

Cells and Tissues

The basic unit of structure and function in the human body is the cell. Each of a cell's parts, or organelles, as well as the entire cell, is organized to perform a specific function. Cells have the ability to metabolize, grow and reproduce, move, and respond to stimuli. The cells of the body differ in shape, size, and in specific roles in the body. Cells that are similar in structure and function form tissues, which, in turn, construct the various body organs.

Student activities in this chapter include questions relating to the structure and function of the generalized animal cell and to the general arrangement of tissues and their contribution to the activities of the various body organs.

CELLS

Overview

1. Answer the following questions by inserting your responses in the answer blanks.

- | | |
|-----------|---|
| _____ 1. | 1-4. Name the four elements that make up the bulk of living matter. |
| _____ 2. | |
| _____ 3. | 5. Name the single most abundant material or substance in living matter. |
| _____ 4. | 6. Name the trace element most important for making bones hard. |
| _____ 5. | |
| _____ 6. | 7. Name the element, found in small amounts in the body, that is needed to make hemoglobin for oxygen transport. |
| _____ 7. | |
| _____ 8. | 8-12. Although there are many specific "jobs" that certain cells are able to do, name five functions common to all cells. |
| _____ 9. | _____ 11. |
| _____ 10. | _____ 12. → |

- _____ 13. 13–15. List three different cell shapes.
- _____ 14. 16. Name the fluid, similar to seawater, that surrounds and bathes all body cells.
- _____ 15.
- _____ 16. 17. Name the flattened cells, important in protection, that fit together like tiles. (This is just one example of the generalization that a cell's structure is very closely related to its function in the body.)
- _____ 17.

Anatomy of a Generalized Cell

2. Complete the following table to fully describe the various cell parts. Insert your responses in the spaces provided under each heading.

Cell structure	Location	Function
	External boundary of the cell	Confines cell contents; regulates entry and exit of materials
Lysosomes		
	Scattered throughout the cell	Control release of energy from foods; form ATP
	Projections of the plasma membrane	Increase the membrane surface area
Golgi apparatus		
Nucleus		
	Two rod-shaped bodies near the nucleus	Direct formation of the mitotic spindle
Nucleolus		
Smooth ER		
Rough ER		
	Attached to membrane systems or scattered in the cytoplasm	Synthesize proteins
Chromatin		
	Scattered in cytoplasm	Detoxify alcohol, hydrogen peroxide, etc.
Inclusions		

3. Using the following list of terms, correctly label all cell parts indicated by leader lines in Figure 3-1. Then select different colors for each structure and use them to color the coding circles and the corresponding structures in the illustration.

- | | |
|---|---|
| <input type="radio"/> Plasma membrane | <input type="radio"/> Mitochondrion |
| <input type="radio"/> Centriole(s) | <input type="radio"/> Nuclear membrane |
| <input type="radio"/> Chromatin thread(s) | <input type="radio"/> Nucleolus |
| <input type="radio"/> Golgi apparatus | <input type="radio"/> Rough endoplasmic reticulum (ER) |
| <input type="radio"/> Microvilli | <input type="radio"/> Smooth endoplasmic reticulum (ER) |

