STUDY QUESTIONS

1. Describe the role of the macrophage in the immune response.
2. State the origin and purpose of lymphocytes.
3. Compare active natural immunity and passive artificial immunity, describing the causative mechanism and giving an example.
4. What is the purpose of a booster vaccination?
5. Describe the purpose of gamma globulins.
6. Where is IgA found in the body?
7. Describe how type III hypersensitivity develops.
8. Explain the process by which an attack of hay fever follows exposure to pollen.
9. Explain why anaphylaxis is considered life threatening.
10. Describe the pathophysiology of a type III hypersensitivity reaction.
11. Define an autoimmune disease, and explain how the causative mechanism differs from a normal defense.
12. Describe two factors that promote a successful organ transplant.
13. Differentiate between a diagnosis of being HIV+ and a diagnosis of having AIDS.
14. Why are opportunistic infections common with AIDS?
15. State three methods of transmitting HIV and three methods by which the virus is not transmitted.
16. Describe two common complications associated with AIDS.

ADDITIONAL RESOURCES

Applegate EJ: *The Anatomy and Physiology Learning System Textbook*, ed 3, Philadelphia, 2006, Saunders.
Greenwood D, Slack RCB, Peutherer JF: *Medical Microbiology*, ed 17, London, 2007, Churchill Livingstone.
Guyton AC, Hall JE: *Textbook of Medical Physiology*, ed 11, Philadelphia, 2005, Saunders.
Journal of Allergy and Clinical Immunology. American Academy of Allergy, Asthma, and Immunology, Washington, DC, and http://www.aaaai.org/members/jaci.stm
Kumar V, Abbas AK, Fausto M: *Robbins and Cotran Pathologic Basis of Disease*, ed 8, Philadelphia, 2007, Saunders.
Miller-Keane, O'Toole M: *Miller-Keane Encyclopedia & Dictionary of Medicine, Nursing & Allied Health*, ed 7, Philadelphia, 2005, Saunders.
Purtilo R: *Ethical Dimensions in the Health Professions*, ed 4, Philadelphia, 2005, Saunders.

Web Sites

http://www.aarda.org American Autoimmune Related Diseases Association
http://www.cdc.gov/mmwr Morbidity and Mortality Weekly Report
http://www.clinicaltrials.gov National Library of Medicine
http://familydoctor.org/online/famdocen/home/healthy/safety/work/004. Occupational Exposure to HIV: Advice for Health Care Workers
http://library.med.utah.edu/WebPath/TUTORIAL/AIDS/AIDS.html AIDS Tutorial
http://www.niams.nih.gov National Institute of Arthritis and Musculoskeletal and Skin Diseases
http://www.rheumatology.org American College of Rheumatology
http://www.transweb.org A Resource on Transplantation and Donation

Information on Vaccinations or on HIV/AIDS

http://www.cdc.gov/travel Information on disease outbreaks and medications for foreign travel
http://www.nih.gov National Institutes of Health
http://www.who.int/en World Health Organization
http://www.who.int/hiv HIV/AIDS information

SECTION III
Pathophysiology of Body Systems

CHAPTER 8

Skin Disorders

CHAPTER OUTLINE

LEARNING OBJECTIVES

After studying this chapter, the student is expected to:

1. Describe common skin lesions.
2. Describe the causes, typical lesions, and location of contact dermatitis, urticaria, and atopic dermatitis.
3. Describe the cause and lesions associated with the inflammatory conditions psoriasis erythematosus, pemphigus, and scleroderma.
4. Distinguish between the bacterial infections impetigo and furuncles.
5. Describe the effects of *Streptococcus pyogenes* on connective tissue in acute necrotizing fasciitis.
6. Describe the affects and treatment of leprosy.
7. Describe the viral infections herpes simplex and warts.
8. Describe the forms of tinea, a fungal infection.
9. Describe the agent, the infection, and manifestations of scabies and pediculosis.
10. Compare the skin cancers, describing the lesion, predisposing factors, and spread of squamous cell carcinoma, malignant melanoma, and Kaposi's sarcoma.

KEY TERMS

albinism
atopic
autoinoculation
denuded
excoriations
keratin
larvae
lichenification
sebum

Review of the Skin

As the largest organ in the body, the skin plays significant roles in both the function of the body physically and in how we are perceived in society. The skin, or integument, consists of two layers, the epidermis and the underlying dermis, along with their associated appendages, such as hair follicles and glands (Fig. 8-1). The *epidermis* consists of five layers, which vary in thickness at different areas of the body. For example, facial skin is relatively thin, but the soles are protected by a thick layer of skin (primarily stratum corneum). There are *no blood vessels or nerves* in the epidermis. Nutrients and fluid diffuse into it from blood vessels located in the dermis.

The innermost layer of the epidermis is the stratum basale, located on the basement membrane. New squamous epithelial cells form by mitosis in the stratum basale (the only layer of the epidermis where mitosis occurs), and one of each pair of cells then moves upward, forming, in turn, the stratum spinosum, the stratum granulosum, and the stratum lucidum (which is present primarily in thick skin), eventually being shed from the outer layer, the stratum corneum. Although these cells are in the stratum granulosum, **keratin**, a protein found in skin, hair, and nails, is deposited in them. Keratin prevents both loss of body fluid through the skin and entry of excessive water into the body, as when swimming. The epithelial cells become flatter as they progress upward away from the dermis, and they eventually die from lack of nutrients. Thus, the stratum corneum, the top or outer layer of the epidermis, consists of many layers of dead, flat, keratinized cells that are constantly sloughed from the surface a few weeks after being formed in the basal layer.

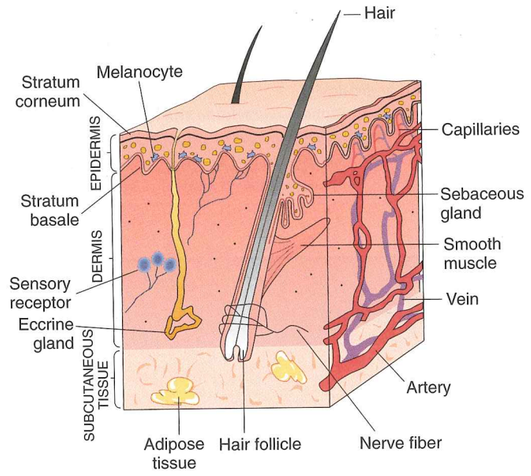

FIGURE 8-1 Diagram of the skin.

The epidermis also contains melanocytes, specialized pigment-producing cells. The amount of *melanin*, or dark pigment, produced by these cells determines skin color. Melanin production depends on multiple genes as well as environmental factors such as sun exposure (ultraviolet light). African Americans rarely develop skin cancer as a result of ultraviolet light exposure because of increased melanin in the skin, which acts as a protection from the sun's rays.

Albinism results from a recessive trait leading to a lack of melanin production. A person with this trait has white skin and hair and lacks pigment in the iris of the eye. This individual must avoid exposure to the sun. *Vitiligo* refers to small areas of hypopigmentation which may gradually spread to involve larger areas. *Melasma*, or *chloasma*, refers to patches of darker skin, often on the face, that may develop during pregnancy. An additional pigment, carotene, gives a yellow color to the skin. Pink tones in the skin are increased with additional vascularity or blood flow in the dermis.

The *dermis* is a thick layer of connective tissue that includes elastic and collagen fibers and varies in thickness over the body. These constituents provide both flexibility and strength in the skin and support for the nerves and blood vessels passing through the dermis. Many sensory receptors for pressure or texture, pain, heat, or cold are found in the dermis. The junction of the dermis with the epidermis is marked by papillae, irregular projections of dermis into the epidermal region. More capillaries are located in the papillae to facilitate diffusion of nutrients into the epidermis. Blood flow is controlled by the sympathetic nervous system.

Embedded in the skin are the *appendages*, or accessory structures—the hair follicles, sweat and sebaceous glands, and nails.

- The *hair follicles* are lined by epidermis that is continuous with the surface, the stratum basale producing the hair. Each hair follicle has smooth muscle attached to it, the arrector pili, controlled by sympathetic nerves. These may be stimulated by emotion or exposure to cold, causing the hairs to stand upright ("on end") or creating small elevations on the skin ("goose bumps").
- *Sebaceous glands* may be associated with hair follicles or may open directly onto the skin. These glands produce an oily secretion, **sebum**, which keeps the hair and skin soft and retards fluid loss from the skin. Secretions of sebum increase at puberty under the influence of the sex hormones.
- *Sweat glands* are of two types:
  - *Eccrine*, or merocrine, glands are located all over the body and secrete sweat through pores onto the skin in response to increased heat or emotional stress (SNS control).
  - *Apocrine* sweat glands are located in the axillae, scalp, face, and external genitalia, and the ducts of these glands open into the hair follicles.

The secretion, sweat or perspiration, is odorless when formed, but bacterial action by normal flora on the constituents of sweat often causes odor to develop.

