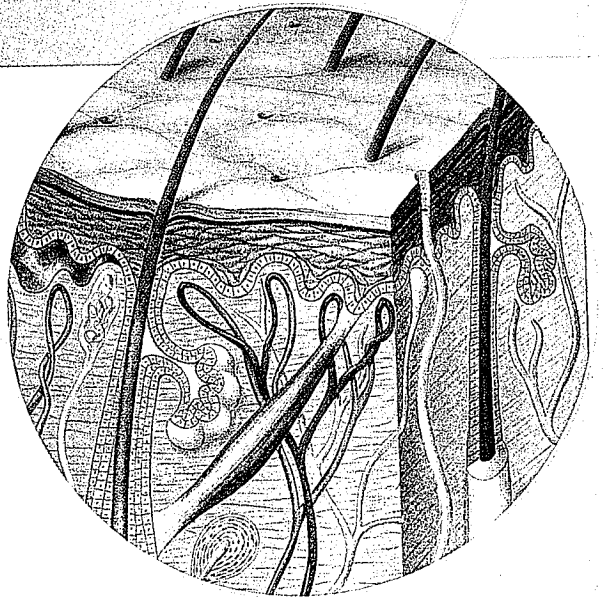


4

The Integumentary System and Body Membranes





CLASSIFICATION OF BODY MEMBRANES, 78

Epithelial Membranes, 78

Connective Tissue Membranes, 80

THE SKIN, 80

Structure of the Skin, 80

Appendages of the Skin, 83

Functions of the Skin, 87

Burns, 89

AFTER YOU HAVE COMPLETED THIS CHAPTER, YOU SHOULD BE ABLE TO:

1. Classify, compare the structure of, and give examples of each type of body membrane.
2. Describe the structure and function of the epidermis and dermis.
3. List and briefly describe each accessory organ of the skin.
4. List and discuss the three primary functions of the integumentary system.
5. Classify burns and describe how to estimate the extent of a burn injury.

In *Chapter 1* the concept of progressive organization of body structures from simple to complex was established. Complexity in body structure and function progresses from cells to tissues and then to organs and organ systems. This chapter discusses the skin and its **appendages**—the hair, the nails, and the skin glands—as an organ system. This system is called the **integumentary system**. **Integument** (in-TEG-yoo-ment) is another name for the skin, and the skin itself is the principal organ of the integumen-

tary system. The skin is one of a group of anatomically simple but functionally important sheetlike structures called **membranes**. This chapter will begin with classification and discussion of the important body membranes. Study of the structure and function of the integument will follow. Ideally, you should study the skin and its appendages before proceeding to the more traditional organ systems in the chapters that follow to improve your understanding of how structure is related to function.

CLASSIFICATION OF BODY MEMBRANES

The term *membrane* refers to a thin, sheetlike structure that may have many important functions in the body. Membranes cover and protect the body surface, line body cavities, and cover the inner surfaces of the hollow organs such as the digestive, reproductive, and respiratory passages. Some membranes anchor organs to each other or to bones, and others cover the internal organs. In certain areas of the body, membranes secrete lubricating fluids that reduce friction during organ movements such as the beating of the heart or lung expansion and contraction. Membrane lubricants also decrease friction between bones in joints. There are two major categories or types of body membranes:

1. **Epithelial membranes**, composed of epithelial tissue and an underlying layer of specialized connective tissue
2. **Connective tissue membranes**, composed exclusively of various types of connective tissue; no epithelial cells are present in this type of membrane

Epithelial Membranes

There are three types of epithelial tissue membranes in the body:

1. Cutaneous membrane
2. Serous membranes
3. Mucous membranes

CUTANEOUS MEMBRANE

The **cutaneous** (kyoo-TAY-nee-us) **membrane** or **skin** is the primary organ of the integumentary system. It is one of the most important and certainly one of the largest and most visible organs. In most individuals the skin composes some 16% of the body weight. It fulfills the requirements necessary for an epithelial tissue membrane in that it has a superficial layer of epithelial cells and an underlying layer of supportive connective tissue. Its structure is uniquely suited to its many functions. The skin will be discussed in depth later in the chapter.

SEROUS MEMBRANES

Like all epithelial membranes, a **serous** (SE-rus) **membrane** is composed of two distinct layers of tissue. The epithelial sheet is a thin layer of simple squamous epithelium. The connective tissue layer forms a very thin, gluelike **basement membrane** that holds and supports the epithelial cells.

The serous membrane that lines body cavities and covers the surfaces of organs in those cavities is in reality a single, continuous sheet of tissue covering two different surfaces. The name of the serous membrane is determined by its location. Using this criterion results in two types of serous membranes; the first type lines body cavities, and the second type covers the organs in those cavities. The serous membrane, which lines the walls of a body cavity much like wallpaper covers the walls of a room, is called the **parietal** (pah-RYE-i-tal) **portion**. The other type of serous membrane, which covers the surface of organs found in body cavities, is called the **visceral** (VIS-er-al) **portion**.

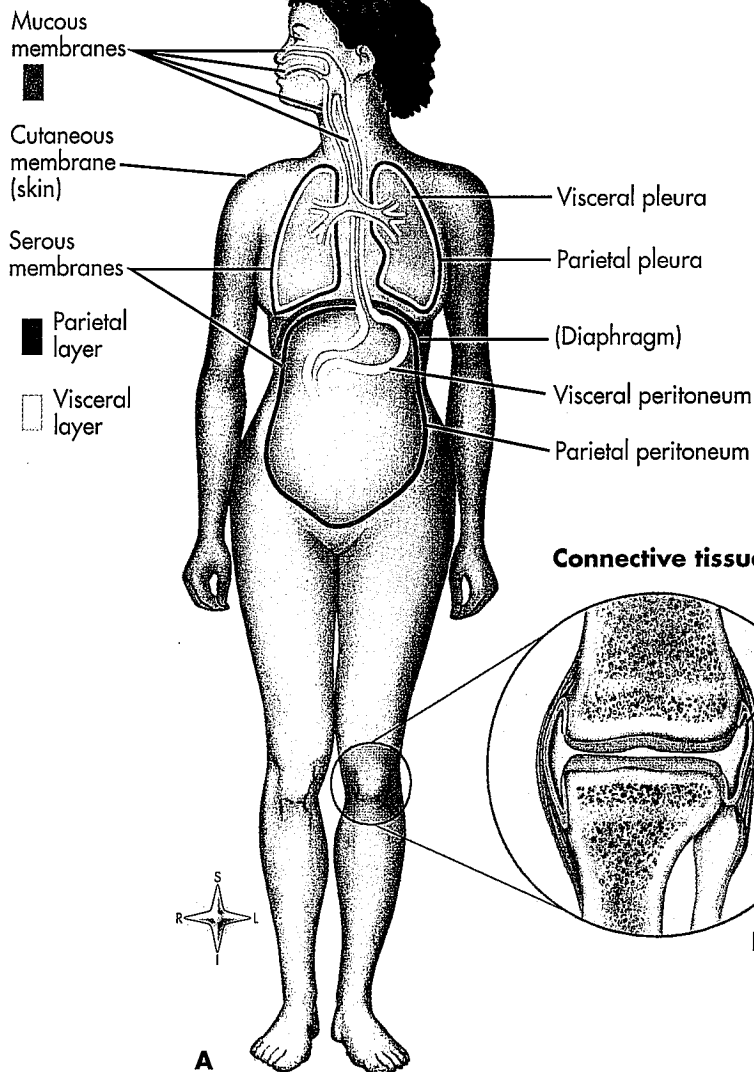
The serous membranes of the thoracic and abdominal cavities are identified in Figure 4-1. In the thoracic cavity the serous membranes are called **pleura** (PLOOR-ah), and in the abdominal cavity, they are called **peritoneum** (pair-i-toe-NEE-um). Look again at Figure 4-1 to note the placement of the **parietal** and **visceral pleura** and the **parietal** and **visceral peritoneum**. In both cases the parietal layer forms the lining of the body cavity, and the visceral layer covers the organs found in that cavity.

