

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. → |

4. Label the specializations of the plasma membrane, shown in Figure 3-3, and color the diagram as you wish. Then, answer the questions provided below that refer to this figure.

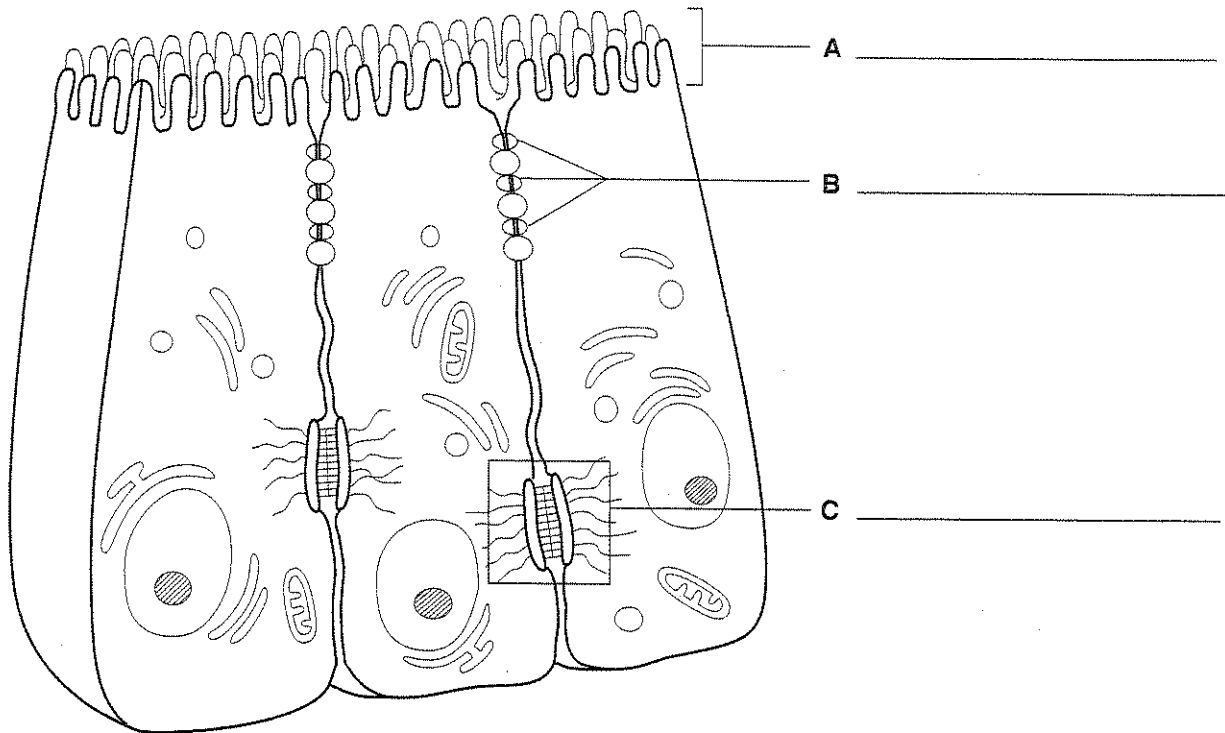


Figure 3-3

1. What type of cell function(s) does the presence of microvilli typically indicate? _____
 2. Which cell junction forms an impermeable barrier? _____
 3. Which cell junction is an anchoring junction? _____
 4. Which junction has linker proteins spanning the intercellular space? _____
 5. Which cell junction is not illustrated, and what is its function? _____
-

Cell Physiology

Membrane Transport

8. Figure 3-4 shows a semipermeable sac, containing 4% NaCl, 9% glucose, and 10% albumin, 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

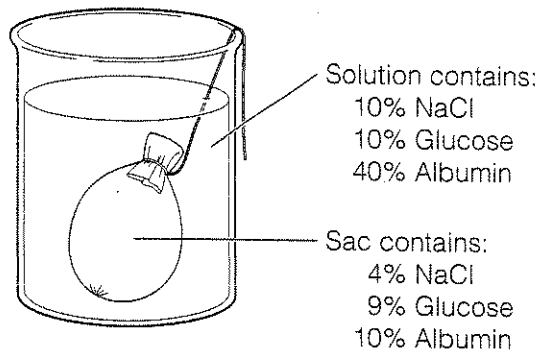


Figure 3-4

9. Figure 3-5 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 3-5, 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? _____

