In the human body, as in any multicellular body, every cell has the ability to perform all activities necessary to remain healthy and alive. In the multicellular body, however, the individual cells are no longer independent. Instead, they aggregate, forming cell communities made of cells similar to one another in form and function. Once specialized, each community is committed to performing a specific activity that helps to maintain homeostasis and serves the body as a whole.

Fully differentiated cell communities are called tissue (from *tissu*, meaning “woven”). Tissues, in turn, are organized into functional units called organs (such as the heart and brain). Because individual tissues are unique in cellular shape and structure, they are readily recognized and are often named for the organ of origin—for example, muscle tissue and nervous tissue.

Student activities in Chapter 4 include questions relating to the structure and function of tissues, membranes, glands and glandular tissue, tissue repair, and the developmental aspects of tissues.

---

**BUILDING THE FRAMEWORK**

---

**Overview of Body Tissues**

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

<table>
<thead>
<tr>
<th></th>
<th>Columnar</th>
<th>Areolar</th>
<th>Cuboidal</th>
<th>Squamous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Collagen</th>
<th>Cell</th>
<th>Matrix</th>
<th>Cell product</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cilia</th>
<th>Flagellum</th>
<th>Microvilli</th>
<th>Elastic fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Glands</th>
<th>Bones</th>
<th>Epidermis</th>
<th>Mucosae</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Adipose</th>
<th>Hyaline</th>
<th>Osseous</th>
<th>Nervous</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Blood</th>
<th>Smooth</th>
<th>Cardiac</th>
<th>Skeletal</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Polarity</th>
<th>Cell-to-cell junctions</th>
<th>Regeneration possible</th>
<th>Vascular</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Matrix</th>
<th>Connective tissue</th>
<th>Collagen</th>
<th>Keratin</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cartilage</th>
<th>GAGs</th>
<th>Vascular</th>
<th>Water retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Twelve tissue types are diagrammed in Figure 4.1. Identify each tissue type by inserting the correct name in the blank below each 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 4.1
3. For 1–5, match the epithelial type named in Column B with the appropriate location in Column A.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lines the stomach and most of the intestines</td>
<td>A. Pseudostratified ciliated columnar</td>
</tr>
<tr>
<td>2. Lines the inside of the mouth</td>
<td>B. Simple columnar</td>
</tr>
<tr>
<td>3. Lines much of the respiratory tract</td>
<td>C. Simple cuboidal</td>
</tr>
<tr>
<td>4. Endothelium and mesothelium</td>
<td>D. Simple squamous</td>
</tr>
<tr>
<td>5. Lines the inside of the urinary bladder</td>
<td>E. Stratified columnar</td>
</tr>
<tr>
<td></td>
<td>F. Stratified squamous</td>
</tr>
<tr>
<td></td>
<td>G. Transitional</td>
</tr>
</tbody>
</table>

For 6–10, match the epithelium named in Column B with the appropriate function in Column A.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Protection</td>
<td>H. Endothelium</td>
</tr>
<tr>
<td>7. Small molecules pass through rapidly</td>
<td>I. Simple columnar</td>
</tr>
<tr>
<td>8. Propel sheets of mucus</td>
<td>J. A ciliated epithelium</td>
</tr>
<tr>
<td>9. Absorption, secretion, or ion transport</td>
<td>K. Stratified squamous</td>
</tr>
<tr>
<td>10. Stretches</td>
<td>L. Transitional</td>
</tr>
</tbody>
</table>

4. Arrange the following types of epithelium from 1 to 5 in order of increasing protectiveness.

- A. Simple squamous
- B. Stratified squamous
- C. Simple cuboidal
- D. Pseudostratified
- E. Simple columnar

5. Arrange the following types of epithelium from 1 to 4 in order of increasing absorptive ability.

- A. Simple squamous
- B. Stratified squamous
- C. Simple cuboidal
- D. Simple columnar
10. Complete the following statements by filling in the appropriate answers.