Beneath the dermis is the *subcutaneous tissue* or *hypodermis*, which consists of connective tissue, fat cells, macrophages, fibroblasts, blood vessels, nerves, and the base of many of the appendages.

A complex mix of *resident (normal) flora* is present on the skin, and the components differ in various body areas (see Chapter 6). Microbes residing under the fingernails may infect inflammatory lesions or breaks in the skin, particularly when one scratches the skin. Microbes, primarily bacteria and fungi, are also present deep in the hair follicles and glands of the skin and may be a source of opportunistic infections when there is injury such as burns (see section on burns in Chapter 5) or other inflammatory lesion. Infection may spread systemically from skin lesions.

APPLY YOUR KNOWLEDGE 8-1

Explain how excessive handwashing may in some cases increase the potential for a bacterial skin infection.

Skin has many functions:

- When unbroken, it provides the *first line of defense* against invasion by microorganisms and other foreign material. The sebaceous glands produce sebum which is acidic and inhibits bacterial growth. The resident flora of the skin is a deterrent to invading organisms.
- Skin prevents excessive fluid loss.
- It is important in controlling body temperature, using two mechanisms: cutaneous vasodilation, which increases peripheral blood flow, and increased secretion and evaporation of sweat—both have a cooling effect on the body
- Sensory perception provided by the skin is important as a defense against environmental hazards, as a learning tool, and as a means of communicating emotions.
- Another important function of the skin is the synthesis and activation of vitamin D on exposure to small amounts of ultraviolet light.

The skin is prone to damage as it is in constant contact with the external environment which includes such threats as toxic chemicals, direct trauma, or animal bites/stings. Systemic disorders additionally may affect the skin. Also, the skin changes with aging, showing loss of elasticity, thinning, and loss of subcutaneous tissue (see Chapter 24). Minor abrasions or cuts of the skin heal quickly with mitosis of the epithelial cells (see Chapter 5 for the healing process). When large areas of the skin are damaged, appendages may be lost, function impaired, and fibrous scar tissue forms, often restricting mobility of joints. See the discussion on burns in Chapter 5 for information on biosynthetic wound coverings or "artificial skin," useful when large areas of skin are damaged.

THINK ABOUT 8-1

a. Describe three ways in which the dermis differs from the epidermis.
b. Explain how the basal layer of the epidermis is nourished.
c. Describe the role of sebaceous glands and eccrine glands.
d. Explain three ways the skin acts as a defense mechanism.

Skin Lesions

The characteristics of skin lesions are frequently helpful in making a diagnosis. Skin lesions may be caused by systemic disorders such as liver disease, systemic infections such as chickenpox (typical rash), or allergies to ingested food or drugs, as well as by localized factors such as exposure to toxins. Common types of lesions are illustrated in Figure 8-2 and defined in Table 8-1. The location, length of time the lesion has been present, and any changes occurring over time are significant. Physical appearance, including color, elevation, texture, type of exudate, and the presence of pain or pruritus (itching) are also important considerations. Some lesions, such as tumors, usually are neither painful nor pruritic and therefore may not be noticed. A few skin disorders, such as herpes, cause painful lesions.

TABLE 8-1 Description of Some Skin Lesions

Macule	Small, flat, circumscribed lesion of a different color than the normal skin
Papule	Small, firm, elevated lesion
Nodule	Palpable elevated lesion; varies in size
Pustule	Elevated, erythematous lesion, usually containing purulent exudate
Vesicle	Elevated, thin-walled lesion containing clear fluid (blister)
Plaque	Large, slightly elevated lesion with flat surface, often topped by scale
Crust	Dry, rough surface or dried exudate or blood
Lichenification	Thick, dry, rough surface (leather-like)
Keloid	Raised, irregular, and increasing mass of collagen resulting from excessive scar tissue formation
Fissure	Small, deep, linear crack or tear in skin
Ulcer	Cavity with loss of tissue from the epidermis and dermis, often weeping or bleeding
Erosion	Shallow, moist cavity in epidermis
Comedone	Mass of sebum, keratin, and debris blocking the opening of a hair follicle

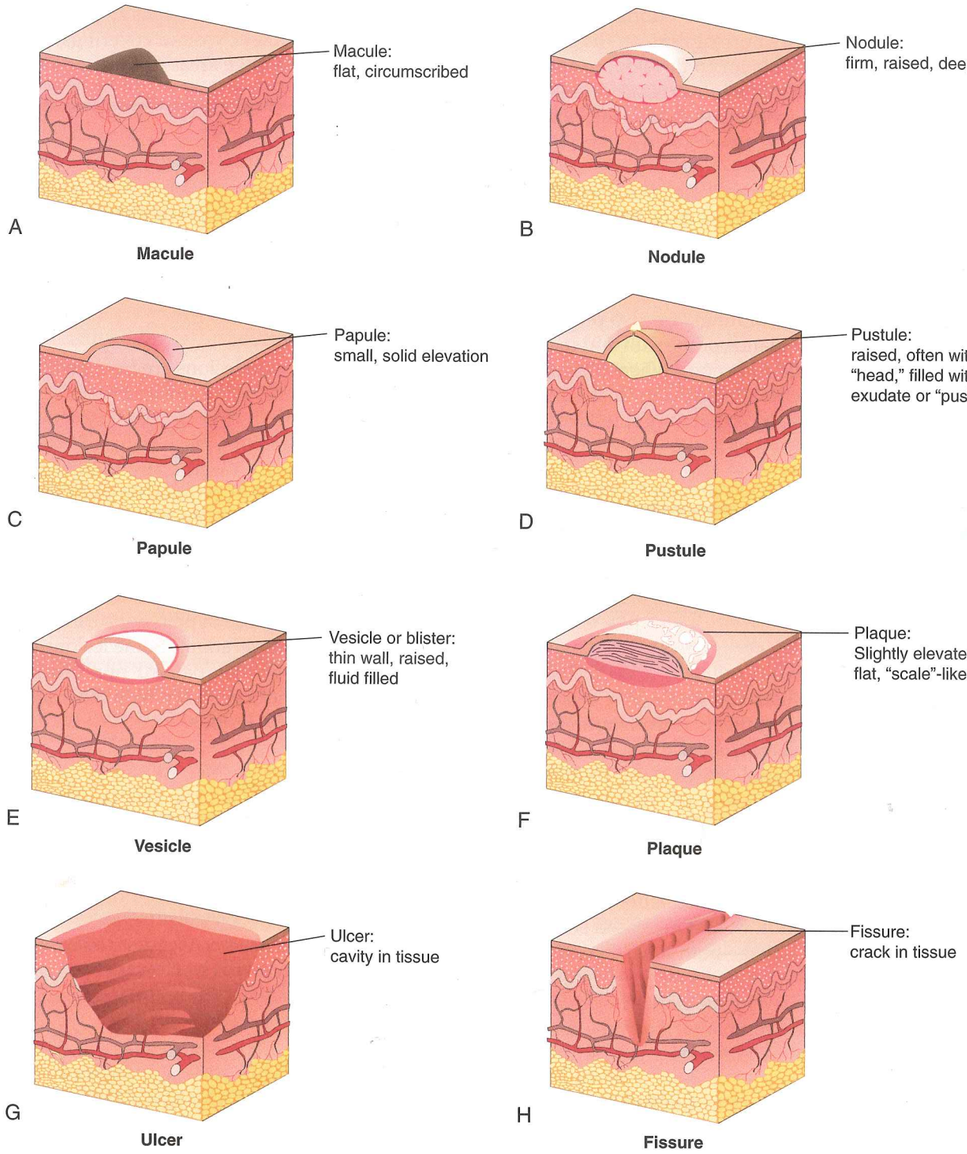

FIGURE 8-2 Common skin lesions.

Pruritus is associated with allergic responses, chemical irritation due to insect bites, or infestations by parasites such as scabies mites. The mechanisms producing pruritus are not totally understood. It is known that release of histamine in a hypersensitivity response causes marked pruritus (see Chapter 7). Pruritus also may result from mild stimulation of pain receptors by irritants. The most common manifestations include redness, and itchiness. Scratching a pruritic area usually increases the inflammation and may lead to secondary infection. Infection results from breaking the skin barrier, thus allowing microbes on the fingers (under the nails) or on the surrounding skin to invade the area. Infection may then produce scar tissue in the area.

Diagnostic Tests

Bacterial infections may require culture and staining of specimens for identification. Skin scrapings for microscopic examination, sample culturing, direct observation of the infected area and other specific procedures (e.g., ultraviolet light, Wood's lamp) are necessary to detect fungal or parasitic infections.

Biopsy is an important procedure in the detection of malignant changes in tissue and provides a safeguard prior to or following removal of any skin lesion.

Blood tests may be helpful in the diagnosis of conditions due to allergy or abnormal immune reactions. Patch or scratch tests are used to screen for allergens and may be followed up by diet restrictions to identify specific food allergens. Drug reactions are assessed utilizing specific antigen–antibody testing.