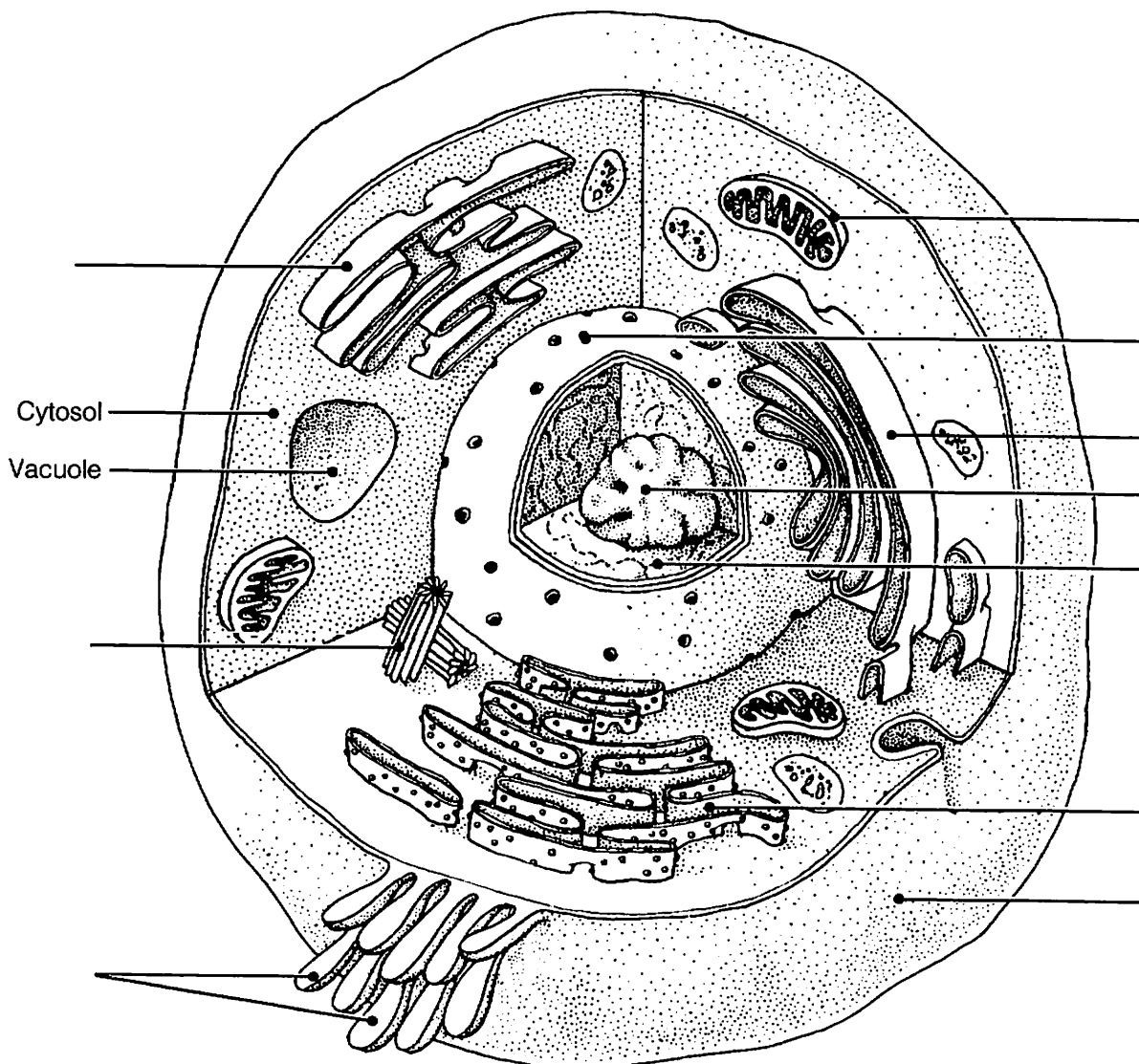


Figure 3-1

Cell Physiology

Membrane Transport

4. A semipermeable sac, containing 4% NaCl, 9% glucose, and 10% albumin, is suspended in a solution with the following composition: 10% NaCl, 10% glucose, and 40% albumin. Assume the sac is permeable to all substances *except* albumin. Using the key choices, insert the letter indicating the correct event in the answer blanks.

Key Choices

- A. Moves into the sac B. Moves out of the sac C. Does not move

_____ 1. Glucose _____ 3. Albumin
 _____ 2. Water _____ 4. NaCl

5. Figure 3-2 shows three microscopic fields (A-C) containing red blood cells. Arrows indicate the direction of net osmosis. Respond to the following questions, referring to Figure 3-2, by inserting your responses in the spaces provided.

1. Which microscopic field contains a *hypertonic* solution? _____

The cells in this field are said to be _____

2. Which microscopic field contains an isotonic bathing solution? _____

What does *isotonic* mean? _____

3. Which microscopic field contains a *hypotonic* solution? _____

What is happening to the cells in this field and why? _____

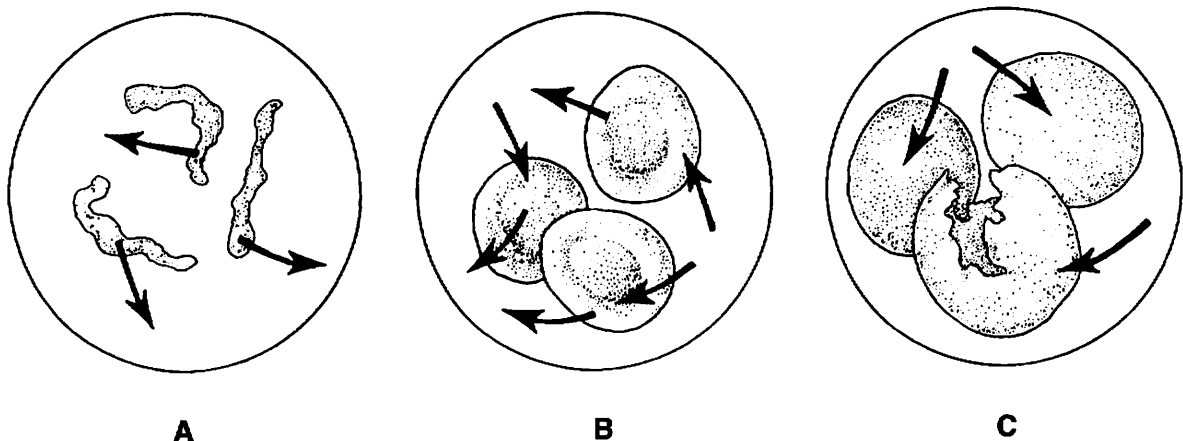


Figure 3-2

6. Select the key choices that characterize each of the following statements. Insert the appropriate letter(s) or corresponding term(s) in the answer blanks.

Key Choices

- | | | |
|-----------------------|------------------------------|-------------------|
| A. Diffusion, simple | C. Endocytosis, phagocytosis | E. Filtration |
| B. Diffusion, osmosis | D. Exocytosis | F. Solute pumping |

- _____ 1. Require ATP (cellular energy)
- _____ 2. Driven by kinetic energy of the molecules
- _____ 3. Driven by hydrostatic (fluid) pressure
- _____ 4. Follow a concentration gradient
- _____ 5. Proceeds against a concentration gradient; require(s) a carrier
- _____ 6. A means of secreting cell products
- _____ 7. Moves water through a semipermeable membrane
- _____ 8. Transports amino acids, some sugars, and Na⁺ through the plasma membrane
- _____ 9. Provides for cellular uptake of solid or large particles from the cell exterior
- _____ 10. Moves small or lipid-soluble solutes through the membrane

7. Figure 3-3 represents a portion of a plasma membrane. Select two different colors for lipid and protein molecules. Color the coding circles and the corresponding molecules in the illustration. Then add a colored arrow for each substance shown inside and outside the cell indicating (a) its *direction* of transport through the membrane; and (b) its *means of transport* (that is, either directly through the lipid portion or by attachment to a protein carrier).

- Lipid molecules
- Protein molecules

Two types of molecules not shown here that contribute to plasma membrane structure

are _____ and _____.