Serous membranes secrete a thin, watery fluid that helps reduce friction and serves as a lubricant when organs rub against one another and against the walls of the cavities that contain them. **Pleurisy** (PLOOR-i-see) is a very painful pathological condition characterized by inflammation of the serous membranes (pleura) that line the chest cavity and cover the lungs. Pain is caused by irritation and friction as the lungs rub against the walls of the chest cavity. In severe cases the inflamed surfaces of the pleura fuse, and permanent damage may develop. The term **peritonitis** (pair-i-toe-NYE-tis) is used to describe inflammation of the serous membranes in the abdominal cavity. Peritonitis is sometimes a serious complication of an infected appendix.

FIGURE 4-1

Types of body membranes. **A**, Epithelial membranes, including cutaneous membrane (skin), serous membranes (parietal and visceral pleura and peritoneum), and mucous membranes. **B**, Connective tissue membranes, including synovial membranes. See text for explanation.

Epithelial membranes



Connective tissue membranes

Synovial membrane

B

MUCOUS MEMBRANES

Mucous (MYOO-kus) **membranes** are epithelial membranes that line body surfaces opening directly to the exterior. Examples of mucous membranes include those lining the respiratory, diges-

tive, urinary, and reproductive tracts. The epithelial component of a mucous membrane varies, depending on its location and function. In the esophagus, for example, a tough, abrasion-resistant stratified squamous epithelium is found. A thin

layer of simple columnar epithelium covers the walls of the lower segments of the digestive tract.

The epithelial cells of most mucous membranes secrete a thick, slimy material called **mucus** that keeps the membranes moist and soft.

The term **mucocutaneous** (myoo-ko-kyoo-TAY-nee-us) **junction** is used to describe the transitional area that serves as a point of “fusion” where skin and mucous membranes meet. Such junctions lack accessory organs such as hair or sweat glands that characterize skin. These transitional areas are generally moistened by mucous glands within the body orifices or openings where these junctions are located. The eyelids, nasal openings, vulva, and anus have mucocutaneous junctions that may become sites of infection or irritation.

Connective Tissue Membranes

Unlike cutaneous, serous, and mucous membranes, connective tissue membranes do not contain epithelial components. The **synovial** (si-NO-vee-al) **membranes** lining the spaces between bones and joints that move are classified as connective tissue membranes. These membranes are smooth and slick and secrete a thick, colorless lubricating fluid called **synovial fluid**. The membrane itself, with its specialized fluid, helps reduce friction between the opposing surfaces of bones in movable joints. Synovial membranes also line the small, cushionlike sacs called **bursae** (BER-see) found between moving body parts.

THE SKIN

The brief description of the skin in Chapter 3 (see p. 58) identified it not only as the primary organ of the integumentary system but also as the largest and one of the most important organs of the body. Architecturally the skin is a marvel. Consider the incredible number of structures fitting into 1 square inch of skin: 500 sweat glands; more than 1000 nerve endings; yards of tiny blood vessels; nearly 100 oil or **sebaceous** (se-BAY-shus) **glands**; 150 sensors for pressure, 75 for heat, and 10 for cold; along with millions of cells.

Structure of the Skin

The skin or cutaneous membrane is a sheetlike organ composed of the following layers of distinct tissue (Figure 4-2):

1. The **epidermis** is the outermost layer of the skin. It is a relatively thin sheet of stratified squamous epithelium.
2. The **dermis** is the deeper of the two layers. It is thicker than the epidermis and is made up largely of connective tissue.

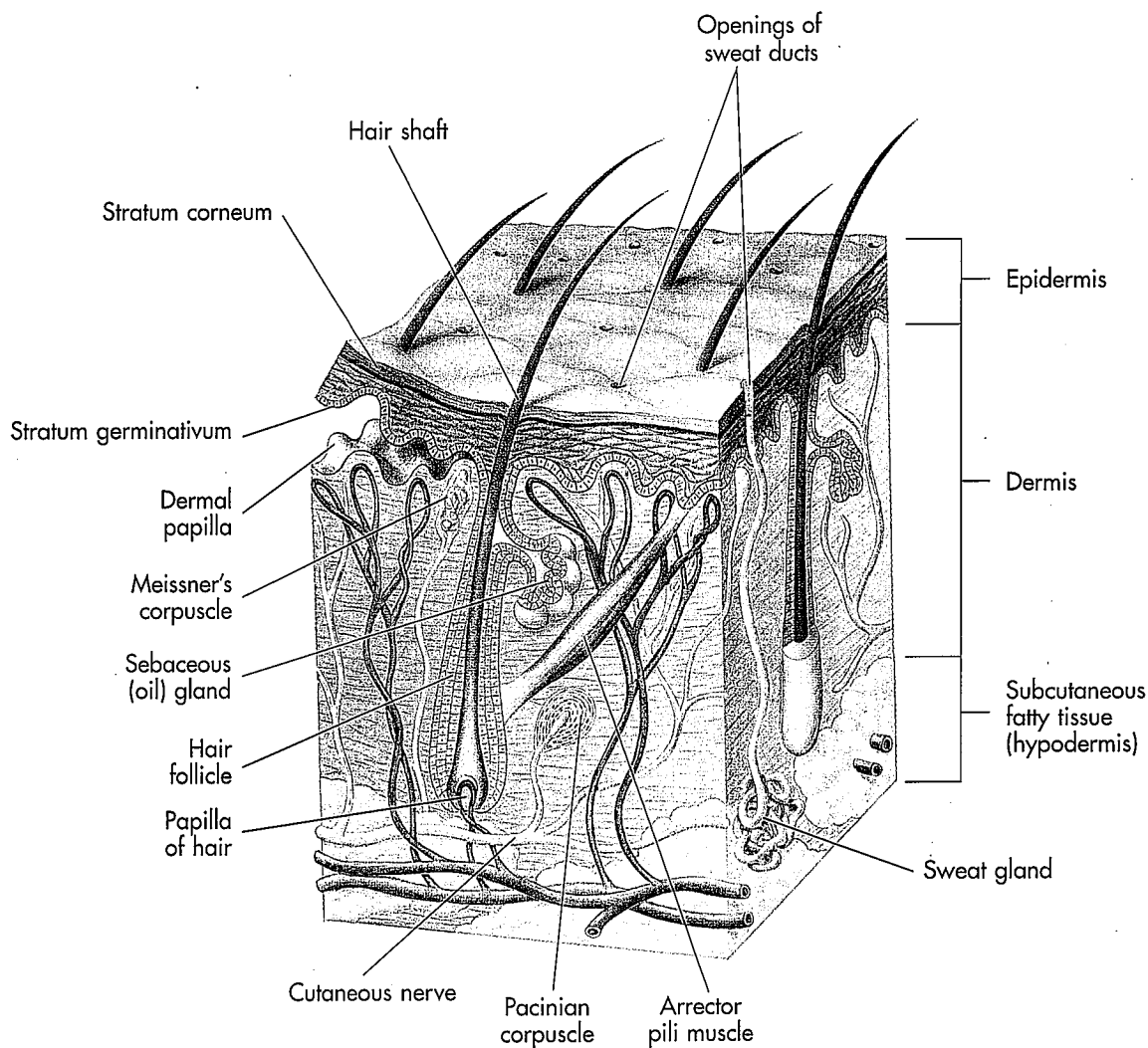
As you can see in Figure 4-2, the layers of the skin are supported by a thick layer of loose connective tissue and fat called **subcutaneous** (sub-kyoo-TAY-nee-us) **tissue** or the **hypodermis** (hypoh-DER-mis). Fat in the subcutaneous layer insulates the body from extremes of heat and cold. It also serves as a stored source of energy for the body and can be used as a food source if required. In addition, the subcutaneous tissue acts as a shock-absorbing pad and helps protect underlying tissues from injury caused by bumps and blows to the body surface.

