Animal Tissues

LABORATORY

32

OVERVIEW

In animals, groups of similar cells specialized to perform the same function are called **tissues.** There are four general classes of tissues: **epithelial, connective, muscle,** and **nervous** tissues. In many cases, several of these tissues associate to carry out a particular function. This structural and functional unit of associated tissues is called an *organ.* An organ such as the stomach is encased, both inside and out, with epithelia, and contains connective, muscle, and nervous tissues within its walls. A group of organs that interact to carry out a particular process is called an *organ system.* The digestive system, for example, is made up of the esophagus, stomach, intestines, liver, and pancreas.

During this laboratory period you will examine the morphology of various types of tissues making up the organs and organ systems of animals.

STUDENT PREPARATION

Prepare for this laboratory by reading the text pages indicated by your instructor. Familiarizing yourself in advance with the information and procedures covered in this laboratory will give you a better understanding of the material and improve your efficiency.

✓ EXERCISE A Epithelial Tissue

Epithelial tissues cover the various internal and external surfaces of the body. These layers of close-fitting cells form an effective barrier between the body and its surroundings. In some cases, such as in the sense organs, epithelial cells serve the function of responding to environmental stimuli. Other epithelial cells are responsible for absorption, secretion, and excretion and are often found in the walls of tubular glands, such as those that produce sweat, tears, and saliva.

Three major types of epithelial tissue can be distinguished according to cell shape: **squamous, cuboidal,** and **columnar.** These may exist as a single layer of cells (**simple**) or as more than one layer of cells (**stratified**). Occasionally, the cells seem to be stratified, but closer examination shows that there is only a single layer of cells; these are called **pseudostratified** epithelial cells (Figure 32A-1). The sheets of epithelial cells generally rest on a **basement membrane,** made up of collagen fibers that the cells secrete as supporting structures. This membrane separates the epithelial cells from underlying tissues.

Objectives

- ☐ Distinguish between squamous, cuboidal, and columnar epithelia.

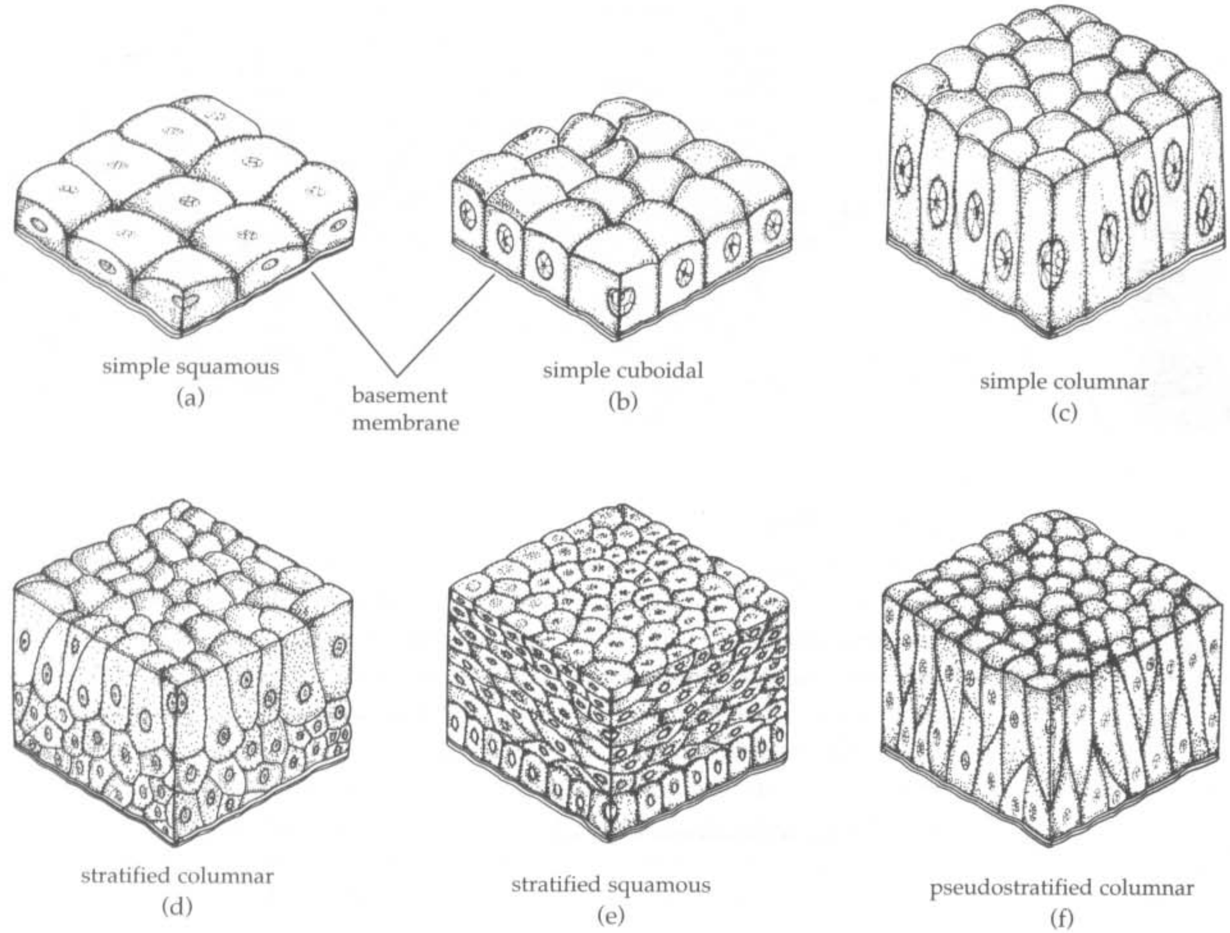


Figure 32A-1 *Epithelial cells may be (a) squamous, (b) cuboidal, or (c) columnar. These can be arranged in single sheets (a), (b), (c), or in stratified multiple layers (d), (e). In pseudostratified epithelia, each cell is connected to the basement membrane (f).*

