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. Hydrogen
   2. Carbon
   3. Oxygen
   4. Nitrogen
   5. Oxygen
   6. Calcium
   7. Iron
   8. Reproduction
   9. Metabolism
   10. Excretion

1–4. Name the four elements that make up the bulk of living matter.

5. Name the single most abundant material or substance in living matter.

6. Name the trace element most important for making bones hard.

7. Name the element, found in small amounts in the body, that is needed to make hemoglobin for oxygen transport.

8–12. Although there are many specific "jobs" that certain cells are able to do, name five functions common to all cells.

   11. Growth
   12. Respond to stimuli
13. List three different cell shapes.

14. Name the fluid, similar to seawater, that surrounds and bathes all body cells.

15. 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.)

Anatomy of a Generalized Cell

2. Using the list of terms on the following page, 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.

![Cell Diagram](image-url)
3. Figure 3–2 is a diagram of a portion of a plasma membrane. Select three different colors and color the coding circles and the corresponding structures in the diagram. Then respond to the questions that follow, referring to Figure 3–2 and insert your answers in the answer blanks.

○ Phospholipid molecules  ○ Carbohydrate molecules  ○ Protein molecules

![Diagram of a plasma membrane]

**Figure 3–2**

1. Name the carbohydrate-rich area at the cell surface (indicated by bracket A). **Glycocalyx**

2. Which label, B or C, indicates the nonpolar region of a phospholipid molecule? **C**

3. Does nonpolar mean hydrophobic or hydrophilic? **Hydrophobic**

4. What are two roles of the membrane proteins? **Transport** and **Receptors**
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? **Absorptive Cell**

2. Which cell junction forms an impermeable barrier? **Tight Junction**

3. Which cell junction is an anchoring junction? **Desmosome**

4. Which junction has linker proteins spanning the intercellular space? **Desmosome**

5. Which cell junction is not illustrated, and what is its function? **Gap junctions**
   
   Function: to electrically couple cells.

   (q16)  p  68-69
5. Relative to cellular organelles, circle the term or phrase that does not belong in each of the following groupings.

1. Peroxisomes  Enzymatic breakdown  Centrioles  Lysosomes
2. Microtubules  Intermediate filaments  Cytoskeleton  Cilia
3. Ribosomes  Smooth ER  Rough ER  Protein synthesis
4. Mitochondrion  Cristae  ATP production  Vitamin A storage
5. Centrioles  Mitochondria  Glia  Flagella
6. ER  Nuclear pores  Ribosomes  Transport vesicles  Golgi apparatus
7. Nucleus  DNA  Lysosomes  Chromatin  Nucleolus

6. Name the cytoskeletal element (microtubules, microfilaments, or intermediate filaments) described by each of the following phrases.

1. Give the cell its shape
2. Resist tension placed on a cell
3. Radiate from the cell center
4. Involved in moving intracellular structures
5. Are the most stable
6. Have the thickest diameter

7. Different organelles are abundant in different cell types. Match the cell types with their abundant organelles by selecting a letter from the key choices.

Key Choices
A. Mitochondria  C. Rough ER  E. Microfilaments  G. Intermediate filaments
B. Smooth ER  D. Peroxisomes  F. Lysosomes  H. Golgi apparatus

1. Cell lining the small intestine (assembles fats)
2. White blood cell; a phagocyte
3. Liver cell that detoxifies carcinogens
4. Muscle cell (contractile cell)
5. Mucus-secreting cell (secretes a protein product)
6. Cell at external skin surface (withstands friction and tension)
7. Kidney tubule cell (makes and uses large amounts of ATP)
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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Water</td>
<td></td>
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</tbody>
</table>

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 hypotonic solution? A

The cells in this field are said to be [crenated (shrunken)]

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

What does isotonic mean? It means that the solution inside the cell has the same solute concentration as the solution outside of the cell.

3. Which microscopic field contains a hypertonic solution? C

What is happening to the cells in this field and why? [hemolysis]
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

Amino acid  P  Fat  O2

Cell exterior  Steroid  H2O  Na+  K+  Glucose

H2O  Cl–  CO2  ATP  ADP + P_i

A  A  B

Cell interior  O2  Na+  K+  Amino acid

CO2  Glucose

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? $\text{Fat, steroids (some), } H_2O \text{ (somewhat), } O_2$

2. Which of the substances shown enters the cell by attachment to a passive-transport protein carrier? $\text{Glucose, amino acids, } (C^+, K^+)$

3. Which of the substances shown moves passively through the membrane by moving through its pores? $H_2O, Cl^-, K^+$

4. Which of the substances shown would have to use a solute pump to be transported through the membrane? $\text{Na}^+(\text{Sodium})$

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
B. Diffusion, simple
C. Diffusion, osmosis
D. Exocytosis
E. Facilitated diffusion
F. Filtration
G. Phagocytosis
H. Pinocytosis
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
Cell Division

12. 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  
B. Amino acids  
C. Bases  
D. Codons  
E. Complementary  
F. Cytosine  
G. Enzymes  
H. Genes  
I. Growth  
J. Guanine  
K. Helix  
L. New  
M. Nucleotides  
N. Old  
O. Phosphate  
P. Proteins  
Q. Replication  
R. Repair  
S. Ribosome  
T. Sugar (deoxyribose)  
U. Template, or model  
V. Thymine  
W. Transcription  
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)__.