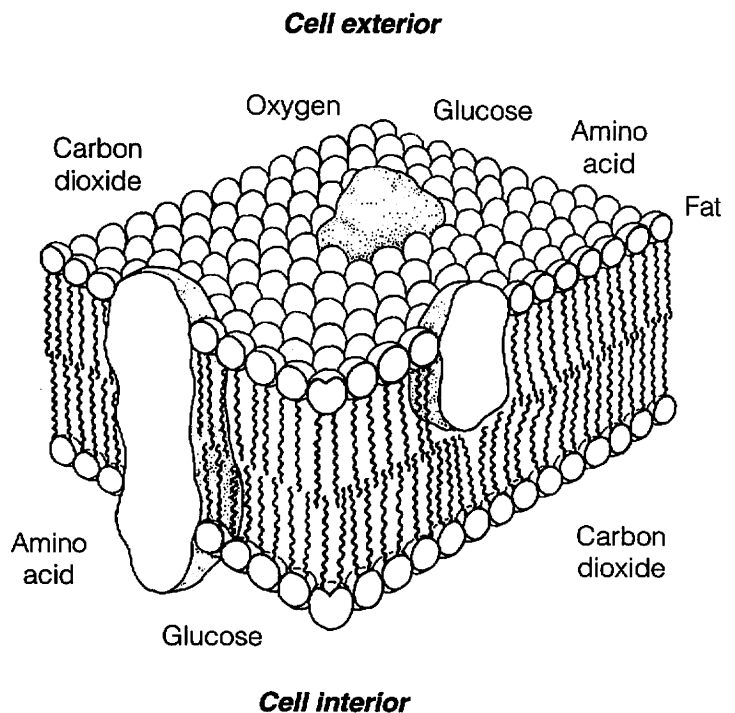


Figure 3-3

Cell Division

8. The following statements provide an overview of the structure of DNA (genetic material) and its role in the body. Choose responses from the key choices that complete the statements. Insert the appropriate answers in the answer blanks.

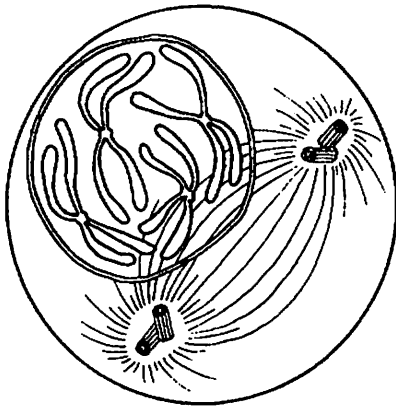
Key Choices

A. Adenine	G. Enzymes	M. Nucleotides	S. Ribosome
B. Amino acids	H. Genes	N. Old	T. Sugar (deoxyribose)
C. Bases	I. Growth	O. Phosphate	U. Template, or model
D. Codons	J. Guanine	P. Proteins	V. Thymine
E. Complementary	K. Helix	Q. Replication	W. Transcription
F. Cytosine	L. New	R. Repair	X. Uracil

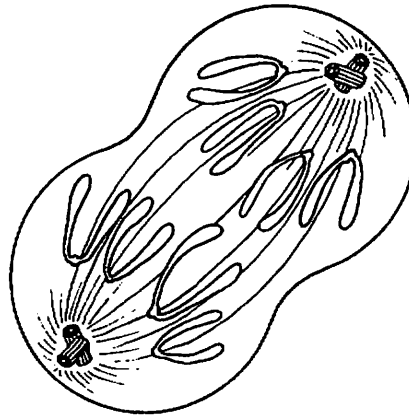
- _____ 1. DNA molecules contain information for building specific _____ (1). In a three-dimensional view, a DNA molecule looks like a spiral staircase; this is correctly called a _____ (2). The constant parts of DNA molecules are the _____ (3) and _____ (4) molecules, forming the DNA-ladder uprights, or backbones. The information of DNA is actually coded in the sequence of nitrogen-containing _____ (5), which are bound together to form the "rungs" of the DNA ladder. When the four DNA bases are combined in different three-base sequences, called triplets, different _____ (6) of the protein are called for. It is said that the N-containing bases of DNA are _____ (7), which means that only certain bases can fit or interact together. Specifically, this means that _____ (8) can bind with guanine, and adenine binds with _____ (9).
- _____ 9. The production of proteins involves the cooperation of DNA and RNA. RNA is another type of nucleic acid that serves as a "molecular slave" to DNA. That is, it leaves the nucleus and carries out the instructions of the DNA for the building of a protein on a cytoplasmic structure called a _____ (10). When a cell is preparing to divide, in order for its daughter cells to have all its information, it must oversee the _____ (11) of its DNA so that a "double dose" of genes is present for a brief period. For DNA synthesis to occur, the DNA must uncoil, and the bonds between the N-bases must be broken. Then the two single strands of _____ (12) each act as a _____ (13) for the building of a whole DNA molecule. When completed, each DNA molecule formed is half _____ (14) and half _____ (15). The fact that DNA replicates before a cell divides ensures that each daughter cell has a complete set of _____ (16). Cell division, which then follows, provides new cells so that _____ (17) and _____ (18) can occur.
- _____ 18.

9. Identify the phases of mitosis depicted in Figure 3–4 by inserting the correct name in the blank under the appropriate diagram. Then select different colors to represent the structures listed below and use them to color in the coding circles and the corresponding structures in the illustration.

