CHAPTER

# 3 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.

_____ 2.

_____ 3.

_____ 4.

_____ 5.

_____ 6.

_____ 7.

_____ 8.

_____ 9.

_____ 10.

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.

_____ 12. →

_____ 13.

_____ 14.

_____ 15.

_____ 16.

_____ 17.

13–15. List three different cell shapes.

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

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.)

## 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.

- ◯ Plasma membrane
- ◯ Centriole(s)
- ◯ Chromatin thread(s)
- ◯ Golgi apparatus
- ◯ Microvilli
- ◯ Mitochondrion
- ◯ Nuclear membrane
- ◯ Nucleolus
- ◯ Rough endoplasmic reticulum (ER)
- ◯ Smooth endoplasmic reticulum (ER)

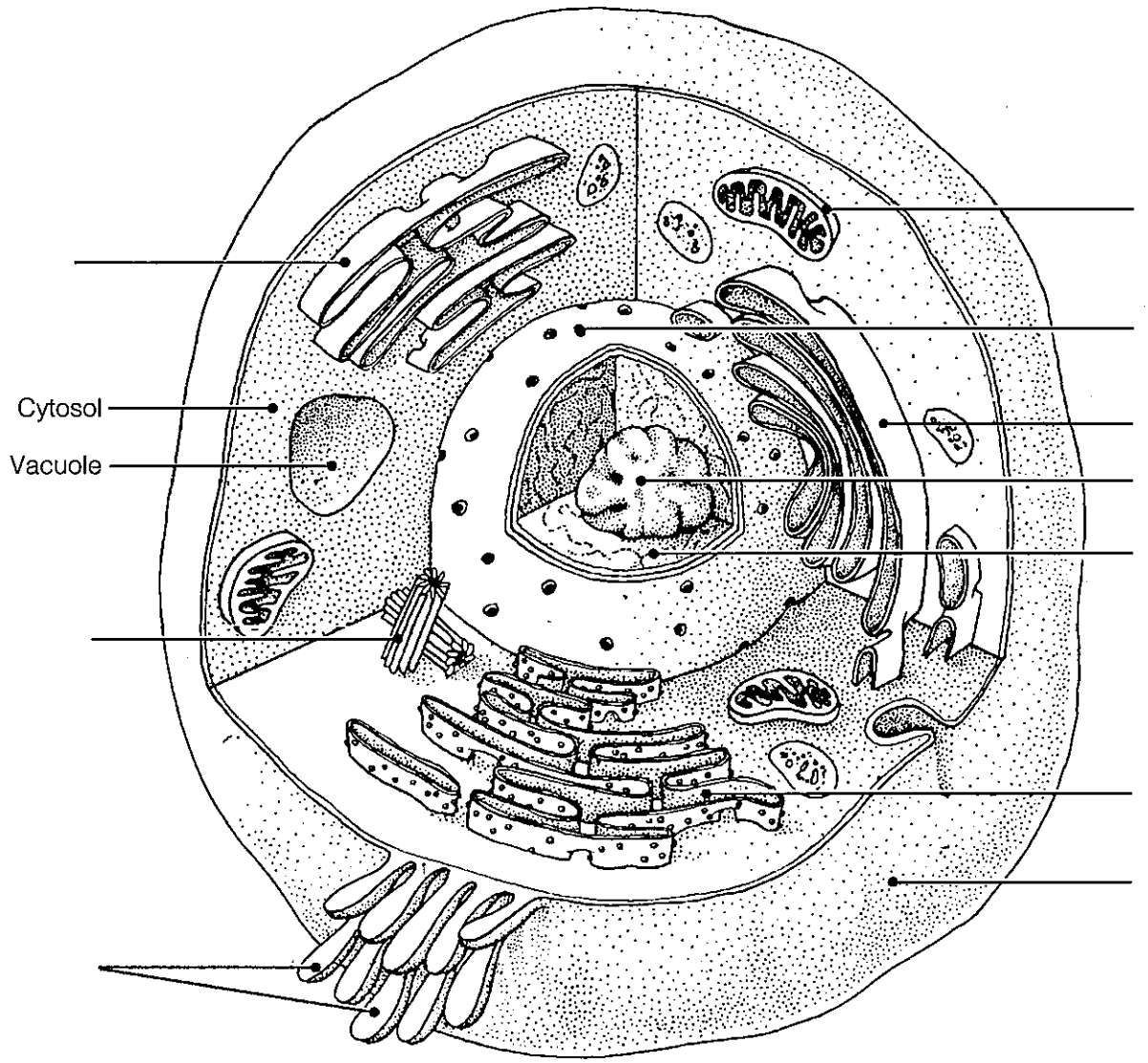



**Figure 3–1**

# 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 _____

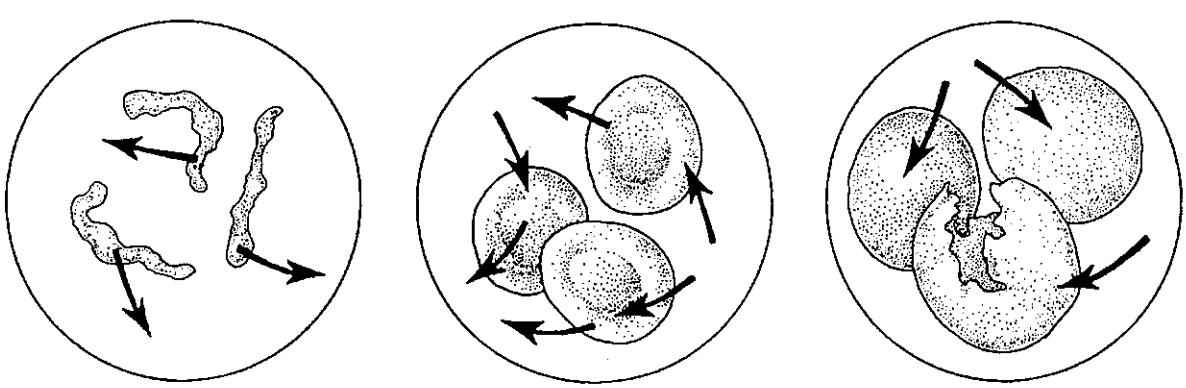
2. Which microscopic field contains an isotonic bathing solution? _____

   What does *isotonic* mean? _____

   _____

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

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