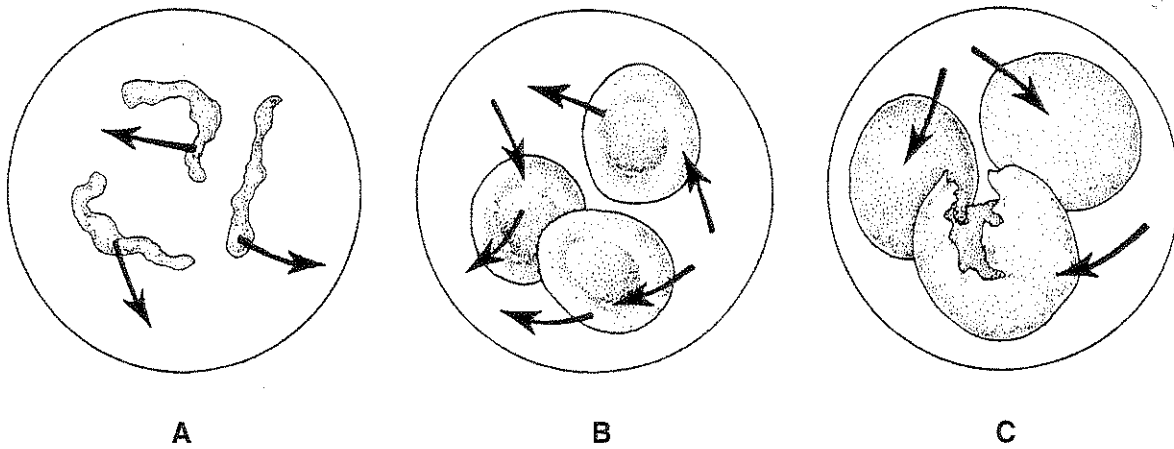


Figure 3-5

10. Figure 3-6 is a simplified diagram of the plasma membrane. Structure A represents channel proteins constructing a pore, structure B represents an ATP-energized solute pump, and structure C is a transport protein that does not depend on energy from ATP. Identify these structures and the membrane phospholipids by color before continuing.