1. Endocrine and exocrine glands are formed from (1) tissue. Unicellular exocrine glands called (2) are found in the intestinal mucosa, where they secrete (3), a lubricating, water-soluble glycoprotein. Multicellular glands are composed of three structures: (4), (5), and (6). Exocrine glands classified as compound tubular are glands with (7) ducts and with secretory cells located in (8) secretory units.

8. Connective Tissue

1. Using the key choices, identify the following connective tissue types. Insert the appropriate answers in the answer blanks.

**KEY CHOICES**

A. Adipose connective tissue  G. Fibrocartilage
B. Areolar connective tissue  H. Hyaline cartilage
C. Dense regular connective  I. Mucous connective
D. Dense irregular connective  J. Osseous tissue
E. Elastic cartilage  K. Reticular connective tissue
F. Elastic connective tissue  L. Vascular tissue

1. Parallel bundles of collagenic fibers provide strength; found in tendons

2. Stores fat

3. The skin dermis

4. Hardest tissue of our “skull cap”

5. Composes the basement membrane; surrounds and cushions blood vessels and nerves; its gel-like matrix contains all categories of fibers and many cell types

6. Forms the embryonic skeleton; covers surfaces of bones at joints; reinforces the trachea
7. Insulates the body

8. Firm, slightly “rubbery” matrix; milky white and “glassy” in appearance

9. Cells are arranged in concentric circles around a nutrient canal; matrix is hard due to calcium salts

10. Contains collagenous fibers; found in intervertebral discs

11. Makes supporting framework of lymphoid organs

12. Found in umbilical cord

13. Found in external ear and auditory tube

14. Provides the medium for nutrient transport throughout the body

15. Forms the “stretchy” ligaments of the vertebral column

2. Areolar connective tissue is often considered to be the prototype of connective tissue proper because of its variety of cell types and fibers. Figure 4.2 shows most of these elements. Identify all structures or cell types provided with leader lines. Color the diagram as your fancy strikes you.

![Diagram of tissue structures](Figure 4.3)
3. Arrange the following tissue types from 1 to 3 in order of decreasing vascularity.
   ___ A. Cartilage
   ___ B. Areolar connective
   ___ C. Dense connective

4. Using the key choices, select the structural or related elements of connective tissue (CT) types that permit specialized functions. Insert the appropriate answers in the answer blanks.

**KEY CHOICES**

A. Adipocytes  D. Elastic fibers  G. Macrophages  J. Osteocytes
B. Chondrocytes  E. Ground substance  H. Matrix  K. Osteoblasts
C. Collagen fibers  F. Hemocytoblast  I. Mesenchyme  L. Reticular fibers

1. Composed of ground substance and structural protein fibers
2. Composed of glycoproteins and water-binding glycosaminoglycans
3. Tough protein fibers that resist stretching or longitudinal tearing
4. Primary bone marrow cell type that remains actively mitotic
5. Fine, branching protein fibers that construct a supportive network
6. Large, irregularly shaped cells, widely distributed, often found in CT; they engulf cellular debris and foreign matter and are active in immunity
7. The medium through which nutrients and other substances diffuse
8. Living elements that maintain the firm, flexible matrix in cartilage
9. Randomly coiled protein fibers that recoil after being stretched
10. The structural element of areolar tissue that is fluid and provides a reservoir of water and salts for neighboring tissues
11. In a loose CT, the nondividing cells that store nutrients
12. The embryonic tissue that gives rise to all types of CT
13. Cellular elements that produce the collagen fibers of bone matrix
Nervous Tissue

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

2. Circle the word that does not apply to neuroglia:
   Support  Insulate  Conduct  Protect

Tissue Repair

1. 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 word(s) by writing the correct word(s) 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 organization, the first phase of tissue repair, capillary buds invade the clot, forming a delicate pink tissue called endodermal tissue.

   4. Fibroblasts synthesize fibers across the gap.

   5. 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.

