Section 6 Types of Tissue

OBJECTIVES:

Upon completing this section, you will be able to:

1. Define the word *histology.*
2. Name and briefly describe the *four* basic types of tissue.
3. Name the *three* subtypes of simple epithelial tissue.
4. List the *five* main subtypes of connective tissue.
5. Name the *three* subtypes of muscle tissue.
6. Name the *two* types of nerve tissue.

Section 6 Types of Tissue

HISTOLOGY

Histology is the microscopic study of cells, tissues, and organs. Also called microscope anatomy, histology has two basic classes: 1) *normal histology*—the study of normal tissues, and 2) *pathologic histology*—the study of diseased tissue. Malignancies are diagnosed according to the pattern of cellular growth and deviations of individual cells from their normal forms.

Nurses involved with the treatment of malignancies must possess a knowledge of histology in order to understand the anatomy and classification of tumors. In this section, we will review the four basic types of tissue, their functions and locations, and the terms used to describe these tissues—terms such as squamous, stratified, cuboidal, columnar, and others.

We are interested in the types of normal body tissue for two reasons: 1) cancers are named according to the cells and tissues from which they arise, and you should be familiar with these names, and 2) different histologic types of cancers have different responses to chemotherapy and radiotherapy.

Basic Types of Tissue

There are *four* basic types of tissue: 1) epithelial tissue, 2) connective tissue (blood, bone, cartilage) muscle tissue, and 4) nerve tissue. The primary tissues are divided into subtypes, which we will discuss shortly.

Each tissue type is designed to perform a specific function. For instance, nerve tissue conducts nerve impulses, muscle tissues are contractile, and epithelial tissues cover body parts.

Tissues differ in several ways: 1) according to the size, shape, and arrangement of their cells; 2) according to the kind or intercellular substance; and 3) according to location and function.

EPITHELIAL TISSUE

Epithelial tissue covers or lines all body surfaces inside and outside the body. Examples of epithelial tissue are the skin and the mucosa and serosa that line the body cavities and internal organs, such as intestines, urinary bladder, uterus, etc. In some cases, epithelial tissue extends into deeper tissue layers to form glands, such as mucus-secreting glands. The term *carcinoma* is reserved for malignant growth arising from epithelial cells.

Epithelial cells are tightly packed together in sheets and have very little intercellular material between them. Securing the epithelium to the underlying connective tissue is a membrane called the *basement membrane*. Since epithelial tissue has no blood vessels, it receives nourishment from nutrients that diffuse from blood vessels in the underlying connective tissue. Dead and injured epithelial cells are constantly being replaced by new cells.

Epithelial tissue always has a free surface exposed to the outside (eg, skin) or to an open space internally (eg, the uterus). Epithelial tissue is concerned with protection, secretion, absorption, and filtration. For example, the surface layer of the skin, the *epidermis*, has tightly packed epithelial cells and *protects* the body from the elements; epithelial cells in glands *secrete* various liquids; epithelial cells in the small intestine *absorb* nutrients into the bloodstream, and so on.

Epithelial tissue may be a single layer thick or several cell layers thick, as shown in Figure 15.