2. 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.
13. Identify the phases of mitosis depicted in Figure 3-7 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.

- Nuclear membrane(s), if present
- Nucleoli, if present
- Chromosomes
- Centrioles
- Spindle fibers

Figure 3-7
14. The following statements describe events that occur during the different phases of mitosis. Identify the phase by choosing the correct response(s) from the key choices and inserting the letter(s) or term(s) in the answer blanks.

**Key Choices**

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

1. Chromatin coils and condenses to form deeply staining bodies.  
   **C**

2. Centromeres break, and chromosomes begin migration toward opposite poles of the cell.  
   **A**

3. The nuclear membrane and nucleoli reappear.  
   **D**

4. When chromosomes cease their poleward movement, this phase begins.  
   **B**

5. Chromosomes align on the equator of the spindle.  
   **C**

6. The nucleoli and nuclear membrane disappear.  
   **C**

7. The spindle forms through the migration of the centrioles.  
   **C**

8. Chromosomal material replicates.  
   **C**

9. Chromosomes first appear to be duplex structures.  
   **C**

10. Chromosomes attach to the spindle fibers.  
    **D**

11. A cleavage furrow forms during this phase.  
    **A, B**

12. The nuclear membrane is absent during the entire phase.  
    **E**

13. A cell carries out its usual metabolic activities.

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

   **Chromosomes**

1. Division of the _**(1)**_ is referred to as mitosis. Cytokinesis is the 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 scaffold for chromosomal attachment and movement is called the _**(6)**_, _**(7)**_ is the period of cell life when the cell is not involved in division.

   **Cytoplasm**

2.

   **condensed**

3.

   **centrioles**

4.

   **Microtubule**

5.

   **Interphase**

6.
Protein Synthesis

16. Figure 3–8 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 3–8, inserting your answers in the answer blanks.

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

Figure 3–8

1. Transfer of the genetic message from DNA to mRNA is called \underline{Transcription}.

2. Assembly of amino acids according to the genetic information carried by mRNA is called \underline{Translation}.

3. The set of three nitrogen bases on tRNA that is complementary to an mRNA codon is called a \underline{anticodon}. The complementary three-base sequence on DNA is called a \underline{triplet}.
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!)

![Diagram of tissue types](image)

**Figure 3-9, A-F**
18. Describe briefly how the particular structure of a neuron relates to its function in the body. A neuron contains dendrites that receive information and axons that transmit information to other neurons, muscles and glands.
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

B. Forms mucous, serous, and epidermal membranes  
C. Allows for organ movements within the body  
D. Transmits electrochemical impulses  
A. Supports body organs  
B. Cells of this tissue may absorb and/or secrete substances  
C. Basis of the major controlling system of the body  
D. The cells of this tissue shorten to exert force  
A. Forms hormones  
B. Packages and protects body organs  
C. Characterized by having large amounts of nonliving matrix  
D. Allows you to smile, grasp, swim, ski, and shoot an arrow  
C. Most widely distributed tissue type in the body  
D. 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)  
B. Simple columnar  
C. Simple cuboidal  
D. Simple squamous  
E. Stratified squamous  
F. Transitional

E. Lines the esophagus and forms the skin epidermis  
B. Forms the lining of the stomach and small intestine  
E. Best suited for areas subjected to friction  
A. Lines much of the respiratory tract  
A. Propels substances (e.g., mucus) across its surface  
F. Found in the bladder lining; peculiar cells that slide over one another  
D. 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.

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

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  Ossous  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  
B. Areolar connective tissue  
C. Dense fibrous connective tissue  
D. Osseous tissue  
E. Reticular connective 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.

**Inflammation**  
1. The nonspecific response of the body to injury is called regeneration.

**Clotting factors**  
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.

**Granulation**  
3. During the first phase of tissue repair, capillary buds invade the clot, forming a delicate pink tissue called endodermal tissue.

**Regeneration**  
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 _____.

2. Mitotic cell division is very important for overall body _____.

3. All tissues except _____. tissue continue to undergo cell division until the end of adolescence. After this time, _____. tissue also becomes amitotic. When amitotic tissues are damaged, they are replaced by _____. tissue, which does not function in the same way as the original tissue. This is a serious problem when heart cells are damaged.

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

11. Neoplasms occur when cells “go wild” and the normal controls of cell _____. are lost. The two types of neoplasms are _____. and _____. The _____. type tends to stay localized and have a capsule. The _____. 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 _____. is usually done. Whenever possible, _____. is the treatment of choice for neoplasms.

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

19. _____.

20. _____.