

## CHAPTER 5

### LECTURE OUTLINE

#### I. INTRODUCTION

1. The skin and its accessory structures make up the integumentary system.
2. The integumentary system functions to guard the body's physical and biochemical integrity, maintain a constant body temperature, and provide sensory information about the surrounding environment.
3. Dermatology is the medical specialty that deals with diagnosing and treating skin disorders.

#### II. STRUCTURE OF THE SKIN

- A. The skin consists of different tissues that are joined together to perform specific functions and is the largest organ of the body. Structurally the skin consists of two parts (Figure 5.1).
  1. The superficial portion of the skin is the epidermis and is composed of epithelial tissue.
  2. The deeper layer of the skin is the dermis and is primarily composed of connective tissue.
  3. Deep to the dermis is the subcutaneous layer or hypodermis.
    - a. It is not a part of the skin.
    - b. It consists of areolar and adipose tissue.
    - c. It serves as a fat storage area, an area for blood vessel passage, and an area of pressure nerve endings.

#### III. EPIDERMIS

1. The epidermis is composed of keratinized stratified squamous epithelium and contains four principal types of cells: keratinocytes, intraepidermal macrophages, melanocytes and tactile epithelial cells (Figure 5.2).
  - a. *Keratinocytes* produce the protein keratin, which helps protect the skin and underlying tissue from heat, microbes, and chemicals, and lamellar granules, which release a waterproof sealant (Figure 5.2a).
  - b. *Melanocytes* produce the pigment melanin which contributes to skin color and absorbs damaging ultraviolet (UV) light (Figure 5.2b).
  - c. *Intraepidermal macrophages or Langerhans* cells participate in immune responses (Figure 5.2c).

- d. *Tactile epithelial cells or Merkel cells* contact a sensory structure called a tactile (Merkel) disc and function in the sensation of touch (Figure 5.2d).

## B. Layers of the Epidermis

- a. There are four or five layers of the epidermis, depending upon the degree of friction and mechanical pressure applied to the skin. From deepest to most superficial the layers of the epidermis are stratum basale (stratum germinativum), stratum spinosum, stratum granulosum, stratum lucidum (only in palms and soles), and stratum corneum (Figure 5.3).
- b. *The stratum basale* is the deepest layer of the epidermis and contains some stem cells capable of undergoing cell division to form new cells.
  - 1) Keratinocytes with a cytoskeleton of tonofilaments are found in this layer.
  - 2) This layer is sometimes called the stratum germinativum to indicate its role in the formation of new cells.
  - 3) When the germinal portion of the epidermis is destroyed, new skin cannot regenerate with a skin graft.
- c. *The stratum spinosum* provides strength and flexibility to the skin.
- d. *The stratum granulosum* marks the transition between the deeper, metabolically active strata and the dead cells of the more superficial strata. This layer also shows the formation of a water repellent sealant between the cells.
  - 1) This layer consists of keratinocytes that are undergoing apoptosis.
  - 2) This layer is characterized by the presence of keratohyalin which converts tonofilaments into keratin.

**Clinical Connection:** Skin grafts- a skin graft is the transfer of a patch of healthy skin taken from a donor site to cover a wound

- e. *The stratum lucidum* is present only in the fingers, palms, and soles.
- f. *The stratum corneum* is the most superficial layer and consists of dead cells.
  - 1) Lamellar granules in this layer make it water-repellent.
  - 2) Constant exposure to friction will cause this layer to increase in depth with the formation of a callus, an abnormal thickening of the epidermis.

**Clinical Connection:** Psoriasis is a chronic skin disorder characterized by a more rapid division and movement of keratinocytes through the epidermal strata

## C. Keratinization and Growth of the Epidermis

- 1. Keratinization, replacement of cell contents with the protein keratin, occurs as cells move to the skin surface over 2-4 weeks.

2. Epidermal growth factor and other hormone-like proteins play a role in epidermal growth.
3. Table 5.1 presents a summary of the features of the epidermal strata.