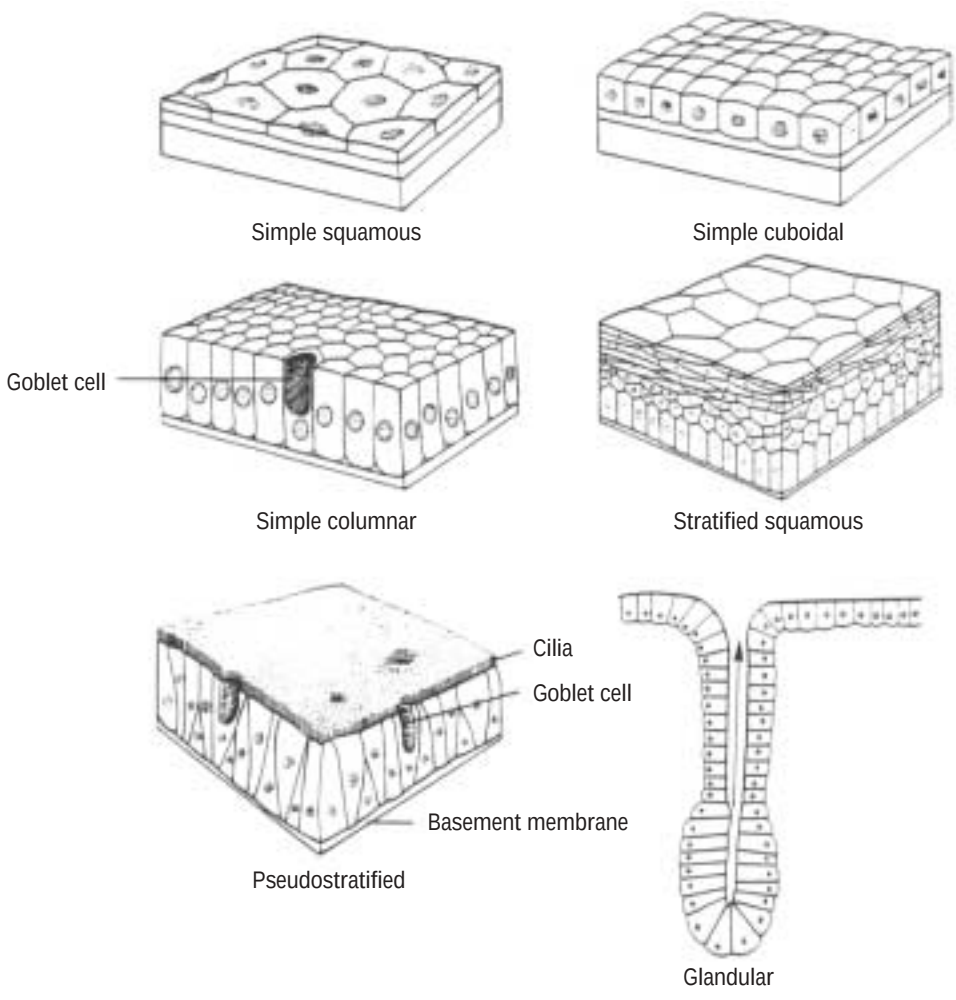
The cell layers are arranged in thin sheets, called membranes, that are firmly attached to the underlying connective tissue by a permeable basement membrane.

Epithelial tissue is classified into subtypes, according to the shape, arrangement, and function of cells. For instance, an epithelial membrane composed of single layers of cell is called *simple*; those several cell layers thick are called stratified. Thin, flat epithelial cells are called *squamous* (plate-like); cube-like cells are called *cuboidal*; and tall, column-like cells are called *columnar.*

These cell types are explained in more detail below.

- *Simple squamous epithelium* is composed of a single layer of thin, flattened cells closely fitted together. lt is found on the surface of the skin (where it is called *epidermis*). Some substances easily pass through simple squamous epithelia.
- *Simple cuboidal epithelium* is composed of a single layer of lightly packed cube-shaped cells. It covers the ovaries, lines a portion of the kidney tubules, and lines the ducts of such glands and organs as the thyroid gland, salivary glands, liver, and pancreas.
- *Simple columnar epithelium* is composed of tall, slender cells. These elongated cells are found lining the intestine, the gallbladder, the Fallopian tubes, and some of the respiratory passages. Scattered among the columnar cells are cells called goblet cells, which secrete mucus onto the surface of the tissue.
- *Pseudostratified columnar epithelium* is so named because it seems to be arranged in several layers, when in reality it is but a single layer thick. As shown in Figure 15, all cells adhere to a basement membrane, but not all of them reach the surface, thus accounting for the "false"

Figure 15.
Types of epithelial cells.



appearance. This tissue lines most of the respiratory passages (eg, the trachea, the bronchi, and the nasal cavity), and contains both ciliated cells and goblet cells. Ciliated cells have microscopic hair-like structures extending from the free surface; constantly moving, the hairs sweep debris-laden mucus toward the throat. Goblet cells secrete mucus.

