Oh, what tangled webs we weave! As the chapter title says, histology is the study of tissues, but you may be surprised to find out that the Greek *histo* doesn’t translate as “tissue” but instead as “web.” It’s a logical next step after reviewing the cell and cellular division to take a look at what happens when groups of similar cells “web” together to form tissues. The four different types of tissue in the body are as follows:

- Epithelial, or skin, tissue (from the Greek *epi-* for “over” or “outer”)
- Connective tissue
- Muscle tissue
- Nerve tissue

In this chapter, you find a quick review of the basics of each of these types of tissues along with practice questions to test your knowledge of them.

## Getting Under Your Skin

Perhaps because of its unique job of both protecting the outer body and lining internal organs, epithelial tissue comes in more varieties than any other tissue.

Epithelial tissues, which generally are arranged in sheets or tubes of tightly-packed cells, always have a free, or *apical*, surface that can be exposed to the air or to fluid. That free surface also can be covered by additional layers of epithelial tissue. But whether it’s layered or not, each epithelial cell has *polarity* (a top and a bottom), and all but one side of the cell is tucked snugly against neighboring cells. The apical side sometimes has cytoplasmic projections such as *cilia*, hair-like growths that can move material over the cell’s surface, or *microvilli*, finger-like projections that increase the cell’s surface area for absorption. Opposite the apical side is the *basal* side (think basement), which typically attaches to some kind of connective tissue.

Epithelial tissue serves several key functions, including the following:

- **Protection**: Skin protects vulnerable structures or tissues deeper in the body.
- **Barrier**: Epithelial tissues prevent foreign materials from getting inside the body.
**Sensation:** Sensory nerve endings embedded in epithelial tissue connect the body with outside stimuli.

**Secretion:** Epithelial tissue in glands can be specialized to secrete enzymes, hormones, and fluids.

Single-layer epithelial tissue is classified as *simple*. Tissue with more than one layer is called *stratified*. Epithelial tissues also can be classified according to shape: *Squamous* is a thin, flat cell; *cuboidal* is, as the name implies, equal in height and width and shaped like a cube; and *columnar* cells are taller than they are wide.

Following are the ten primary types of epithelial tissues:

- **Simple squamous epithelium:** Looking a bit like rolling tundra, this flat layer of scale-like cells is useful in diffusion, secretion, or absorption. Each cell nucleus is centrally located and is round or oval. Simple squamous epithelium lines the lungs’ air sacs where oxygen and carbon dioxide are exchanged; forms blood filters inside the kidneys; and lines the inner surface of the eardrum, known as the tympanic membrane.

- **Simple cuboidal epithelium:** These cube-shaped cells, found in a single layer that looks like a microscopic mattress, have centrally located nuclei that usually are round. Found in the ovaries, kidneys, and some glands, this type of epithelium functions in secretion, absorption, and tube formation.

- **Simple columnar epithelium:** These densely packed cells are taller than they are wide, with nuclei located near the base of each cell. Found lining the digestive tract from the stomach to the anal canal, this type of epithelium functions in secretion and absorption.

- **Simple columnar ciliated epithelium:** A close cousin to simple columnar epithelium, this type of tissue has hair-like cilia that can move mucus and other substances across the cell. It’s found lining the small respiratory tubes.

- **Pseudostratified columnar epithelium:** Pay attention to the prefix *pseudo*— here, which means “false.” It may look multilayered because the cells’ nuclei are scattered at different levels, but it’s not. This type of epithelium is found in the salivary glands and some segments of the male reproductive system, including the urethra.

- **Pseudostratified columnar ciliated epithelium:** Another variation on a theme, this tissue is nearly identical to pseudostratified columnar epithelium. The difference is that this tissue’s free surface has cilia, making it ideal for lining air passages because the cilia’s uniform waving action causes a thin layer of mucus to move in one direction — toward the throat and mouth — and trap dust particles.

- **Stratified squamous epithelium:** This tissue is the stuff you see everyday — your outer skin, or epidermis. This multilayered tissue has squamous cells on the outside plus deeper layers of cuboidal or columnar cells. Found in areas where the outer cell layer is constantly worn away, this type of epithelium regenerates its surface layer with cells from lower layers.

- **Stratified cuboidal epithelium:** This multilayered epithelium can be found in sweat glands, conjunctiva of the eye, and the male urethra. Its function is primarily protection.

- **Stratified columnar epithelium:** Also multilayered, this epithelium is found lining parts of the male urethra, excretory ducts of glands, and some small areas of the anal mucus membrane.

