Body membranes cover surfaces, line body cavities, and form protective (and often lubricating) sheets around organs. They fall into two major groups: (1) epithelial membranes, which include the cutaneous, mucous, and serous membranes; and (2) connective tissue membranes, represented by synovial membranes. The cutaneous membrane, generally called the skin or integumentary system, will receive most of our attention in this chapter, but first we will consider the other body membranes.

Classification of Body Membranes

4-1 List the general functions of each membrane type—cutaneous, mucous, serous, and synovial—and give its location in the body.

4-2 Compare the structure (tissue makeup) of the major membrane types.

The two major categories of body membranes—epithelial and connective tissue—are classified in part according to their tissue makeup.
Epithelial Membranes

The epithelial membranes, also called covering and lining membranes, include the cutaneous membrane (skin), the mucous membranes, and the serous membranes (Figure 4.1). However, calling these membranes “epithelial” is not only misleading but also inaccurate. Although they all do contain an epithelial sheet, it is always combined with an underlying layer of connective tissue. Hence these membranes are actually simple organs. Because we will discuss the skin in some detail shortly, we will list it here solely as a subcategory of the epithelial membranes.

Cutaneous Membrane

The cutaneous (ku-ta’ne-us) membrane is your skin. Its superficial epidermis is composed of a keratinizing stratified squamous epithelium. The underlying dermis is mostly dense (fibrous) connective tissue. Unlike other epithelial membranes, the cutaneous membrane is exposed to air and is a dry membrane.

Mucous Membranes

A mucous (mu’kus) membrane (mucosa) is composed of epithelium (the type varies with the site) resting on a loose connective tissue membrane called a lamina propria. This membrane type lines all body cavities that open to the exterior, such as those of the hollow organs of the respiratory, digestive, urinary, and reproductive tracts (Figure 4.1b). Notice that the term mucosa refers only to the location of the epithelial membranes, not their cellular makeup, which varies. However, most mucosae contain either stratified squamous epithelium (as in the mouth and esophagus) or simple columnar epithelium (as in the rest of the digestive tract). In all cases, they are “wet,” or moist, membranes that are almost continuously bathed in secretions or, in the case of the urinary mucosae, urine.

The epithelium of mucosae is often adapted for absorption or secretion. Although many mucosae secrete mucus, not all do. The mucosae of the respiratory and digestive tracts secrete large amounts of protective, lubricating mucus; that of the urinary tract does not.

Serous Membranes

A serous membrane (serosa) is composed of a layer of simple squamous epithelium resting on a thin layer of areolar connective tissue. In contrast to mucous membranes, which line open body cavities, serous membranes line body cavities that are closed to the exterior (except for the dorsal body cavity and joint cavities).

Serous membranes occur in pairs (Figure 4.1c). The parietal (pah-ri’-tal: parie = wall) layer lines a specific portion of the wall of the ventral body cavity. It folds in on itself to form the visceral (vis’er-al) layer, which covers the outside of the organs in that cavity.

You can visualize the relationship between the serosal layers by pushing your fist into a limp balloon only partially filled with air or water (Figure 4.1d). The part of the balloon that clings to your fist can be compared to the visceral serosa clinging to the organ’s external surface. The outer wall of the balloon represents the parietal serosa that lines the walls of the cavity and that, unlike the balloon, is never exposed but is always fused to the cavity wall. In the body, the serous layers are separated by air but by a scanty amount of thin, clear fluid, called serous fluid, which is secreted by both membranes. Although there is a potential space between the two membranes, they tend to lie very close to each other.

The serous fluid allows the organs to slide easily across the cavity walls and one another without friction as they carry out their routine functions. This is extremely important when mobile organs such as the pumping heart and a churning stomach are involved.

The specific names of the serous membranes depend on their locations. The serosa lining the abdominal cavity and covering its organs is the peritoneum (per”i-to-ne’um). In the thorax, serous membranes isolate the lungs and heart from one another. The membrane surrounding the lungs (Figure 4.1c) is the pleura (ploo’rah); that around the heart is the pericardium (per”i-kar’de-um).

Connective Tissue Membranes

Synovial (si-no’ve-al) membranes are composed of soft areolar connective tissue and contain no epithelial cells at all. These membranes line the fibrous capsules surrounding joints (Figure 4.2, p. 112), where they provide a smooth surface and secrete a lubricating fluid. They also line small sacs of connective tissue called bursae (ber’se) and the tubelike tendon sheaths. Both of these structures cushion organs moving against each other during muscle activity—such as the movement of a tendon across a bone’s surface.
Chapter 4: Skin and Body Membranes

(a) Cutaneous membrane (the skin) covers the body surface.

(b) Mucous membranes line body cavities open to the exterior.

(c) Serous membranes line body cavities closed to the exterior.

(d) A fist thrust into a flaccid balloon demonstrates the relationship between the parietal and visceral serous membrane layers.

Figure 4.1 Classes of epithelial membranes.
reticular layers), hair and hair follicle, sebaceous gland, and sweat gland.

4-5 Name the layers of the epidermis, and describe the characteristics of each.

Would you be enticed by an advertisement for a coat that is waterproof, stretchable, and washable, that invisibly repairs small cuts, rips, and burns, and that is guaranteed to last a lifetime with reasonable care? Sounds too good to be true, but you already have such a coat—your cutaneous membrane, or skin. The skin and its derivatives (sweat and oil glands, hair, and nails) serve a number of functions, mostly protective. Together, these organs are called the integumentary (in-teg′u-men′ta-re) system.

Functions of the Integumentary System

Also called the integument (in-teg′u-ment), which simply means “covering,” the skin multi-tasks. Its functions go well beyond serving as a large opaque bag for body contents. It is absolutely essential because it keeps water and other precious molecules in the body. It also keeps water (and other things) out. (This is why you can swim for hours without becoming waterlogged.) Structurally, the skin is a marvel. It is pliable yet tough, which allows it to take constant punishment from external agents. Without our skin, we would quickly fall prey to bacteria and perish from water and heat loss.

The integumentary system performs a variety of functions; most, but not all, protective (Table 4.1). It insulates and cushions the deeper body organs and protects the entire body from mechanical damage (bumps and cuts), chemical damage (such as from acids and bases), thermal damage (heat and cold), ultraviolet radiation (in sunlight), and bacteria. The uppermost layer of the skin is full of keratin and is cornified, or hardened, to help prevent water loss from the body surface.