A B C

**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
B. Diffusion, osmosis
C. Endocytosis
D. Exocytosis
E. Filtration
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

_____ 11. Includes phagocytosis, pinocytosis, and a receptor-mediated form.

**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 _____.

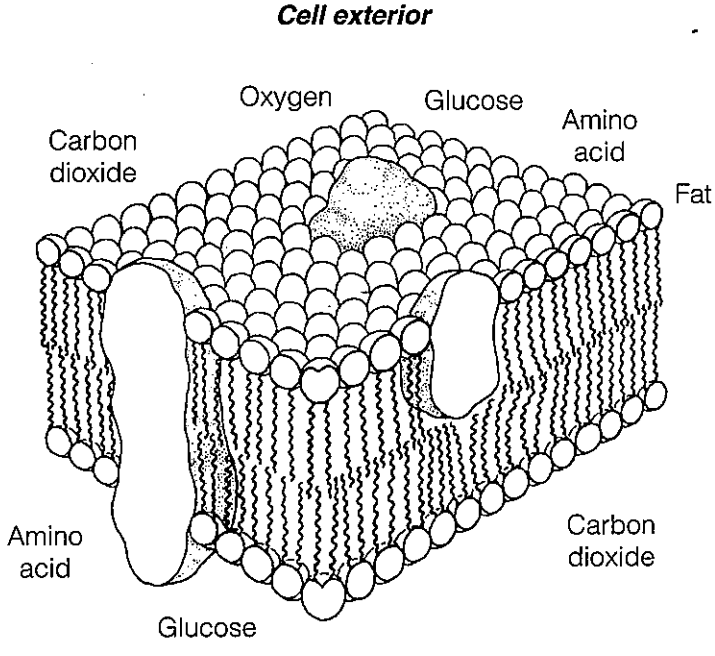



**Figure 3–3**

## *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 |

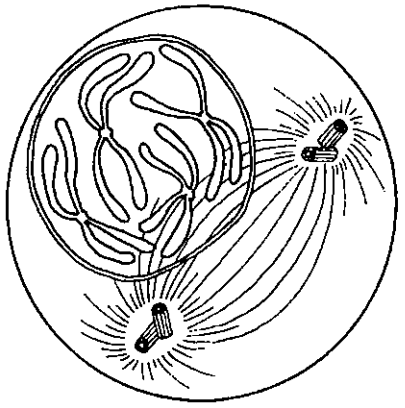
_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.
_____ 9.
_____ 10.
_____ 11.
_____ 12.
_____ 13.
_____ 14.
_____ 15.
_____ 16.
_____ 17.
_____ 18.

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)__.

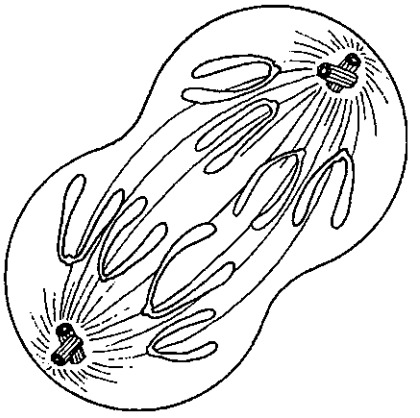
The production of proteins involves the cooperation of DNA and RNA. RNA is another type of nucleic acid that serves as a "molecular slave" to DNA. That is, it leaves the nucleus and carries out the instructions of the DNA for the building of a protein on a cytoplasmic structure called a __(10)__. When 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.