✓ PART I Squamous Epithelium

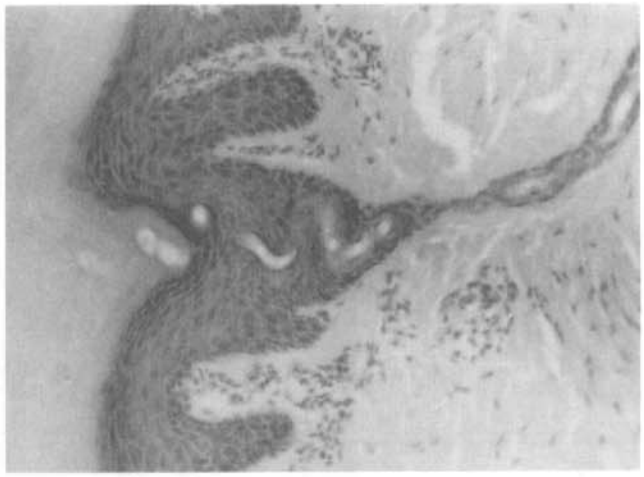
Simple squamous epithelium consists of a single layer of flattened, polygonal cells that is easily permeable to gases and liquids. This type of tissue is found inside the lung alveoli (air sacs), in the blood vessels, and in the lining of the heart. It is also found in the membranes lining the abdominal and thoracic cavities. **Stratified squamous epithelium** is found in areas of the body where additional protection is required, for example, on the skin and in the mouth, the esophagus, the anus, and the vagina (Figure 32A-2).

Procedure

1. Obtain a small piece of shed skin (epidermis) from a frog. You may find this tissue floating in the bowel or loosely attached to the frog.
2. Make a temporary wet-mount slide using frog Ringer's solution. Add a drop of methylene blue stain before covering the tissue with a coverslip. Observe the slide at high power (40×).

   a. What shape are the cells? ________________ *b. How are they arranged?* ________________
3. On the upper third of a separate sheet of paper, draw and label your observations.

Figure 32A-2 *Stratified squamous epithelium.*



4. Repeat step 2 using a very thin piece of skin from the webbing between the toes of a pithed frog. Carefully scrape this area with a scalpel and remove the tissue with a pair of forceps. Alternatively, you may use a prepared slide of frog skin.

   c. *How do these cells differ from those of the shed skin?* __________

   Do you see cells containing darkly stained objects? These are **chromatophores,** pigment-containing cells in the underlayer of the skin called the dermis. The skin is composed of several layers, including the epidermis and underlying dermis.

   d. *Why did you not see chromatophores in the shed skin?* __________

   e. *How does the size of a chromatophore cell compare with that of an epithelial cell?*

5. Use the middle third of your sketch sheet to draw and label your observations of the cells in the webbing.
6. Use high power (40×) to examine a prepared slide of the stratified squamous epithelium from the esophagus. On the lower third of the sheet of paper, draw your observations. Insert the sheet into the laboratory manual.

   f. *Are the cells of the esophageal epithelium ciliated?* ____ g. *Do they differ in shape from the simple squamous cells of the frog's skin?* __________

✓ **PART 2** **Columnar Epithelium**

Columnar epithelium consists of a layer of closely packed, columnar cells in which the length of each cell greatly exceeds its width. This type of epithelium is found lining the intestinal lumen of vertebrates, where it is involved in the secretion of some digestive enzymes and in the uptake of the products of digestion. Some cells (goblet cells) are specialized for the secretion of mucus—a substance containing the protein mucin—which provides mechanical protection of the gut lining and buffers the contents of the lumen. Columnar epithelium also makes up the lining of the respiratory tract and reproductive organs, where the cells are ciliated (Figure 32A-3).

a. *What might be the function of cilia in the reproductive system?*

b. *What might be the function of cilia in the respiratory system?*

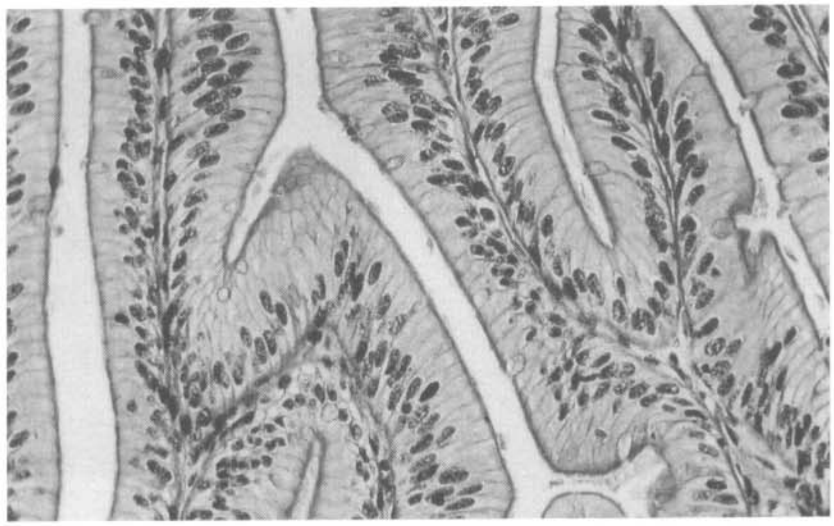


Figure 32A-3 *Columnar epithelium.*

Procedure

1. Use high power (40×) to observe a prepared slide of columnar epithelium from the lining of a human kidney tubule. On the upper half of a separate piece of paper, draw a section of the tissue. Label the cell nuclei and the basement membrane.

   c. What shape are the cells? ____________________

   d. How are the cells arranged? ____________________

✓ PART 3 Cuboidal Epithelium

When seen in cross section, **cuboidal epithelial** cells are shaped like cubes (Figure 32A-4). These cells often serve a secretory function and are associated with the walls of ducts and glands.