The skin’s rich capillary network and sweat glands (both controlled by the nervous system) play an important role in regulating heat loss from the body surface (as described in Figure 14.24 p. 500). The skin acts as a mini-excretory system; urea, salts, and water are lost when we sweat. The skin is also a chemical plant; it manufactures several proteins important to immunity and synthesizes vitamin D. (Modified cholesterol molecules located
Chapter 4: Skin and Body Membranes

4 Structure of the Skin

The skin is composed of two kinds of tissue. The outer epidermis (ep′i-der′mis) is made up of stratified squamous epithelium that is capable of keratinizing (ker′ah-tin-iz-ing), or becoming hard and tough. The underlying dermis is made up mostly of dense connective tissue. The epidermis and dermis are firmly connected and the dermis is fairly tear resistant. However, a burn or friction (such as the rubbing of a poorly fitting shoe) may cause them to separate, allowing interstitial fluid to accumulate in the cavity between the layers, which results in a blister.

Deep to the dermis is the subcutaneous tissue, or hypodermis, which essentially is adipose tissue. It is not considered part of the skin, but it does anchor the skin to underlying organs and provides a site for nutrient (fat) storage. Subcutaneous tissue serves as a shock absorber and insulates the deeper tissues from extreme

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Table 4.1 Functions of the Integumentary System

<table>
<thead>
<tr>
<th>Functions</th>
<th>How accomplished</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protects deeper tissues from</td>
<td>Physical barrier contains keratin, which toughens cells; fat cells to cushion blows; and pressure receptors, which alert the nervous system to possible damage.</td>
</tr>
<tr>
<td>• Mechanical damage (bumps)</td>
<td>Has relatively impermeable keratinized cells; contains pain receptors, which alert the nervous system to possible damage.</td>
</tr>
<tr>
<td>• Chemical damage (acids and bases)</td>
<td>Has an unbroken surface and &quot;acid mantle&quot; (skin secretions are acidic and thus inhibit bacteria). Phagocytes ingest foreign substances and pathogens, preventing them from penetrating into deeper body tissues.</td>
</tr>
<tr>
<td>• Bacterial damage</td>
<td>Melanin produced by melanocytes offers protection from UV damage.</td>
</tr>
<tr>
<td>• Ultraviolet radiation (damaging effects of sunlight)</td>
<td></td>
</tr>
<tr>
<td>• Thermal (heat or cold) damage</td>
<td>Contains heat/cold/pain receptors.</td>
</tr>
<tr>
<td>• Desiccation (drying out)</td>
<td>Contains a water-resisting glycolipid and keratin.</td>
</tr>
<tr>
<td>Aids in body heat loss or heat retention (controlled by the nervous system)</td>
<td>Heat loss: By activating sweat glands and by allowing blood to flush into skin capillary beds so that heat can radiate from the skin surface. Heat retention: By not allowing blood to flush into skin capillary beds.</td>
</tr>
<tr>
<td>Aids in excretion of urea and uric acid</td>
<td>Contained in perspiration produced by sweat glands.</td>
</tr>
<tr>
<td>Synthesizes vitamin D</td>
<td>Modified cholesterol molecules in skin converted to vitamin D by sunlight.</td>
</tr>
</tbody>
</table>

in the skin are converted to vitamin D by sunlight.) Finally, the cutaneous sensory receptors (Figure 4.3, p. 114), which are actually part of the nervous system, are located in the skin. These tiny sensors, which include touch, pressure, temperature, and pain receptors, provide us with a great deal of information about our external environment. They alert us to bumps and the presence of tissue-damaging factors as well as to the feel of wind in our hair and a caress.

**Did You Get It?**

4. Explain the relationships between the words skin, cutaneous membrane, integument, and integumentary system.

5. What are three important functions of the integumentary system?

(For answers, see Appendix D.)
temperature changes occurring outside the body. It is also responsible for the curves that are more a part of a woman’s anatomy than a man’s. We describe the main skin areas and structures next. (As you read, locate them on Figure 4.3 and Figure 4.4).

Epidermis
The epidermis is composed of up to five layers, or strata (strah’tah; “bed sheets”). From the inside out these are the stratum basale, spinosum, granulosum, lucidum, and corneum (all illustrated in Figure 4.4, except stratum lucidum, which is found only in thick skin).

Like all other epithelial tissues, the epidermis is avascular; that is, it has no blood supply of its own. This explains why a man can shave daily and not bleed even though he cuts off many cell layers each time he shaves.

Most cells of the epidermis are keratinocytes (keratin cells), which produce keratin, the fibrous protein that makes the epidermis a tough protective layer. The deepest cell layer of the epidermis, the stratum basale (str’a’tum bâ-sah’le), lies closest to the dermis and is connected to it along a wavy borderline that resembles corrugated cardboard. This basal layer contains the most adequately nourished of the epidermal cells because nutrients diffusing from the dermis reach them first. These cells are constantly dividing, and millions of new cells are produced daily; hence its alternate name, stratum germinativum (jer’min-ah-tiv’um; “germinating layer”). The daughter cells are pushed upward, away from the source of nutrition, to become part of the epidermal layers closer to the skin surface. As they move away from the dermis and become part of the more superficial layers, the stratum spinosum and then the stratum granulosum, they become flatter and increasingly full of keratin (keratinized). As they leave the stratum granulosum, they die, forming
the blood supply (in the dermis) effectively dooms the stratum lucidum cells and the more superficial epidermal cells because they are unable to get adequate nutrients and oxygen.

The outermost layer, the **stratum corneum** (kor’ne-um), is 20 to 30 cell layers thick but it accounts for about three-quarters of the epidermal thickness. The shinglelike dead cell remnants, located in the stratum lucidum, are the consequence of accumulating keratin inside them, secreting a water-repellent glycolipid into the extracellular space, and their increasing distance from the blood supply (in the dermis).
completely filled with keratin, are referred to as cornified or horny cells (cornu = horn). The common saying “Beauty is only skin deep” is especially interesting in light of the fact that nearly everything we see when we look at someone is dead! Keratin is an exceptionally tough protein. Its abundance in the stratum corneum allows that layer to provide a durable “overcoat” for the body, which protects deeper cells from the hostile external environment (air) and from water loss and helps the body resist biological, chemical, and physical assaults. The stratum corneum rubs and flakes off slowly and steadily as the dandruff familiar to everyone. The average person sheds about 18 kg (40 lb) of these flakes in a lifetime, providing a food source for the dust mites that inhabit our homes and bed linens. This layer is replaced by cells produced by the division of the deeper stratum basale cells. Indeed, we have a totally “new” epidermis every 25 to 45 days.

Melanin (mel’ah-nin), a pigment that ranges in color from yellow to brown to black, is produced by special spider-shaped cells called melanocytes (mel’ah-no-sitz), found chiefly in the stratum basale. When the skin is exposed to sunlight, which stimulates the melanocytes to produce more of the melanin pigment, tanning occurs. As the melanocytes produce melanin, it accumulates within them in membrane-bound granules called melanosomes. These granules then move to the ends of the melanocytes’ spidery arms, where they are taken up by nearby keratinocytes. Inside the keratinocytes, the melanin forms a pigment umbrella over the superficial, or “sunny,” side of their nuclei and shields their genetic material (DNA) from the damaging effects of ultraviolet radiation in sunlight. Freckles and moles are seen where melanin is concentrated in one spot.