#### IV. DERMIS

- A. The dermis is composed of connective tissue containing collagen and elastic fibers and has two regions (Figure 5.1).
  1. *The papillary layer* is areolar connective tissue containing fine elastic fibers, dermal papillae, corpuscles of touch (Meissner's corpuscles), and free nerve endings for sensations of heat, cold, pain, tickle, and itch.
  2. *The reticular layer* is the deeper part of the dermis consisting of dense, irregular connective tissue containing bundles of collagen fibers and some elastic fibers.
    - a. Spaces between the fibers may contain adipose cells, hair follicles, sebaceous glands, and sudoriferous glands.
    - b. The collagen and elastic fibers provide strength, extensibility (ability to stretch), and elasticity (ability to return to original shape after stretching) to skin.
- B. Epidermal ridges increase friction for better grasping ability and provide the basis for fingerprints and footprints. The ridges typically reflect contours of the underlying dermis.
- C. Table 5.2 presents a comparison of the structural features of the papillary and reticular regions of the dermis.
- D. **Clinical Connection:** Tension Lines and Surgery. Making surgical incisions along lines of cleavage reduces skin scars
- E. **Clinical Connection:** Stretch Marks. Results in internal scarring when the skin is stretched too much

#### V. STRUCTURE AND BASIS OF SKIN COLOR

- A. Melanin, hemoglobin, and carotene are three pigments that impart a wide variety of colors to skin
- B. Melanocytes synthesize melanin from the amino acid tyrosine in the presence of an enzyme called tyrosinase
  1. *Melanin:* causes the skin's color to vary from pale yellow to reddish-brown to black.
    - a. pheomelanin (fe<sup>-</sup>-o<sup>-</sup>-MEL-a-nin) (yellow to red)
    - b. eumelanin (u<sup>-</sup>-MEL-a-nin) (brown to black)

2. *Freckles*: accumulation of melanin in patches in some people who are genetically predisposed
- C. Overexposure to the sun can lead to photodamage of the skin and photosensitivity in individuals who are taking certain medications.
- D. **Clinical Connection:** Albinism and Vitiligo: Albinism is the inherited inability of an individual to produce melanin. Vitiligo is the complete or partial loss of melanocytes from patches of the skin resulting in irregular white spots.
- E. **Clinical Connection:** The color of skin and mucous membranes can provide clues for diagnosing certain problems, such as cyanosis, jaundice, and erythema
- F. Tattoos and skin piercings have medical implications

## VI. ACCESSORY STRUCTURES OF THE SKIN

### A. General Characteristics

1. Accessory structures of the skin develop from the embryonic epidermis and include hair, glands, and nails.

### B. Hair

1. Hairs, or pili, are present on most skin surfaces except the palms, palmar surfaces of the digits, soles, and plantar surfaces of the digits.

#### 2. Anatomy of Hair

- a. Hair consists of a shaft above the surface (Figure 5.4a), a root that penetrates the dermis and subcutaneous layer (Figure 5.4c,d), the cuticle (Figure 5.4b), and a hair follicle (Figure 5.4c,d).
- b. There are three concentric layers of cells: medulla, cortex, and cuticle of the hair (Figure 5.4c, d).
  - 1) The medulla, which may be lacking in thinner hair, is composed of two or three rows of irregularly shaped cells that contain large amounts of pigment granules.
  - 2) The cortex forms the major part of the shaft and consists of elongated cells.
  - 3) The cuticle of the hair, the outermost layer, consists of a single layer of thin, flat cells that are the most heavily keratinized.
- 1) The external root sheath is a downward continuation of the epidermis.
- 2) The internal root sheath is produced by the matrix.
  - 1) The hair matrix cells arise from the stratum basale

- i. New hairs develop from cell division of the matrix in the bulb
- 2) The base of each hair follicle is surrounded by the dermal root sheath, an onion-shaped structure.
- c. Associated with hairs are sebaceous (oil) glands, arrectores pilorum muscles, and root plexuses (Figure 5.4a).
- d. Clinical Connection: Hair removal**
  - 1) Depilatories dissolve the protein in the hair shaft
  - 2) Electrolysis uses an electric current to destroy the hair matrix.

### 3. Hair Growth

- a. The hair growth cycle consists of a growing stage and a resting stage.
- b. Both rate of growth and the replacement cycle can be altered by illness, diet, high fever, surgery, blood loss, severe emotional stress, and gender.
- c. **Clinical Connection:** Chemotherapy can cause hair loss.

### 4. Types of hair

- a. Lanugo is a fine, nonpigmented hair that covers the fetus.
- b. Vellus hair is a short, fine hair that replaces lanugo
- c. Course pigmented hair appears in response to androgens
- d. Hair that appears in response to androgens and hair of the head, eyelashes and eyebrows is known as terminal hair.