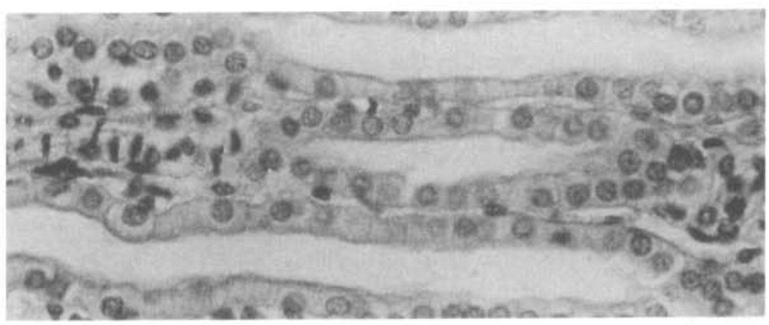


Figure 32A-4 *Cuboidal epithelium.*

Procedure

1. Use high power (40×) to observe a prepared slide of cuboidal epithelium from the human thyroid gland. On the lower portion of your sheet of paper, draw a section of this tissue; include several cells and the basement membrane. Label as many structures as you are able to identify.

   a. How are the cells arranged? ____________________

2. Work in groups of four. Obtain a live frog that has been cooled down in an ice bath, and place the frog on its back on a board covered with moist cheesecloth. Gently pull the lower jaw downward so that the mouth is opened wide; secure the upper jaw by tying a piece of string loosely around the jaw and the board. Tie the lower jaw open in the same manner.

3. Obtain some fine cork particles and position them on the roof of the mouth between the two eyes. Place the frog under a dissecting microscope and observe the movement of particles over a period of time.

   b. Do the particles move in a particular direction? ______

   c. How far do the particles move in 1 minute? ______

4. Using a sharp scalpel or fine tweezers, remove a small sample of tissue from the *surface* of the roof of the mouth. Use frog Ringer's solution to make a temporary wet-mount slide of the tissue. Study the ciliated epithelial cells at high power (40×). You may need to adjust the illumination.

   d. Do the cilia beat rhythmically? ______ *e. Do all cilia beat in the same direction?* ______

   f. Record your observations. ______

5. Release the frog and return it to the tank.

✓ EXERCISE B Connective Tissue

Connective tissues bind other tissues together, giving substantial form and support to the organs.

Cells of connective tissue are usually widely separated by a **matrix,** an intercellular space filled with fluid, fibers, and solid materials. The relative abundance and arrangement of the cells and the character of the matrix determine the properties of a particular kind of connective tissue.

The **mesenchyme cell** is a type of connective tissue cell found in abundance during the early development of most animals. Mesenchyme cells are undifferentiated and relatively unspecialized, giving rise to all of the connective tissues of an embryo and all of the various cell types of adult connective tissue. (Connective tissues are defined as those that have a mesenchymal origin in the embryo.) In the adult, connective tissue cells remain relatively unspecialized, and most can transform from one type to another. Included among the connective tissues are the following: cartilage, bone, loose connective tissue, dense connective tissue (ligaments and tendons), adipose (fat) tissue, and blood.

Objectives

- ☐ Describe the structure of cartilage.
- ☐ Compare hyaline cartilage with elastic cartilage.
- ☐ Compare and contrast the structure of cartilage with that of bone.
- ☐ Distinguish between loose and dense connective tissue.
- ☐ Describe the structure of adipose tissue.
- ☐ Describe the structure of red blood cells.

✓ PART 1 Cartilage

Cartilage—or gristle, as it is often called—is a connective tissue commonly having a dense fibrous matrix giving it a "rubbery" consistency.

The skeletal system of vertebrates is composed of cartilage and bone. In the embryonic development of vertebrates, cartilage serves as part of the initial supporting skeleton. As the organism matures, most of the cartilage is gradually replaced by bone in a process called **ossification** [see the discussion of endochondral (replacement) bone in Part 2 of this exercise]. Once the last of the cartilage in a bone has disappeared, the bone can no longer increase in length. This does not mean, however, that bones are nonliving and cannot change shape.

Some cartilage in the human body is never replaced by bone. One example is **hyaline cartilage** found at the ends of long bones such as the humerus of the arm and the femur and tibia of the leg

(Figure 32B-1). Hyaline cartilage is also found at the end of the nose, in the major cartilage rings of the trachea and bronchi of the respiratory system, and in the rib cartilages. Another type of cartilage, **elastic cartilage,** occurs in the ear and in the trachea; elastic fibers are embedded in the matrix.

Distributed throughout the firm but elastic matrix of cartilage are numerous **lacunae** ("lakes") containing cartilage cells (**chondrocytes**), which secrete the matrix. Note that cartilage cells shrink somewhat during the processes required for the preparation of slides. Thus, you will not see the cells filling as much of the lacunar space as they do in living tissue.

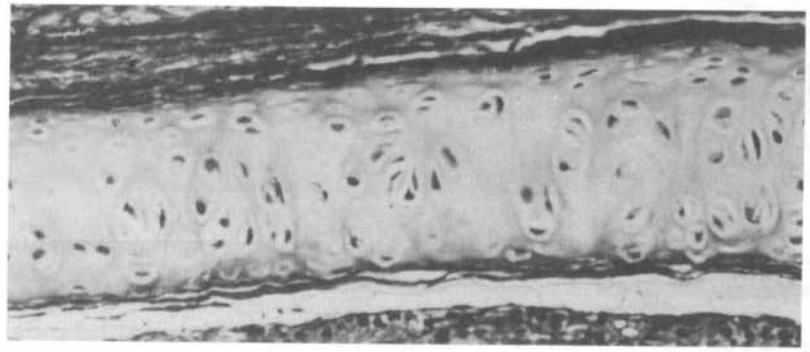


Figure 32B-1 *Hyaline cartilage showing lacunae.*

Procedure

1. Use high power (40×) to examine slides of human elastic and hyaline cartilage. On a separate piece of paper, draw a section of each tissue and label the **matrix, lacunae,** and **chondrocytes.**
   a. *In which tissue are the chondrocytes closest together?* ________________
   b. *Do you see any fibers or other types of cells in the matrix of hyaline cartilage?* ______ *Of elastic cartilage?* ______
   c. *Why might the matrix of hyaline cartilage contain elastic fibers?* ________________

   As we age, or following injury, cartilage may begin to degenerate. Often this occurs in joints that are used to bend and lift, such as elbows, knees, and neck. As a consequence, **osteoarthritis** develops.