Scattered in the epidermis are epidermal dendritic cells, which are important in alerting and activating immune system cells to a threat such as bacterial or viral invasion. Seen here and there at the epidermal-dermal junction are Merkel cells, which are associated with sensory nerve endings and serve as touch receptors called Merkel discs.

Did You Get It?

6. What cell type is most abundant in the epidermis?
7. Which layer of the epidermis produces new epidermal cells?
8. Excess shedding of scales from the superficial layer of the skin of the scalp causes dandruff. What is the name of that skin layer?

(For answers, see Appendix D.)

Dermis

The dermis is your “hide.” It is a strong, stretchy envelope that helps to bind the body together. When you purchase leather goods (bags, belts, shoes, and the like), you are buying the treated dermis of animals.

The dense (fibrous) connective tissue making up the dermis consists of two major regions—the papillary and the reticular areas (Figure 4.5). Like the epidermis, the dermis varies in thickness. For example, it is particularly thick on the palms of the hands and soles of the feet but is quite thin on the eyelids.

The papillary layer is the upper dermal region. It is uneven and has peglike projections from its superior surface, called dermal papillae (pah-pil’e; papill = nipple), which indent the epidermis above. Many of the dermal papillae contain capillary loops, which furnish nutrients to the epidermis. Others house pain receptors (free nerve endings) and touch receptors. On the palms of the hands and soles of the feet, the papillae are arranged in definite patterns that form looped and whorled ridges on the epidermal surface that increase friction and enhance the gripping ability of the fingers and feet. Papillary patterns are genetically determined. The ridges of the fingertips are well provided with sweat pores and leave unique, identifying films of sweat called fingerprints on almost anything they touch.

The reticular layer is the deepest skin layer. It contains irregularly arranged connective tissue fibers, as well as blood vessels, sweat and oil glands, and deep pressure receptors called lamellar corpuscles.
body heat to radiate from the skin surface. If the environment is cool and body heat must be conserved, blood bypasses the dermis capillaries temporarily, allowing internal body temperature to stay high.

**Homeostatic Imbalance 4.2**
Any restriction of the normal blood supply to the skin results in cell death and, if severe or prolonged enough, skin ulcers. **Decubitus** (de-ku’bi-tus) ulcers (bedsores) occur in bedridden patients who are not turned regularly or who are dragged or pulled across the bed repeatedly. The weight of the body puts pressure on the skin, especially over bony projections. Because this pressure restricts the blood supply, the skin becomes pale or blanched at pressure points. At first, the skin reddens when pressure is released, but if the situation is not corrected, the cells begin to die, and small cracks or breaks in the skin appear at compressed sites. Permanent damage to the superficial blood vessels and tissue eventually results in degeneration and ulceration of the skin (Figure 4.6).

The dermis also has a rich nerve supply. As mentioned earlier, many of the nerve endings have specialized receptor end-organs that send messages to the central nervous system for interpretation when they are stimulated by environmental factors (pressure, temperature, and the like). (We discuss these cutaneous receptors in more detail in Chapter 7.)
When it comes to preventing wrinkles, it helps to have good genes, to not smoke, to use a good sunscreen, and to think pleasant thoughts. Good genes speak for themselves—it’s partly the luck of the draw whether you look your age or not. Smoking ages the skin by increasing production of an enzyme that destroys collagen. Collagen supports the skin and provides it with elasticity, so with less of it, wrinkles appear.

UV radiation damage from too much unprotected exposure to the sun causes elastic fibers to clump, which results in leathery skin. For those wrinkled by years of smoking and sun damage, a surgical face-lift that removes the excess and sagging skin followed by laser resurfacing or microdermabrasion seems to be the only way to banish the wrinkles.

However, for those who sport frown lines, furrowed brows, or crow’s feet due to frequent and repetitive facial expressions, cosmetic injections of Botox may be the answer to regaining younger-looking skin.

Botulinum toxin type A, more familiarly called Botox Cosmetic, is a toxin produced by the bacterium that causes botulism, a dreaded form of food poisoning. Used in injectable doses (considerably less than the amount that would induce botulism), the purified toxin helps regulate acetylcholine (ACh) release by nerve cells. (ACh plays a key role in relaying messages from nerves to muscles.) By inhibiting the underlying muscles’ ability to contract, existing lines are smoothed out and nearly invisible in a week.

Botox was approved in 1989 to treat two eye muscle disorders—blepharospasm (uncontrollable blinking) and strabismus (misaligned eyes). The discovery that Botox could be used cosmetically was pure luck—physicians using the toxin to counter abnormal eye contractions noticed that the vertical frown lines between the eyes (which make people look tired, angry, or displeased) had softened.

The recent rise in popularity of Botox “shots” has led to changes in the way it is marketed. Some physicians buy the toxin in bulk and arrange “Botox parties” or “Botox happy hours,” get-togethers for 10 to 15 people, which make the treatment both more relaxed and more affordable. One by one, as their names are called, each “guest” slips away for about 15 minutes to a private examining room to be injected with Botox Cosmetic. Anesthesia is rarely needed, but sedatives and numbing agents are usually available. The U.S. Food and Drug Administration is concerned that such gatherings may trivialize a medical treatment and have the potential for being abused as unqualified people begin to dispense the toxin in salons, gyms, and other retail establishments.

The process has some risks. If too much toxin is injected, a person can end up with droopy eyelid muscles or temporary muscle weakness for weeks (the effects of Botox Cosmetic last 3 to 6 months). Still, battling the signs of age in a noninvasive way is appealing to many people, and the fact that there is little or no recovery time allows treatment during a lunch hour. The attraction of Botox to physicians is both professional (a new tool to fight wrinkles) and monetary (truly dedicated patients are back for injections every 3 to 6 months). Vanity pays!
Skin Color

Name the factors that determine skin color, and describe the function of melanin.

Three pigments contribute to skin color:

1. The amount and kind (yellow, reddish brown, or black) of melanin in the epidermis.
2. The amount of carotene deposited in the stratum corneum and subcutaneous tissue. Carotene is an orange-yellow pigment plentiful in carrots and other orange, deep yellow, or leafy green vegetables. The skin tends to take on a yellow-orange cast when the person eats large amounts of carotene-rich foods.
3. The amount of oxygen-rich hemoglobin (pigment in red blood cells) in the dermal blood vessels.

People who produce a lot of melanin have brown-toned skin. In light-skinned (Caucasian) people, who have less melanin, the crimson color of oxygen-rich hemoglobin in the dermal blood supply flushes through the transparent cell layers above and gives the skin a rosy glow.

Homeostatic Imbalance 4.3

When hemoglobin is poorly oxygenated, both the blood and the skin of Caucasians appear blue, a condition called cyanosis (si"ah-no"sis). Cyanosis is common during heart failure and severe breathing disorders. In black people, the skin does not appear cyanotic in the same situations because of the masking effects of melanin, but cyanosis is apparent in their mucous membranes and nail beds.

