TABLE 5.7 Connective Tissues

Type	Description	Function	Location
Loose connective tissue	Cells in fluid-gel matrix	Binds organs, holds tissue fluids	Beneath the skin, between muscles, beneath epithelial tissues
Adipose tissue	Cells in fluid-gel matrix	Protects, insulates, and stores fat	Beneath the skin, around the kidneys, behind the eyeballs, on the surface of the heart
Reticular connective tissue	Cells in fluid-gel matrix	Supports	Walls of liver, spleen, and lymphatic organs
Dense connective tissue	Cells in fluid-gel matrix	Binds organs	Tendons, ligaments, dermis
Elastic connective tissue	Cells in fluid-gel matrix	Provides elastic quality	Connecting parts of the spinal column, in walls of arteries and airways
Hyaline cartilage	Cells in solid-gel matrix	Supports, protects, provides framework	Ends of bones, nose, and rings in walls of respiratory passages
Elastic cartilage	Cells in solid-gel matrix	Supports, protects, provides flexible framework	Framework of external ear and part of larynx
Fibrocartilage	Cells in solid-gel matrix	Supports, protects, absorbs shock	Between bony parts of spinal column, parts of pelvic girdle, and knee
Bone	Cells in solid matrix	Supports, protects, provides framework	Bones of skeleton, middle ear
Blood	Cells and platelets in fluid matrix	Transports gases, defends against disease, clotting	Throughout the body within a closed system of blood vessels and heart chambers

1. Describe the general characteristics of cartilage.
2. Explain why injured bone heals more rapidly than does injured cartilage.
3. What are the major components of blood?

Types of Membranes

After discussing epithelial and connective tissues, membranes are better understood. **Epithelial membranes** are thin, sheetlike structures that are usually composed of epithelial and underlying connective tissues, covering body surfaces and lining body cavities. The three major types of epithelial membranes are *serous*, *mucous*, and *cutaneous*.

Serous (se′rus) **membranes** line the body cavities that do not open to the outside and reduce friction between the organs and cavity walls. They form the inner linings of the thorax and abdomen, and they cover the organs within these cavities (see figs. 1.11 and 1.12). A serous membrane consists of a layer of simple squamous epithelium (mesothelium) and a thin layer of loose connective tissue. Cells of a serous membrane secrete watery *serous fluid*, which helps lubricate membrane surfaces.

Mucous (mu′kus) **membranes** line the cavities and tubes that open to the outside of the body. These include the oral and nasal cavities and the tubes of the digestive, respiratory, urinary, and reproductive systems. A mucous membrane consists of epithelium overlying a layer of loose connective tissue; however, the type of epithelium varies with the location of the membrane. For example, stratified squamous epithelium lines the oral cavity, pseudostratified columnar epithelium lines part of the nasal cavity, and simple columnar epithelium lines the small intestine. Goblet cells within a mucous membrane secrete *mucus*.

Another epithelial membrane is the **cutaneous** (ku-ta′ne-us) **membrane**, more commonly called *skin*. It is part of the integumentary system described in detail in chapter 6.

Some membranes are composed entirely of connective tissues. These include **synovial membrane** (sĭ-no′ve-al mem′brān), lining joints and discussed further in chapter 8 (pp. 265–266).

1. Name the four types of membranes, and explain how they differ.
2. Explain how the membrane types differ.

Muscle Tissues

General Characteristics

Due to their elongated shape, the cells in **muscle tissues** are sometimes called *muscle fibers*. Muscle tissues are contractile; they can shorten and thicken. As they contract, muscle cells pull at their attached ends, which moves body parts. The three types of muscle tissue (skeletal, smooth, and cardiac) are discussed further in chapter 9.

Skeletal Muscle Tissue

Skeletal muscle tissue (fig. 5.28) forms muscles that usually attach to bones and that are controlled by conscious

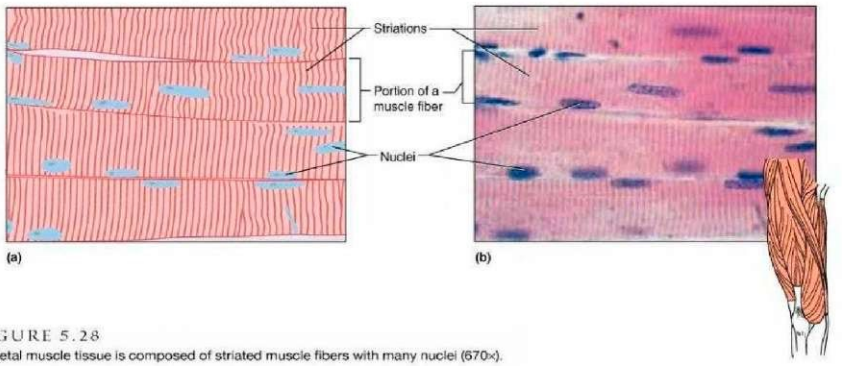

FIGURE 5.28
Skeletal muscle tissue is composed of striated muscle fibers with many nuclei (670×).