PART 2 Bone

Bone consists of a dense matrix of calcium salts and proteins secreted by bone-forming cells called **osteoblasts.** Protein is laid down as minute fibers that contribute strength and resiliency to bone; mineral salts contribute hardness. [However, the earliest bone found in fossil agnathan fishes (and in many modern teleost fishes) was acellular.] Cellular bone, containing mature osteoblasts called **osteocytes,** is not a fixed, unchanging tissue. It is constantly being remodeled by **osteoclasts,** multinucleated cells that break down the bone structure, and the continued synthetic activity of osteoblasts. The dynamic nature of cellular bone also enables it to serve as a calcium reserve: birds use calcium from their skeleton in the production of egg shells; mammals may also draw on skeletal reserves during the prenatal development of their young and in the production of milk.

Bone tissue is of two types: **dermal bone,** which forms by means of calcium deposition within the dermis of the skin, and **endochondral bone,** which replaces the cartilage of the embryo as the organism grows. Dermal bone is prevalent in lower vertebrates, where it forms like those scales and plates that covered many early and primitive fishes. In bony fishes (the group that includes trout, perch, and salmon) and in terrestrial vertebrates, dermal bone is found only in elements of the skull and pectoral (forelimb) girdle. The shapes of the long bones of adult vertebrates are prepatterned in the cartilage of the embryo. Although cartilage continues to provide support during the period of growth, most cartilage is gradually replaced by endochondral bone, through the process of ossification, as the animal matures. Endochondral bone predominates in the skeleton of higher vertebrates.

The long bones of higher vertebrates are not solid structures. Rather they are constructed to provide maximum strength with minimum weight. This is accomplished by surrounding the outer portion of the bone with heavy, **compact bone** to provide strength. A **marrow cavity** in the center of the bone shaft and **spongy bone** at the ends of the long bones reduce weight (Figure 32B-2). In mammals and their immediate reptilian ancestors, most dinosaurs, and a scattering of other vertebrates, the plates (**lamellae**) of secondary bone and osteocytes are arranged concentrically to form **Haversian systems.** In the process of bone formation, mature osteoblasts (osteocytes) become trapped in lacunae, microscopic cavities formed by their secretions of bone matrix. The lacunae are linked together by a series of small channels (**canaliculi**) that combine to form a large system of canals (**Haversian canals**). Many of the Haversian canals are large enough to contain blood vessels, which deliver oxygen and minerals to the living osteocytes. If you have ever observed a broken bone, you probably noted that it was quite bloody. Bone is a living tissue and must be supplied with nutrients and oxygen by the circulatory system, as is true for all the tissues of the body (Figure 32B-3).

The strength of bones depends on the rate at which osteoclasts reabsorb calcium and phosphorus and the rate at which osteoblasts replace these vital elements. In individuals with strong bones, osteoblasts synthesize bone materials more rapidly than osteoclasts break them down. Bones subject to disuse, especially in older people, tend to become weakened. **Osteoporosis,** a condition characterized by weakened bones, is common among postmenopausal women. Steroid hormone therapy combined with intake of extra calcium and vitamin D, a treatment that has been shown to stimulate osteoblast activity, is a common regimen among aging women. As your parents age, you might notice that they seem to "shrink" over the years. Bone loss occurs more rapidly in spongy bones. Vertebrae are composed of spongy bone, and the spinal column compresses with time and age.

Details of the cellular architecture of mammalian long bone can be observed by grinding a section of compact bone until it is extremely thin and mounting it on a slide for inspection under the microscope. Note that cellular elements are lost in this process.

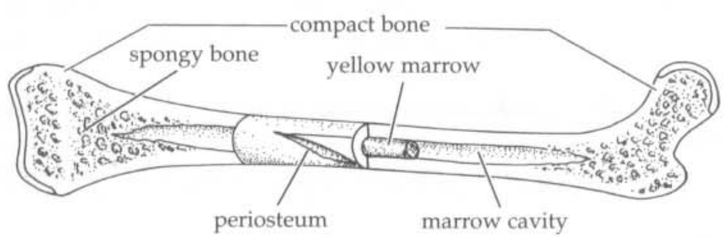


Figure 32B-2 *The outer area of a long bone is composed of compact bone. Spongy bone occurs at the ends, and the marrow cavity extends through the center of the bone shaft. The surface of the bone is covered by a thin fibrous layer, the* periosteum peri-, *around;* osteon, *bone), to which muscles are attached by tendons.*

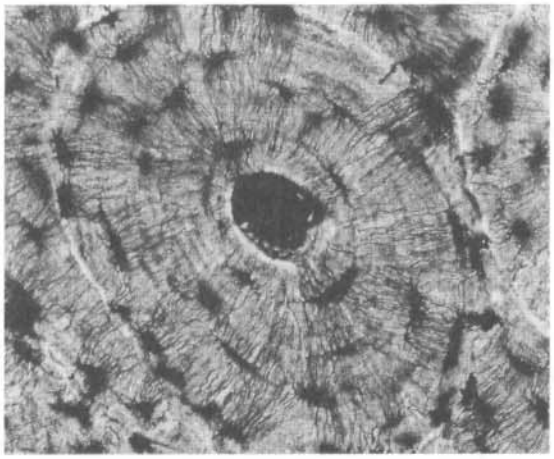
Procedure

1. Use high power (40×) to study a slide of human compact bone. On a separate sheet of paper, draw a portion of the bone. Label the structures shown in Figure 32B-3b: the Haversian canals, canaliculi, lacunae, and lamellae.