- Channel
 Solute pump
 Passive transport protein carrier
 Phospholipids

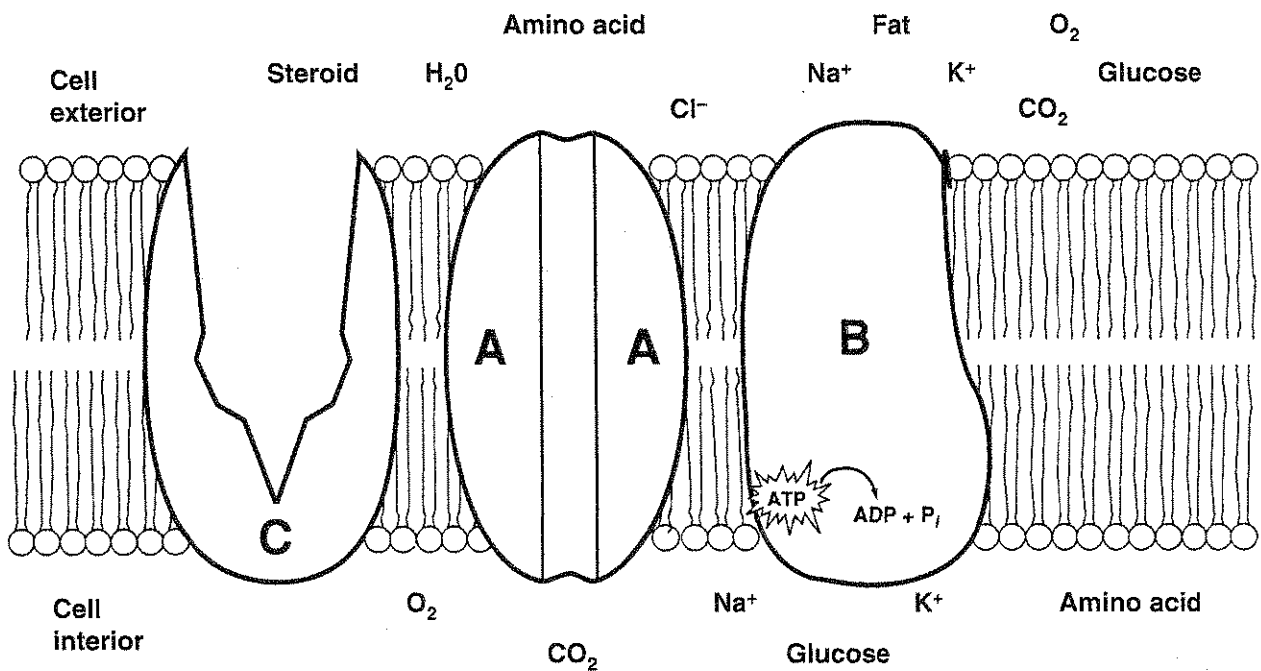


Figure 3-6

Now add arrows to Figure 3-6 as instructed next: For each substance that moves through the plasma membrane, draw an arrow indicating its (most likely) direction of movement (into or out of the cell). If it is moved actively, use a red arrow; if it is moved passively, use a blue arrow.



Finally, answer the following questions referring to Figure 3-6:

1. Which of the substances shown moves passively *through the lipid part* of the membrane? _____
2. Which of the substances shown enters the cell by attachment to a passive-transport protein carrier? _____
3. Which of the substances shown moves passively through the membrane by moving through its pores? _____
4. Which of the substances shown would have to use a solute pump to be transported through the membrane? _____

11. Select the key choices that characterize each of the following statements. Insert the appropriate answers in the answer blanks.

Key Choices

- | | | |
|-----------------------|--------------------------|----------------------------------|
| A. Active transport | D. Exocytosis | G. Phagocytosis |
| B. Diffusion, simple | E. Facilitated diffusion | H. Pinocytosis |
| C. Diffusion, osmosis | F. Filtration | I. Receptor-mediated endocytosis |

- | | |
|-------|---|
| _____ | 1. Engulfment processes that require ATP |
| _____ | 2. Driven by molecular energy |
| _____ | 3. Driven by hydrostatic (fluid) pressure (typically blood pressure in the body) |
| _____ | 4. Moves down a concentration gradient |
| _____ | 5. Moves up (against) a concentration gradient; requires a carrier |
| _____ | 6. Moves small or lipid-soluble solutes through the membrane |
| _____ | 7. Transports amino acids and Na ⁺ through the plasma membrane |
| _____ | 8. Examples of vesicular transport |
| _____ | 9. A means of bringing fairly large particles into the cell |
| _____ | 10. Used to eject wastes and to secrete cell products |
| _____ | 11. Membrane transport using channels or carrier proteins that does not require ATP |

BODY TISSUES

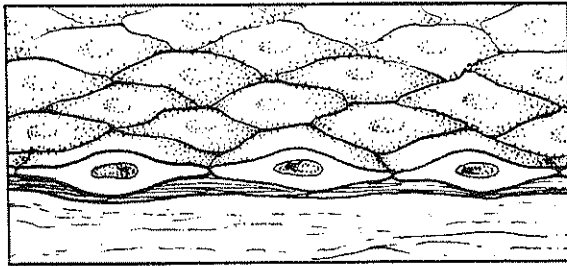
17. Twelve tissue types are diagrammed in Figure 3–9. Identify each tissue type by inserting the correct name in the blank below it on the diagram. Select different colors for the following structures and use them to color the coding circles and corresponding structures in the diagrams.