   6. If tissue damage is very severe, tissue repair is more likely to occur by fibrosis, or scarring.

   7. During fibrosis, fibroblasts in the granulation tissue lay down keratin fibers, which form a strong, compact, but inflexible mass.

   8. The repair of cardiac muscle and nervous tissue occurs only by fibrosis.

   9. Organization is replacement of a blood clot by granulation tissue.

   10. Granulation tissue resists infection by secreting virus-inhibiting substances.

   11. Problems associated with regeneration include shrinking, loss of elasticity, and formation of adhesions.
5. Using the key choices, choose all responses that apply to the following
descriptions. Enter the appropriate letters and/or terms in the answer blanks.
(Note: S. = stratum)

**KEY CHOICES**

A. S. basale  
B. S. corneum  
C. S. granulosum  
D. S. lucidum  
E. S. spinosum  
F. Papillary layer  
G. Reticular layer  
H. Epidermis (as a whole)  
I. Dermis (as a whole)  
J. Hypodermis

_________  1. Layer of translucent cells, absent in thin skin
_________  2. Strata containing all (or mostly) dead cells
_________  3. Dermal layer responsible for fingerprints
_________  4. Vascular region
_________  5. Actively mitotic epidermal region, the deepest epidermal layer
_________  6. Shinglcelike cells that slough off; the basis of “dandruff”
_________  7. Site of elastic and collagen fibers
_________  8. General site of melanin formation
_________  9. Major skin area where derivatives (hair, nails) reside
_________ 10. Largely adipose tissue; anchors the skin to underlying tissues
_________ 11. The stratum germinativum
_________ 12. Epidermal layer where most melanocytes are found
_________ 13. Cells of this layer contain keratohyalin and lamellated granules
_________ 14. Accounts for the bulk of epidermal thickness
_________ 15. When tanned, becomes leather; provides mechanical strength to the skin
_________ 16. Epidermal layer containing the “oldest” cells

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

1. Reticular layer  Keratin  Dermal papillae  Meissner’s corpuscles
2. Melanin  Freckle  Wart  Malignant melanoma
3. Prickle cells  Stratum basale  Stratum spinosum  Cell shrinkage
4. Langerhans’ cells  Epidermal dendritic cells  Keratinocytes  Macrophages
5. Meissner’s corpuscles  Pacinian corpuscles  Merkel cells  Arrector pili
6. Waterproof substance  Elastin  Lamellated granules  Produced by keratinocytes
7. Mast cells  Macrophages  Fibroblasts  Melanocytes
8. Intermediate filaments  Keratin fibrils  Keratoxyline  Lamellated granules
9. Keratinocyte  Fibroblast  Merkel cell  Langerhans’ cell

7. This exercise examines the relative importance of three pigments in determining skin color. Indicate which pigment is identified by the following descriptions by inserting the appropriate answer from the key choices in the answer blanks.

**KEY CHOICES**

A. Carotene  
B. Hemoglobin  
C. Melanin

1. Most responsible for the skin color of dark-skinned people  
2. Provides an orange cast to the skin  
3. Provides a natural sunscreen  
4. Most responsible for the skin color of Caucasians  
5. Phagocytized by keratinocytes  
6. Found predominantly in the stratum corneum  
7. Found within red blood cells in the blood vessels

8. Abnormalities of skin color can be helpful in alerting a physician to certain pathologies. Match the clinical terms in Column B with the possible-cause descriptions in Column A. Place the correct letter in each answer blank.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A bluish cast of the skin resulting from inadequate oxygenation of the blood</td>
<td>A. Cyanosis</td>
</tr>
<tr>
<td>2. Observation of this condition might lead to tests for anemia or low blood pressure</td>
<td>B. Erythema</td>
</tr>
<tr>
<td>3. Accumulation of bile pigments in the blood; may indicate liver disease</td>
<td>C. Hematoma</td>
</tr>
<tr>
<td>4. Clotted mass of blood that may signify bleeder’s disease</td>
<td>D. Jaundice</td>
</tr>
<tr>
<td>5. A common result of inflammation, allergy, and fever</td>
<td>E. Pallor</td>
</tr>
</tbody>
</table>
Developmental Aspects of the Integumentary System