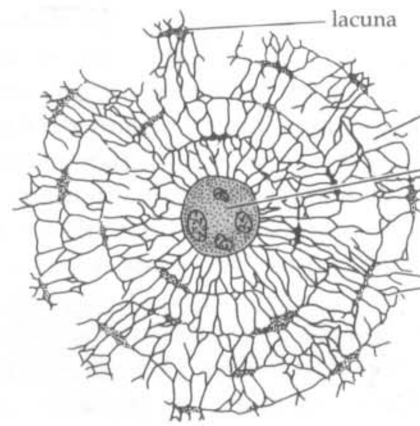
   a. Suggest how a broken bone heals. ______________________________

   ____

Bone first appeared, together with cartilage, in the earliest fishes found in the fossil record. In the evolution of fish, the replacement of cartilage by bone in adults was favored in those groups that developed a swim bladder/lung, a structure that can change the body's density relative to that of water. A fish can ascend or descend in the water by simply adding gas or removing gas from its swim bladder,



(a)



(b)

Figure 32B-3 *(a) A bony matrix is deposited in concentric cylinders, or* lamellae, *around the* Haversian canal, *which contains blood vessels and nerves. Each bone cell within its lacuna is connected to adjacent bone cells and to the Haversian canal by cellular extensions occupying minute canals (*canaliculi*) in the matrix. Oxygen carried in the blood vessels of the Haversian system is transported to the bone cells by the cytoplasmic extensions, and wastes are returned to the Haversian system along the same route. (b) Diagrammatic representation of the Haversian system.*

thus reducing the energy required to change or maintain its position. In the evolution of those fish that lack a swim bladder—for example, the extinct armored fishes (the placoderms) and the elasmobranchs (the group that includes sharks, skates, and rays)—dense bone was replaced by lighter cartilage, thus reducing the body's overall density. Some cartilaginous fishes retain bone in their vertebrae, where support is needed.

Among vertebrates, the replacement of cartilage by bone during maturation to adulthood may have been extremely important in the transition to life on land, where the body of a large, active animal, no longer supported by the buoyancy of water, requires a strong internal support structure.

✓ PART 3 Loose and Dense Connective Tissue

Connective tissue is responsible for the attachment of skin to muscle, muscle to bone (**tendons**), and bone to bone (**ligaments**).

Loose connective, or **areolar, tissue** connects organs and tissues (Figure 32B-4). **Dense connective tissue** is more compact and shows a more or less orderly arrangement of its composite fibers, depending on its function. Such tissue is found in the periosteum covering bones, in the dermis of skin, and as part of the ligaments and tendons used for support.

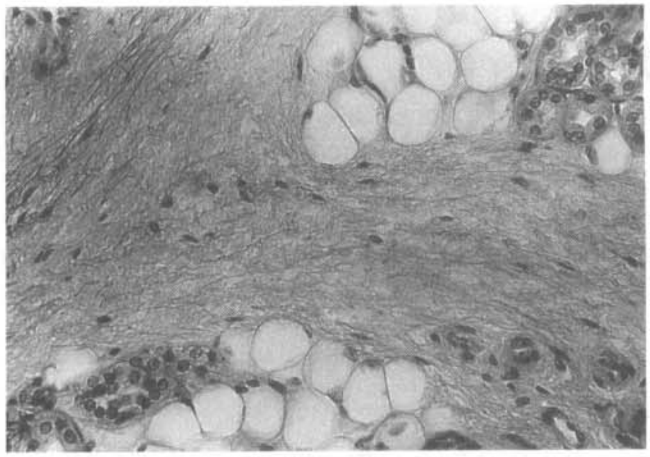
Procedure

1. Use high power (40×) to examine a prepared slide of areolar tissue. On the top half of a sheet of paper, draw what you observe. Identify fibroblasts, elastic fibers (yellow and branched), and collagen fibers (white and unbranched).

   a. Do you see any white blood cells? ______ *What purpose do you think is served by these cells wandering around in the connective tissues of the body?* ____________________

   ____

Figure 32B-4 *Loose connective tissue is composed of two types of fibers, white collagenous fibers and yellow elastic fibers, embedded in a semisolid ground substance.* Fibroblasts *secrete both the matrix and fibers. White blood cells (macrophages) may also be seen wandering through the tissue.*

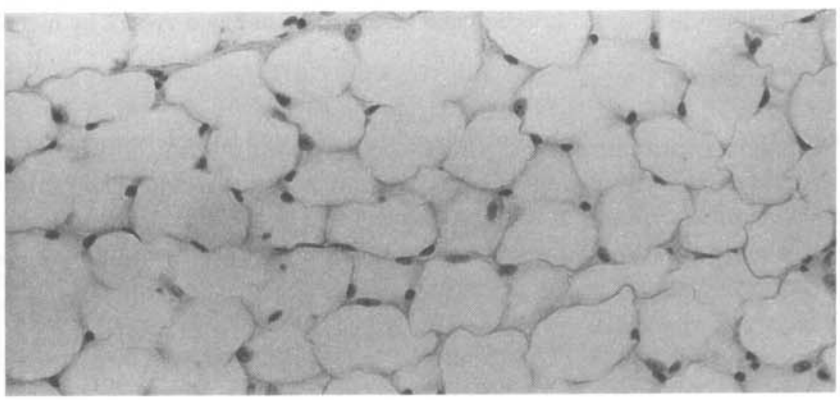


2. Examine a prepared slide of a human tendon. On the lower half of your sheet of paper, draw your observations. Label fibroblasts and bundles of elastic fibers.

✓ PART 4 Adipose (Fat) Tissue

Fat, or **adipose tissue,** is included among the connective tissues because of its mesenchymal origin and its association with other connective tissue elements (Figure 32B-5).

Figure 32B-5 *Adipose tissue with fat removed so that the large central vacuole of each cell is visible. Small, darkly stained nuclei are evident in the cytoplasm surrounding the vacuoles.*



Procedure

1. Use high power (40×) to examine a prepared slide of cat adipose tissue. You will notice the enlarged fat cells containing fat globules, found in the center of each cell in a single large vacuole. The living contents of the cell form a shell around the fat globules. With weight loss, the fat globules become smaller, but the cell itself is not destroyed; it just waits to become filled with fat again. In addition, extra fat cells may form if excess food is available. On a separate sheet of paper, draw a section of the adipose tissue and label the nucleus, cytoplasm, and fat vacuole of the fat cell.
2. Examine a prepared slide of a section of adipose tissue from which the fat has been removed.
   a. Compare these cells with the adipose tissue observed in step 1.