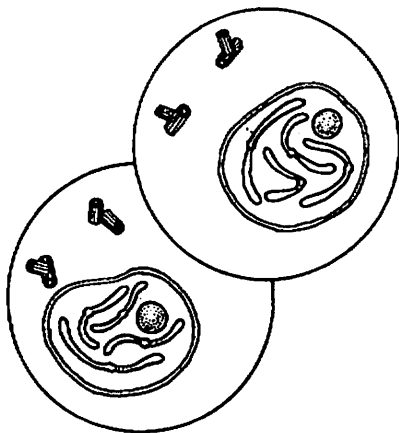
- | | |
|---|--------------------------------------|
| <input type="radio"/> Nuclear membrane(s), if present | <input type="radio"/> Centrioles |
| <input type="radio"/> Nucleoli, if present | <input type="radio"/> Spindle fibers |
| <input type="radio"/> Chromosomes | |



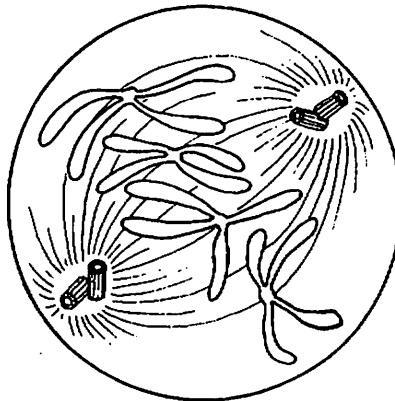
A _____



B _____



C _____



D _____

Figure 3–4

10. The following statements describe events that occur during the different phases of mitosis. Identify the phase by choosing the correct response(s) from key choices and inserting the letter(s) or term(s) in the answer blanks.

Key Choices

- A. Anaphase C. Prophase E. None of these
 B. Metaphase D. Telophase

- _____ 1. Chromatin coils and condenses to form deeply staining bodies.
 _____ 2. Centromeres break, and chromosomes begin migration toward opposite poles of the cell.
 _____ 3. The nuclear membrane and nucleoli reappear.
 _____ 4. When chromosomes cease their poleward movement, this phase begins.
 _____ 5. Chromosomes align on the equator of the spindle.
 _____ 6. The nucleoli and nuclear membrane disappear.
 _____ 7. The spindle forms through the migration of the centrioles.
 _____ 8. Chromosomal material replicates.
 _____ 9. Chromosomes first appear to be duplex structures.
 _____ 10. Chromosomes attach to the spindle fibers.
 _____ 11. A cleavage furrow forms during this phase.
 _____ 12. The nuclear membrane is absent during the entire phase.
 _____ 13. Period during which a cell carries out its *usual* metabolic activities.

11. Complete the following statements. Insert your answers in the answer blanks.

- _____ 1. Division of the (1) is referred to as mitosis. Cytokinesis is division of the (2). The major structural difference between chromatin and chromosomes is that the latter are (3). Chromosomes attach to the spindle fibers by undivided structures called (4). If a cell undergoes nuclear division but not cytoplasmic division, the product is a (5). The structure that acts as a scaffolding for chromosomal attachment and movement is called the (6). (7) is the period of cell life when the cell is not involved in division.
 _____ 2.
 _____ 3.
 _____ 4.
 _____ 5.
 _____ 6.
 _____ 7.

Protein Synthesis

12. Figure 3-5 is a diagram illustrating protein synthesis. Select four different colors, and use them to color the coding circles and the corresponding structures in the diagram. Next, using the letters of the genetic code, label the nitrogen bases on strand 2 of the DNA double helix, on the mRNA strands, and on the tRNA molecules. Then, answer the questions that follow referring to Figure 3-5, inserting your answers in the answer blanks.

- Backbones of the DNA double helix tRNA molecules
- Backbone of the mRNA strands Amino acid molecules