Emotions also influence skin color, and many alterations in skin color signal certain disease states:

- **Redness, or erythema** (er"th-e-mah). Reddened skin may indicate embarrassment (blushing), fever, hypertension, inflammation, or allergy.
- **Pallor, or blanching**. Under certain types of emotional stress (fear, anger, and others), some people become pale. Pale skin may also signify anemia, low blood pressure, or impaired blood flow into the area.
- **Jaundice** (jon"dis), or a yellow cast. An abnormal yellow skin tone usually signifies a liver disorder in which excess bile pigments are absorbed into the blood, circulated throughout the body, and deposited in body tissues.

- **Bruises, or black-and-blue marks**. Black-and-blue marks reveal sites where blood has escaped from the circulation and has clotted in the tissue spaces. Such clotted blood masses are called hematomas. An unusual tendency to bruising may signify a deficiency of vitamin C in the diet or hemophilia (bleeder’s disease).

Did You Get It?

9. You have just gotten a paper cut. It is very painful, but it doesn’t bleed. Has the cut penetrated into the dermis or just the epidermis?

10. What pigments determine skin color?

(For answers, see Appendix D.)

Appendages of the Skin

Describe the distribution and function of the epidermal derivatives—sebaceous glands, sweat glands, and hair.

The skin appendages include cutaneous glands, hair and hair follicles, and nails (see Figure 4.3). Each of these appendages arises from the epidermis and plays a unique role in maintaining body homeostasis.

Cutaneous Glands

The cutaneous glands are all exocrine glands that release their secretions to the skin surface via ducts. They fall into two groups: sebaceous glands and sweat glands. As these glands are formed by the cells of the stratum basale, they push into the deeper skin regions and ultimately reside almost entirely in the dermis.

Sebaceous (Oil) Glands

The sebaceous (seh-ba’shus) glands, or oil glands, are found all over the skin, except on the palms of the hands and the soles of the feet. Their ducts usually empty into a hair follicle (see Figure 4.3 and Figure 4.7, on p. 120), but some open directly onto the skin surface.

The product of the sebaceous glands, sebum (se’bum; seb = grease), is a mixture of oily substances and fragmented cells. Sebum is a lubricant that keeps the skin soft and moist and prevents the hair from becoming brittle. Sebum also contains chemicals that kill bacteria, so it is important in preventing the bacteria present on the skin surface from invading the deeper skin regions. The sebaceous glands become very active when male sex hormones are produced in increased amounts (in both sexes) during adolescence. Thus, the skin tends to become oilier during this period of life.
If a sebaceous gland's duct is blocked by sebum, a **whitehead** appears on the skin surface. If the accumulated material oxidizes and dries, it darkens, forming a **blackhead**. Acne is an active infection of the sebaceous glands accompanied by pimples on the skin. It can be mild or extremely severe, leading to permanent scarring. **Seborrhea** (seb"o-re‘ah; “fast-flowing sebum”), known as “cradle cap” in infants, is caused by overactivity of the sebaceous glands. It begins on the scalp as pink, raised lesions that gradually form a yellow to brown crust that sloughs off oily scales. Careful washing to remove the excessive oil often helps cradle cap in a newborn baby.
Sweat Glands  Sweat glands, also called sudoriferous (su"do-ri-f"er-us; sudor = sweat) glands, are widely distributed in the skin. Their number is staggering—more than 2.5 million per person. There are two types of sweat glands, eccrine and apocrine.

The eccrine (ek’rin) glands are far more numerous and are found all over the body. They produce sweat, a clear secretion that is primarily water plus some salts (sodium chloride), vitamin C, traces of metabolic wastes (ammonia, urea, uric acid), and lactic acid (a chemical that accumulates during vigorous muscle activity). Sweat is acidic (pH from 4 to 6), a characteristic that inhibits the growth of certain bacteria, which are always present on the skin surface. Typically, sweat reaches the skin surface via a duct that opens externally as a funnel-shaped pore (see Figures 4.3 and 4.7). Notice, however, that the facial “pores” commonly referred to when we talk about our complexion are the external outlets of hair follicles, not these sweat pores.

The eccrine sweat glands are an important and highly efficient part of the body’s heat-regulating equipment. They are supplied with nerve endings that cause them to secrete sweat when the external temperature or body temperature is high. When sweat evaporates off the skin surface, it carries large amounts of body heat with it. On a hot day, it is possible to lose up to 7 liters of body water in this way. The heat-regulating functions of the body are important—if internal temperature changes more than a few degrees from the normal 37°C (98.2°F), life-threatening changes occur in the body. (We discuss body temperature regulation in more detail in Chapter 14.)

Apocrine (ap’o-krin) glands are largely confined to the axillary (armpit) and genital areas of the body. They are usually larger than eccrine glands, and their ducts empty into hair follicles. Their secretion contains fatty acids and proteins, as well as all the substances present in eccrine secretion; consequently, it may have a milky or yellowish color. The secretion is odorless, but when bacteria that live on the skin use its proteins and fats as a source of nutrients for their growth, it takes on a musky, unpleasant odor.

Apocrine glands begin to function during puberty under the influence of androgens (male sex hormones). Although their secretion is produced almost continuously, apocrine glands play a minimal role in thermoregulation. Their precise function is not yet known, but they are activated by nerve fibers during pain and stress and during sexual foreplay.

Hair and Hair Follicles

Hair is an important part of our body image. Consider, for example, the spiky hair style of punk rockers and the flowing locks of some high-fashion models. Millions of hairs are scattered all over the body. But, other than serving a few minor protective functions—such as guarding the head against bumps, shielding the eyes (via eyelashes), and helping to keep foreign particles out of the respiratory tract (via nose hairs)—our body hair has lost much of its usefulness. Hair served early humans (and still serves hairy animals) by providing insulation in cold weather, but now we have other means of keeping warm.

Hairs  A hair, produced by a hair follicle, is a flexible epithelial structure. That part of the hair enclosed in the follicle is called the root. The part projecting from the surface of the scalp or skin is called the shaft (Figure 4.8, p. 122). A hair forms by division of the well-nourished stratum basale epithelial cells in the matrix (growth zone) of the hair bulb at the inferior end of the follicle. As the daughter cells are pushed farther away from the growing region, they become keratinized and die. Thus the bulk of the hair shaft, like the bulk of the epidermis, is dead material and almost entirely protein.