   ____

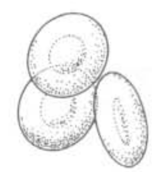
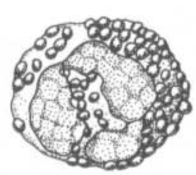
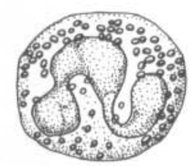
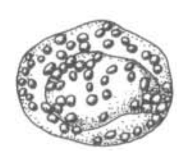
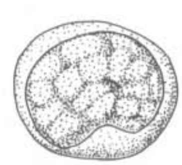
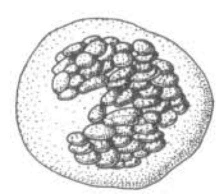
   ____

PART 5 Blood

Blood is usually classified as a connective tissue because its cellular components (**erythrocytes, leukocytes,** and **platelets**) are suspended in an intercellular fluid matrix (**plasma**). However, since connective tissue is strictly defined as being of mesenchymal origin and not all blood cells are of mesenchymal origin, blood could instead be classified as a specialized tissue.

Mammalian blood consists of approximately 55 percent plasma (the intercellular fluid matrix) and 45 percent formed (cellular) elements. Plasma consists of water (90 percent) plus dissolved substances—plasma proteins, enzymes, digested food material, metabolic wastes, hormones, antibodies, and certain gases.

Table 32B-1 Components of Human Blood

Cells	Description	Structure
Red blood cells (erythrocytes) 3.5–5.5 million cells per milliliter	The most numerous cell type. Faintly biconcave disks. No nuclei. Contain the pigment hemoglobin, essential in the transportation of oxygen to cells and tissues. Less than normal quantities of red blood cells or hemoglobin causes anemia, a condition in which the cells and tissues are deprived of oxygen.	 erythrocytes
White blood cells (leukocytes) 6,000–9,000 cells per milliliter	Nucleated disks of an amoeboid shape. Move by means of pseudopods. These cells prevent infection and the clogging of blood vessels by ingesting bacteria and other foreign materials.	
Granulocytes	Neutrophils, eosinophils, and basophils transform into phagocytic macrophages. Contain cytoplasmic granules.	 eosinophil  neutrophil  basophil
Agranulocytes	B- and T-lymphocytes are responsible for the immune response. Cell nucleus rounded. No cytoplasmic granules. Monocytes engulf foreign material, including bacteria at sites of infection.	 lymphocyte  monocyte
Platelets (thrombocytes) 150,000–400,000 cells per milliliter	Platelets are responsible for blood clotting. These are cell fragments that rupture on the rough edges of torn blood vessels and release materials that initiate blood clotting.	 platelets

Procedure

1. Obtain a prepared slide of a human blood smear. Use high power (40×) to identify the cell types listed in Table 32B-1 and draw your observations on a separate sheet of paper. Be sure your drawings reflect the relative proportions and sizes of the different blood cell types. Label erythrocytes, leukocytes, and platelets.

   a. How many different types of white blood cells do you find? ______ *What are these types?*

   ____

   b. Compare the structure of white blood cells and red blood cells.

   ____

   ____

   c. What is the general shape of the red blood cells? ______________________________

2. Obtain a sample of blood from a pithed frog. Cut through the skin and muscle along the centerline of the abdomen to expose the superficial ventral abdominal vein. Nick the vein and place a drop of blood on a clean glass slide. Place one drop of frog Ringer's solution (or 0.85% saline) onto the same slide and mix with the blood. Add one drop of methylene blue stain and observe the blood cells at 40×. Alternatively, you may use a prepared slide of frog blood to make your observations.

   d. Are frog blood cells different from yours? ______ *e. Do they have nuclei?* ______ *f. Do your red blood cells have nuclei?* ______

   g. What distinguishes the red blood cells of humans from those of frogs?

   ____

✓ EXERCISE C Muscle Tissue

Most muscle movements result from the contraction of elongated cylindrical or spindle-shaped muscle cells called **muscle fibers,** each of which contains many microscopic elongated, parallel **myofibrils.** These fibrils are composed of the proteins actin and myosin. If the myofibrils have the appearance of alternating dark and light cross-bands (or striations) under the light microscope, the muscle fibers are classified as striated muscle tissue. Skeletal muscle and cardiac (heart) muscle are examples of striated muscle. Smooth muscle fibers also contain myofibrils but do not exhibit these cross-striations. Striations represent the alignment of actin and myosin fibers and play a fundamental role in muscle contraction.

Objectives

- ☐ Distinguish between smooth, skeletal, and cardiac muscle.
- ☐ Compare and contrast the functions of the three types of muscle.
- ☐ Describe the locations in which smooth, skeletal, and cardiac muscle are found.

✓ PART I Skeletal Muscle

Skeletal muscle (also called **striated** or **voluntary** muscle) makes up the muscle masses that are attached to and move the bones of the body. In skeletal muscle, several elongated cylindrical cells are fused to form a multinucleate unbranched muscle fiber. The nuclei lie in the periphery of the fiber (Figure 32C-1a, b).

Procedure

1. Use high power (40×) to examine a prepared slide of skeletal muscle and make a drawing of this tissue on the upper third of a separate sheet of paper. Indicate the position of nuclei and label the cross-striations.

