CHAPTER 5
The Integumentary System
Introduction

The organs of the integumentary system include the skin and its accessory structures including hair, nails, and glands, as well as blood vessels, muscles and nerves.
The integumentary system:

- Maintains the body’s integrity
- Maintains temperature
- Converts inactive vitamin D to its active form
- Provides sensory information
- Maintains homeostasis.
FOCUS on HOMEOSTASIS

SKELETAL SYSTEM
• Skin helps activate vitamin D, needed for proper absorption of dietary calcium and phosphorus to build and maintain bones

MUSCULAR SYSTEM
• Skin helps provide calcium ions, needed for muscle contraction

NERVOUS SYSTEM
• Nerve endings in skin and subcutaneous tissue provide input to brain for touch, pressure, thermal, and pain sensations

ENDOCRINE SYSTEM
• Keratinocytes in skin help activate vitamin D to calcitriol, a hormone that aids absorption of dietary calcium and phosphorus

CARDIOVASCULAR SYSTEM
• Local chemical changes in dermis cause widening and narrowing of skin blood vessels, which help adjust blood flow to skin

CONTRIBUTIONS OF THE INTEGUMENTARY SYSTEM FOR ALL BODY SYSTEMS
• Skin and hair provide barriers that protect all internal organs from damaging agents in external environment
• Sweat glands and skin blood vessels regulate body temperature, needed for proper functioning of other body systems

LYMPHATIC SYSTEM and IMMUNITY
• Skin is “first line of defense” in immunity, providing mechanical barriers and chemical secretions that discourage penetration and growth of microbes
• Intraepidermal macrophages in epidermis participate in immune responses by recognizing and processing foreign antigens
• Macrophages in dermis phagocytize microbes that penetrate skin surface

RESPIRATORY SYSTEM
• Hairs in nose filter dust particles from inhaled air
• Stimulation of pain nerve endings in skin may alter breathing rate

DIGESTIVE SYSTEM
• Skin helps activate vitamin D to the hormone calcitriol, which promotes absorption of dietary calcium and phosphorus in small intestine

URINARY SYSTEM
• Kidney cells receive partially activated vitamin D hormone from skin and convert it to calcitriol
• Some waste products are excreted from body in sweat, contributing to excretion by urinary system

REPRODUCTIVE SYSTEMS
• Nerve endings in skin and subcutaneous tissue respond to erotic stimuli, thereby contributing to sexual pleasure
• Suckling of a baby stimulates nerve endings in skin, leading to milk ejection
• Mammary glands (modified sweat glands) produce milk
• Skin stretches during pregnancy as fetus enlarges
The skin has 3 major layers:

- The outer is called the **epidermis**
- The inner is called the **dermis**
- The subcutaneous (**subQ**) layer (also called the hypodermis) is located underneath the dermis.
Structures of the Skin

(a) Sectional view of skin and subcutaneous layer
Dermatologist are doctors who treat disorders of all layers of the integumentary system.

(a) First-degree burn (sunburn)  
(b) Second-degree burn (note the blisters in the photograph)  
(c) Third-degree burn (notice the blackened skin)

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The Epidermis

Contains four major types of cells:

- Keratinocytes
- Melanocytes
- Intraepidermal macrophages
- Tactile epithelial cells
Keratinocytes produce keratin - a tough fibrous protein that provides protection.

Melanocytes produce the pigment melanin.

Intraepidermal macrophages are involved in the immune responses.

Tactile epithelial cells function in the sensation of touch.
The epidermis is composed of four layers in thin skin, and five layers in thick skin. They are (from deep to superficial):

- The **stratum basale**
- The **stratum spinosum**
- The **stratum granulosum**
- The **stratum lucidum** (only present in thick skin)
- The **stratum corneum**
The Epidermis

Location of four principal cell types in epidermis of thick skin

(d) Sectional view of dermal papillae, epidermal ridges, and epidermal layers
The Epidermis

Types of skin:

- **Thin (hairy) skin** covers all body regions except the palms, palmar surfaces of digits, and soles.
- **Thick (hairless) skin** covers the palms, palmar surfaces of digits, and soles.
Skin Pigments