Epithelial cells

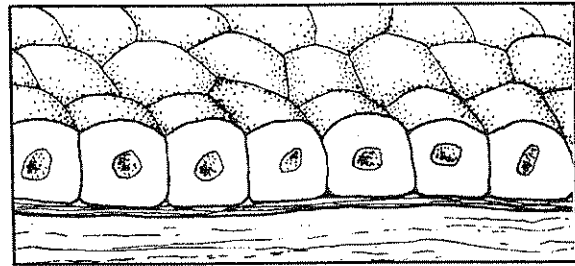
Nerve cells

Muscle cells

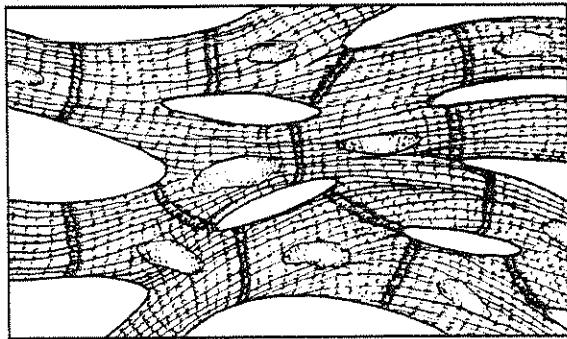
Matrix (Where found, matrix should be colored differently from the living cells of that tissue type. Be careful; this may not be as easy as it seems!)