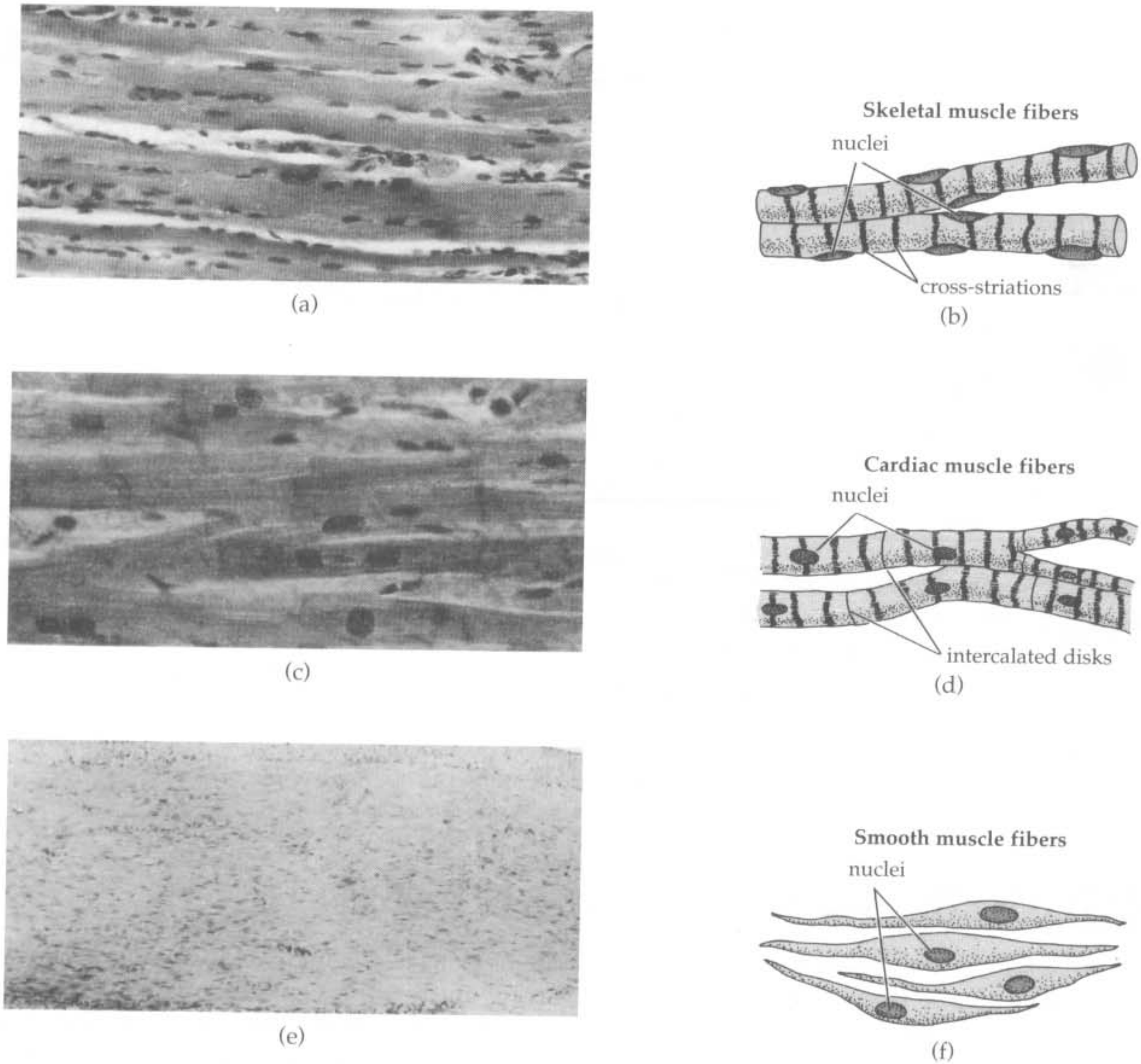


Figure 32C-1 *(a) (b) Skeletal muscle composed of fused cells producing multinucleate, unbranched fibers with cross-striations. (c) (d) Cardiac muscle composed of fused cells forming branched fibers with individual nucleated cells separated by intercalated disks. Cross-striations are also present. (e) (f) Smooth muscle with elongated single muscle cells (fibers) having central nuclei and no cross-striations.*

2. Use your observations to fill in Table 32C-1.
   a. *What do the cross-striations represent?* ______________________________

   ____

   b. *Why are they important?* ______________________________

   ____

✔ PART 2 Cardiac Muscle

Cardiac muscle is found only in the wall of the heart. The cells are cylindrical and striated. Unlike other muscle tissues, the fibers are branched. Individual cells are separated by transverse membranes called **intercalated disks,** which appear as dark bands crossing the fibers. Nuclei are centrally located (Figure 32C-1c, d).

Procedure

1. Use high power (40×) to examine a prepared slide of cardiac muscle and make a drawing of this tissue in the middle third of your sheet of paper. Indicate the position of nuclei and label the cross-striations and intercalated disks.

   a. What is the significance of the intercalated disks in the functioning of heart muscle?

   ____

2. Use your observations to fill in Table 32C-1.

Table 32C-1 Muscle Tissue Characteristics

Characteristic	Skeletal	Cardiac	Smooth
Shape of muscle fiber			
Number of nuclei per fiber			
Location of nuclei			
Function			
Location			

✓ **PART 3** Smooth Muscle

Smooth muscles are found chiefly in the wall of the alimentary, urinary, and genital tracts and in the walls of arteries and veins. Smooth muscle fibers are spindle-shaped cells with no cross-striations, but with faint longitudinal striations. A single, elongated, central nucleus is present in each fiber (Figure 32C-1e, f).

Procedure

1. Use high power (40×) to examine a prepared slide of smooth muscle and draw a section of this tissue on the lower third of your sheet of paper. Label a nucleus and a muscle fiber.

   a. Are actin and myosin present in smooth muscle? ________

2. Remove a flap of skin from the thigh of a pithed frog.
3. Cut a *small* piece of muscle from the thigh. Make a wet-mount slide using Ringer's solution. Use dissecting needles to tease the tissue apart; add a drop of methylene blue.
4. Cover the tissue with a coverslip. If the coverslip does not lie flat, remove the coverslip, tease the tissue further, and try again. Use high power (40×) to study the shape and size of the cells.

   b. Describe the shape and appearance of the muscle cells. ________

   ____

   c. What type of muscle tissue is represented? ______________________________

5. Use your observations to fill in Table 32C-1.

✓ EXERCISE D Nervous Tissue

The basic functional unit of the nervous system is the individual nerve cell or **neuron.** The function of the neuron is the conduction of a nerve impulse (the action potential, an electrochemical signal) to another neuron or to a muscle fiber or gland. However, only about 10 percent of the cells in the nervous system are neurons. The remainder are glial elements and sheath cells, which isolate, assist, and support neurons functionally and sustain them metabolically.