**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.

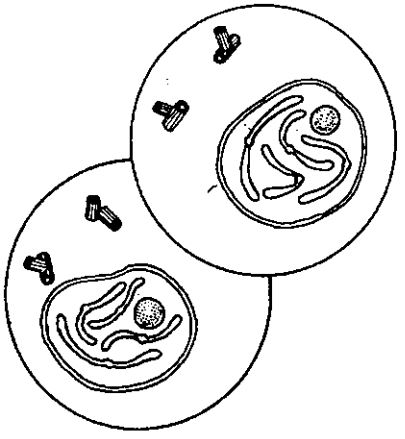
- ◯ Nuclear membrane(s), if present
- ◯ Nucleoli, if present
- ◯ Chromosomes
- ◯ Centrioles
- ◯ Spindle fibers



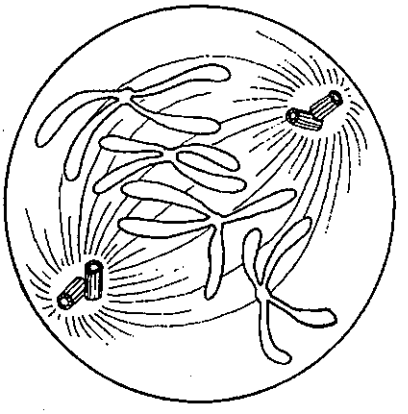
**A** _____



**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.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.

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.

## *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

◯ Backbone of the mRNA strands

◯ tRNA molecules

◯ Amino acid molecules

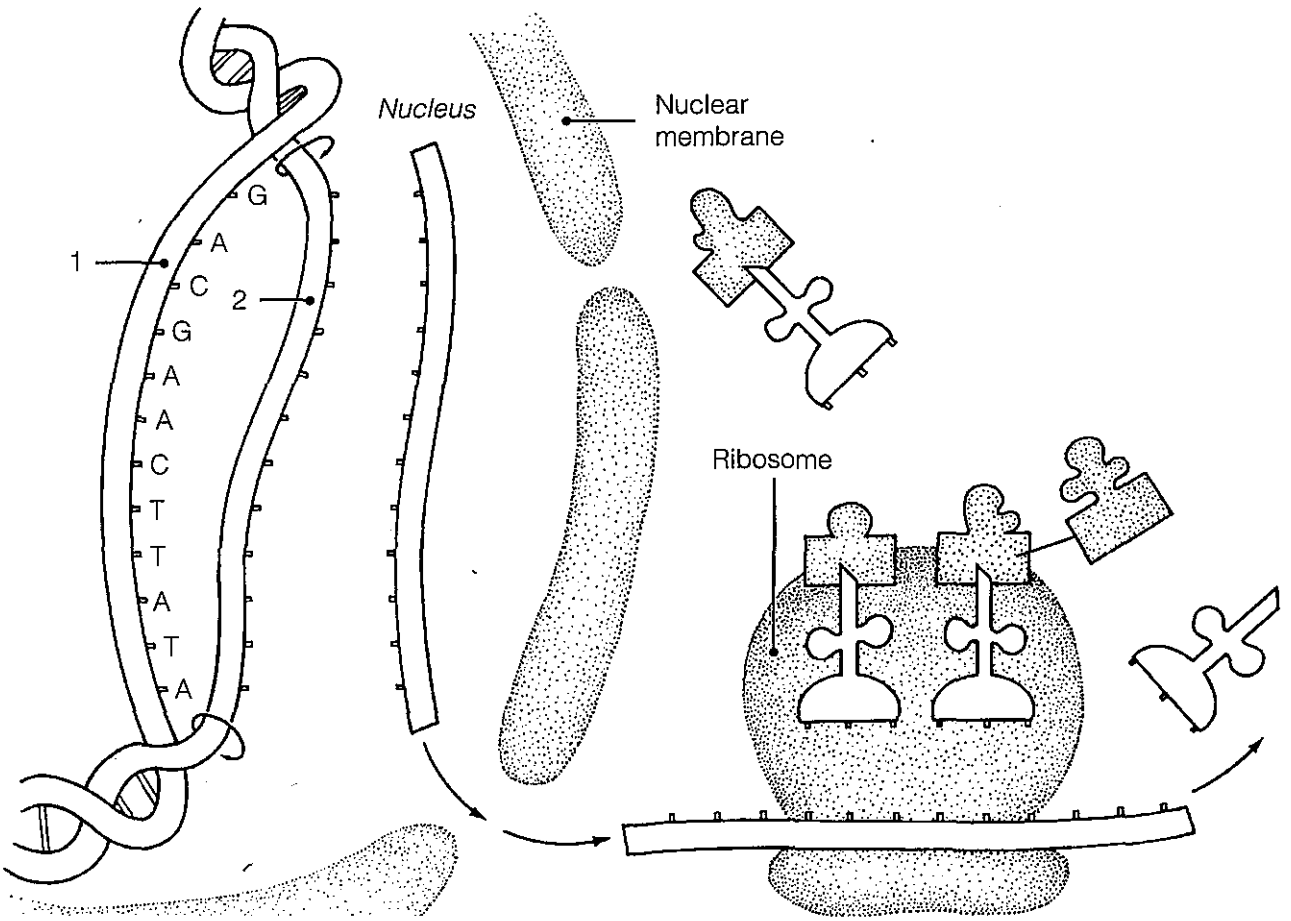



**Figure 3–5**

1. Transfer of the genetic message from DNA to mRNA is called _____.

2. Assembly of amino acids according to the genetic information carried by mRNA is called _____.

3. 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 _____.