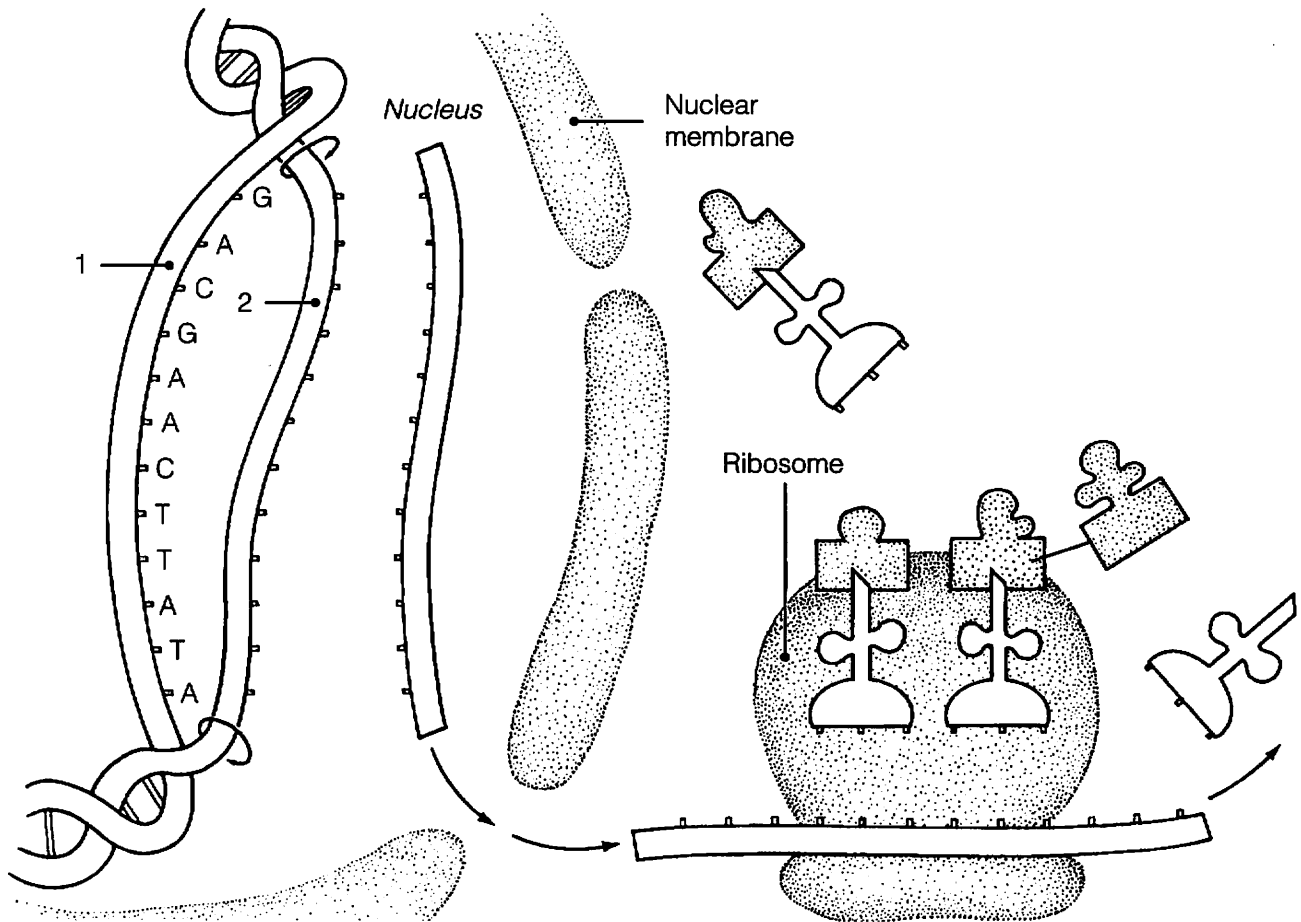


Figure 3-5

- Transfer of the genetic message from DNA to mRNA is called _____.
- Assembly of amino acids according to the genetic information carried by mRNA is called _____.
- The set of three nitrogen bases on tRNA that is complementary to an mRNA codon is called a _____. The complementary three-base sequence on DNA is called a _____.

BODY TISSUES

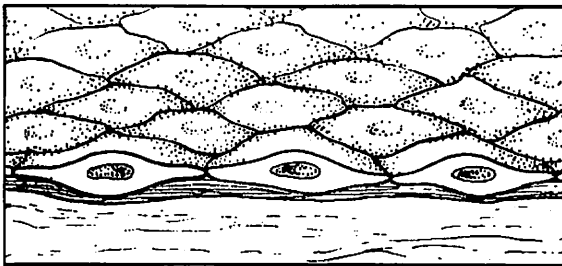
13. Twelve tissue types are diagrammed in Figure 3–6. Identify each tissue type by inserting the correct name in the blank below it on the diagram. Select different colors for the following structures and use them to color the coding circles and corresponding structures in the diagrams.

Epithelial cells

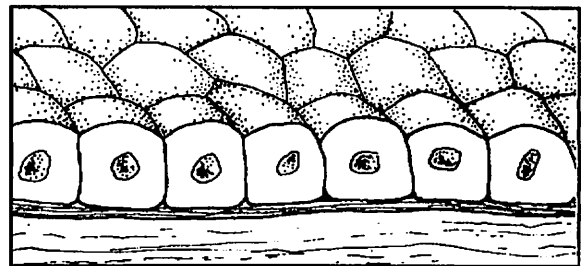
Nerve cells

Muscle cells

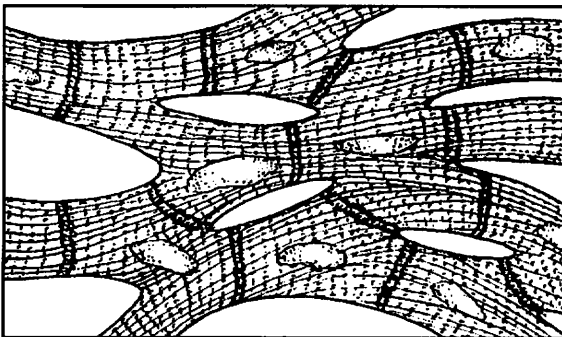
Matrix (Where found, matrix should be colored differently from the living cells of that tissue type. Be careful, this may not be as easy as it seems!)