General Treatment Measures

Pruritus may be treated by antihistamines or glucocorticoids, administered topically or orally. Identification and avoidance of allergens reduce the risk of recurrence. With many skin disorders, extremes of heat or cold and contact with certain rough materials such as wool aggravate the skin lesions. Soaks or compresses using solutions such as Burow's solution (aluminum acetate) or colloidal oatmeal (Aveeno) may cool the skin and reduce itching. Some topical skin preparations contain a local anesthetic to reduce itching and burning sensations. Infections may require appropriate topical antimicrobial treatment. If the infection is severe, systemic medication may be preferred.

Precancerous lesions may be removed, by surgery, laser therapy, electrodesiccation (heat), or cryosurgery (e.g., freezing by liquid nitrogen).

THINK ABOUT 8-2

a. Describe each of the following: (1) macule; (2) vesicle; and (3) pustule.
b. Explain two causes of pruritus.
c. List four potential causes of skin lesions.
d. Explain why cellular components of all resected skin lesions should be evaluated by a pathologist.

There are a large number of skin disorders. Only a small number of representative dermatologic conditions are included here.

Inflammatory Disorders

Burns cause an acute inflammatory response. This topic is covered in Chapter 5 along with the processes of healing.

Contact Dermatitis

Contact dermatitis may be caused by exposure to an allergen or by direct chemical or mechanical irritation of the skin. *Allergic* dermatitis may result from exposure to any of a multitude of substances, including metals, cosmetics, soaps, chemicals, and plants. Sensitization occurs on the first exposure (type IV cell-mediated hypersensitivity—see Chapter 7), and on subsequent exposures, manifestations such as a pruritic rash develop at the site a few hours after exposure to that allergen. The location of the lesions is usually a clue to the identity of the allergen (Fig. 8-3). For example, poison ivy may cause lesions, often linear, on the ankles or hands, or a necklace may cause a rash around the neck. Typical allergic dermatitis is indicated by a pruritic, erythematous, and edematous area, which is often covered with small vesicles.

Direct *chemical* irritation does not involve an immune response but is an inflammatory response caused by direct exposure to substances such as soaps and cleaning materials, acids, or insecticides. The skin is usually red and edematous and may be pruritic or painful. Removal of the irritant as soon as possible and reduction of the inflammation with topical glucocorticoids are usually effective treatment.

Urticaria

Urticaria (hives) results from a type I hypersensitivity reaction, commonly caused by ingested substances such as shellfish or certain fruits or drugs. The subsequent release of histamine causes the eruption of hard, raised erythematous lesions on the skin, often scattered all

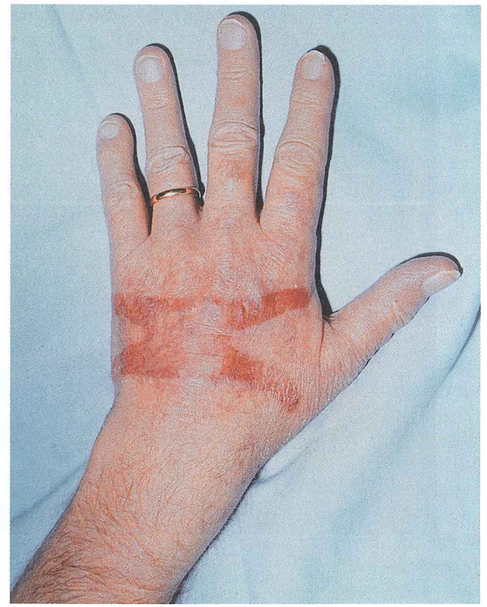

FIGURE 8-3 Contact dermatitis resulting from adhesive tape. Note how the location and shape of the rash indicate the causative agent. *(Courtesy of Dr. M. McKenzie, Toronto, Canada.)*

over the body (Fig. 8-4). The lesions are highly pruritic. Occasionally hives also develop in the pharyngeal mucosa and may obstruct the airway, causing difficulty with breathing. In this case, medical assistance should be sought as quickly as possible.

Atopic Dermatitis

Atopic dermatitis (eczema) is a common problem in infancy and may persist into adulthood in some persons. **Atopic** refers to an inherited tendency toward allergic conditions. Frequently the family history includes individuals with eczema, allergic rhinitis or hay fever, and asthma, indicating a genetic component. Chronic inflammation results from the response to allergens (Fig. 8-5). Eosinophilia and increased serum IgE levels indicate the allergenic basis for atopic dermatitis (type I hypersensitivity).

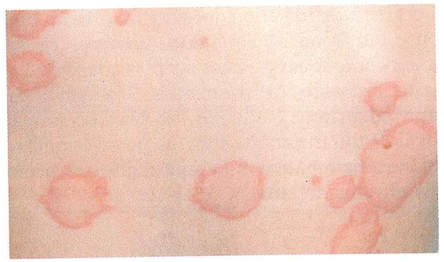

FIGURE 8-4 Urticaria (hives). *(From Dorland's Illustrated Medical Dictionary, ed 32, St. Louis, 2012, Saunders.)*

In infants, the pruritic lesions are moist, red, vesicular, and covered with crusts. Involved areas are usually located symmetrically on the face, neck, extensor surfaces of the arms and legs, and buttocks.

In adults, the affected skin appears dry and scaling with **lichenification** (thick and leathery patches), although it may be moist and red in the skin folds. Pruritus is common. Areas affected include the flexor surfaces of the arms and legs (e.g., antecubital areas) and the hands and feet. Potential complications include secondary infections due to scratching and disseminated viral infections such as herpes. Affected areas also become more sensitive to many irritants such as soaps and certain fabrics. Marked changes in temperature and humidity tend to aggravate the dermatitis, leading to more exacerbations in patients living in areas with dry winter months or hot, humid summers.

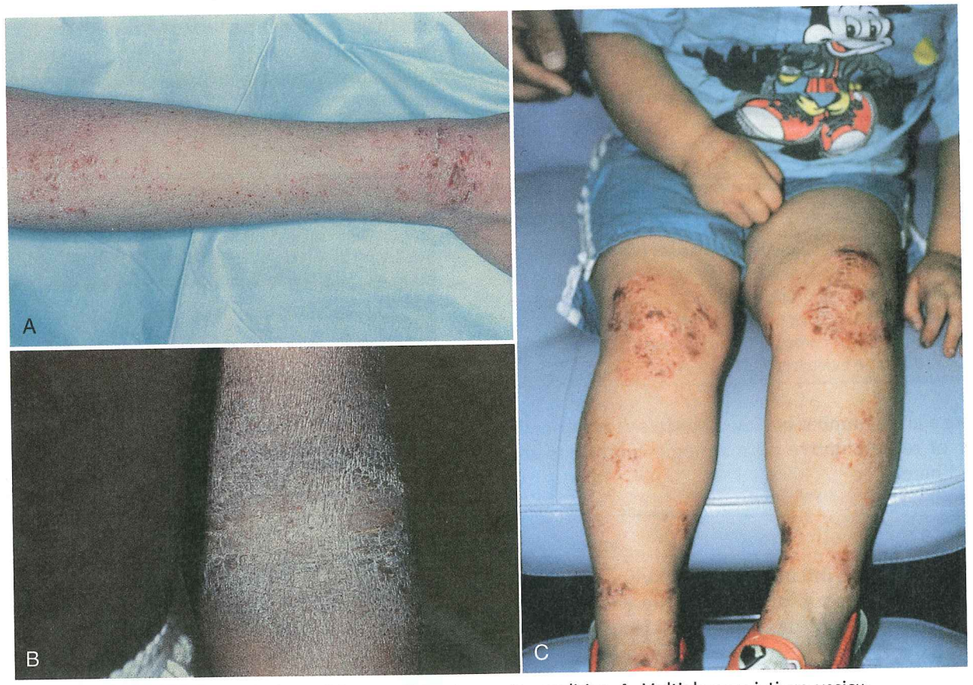

FIGURE 8-5 Atopic dermatitis—an extremely pruritic condition. **A,** Multiple excoriations, vesiculation, and marked lichenification are seen in this patient. **B,** Minute excoriations with marked lichenification in the antecubital fossa. *(From Callen JP, et al:* Color Atlas of Dermatology, *Philadelphia, 1993, Saunders, p 192.)* **C,** Atopic dermatitis. Characteristic lesions with crusting from irritation and scratching over knees and around ankles. *(From McCance KL, et al:* Pathophysiology, *ed 6, St. Louis, 2010, Mosby. Courtesy Department of Dermatology, School of Medicine, University of Utah.)*

Identification and elimination of the aggravating agents and the use of topical glucocorticoids are helpful. Antihistamines may reduce pruritus, and avoidance of skin irritants such as strong detergents or wool, a change to a hypoallergenic diet, and adequate moisturizing of the skin may reduce the inflammation. In severe cases, topical glucocorticoids may be used when severe pruritus interferes with sleeping and eating, particularly in infants, when the condition further exacerbates irritability and stress.