Each hair is made up of a central core called the medulla (me-dul’ah), consisting of large cells and air spaces, surrounded by a bulky cortex layer composed of several layers of flattened cells. The cortex is, in turn, enclosed by an outermost cuticle formed by a single layer of cells that overlap one another like shingles on a roof. This arrangement of the cuticle cells helps to keep the hairs apart and keeps them from matting (see Figure 4.8b and Figure 4.9 on p. 123). The cuticle is the most heavily keratinized region; it provides strength and helps keep the inner hair layers tightly compacted. Because it is most subject to abrasion, the cuticle tends to wear away at the tip of the shaft, allowing the keratin fibrils in the inner hair regions to frizz out, a phenomenon called “split ends.” Hair pigment is made by melanocytes in the hair bulb, and varying amounts of different types of melanin (yellow, rust, brown, and black) combine to produce all varieties of hair color from pale blond to pitch black.
Hairs come in a variety of sizes and shapes. They are short and stiff in the eyebrows, long and flexible on the head, and usually nearly invisible almost everywhere else. When the hair shaft is oval, hair is smooth and silky and the person has wavy hair. When the shaft is flat and ribbonlike, the hair is curly or kinky. If it is perfectly round, the hair is straight and tends to be coarse. Hairs are found all over the body surface except the palms of the hands, soles of the feet,
fur. It is especially dramatic in a scared cat, whose fur actually stands on end to make it look larger to scare off its enemy. However, this hair-raising phenomenon is not very useful to human beings.

Nails

A nail is a scalelike modification of the epidermis that corresponds to the hoof or claw of other animals. Each nail has a free edge, a body (visible attached portion), and a root (embedded in the skin). The borders of the nail are overlapped by skin folds, called nail folds. The edge of the thick proximal nail fold is commonly called the cuticle (Figure 4.10).

The stratum basale of the epidermis extends beneath the nail as the nail bed. Its thickened proximal area, called the nail matrix, is responsible for nail growth. As the nail cells are produced by the matrix, they become heavily keratinized and die. Thus, nails, like hairs, are mostly nonliving material.

Hair Follicles

Hair follicles (folli = bag) are actually compound structures. The inner epithelial root sheath is composed of epithelial tissue and forms the hair. The outer fibrous sheath is actually dermal connective tissue. This dermal region supplies blood vessels to the epidermal portion and reinforces it. Its nipplelike hair papilla provides the blood supply to the matrix in the hair bulb (the deepest part of the follicle).

Look carefully at the structure of the hair follicle (see the front corner of Figure 4.3). Notice that it is slightly slanted. Small bands of smooth muscle cells—arrector pili (ah-rek’tor pi’li; “raiser of hair”)—connect each side of the hair follicle to the dermal tissue. When these muscles contract (as when we are cold or frightened), the hair is pulled upright, dimpling the skin surface with “goose bumps.” This action helps keep animals warm in winter by adding a layer of insulating air to the fur. It is especially dramatic in a scared cat, whose fur actually stands on end to make it look larger to scare off its enemy. However, this hair-raising phenomenon is not very useful to human beings.
Nails are transparent and nearly colorless, but they look pink because of the rich blood supply in the underlying dermis. The exception to this is the region over the thickened nail matrix that appears as a white crescent and is called the lunule (loo’nyul; lunul = crescent). As noted earlier, when the supply of oxygen in the blood is low, the nail beds take on a cyanotic (blue) cast.

**Did You Get It?**

11. Which of the cutaneous gland types can make your hair limp and oily?

12. What are the three concentric regions of a hair shaft, from the outside in?

13. What is sebum?

14. How do secretions of apocrine glands differ from those of the eccrine sweat glands?

15. When a factory worker caught his finger in a machine, the entire nail, plus the nail matrix and bed, was torn off. Will his nail grow back? Why or why not?

(For answers, see Appendix D.)

**Homeostatic Imbalances of Skin**

4-8 Differentiate first-, second-, and third-degree burns.

4-9 Explain the importance of the “rule of nines.”

4-10 Summarize the characteristics of basal cell carcinoma, squamous cell carcinoma, and malignant melanoma.

When the skin rebels, it is quite a visible revolution. Loss of homeostasis in body cells and organs reveals itself on the skin, sometimes in startling ways. The skin can develop more than 1,000 different ailments. The most common skin disorders are bacterial, viral, or fungal infections. Less common, but far more damaging to body well-being, are burns and skin cancers. We briefly summarize a number of the homeostatic imbalances of the skin here.

**Burns**

There are few threats to life more serious than burns. A burn is tissue damage and cell death caused by intense heat, electricity, ultraviolet radiation (sunburn), or certain chemicals (such as acids), which denature proteins and cause cell death in the affected areas.

When the skin is burned and its cells are destroyed, two life-threatening problems result. First, the body loses its precious supply of fluids containing proteins and electrolytes as these seep from the burned surfaces. Dehydration and electrolyte imbalance follow and can lead to a shutdown of the kidneys and circulatory shock (inadequate circulation of blood caused by low blood volume). To save the patient, lost fluids must be replaced immediately. The volume of fluid lost can be estimated indirectly by determining how much of the body surface is burned (extent of burns), using the rule of nines. This method divides the body into 11 areas, each accounting for 9 percent of the total body surface area, plus an additional area surrounding the genitals (the perineum) representing 1 percent of body surface area (Figure 4.11a).

Later, infection becomes the most important threat and is the leading cause of death in burn victims. Burned skin is sterile for about 24 hours. But after that, pathogens (path’o-jenz) such as bacteria and fungi easily invade areas where the skin has been destroyed and multiply rapidly in the nutrient-rich environment of dead tissues. To make matters worse, the patient’s immune system becomes depressed within one to two days after severe burn injury.

Burns are classified according to their severity (depth) as first-, second-, or third-degree burns (Figure 4.11b). In first-degree burns, only the epidermis is damaged. The area becomes red and swollen. Except for temporary discomfort, first-degree burns are not usually serious and generally heal in two to three days without any special attention. Sunburn is usually a first-degree burn.

Second-degree burns involve injury to the epidermis and the upper region of the dermis. The skin is red and painful, and blisters appear. Because sufficient numbers of epithelial cells are still present, regrowth (regeneration) of the epithelium can occur. Ordinarily, no permanent scars result if care is taken to prevent infection. First- and second-degree burns are referred to as partial-thickness burns.

Third-degree burns destroy the entire thickness of the skin, so these burns are also called full-thickness burns. The burned area appears blanched (gray-white) or blackened, and because the nerve endings in the area are destroyed, the burned area is not painful. In third-degree burns, regeneration is not possible, and skin grafting must be done to cover the underlying exposed tissues.
Would you expect to see hair regeneration in an area that suffers third-degree burns? Why or why not?

In general, burns are considered critical if any of the following conditions exists:

1. Over 25 percent of the body has second-degree burns,
2. Over 10 percent of the body has third-degree burns, or
3. There are third-degree burns of the face, hands, or feet.

Facial burns are particularly dangerous because of the possibility of burns in respiratory passageways, which can swell and cause suffocation. Joint injuries are troublesome because the scar tissue that eventually forms can severely limit joint mobility.