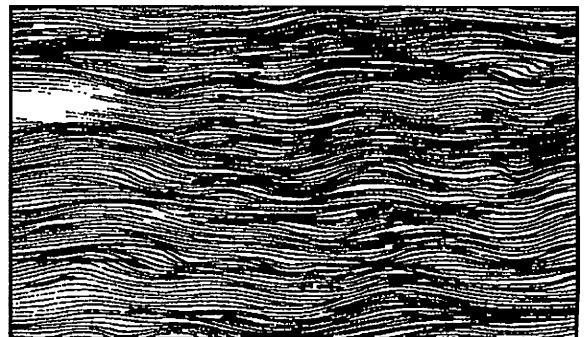
A _____



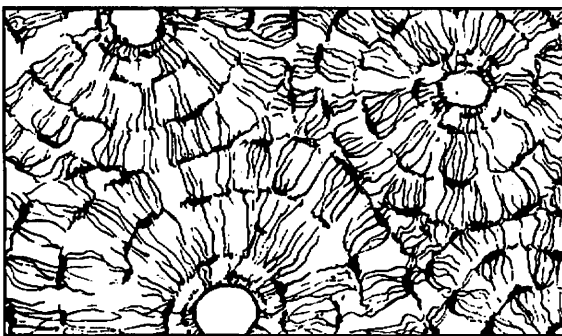
B _____



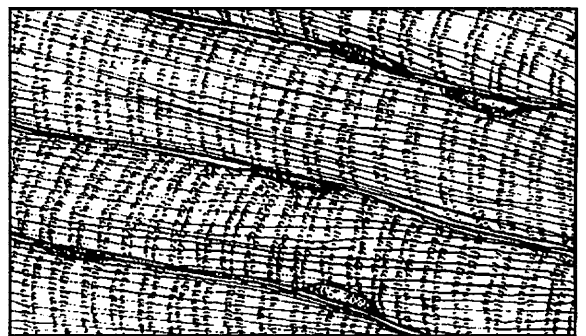
C _____



D _____



E _____



F _____

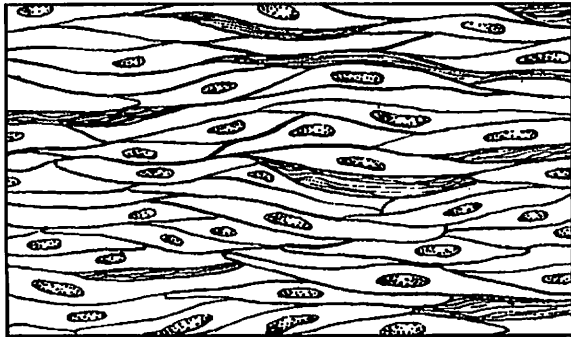
Figure 3–6, A–F



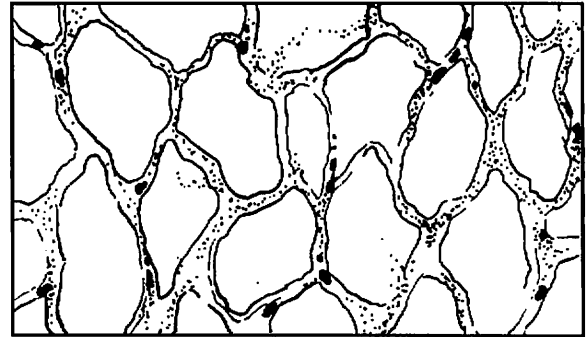
G _____



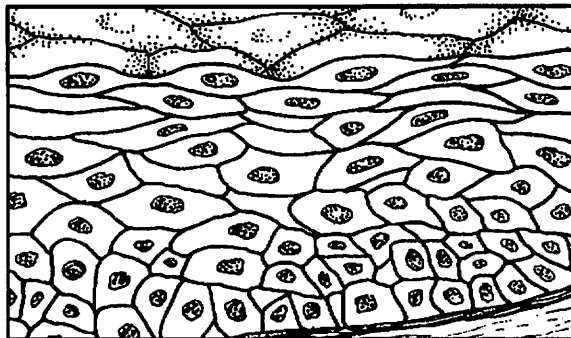
H _____



I _____



J _____



K _____



L _____

Figure 3-6, G-L

14. Describe briefly how the particular structure of a neuron relates to its function in the body. _____

- 15.** Using key choices, correctly identify the *major* tissue types described. Enter the appropriate letter or tissue type term in the answer blanks.

Key Choices

- A. Connective B. Epithelium C. Muscle D. Nervous

- _____ 1. Forms mucous, serous, and epidermal membranes
- _____ 2. Allows for organ movements within the body
- _____ 3. Transmits electrochemical impulses
- _____ 4. Supports body organs
- _____ 5. Cells of this tissue may absorb and/or secrete substances
- _____ 6. Basis of the major controlling system of the body
- _____ 7. The cells of this tissue shorten to exert force
- _____ 8. Forms hormones
- _____ 9. Packages and protects body organs
- _____ 10. Characterized by having large amounts of nonliving matrix
- _____ 11. Allows you to smile, grasp, swim, ski, and shoot an arrow
- _____ 12. Most widely distributed tissue type in the body
- _____ 13. Forms the brain and spinal cord

- 16.** Using key choices, identify the following specific type(s) of epithelial tissue. Enter the appropriate letter or classification term in the answer blanks.

Key Choices

- A. Pseudostratified columnar (ciliated) C. Simple cuboidal E. Stratified squamous
- B. Simple columnar D. Simple squamous F. Transitional

- _____ 1. Lines the esophagus and forms the skin epidermis
- _____ 2. Forms the lining of the stomach and small intestine
- _____ 3. Best suited for areas subjected to friction
- _____ 4. Lines much of the respiratory tract
- _____ 5. Propels substances (e.g., mucus) across its surface
- _____ 6. Found in the bladder lining; peculiar cells that slide over one another
- _____ 7. Forms thin serous membranes; a single layer of flattened cells

17. Epithelium exhibits many plasma membrane modifications. Figure 3-7 depicts some of these modifications.

First: Choose a color for the coding circles and the corresponding structures in the figure.

- | | |
|---|---|
| <input type="radio"/> Epithelial cell cytoplasm | <input type="radio"/> Connective tissue |
| <input type="radio"/> Epithelial cell nucleus | <input type="radio"/> Blood vessel |
| <input type="radio"/> Nerve fibers | |

Second: Correctly identify the following structures or regions by labeling the appropriate leader lines using terms from the list below:

- | | | |
|----------------------|----------------------|--------------------|
| A. Apical region | D. Cilia | G. Epithelium |
| B. Basement membrane | E. Connective tissue | H. Microvilli |
| C. Capillary | F. Desmosome | I. Tight junctions |