### 5. Hair Color

- a. Hair color is due primarily to the amount and type of melanin.
- b. Graying of hair occurs because of a progressive decline in tyrosinase.
- c. Functions of hair include protection, decrease in heat loss, and sensing light touch.
- d. **Clinical Connection:** Hormones influence the growth and loss of hair

## C. Skin Glands

1. Sebaceous (oil) glands are usually connected to hair follicles; they are absent in the palms and soles ( Figures 5.1 and 5.4a).
  - a. Sebaceous glands produce sebum, which moistens hairs, waterproofs and softens the skin, and inhibits bacterial growth.
  - b. **Clinical Connection:** Acne results when sebaceous glands become inflamed
2. Sudoriferous (sweat) glands are divided into apocrine and eccrine types.
3. Eccrine sweat glands have an extensive distribution; their ducts terminate at pores at the surface of the epidermis.

- a. The main function of eccrine sweat glands is to help regulate body temperature through evaporation.
  - b. They also help eliminate wastes such as urea.
- 4. Apocrine sweat glands are limited in distribution to the skin of the axilla, pubis, and areolae; their duct open into hair follicles.
  - a. Table 5.3 compares sebaceous, eccrine, apocrine and ceruminous sweat glands.
- 5. Ceruminous glands are modified sudoriferous glands that produce a waxy substance called cerumen.
  - a. These glands are found in the external auditory meatus.
  - b. **Clinical Connection:** Impacted Cerumen: An abnormal amount of cerumen in the external auditory meatus or canal can result in impaction and prevent sound waves from reaching the ear drum

#### D. Nails

- 1. Nails are hard, keratinized epidermal cells over the dorsal surfaces of the terminal portions of the fingers and toes.
- 2. The principal parts of a nail are the body, free edge, root, lunula, eponychium, and matrix (Figure 5.5).
- 3. Cell division of the matrix cells produces new nails.
- 4. Functionally, nails help in grasping and manipulating small objects in various ways and provide protection against trauma to the ends of the digits.

### VII. TYPES OF SKIN

- A. Thin skin covers all parts of the body except for the palms, palmar surfaces of the digits, and soles.
  - 1. Thin skin lacks epidermal ridges.
  - 2. It has a sparser distribution of sensory receptors than thick skin.
- B. Thick skin covers the palms, palmer surfaces of the digitis, and soles.
  - 1. It features a stratum lucidum and thick epidermal ridges.
  - 2. It lacks hair follicles, arrector pili muscles, and sebaceous glands, and has more sweat glands than thin skin.
  - 3. Table 5.4 reviews the differences between thick and thin skin

### VIII. FUNCTIONS OF SKIN

- A. Thermoregulation, the homeostatic control of body temperature, is due to the skin liberating sweat at its surface and by adjusting the flow of blood in the dermis.
- B. Blood Reservoir, The dermis houses an extensive network of blood vessels that carry 8–10% of the total blood flow in a resting adult.
- C. Protection, The skin provides protection through physical, chemical and biological barriers.
- D. Cutaneous sensations, including touch, pressure, vibration, tickle, heat, cold, and pain arise in the skin.
- E. Excretion and Absorption, The skin plays minor roles in excretion, the elimination of wastes from the body, and absorption, the passage of material from the external environment into body cells.
- F. Synthesis of Vitamin D requires activation of a precursor molecule in the skin by UV light, with enzymes in the liver and kidneys modifying the activated molecule to produce calcitriol, the most active form of vitamin D.
  - 1. **Clinical Connection:** Transdermal drug administration is a method of drug passage across the epidermis and into the blood vessels of the dermis .

## **IX. MAINTAINING HOMEOSTASIS: SKIN WOUND HEALING**

### **A. Epidermal Wound Healing**

- 1. In an epidermal wound (e.g., an abrasion or a first-degree or second-degree burn), the central portion of the wound usually extends deep down to the dermis, whereas the wound edges usually involve only superficial damage to the epidermal cells.
- 2. Epidermal wounds are repaired by enlargement and migration of basal cells (Figure 5.6a), contact inhibition, and division of migrating and stationary basal cells.
- 3. Epidermal growth factor stimulates basal cells to divide and replace the ones that have moved into the wound (Figure 5.6b).

### **B. Deep Wound Healing**

- 1. When an injury extends to tissues deep to the epidermis, the repair process is more complex than epidermal healing, and scar formation results.
  - a. Phases of Deep Wound Healing
  - b. During the inflammatory phase, a blood clot unites the wound edges, epithelial cells migrate across the wound, vasodilatation and increased permeability of blood vessels deliver phagocytes, and fibroblasts form (Figure 5.6c).