EPIDERMIS

The tightly packed epithelial cells of the epidermis are arranged in many distinct layers. The cells of the innermost layer, called the **stratum germinativum**, undergo mitosis and reproduce themselves (see Figure 4-2). As they move toward the surface of the skin, these new cells “specialize” in ways that increase their ability to provide protection for the body tissues that lie below them. This ability is of critical clinical significance. It enables the skin to repair itself if it is injured. The self-repairing characteristic of normal skin makes it possible for the body to maintain an effective barrier against infection, even when it is subjected to injury and normal wear and tear. As new cells are produced in the deep layer of the epidermis, they move upward through additional layers, or “strata” of cells. As they approach the surface, the cytoplasm is replaced by one of nature’s most unique proteins, a substance called **keratin** (KARE-ah-tin). Keratin is a tough, waterproof material that provides cells in the outer layer of the skin with a horny, abrasion-resistant, and protective quality. The tough outer layer of the epidermis is called

FIGURE 4-2

Microscopic view of the skin. The epidermis, shown in longitudinal section, is raised at one corner to reveal the ridges in the dermis.



the **stratum corneum** (KOR-nee-um). Cells filled with keratin are continually pushed to the surface of the epidermis. In the photomicrograph of the skin shown in Figure 4-3, many of the outermost cells of the stratum corneum have been dislodged. These dry, dead cells filled with keratin “flake off” by the thousands onto our clothes, our bath water, and things we handle. Millions of epithelial cells

reproduce daily to replace the millions shed—just one example of the work our bodies do without our knowledge, even when we seem to be resting.

The deepest cell layer of the epidermis identified in Figure 4-2 is responsible for the production of a specialized **pigment** substance that gives color to the skin. The term *pigment* comes from a Latin

FIGURE 4-3

Photomicrograph of the skin. Many dead cells of the stratum corneum have flaked off from the surface of the epidermis. Note that the epidermis is very cellular. The dermis has fewer cells and more connective tissue.



word meaning “paint.” It is this epidermal layer that gives color to the skin. The brown pigment **melanin** (MEL-ah-nin) is produced by specialized cells in this layer. These cells are called **melanocytes** (MEL-ah-no-sites). The higher the concentration of melanin, the deeper the color of skin. The amount of melanin in your skin depends first on the skin color genes you have inherited. That is, heredity determines how dark or light your basic skin color is. However, other factors such as sunlight can modify this hereditary effect. Prolonged exposure to sunlight in light-skinned people darkens the exposed area because it leads to increased melanin deposits in the epidermis. If the skin contains little melanin, as under the nails where there is no melanin at all, a change in color can occur if the volume of blood in the skin changes significantly or if the amount of oxygen in the blood is increased or decreased. In these individuals increased blood flow to the skin or increased blood oxygen levels can cause a pink flush to appear. However, if blood oxygen levels decrease or if actual blood flow is reduced dramatically, the skin turns a bluish gray color—a condition called **cyanosis** (SYE-ah-NO-sis). In general, the less abundant the melanin deposits in the skin, the more visible the changes in color caused by the change in skin blood volume or oxygen level. Con-

versely, the richer the skin’s pigmentation, the less noticeable such changes will be.

The cells of the epidermis are packed tightly together. They are held firmly to one another and to the dermis below by specialized junctions between the membranes of adjacent cells. If these specialized links, sometimes described as “spot welds,” are weakened or destroyed, the skin falls apart. When this occurs because of burns, friction injuries, or exposure to irritants, **blisters** may result.

The junction that exists between the thin epidermal layer of the skin above and the dermal layer below is called the **dermal-epidermal junction**. The area of contact between dermis and epidermis “glues” them together and provides support for the epidermis, which is attached to its upper surface. Blister formation also occurs if this junction is damaged or destroyed. The junction is visible in Figure 4-2, which shows the epidermis raised on one corner to reveal the underlying dermis more clearly.

DERMIS

The dermis is the deeper of the two primary skin layers and is much thicker than the epidermis. It is composed largely of connective tissue. Instead of cells being crowded close together like the epithe-

CLINICAL APPLICATION

Subcutaneous Injection



Although the subcutaneous layer is not part of the skin, it carries the major blood vessels and nerves to the skin above it. The rich blood supply and loose, spongy texture of the subcutaneous layer make it an ideal site for the rapid and relatively pain-free absorption of injected material. Liquid medicines such as insulin and pelleted implant materials are often administered by **subcutaneous injection** into the spongy and porous layer beneath the skin. Because the subcutaneous layer is also called the hypodermis, it is not surprising that subcutaneous injections are given with a *hypodermic needle*.

lial cells of the epidermis, they are scattered far apart, with many fibers in between. Some of the fibers are tough and strong (collagen or white fibers), and others are stretchable and elastic (elastic or yellow fibers).

The upper region of the dermis is characterized by parallel rows of peglike projections called **dermal papillae** (pah-PIL-ee), which are visible in Figure 4-2. These upward projections are interesting and useful features. They form an important part of the dermal-epidermal junction that helps bind the skin layers together. In addition, they form the ridges and grooves that make possible fingerprinting as a means of identification.