Infections and Allergies

- **Athlete’s foot.** An itchy, red, peeling condition of the skin between the toes, resulting from fungus infection. Also called *tinea pedis.*
- **Boils and carbuncles** (kar’bun-kulz). Inflammation of hair follicles and sebaceous glands, common on the dorsal neck. Carbuncles are composite boils typically caused by bacterial infection (often *Staphylococcus aureus*).
• **Cold sores** (fever blisters). Small fluid-filled blisters that itch and sting, caused by a herpes simplex infection. The virus localizes in a cutaneous nerve, where it remains dormant until activated by emotional upset, fever, or UV radiation. Cold sores usually occur around the lips and in the oral mucosa of the mouth (Figure 4.12a).

• **Contact dermatitis.** Itching, redness, and swelling of the skin, progressing to blistering. It is caused by exposure of the skin to chemicals (such as those in poison ivy) that provoke allergic responses in sensitive individuals.

• **Impetigo** (im-peh-ti’go; impet = an attack). Pink, water-filled, raised lesions (commonly around the mouth and nose) that develop a yellow crust and eventually rupture (Figure 4.12b). Caused by a highly contagious staphylococcus infection, impetigo is common in elementary school–aged children.

• **Psoriasis** (so-ri’ah-sis). A chronic condition, characterized by overproduction of skin cells that results in reddened epidermal lesions covered with dry, silvery scales that itch, burn, crack, and sometimes bleed (Figure 4.12c). When severe, psoriasis may be disfiguring. It is believed to be an autoimmune disorder in which the immune system attacks a person’s own tissues. Attacks are often triggered by trauma, infection, hormonal changes, or stress.

**Skin Cancer**

Numerous types of neoplasms (tumors) arise in the skin. Most skin neoplasms are benign and do not spread (metastasize) to other body areas. (A wart caused by a virus is one such example.) However, some skin neoplasms are malignant, or cancerous, and they tend to invade other body areas.

Recall that mitosis gone wild is the basis for cancer (Chapter 3, p. 85). In malignant cancers, the stages of mitosis occur so quickly that errors are made. As a result, these cells lack normal control of such processes as mitosis and cell division. Cells experiencing rapid, uncontrolled growth become cancerous.

Skin cancer is the single most common type of cancer in humans. One in five Americans now develops skin cancer at some point in his or her life. The most important risk factor is overexposure to ultraviolet radiation in sunlight. Frequent irritation of the skin by infections, chemicals, or physical trauma also seems to be a predisposing factor.

**Basal Cell Carcinoma** Basal cell carcinoma (kar"si-no’mah) is the least malignant and most common skin cancer. Cells of the stratum basale, altered so that they cannot form keratin, no longer honor the boundary between epidermis and dermis. They proliferate, invading the dermis and subcutaneous tissue. The cancer lesions occur most often on sun-exposed areas of the face and appear as shiny, dome-shaped nodules that later develop a central ulcer with a “pearly” beaded edge (Figure 4.13a). Basal cell carcinoma is relatively slow-growing, and metastasis seldom occurs before it is noticed. Full cure is the rule in 99 percent of cases in which the lesion is removed surgically.
Squamous Cell Carcinoma  

Squamous cell carcinoma arises from the cells of the stratum spinosum. The lesion appears as a scaly, reddened papule (small, rounded elevation) that gradually forms a shallow ulcer with a firm, raised border (Figure 4.13b). This variety of skin cancer appears most often on the scalp, ears, dorsum of the hands, and lower lip. It grows rapidly and metastasizes to adjacent lymph nodes if not removed. This epidermal cancer is also believed to be sun-induced. If it is caught early and removed surgically or by radiation therapy, the chance of complete cure is good.

Malignant Melanoma  

Malignant melanoma (mel"-ah-no’mah) is a cancer of melanocytes. It accounts for only about 5 percent of skin cancers, but it is often deadly. Melanoma can begin wherever there is pigment; most such cancers appear spontaneously, but some develop from pigmented moles. It arises from accumulated DNA damage in a skin cell and usually appears as a spreading brown to black patch (Figure 4.13c) that metastasizes rapidly to surrounding lymph and blood vessels. The chance for survival is about 50 percent, and early detection helps. The American Cancer Society suggests that people who sunbathe frequently or attend tanning parlors examine their skin periodically for new moles or pigmented spots and apply the ABCD rule for recognizing melanoma:

- **Asymmetry.** The two sides of the pigmented spot or mole do not match.
- **Border irregularity.** The borders of the lesion are not smooth but exhibit indentations.
- **Color.** The pigmented spot contains areas of different colors (blacks, browns, tans, and sometimes blues and reds).
- **Diameter.** The spot is larger than 6 millimeters (mm) in diameter (the size of a pencil eraser).

Some experts have found that adding an E, for a lesion that is evolving, or changing, improves diagnosis. The usual therapy for malignant melanoma is wide surgical excision along with immunotherapy.

**Did You Get It?**

16. What are the two life-threatening consequences of a severe burn?

17. What are the criteria for classifying burns as first-, second-, or third-degree?

18. What name is given to the rule for recognizing the signs of melanoma?

19. What is the single most common risk factor for skin cancer?

20. Why do no skin cancers develop from stratum corneum cells?

(For answers, see Appendix D.)
Developmental Aspects of Skin and Body Membranes

During the fifth and sixth months of fetal development, the soon-to-be-born infant is covered with a downy type of hair called lanugo (lah-noo’go). This hairy cloak has usually been shed by birth, and when a baby is born, its skin is covered with vernix caseosa (ver’niks kah-se-o’sa). This white, cheesy-looking substance, produced by the sebaceous glands, protects the baby’s skin while it is floating in its water-filled sac inside the mother. The newborn’s skin is very thin, and blood vessels are easily seen through it. Commonly, there are accumulations in the sebaceous glands, which appear as small white spots called milia (mil’e-ah), on the baby’s nose and forehead. These normally disappear by the third week after birth. As the baby grows, its skin becomes thicker and moist, and more subcutaneous fat is deposited.

During adolescence, the skin and hair become more oily as sebaceous glands are activated, and acne may appear. Acne usually subsides in early adulthood, and the skin reaches its optimal appearance when we are in our twenties and thirties. Then visible changes in the skin begin to appear as it is continually assaulted by abrasion, chemicals, wind, sun, and other irritants and as its pores become clogged with air pollutants and bacteria. As a result, pimples, scales, and various kinds of dermatitis (der”mah-ti’tis), or skin inflammation, become more common.

During old age, the amount of subcutaneous tissue decreases, leading to the intolerance to cold so common in older adults. The skin also becomes drier (because of decreased oil production), and as a result, it may become itchy and bothersome. Thinning of the skin, another result of the aging process, makes it more susceptible to bruising and other types of injuries. The decreasing elasticity of the skin, along with the loss of subcutaneous fat, allows bags to form under our eyes, and our jowls begin to sag. Smoking and sunlight speed up this loss of elasticity, so two of the best things you can do for your skin are to stop smoking if you have that habit and to shield your skin from the sun by wearing sunscreens and protective clothing. In doing so, you will also be decreasing the chance of skin cancer. There is no way to avoid the aging of the skin, but good nutrition, plenty of fluids, and cleanliness help delay the process.