- *Stratified epithelium* consists of many layers of cells, but only the surface layer of cells is flat. It is named according to the shape of the cells in the surface layer. Among the various types of stratified epithelium are:
- *Stratified squamous keratinized epithelium* consists of flattened, dead, dry cells, composing the epidermis of the skin. Keratin is a protein found in fingernails and toenails, hair, and the epidermis. Keratinization is the process whereby cells form keratin.
- *Stratified squamous nonkeratinized epithelium* is composed of living cells lining the mouth, esophagus, vagina, and anal canal.
- *Transitional epithelium* consists of flexible, pliable cells that are capable of stretching and then resuming their original shape. Transitional cells are found in the urinary bladder and other structures subject to periodic distention.
- *Glandular epithelium* is found in glands. Examples are sweat and mucus-secreting glands.

Tumors of epithelial origin are listed in Table 12. Remember that malignant tumors of epithelial origin are called carcinomas.

Connective Tissue

Connective tissue, the most abundant and most widely distributed of all tissues, is found throughout the body. It consists of three elements: *cells, ground substances* (also called matrix or intercellular material), and *fibers*. In contrast to epithelial tissue, connective tissue consists of large amounts of intercellular material and fewer cells. Another difference between epithelial and connective tissue is that while the former is avascular, the latter usually is well supplied with blood vessels. As shown in Figure 16 and outlined below, there are five subtypes of connective tissue.

1. *Embryonal* connective tissue is found in the embryo and fetus.
2. *Vascular tissue, blood and lymph,* is connective tissue in which the intercellular material is plasma for blood and an ultrafiltrate of plasma for lymph. The lining of the blood and lymph vessels is called endothelium, and the lining of body cavities is called mesothelium.
3. *Connective tissue proper* consists of several types, ranging from tough fibers to soft, gelatinous material.
4. *Cartilage* is characterized by intercellular material that has a rubbery substance.
5. *Bone* is a hard matrix due to the presence of lime salts.

Connective tissue performs several different functions, ranging from connecting, supporting, and protecting other tissue to helping protect the body against disease. For example, bone serves as the main support system of the body, while tendons, ligaments, and fascia connect other tissues of the body. Blood transports oxygen, nutrients, and waste products, and helps to fight bacterial infection.

Important connective tissue is listed in Table 13, and various connective tissue tumors are listed in Table 14.

A point about terminology: malignant tumors of connective tissue (and muscle) are known as *sarcomas*. There are, however, two exceptions. Cancers affecting the lymph nodes are called *lymphomas*, and cancers involving the white blood cells are called *leukemias*.

Table 12.
Tumors of Epithelial Tissue

Tissue of Origin	Benign Tumor	Malignant Tumor
Stratified squamous	Squamous cell papilloma	Squamous cell or epidermoid carcinoma
Basal cells of skin or adnexa		Basal cell carcinoma
Skin adnexal glands:		
Sweat glands	Sweat gland adenoma	Sweat gland carcinoma
Sebaceous glands	Sebaceous gland adenoma	Sebaceous gland carcinoma
Epithelium lining:		
Glands or ducts—Well-differentiated group	Adenoma Papilloma Papillary adenoma Cystadenoma	Adenocarcinoma Papillary carcinoma Papillary adenocarcinoma Cystadenocarcinoma Medullary carcinoma
Poorly differentiated group		Undifferentiated carcinoma (simplex)
Respiratory tract		Bronchogenic carcinoma Bronchial “adenoma”
Neuroectoderm	Nevus	Melanoma
Renal epithelium	Renal tubular adenoma	Renal cell carcinoma (hypernephroma)
Liver cells	Liver cell adenoma	Hepatocellular carcinoma
Bile duct	Bile duct adenoma	Bile duct carcinoma (cholangiocarcinoma)
Urinary tract epithelium (transitional)	Transitional cell papilloma	Papillary carcinoma Transitional cell carcinoma Squamous cell carcinoma
Placental epithelium	Hydatidiform mole	Choriocarcinoma
Testicular epithelium (germ cells)		Seminoma Embryonal carcinoma

Source: Robbins SL, Cotran AS, Kumar V: *Pathologic Basis of Disease.* 3rd ed. Philadelphia, PA: WB Saunders Co; 1984:217. Reprinted with permission.