You can observe these ridges on the tips of the fingers and on the skin covering the palms of your hands. Observe in Figure 4-2 how the epidermis follows the contours of the dermal papillae. These ridges develop sometime before birth. Not only is their pattern unique in each individual, but also it never changes except to grow larger—two facts that explain why our fingerprints or footprints positively identify us. Many hospitals identify newborn babies by footprinting them soon after birth.

The deeper area of the dermis is filled with a dense network of interlacing fibers. Most of the fibers in this area are collagen that gives toughness

to the skin. However, elastic fibers are also present. These make the skin stretchable and elastic (able to rebound). As we age, the number of elastic fibers in the dermis decreases, and the amount of fat stored in the subcutaneous tissue is reduced. Wrinkles develop as the skin loses elasticity, sags, and becomes less soft and pliant.

In addition to connective tissue elements, the dermis contains a specialized network of nerves and nerve endings to process sensory information such as pain, pressure, touch, and temperature. At various levels of the dermis, there are muscle fibers, hair follicles, sweat and sebaceous glands, and many blood vessels.

Appendages of the Skin

HAIR

The human body is covered with millions of hairs. Indeed, at the time of birth most of the specialized structures called **follicles** (FOL-li-kuls) that are required for hair growth are already present. They develop early in fetal life and by birth are present in most parts of the skin. The hair of a newborn infant is extremely fine and soft; it is called **lanugo** (lah-NOO-go) from the Latin word meaning “down.” In premature infants, lanugo may be noticeable over most of the body, but soon after birth the lanugo is lost and replaced by new hair that is stronger and more pigmented. Although only a few areas of the skin are hairless—notably the lips, the palms of the hands, and the soles of the feet—most body hair remains almost invisible. Hair is most visible on the scalp, eyelids, and eyebrows. The coarse hair that first appears in the pubic and axillary regions at the time of puberty develops in response to the secretion of hormones.

Hair growth begins when cells of the epidermal layer of the skin grow down into the dermis, forming a small tube called the hair follicle. The relationship of a hair follicle and its related structures to the epidermal and dermal layers of the skin is shown in Figure 4-4. Hair growth begins from a small, cap-shaped cluster of cells called the **hair papilla** (pah-PIL-ah), which is located at the base of the follicle. The papilla is nourished by a dermal blood vessel. Note in Figure 4-4 that part of

HEALTH & WELL-BEING

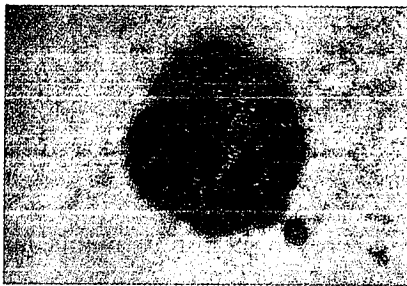
Healthy Skin



Skin, like any organ, is blemish-free in its ideal, healthy condition. But because it faces our external environment, it is subject to all kinds of injuries and insults. For example, viruses called *papillomaviruses* often cause benign neoplasms (bumps) called **warts**. Various fungi can cause itchy rashes on the skin, especially where the skin is wet and in the dark. For example, in **tinea pedis** (TIN-ee-ah PED-is) or **athlete's foot**, the wet, dark conditions inside an athletic sneaker can produce a mild fungal infection. Minor bacterial infections (such as **acne**) or more serious *Staphylococcus* or **staph** infections can cause skin damage or even body-wide infections. Perhaps the most serious problem in skin is skin cancer. The most serious type of skin cancer is **malignant**

melanoma (mel-ah-NO-mah), which is a malignant neoplasm involving the melanin-producing cells of the skin. Melanoma (A) is triggered by the long-term effects of childhood exposure to the ultraviolet radiation of the sun and has reached epidemic proportions recently as the first generation of serious sunbathers has reached later adulthood. Another type of skin cancer is **Kaposi sarcoma (KS)** (KAP-oh-see sar-KO-mah), which produces a purplish tumor on the skin (B). Historically, KS only rarely affected older men of Mediterranean heritage, but now it often affects people of all ages who have lost their immune function because of acquired immunodeficiency syndrome (AIDS).

Malignant melanoma



A

Kaposi sarcoma



B

the hair, namely the **root**, lies hidden in the follicle. The visible part of a hair is called the **shaft**. Figure 4-5 shows shafts of hair extending from their follicles.

As long as cells in the papilla of the hair follicle remain alive, new hair will replace any that is cut or plucked. Contrary to popular belief, frequent cutting or shaving does not make hair grow faster or become coarser. Why? Because neither process affects the epithelial cells that form the hairs, since they are embedded in the dermis.

A tiny, smooth (involuntary) muscle can be seen in Figure 4-4. It is called an **arrector pili** (ah-REK-tor PYE-lie) muscle. It is attached to the base of a dermal papilla above and to the side of a hair follicle below. Generally, these muscles contract only when we are frightened or cold. When contraction

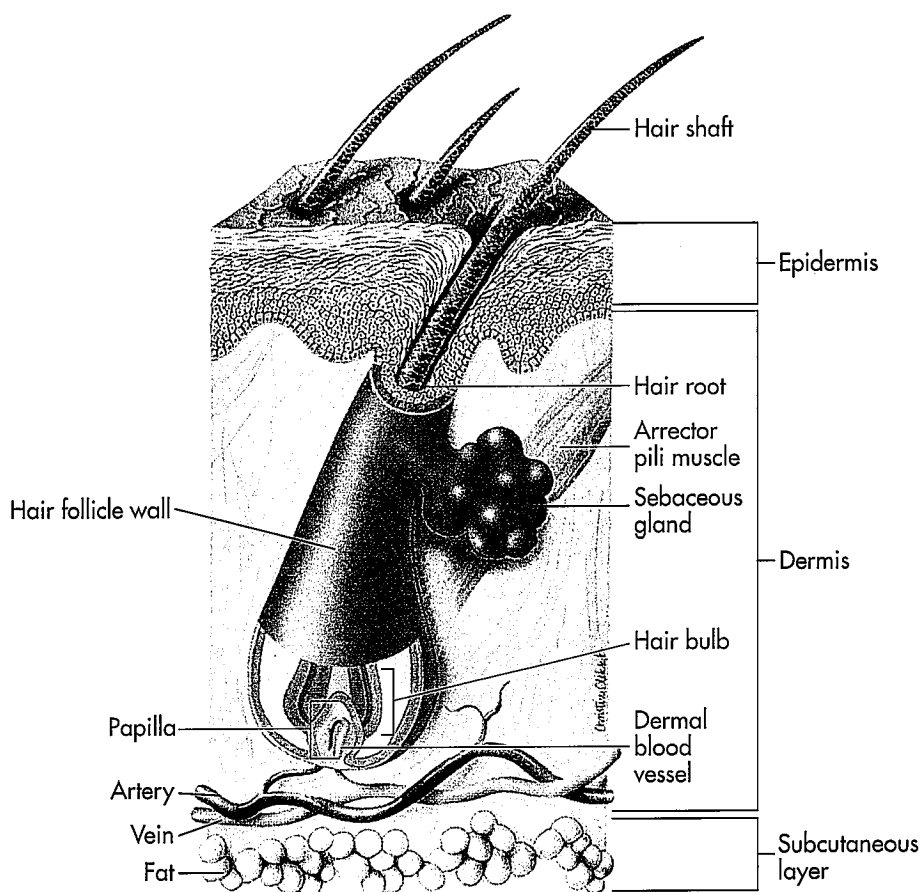
occurs, each muscle simultaneously pulls on its two points of attachment (that is, up on a hair follicle but down on a part of the skin). This produces little raised places, called *goose pimples*, between the depressed points of the skin and at the same time pulls the hairs up until they are more or less straight. The name *arrector pili* describes the function of these muscles; it is Latin for "erectors of the hair." We unconsciously recognize these facts in expressions such as "I was so frightened my hair stood on end."