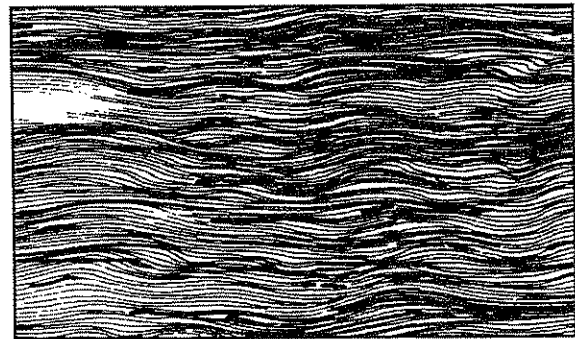
A _____



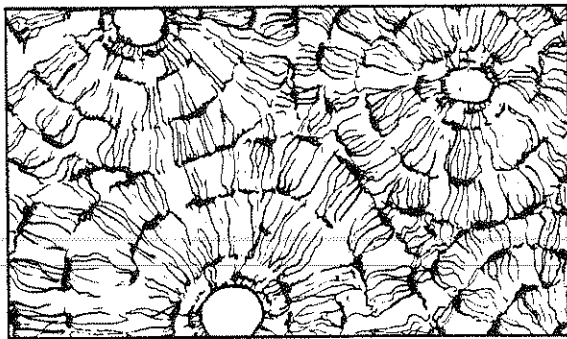
B _____



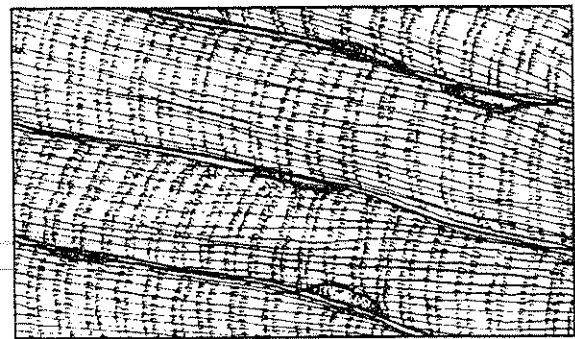
C _____



D _____

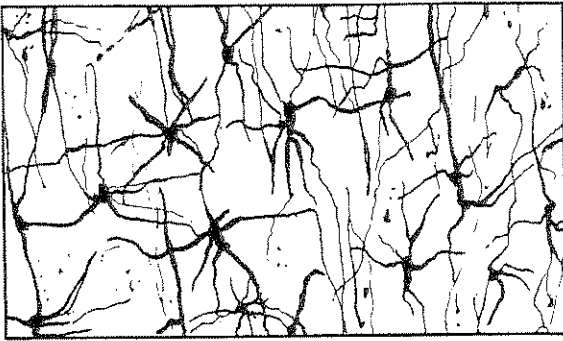


E _____

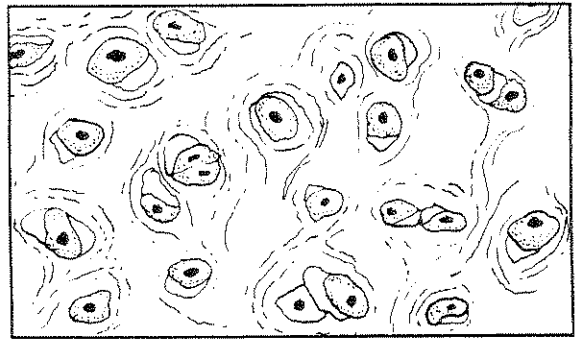


F _____

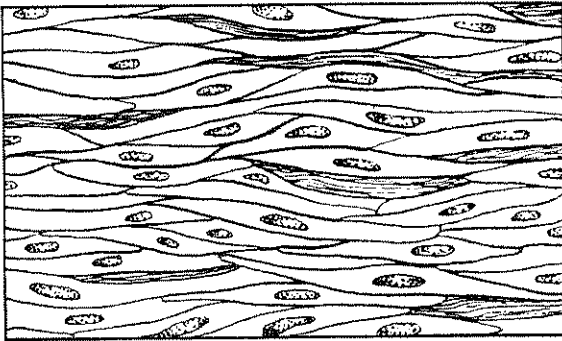
Figure 3–9, A–F



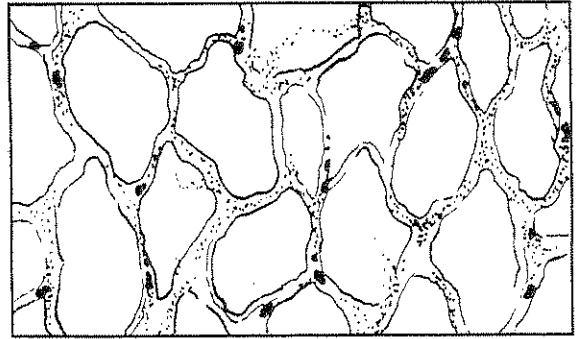
G _____



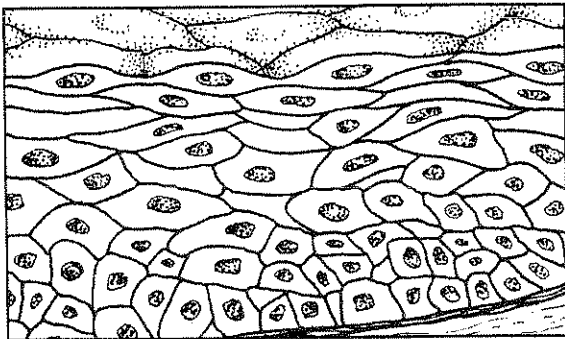
H _____



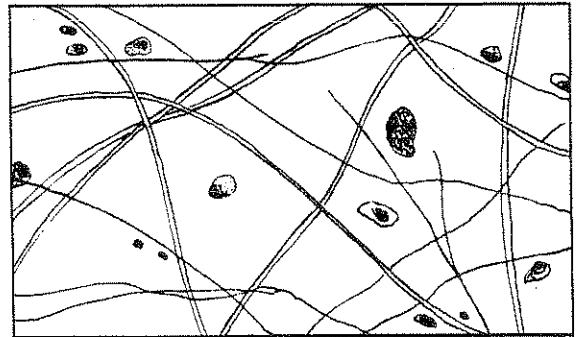
I _____



J _____



K _____



L _____

Figure 3-9, G-L

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

19. Using the 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

20. Using the 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

21. 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 discs			
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			

22. 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 |

23. Using the 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

24. 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

25. 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
- _____ 7. (6) insults, such as the presence of toxic substances in the blood, are important. Another theory states that external
- _____ 8. (7) factors, such as X rays, help to cause aging. A third theory suggests that aging is programmed in our (8). Three
- _____ 9. examples of aging processes seen in all people are (9), (10), and (11).
- _____ 10.
- _____ 11. Neoplasms occur when cells "go wild" and the normal controls of cell (12) are lost. The two types of neoplasms are
- _____ 12. (13) and (14). The (15) type tends to stay localized and have a capsule. The (16) type is likely to invade other body
- _____ 13. 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
- _____ 14. possible, (18) is the treatment of choice for neoplasms.
- _____ 15.
- _____ 16. An overgrowth of tissue that is not considered to be a neoplasm is referred to as (19). Conversely, a decrease in the
- _____ 17. size of an organ or tissue, resulting from loss of normal stimulation, is called (20).
- _____ 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.

26. 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 saclike 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
- _____ 12. 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

27. 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. Because you can expect that cells were ruptured in the injured area, what do you *think* was happening here?
28. 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.
29. 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?