Figure 16.
Types of connective tissue.

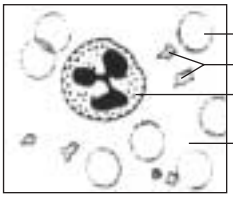
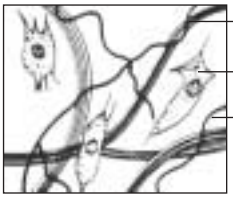
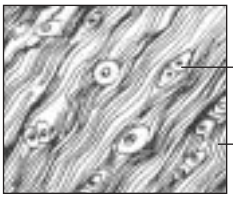
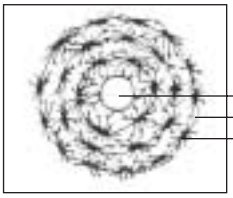
Example	Tissue Type
	A. Embryonal connective tissue. Found in the embryo and fetus.
 Red blood cell Platelets White blood cell Intercellular material	B. Vascular tissue … blood and lymph.
 White fiber Fibroblast Yellow fiber	C. Connective tissue proper. Several types. Example is loose connective tissue that binds skin to underlying organs. Fills spaces between muscles. Lies beneath epithelium. Contains blood vessels that supply epithelium with nourishment.
 Cartilage cell White fibers	D. Cartilage. Examples are hyaline, elastic, and fibrocartilage, the last illustrated here. Fibrocartilage is a tough tissue that acts as a shock absorber between bones, such as the vertebrae.
 Haversian canal Canaliculi Lacuna	E. Bone or osseous tissue, the most rigid of connective tissue.

Table 13.
Important Connective Tissue

Type of Connective Tissue	Location	Function
1. Embryonal	Under skin, and along developing bones	Forms all other types of connective tissue
2. Blood (vascular)	Blood	Transportation; fights infections
3. Connective tissue proper		
a. Loose or areolar	Between other tissues Between organs Superficial fascia	Supporting and cementing parts of body together
b. Adipose (fat)	Subcutaneous layer of skin, mucous membranes, blood vessels, nerves, body organs	Protection, insulation, support
c. Collagenous	Tendons, ligaments, aponeuroses (ie, end of muscle where it becomes tendon), deep fascia, scars, etc.	Gives flexible but strong support
d. Dense elastic	in structures that are extensible and elastic: vocal cords, walls of arteries, trachea, lungs, bronchial tubes, between vertebrae	Furnishes elasticity, thus allowing stretching of structures
e. Reticular	Liver, spleen, lymph nodes, thymus, tonsils, bone marrow, various other structures	Protection and supporting framework
4. Cartilage		
a. Hyaline (also called gristle)	Part of nasal septum; covers surfaces that move against one another; ends of long bones, ribs, larynx, trachea, etc.	Furnishes firm but flexible support
b. Fibrocartilage	Discs between vertebrae; symphysis pubis (in pelvis)	Support and fusion
c. Elastic	Epiglottis, larynx, external ear	Support and shape