RECEPTORS

Receptors in the skin make it possible for the body surface to act as a sense organ, relaying messages to the brain concerning sensations such as touch, pain, temperature, and pressure. Receptors differ

FIGURE 4-4

Hair follicle. Relationship of a hair follicle and related structures to the epidermal and dermal layers of the skin.



in structure from the highly complex to the very simple. Figure 4-6 shows enlarged views of a **Meissner's (MIZE-ners) corpuscle** and a **Pacinian (pah-SIN-ee-an) corpuscle**. Look again at Figure 4-2 and find these receptors. The Pacinian corpuscle is deep in the dermis. It is capable of detecting *pressure* on the skin surface. The Meissner's corpuscle is generally located close to the skin surface. It is capable of detecting sensations of *light touch*. Both specialized receptors are widely distributed in skin. Additional receptors in the skin respond to other types of stimuli. For example, **free nerve endings** respond to pain, and receptors called **Krause's end bulbs** detect sensations of

touch, low frequency vibration, and possibly cold. Other receptors mediate sensations of heat, crude touch, and vibration.

NAILS

Nails are classified as accessory organs of the skin and are produced by cells in the epidermis. They form when epidermal cells over the terminal ends of the fingers and toes fill with keratin and become hard and platelike. The components of a typical fingernail and its associated structures are shown in Figure 4-7. In this illustration the fingernail of the index finger is viewed from above and in sagittal section. (Recall that a sagittal section divides a

FIGURE 4-5

Hair shaft and follicle. Scanning electron micrograph showing shafts of hair extending from their follicles.



FIGURE 4-7

Structure of nails. **A**, Fingernail viewed from above. **B**, Sagittal section of fingernail and associated structures.

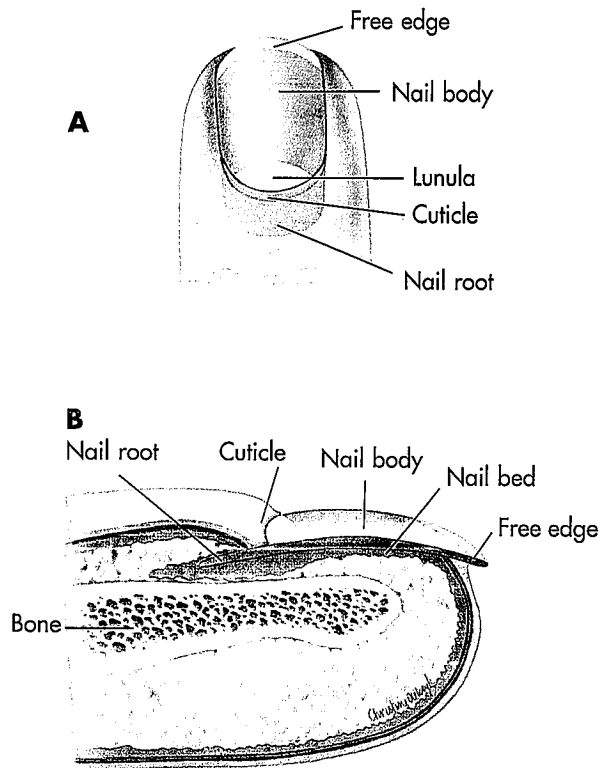
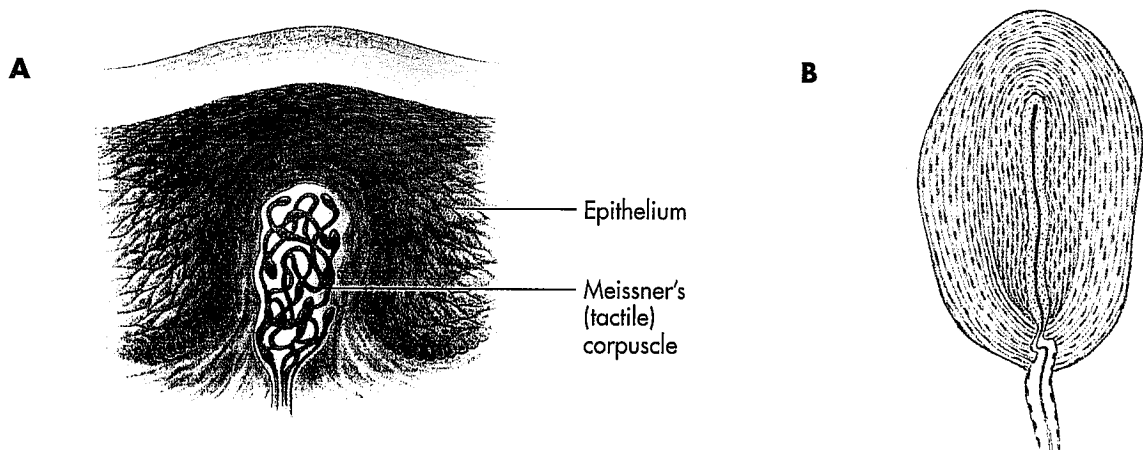


FIGURE 4-6

Skin receptors. Receptors are specialized nerve endings that make it possible for the skin to act as a sense organ. **A**, Meissner's corpuscle. **B**, Pacinian corpuscle. (See also Figure 4-2.)



body part into right and left portions.) Look first at the nail as seen from above. The visible part of the nail is called the **nail body**. The rest of the nail, namely, the **root**, lies in a groove and is hidden by a fold of skin called the **cuticle** (KYOO-ti-kul). In the sagittal section you can see the nail root from the side and note its relationship to the cuticle, which is folded back over its upper surface. The nail body nearest the root has a crescent-shaped white area known as the **lunula** (LOO-nyoo-lah), or “little moon.” You should be able to identify this area easily on your own nails; it is most noticeable on the thumbnail. Under the nail lies a layer of epithelium called the **nail bed**, which is labeled on the sagittal section in Figure 4-7. Because it contains abundant blood vessels, it appears pink in color through the translucent nail bodies. If blood oxygen levels drop and cyanosis develops, the nail bed will turn blue.

SKIN GLANDS

The skin glands include the two varieties of **sweat** or **sudoriferous** (soo-doe-RIF-er-us) **glands** and the microscopic **sebaceous glands**.