Psoriasis

Psoriasis is a chronic inflammatory skin disorder that affects 1% to 3% of the population and is considered to be genetic in origin following recent research studies in mice. Onset usually occurs in the teen years, and the course is marked by remissions and exacerbations. Cases vary in severity and psoriatic arthritis is associated with psoriasis in some cases.

Psoriasis results from the abnormal activation of T cells and an associated increase in cytokines in affected tissues. These immunologic changes then lead to excessive proliferation of keratinocytes and the symptoms of the disease. Animal studies have shown that a reduction in T-cell activity leads to regression of skin changes in a short period of time.

The rate of cellular proliferation is greatly increased, leading to thickening of the dermis and epidermis. Epidermal shedding may occur in 1 day rather than the normal 2-week turnover period. The lesion begins as a small red papule that enlarges. A silvery plaque forms while the base remains erythematous because of inflammation and vasodilation. (Figure 8-6 illustrates the acute inflammatory stage and the chronic lesion.) If the plaque is removed, small bleeding points are apparent. Lesions are commonly found on the face, scalp, elbows, and knees and may be accompanied by itching or burning sensation. The fingernails may be thickened, pitted or ridged.

Treatments that reduce cell proliferation include glucocorticoids, tar preparations, and, in severe cases, the antimetabolite methotrexate. Exposure to ultraviolet light is frequently part of the treatment regimen. Research on new treatments related to immunologic changes in psoriasis is underway.

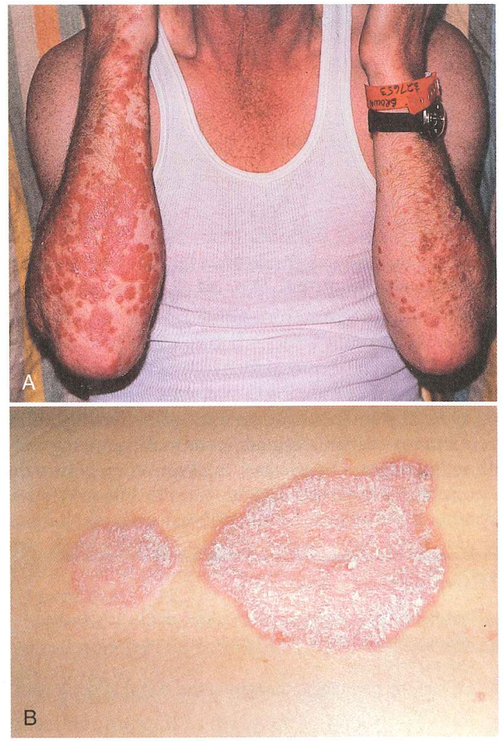

FIGURE 8-6 **A,** Psoriasis—acute inflammatory stage. *(Courtesy of Dr. M. McKenzie, Toronto, Canada.)* **B,** Psoriasis. *(From Lookingbill DP, Marks JG:* Principles of Dermatology, *ed 3, Philadelphia, 2000, Saunders.)*

Pemphigus

Pemphigus is an *autoimmune* (see Chapter 7) disorder that comes in several forms: pemphigus vulgaris, pemphigus foliaceus, and pemphigus erythematosus. The severity of the disease varies among individuals.

The autoantibodies disrupt the cohesion between the epidermal cells, causing blisters to form. In the most common form, pemphigus vulgaris, the epidermis separates above the basal layer. Blisters form initially in the oral mucosa or scalp and then spread over the face and trunk during the ensuing months. The vesicles become large and tend to rupture, leaving large **denuded** areas of skin covered with crusts.

Systemic glucocorticoids such as prednisone and other immunosuppressants are used to treat pemphigus.

Scleroderma

Scleroderma may occur as a skin disorder, or it may be systemic, affecting the viscera. The primary cause is not known but increased collagen deposition is observed in all cases. Collagen deposition in the arterioles and capillaries reduces blood flow to the skin and/or internal organs.

Collagen deposits, inflammation, and fibrosis with decreased capillary networks develop in the skin, leading to hard, shiny, tight, immovable areas of skin. The fingertips are narrowed and shortened, and Raynaud's phenomenon may be present, further predisposing the individual to ulceration and atrophy in the

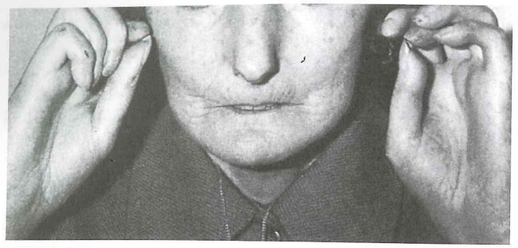

FIGURE 8-7 Scleroderma. *(From Odom RB, James WD, Berger TG: Andrews' Diseases of the Skin, ed 9, Philadelphia, 2000, Saunders.)*

fingers. The facial expression is lost as the skin tightens, and movement of the mouth and eyes may be impaired (Fig. 8-7). The cutaneous form may also affect the microcirculation of various organs, eventually causing renal failure, intestinal obstruction, or respiratory failure due to pulmonary hypertension.

THINK ABOUT 8-3

a. Describe the typical lesions of atopic dermatitis in the infant and adult in terms of their location and characteristics.
b. Explain the pathologic changes in the skin that occur with psoriasis.
c. Describe the development of the skin lesions of pemphigus vulgaris.
d. Explain how the deposition of collagen in scleroderma may lead to tissue/organ damage.
e. Name two findings in the evaluation of a blood sample that would indicate the allergenic basis for atopic dermatitis.

Skin Infections

Infections occur frequently in the skin. They may be caused by bacteria, viruses, fungi, or other types of microorganisms as well as parasites. Pathogens or opportunistic microbes may penetrate the skin through minor abrasions or cuts as well as through inflamed areas. When serious infections develop, it is essential to culture the exudate to identify the causative organism and determine appropriate treatment.

Bacterial Infections

Bacterial infections of the skin are common. They may be primary, often caused by resident flora, or they may be secondary, developing in wounds or pruritic lesions. Some infections are superficial; others can involve deeper tissues (abscesses).

Acne, a staphylococcal infection common in young adults, is covered in Chapter 23 (see Fig. 23-5).

Cellulitis

Cellulitis (erysipelas) is an infection of the dermis and subcutaneous tissue, usually arising secondary to an injury, a furuncle (boil), or an ulcer (see Fig. 5-3). The causative organism is usually *Staphylococcus aureus*, or occasionally Streptococcus.

It frequently occurs in the lower trunk and legs, particularly in individuals with restricted circulation in the extremities or those who are immunocompromised and the area becomes red, swollen, and painful. Red streaks running along the lymph vessels proximal to the infected area may develop. Systemic antibiotics are usually necessary to treat the infection along with analgesics for pain.

Furuncles

A furuncle (boil) is an infection, usually by *S. aureus*, which begins in a hair follicle (folliculitis) and spreads into the surrounding dermis (Fig. 8-8*A*). Common locations are the face, neck, and back. Initially, the lesion is a firm, red, painful nodule, which develops into a large, painful mass called an abscess that frequently drains large amounts of purulent exudate (pus). Pus is composed of leukocytes, cellular debris from dead blood cells and bacteria and a thin protein rich fluid component.

Squeezing boils can result in the spread of infection by **autoinoculation** (transfer, perhaps by fingers, of microbes from one site of infection on the body to another site) to other areas of the skin, cause cellulitis, or can force the bacteria in the abscess deeper into the dermis or subcutaneous tissue. Also, compression of furuncles in the nasal area may lead to thrombi or infection that spreads to the brain if the infected material reaches the cavernous sinus (a collecting point for venous blood from the face and brain) in the facial bones.

Carbuncles are a collection of furuncles that coalesce to form a large infected mass, which may drain through several sinuses or develop into a single large abscess.

Impetigo

Impetigo is a common infection in infants and children but can also occur in adults. *Staphylococcus aureus* may cause highly contagious infections in neonates, which is a threat in neonatal nurseries. In older children, infection results primarily from *S. aureus* but, alternatively, may be caused by group A beta-hemolytic streptococci. The infection is easily spread by direct contact with the hands, eating utensils, or towels. Activities involving close physical contact or contact with infected fomites can cause a rapid spread of this infection. Impetigo has often been seen spreading through individual members of wrestling teams and other full contact sports in which the mats or equipment may serve to spread the infection from one person to the next.