Table 14.
Tumors of Connective Tissue

Tissue of Origin	Benign Tumor	Malignant Tumor
Fibrous tissue	Fibroma	Fibrosarcoma
Myxomatous tissue	Myxoma	Myxosarcoma
Fatty tissue	Lipoma	Liposarcoma
Cartilage	Chondroma	Chondrosarcoma
Bone	Bone osteoma	Osteogenic sarcoma Ewing's tumor
Notochordal tissue		Chordoma (chordosarcoma)
Blood vessels	Hemangioma Hemangioendothelioma	Angiosarcoma Endotheliosarcoma (multiple sarcoma, Kaposi's sarcoma)
Lymph vessels	Lymphangioma Lymphangioendothelioma	Lymphangiosarcoma Lymphangioendotheliosarcoma
Synovia		Synovioma (synoviosarcoma)
Mesothelium (lining of body cavities)		Mesothelioma (mesotheliosarcoma)
Brain coverings	Meningioma	
Glomus	Glomus tumor (glomangioma)	
Hematopoietic cells		Granulocytic leukemia Monocytic leukemia
Lymphoid tissue		Malignant lymphomas Lymphocytic leukemia Plasmacytoma (multiple myeloma) Hodgkin's disease

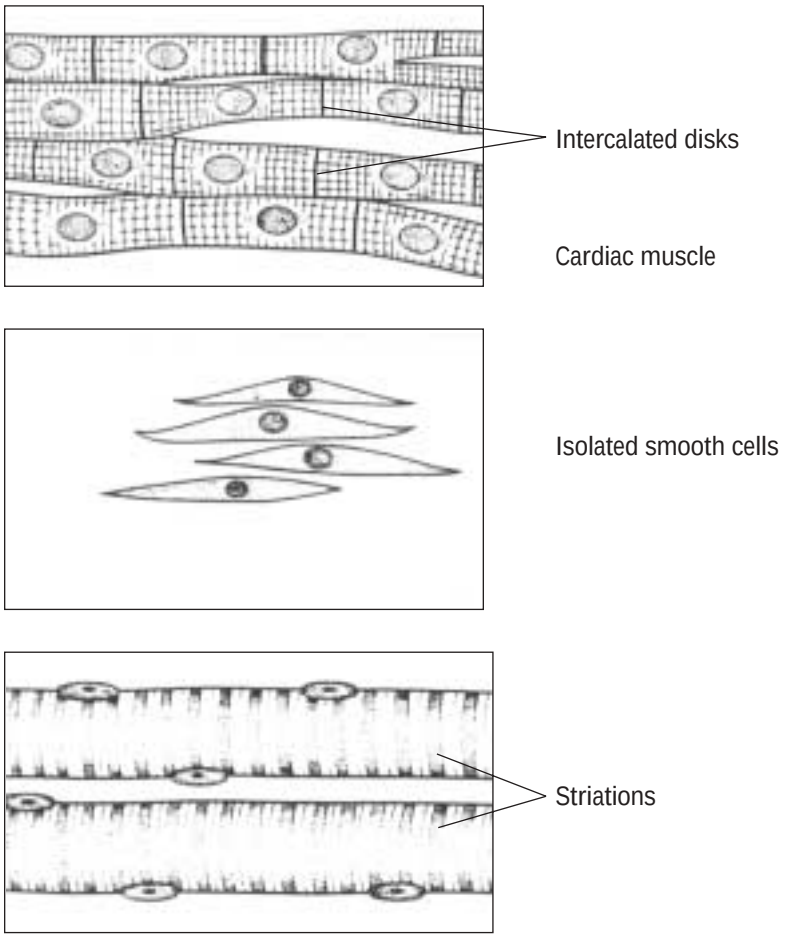
Muscle Tissue

The third major type of tissue with which you should be familiar is *muscle* tissue. Muscle tissue accounts for nearly one-half of the total body weight and consists of three distinct subtypes: *striated (skeletal) muscle*, *smooth (visceral) muscle*, and *cardiac muscle* (Figure 17).

Each type of muscle cell is designed to perform one basic function. Striated muscle is attached to bones that move the skeleton. Smooth muscle is located in the walls of hollow internal structures, such as the intestines and blood vessels, allowing such organs to expand and contract. Cardiac muscle occurs only in the heart, where it forms the walls and enables the heart to pump blood.