Sweat (sudoriferous) glands. Sweat glands are the most numerous of the skin glands. They can be classified into two groups—**eccrine** (EK-rin) and **apocrine** (AP-o-krin)—based on type of secretion and location. **Eccrine sweat glands** are by far the more numerous, important, and widespread sweat glands in the body. They are quite small and, with few exceptions, are distributed over the total body surface. Throughout life they produce a transparent, watery liquid called **perspiration**, or **sweat**. Sweat assists in the elimination of waste products such as ammonia and uric acid. In addition to elimination of waste, sweat plays a critical role in helping the body maintain a constant temperature. Anatomists estimate that a single square inch of skin on the palms of the hands contains about 3000 eccrine sweat glands. With a magnifying glass you can locate the pinpoint-size openings on the skin that you probably call **pores**. The pores are outlets of small ducts from the eccrine sweat glands.

Apocrine sweat glands are found primarily in the skin in the armpit (axilla) and in the pigmented

skin areas around the genitals. They are larger than the eccrine glands, and instead of watery sweat, they secrete a thicker secretion. The odor associated with apocrine gland secretion is not caused by the secretion itself. Instead, it is caused by the contamination and decomposition of the secretion by skin bacteria. Apocrine glands enlarge and begin to function at puberty.

Sebaceous glands. Sebaceous glands secrete oil for the hair and skin. Oil or sebaceous glands grow where hairs grow. Their tiny ducts open into hair follicles (see Figure 4-4) so that their secretion, called **sebum** (SEE-bum), lubricates the hair and skin. Someone aptly described sebum as “nature’s skin cream” because it prevents drying and cracking of the skin. Sebum secretion increases during adolescence, stimulated by the increased blood levels of the sex hormones. Frequently sebum accumulates in and enlarges some of the ducts of the sebaceous glands, forming white pimples. This sebum often darkens, forming a **blackhead**. Sebum secretion decreases in late adulthood, contributing to increased wrinkling and cracking of the skin.

Functions of the Skin

The skin or cutaneous membrane serves three important functions that contribute to survival. The most important functions are:

1. Protection
2. Temperature regulation
3. Sense organ activity

PROTECTION

The skin as a whole is often described as our “first line of defense” against a multitude of hazards. It protects us against the daily invasion of deadly microbes. The tough, keratin-filled cells of the stratum corneum also resist the entry of harmful chemicals and protect against physical tears and cuts. Because it is waterproof, **keratin** also protects the body from excessive fluid loss. Melanin in the pigment layer of the skin prevents the sun’s harmful ultraviolet rays from penetrating the interior of the body.

CLINICAL APPLICATION

Decubitus Ulcers



Family members, nurses, or other professionals who provide home health care services for bedridden or otherwise immobilized individuals need to be aware of the causes and nature of **decubitus** (de-KU-bi-tus) **ulcers** or pressure sores. Decubitus means “lying down,” a name that hints at a common cause of pressure sores: lying in one position for long periods. Also called *bedsores*, these lesions appear after blood flow to a local area of skin slows because of pressure on skin covering a bony prominence such as the heel (see illustration). Ulcers form and infections develop as lack of blood flow causes tissue damage. Frequent changes in body position and soft support cushions help prevent decubitus ulcers.



HEALTH & WELL-BEING

Exercise and the Skin



Excess heat produced by the skeletal muscles during exercise increases the core body temperature far beyond the normal range. Because blood in vessels near the skin’s surface dissipates heat well, the body’s control centers adjust blood flow so that more warm blood from the body’s core is sent to the skin for cooling. During exercise, blood flow in the skin can be so high that the skin takes on a redder coloration.

To help dissipate even more heat, sweat production increases to as high as 3 L per hour during exercise. Although each sweat gland produces very little of this total, over 3 million individual sweat glands are found throughout the skin. Sweat evaporation is essential to keeping body temperature in balance, but excessive sweating can lead to a dangerous loss of fluid. Because normal drinking may not replace the water lost through sweating, it is important to increase fluid consumption during and after any type of exercise to avoid **dehydration**.

tion and by regulating the flow of blood close to the body surface. When sweat evaporates from the body surface, heat is also lost. The principle of heat loss through evaporation is basic to many cooling systems. When increased quantities of blood are allowed to fill the vessels close to the skin, heat is also lost by radiation. Blood supply to the skin far exceeds the amount needed by the skin. Such an abundant blood supply primarily enables the regulation of body temperature.

SENSE ORGAN ACTIVITY

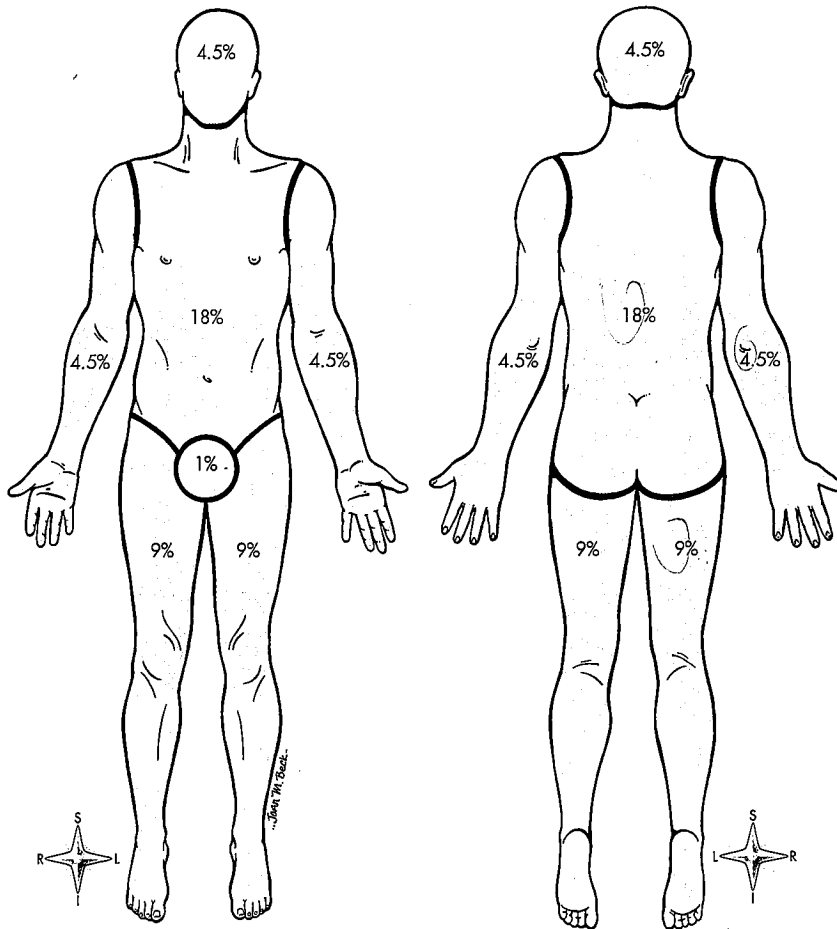
The skin functions as an enormous sense organ. Its millions of nerve endings serve as antennas or receivers for the body, keeping it informed of changes in its environment. The specialized receptors shown in Figures 4-2 and 4-6 make it possible for the body to detect sensations of light touch (Meissner’s corpuscles) and pressures (Pacinian corpuscles). Other receptors make it possible for us to respond to the sensations of pain, heat, and cold.