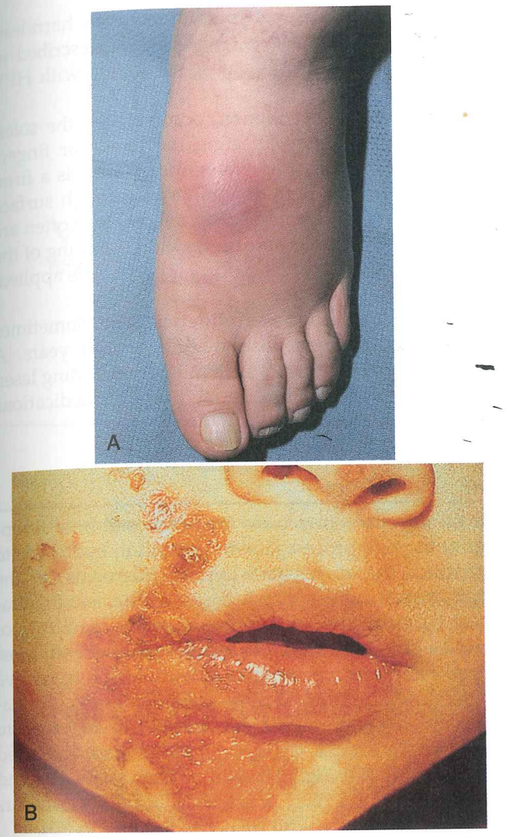

FIGURE 8-8 **A**, Furuncle. *(From Lookingbill D, Marks J: Principles of Dermatology, ed 2, Philadelphia, 1993, Saunders.)*
B, Impetigo. Note the yellowish pustules with brownish crust, the inflammation, and the spreading lesions on the face. *(Courtesy of Dr. M. McKenzie, Toronto, Canada.)*

Lesions commonly occur on the face and begin as small vesicles, which rapidly enlarge and rupture to form yellowish-brown crusty masses (see Fig. 8-8*B*). Underneath this characteristic crust, the lesion is red and moist and exudes a honey-colored liquid. Additional vesicles develop around the primary site by autoinoculation with hands, towels, or clothes. Pruritus is common, leading to scratching and further spread of infection.

Topical antibiotics may be used in the early stages, but systemic administration of these drugs is necessary if the lesions are extensive. Unfortunately, the number of antibiotic-resistant strains of *S. aureus* is increasing, resulting in local outbreaks of infection. Another concern with impetigo due to certain strains of streptococci or staphylococci is glomerulonephritis, which can develop if treatment is not instituted promptly (see Chapter 18).

Acute Necrotizing Fasciitis

It has been termed *flesh-eating disease* because of the extremely rapid tissue invasion resulting from reduced blood supply to the tissues and the secretion of protease enzymes that destroy tissue Although a mixture of aerobic and anaerobic microbes is frequently present at the site, the fulminant course with severe inflammation and tissue necrosis appears primarily to result from the actions of a highly virulent strain of gram-positive, group A, beta-hemolytic *Streptococcus* (*S. pyogenes*, also responsible for "strep throat"). This strain also produces a toxin causing toxic shock (see Chapter 12). Although relatively rare, there has been an increase in cases during the past few years and the cases seem to increase in frequency in the cold months.

There is often a history of minor trauma or infection in the skin and subcutaneous tissue of an extremity. The superficial fascia in the subcutaneous tissue and fascia surrounding the skeletal muscle, as well as other soft tissues, become edematous and necrotic, with occlusion of small blood vessels leading to gangrene. The infected area appears markedly inflamed and very painful, rapidly increases in size, and dermal gangrene is apparent.

Systemic toxicity develops with fever, tachycardia, hypotension, mental confusion, and disorientation, and possibly organ failure.

Diagnosis during the early stages of this infection is sometimes difficult as the signs/symptoms can be very similar to cellulitis. This delay in diagnosis and subsequent treatment is extremely dangerous as this infection progresses so rapidly.

Treatment includes aggressive antimicrobial therapy, fluid replacement, excision of all infected tissue, treatment with high oxygen flow in hyperbaric chambers and possibly amputation to prevent further spread of infection. Delays in treatment result in greater tissue loss, potential amputation, and higher probability of mortality. Case fatality rates are estimated by the CDC to be 20% to 30%.

Leprosy

Leprosy (Hansen's disease) is caused by the bacterium *Mycobacterium leprae* and in the past has affected millions of people worldwide. According to data from the World Health Organization, the global number of new cases has decreased dramatically although it is still a problem in parts of Africa, Asia, the South Pacific, and some areas of South America. The organism is not highly contagious, and extended contact with a source is required for infection.

This chronic disease is classified into three major types. The clinical signs and symptoms vary but generally affect the skin, mucous membranes, and peripheral nerves. In addition to the formation of characteristic skin lesions or macules, the loss of feeling due to nerve damage results in a situation where the person may

damage or destroy tissue through injury but not know it immediately. This damage can lead to the loss of limbs or other extremities due to irreparable damage and/or infection and eventual tissue necrosis.

The actual mechanism of pathogenicity of *Mycobacterium leprae* is largely unknown because this organism cannot easily be grown of culture media, which makes laboratory studies very difficult.

The method of diagnosis involves microscopic examination of a skin biopsy to identify the presence of the bacterium.

Treatment of leprosy primarily involves the use of antibiotics to control the causative organism as well as treat any secondary infections, rehabilitation, and education.

Viral Infections

Herpes Simplex

Herpes simplex (cold sores) virus type 1 (HSV-1) is the most common cause of cold sores or fever blisters, which occur on or near the lips. Herpes simplex type 2 (genital herpes) is considered in Chapter 19, Herpes zoster or shingles is presented in Chapter 14, and herpetic stomatitis is covered in Chapter 17. Both types of Herpes simplex virus cause similar effects and type 2 may cause oral as well as genital lesions.

The primary infection may be asymptomatic, but the virus remains in a latent stage in the sensory nerve ganglion of the trigeminal nerve, from which it may be reactivated, causing the skin lesion (Fig. 8-9). Recurrence may be triggered by infection such as a common cold, sun exposure, or stress. Reactivation usually is indicated by a preliminary burning or tingling sensation along the nerve and at the site on the lips, followed by development of painful vesicles, which then rupture and form a crust. Spontaneous healing occurs in 2 to 3 weeks. The acute stage and viral shedding and spreading may be reduced by the topical application of antiviral drugs such as acyclovir (Zovirax).

The virus is spread by direct contact with fluid from the lesion. Viral particles may be present in the saliva for some weeks following healing of the lesion and therefore can spread the infection to others or to the fingers; for example, if there is a break in the skin. A potential complication is spread of the virus to the eyes, causing keratitis (infection and ulceration of the cornea). Another complication is herpetic whitlow, a very painful infection of the fingers, which can pose a risk for dental personnel (see Fig. 17-6).

Verrucae

Warts (verrucae) are caused by human papillomaviruses (HPVs). There are many types of these viruses, associated with a variety of diseases. Common plantar warts, discussed here, are caused by HPV types 1 through 4. They frequently develop in children and young adults and are annoying but relatively harmless. Genital warts (HPV types 6 and 11) are described in Chapter 19, as is cervical cancer, associated with HPV types 16 and 18.

Plantar warts are common, occurring on the soles, with a similar variety affecting the hands or fingers (dorsal surface) and face. Warts appear first as a firm, raised papule, and then they develop a rough surface (Fig. 8-10). They are white or tan in color and often are multiple. The infection spreads by viral shedding of the surface skin. They may be painful if pressure is applied, especially on the feet.

Warts tend to persist even with treatment. Sometimes they resolve spontaneously within several years. A variety of local treatments are available, including laser, freezing with liquid nitrogen, and topical medications with ASA compounds.

Fungal Infections

Fungal infections (mycoses) are diagnosed from scrapings of the skin processed with potassium hydroxide to accentuate the spores and hyphae (filaments) of the fungal growth, which then becomes fluorescent in ultraviolet light. Microscopic examination and culturing of samples can also be used to aid in identification. Most fungal infections are superficial, because the fungi live off the dead, keratinized cells of the epidermis (dermatophytes). Specific antifungal agents are required to treat these infections. Candidal infections are discussed in Chapter 17 (see Fig. 17-5, oral candida or thrush) and in Chapter 19 (vaginal infection). *Candida* also occurs frequently in clients with diabetes (see Fig. 16-8*B*).

Tinea

Tinea may cause several types of superficial skin infections (dermatophytoses or *ringworm*), depending on the area of the body affected.

Tinea capitis is an infection of the scalp that is common in school-aged children (Fig. 8-11*A*). The infection may result from *Microsporum canis*, transmitted by cats and dogs, or by *Trichophyton tonsurans*, transmitted by humans. It manifests as a circular bald patch as hair is broken off above the scalp. Erythema or scaling may be apparent. Oral antifungal agents such as griseofulvin are recommended.

Tinea corporis is a fungal infection of the body, particularly the nonhairy parts (Fig. 8-11*B*). The lesion is a round, erythematous ring of vesicles or papules with a clear center (ringworm) scattered over the body. Pruritus or a burning sensation may be present. Topical antifungal medications such as tolnaftate or ketoconazole are effective.