effort. For this reason, it is often called *voluntary* muscle tissue. Skeletal muscle cells are long—up to or more than 40 mm in length—and narrow—less than 0.1 mm in width. These threadlike cells of skeletal muscle have alternating light and dark cross-markings called *striations*. Each cell has many nuclei (multinucleate). A message from a nerve cell can stimulate a muscle cell to contract by causing protein filaments within the muscle cell to slide past one another. Then, the muscle cell relaxes when nerve stimulation stops. Skeletal muscles move the head, trunk, and limbs and enable us to make facial expressions, write, talk, and sing, as well as chew, swallow, and breathe.

Smooth Muscle Tissue

Smooth muscle tissue (fig. 5.29) is called smooth because its cells lack striations. Smooth muscle cells are shorter than those of skeletal muscle and are spindle-shaped, each with a single, centrally located nucleus. This tissue comprises the walls of hollow internal organs, such as the stomach, intestines, urinary bladder, uterus, and blood vessels. Unlike skeletal muscle, smooth muscle usually cannot be stimulated to contract by conscious efforts. Thus, its actions are *involuntary*. For example, smooth muscle tissue moves food through the digestive tract, constricts blood vessels, and empties the urinary bladder.

Cardiac Muscle Tissue

Cardiac muscle tissue (fig. 5.30) is only in the heart. Its cells, which are striated and branched, are joined end-to-end. The resulting muscle cells are branched and interconnected in complex networks. Each cardiac muscle cell has a single nucleus. Where one cell touches another cell is a specialized intercellular junction called an *intercalated disc*, seen only in cardiac tissue.

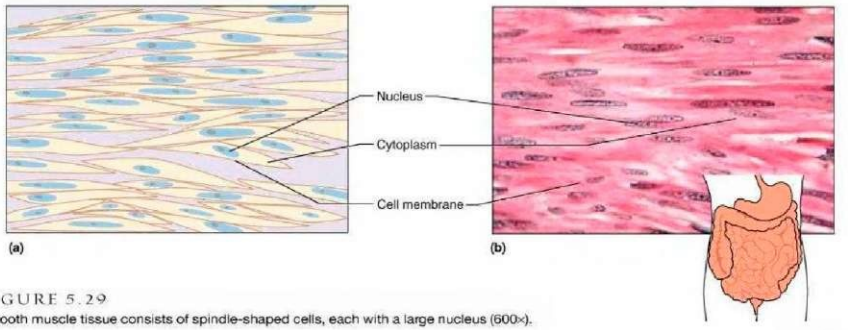

FIGURE 5.29
Smooth muscle tissue consists of spindle-shaped cells, each with a large nucleus (600×).

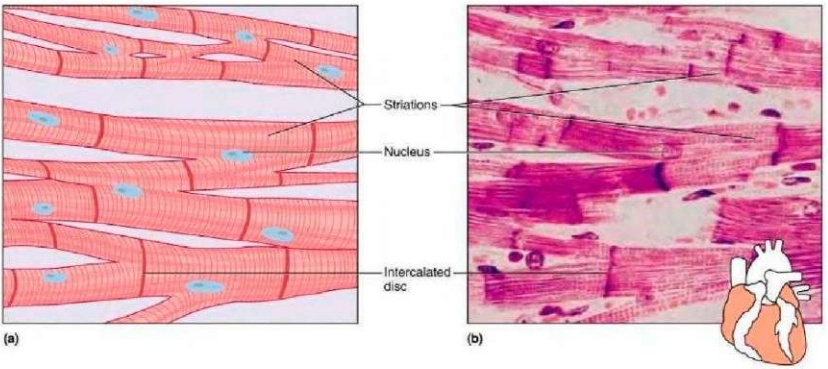

FIGURE 5.30
Cardiac muscle cells are branched and interconnected, with a single nucleus each (360×).

Cardiac muscle, like smooth muscle, is controlled involuntarily and, in fact, can continue to function without being stimulated by nerve impulses. This tissue makes up the bulk of the heart and pumps blood through the heart chambers and into blood vessels.

1. List the general characteristics of muscle tissue.
2. Distinguish among skeletal, smooth, and cardiac muscle tissues.

The cells of different tissues vary greatly in their abilities to divide. Cells that divide continuously include the epithelial cells of the skin and inner lining of the digestive tract and the connective tissue progenitor cells that form blood cells in red bone marrow. However, skeletal and cardiac muscle cells and nerve cells do not usually divide at all after differentiating.

Fibroblasts respond rapidly to injuries by increasing in number and fiber production. They are often the principal agents of repair in tissues that have limited abilities to regenerate. For instance, fibroblasts form scar tissue after a heart attack occurs. Many, if not all, organs include pockets of stem or progenitor cells that can divide and replace damaged, differentiated cells, under certain conditions. Certain bone marrow stem cells may travel to the heart, where they differentiate as cardiac muscle cells. Several clinical trials are testing the ability of such cells to help heal the damage of a heart attack.