1. Match the choices in Column B with the appropriate descriptions in Column A.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Skin inflammations that increase in frequency with age</td>
<td>A. Acne</td>
</tr>
<tr>
<td>2. Cause of graying hair</td>
<td>B. Cold intolerance</td>
</tr>
<tr>
<td>3. Small white bumps on the skin of newborn babies, resulting from accumulations of sebaceous gland material</td>
<td>C. Dermatitis</td>
</tr>
<tr>
<td>4. Reflects the loss of insulating subcutaneous tissue with age</td>
<td>D. Delayed action gene</td>
</tr>
<tr>
<td>5. A common consequence of accelerated sebaceous gland activity during adolescence</td>
<td>E. Lanugo</td>
</tr>
<tr>
<td>6. Oily substance produced by the fetus's sebaceous glands</td>
<td>F. Milia</td>
</tr>
<tr>
<td>7. The hairy &quot;cloak&quot; of the fetus</td>
<td>G. Vernix caseosa</td>
</tr>
</tbody>
</table>

The Incredible Journey: A Visualization Exercise for the Skin

Your immediate surroundings resemble huge, grotesquely twisted vines...you begin to climb upward.

1. Complete the narrative by inserting the missing words in the answer blanks.

For this trip, you are miniaturized for injection into your host's skin. Your journey begins when you are injected into a soft gel-like substance. Your immediate surroundings resemble huge, grotesquely twisted vines. But when you peer carefully at the closest "vine," you realize you are actually seeing connective tissue fibers. Most of the fibers are fairly straight, although tangled together, and look like strong cables. You identify these as the *(1)* fibers. Here and there are fibers that resemble coiled springs. These must be the *(2)* fibers.
3. that help give skin its springiness. At this point, there is little question that you are in the (3) region of the skin particularly since you can also see blood vessels and nerve fibers around you.

4. Carefully, using the fibers as steps, you begin to climb upward. After climbing for some time and finding that you still haven't reached the upper regions of the skin, you stop for a rest. As you sit, a strange-looking cell approaches, moving slowly with parts alternately flowing forward and then receding. Suddenly you realize that this must be a (4) that is about to dispose of an intruder (you) unless you move in a hurry! You scramble to your feet and resume your upward climb. On your right is a large fibrous structure that looks like a tree trunk anchored in place by muscle fibers. By scurrying up this (5) sheath, you are able to escape from the cell and again scan your surroundings. Directly overhead are tall cubelike cells, forming a continuous sheetlike membrane. In your rush to escape you reached the (6) region of the skin. As you watch the activity of the cells in this layer, you notice that many of the cells are pinching in two and that the daughter cells are being forced upward. Obviously, this is the specific layer that continually replaces cells that rub off the skin surface, and these cells are the (7) cells.

Looking through the transparent cell membrane of one of the basal cells, you see a dark mass hanging over the nucleus. You wonder if this cell could have a tumor; but then, looking through the membranes of the neighboring cells, you find that they also have dark umbrella-like masses hanging over their nuclei. As you consider this matter, a black cell with long tentacles begins to pick its way carefully between the other cells. As you watch, one of the transparent cells engulfs the end of a tentacle of the black cell, and within seconds contains some of its black substance. Suddenly, you remember that one of the skin's protective functions is to protect the deeper layers from sun damage; the black substance must be the protective pigment (8).

Once again you begin your upward climb and notice that the cells are becoming shorter and harder and are full of a tough, waxy substance. This substance has to be (9), which would account for the increasing hardness of the cells. Climbing still higher, the cells become flattened like huge shingles. The only material apparent in the cells is the waxy substance; there is no nucleus, and there appears to be no activity in these cells. Considering the clues—shinglelike cells, no nuclei, full of the waxy substance, no activity—these cells are obviously (10) and therefore are very close to the skin surface.