Hair loses its luster as we age, and by age 50 the number of hair follicles has dropped by one-third and continues to decline, resulting in hair thinning and some degree of baldness, or alopecia (al”o-pe’she-ah), in most people. Many men become obviously bald as they age, a phenomenon called male pattern baldness. A bald man is not really hairless—he does have hairs in the bald area. But, because those hair follicles have begun to degenerate, the hairs are colorless and very tiny (and may not even emerge from the follicle). Such hairs are called vellus (vell = wool) hairs.

Another phenomenon of aging is graying hair. Like balding, this is usually genetically controlled by a “delayed-action” gene. Once the gene takes effect, the amount of melanin deposited in the hair decreases or becomes entirely absent, which results in gray-to-white hair.

Homeostatic Imbalance 4.5

Certain events can cause hair to gray or fall out prematurely. For example, many people have claimed that they turned gray nearly overnight because of some emotional crisis in their life. In addition, we know that anxiety, protein-deficient diets, therapy with certain chemicals (chemotherapy), radiation, excessive vitamin A, and certain fungal diseases (ringworm) can cause both graying and hair loss. However, when the cause of these conditions is not genetic, hair loss is usually not permanent.

Did You Get It?

21. What change in aging skin accounts for wrinkles and cold intolerance in older adults?

22. What is the source of vernix caseosa that covers the skin of the newborn baby?

(For answers, see Appendix D.)
“If you have a basic understanding of anatomy and medical terminology, you will be much more accurate at interpreting and transcribing what you hear.”

Every time you consult a doctor or are hospitalized, your medical record gets longer. Medical transcriptionists play a key role in creating and maintaining these vital documents.

A medical transcriptionist is a medical language specialist who interprets and transcribes notes dictated by physicians and other healthcare professionals. These reports, which cover all aspects of a patient’s assessment, diagnosis, treatment, and outcome, become part of the person’s confidential medical record. Medical transcriptionists work in hospitals, clinics, doctors’ offices, transcription services, insurance companies, and home healthcare agencies.

What does it take to be a transcriptionist? “Certainly, you need a good English background,” says Pamela Shull, an experienced transcriptionist in San Jose, California. “Strong grammar, spelling, and punctuation skills are crucial. Physicians often dictate these records on the go, and a good transcriptionist must be able to edit the dictated material for grammar and clarity.”

Knowledge of anatomy and physiology, however, is even more important. Notes Shull, “If you understand anatomy and medical terminology, you will be much more accurate at interpreting and transcribing what you hear. A hospital transcriptionist deals with terms from a wide variety of medical specialties—one dictation might be from a gynecologist, the next from an orthopedic surgeon, and the next from a pediatrician.” This is why anatomy and physiology, medical terminology, and the study of disease processes make up most of the curriculum in medical transcription training programs.

All health professionals who treat a patient rely on these typed documents, so accurate transcription is vital: “I see the transcriptionist as a partner with physicians. We work with them to create excellent medical records, so patients will always be assured of receiving the best and most appropriate care possible.”

Shull enjoys the variety of medical transcription work. “It’s fascinating because you get to follow each patient’s story, from the initial problem to diagnosis and treatment,” she says. “You feel like you know these people. It’s like watching a gripping television drama—only this is real life!”

Classes for medical transcription are offered through community colleges, proprietary schools, and home-study programs and vary in length from several months to two years. Accreditation procedures vary from state to state. The Association for Healthcare Documentation Integrity (AHDI) evaluates medical transcription programs and posts a list of recommended programs on its website.

For more information, contact the AHDI:
4230 Kiernan Avenue, Suite 130
Modesto, CA 95356
(800) 982-2182 or (209) 527-9620
http://ahdionline.org/

For additional information on this career and others, click the Focus on Careers link at MasteringA&P®.
Homeostatic Relationships between the Integumentary System and Other Body Systems

**Endocrine System**
- Skin protects endocrine organs
- Androgens produced by the endocrine system activate sebaceous glands and help regulate hair growth; estrogen helps maintain skin hydration

**Lymphatic System/Immunity**
- Skin protects lymphoid organs; prevents pathogen invasion
- Lymphatic system prevents edema by picking up excessive leaked fluid; immune system protects skin cells

**Digestive System**
- Skin protects digestive organs; provides vitamin D needed for calcium absorption
- Digestive system provides needed nutrients for the skin

**Urinary System**
- Skin protects urinary organs; excretes salts and some nitrogen-containing wastes in sweat
- Urinary system activates vitamin D made by keratinocytes; disposes of nitrogen-containing wastes of skin metabolism

**Respiratory System**
- Skin protects respiratory organs
- Respiratory system furnishes oxygen to skin cells and removes carbon dioxide via gas exchange with blood

**Cardiovascular System**
- Skin protects cardiovascular organs; prevents fluid loss from body surface; serves as blood reservoir
- Cardiovascular system transports oxygen and nutrients to skin and removes wastes from skin; provides substances needed by skin glands to make their secretions

**Reproductive System**
- Skin protects reproductive organs; highly modified sweat glands (mammary glands) produce milk. During pregnancy, skin stretches to accommodate growing fetus; changes in skin pigmentation may occur

**Skeletal System**
- Skin protects bones; skin synthesizes vitamin D that bones need for normal calcium absorption and deposit of bone (calcium) salts, which make bones hard
- Skeletal system provides support for the skin

**Nervous System**
- Skin protects nervous system organs; cutaneous sensory receptors located in skin
- Nervous system regulates diameter of blood vessels in skin; activates sweat glands, contributing to thermoregulation; interprets cutaneous sensation; activates arrector pili muscles

**Integumentary System (Skin)**
- Skin protects skin
- Active muscles generate large amounts of heat, which increases blood flow to the skin and may promote activation of sweat glands of skin
Classification of Body Membranes  (pp. 109–112)

1. Epithelial: Simple organs, epithelium and connective tissue components.
   a. Cutaneous (the skin): epidermis (stratified squamous epithelium) underlain by the dermis (dense connective tissue); protects body surface.
   b. Mucous: epithelial sheet underlain by a lamina propria (areolar connective tissue); lines body cavities open to the exterior.
   c. Serous: simple squamous epithelium resting on a scant connective tissue layer; lines the ventral body cavity.

2. Connective tissue: Synovial; lines joint cavities.

The Integumentary System (Skin)  (pp. 112–127)

1. Skin functions include protecting the deeper tissue from chemicals, bacteria, bumps, and drying; regulating body temperature through radiation and sweating; and synthesizing defensive proteins and vitamin D. The cutaneous sensory receptors are located in the skin.

