Chapter 5
The Integumentary System
Preview Questions

1. What are some useful functions of our skin?
2. How is human skin well suited for our environment? (Think of prehistoric man)
3. What are some diseases or disorders related to the skin?
Warm Up

- Read the article: “Will exoskeletons ever fly?”
- Then answer this question in your notebooks:
  - What futuristic technology would you like to see in your lifetime? Explain why.
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.

- **Dermatology** is the medical specialty for the diagnosis and treatment of disorders of the integumentary system.
Structure of the Skin

- The skin (cutaneous membrane) covers the body and is the largest organ of the body by surface area and weight.
- Its area is about 2 square meters (22 square feet) and weighs 4.5-5kg (10-11 lb), about 16% of body weight.
- It is 0.5 – 4 mm thick, thinnest on the eyelids, thickest on the heels; the average thickness is 1 – 2 mm.
Structure of the Skin

- It consists of two major layers:
  - outer, thinner layer called the **epidermis**, consists of epithelial tissue
  - inner, thicker layer called the **dermis**
- Beneath the dermis is a **subcutaneous (subQ) layer** (also called **hypodermis**) which attaches the skin to the underlying tissues and organs.
Components of the Integumentary System

(a) Sectional view of skin and subcutaneous layer

- Epidermal ridges
- Dermal papillae
- Capillary loop
- Sweat pore
- Sebaceous (oil) gland
- Meissner corpuscle (corpuscle of touch)
- Arrector pili muscle
- Hair follicle
- Hair root
- Eccrine sweat gland
- Apocrine sweat gland
- Pacinian (lamellated) corpuscle
- Sensory nerve
- Adipose tissue

Hair shaft
Free nerve ending
EPIDERMIS
Papillary region
DERMIS
Reticular region
Subcutaneous layer
Blood vessels: Vein
Artery
Structure of the Skin

- The **epidermis** has a number of important characteristics:
- the epidermis is composed of keratinized stratified squamous epithelium
- it contains four major types of cells:
- **Keratinocytes** (90% of the cells) produce keratin which is a tough fibrous protein that provides protection
Structure of the Skin

- **Melanocytes**: which produce the pigment melanin that protects against damage by ultraviolet radiation

- **Langerhans cells**: involved in immune responses, arise from red bone marrow

- **Merkel cells**: which function in the sensation of touch along with the adjacent tactile discs
Structure of the Epidermis

- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum basale
- Dermis

Key:
- Dead keratinocytes, those on the surface flake off
- Living keratinocytes
- Dendritic cell
- Melanocyte
- Dividing keratinocyte (stem cell)
- Tactile cell
- Sensory nerve ending
Types of Cells in the Epidermis

(a) Keratinocyte
(b) Melanocyte
(c) Langerhans cell
(d) Merkel cell

Figure 05.02 Tortora - PAP 12/e
Copyright © John Wiley and Sons, Inc. All rights reserved.
Layers of the Epidermis

(a) Four principal cell types in epidermis

(b) Photomicrograph of a portion of thick skin
(a) Four principal cell types in epidermis:

- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Dead keratinocytes
- Lamellar granules
- Keratinocyte
- Langerhans cell
- Merkel cell
- Merkel disc
- Sensory neuron
- Melanocyte
- Dermis
(b) Photomicrograph of a portion of thick skin
Epidermis

- The epidermis contains four major layers (thin skin) or five major layers (thick skin)
- **Stratum basale** (deepest layer) or **stratum germinativum**, where continuous cell division occurs which produces all the other layers
- **Stratum spinosum**, 8-10 layers of keratinocytes
- **Stratum granulosum**, which includes keratohyalin and lamellar granules
Epidermis

- **Stratum lucidum** is present only in **thick skin** (the skin of the fingertips, palms, and soles)
- **Stratum corneum**: composed of many sublayers of flat, dead keratinocytes called **corneocytes** or **squames** that are continuously shed and replaced by cells from deeper strata; constant friction can stimulate formation of a **callus**.
- **Keratinization**, the accumulation of more and more protective keratin, occurs as cells move from the deepest layer to the surface layer
- **Dandruff** - an excess of keratinized cells shed from the scalp
Dermis

- The dermis has several important characteristics:
- is composed of connective tissue containing collagen and elastic fibers
- contains two layers
- the outer papillary region consists of areolar connective tissue containing thin collagen and elastic fibers, dermal papillae (including capillary loops), corpuscles of touch and free nerve endings
Dermis

- The deeper **reticular region** consists of dense irregular connective tissue containing collagen and elastic fibers adipose cells, hair follicles, nerves, sebaceous (oil) glands, and sudoriferous (sweat) glands.