TEMPERATURE REGULATION

The skin plays a key role in regulating the body’s temperature. Incredible as it seems, on a hot and humid day the skin can serve as a means for releasing almost 3000 calories of body heat—enough heat energy to boil more than 20 liters of water! It accomplishes this feat by regulating sweat secre-

FIGURE 4-8

The “rule of nines.” Dividing the body into 11 areas of 9% each helps one to estimate the amount of skin surface burned in an adult.



Burns

Burns constitute one of the most serious and frequent problems that affect the skin. Typically, we think of a burn as an injury caused by fire or by contact of the skin with a hot surface. However, overexposure to ultraviolet light (sunburn) or contact of the skin with an electric current or a harmful chemical such as an acid can also cause burns.

ESTIMATING BODY SURFACE AREA

When burns involve large areas of the skin, treatment and the possibility for recovery depend in large part on the **total area involved** and the **severity of the burn**. The severity of a burn is determined by the depth of the injury, as well as by the amount of body surface area affected.

The “rule of nines” is one of the most frequently used methods of determining the extent of a burn injury. With this technique (Figure 4-8) the

body is divided into 11 areas of 9% each, with the area around the genitals representing the additional 1% of body surface area. As you can see in Figure 4-8, in the adult 9% of the skin covers the head and each upper extremity, including front and back surfaces. Twice as much, or 18%, of the total skin area covers the front and back of the trunk and each lower extremity, including front and back surfaces.

CLASSIFICATION OF BURNS

The classification system used to describe the severity of burns is based on the number of tissue layers involved. The most severe burns destroy not only layers of the skin and subcutaneous tissue but underlying tissues, as well.

First-degree burns. A **first-degree burn** (for example, a typical sunburn) causes minor discomfort and some reddening of the skin. Although the surface layers of the epidermis may peel in 1 to 3 days, no blistering occurs, and actual tissue destruction is minimal.

Second-degree burns. A **second-degree burn** involves the deep epidermal layers and always causes injury to the upper layers of the dermis. Although deep second-degree burns damage sweat glands, hair follicles, and sebaceous glands, complete destruction of the dermis does not occur. Blisters, severe pain, generalized swelling, and fluid loss characterize this type of burn. Scarring is common. First- and second-degree burns are called **partial-thickness burns**.

Third-degree burns. A **third-degree, or full-thickness burn** is characterized by complete destruction of the epidermis and dermis. In addition, tissue death extends below the primary skin layers into the subcutaneous tissue. Third-degree burns often involve underlying muscles and even bone. One distinction between second- and third-degree burns is that third-degree lesions are insensitive to pain immediately after injury because of the destruction of nerve endings. The fluid loss that results from third-degree burns is a very serious problem. Another serious problem with third-degree burns is the great risk of infection.



Outline Summary

CLASSIFICATION OF BODY MEMBRANES

- A Classification of body membranes (Figure 4-1)
 - 1 Epithelial membranes—composed of epithelial tissue and an underlying layer of connective tissue
 - 2 Connective tissue membranes—composed largely of various types of connective tissue
- B Epithelial membranes
 - 1 Cutaneous membrane—the skin
 - 2 Serous membranes—simple squamous epithelium on a connective tissue basement membrane
 - a Types
 - (1) Parietal—line walls of body cavities
 - (2) Visceral—cover organs found in body cavities
 - b Examples
 - (1) Pleura—parietal and visceral layers line walls of thoracic cavity and cover the lungs
 - (2) Peritoneum—parietal and visceral layers line walls of abdominal cavity and cover the organs in that cavity
 - c Diseases
 - (1) Pleurisy—inflammation of the serous membranes that line the chest cavity and cover the lungs
 - (2) Peritonitis—inflammation of the serous membranes in the abdominal cavity that line the walls and cover the abdominal organs
 - 3 Mucous membranes
 - a Line body surfaces that open directly to the exterior
 - b Produce mucus, a thick secretion that keeps the membranes soft and moist
- C Connective tissue membranes
 - 1 Do not contain epithelial components
 - 2 Produce a lubricant called *synovial fluid*
 - 3 Examples are the synovial membranes in the spaces between joints and in the lining of bursal sacs

THE SKIN

- A Structure (Figure 4-2)—two primary layers called *epidermis* and *dermis*
 - 1 Epidermis
 - a Outermost and thinnest primary layer of skin
 - b Composed of several layers of stratified squamous epithelium
 - c Stratum germinativum—innermost layer of cells that continually reproduce, and new cells move toward the surface
 - d As cells approach the surface, they are filled with a tough, waterproof protein called *keratin* and eventually flake off
 - e Stratum corneum—outermost layer of keratin-filled cells
 - f Pigment-containing layer—epidermal layer that contains pigment cells called *melanocytes*, which produce the brown pigment melanin
 - g Blisters—caused by breakdown of union between cells or primary layers of skin
 - h Dermal-epidermal junction—specialized area between two primary skin layers
 - 2 Dermis
 - a Deeper and thicker of the two primary skin layers and composed largely of connective tissue
 - b Upper area of dermis characterized by parallel rows of peglike dermal papillae
 - c Ridges and grooves in dermis form pattern unique to each individual (basis of fingerprinting)
 - d Deeper areas of dermis filled with network of tough collagenous and stretchable elastic fibers
 - e Number of elastic fibers decreases with age and contributes to wrinkle formation
 - f Dermis also contains nerve endings, muscle fibers, hair follicles, sweat and sebaceous glands, and many blood vessels


 Outline Summary—cont'd

B Appendages of the skin

- 1 Hair (Figures 4-4 and 4-5)
 - a Soft hair of fetus and newborn is called *lanugo*
 - b Hair growth requires epidermal tubelike structure called *hair follicle*
 - c Hair growth begins from hair papilla
 - d Hair root lies hidden in follicle and visible part of hair called *shaft*
 - e Arrector pili—specialized smooth muscle that produces “goose pimples” and causes hair to stand up straight
- 2 Receptors (Figure 4-6)
 - a Specialized nerve endings—make it possible for skin to act as a sense organ
 - b Meissner’s corpuscle—capable of detecting light touch
 - c Pacinian corpuscle—capable of detecting pressure
- 3 Nails (Figure 4-7)
 - a Produced by epidermal cells over terminal ends of fingers and toes
 - b Visible part is called *nail body*
 - c Root lies in a groove and is hidden by cuticle
 - d Crescent-shaped area nearest root is called *lunula*
 - e Nail bed may change color with change in blood flow
- 4 Skin glands
 - a Types
 - (1) Sweat or sudoriferous
 - (2) Sebaceous
 - b Sweat or sudoriferous glands
 - (1) Types
 - (a) Eccrine sweat glands
 - Most numerous, important, and wide-spread of the sweat glands
 - Produce perspiration or sweat, which flows out through pores on skin surface
 - Function throughout life and assist in body heat regulation