2. The epidermis, the more superficial part of the skin, is formed of stratified squamous keratinizing epithelium and is avascular. Moving from its superficial to deep region, its layers are the stratum corneum, stratum lucidum (in thick skin only), stratum granulosum, stratum spinosum, and stratum basale. Cells at its surface are dead and continually flake off. They are replaced by division of cells in the basal cell layer. As the cells move away from the basal layer, they accumulate keratin and die. Melanin, a pigment produced by melanocytes, protects the nuclei of epithelial cells from the damaging rays of the sun.

3. The dermis is composed of dense connective tissue. It is the site of blood vessels, nerves, and epidermal appendages. It has two regions, the papillary and reticular layers. The papillary layer has ridges, which press on the epidermis to produce fingerprints.

4. Skin appendages are formed from the epidermis but reside in the dermis.
   a. Sebaceous glands produce an oily product (sebum), usually ducted into a hair follicle. Sebum keeps the skin and hair soft and contains bacteria-killing chemicals.
   b. Sweat (sudoriferous) glands, under the control of the nervous system, produce sweat, which is ducted to the epithelial surface. These glands are part of the body’s heat-regulating apparatus. There are two types: eccrine (the most numerous) and apocrine (their product includes fatty acids and proteins, which skin bacteria metabolize).
   c. A hair is primarily dead keratinized cells and is produced by the matrix in the hair bulb. The root is enclosed in a sheath, the hair follicle.
   d. Nails are hornlike derivatives of the epidermis. Like hair, nails are primarily dead keratinized cells.

5. Most minor afflictions of the skin result from infections or allergic responses; more serious are burns and skin cancer. Because they interfere with skin’s protective functions, burns represent a major threat to the body.
   a. Burns result in loss of body fluids and invasion of bacteria. The extent of burns is assessed by the rule of nines. The severity (depth) of burns is described as first-degree (epidermal damage only), second-degree (epidermal and some dermal injury), and third-degree (epidermis and dermis totally destroyed). Third-degree burns require skin grafting.
   b. The most common cause of skin cancer is exposure to ultraviolet radiation. Basal cell carcinoma and squamous cell carcinoma can be completely cured if they are removed before metastasis. Malignant melanoma, a cancer of melanocytes, is still fairly rare but is fatal in about half the cases.

Developmental Aspects of Skin and Body Membranes  (p. 128)

1. The skin is thick, resilient, and well hydrated in youth but loses its elasticity and thins as the person ages. Skin cancer is a major threat to skin exposed to excessive sunlight.

2. Balding and/or graying occurs with aging. Both are genetically determined, but other factors (drugs, emotional stress, and so on) can result in either.
REVIEW QUESTIONS

Multiple Choice
More than one choice may apply.

1. Select the one false statement about mucous and serous membranes.
   a. The epithelial type is the same in all serous membranes, but there are different epithelial types in different mucous membranes.
   b. Serous membranes line closed body cavities, whereas mucous membranes line body cavities open to the outside.
   c. Serous membranes always produce serous fluid, and mucous membranes always secrete mucus.
   d. Both membranes contain an epithelium plus a layer of loose connective tissue.
   e. secrete a lubricating fluid.

2. Serous membranes
   a. line the mouth.
   b. have parietal and visceral layers.
   c. consist of epidermis and dermis.
   d. have a connective tissue layer called the lamina propria.
   e. secrete a lubricating fluid.

3. Which is not a component of sweat?
   a. Water
   b. Sodium chloride
   c. Sebum
   d. Ammonia
   e. Vitamin D

4. Which structure is not associated with a hair?
   a. Shaft
   b. Cortex
   c. Matrix
   d. Cuticle
   e. Lunule

5. In investigating the cause of thinning hair, which of the following questions needs to be asked?
   a. Is the diet deficient in proteins?
   b. Is the person taking megadoses of vitamin C?
   c. Has the person been exposed to excessive radiation?
   d. Has the person recently suffered severe emotional trauma?

6. Which structure is not associated with a nail?
   a. Nail bed
   b. Lunule
   c. Nail folds
   d. Nail follicle
   e. Reticular layer of the dermis
   f. Dermal blood supply
   g. Papillary layer of the dermis
   h. Hypodermis
   i. Melanocytes
   j. Stratum corneum
   k. Eccrine sweat glands

7. Which one of the following is not associated with the production of perspiration?
   a. Sweat glands
   b. Sweat pores
   c. Arrector pili
   d. Eccrine gland
   e. Apocrine gland

8. Which of the following is not a skin structure?
   a. Nerve fiber
   b. Hair
   c. Hair papilla
   d. Nail

9. Match the structures on the right with their function listed on the left.
   1. Protection from ultraviolet radiation
   2. Insulation, energy storage
   3. Waterproofing and preventing water loss
   4. Temperature regulation
   5. Excretion of water, urea, and salts
   6. Produces the patterns for fingerprints

   a. Reticular layer of the dermis
   b. Dermal blood supply
   c. Papillary layer of the dermis
   d. Hypodermis
   e. Melanocytes
   f. Stratum corneum
   g. Eccrine sweat glands

Short Answer Essay

10. What is the name of the connective tissue membrane found lining the joint cavities?

11. From what types of damage does the skin protect the body?

12. Explain why we become tanned after sitting in the sun.

13. What is a decubitus ulcer? Why does it occur?

14. Name two different categories of skin secretions and the glands that manufacture them.

15. How does the skin help to regulate body temperature?

16. What is a blackhead?

17. What are arrector pili? What do they do?

18. Which skin cancer arises from the youngest epidermal cells?

19. Why does hair turn gray?

20. Name three changes that occur in the skin as one ages.

22. A nurse tells a doctor that a patient is cyanotic. What is cyanosis? What does its presence indicate?

23. Both newborn infants and aged individuals have very little subcutaneous tissue. How does this affect their sensitivity to cold environmental temperature?

24. A 40-year-old beachboy is complaining to you that his suntan made him popular when he was young—but now his face is all wrinkled, and he has several darkly pigmented moles that are growing rapidly and are as big as large coins. He shows you the moles, and immediately you think “ABCD.” What does that mean, and why should he be concerned?

25. Rebecca, 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?

26. The water of a swimming pool is hypotonic to our cells. Why do we not swell and pop when we go for a swim?

27. Mr. Rossi, a fisherman in his late sixties, 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?

28. Mr. Grayson is receiving a drug treatment transdermally (through the skin). Explain why drugs delivered by this route are fat-soluble rather than water-soluble.

29. Which type of injection would allow a drug to be absorbed more rapidly—intradermal or subcutaneous (a shallow injection just deep to the epidermis)? Why?

30. Think about the types and characteristics of cell junctions (Chapter 3). How does this help to explain why sunburned skin often peels in sheets?