- **Stratified transitional epithelium:** This epithelium is referred to as *transitional* because its cells can shape-shift from cubes to squamous-like flat surfaces and back again. Found lining the bladder, the cells flatten out to make room for urine.
Following are some practice questions dealing with epithelial tissue:

1. Epithelial cells can be shaped
   a. Like columns
   b. Like cubes
   c. Thin and flat
   d. All of the above

2. Epithelial tissue is classified by
   a. Number of layers
   b. Composition of matrix
   c. Cell shape
   d. Both the number of layers and the cell shape

3. The epithelial tissue that has the ability to stretch is
   a. Simple squamous
   b. Transitional
   c. Pseudostratified columnar
   d. Simple columnar

4.–8. Match the epithelial tissue with its location in the body.
   4. _____ Simple columnar a. Urinary bladder
   5. _____ Stratified squamous b. Tubules of the kidney
   6. _____ Transitional c. Digestive tract
   7. _____ Pseudostratified columnar ciliated d. Epidermis of the skin
   8. _____ Simple cuboidal e. Respiratory passages

9. A tissue that’s one layer thick but appears to be multilayered and is composed of cells taller than they are wide is
   a. Stratified ciliated columnar epithelium
   b. Simple squamous epithelium
   c. Pseudostratified columnar epithelium
   d. Transitional epithelium
10.–19. Use the terms that follow to identify the epithelial tissues shown in Figure 4-1.

- a. Stratified squamous
- b. Simple columnar
- c. Squamous
- d. Transitional stretched
- e. Simple squamous
- f. Columnar
- g. Pseudostratified
- h. Cuboidal
- i. Transitional relaxed
- j. Simple cuboidal

**Making a Connection: Connective Tissue**

Connective tissues connect, support, and bind body structures together. Unlike other types of tissues, connective tissues are classified more by the stuff in which the cells lay — the extracellular matrix — than by the cells themselves. The cells that produce that matrix are scattered within it like chocolate chips in ice cream. The load-bearing
strength of connective tissue comes from a fibrous protein called collagen. All connective tissues contain a varying mix of collagen, elastic, and reticular fibers.

Following are the primary types of connective tissue:

- **Areolar, or loose, tissue**: This tissue exists between and around almost everything in the body to bind structures together and fill space. It’s made up of wavy ribbons called collagenous protein fibers, cylindrical threads called elastic fibers, and amorphous ground substance, a semisolid gel. Various cells including lymphocytes, fibroblasts, fat cells, and mast cells are scattered throughout the ground substance (see Figure 4-2).

- **Dense regular connective tissue**: Made up of parallel, densely packed bands or sheets of fibers (see Figure 4-2), this type of tissue is found in tendons as bundles of collagenous fibers attaching muscles to bone and in ligaments as bundles of elastic fibers extending from bone to bone, surrounding a joint, and anchoring organs. It usually resists force in just two directions.

- **Dense irregular connective tissue**: Also known as dense fibrous connective tissue, it consists of fibers that twist and weave around each other, forming a thick tissue that can withstand stresses applied from any direction. This tissue makes up the strong inner skin layer called the dermis as well as the outer capsule of organs like the kidney and the spleen.

- **Adipose tissue**: Composed of fat cells, this tissue forms padding around internal organs, reduces heat loss through the skin, and stores energy in fat molecules called triglycerides. Fat molecules fill the cells, forcing the nuclei against the cell membranes and giving them a ring-like shape. Adipose has an intracellular matrix rather than an extracellular matrix.

- **Reticular tissue**: Literally translated as “web-like” or “net-like,” reticular tissue is made up of slender, branching reticular fibers with reticular cells overlaying them. Its intricate structure makes it a particularly good filter, which explains why it’s found inside the spleen, lymph nodes, and bone marrow.
**Cartilage:** These firm but flexible tissues, made up of collagen and elastic fibers, have no blood vessels or nerve cells (a state called *non-vascular* or *avascular*). Cartilage contains openings called lacunae (from the Latin word *lacus* for “lake” or “pit”) that enclose mature cells called chondrocytes, which are preceded by cells called chondroblasts. A membrane known as the *perichondrium* surrounds cartilage tissue, which also contains a gelatinous protein called chondrin. There are three types of cartilage:

- **Hyaline cartilage:** The most abundant cartilage in the body, it’s elastic and made up of a uniform matrix pocked with chondrocytes. It lays the foundation for the embryonic skeleton, forms the rib (or *costal*) cartilages, makes up nose cartilage, and covers the articulating surfaces of bones.

- **Fibrocartilage:** As the name implies, fibrocartilage contains thick, compact collagen fibers. The sponge-like structure, with the lacunae and chondrocytes lined up within the fibers, makes it a good shock absorber. It’s found in the intervertebral discs of the vertebral column and in the symphysis pubis at the front of the pelvis.

- **Elastic cartilage:** Similar to hyaline cartilage, elastic cartilage has more tightly packed lacunae and chondrocytes between parallel elastic fibers. This structure, which makes up the ear lobe and other structures where a specific form is important, tends to bounce back to its original shape after being bent.

**Bone, or osseous, tissue:** Essentially, bone is mineralized connective tissue formed into repeating patterns called *Haversian systems*. In the center of each system is a large opening, the *Haversian canal*, that contains blood vessels, lymph vessels, and nerves. The central canal is surrounded by thin membranes called lamellae that contain the lacunae, which in turn contain osteocytes (bone cells). Smaller canaliculi connect the lacunae and circulate tissue fluids from the blood vessels to nourish the osteocytes. (We explore bone in more detail in Chapter 5.)