- **Striae** or **stretch marks** can appear if the skin is stretched too much.
Dermis

- **Lines of cleavage** - “tension lines” in the skin indicate the predominant direction of underlying collagen fibers.

- **Epidermal ridges** reflect contours of the underlying dermal papillae and form the basis for *fingerprints* (and footprints); their function is to increase firmness of grip by increasing friction.

- **Dermatoglyphics** - the study of the pattern of epidermal ridges.
Variations in skin color arise from variations in the amounts of three pigments: melanin, carotene, and hemoglobin.

**Melanin** - a yellow-red or brown-black pigment produced by melanocytes (located mostly in the epidermis, where it absorbs UV radiation)

The amount of melanin causes the skin’s color to vary from pale yellow to red to tan to black.

The number of melanocytes are about the same in all people; differences in skin color is due to the amount of pigment produced.
Structural Basis of Skin Color

- A benign localized overgrowth of melanocytes is a **nevus** or mole
- **Albinism** is an inherited inability to produce melanin - **vitiligo** is a condition in which there is a partial or complete loss of melanocytes from patches of skin
- **Carotene** - yellow-orange pigment (found in the stratum corneum, dermis, and subcutaneous layer)
- **Hemoglobin** - red color (located in erythrocytes flowing through dermal capillaries)
Subcutaneous Layer

- **Subcutaneous (subQ) layer** (also called **hypodermis**) is not part of the skin but, among its functions, it attaches the skin to the underlying tissues and organs; this layer (and sometimes the dermis) contains **lamellated (pacinian) corpuscles** which detect external pressure applied to the skin.
Accessory Structures of the Skin

- include hair, skin glands, and nails
- **Hairs (pili)** have a number of important functions:
  - protection
  - reduction of heat loss
  - sensing light touch
Accessory Structures of the Skin - Hair

- Hair is composed of dead, keratinized epidermal cells
- Hair consists of:
  - shaft which mostly projects above the surface of the skin
  - root which penetrates into the dermis
  - hair follicle
  - epithelial root sheath
  - dermal root sheath
Accessory Structures of the Skin

- There are different types of hairs including lanugo, vellus hairs and terminal hairs
- Hair color is determined by the amount and type of melanin
- Sebaceous (oil) glands are connected to hair follicles
Accessory Structures of the Skin

- **Lanugo:** is very fine, soft, and usually unpigmented, downy hair on the body of a fetus or newborn baby.

- It is the first hair to be produced by the fetal hair follicles, and it usually appears on the fetus at about 5 months of gestation.
Accessory Structures of the Skin

- **Vellus hairs**: is short, fine, light-colored, and barely noticeable hair that develops on most of a person's body from his/her childhood.

- Exceptions include the lips, the back of the ear, the palm of the hand, the sole of the foot, some external genital areas, the navel and scar tissue.

- Each strand of vellus hair is usually less than 2 mm (1/13 inch) long and the follicle is not connected to a sebaceous gland.
Accessory Structures of the Skin

- **Terminal hairs**: are thick, long, and dark, as compared with vellus hair.
- During puberty, the increase in androgenic hormone levels causes vellus hair to be replaced with terminal hair in certain parts of the human body.
A. Vellus Hair.  B. Terminal Hair
Development of terminal hair

Vellus hair  
prepubertal stage

Androgens

Terminal hair  
adult stage
Skin Glands

- Sebaceous glands secrete an oily substance called **sebum** which prevents dehydration of hair and skin, and inhibits growth of certain bacteria.

- **Sudoriferous (sweat) glands**—2 types:
  - **Eccrine** sweat glands
  - **Apocrine** sweat glands
Sudoriferous (Sweat) Glands

- Numerous **eccrine (or merocrine) sweat glands** helps to cool the body by evaporating, and also eliminates small amounts of wastes.

- **Apocrine sweat glands**, located mainly in the skin of the axilla, groin, areolae, and bearded facial regions of adult males.
  - their excretory ducts open into hair follicles - this sweat is secreted during emotional stress and sexual excitement.
Ceruminous Glands

- Modified sweat glands located in the ear canal

- Along with nearby sebaceous glands, they are involved in producing a waxy secretion called **cerumen** (earwax) which provides a sticky barrier that prevents entry of foreign bodies into the ear canal.
Nails

- Nails are composed of hard, keratinized epidermal cells located over the dorsal surfaces of the ends of fingers and toes.