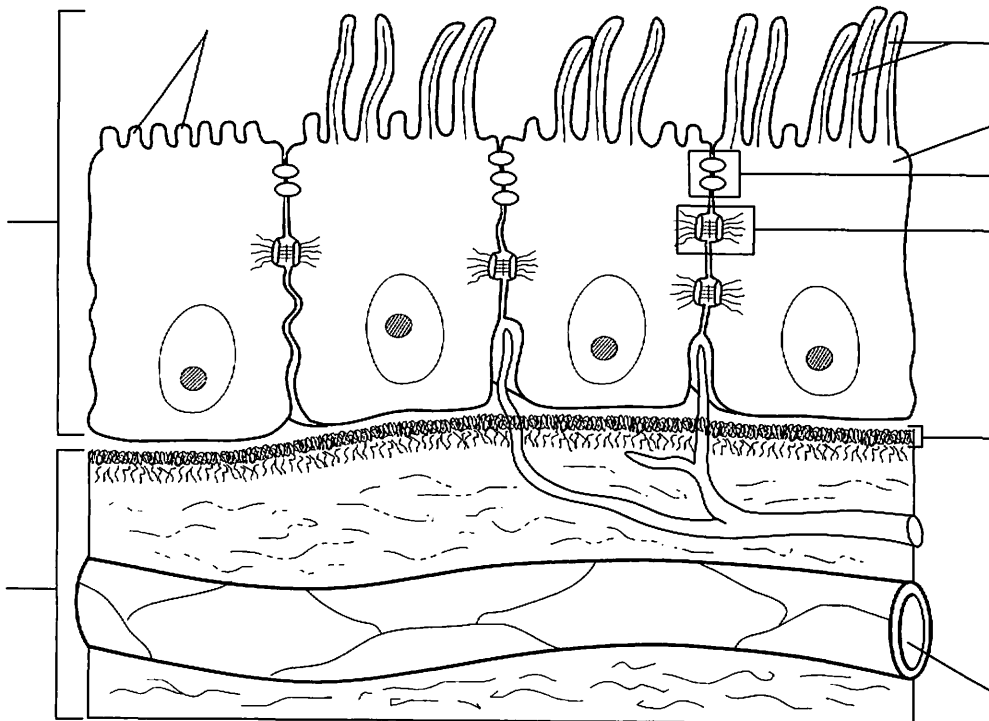


Figure 3-7

18. The three types of muscle tissue exhibit certain similarities and differences. Check (✓) the appropriate spaces in the following table to indicate which muscle types exhibit each characteristic.

Characteristic	Skeletal	Cardiac	Smooth
1. Voluntarily controlled			
2. Involuntarily controlled			
3. Banded appearance			
4. Single nucleus in each cell			
5. Multinucleate			
6. Found attached to bones			
7. Allows you to direct your eyeballs			
8. Found in the walls of stomach, uterus, and arteries			
9. Contains spindle-shaped cells			
10. Contains cylindrical cells with branching ends			
11. Contains long, nonbranching cylindrical cells			
12. Displays intercalated disks			
13. Concerned with locomotion of the body as a whole			
14. Changes the internal volume of an organ as it contracts			
15. Tissue of the circulatory pump			

19. Circle the term that does not belong in each of the following groupings.

1. Collagen Cell Matrix Cell product
2. Cilia Flagellum Microvilli Elastic fibers
3. Glands Bones Epidermis Mucosae
4. Adipose Hyaline Osseous Nervous
5. Blood Smooth Cardiac Skeletal

20. Using key choices, identify the following connective tissue types. Insert the appropriate letter or corresponding term in the answer blanks.

Key Choices

- A. Adipose connective tissue C. Dense fibrous connective tissue E. Reticular connective tissue
 B. Areolar connective tissue D. Osseous tissue F. Hyaline cartilage

- _____ 1. Provides great strength through parallel bundles of collagenic fibers; found in tendons
- _____ 2. Acts as a storage depot for fat
- _____ 3. Composes the dermis of the skin
- _____ 4. Forms the bony skeleton
- _____ 5. Composes the basement membrane and packages organs; includes a gel-like matrix with all categories of fibers and many cell types
- _____ 6. Forms the embryonic skeleton and the surfaces of bones at the joints; reinforces the trachea
- _____ 7. Provides insulation for the body
- _____ 8. Structurally amorphous matrix, heavily invaded with fibers; appears glassy and smooth
- _____ 9. Contains cells arranged concentrically around a nutrient canal; matrix is hard due to calcium salts
- _____ 10. Forms the stroma or internal "skeleton" of lymph nodes, the spleen, and other lymphoid organs

Tissue Repair

21. For each of the following statements about tissue repair that is true, enter *T* in the answer blank. For each false statement, correct the underlined words by writing the correct words in the answer blank.

- _____ 1. The nonspecific response of the body to injury is called regeneration.
- _____ 2. Intact capillaries near an injury dilate, leaking plasma, blood cells, and antibodies, which cause the blood to clot. The clot at the surface dries to form a scab.
- _____ 3. During the first phase of tissue repair, capillary buds invade the clot, forming a delicate pink tissue called endodermal tissue.
- _____ 4. When damage is not too severe, the surface epithelium migrates beneath the dry scab and across the surface of the granulation tissue. This repair process is called proliferation.

- _____ 5. If tissue damage is very severe, tissue repair is more likely to occur by fibrosis, or scarring.
- _____ 6. During fibrosis, fibroblasts in the granulation tissue lay down keratin fibers, which form a strong, compact, but inflexible mass.
- _____ 7. The repair of cardiac muscle and nervous tissue occurs only by fibrosis.

DEVELOPMENTAL ASPECTS OF CELLS AND TISSUES

22. Correctly complete each statement by inserting your responses in the answer blanks.

- _____ 1. During embryonic development, cells specialize to form (1). Mitotic cell division is very important for overall body (2).
- _____ 2. All tissues except (3) tissue continue to undergo cell division until the end of adolescence. After this time, (4)
- _____ 3. tissue also becomes amitotic. When amitotic tissues are damaged, they are replaced by (5) tissue, which does not function in the same way as the original tissue. This is a serious problem when heart cells are damaged.
- _____ 4.
- _____ 5.