Neurons consist of three major sections: the cell body (soma), dendrites, and the axon (Figure 32D-1). The **cell body** contains the nucleus and most of the cellular organelles. Cellular extensions or fibers that conduct the nerve impulse toward the cell body are called **dendrites.** **Axons** conduct the nerve impulse away from the cell body. The number of nerve fibers extending from the cell body depends on the particular neuron and its location within the nervous system. The junction of two neurons is called a **synapse.**

Neurons of the central nervous system maintain a background of spontaneous activity, monitor and control a variety of physiological functions, receive information and integrate it with genetically determined functions or learned responses, and initiate motor activities. Various structural and functional adaptations are responsible for this coordinated control.

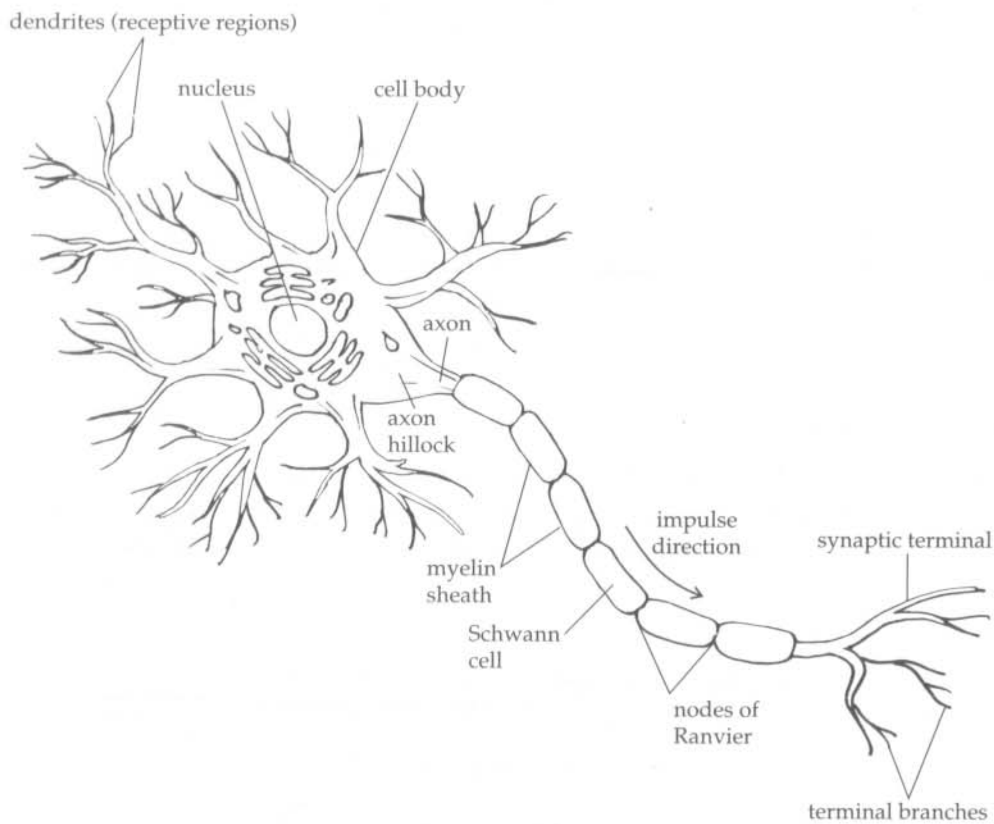


Figure 32D-1 *A typical motor neuron with its cell body, dendrites, and axon. The axon is encased within a myelin sheath produced by Schwann cells.*

Objectives

- ☐ Draw and label the major parts of a nerve cell, including the axon, dendrites, and cell body.
- ☐ Describe the function of each part of a nerve cell.

Procedure

Obtain a prepared slide of motor neurons from the spinal cord and examine it at high power (40×). On a separate sheet of paper, draw a single neuron and label all parts: the cell body, nucleus, axon, and dendrites.

a. Can you see an entire motor neuron on this slide? ______ *b. Why or why not?* ____________________

____

c. A single motor neuron extends from its cell body in the spinal cord to the most distant extremity of your body. Where would you find the nerve endings of the longest cell in your body? ____________________

Laboratory Review Questions and Problems

1. What are the four groups of tissues studied in today's laboratory?

2. Which group is composed of the most diverse cell types?

3. What is common to all types of connective tissue? Describe any variations in components among the different connective tissues.

4. Where in the body do you find loose connective tissue? Dense connective tissue?

5. Use a separate sheet of paper to prepare a summary table listing the six types of connective tissues, the specific types of cells in each tissue type, one place in the human body where the tissue is found, the appearance of the tissue, and its major function.

6. Stratified squamous epithelium regenerates rapidly by division and is found in areas that are subject to abrasion. Simple squamous epithelium is leaky and is usually found in areas where exchange occurs across a surface. Cuboidal and columnar epithelia contain a lot of cytoplasm and usually occur where secretory products are made. Predict which type of epithelium you would find in each of the following:

   Esophagus

Lungs

Blood vessels

Kidney tubules

Intestine

7. How does dermal bone differ from endochondral bone?

8. When you break a bone it hurts and usually there is some bleeding. Why?

9. How is bone continuously "re-worked"?

10. How does the matrix of cartilage differ from that of bone?

11. Compare the three types of muscle tissue using the following criteria: striated or unstriated; voluntary or involuntary; uninucleate or multinucleate fibers; branched or unbranched fibers; spindle-shaped or rectangular fibers.

12. Why is blood usually considered a type of connective tissue? What are the major functions of red blood cells? White blood cells?

13. Draw a typical nerve cell and label the cell body, axon, and dendrites. Do all nerve cells have this same structure?