- Melanin is produced by melanocytes in the stratum basale
Skin Pigments

- Albinism is a congenital disorder characterized by the complete or partial absence of pigment in the skin, hair, and eyes due to a defect of an enzyme involved in the production of melanin.
Vitiligo is a chronic disorder that causes depigmentation patches in the skin. The precise cause, is not known, but is most likely a combination of genetic factors coupled with a disorder of the immune system (autoimmune disease).
The dermis is composed of connective tissue containing collagen and elastic fibers. It contains two regions:

- The papillary region lies just below the epidermis
- The reticular region consists of dense irregular connective tissue
The subcutaneous layer is also called the hypodermis, and it attaches the skin to underlying tissues and organs.
The skin contains different types of sensory receptors found in different layers:

- **Superficially**
  - Type I cutaneous mechanoreceptors, free nerve endings, corpuscles of touch and hair root plexuses

- **Deep**
  - Lamellated corpuscles
Sensory Receptors

Location of four principal cell types in epidermis of thick skin
Accessory Structures of the Skin
Hair

Present on most surfaces except the palms, anterior surfaces of fingers, and the soles of the feet.

Composed of dead, keratinized epidermal cells.

Genetics determines thickness and distribution.
The parts of a hair include:

- The shaft (above the skin surface)
- The follicle (below the level of the skin)
- A root that penetrates into
  the dermis includes:
  - An epithelial root sheath
  - A dermal root sheath
Hair

Sebaceous gland
Hair root plexus
Bulb
Papilla of the hair
Apocrine sweat gland
Blood vessels

(a) Hair and surrounding structures
Hair

(c) Frontal and transverse sections of hair root
The skin contains 4 types of glands.

- **Sebaceous (oil) glands** are connected to hair follicles.
- **Eccrine sweat glands** are the most numerous.
- **Apocrine sweat glands** are located mainly in hairy skin.
- **Ceruminous glands** are modified sweat glands located in the ear canal.
Nails

Made of keratinized epidermal cells

Nail structures include:

- Free edge
- Transparent nail body (plate) with a whitish lunula at its base
- Nail root embedded in a fold of skin

(a) Dorsal view
Nails

NAIL ROOT is the portion that is not visible

EPONYCHIUM (cuticle) is the stratum corneum of the epidermis

LUNULA is the thick, white part of the nail

NAIL BED is the skin below the nail plate

NAIL BODY is the visible portion of the nail

Sagittal plane

FREE EDGE extends past the finger or toe

HYPONYCHIUM secures nail to the fingertip

Epidermis

Dermis

Phalanx (finger bone)

NAIL MATRIX is the epithelium proximal to the nail root. It contains dividing cells, which produce new nail cells

(b) Sagittal section showing internal detail
The Integumentary System

Anatomy Overview:

You must be connected to the Internet and in Slideshow Mode to run this animation.
Two kinds of wound-healing processes can occur, depending on the depth of the injury.

- **Epidermal wound healing** occurs following superficial wounds that affect only the epidermis.
**Wound Healing**

- **Deep wound healing** occurs when an injury extends to the dermis and subcutaneous layer.
Development of the Integumentary System

The epidermis develops from the ectoderm.

- Nails, hair, and skin glands are epidermal derivatives.

(a) Fourth week
The dermis develops from the mesoderm.
Aging

The integumentary system changes with age:

- Wrinkles develop.
- Dehydration and cracking occurs.
- Sweat production decreases.
- A decrease in the numbers of functional melanocytes results in gray hair and atypical skin pigmentation.
- Subcutaneous fat is lost, and there is a general decrease in skin thickness.
- Nails may also become more brittle.
With age, there is also an increased susceptibility to pressure ulcers ("bed sores").

Pressure ulcer on heel
Excessive exposure to ultraviolet light (from the sun or tanning salons) is the most common cause of skin cancer. The three major types are basal cell carcinoma, squamous cell carcinoma and malignant melanoma.
A **burn** is tissue damage caused by excessive heat, electricity, radioactivity, or corrosive chemicals that denature (break down) the proteins in the skin cells.

Burns are graded according to their severity.
A *first-degree burn* involves only the epidermis (sunburn).
A second-degree burn destroys the epidermis and part of the dermis (blister).
A **third-degree burn** is a full-thickness burn (destroys the epidermis, dermis, and subcutaneous layer).
The rule of nines is used to estimate the surface area of an adult affected by a burn.
End of Chapter 5

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