Tinea pedis, or athlete's foot, involves the feet, particularly the toes. *Trichophyton mentagrophytes* or *Trichophyton rubrum* are the usual causative organisms. This condition may be associated with swimming pools and

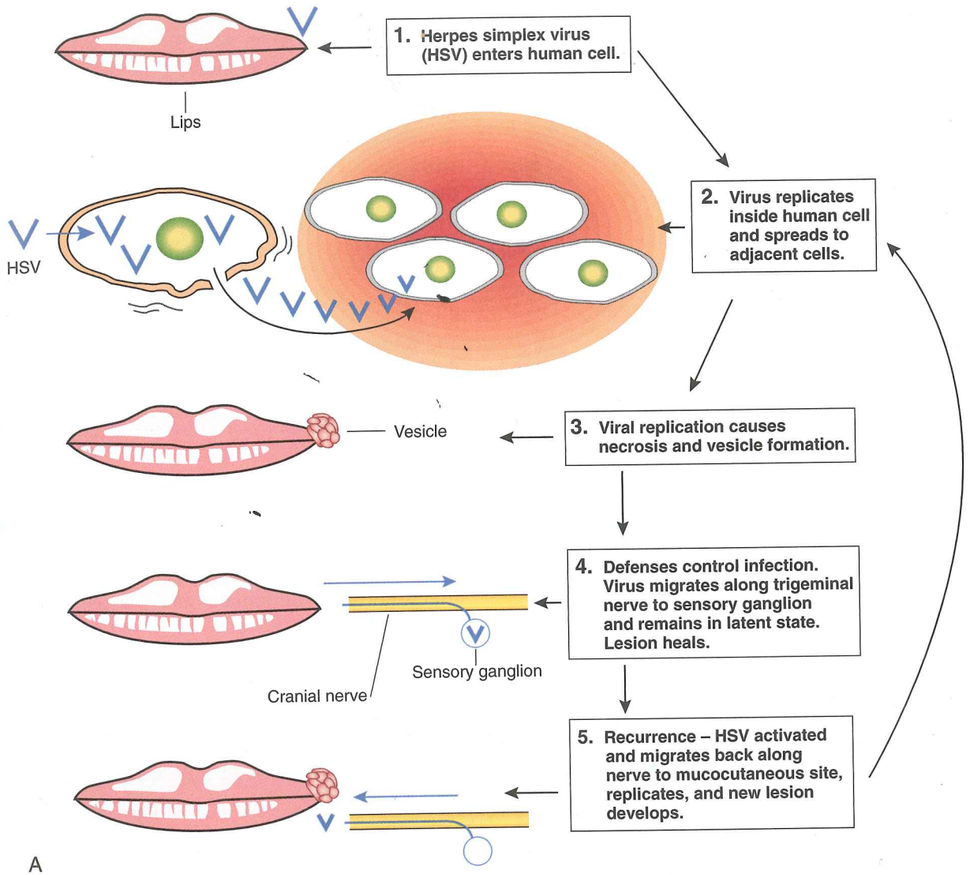

FIGURE 8-9 Herpes simplex. **A**, Recurrent infection by herpes simplex virus. **B**, Herpes simplex on the face. *(Courtesy of Dr. M. McKenzie, Toronto, Canada.)*

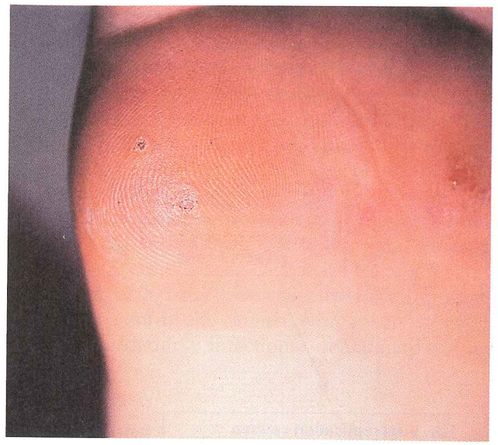

FIGURE 8-10 Plantar warts on sole of foot. *(Courtesy of Dr. M. McKenzie, Toronto, Canada.)*

gymnasia if appropriate precautions are not in place (e.g., wearing sandals, changing to clean, dry socks). The organisms may be normal flora that become opportunists or that spread easily from lesions under conditions of excessive warmth and moisture. The skin between the toes becomes inflamed and macerated, with painful and pruritic fissures (Fig. 8-11C). The feet may have a foul odor. Secondary bacterial infection is common, adding to the inflammation and necrosis. Topical tolnaftate is usually effective.

Tinea unguium, or onychomycosis, is an infection of the nails, particularly the toenails. Infection begins at the tip of one or two nails, the nail turning first white and then brown. The nail then thickens and cracks, and the infection tends to spread to other nails.

Other Infections

Scabies

Scabies is the result of an invasion by a mite, *Sarcoptes scabiei*. The female mite burrows into the epidermis, laying eggs over a period of several weeks as she moves along in the stratum corneum (Fig. 8-12). The male dies after fertilizing the female, and the female dies after

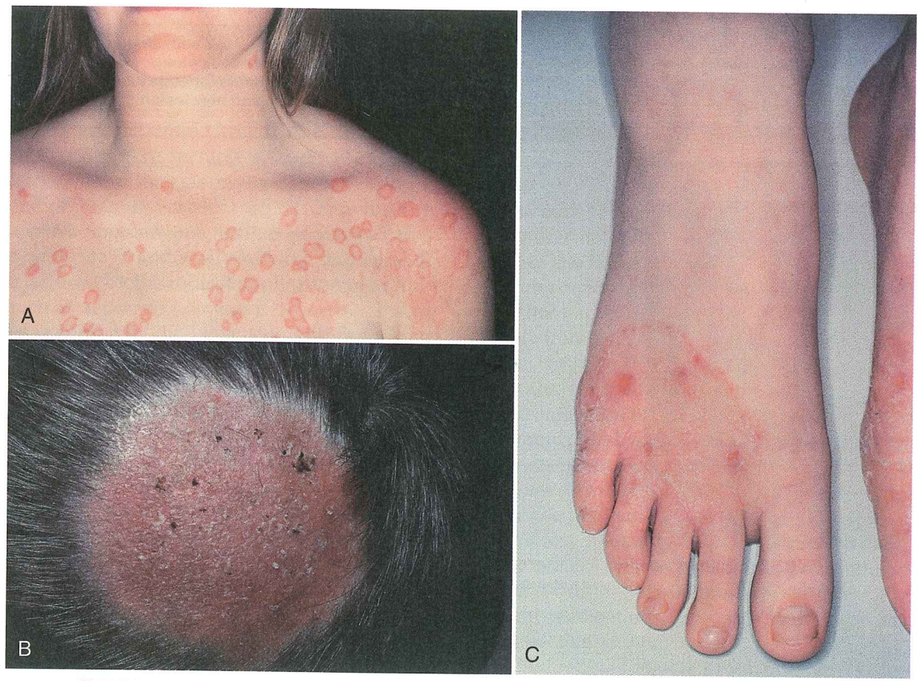

FIGURE 8-11 **A,** Tinea corporis. Annular scaly plaques in superficial basal cell epithelioma. **B.** Tinea capitis, localized patch. **C.** Tinea pedis. *(From Callen JP, et al:* Color Atlas of Dermatology, *Philadelphia, 1993, Saunders.)*

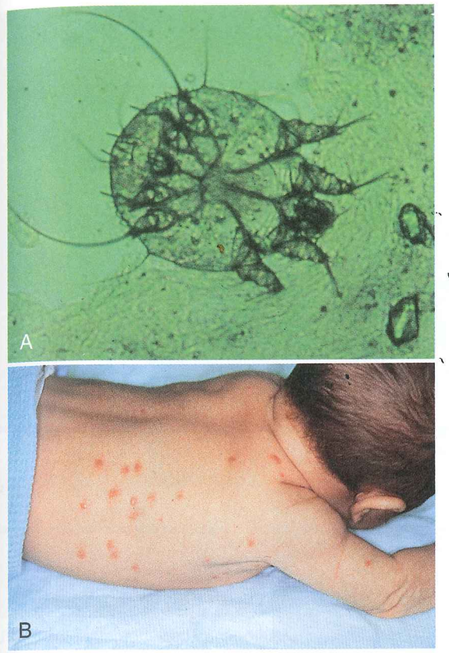

FIGURE 8-12 Scabies. **A,** Scabies mite, as seen clinically when removed from its burrow. **B,** Characteristic scabies bites. *(From McCance KL, et al:* Pathophysiology, *ed 6, St. Louis, 2010, Mosby. Courtesy Department of Dermatology, School of Medicine, University of Utah.)*

laying the eggs. The **larvae** emerging from the eggs migrate to the skin surface and then burrow into the skin in search of nutrients. As the larvae mature into adults, the cycle is repeated. The burrows appear on the skin as tiny, light brown lines, often with small vesicles and erythema. The inflammation and pruritus that result are caused by the damage done to the skin by the burrowing and the presence of mite fecal material in the burrow.