- _____ 6. Aging begins almost as soon as we are born. Three explanations of the aging process have been offered. One states that (6) insults, such as the presence of toxic substances in the blood, are important. Another theory states that external (7) factors, such as X-rays, help to cause aging. A third theory suggests that aging is programmed in our (8). Three examples of aging processes seen in all people are (9), (10), and (11).
- _____ 7.
- _____ 8.
- _____ 9.
- _____ 10.

- _____ 11. Neoplasms occur when cells "go wild" and the normal controls of cell (12) are lost. The two types of neoplasms are (13) and (14). The (15) type tends to stay localized and have a capsule. The (16) type is likely to invade other body tissues and spread to other (distant) parts of the body. To correctly diagnose the type of neoplasm, a microscopic examination of the tissue called a (17) is usually done. Whenever possible, (18) is the treatment of choice for neoplasms.
- _____ 12.
- _____ 13.
- _____ 14.

- _____ 15. An overgrowth of tissue that is not considered to be a neoplasm is referred to as (19). Conversely, a decrease in the size of an organ or tissue, resulting from loss of normal stimulation, is called (20).
- _____ 16.
- _____ 17.
- _____ 18.
- _____ 19.
- _____ 20.



INCREDIBLE JOURNEY

A Visualization Exercise for the Cell

A long, meandering membrane with dark globules clinging to its outer surface now comes into sight.

23. Where necessary, complete statements by inserting the missing words in the answer blanks.

- _____ 1. For your second journey, you will be miniaturized to the size of a small protein molecule and will travel in a microsubmarine, specially designed to enable you to pass easily through living membranes. You are injected into the intercellular space
- _____ 2. between two epithelial cells, and you are instructed to observe one of these cells firsthand, and to identify as many of its structures as possible.
- _____ 3.
- _____ 4.
- _____ 5. You struggle briefly with the controls and then maneuver your microsub into one of these cells. Once inside the cell,
- _____ 6. you find yourself in a kind of "sea." This salty fluid that surrounds you is the (1) of the cell.
- _____ 7.
- _____ 8. Far below looms a large, dark, oval structure, much larger than anything else you can see. You conclude that it is the (2). As you move downward, you pass a cigar-shaped structure with strange-looking folds on its inner surface.
- _____ 9. Although you have a pretty good idea that it must be a (3),
- _____ 10. you decide to investigate more thoroughly. After passing through the external membrane of the structure, you are confronted with yet another membrane. Once past this mem-

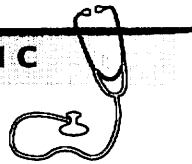
brane, you are inside the strange-looking structure. You activate the analyzer switch in your microsub for a readout indicating which molecules are in your immediate vicinity. As suspected, there is an abundance of energy-rich (4) molecules. Having satisfied your curiosity, you leave this structure to continue the investigation.

A long, meandering membrane with dark globules clinging to its outer surface now comes into sight. You maneuver closer and sit back to watch the activity. As you watch, amino acids are joined together and a long, threadlike protein molecule is built. The globules must be (5), and the membrane, therefore, is the (6). Once again, you head toward the large dark structure seen and tentatively identified earlier. On approach, you observe that this huge structure has very large openings in its outer wall; these openings must be the (7). Passing through one of these openings, you discover that from the inside the color of this structure is a result of dark, coiled, intertwined masses of (8), which your analyzer confirms contain genetic material, or (9) molecules. Making your way through this tangled mass, you pass two round, dense structures that appear to be full of the same type of globules you saw outside. These two round structures are (10). All this information confirms your earlier identification of this cellular structure, so now you move to its exterior to continue observations.

- _____ 11. Just ahead, you see what appears to be a mountain of flattened sacs with hundreds of small sac-like vesicles at its edges. The vesicles seem to be migrating away from this area and heading toward the outer edges of the cell. The mountain of sacs must be the (11). Eventually you come upon a rather simple-looking membrane-bound sac. Although it doesn't look too exciting, and has few distinguishing marks, it does not resemble anything else you have seen so far. Deciding to obtain a chemical analysis before entering this sac, you activate the analyzer and on the screen you see "Enzymes — Enzymes — Hydrolases — Hydrolases — Danger — Danger." There is little doubt that this innocent-appearing structure is actually a (12).

Completing your journey, you count the number of organelles identified so far. Satisfied that you have observed most of them, you request retrieval from the intercellular space.

AT THE CLINIC



24. Johnny lacerated his arm and rushed home to Mom so she could "fix it." His mother poured hydrogen peroxide over the area and it bubbled vigorously where it came in contact with the wound. Since you can expect that cells were ruptured in the injured area, what do you *think* was happening here?
25. The epidermis (epithelium of the cutaneous membrane or skin) is a keratinized stratified squamous epithelium. Explain why that epithelium is much better suited for protecting the body's external surface than a mucosa consisting of a simple columnar epithelium would be.
26. Streptomycin (an antibiotic) binds to the small ribosomal subunit of bacteria (but not to the ribosomes of the host cells infected by bacteria). The result is the misreading of bacteria mRNA and the breakup of polysomes. What process is being affected, and how does this kill the bacterial cells?

- 27.** Systemic lupus erythematosus (often simply called lupus) is a condition that sometimes affects young women. It is a chronic (persistent) inflammation that affects all or most of the connective tissue proper in the body. Suzy is told by her doctor that she has lupus, and she asks if it will have widespread or merely localized effects within the body. What would the physician answer?
- 28.** Mrs. Linsey sees her gynecologist because she is unable to become pregnant. The doctor discovers granulation tissue in her vaginal canal and explains that sperm are susceptible to some of the same chemicals as bacteria. What is inhibiting the sperm?