When viewed under the light microscope, striated muscle cells appear long and thread-like with alternating light and dark cross strips called striations. In contrast, smooth muscle has no striations, Cardiac muscle cells, each of which has a nucleus, are slightly striated. Each cardiac muscle cell tends to divide into a "y" or "x" shape, so that it has more than two ends and joins more than two other cells, ie, it intercalates. The ends of one cardiac

Figure 17.
Types of muscle tissue.



muscle cell are separated from adjoining cells by a band called an intercalated disk. Unlike skeletal muscle, smooth muscle and cardiac muscle are controlled involuntarily, ie, an individual cannot stop or start the muscle action.

Tumors of muscle tissue are listed in Table 15.

Nerve Tissue

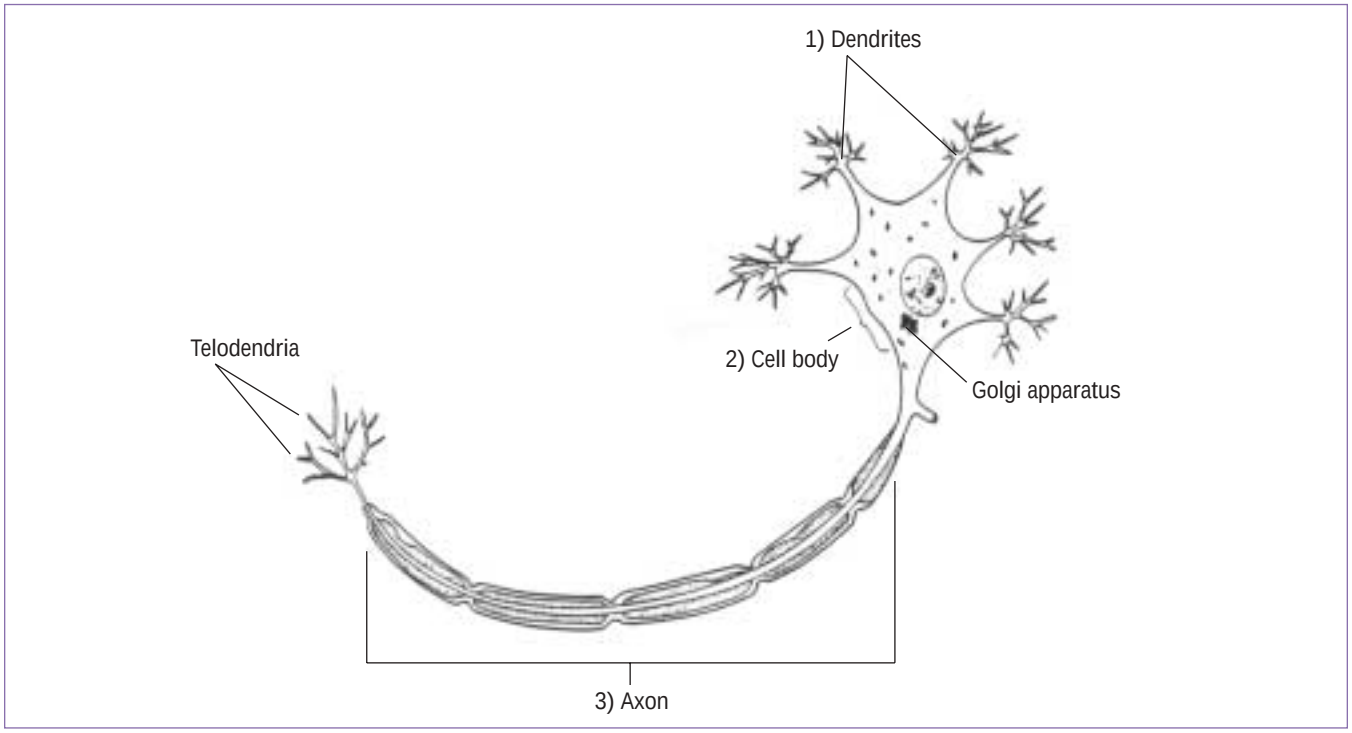
The fourth primary type of tissue is nerve tissue. Nerve tissue is found in the brain, spinal cord, and accompanying nerves. The function of the nerve tissue is to move and coordinate bodily functions. Nerve tissue is composed at two subtypes of tissue:

1. Specialized cells called *neurons (nerve cells)* receive stimuli and conduct impulses to and from all parts of the body (Figure 18).
2. *Neuroglial or glial cells.* Unlike bone, which is rigid, nerve tissue has a wet noodle-like compactness, and therefore must be supported by connective tissue. Some glial cells support neurons in the brain and spinal cord by entwining around them, while others bind neurons to other connective tissue.