- c. During the migratory phase, epithelial cells beneath the scab bridge the wound, fibroblasts begin scar tissue, and damaged blood vessels begin to grow. During this phase, tissue filling the wound is called granulation tissue.
- d. During the proliferative phase, the events of the migratory phase intensify.
- e. During the maturation phase, the scab sloughs off, the epidermis is restored to normal thickness, collagen fibers become more organized, fibroblasts begin to disappear, and blood vessels are restored to normal (Figure 5.6d).
- f. Scar tissue formation (fibrosis) can occur in deep wound healing.

## **X. DEVELOPMENT OF THE INTEGUMENTARY SYSTEM**

- A. The epidermis is derived from ectoderm. Hair, nails, and skin glands are epidermal derivatives.
- B. The dermis, and associated structures, are derived from wandering mesenchymal cells and derived from the mesoderm
- C. The sequence of skin development is shown in Figure 5.7.

## **XI. AGING AND THE INTEGUMENTARY SYSTEM**

- A. With puberty, some adolescents develop acne.
- B. Most effects of aging of the skin do not occur until an individual reaches the late forties.
- C. Among the effects of aging on the integument are wrinkling, slower growth of hair and nails, dryness and cracking due to sebaceous gland atrophy, decrease in number of melanocytes (gray hair, blotching) and Langerhans cells (decreased immune responsiveness), and loss of subcutaneous fat (thinner skin).
- D. Several cosmetic anti-aging treatments are available to diminish the effects of aging or sun-damaged skin
  - 1. Topical products that bleach the skin to tone down blotches and blemishes (hydroquinone) or decrease fine wrinkles and roughness (retinoic acid).
  - 2. Microdermabrasion, the use of tiny crystals under pressure to remove and vacuum the skin's surface cells to improve skin texture and reduce blemishes.
  - 3. Chemical peel, the application of a mild acid (such as glycolic acid) to the skin to remove surface cells to improve skin texture and reduce blemishes.
  - 4. Laser resurfacing, the use of a laser to clear up blood vessels near the skin surface
  - 5. Dermal fillers, injections of collagen from cows

6. Fat transplantation, in which fat from one part of the body is injected into another location
7. Botulinum toxin or Botox®, a diluted version of a toxin that is injected into the skin to paralyze skeletal muscles that cause the skin to wrinkle.
8. Radio frequency nonsurgical facelift, the use of radio frequency emissions to tighten the deeper layers of the skin
9. Facelift, browlift, or necklift, invasive surgery in which loose skin and fat are removed surgically

10. **Clinical Connection:** Sun Damage, Sunscreens and Sunblocks

**XII. Focus on Homeostasis:** The contributions of the integumentary system to all body systems.

- A. **Skeletal System:** helps with Vit D production
- B. **Muscular System:** provides Calcium ions
- C. **Nervous System:** nerve endings provide input to the brain
- D. **Endocrine System:** vitamin D is converted to calcitriol
- E. **Cardiovascular System:** vasodilation and vasoconstriction
- F. **Lymphatic System:** First line of defense
- G. **Respiratory System:** remove dust particles
- H. **Digestive System:** promotes absorption of calcium
- I. **Urinary System:** waste products excreted through sweat
- J. **Reproductive System:** respond to erotic pleasure

**XIII. DISORDERS: HOMEOSTATIC IMBALANCES**

- A. Skin cancer can be caused by excessive exposure to sunlight.
  1. The three most common forms are basal cell carcinoma, squamous cell carcinoma, and malignant melanoma.(Figure 5.8)
  2. Among the risk factors for skin cancer are skin type, sun exposure, family history, age, and immunologic status.
- B. Burns
  1. Tissue damage from excessive heat, electricity, radioactivity, or corrosive chemicals that destroys (denatures) proteins in the exposed cells is called a burn.
  2. Generally, the systemic effects of a burn are a greater threat to life than are the local effects.
  3. Depending on the depth of damage, skin burns are classified as first-degree and second-degree (partial-thickness) and third-degree (full-thickness) (Figure 5.9)

4. The seriousness of a burn is determined by its depth, extent, and area involved, as well as the person's age and general health. When the burn area exceeds 70%, over half of the victims die.
  5. A method for determining the extent of a burn is the rule of nines method (Figure 5.10).
- C. **Pressure ulcers**, are caused by a constant deficiency of blood to tissues overlying a bony projection that has been subjected to prolonged pressure against an object such as a bed, cast, or splint; the deficiency results in tissue ulceration. (Figure 5.11)