(b) Apocrine sweat glands

- Found primarily in axilla and around genitalia
- Secrete a thicker secretion quite different from eccrine perspiration
- Breakdown of secretion by skin bacteria produces odor

c Sebaceous glands

- (1) Secrete oil or sebum for hair and skin
- (2) Level of secretion increases during adolescence
- (3) Amount of secretion is regulated by sex hormones
- (4) Sebum in sebaceous gland ducts may darken to form a blackhead

C Functions of the skin

- 1 Protection—first line of defense
 - a Against infection by microbes
 - b Against ultraviolet rays from sun
 - c Against harmful chemicals
 - d Against cuts and tears
- 2 Temperature regulation
 - a Skin can release almost 3000 calories of body heat per day
 - (1) Mechanisms of temperature regulation
 - (a) Regulation of sweat secretion
 - (b) Regulation of flow of blood close to the body surface
- 3 Sense organ activity
 - a Skin functions as an enormous sense organ
 - b Receptors serve as receivers for the body, keeping it informed of changes in its environment

D Burns

- 1 Treatment and recovery or survival depend on total area involved and severity or depth of the burn
- 2 Body surface area is estimated using the “rule of nines” (Figure 4-8) in adults
 - a Body is divided into 11 areas of 9% each
 - b Additional 1% of body surface area is around genitals



Outline Summary—cont'd

- 3 Classification of burns
- a First-degree (partial-thickness) burns—only the surface layers of epidermis involved
 - b Second-degree (partial-thickness) burns—involve the deep epidermal layers and always cause injury to the upper layers of the dermis
 - c Third-degree (full-thickness) burns—characterized by complete destruction of the epidermis and dermis
 - (1) May involve underlying muscle and bone
 - (2) Lesion is insensitive to pain because of destruction of nerve endings immediately after injury—intense pain is soon experienced
 - (3) Risk of infection is increased



New Words

apocrine sweat gland	follicle	mucocutaneous	sebaceous gland
arrector pili	hypodermis	junction	serous membrane
blister	Kaposi sarcoma (KS)	mucous membrane	stratum corneum
bursa	keratin	mucus	subcutaneous
cutaneous	Krause's end bulb	Pacinian corpuscle	sudoriferous gland
cuticle	lanugo	papilla	synovial membrane
cyanosis	lunula	parietal	tinea pedis
dehydration	malignant melanoma	peritoneum	visceral portion
dermis	Meissner's corpuscle	peritonitis	
eccrine sweat gland	melanin	pleura	
epidermis	melanocyte	pleurisy	



Review Questions

1. Define *membrane*.
2. Explain the structure of a serous membrane. Include the difference between the parietal and visceral membranes.
3. Explain the structure of a mucous membrane. Include an explanation of the mucocutaneous junction.
4. Explain the structure of a synovial membrane. What is the function of synovial fluid?
5. Name and briefly describe the layers of the epidermis.
6. Explain the structure of the dermis.
7. Differentiate between the *hair papilla*, the *hair root* and the *hair shaft*.
8. Explain what occurs when the arrector pili contract.
9. Name the four receptors of the skin. To what type of stimuli does each respond?
10. Give the location of the eccrine glands and their function, and describe the type of fluid they produce.



Review Questions—cont'd

11. Give the location of the apocrine glands and their function, and describe the type of fluid they produce.
12. Give the location of the sebaceous glands and their function, and describe the type of fluid they produce.
13. Explain the difference between a second-degree and third-degree burn. Which is considered a "full-thickness" burn?



Critical Thinking

14. Explain the protective function of melanin.
15. Explain fully the role of the skin in temperature regulation.
16. If a person burned all of his back, the back of his right arm, and the back of his right thigh, approximately what percent of his body surface area was involved? How did you determine this?



Chapter Test

1. The _____, _____, and _____ are the three types of epithelial membranes.
2. Epithelial membranes are usually composed of two distinct layers: the epithelial layer and a supportive connective tissue layer called the _____.
3. The membrane lining the interior of the chest wall is called the _____.
4. The membrane covering the organs of the abdomen is called the _____.
5. The connective tissue membrane that lines the space between the bone and joints is called the _____.
6. The two main layers of the epidermis of the skin are the _____ and the _____.
7. As new skin cells approach the surface of the skin, their cytoplasm is replaced by a unique waterproof protein called _____.
8. The upper region of the dermis forms projections called _____ that form unique fingerprints.
9. The _____ are sweat glands that can be found all over the body and produce a transparent watery liquid.
10. The _____ are sweat glands that can be found in the armpits and produce a thicker secretion.
11. Sebaceous glands secrete an oil called _____.
12. _____, _____, and _____ are the three functions of the skin.
13. The receptors in the skin that respond to pain are the:
 - a. Meissner's corpuscle
 - b. Pacinian corpuscle
 - c. free nerve endings
 - d. Krause's end bulbs
14. The receptors in the skin that respond to touch and cold are the:
 - a. Meissner's corpuscle
 - b. Pacinian corpuscle
 - c. free nerve endings
 - d. Krause's end bulbs
15. The receptors in the skin that respond to light touch are the:
 - a. Meissner's corpuscle
 - b. Pacinian corpuscle
 - c. free nerve endings
 - d. Krause's end bulbs
16. The receptors in the skin that respond to deep pressure are the:
 - a. Meissner's corpuscle
 - b. Pacinian corpuscle
 - c. free nerve endings
 - d. Krause's end bulbs



Chapter Test—cont'd

Match the description of the part of the hair in Column B with the name of the structure in Column A.

COLUMN A

17. ___ Hair follicle
18. ___ Hair papilla
19. ___ Hair root
20. ___ Hair shaft

COLUMN B

- a. The part of the hair hidden in the follicle
- b. The growth of the epidermal cells into the dermis forming a small tube
- c. The part of the hair that is visible extending from the follicle
- d. A cup-like cluster of cells where hair growth begins



Study Tips

Before starting your study of Chapter 4, go back to Chapter 3 and review the synopsis of the integumentary system. The body membranes are either epithelial or connective. The epithelial membranes cover or protect; this is the general function of epithelial tissue (Chapter 2). The difference between mucous and serous membranes is where they are; if the membrane is exposed to the environment in any way, it is mucous membrane. Connective membranes cover joints. The skin is divided into two parts. *Epi* means "on," so the epidermis is *on* the dermis. Its job is protective. The dermis contains most of the skin

structures; nails, sense receptors, hair, glands, blood vessels, and muscles. The functions of the skin—protection, sensation, and heat regulation—are related to its location. Burns are classified by how much damage has been done to the skin and how deeply the damage occurred.

In your study groups, have a photocopy of the figures on the membranes, the microscopic view of the skin, the hair, and the nails. Blacken out the labels and quiz each other on the location and function of various structures. Go over the questions in the back of the chapter and discuss possible test questions.

5

The Skeletal System