Table 15.
Tumors of Muscle Tissue

Tissue of Origin	Benign Tumor	Malignant Tumor
Smooth muscle	Leiomyoma	Leiomyosarcoma
Striated muscle	Rhabdomyoma	Rhabdomyosarcoma

Figure 18.
Nerve tissue. A neuron showing the three main parts: 1) dendrites, 2) cell body, and 3) axon.



Among the several varieties of glial cells are astrocytes, oligodendrocytes, microglia, and ependymal cells.

Tumors of the nervous system are named according to where they arise. For example, cancers arising from astrocytic cells of the brain are called *astrocytomas*; those arising from oligodendrocytes are called *oligodendrogliomas*; and those arising from ependymal cells are called *ependymomas*.

Both the brain and spinal cord are covered by three thin layers of tissue called *meninges*: the *dura mater* (external layer); the *arachnoid* (middle layer); and the *pia mater* (internal layer). The major type of brain-surface tumor is the *meningioma*, so-called because it arises from the meninges. Because the spinal cord contains the same basic nerve cell types as the brain, it develops the same kinds of tumors. Table 16 lists the various types of tumors occurring in nerve tissue.

SUMMARY

Histology is the microscopic study of the structure and function of cells, tissues, and organs.

The four basic types of tissues are: 1) *epithelial* tissue, 2) *connective* tissue, 3) *muscle* tissue, and 4) *nerve* tissue.

Epithelial tissue covers the external and internal surfaces of the body. Its functions are *protection, secretion, absorption,* and *filtration*. The three subtypes of epithelial tissue are: 1) cuboidal, 2) squamous, 3) columnar.

Connective tissue is found throughout the body. Its functions range from *connecting, supporting,* and *protecting* other tissues to fighting disease. The five subtypes of connective tissue are: 1) *embryonal*, 2) *connective tissue proper*, 3) *blood and lymph*, 4) *cartilage*, 5) *bone*.

Muscle tissue functions to move and support body parts; it also forms the walls of the heart and blood vessels, in which it functions to move blood throughout the body. The three subtypes of muscle tissue are: 1) *striated (skeletal)* muscle, 2) *smooth (visceral)* muscle, and 3) *cardiac* muscle.

Nerve tissue is composed of specialized cells called *nerve cells* or *neurons* and *glial* or *neuroglial cells. Neurons* receive stimuli and conduct impulses to and from all parts of the body. The *neuroglial* or *glial cells,* which have a glue-like consistency, bind and support neurons.

Selected Bibliography

Robbins SL, Cotran RS, Kumar V: *Pathologic Basis of Disease.* 4th ed. Philadelphia, PA: WB Saunders Co; 1989.

Table 16.
Tumors of Nerve Tissue

Tissue of Origin	Benign Tumor	Malignant Tumor
Glial tissue		Glioma
Meninges	Meningioma	Meningeal sarcoma
Peripheral nerve cells	Neuroma Ganglioneuroma	Neuroblastoma
Retina		Retinoblastoma
Adrenal medulla	Pheochromocytoma	Pheochromocytoma
Nerve sheath	Neurilemoma (schwannoma) Neurofibroma	Anaplastic neurilemoma (schwannoma) Anaplastic neurofibroma (neurogenic sarcoma)