**Blood:** Yes, blood is considered a type of connective tissue. Like other connective tissues, it has an extracellular matrix — in this case, plasma — in which are suspended erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets). (Blood also is considered a vascular tissue because it circulates inside arteries and veins, but we get into that in Chapter 10.) Roughly half of blood’s volume is fluid or plasma while the other half is suspended cells. Erythrocytes are concave on both sides and contain a pigment, hemoglobin, which supplies oxygen to the body’s cells and takes carbon dioxide away. There are approximately 5 million erythrocytes per cubic millimeter of whole blood. Thrombocytes, which number approximately 250,000 per cubic millimeter, are fragments of cells used in blood clotting. Leukocytes are large phagocytic cells (literally “cell that eats”) that are part of the body’s immune system. There are, however, relatively few of them — less than 10,000 per cubic millimeter.

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20. Adipose tissue is composed of
   a. Mast cells
   b. Chondrocytes
   c. Osteocytes
   d. Fat cells

21. Tendons are composed of
   a. Elastic tissue
   b. Dense regular connective tissue
   c. Areolar connective tissue
   d. Fibrocartilage
22. The tissue covering the surface of articulating bones is
   a. Hyaline cartilage
   b. Areolar
   c. Vascular tissue
   d. Fibrocartilage

23. Vascular connective tissue is
   a. Hyaline cartilage
   b. Elastic tissue
   c. Blood
   d. Bone

24. Tissue containing lacunae with osteocytes is
   a. Elastic cartilage
   b. Bone
   c. Hyaline cartilage
   d. Blood

25. Blood contains cells functional in clotting called
   a. Phagocytes
   b. Erythrocytes
   c. Leukocytes
   d. Thrombocytes

**Flexing It: Muscle Tissue**

Although we review how muscles work in Chapter 6, in histology you should know that muscle tissue is made up of fibers known as myocytes. The cytoplasm within the fibers is called sarcoplasm, and within that sarcoplasm are minute myofibrils that contain the protein filaments actin and myosin. These filaments slide past each other during a muscle contraction, shortening the fiber.

Following are the three types of muscle tissue (see Figure 4-3):

- **Smooth muscle tissue:** This type of tissue contracts without conscious control. Made up of spindle-shaped fibers with large, centrally located nuclei, it’s found in the walls of internal organs, or viscera. Smooth muscle gets its name from the fact that, unlike other muscle tissue types, it is not striated.

- **Cardiac muscle tissue:** Also known as myocardium, cardiac muscle tissue is made of branching fibers, each with a central nucleus and alternating light and dark striations. Between the fibers are dark structures called intercalated discs. As with smooth muscle, cardiac muscle tissue contractions occur through the autonomic nervous system (involuntary control).

- **Skeletal, or striated, muscle tissue:** Biceps, triceps, pecs — these are the muscles that bodybuilders focus on. As the name implies, skeletal muscles attach to the skeleton and are used throughout the central nervous system for movement. Muscle fibers are cylindrical with several nuclei in each cell (which makes them multinucleated) and cross-striations throughout.
26. Which type of tissue is multinucleated?
   a. Skeletal muscle tissue
   b. Cardiac muscle tissue
   c. Smooth muscle tissue

27. A tissue that has intercalated discs is
   a. Cardiac muscle
   b. Skeletal muscle
   c. Smooth muscle
   d. Striated muscle

28. Skeletal muscle tissue has prominent lines across the fiber called
   a. Fibroblasts
   b. Multinucleation
   c. Lacunae
   d. Striations

29. Smooth muscle tissue is found in the
   a. Heart
   b. Urinary bladder
   c. Bicep
   d. Deltoid

**Getting the Signal Across: Nerve Tissue**

There’s only one type of nerve tissue and only one primary type of cell in it: the *neuron*. Nerve tissue is unique in that it can both generate and conduct electrical signals in the body. That process starts when sense receptors receive a stimulus that causes electrical impulses to be sent through finger-like cytoplasmic projections called
dendrites. From there, the impulse moves through the body of the cell and into another type of cytoplasmic projection (or nerve process) called an axon that hands the signal off to the next cell down the line. (We look more closely at how all that happens when we examine the central nervous system in Chapter 15.)

Following are some practice questions dealing with nerve tissue:

30. Cells capable of producing and transmitting electrical impulses are
   a. Schwann cells
   b. Neurons
   c. Chondrocytes
   d. Thrombocytes

31. The cytoplasmic projection of a neuron that carries impulses away from the cell body is called
   a. A myofibril
   b. A dendrite
   c. An axon
   d. A cross-striation

32. The cytoplasmic projections that receive stimuli from sense receptors are
   a. Dendrites
   b. Collagenous fibers
   c. Axons
   d. Schwann projections

33–37. Match each description with the appropriate tissue.

33. ____ Precedes bone formation in embryonic development  
   a. Areolar tissue

34. ____ Found in visceral walls  
   b. Hyaline cartilage

35. ____ Found in and around most structures in the body  
   c. Bone

36. ____ Found in the external ear  
   d. Elastic cartilage

37. ____ Supports soft tissues of the body  
   e. Smooth muscle