Suddenly, you feel a strong agitation in your immediate area. The pressure is tremendous. Looking upward through the transparent cell layers, you see your host's fingertips vigorously scratching the area directly overhead. You wonder if you are causing his skin to sting or tickle. Then, within seconds, the cells around you begin to separate and fall apart, and you are catapulted out into the sunlight. Since the scratching fingers might descend once again, you quickly advise your host of your whereabouts.
At the Clinic — Honors

1. Xeroderma pigmentosum is a severe, genetically linked skin cancer in which DNA repair mechanisms are impaired. Why would sufferers of this condition need to stay out of the sun?

2. A new mother brings her infant to the clinic, worried about a yellowish, scummy deposit that has built up on the baby's scalp. What is this condition called, and is it serious?

3. During a diaper change, an alert day care worker notices a dark, bruised-looking area at the base of a baby's spine. Worried about possible child abuse, she reports the spot to her supervisor, who tells her not to worry because it is a Mongolian spot. What is a Mongolian spot?

4. Hives are welts, or reddened "bumps," that indicate sites of local inflammation. They are often a sign of an allergic reaction. Recall from Chapter 3 the role of capillary permeability and plasma loss in causing edema. Would systemic hives be cause for worry?

5. A worker in a furniture refinishing establishment fell into a vat of paint stripper, but quickly removed his clothes and rinsed off in the safety shower. Were his safety measures adequate? What vital organs might suffer early damage from poisoning through skin by organic solvents?
6. What two factors in the treatment of critical third-degree burn patients are absolutely essential?

7. Mr. Bellazono, a fisherman in his late 60s, comes to the clinic to complain of small ulcers on both forearms as well as on his face and ears. Although he has had them for several years, he has not had any other problems. What is the likely diagnosis, and what is the likely cause?

8. The hypodermis of the face is quite loose and has few connections to the deep fascia of the muscles. Explain how this relates to the greater need to suture cuts on the face compared to other body regions.

9. Martha, the mother of a 13-month-old infant, brings her child to the clinic because his skin has turned orange. Why does the pediatrician inquire about the child’s diet?

10. Mrs. Ibañez volunteered to help at a hospital for children with cancer. When she first entered the cancer ward, she was upset by the fact that most of the children had no hair. What is the explanation for their baldness?

Stop and Think

1. How can the skin be both a membrane and an organ?

2. Why does the border between the epidermis and the dermis undulate?

3. The skin covering your shins is not freely movable. Palpate (feel) your shins and compare that region to the other regions of the body. Then try to deduce why there is little free movement of the skin of the shins.
4. In terms of both function and benefit, why are surface keratinocytes dead?

5. What nerve endings in the skin respond to the lightest touch?

6. Soon after her baby was born, Mrs. Jackson realized that something was wrong with the infant’s skin. Holding the child caused blisters to form. The blisters broke, became infected, scarred, and eventually the child’s fingers fused together. What hereditary disease did the child have? (Hint: see Clinical Terms)

7. Why does sunburned skin peel in sheets?

8. Explain each of these familiar phenomena in terms of what you learned in this chapter:
   - pimples and blackheads
   - goose bumps
   - greasy hair and shiny nose
   - stretch marks from gaining weight
   - turning blue from holding your breath
   - leaving fingerprints
   - pores on the face
   - the almost hairless body of humans
   - blisters
   - bruises

9. Would increasing protein intake (such as by taking gelatin supplements) increase hair and nail strength in an otherwise healthy individual?

10. Studies have shown that women who live or work together tend to develop synchronized monthly cycles. What aspect of the integumentary system might explain this sexual signaling?

11. If our cells and body fluids are hyperosmotic to the water of a swimming pool (and they are), then why do we not swell and pop when we go for a swim?