Section 6

Evaluation Frames

1. Define the word histology.

   _____

   _____

2. Name and briefly describe the *four* basic types of tissue.

   a) _____

   _____

   b) _____

   _____

   c) _____

   _____

   d) _____

   _____

3. Name the *three* subtypes of simple epithelial tissue.

   a) _____

   b) _____

   c) _____

4. Malignant tumors of epithelial origin are called:

   _____

5. List the *five* main subtypes of connective tissue.

   a) _____

   b) _____

   c) _____

   d) _____

   e) _____

6. Solid tumors of connective tissue are called:

   _____

7. Connective tissue tumors involving the blood are called: _____

8. Connective tissue tumors involving the lymphoid tissue are called: _____

9. Name the *three* subtypes of muscle tissue.

   a) _____

   b) _____

   c) _____

10. A malignant tumor of smooth muscle origin is called: _____

11. A malignant tumor originating in striated muscle tissue is called: _____

12. An example of a malignant tumor of nerve cell origin is a _____ , which develops in the glial tissue.

Section 6

ANSWERS

1. Histology is the microscopic study of cells, tissues, and organs.

2. a) Epithelial tissues cover the external and internal surfaces of the body, and are concerned with protection, secretion, absorption, and filtration.

   b) Connective tissues are found throughout the body and function to protect, support, and connect other tissues, as well as to help protect the body against disease.

   c) Muscle tissue performs important functions of support, movement, and protection of body parts; it also propels blood throughout the body.

   d) Nerve tissue is composed of two types of specialized cells: neurons and neuroglial (glial) cells. Neurons receive stimuli and conduct impulses to and from all body parts. Glial cells function to support and bind neurons.

3. a) cuboidal

   b) squamous

   c) columnar

4. carcinomas

5. a) embryonal

   b) connective tissue proper

   c) vascular (blood and lymph)

   d) cartilage

   e) bone

6. sarcomas

7. leukemias

8. lymphomas

9. a) striated (skeletal) muscle

   b) smooth (visceral) muscle

   c) cardiac muscle

10. leiomyosarcoma

11. rhabdomyosarcoma

12. glioma

If you completely understood the preceding material, proceed to Section 7. Otherwise, continue with the reinforcement frames on the next page.

Reinforcement Frames

6.1 Section 6 discusses the various types of tissues. The word histology is derived from two Greek forms: *histo* (web) and *ology*, meaning "the study of." The study of microscopic structures of cells, tissues, and organs is called .....

histology

6.2 Microscopic anatomy is another name for ..... A medical doctor specially trained in the study of histology is a histologist. A pathologist is an expert in the field of disease or pathology. One specially trained to recognize and identify abnormal cell growth patterns and deviations in tissues is called a .....

histology histopathologist

6.3 The science of histology involves the study of four basic types of tissue: 1) epithelial tissue, 2) connective tissue, 3) muscle tissue, and 4) nerve tissue. *Epi* is a Greek preposition meaning "upon." The type of tissue *covering* the external and internal surfaces of the body that is concerned with protection, secretion, absorption, and filtration is called ..... tissue.

epithelial

6.4 There are (three/four/five) ..... subtypes of simple epithelial tissue

three

6.5 The three subtypes of epithelial tissue are ....., ..., ...

cuboidal squamous columnar

6.6 A second type of tissue found in the body is connective tissue. The five subtypes of connective tissue are 1) embryonal, 2) connective tissue proper, 3) blood and lymph, 4) cartilage, and 5) bone. From the above and with some careful thought, we can determine that three functions of solid types of..... tissue are to connect, support, and protect other tissues.

connective

6.7 The two liquid forms of connective tissue are ..... and ..... Blood transports oxygen, nutrients, and waste products and helps to fight bacterial infection. Lymph returns waste products to the blood for elimination from the body and also filters out debris.

blood lymph

6.8 The third type of body tissue that we discussed in Section 6 was muscle tissue. Muscle tissue makes up about one-half of the total body weight and performs important support and protection functions, as well as providing the mechanism for the ..... of body parts.

movement

6.9 The fourth type of tissue studied is composed of two specialized types of cells. One type receives stimuli and conducts impulses to and from all parts of the body. These cells are called .....

neurons (nerve cells)

6.10 The second type of cell serves to bind neurons to surrounding tissues. These cells are called..... and..... cells.

glial neuroglial