30. 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?
31. 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?
32. Sarah, a trainee of the electron microscopist at the local hospital, is reviewing some micrographs of muscle cells and macrophages (phagocytic cells). She notices that the muscle cells are loaded with mitochondria while the macrophages have abundant lysosomes. Why is this so?
33. Bradley tripped and tore one of the tendons surrounding his ankle. In anguish with pain, he asked his doctor how quickly he could expect it to heal. What do you think the doctor's response was and why?
34. In normally circulating blood, the plasma proteins cannot leave the bloodstream easily and, thus, tend to remain in the blood. But if stasis (blood flow stoppage) occurs, the proteins will begin to leak out into the interstitial fluid. Explain why this leads to edema (water buildup in the tissues).



THE FINALE: MULTIPLE CHOICE

35. Select the best answer or answers from the choices given.

- A cell's plasma membrane would not contain:
 - phospholipid
 - nucleic acid
 - protein
 - cholesterol
 - glycolipid
 - Which of the following would you expect to find in or on cells whose main function is absorption?
 - Microvilli
 - Cilia
 - Desmosomes
 - Gap junctions
 - Secretory vesicles
 - Which cytoskeletal element interacts with myosin to produce contractile force in muscle cells?
 - Microtubules
 - Microfilaments
 - Intermediate filaments
 - None of the above
 - If a 10% sucrose solution within a semipermeable sac causes the fluid volume in the sac to increase a given amount when the sac is immersed in water, what would be the effect of replacing the sac solution with a 20% sucrose solution?
 - The sac would lose fluid.
 - The sac would gain the same amount of fluid.
 - The sac would gain more fluid.
 - There would be no effect.
 - Which of the following are possible functions of the glycocalyx?
 - Determination of blood groups
 - Binding sites for toxins
 - Aiding the binding of sperm to egg
 - Guiding embryonic development
 - Increasing the efficiency of absorption
 - A cell stimulated to increase steroid production will have:
 - abundant ribosomes
 - a rough ER
 - a smooth ER
 - a Golgi apparatus
 - abundant secretory vesicles
 - A cell's ability to replenish its ATP stores has been diminished by a metabolic poison. What organelle is most likely to be affected?
 - Nucleus
 - Plasma membrane
 - Centriole
 - Microtubule
 - Mitochondrion
 - The fundamental structure of the plasma membrane is determined almost exclusively by:
 - phospholipid molecules
 - peripheral proteins
 - cholesterol molecules
 - integral proteins
- 9–11. Consider the following information for Questions 9–11:
- A DNA segment has this nucleotide sequence:
- A A G C T C T T A C G A A T A T T C
- Which mRNA is complementary?
 - A A G C T C T T A C G A A T A T T C
 - T T C G A G A A T G C T T A T A A G
 - A A G C U C U U A C G A A U A U U C
 - U U C G A G A A U G C U U A U A A G

10. How many amino acids are coded in this segment?
- A. 18 C. 6
B. 9 D. 3
11. What is the tRNA anticodon sequence for the fourth codon from the left?
- A. G C. GCU
B. GC D. CGA
12. The organelle that consists of a stack of 3–10 membranous discs associated with vesicles is:
- A. mitochondrion
B. smooth ER
C. Golgi apparatus
D. lysosome
13. An epithelium “built” to stretch is:
- A. simple squamous
B. stratified squamous
C. simple cuboidal
D. pseudostratified
E. transitional
14. Which of the following fibrous elements give a connective tissue high tensile strength?
- A. Reticular fibers
B. Elastic fibers
C. Collagen fibers
D. Myofilaments
15. Viewed through the microscope, most cells in this type of tissue have only a rim of cytoplasm.
- A. Reticular connective
B. Adipose connective
C. Areolar connective
D. Osseous tissue
E. Hyaline cartilage
16. Which type of cartilage is most abundant throughout life?
- A. Elastic cartilage
B. Fibrocartilage
C. Hyaline cartilage
17. Which of the following terms describe skeletal muscle?
- A. Striated
B. Intercalated discs
C. Multinucleated
D. Voluntary
E. Branching
18. Events of tissue repair include:
- A. regeneration
B. organization
C. granulation
D. fibrosis
E. inflammation