Nervous Tissues

Nervous tissues are found in the brain, spinal cord, and peripheral nerves. The basic cells are called *nerve cells*, or **neurons** (nu'ronz), and they are highly specialized. Neurons sense certain types of changes in their surroundings and respond by transmitting nerve impulses along cellular processes to other neurons or to muscles or glands (fig. 5.31). As a result of the extremely complex patterns by which neurons connect with each other and with muscle and gland cells, they can coordinate, regulate, and integrate many body functions.

In addition to neurons, nervous tissue includes very abundant **neuroglial cells** (nu-rog'le-ahl selz), shown in figure 5.31. These cells support and bind the components of nervous tissue, carry on phagocytosis, and help supply nutrients to neurons by connecting them to blood vessels. They also play a role in cell-to-cell communications and may give rise to neural stem cells. Nervous tissue is discussed in chapter 10.

Table 5.8 summarizes the general characteristics of muscle and nervous tissues. From Science to Technology 5.1 discusses tissue engineering, which is part of a new field called regenerative medicine.

1. Describe the general characteristics of nervous tissue.
2. Distinguish between neurons and neuroglial cells.

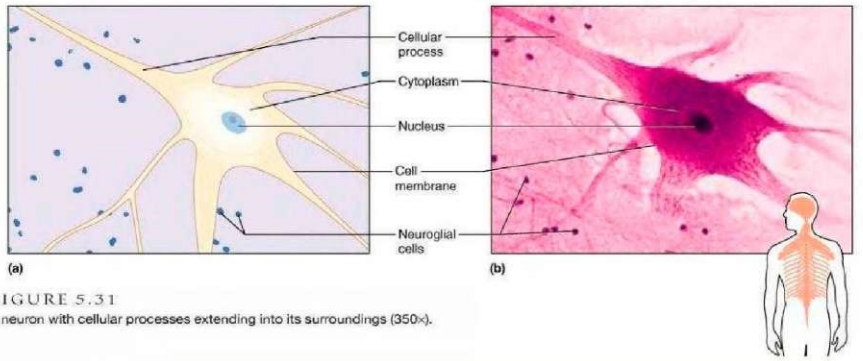

FIGURE 5.31
A neuron with cellular processes extending into its surroundings (350×).

TABLE 5.8 Muscle and Nervous Tissues

Type	Description	Function	Location
Skeletal muscle tissue	Long, threadlike cells, striated, many nuclei	Voluntary movements of skeletal parts	Muscles usually attached to bones
Smooth muscle tissue	Shorter cells, single, central nucleus	Involuntary movements of internal organs	Walls of hollow internal organs
Cardiac muscle tissue	Branched cells, striated, single nucleus	Heart movements	Heart muscle
Nervous tissue	Cell with cytoplasmic extensions	Sensory reception and conduction of nerve impulses	Brain, spinal cord, and peripheral nerves

CHAPTER SUMMARY

Introduction (page 143)

Cells are organized in layers or groups to form tissues, the study of which is called histology. The four major types of human tissue are epithelial, connective, muscle, and nervous.

Epithelial Tissues (page 143)

1. General characteristics
   a. Epithelial tissue covers all free body surfaces, forms the inner lining of body cavities, lines hollow organs, and is the major tissue of glands.
   b. A basement membrane anchors epithelium to connective tissue. Epithelial tissue lacks blood vessels, has cells that are tightly packed, and is continuously replaced.
   c. It functions in protection, secretion, absorption, and excretion.
2. Simple squamous epithelium
   a. This tissue consists of a single layer of thin, flattened cells through which substances pass easily.
   b. It functions in the exchange of gases in the lungs and lines blood vessels, lymph vessels, and membranes within the thorax and abdomen.
3. Simple cuboidal epithelium
   a. This tissue consists of a single layer of cube-shaped cells.
   b. It carries on secretion and absorption in the kidneys and various glands.
4. Simple columnar epithelium
   a. This tissue is composed of elongated cells whose nuclei are near the basement membrane.
   b. It lines the uterus and digestive tract, where it functions in protection, secretion, and absorption.
   c. Absorbing cells often possess microvilli.
   d. This tissue usually contains goblet cells that secrete mucus.
5. Pseudostratified columnar epithelium
   a. This tissue appears stratified because the nuclei are at two or more levels.
   b. Its cells may have cilia that move mucus over the surface of the tissue.
   c. It lines tubes of the respiratory system.
6. Stratified squamous epithelium
   a. This tissue is composed of many layers of cells; the top layers are flattened.
   b. It protects underlying cells from harmful environmental effects.
   c. It covers the skin and lines the oral cavity, esophagus, vagina, and anal canal.