct is present.
5. List seven functions of connective tissue.
6. List three types of connective tissue that have a matrix with protein fibers as the primary feature.
7. Name three types of cartilage found in the human body.
8. List three types of muscle tissue found in the human body.

9. List the two major categories of membranes found in the human body.
  
10. List the five major symptoms of inflammation.
  
11. List the three categories into which cells can be classified according to their regenerative ability.

## WORD PARTS

Give an example of a new vocabulary word that contains each word part.

WORD PART	MEANING	EXAMPLE
epi-	upon; over	1. _____
squam-	scale; flat	2. _____
acin-	grape; sac	3. _____
desmo-	band; ligament	4. _____
-cyte	cell	5. _____
-crine	to separate	6. _____

## MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

- \_\_\_\_\_ 1. A tissue that covers a surface, is one cell layer thick, and is composed of flat cells is
- simple squamous epithelium.
  - simple cuboidal epithelium.
  - simple columnar epithelium.
  - stratified squamous epithelium.
  - transitional epithelium.
- \_\_\_\_\_ 2. Epithelium composed of two or more layers of cells with only the deepest layer in contact with the basement membrane is known as
- stratified epithelium.
  - simple epithelium.
  - pseudostratified epithelium.
  - columnar epithelium.
- \_\_\_\_\_ 3. Given these characteristics:
- capable of contraction
  - covers all free body surfaces
  - lacks blood vessels
  - comprises various glands
  - anchored to connective tissue by a basement membrane.
- Which of these are characteristics of epithelial tissue?
- 1,2,3
  - 2,3,5
  - 3,4,5
  - 1,2,3,4
  - 2,3,4,5
- \_\_\_\_\_ 4. Stratified epithelium is usually found in areas of the body where the principal activity is
- filtration.
  - protection.
  - absorption.
  - diffusion.
- \_\_\_\_\_ 5. An epithelial cell with microvilli would most likely be found
- lining blood vessels.
  - lining the nasal cavity.
  - in serous membranes.
  - lining the small intestine.
- \_\_\_\_\_ 6. A type of junction between epithelial cells whose ONLY function is to prevent the cells from coming apart (provides mechanical strength) is the
- desmosome.
  - gap junction.
  - dermatome.
  - tight junction.
- \_\_\_\_\_ 7. Pseudostratified ciliated epithelium can be found lining the
- digestive tract.
  - trachea.
  - urinary bladder.
  - kidney tubules.
- \_\_\_\_\_ 8. In parts of the body such as the urinary bladder, where considerable stretching occurs, one can expect to find which of these type of cells?
- cuboidal epithelium
  - pseudostratified epithelium
  - transitional epithelium
  - squamous epithelium
- \_\_\_\_\_ 9. An exocrine gland with many branches, and with the ends of the ducts expanded into a saclike structures is a
- simple tubular gland.
  - simple acinar (alveolar) gland.
  - compound tubular gland.
  - compound acinar (alveolar) gland.
- \_\_\_\_\_ 10. The fibers in dense connective tissue are formed by
- fibroblasts.
  - adipose cells.
  - osteoblasts.
  - macrophages.
  - mast cells.

- \_\_\_\_\_ 11. A tissue that contains a large amount of extracellular collagen organized as parallel fibers would probably be found in
- a muscle.
  - a tendon.
  - adipose tissue.
  - bone.
  - cartilage.
- \_\_\_\_\_ 12. Which of these is true of adipose tissue?
- site of energy storage
  - a type of connective tissue
  - acts as a protective cushion
  - functions as a heat insulator
  - all of the above
- \_\_\_\_\_ 13. Hyaline cartilage is found in
- the external ear.
  - the disks between the vertebrae.
  - joints, covering the ends of bones.
  - the costal cartilages.
  - both c and d.
- \_\_\_\_\_ 14. Blood is an example of
- epithelial tissue.
  - connective tissue.
  - muscle tissue.
  - nervous tissue.
- \_\_\_\_\_ 15. Which of these is characteristic of skeletal muscle?
- under involuntary (unconscious) control
  - cells tapered at each end
  - intercalated disks present
  - several nuclei per cell
  - all of the above
- \_\_\_\_\_ 16. Which of these statements about nervous tissue is NOT true?
- Neurons have cell processes (extensions) called axons.
  - Electrical signals (action potentials) are conducted along axons.
  - Dendrites contain the nucleus, and control general cell function.
  - Neurons are nourished and protected by neuroglia.
- \_\_\_\_\_ 17. A bullet that passes through one's upper arm without hitting bone could contact which of these tissue types?
- nervous
  - muscle
  - connective
  - epithelial
  - all of the above
- \_\_\_\_\_ 18. Linings of the digestive, respiratory, excretory, and reproductive tracts are composed of
- serous membranes.
  - synovial membranes.
  - periosteum.
  - mucous membranes.
- \_\_\_\_\_ 19. Chemical mediators of inflammation
- stimulate nerve endings to produce the symptom of pain.
  - increase the permeability of blood vessels.
  - are released into or activated in tissues following injury.
  - cause dilation (expansion) of blood vessels.
  - all of the above
- \_\_\_\_\_ 20. Which of these tissues consist of labile cells (which actively divide throughout life)?
- connective tissue
  - muscle tissue
  - nervous tissue (neurons)
  - skin and mucous membrane cells



## FINAL CHALLENGES



Use a separate sheet of paper to complete this section.

1. On a histology exam, Slide Mann was asked to identify the types of epithelial tissue lining the inner surface of an organ. He identified the first tissue as stratified squamous epithelium and the second tissue as stratified cuboidal. In both cases he was wrong. Given that the tissues both came from the same organ, what was the epithelial type?
2. Slide Mann was examining a ligament under the microscope. Slide knew that ligaments attached bones to bones, so he was surprised to observe a large number of elastic fibers in the ligament. Why did it seem inappropriate for a ligament to have elastic fibers?
3. When Slide Mann asked his instructor about the ligament with elastic fibers, the instructor responded with a question for Slide, "Do you think the ligament joined the bones of the spine (vertebrae) to each other or did it join the thigh bone (femur) to the hip bone (coxa)?" Explain why this question should make everything clear to Slide.
4. "Raddy" McDude was riding his skateboard, tried to jump a park bench, and severely twisted his knee. Upon examination, the doctor determined that he had torn cartilage in his knee, and that the torn cartilage must be surgically removed. Why didn't the doctor tell Raddy to just rest the knee until the cartilage healed?