Common sites include the areas between the fingers, the wrists, the inner surfaces of the elbow, and the waistline. Topical treatment with lindane is effective. Mites can survive for only a short time away from the human host and are usually spread only by close contact.

Pediculosis

Pediculosis (lice) can take three forms in humans. *Pediculus humanus corporis* is the body louse, *Pediculus pubis* is the pubic louse, and *Pediculus humanus capitis* is the head louse (cooties). Lice are small, brownish parasites that feed off human blood (humans are hosts only to human lice, not to animal lice) and cannot survive for long without the human host.

Female lice lay eggs on hair shafts, cementing the egg firmly to the hair close to the scalp (Fig. 8-13). The egg, or *nit*, appears as a small, whitish shell attached to a hair. After hatching, the louse bites the human host, sucking blood for its survival. The site of each bite is demonstrated by a macule or papule, which is highly pruritic owing to the mite saliva. The **excoriations** that result from scratching and the visible nits provide evidence of infestation; the adult lice usually are not visible.

Topical permethrin, malathion, or pyrethrin is used to treat lice, although resistance to these drugs is widespread. A fine-toothed comb can be used to remove empty nits from the hair. Clothing, linen, and the surrounding area need to be carefully cleaned to prevent reinfection.

THINK ABOUT 8-4

a. Distinguish between tinea pedis and tinea capitis by location and lesion.
b. State one significant identifying feature of the lesions of: (1) impetigo, and (2) herpes simplex.
c. State the causative organism of: (1) scabies, (2) ringworm, and (3) pediculosis.
d. Explain why herpes simplex tends to recur.

Skin Tumors

Keratoses

Keratoses are benign lesions that are usually associated with aging or skin damage. *Seborrheic keratoses* result from proliferation of basal cells, leading to an oval elevation that may be smooth or rough and is often dark in color. This type of keratosis is often found on the face or upper trunk. *Actinic keratoses* occur on skin exposed to ultraviolet radiation and commonly arise in fair-skinned persons. The lesion appears as a pigmented, scaly patch. Actinic keratoses may develop into squamous cell carcinoma.

There is increasing concern regarding the continued rise in skin lesions related to sun exposure. Recent estimates indicate that one in seven persons will develop skin cancer. Skin cancers currently represent 50% of all cancers diagnosed in the United States. In recent years, increased exposure to harmful ultraviolet rays is a result of more participation in outdoor sports, clothes that expose more skin along with the desire to have a fashionable tan, and increased use of tanning salons, as well as depletion of the protective ozone layer around the earth. The danger is evidenced by the increased incidence of tumors in those who have experienced severe sunburns, those who work or spend considerable time outdoors in the sun, or those who have blond hair and light-colored skin containing less melanin.

Guidelines to reduce the risk of skin cancers have been developed. They include:

- Reducing sun exposure at midday and early afternoon

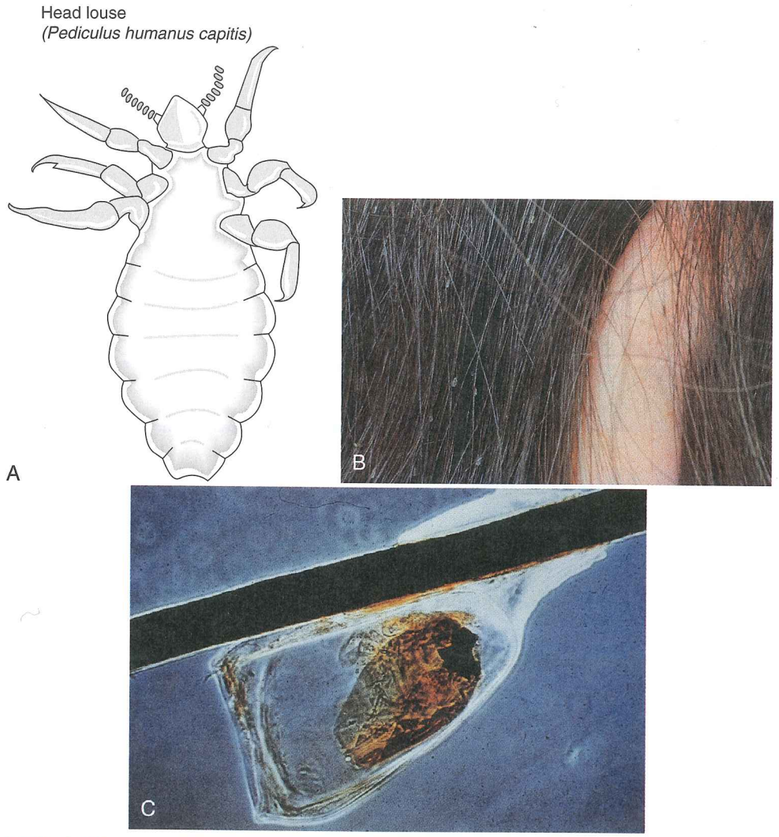

FIGURE 8-13 Pediculosis. **A**, Schematic representation of a louse. **B**, Lice in hair. *(From Callen JP, et al:* Color Atlas of Dermatology, *Philadelphia, 1993, Saunders.)* **C**, Nit (egg case) of head louse attached to hair shaft. *(From Kumar V, Abbas AK, Fausto M:* Robbins and Cotran Pathologic Basis of Disease, *ed 7, Philadelphia, 2005, Saunders.)*

- Covering up with clothing, remaining in shade, and wearing broad-brimmed hats to protect face and neck
- Applying sunscreen or sunblock, minimum SPF-15 (sun protection factor), broad spectrum, to protect from UVA and UVB rays

WARNING SIGNS OF SKIN CANCER

1. A sore that does not heal
2. A change in shape, size, color, or texture of a lesion, especially an expanding, irregular circumference or surface
3. New moles or odd-shaped lesions that develop
4. A skin lesion that bleeds repeatedly, oozes fluid, or itches

It is recommended that individuals routinely check skin, particularly exposed areas, moles, lesions resulting from sun damage, dark spots, or keratoses. Photodynamic therapy for keratoses and skin cancer involves a light-sensitive drug in a cream that is absorbed by the tumor cells. A laser then destroys the cells containing the chemical.

- Protecting infants and children from exposure and sun damage to skin that may lead to skin cancer (see Chapter 20).

Squamous Cell Carcinoma

Skin cancer is easy to detect and accessible for treatment and when identified in the early stages should have a good prognosis. Squamous cell carcinoma is similar to the common basal cell carcinoma in many respects (see Chapter 20 and Fig. 20-11). Both of these malignant tumors have an excellent prognosis when the lesion is removed within a reasonable time.

Squamous cell carcinoma is a painless, malignant tumor of the epidermis; sun exposure is a major contributing factor. The lesions are found most frequently on exposed areas of the skin, such as the face and neck (Fig. 8-14). Smokers also have a higher incidence of squamous cell carcinoma in the lower lip region and mucous membranes of the mouth. Scar tissue is also a source of carcinoma, particularly in the African-American population. Actinic keratoses predispose to in situ or intraepidermal squamous cell carcinoma, which usually remains limited to the epidermis for a long time.

The invasive type of squamous cell carcinoma arises from premalignant conditions such as leukoplakia. This carcinoma develops as a scaly, slightly elevated, reddish lesion with an irregular border and central ulceration. The tumor grows relatively slowly in all directions, invading surrounding tissues, and then spreads to the regional lymph nodes. It rarely metastasizes to distant sites.

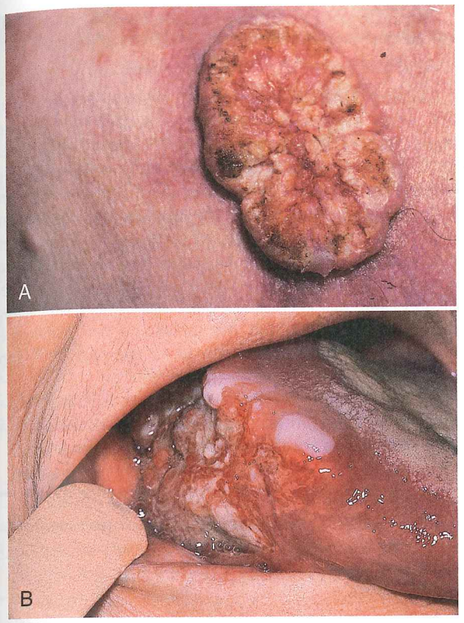

FIGURE 8-14 Squamous cell carcinoma. **A**, Skin. *(From Callen JP, et al:* Color Atlas of Dermatology, *Philadelphia, 1993, Saunders.)* **B**, Squamous cell carcinoma at the base of the tongue. *(From Cooke RA, Stewart B:* Colour Atlas of Anatomical Pathology, *ed 3, Sydney, 2004, Churchill Livingstone.)*

Malignant Melanoma

This much more serious form of skin cancer develops from the melanocytes and is increasing in incidence. The development of malignant melanoma depends on genetic factors, exposure to ultraviolet radiation, and hormonal influences.