- Each nail consists of:
  - **free edge**
  - transparent **nail body (plate)** with a whitish **lunula** at its base
  - **nail root** embedded in a fold of skin
Nails

(a) Dorsal view

(b) Sagittal section showing internal detail

Figure 05.05 Tortora - PAP 12/e
Copyright © John Wiley and Sons, Inc. All rights reserved.
Free edge
Nail body (plate)
Lunula
Eponychium (cuticle)
Nail root
Types of Skin

- There are two major 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
Functions of the Skin

- regulation of body temperature
- blood reservoir
- protection
- cutaneous sensations
- excretion and absorption
- synthesis of vitamin D
Wound Healing

Two types of wound healing:

- **Epidermal**: wounds that only effect the epidermis.
- **Deep wound**: wounds that penetrate the dermis.
Epidermal Wound Healing

- These wounds involve slight damage to the superficial cells of the epidermis.
  - This includes minor burns or abrasions (scraped skin).
- It begins with epidermal basal cells migrating across the wound until they meet with other basal cells.
- A hormone called Epidermal growth factor then stimulates the cells to divide to thicken the new epidermis.
Epidermal Wound Healing

(a) Division of basal epithelial cells and migration across wound

(b) Thickening of epidermis

Epidermal wound healing

Figure 05.06  Tortora - PAP 12/e
Copyright © John Wiley and Sons, Inc. All rights reserved.
Epidermal Wound Healing

(a) Division of basal epithelial cells and migration across wound
Epidermal Wound Healing
Deep Wound Healing

Deep wound healing occurs when injury extends to the dermis and/or subcutaneous layer (aka the hypodermis).

- This usually includes the formation of scar tissue and the healed tissue may lose some of its function.

Four phases:
- Inflammatory phase
- Migratory phase
- Proliferative phase
- Maturation phase
Deep Wound Healing

- **Inflammatory phase:** a blood clot forms in the wound and unites the edges.
- **Migratory phase:** the clot becomes a scab and the tissue under the scab unites the wound.
- **Proliferative phase:** extensive growth of tissue. Blood vessels grow. Collagen is replaced.
- **Maturation phase:** The scab falls off and the blood vessels are fully restored.
  - **Fibrosis:** formation of scar tissue.
(a) Division of basal epithelial cells and migration across wound
(b) Thickening of epidermis
(c) Inflammatory phase

- Blood clot in wound
- Epithelium migrating across wound
- Fibroblast
- Collagen fibers
- Monocyte (macrophage)
- Neutrophil
- Dilated blood vessel
- Damaged blood vessel
- End of clot
Development of the Integumentary System

- The epidermis develops from the **ectoderm**; nails, hair, and skin glands are epidermal derivatives - the epidermis of a fetus is protected by a fatty substance called **vernix caseosa**

- The dermis develops from the **mesoderm**
Development of the Integumentary System

- **Fourth week:** epidermis is only a single layer of cells.
- **Seventh week:** basal layer forms.
- **Eleven weeks:** All layers of the epidermis are present.
- **Twelve weeks:** hair buds form which are the precursors to hair follicles.
(c) Eleven weeks
- Intermediate layer
- Epidermal ridge
- Basal layer
- Dermal papilla
- Melanoblast
- Developing collagen and elastic fibers

(g) Eighteen weeks
- Hair shaft
- Sweat pore
- Duct of sudoriferous gland
- Arrector pili muscle
- Epithelial root sheath
- Dermal root sheath
- Secretory portion of sudoriferous gland
- Sebaceous gland
- Bulb
- Papilla of the hair
- Blood vessels

(d) Twelve weeks
- Basal layer
- Bud of developing sudoriferous gland
- Hair bud

(h) At birth
- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum basale
- Melanocyte
- Epidermis
- Dermis
Aging and the Integumentary System

Effects:

- wrinkling
- decrease of skin’s immune responsiveness
- dehydration and cracking of the skin
- decreased sweat production
- decreased numbers of functional melanocytes resulting in gray hair and atypical skin pigmentation
- loss of subcutaneous fat
- a general decrease in skin thickness
- an increased susceptibility to pathological conditions
- Growth of hair and nails decreases; nails may also become more brittle with age.
Online Quiz

- Working in pairs, complete the online quiz.
- You can find the link to the quiz on Edline.
- Use the book or the internet as a resource.
- Each partner in the group will copy down the questions and the correct answer for 20 of 40 the questions.
- At the bottom you can email the quiz to yourself to study for the test.
**Videos**

- **Skin color:**

- **Skin surgery:** [http://www.youtube.com/watch?v=mliaxYqJtI0](http://www.youtube.com/watch?v=mliaxYqJtI0)

- **Basal cell carcinoma removal (pretty graphic):**
  [http://www.youtube.com/watch?v=9dquCESihow](http://www.youtube.com/watch?v=9dquCESihow)

- **Home video of basic skin cancer removal:**
  - [http://www.youtube.com/watch?v=kysyUltygxg](http://www.youtube.com/watch?v=kysyUltygxg)

  *This is bad…*
  [http://www.youtube.com/watch?v=jA2YdxgzBRE](http://www.youtube.com/watch?v=jA2YdxgzBRE)