Melanomas arise from melanocytes in the basal layer of the epidermis or from a nevus (mole), a collection of melanocytes. There are many types of nevi, most of which do not become malignant. Nevi that grow; change shape, color, size, or texture; or bleed are to be suspected (Box 8-1). Malignant melanoma often appears as a multicolored lesion with an irregular border (Fig. 8-15). Melanomas grow quickly, extending down into the tissues, then metastasize quickly to the regional lymph nodes and then to other organs, leading to a poor prognosis in many cases. When they are surgically removed, an extensive amount of tissue around and below the lesion is excised as well to ensure that all the malignant cells are removed. Additional radiation and chemotherapy now provides a 5-year survival rate of approximately 99% in cases of localized tumors and 7% to 70% in cases in which the tumor has invaded or metastasized, depending on what tissues have been invaded and the extent of the metastasis. In the United States 80% of melanomas are identified in the localized stage.

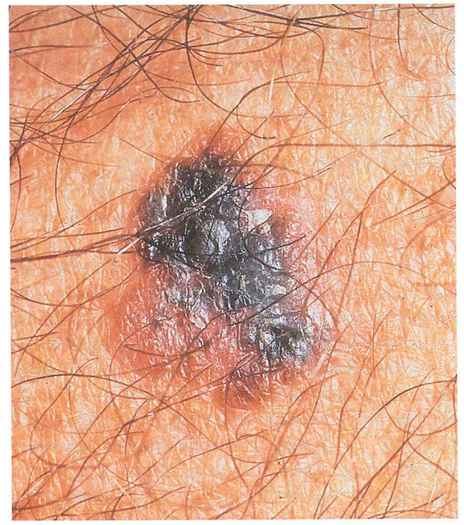

FIGURE 8-15 Malignant melanoma. *(Courtesy of Dr. M. McKenzie, Toronto, Canada.)*

BOX 8-1 "ABCD" Signs That a Mole or Nevus May be Melanoma

Area of the mole is increased
Border is irregular
Color is changed in mole
Diameter of the mole is increased

Kaposi's Sarcoma

This formerly rare type of skin cancer has come into prominence in recent years because of its association with human immunodeficiency virus (HIV) infection or

acquired immunodeficiency syndrome (AIDS) (see Chapter 7). Kaposi's sarcoma was a relatively rare cancer that occurred in older men originating from Eastern Europe or the Mediterranean area before the HIV pandemic. The disease is also endemic in Africa and affects younger individuals. Cases are still seen in individuals who are not HIV positive.

In immunosuppressed patients, the cancer is quite common and may affect the viscera as well as the skin. Herpesvirus #8 (kSHV) forms part of the etiology of these tumors. The malignant cells arise from the endothelium in small blood vessels. The multiple skin lesions commence as purplish macules, often on the face, scalp, oral mucosa, or lower extremities. Initially, the lesions are nonpruritic and nonpainful. These lesions progress to form large, irregularly shaped plaques or nodules, which may be darker in color, purplish or brownish (see Fig. 7-17*B*). In immunocompromised patients, the lesions develop rapidly over the upper body and may become painful. A combination of radiation, chemotherapy, surgery, and biologic therapy constitute the common treatment.

THINK ABOUT 8-5

a. Explain why squamous cell carcinoma has a better prognosis than malignant melanoma.
b. List skin disorders to which exposure to sunlight is a predisposing factor.
c. List the signs of possible malignant changes in a skin lesion.
d. Compare the characteristics of the typical lesion of squamous cell carcinoma, melanoma, and Kaposi's sarcoma.
e. List the four warning signs of skin cancer.

CASE STUDY A

Atopic Dermatitis

J.W., at age 5 months, had a moist, erythematous rash on the cheeks, chest, and extensor surfaces of the arms, caused by atopic dermatitis. She had a secondary bacterial infection on one cheek.

1. State the factors in the family history that may support a genetic predisposition to atopic dermatitis in this infant.
2. Explain why a secondary bacterial infection has probably developed.
3. List four factors that tend to aggravate atopic dermatitis.
4. Explain two ways in which administration of an antihistamine could help J.W. sleep.

   Two years later, eczema has persisted, although controlled partially by use of moisturizers and hydrocortisone cream. The skin in some areas is thick and rough in texture.
5. Explain how hydrocortisone cream may reduce the inflammation and skin damage.

CASE STUDY B

Malignant Melanoma

Mr. P.X. age 45, had been swimming and was sitting on the beach when a friend commented on a dark reddish-black "pimple" with a rough surface on it on his upper back. Mr. P.X. said he had numerous moles on his body and it was not of concern. However, later he thought about the comment and saw his physician, who thought the lesion was suspicious and should be checked. The border and surface of the mass were irregular, and it appeared to be quite thick. A similar small lesion was located nearby. The lesion was diagnosed as a superficial spreading malignant melanoma, and surgery was scheduled. Surgery revealed that the melanoma had penetrated through the dermis and had spread to the regional lymph nodes.

1. Explain the factors that make this lesion suspicious for cancer.
2. List the possible predisposing factors in this patient.
3. Predict the prognosis and the reasons for it in this case.

CHAPTER SUMMARY

The skin or integument has many important functions, particularly in protecting the body from the environment. Secondary effects of many skin lesions include infection or scar tissue. Skin lesions may be distinguished by their physical characteristics, location, exudate if any, and the presence of pruritus or pain.

- *Contact dermatitis* may be caused by an irritant or an allergen, often identifiable by the location of the lesion.
- *Urticaria* (hives) results from a type I hypersensitivity to ingested food or drugs.
- *Atopic dermatitis* (eczema) is a familial hypersensitivity beginning in infancy and often associated with hay fever and asthma.
- *Psoriasis* is a chronic inflammatory disorder characterized by accelerated cell proliferation. The typical lesion is a silvery plaque covering an erythematous base.
- *Staphylococcus aureus* is a common cause of skin infections, including *cellulitis* (in the legs and lower trunk), *furunculosis* (in hair follicles), and *impetigo* (on the faces of young children).
- *Acute necrotizing fasciitis* is characterized by bacterial invasion with rapid tissue destruction and septic shock.
- *Herpes simplex virus type 1* (cold sores) causes recurrent painful vesicles around the mouth. It may be transmitted in the exudate or the saliva. Between exacerbations the virus remains in a latent form in a nearby sensory ganglion.
- *Mycoses* are fungal infections such as *tinea*, which may affect the feet (athlete's foot), the scalp, or the body.

- *Pediculosis* (lice) may infect the scalp or body, thriving on human blood.
- There is increasing evidence of sun damage to skin predisposing patients to malignant tumors.
- *Squamous cell carcinoma* is a slow-growing tumor common to exposed areas.
- *Malignant melanoma*, arising from a nevus, grows quickly and metastasizes early.

STUDY QUESTIONS

1. Describe the structure of a hair follicle, including any gland associated with it.
2. Describe the location of resident or normal flora related to the skin and its appendages.
3. State the location of nerves and blood vessels in the skin.
4. List the functions of the skin.
5. Define the terms *papule*, *ulcer*, and *fissure*.
6. Explain how glucocorticoids may reduce pruritus, and give examples of conditions for which these drugs may be helpful.
7. Compare the mechanisms and possible causes of allergic and irritant contact dermatitis.
8. Describe the manifestations of each of the following and state the causative agents for each:
   a. shingles
   b. boils
   c. scabies
   d. scleroderma
9. Prepare a list of contagious skin disorders.
10. Suggest a preventive measure that could reduce the risk of skin cancer.
11. Explain why allergic responses tend to recur.
12. Compare the characteristics of the exudate found in a furuncle and in herpes simplex.
13. Explain why Kaposi's sarcoma is more common in immunocompromised patients.
14. Explain the specific cause of pruritus with:
    a. scabies
    b. pediculosis
    c. contact dermatitis

ADDITIONAL RESOURCES

Gawkrodger D: *Dermatology: An Illustrated Colour Text*, ed 4, New York, 2008, Churchill Livingstone.
Graham-Brown R, Bourke J, Cunliffe T: *Dermatology: Fundamentals of Practice*. St. Louis, 2008, Mosby.
Habib T: *Clinical Dermatology*, ed 4, Philadelphia, 2004, Saunders.
Thibodeau G, Patton K: *Anatomy and Physiology*, ed 7, St. Louis, 2010, Mosby.

Web Sites

http://www.aad.org American Academy of Dermatology
http://www.niams.nih.gov National Institute of Arthritis and Musculoskeletal and Skin Diseases
http://www.cancer.org/docroot/cri/content/cri_2_4_1x_what_is_kaposis_sarcoma_21.asp American Cancer Society—Information on Kaposi's sarcoma
http://www.cancer.org/docroot/CRI/CRI_2x.asp?sitearea=&dt=39 American Cancer Society—Information on skin cancer—melanoma