

Principles of Anatomy and Physiology
14th Edition
Gerard J. Tortora / Bryan Derrickson
WILEY

CHAPTER 5
The Integumentary System

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

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.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Introduction

The integumentary system:

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

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Introduction

FOCUS on HOMEOSTASIS

SELEKTAL 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 vitamin D, 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, a hormone that aids absorption of dietary calcium and phosphorus

CARDIOVASCULAR SYSTEM

- Local chemical changes in dermis cause constricting and relaxing 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 damage to agents in external environment
- Body fluids 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 blocking structures that destroy bacteria, fungi, and viruses
- Intercellular macrophages in epidermis participate in immune response by recognizing and phagocytosing foreign agents
- Melanocytes in dermis synthesize melanin that protects skin surface

RESPIRATORY SYSTEM

- Skin is thick, but dust particles from atmosphere or hair wave 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 make partially activated vitamin D hormone from skin and convert it to calcitriol
- Some amino acids are released from body in sweat, contributing to conversion to energy sources

REPRODUCTIVE SYSTEMS

- Nerve endings in skin and subcutaneous tissue respond to sexual stimuli, thereby contributing to sexual pleasure
- Lack of body temperature nerve endings in skin, leading to risk of infection
- Mammary glands (modified sweat glands) produce milk
- Skin stretches during pregnancy as fetus enlarges

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Structures of the Skin

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.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Structures of the Skin

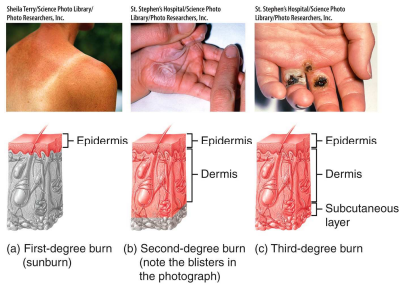
Labels include: Hair shaft, Papillary vascular plexus, Free nerve ending, Epidermal ridges, Dermal papillae, Capillary loop, Sweat pore, Sebaceous (oil) gland, Corpuscle of touch (Meissner corpuscle), Arrector pili muscle, Hair follicle, Hair root, Eccrine sweat gland, Apocrine sweat gland, Lamellated (pacinian) corpuscle, Sensory nerve, Adipose tissue, Cutaneous vascular plexus, Papillary region, Reticular region, Subcutaneous layer, Blood vessels: Vein, Artery.

(a) Sectional view of skin and subcutaneous layer

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Structures of the Skin

Dermatologist are doctors who treat disorders of all layers of the integumentary system.

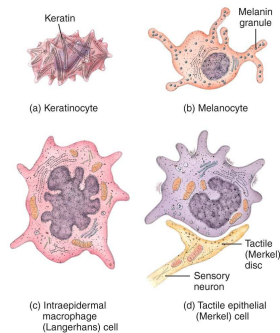


Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis

Contains four major types of cells:

- Keratinocytes
- Melanocytes
- Intraepidermal macrophages
- Tactile epithelial cells



Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis

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.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

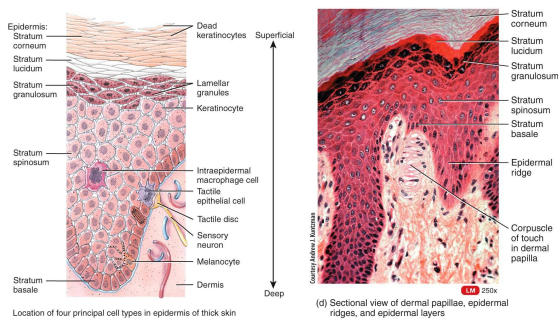
The Epidermis

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**

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis



Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis

Types of skin:

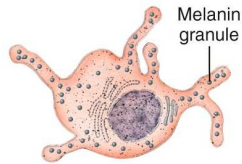
- **Thin (hairy) skin** covers all body regions except the palms, palmar surfaces of digits, and soles.
- **Thick (hairless) skin** covers the palms, palmar surfaces of digits, and soles.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis

Skin Pigments

- Melanin is produced by melanocytes in the stratum basale



(b) Melanocyte

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis

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.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Epidermis

Skin Pigments

- 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).

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Dermis

The dermis is composed of **connective tissue** containing collagen and elastic fibers.

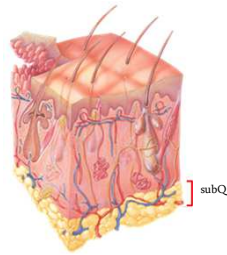
It contains two regions:

- The **papillary region** lies just below the epidermis
- The **reticular region** consists of **dense irregular connective tissue**

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Subcutaneous Layer

The **subcutaneous layer** is also called the **hypodermis**, and it attaches the skin to underlying tissues and organs.



Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

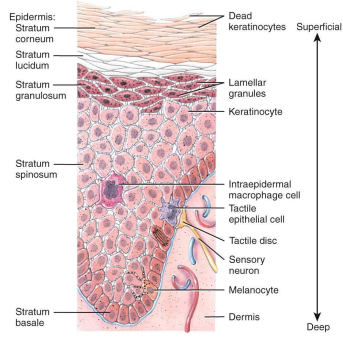
Sensory Receptors

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

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

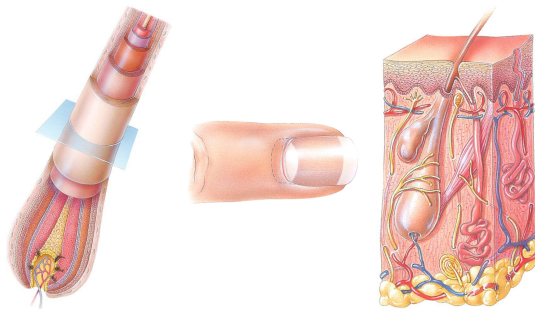
Sensory Receptors



Location of four principal cell types in epidermis of thick skin

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Accessory Structures of the Skin



Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Hair

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

Composed of dead, keratinized epidermal cells.

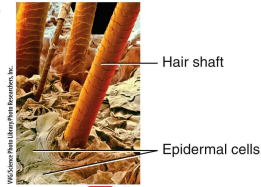
Genetics determines thickness and distribution.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Hair

The parts of a hair include:

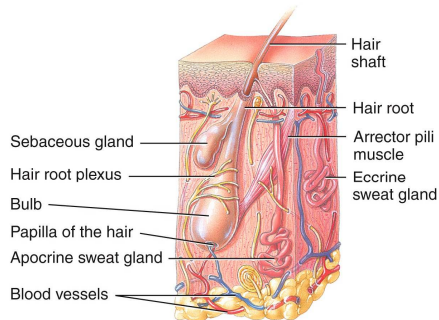
- The shaft (above the skin surface)
- The follicle (below the level of the skin)
- A root that penetrates into the dermis includes:
 - An epithelial root sheath
 - A dermal root sheath



(b) Several hair shafts showing the shinglelike cuticle cells

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

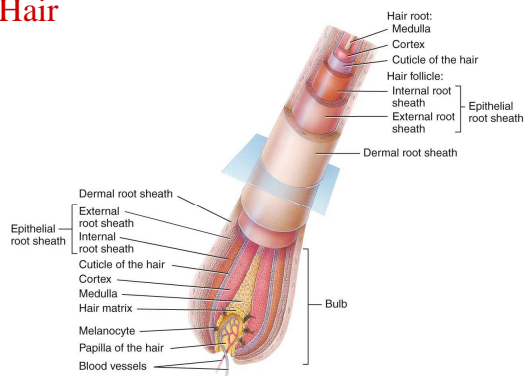
Hair



(a) Hair and surrounding structures

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Hair



(c) Frontal and transverse sections of hair root

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Skin Glands

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.



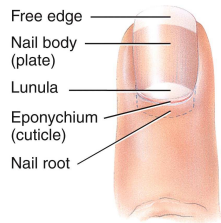
Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Nails

Made of keratinized epidermal cells

Nail structures include:

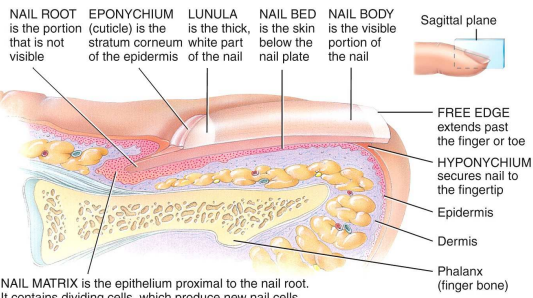
- Free edge
- Transparent nail body (plate) with a whitish lunula at its base
- Nail root embedded in a fold of skin



(a) Dorsal view

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Nails



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

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

The Integumentary System

Anatomy Overview:

The Integumentary System

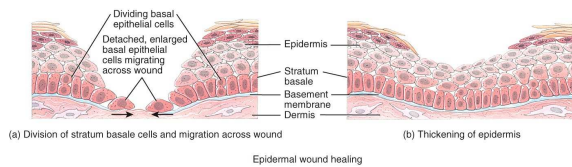
You must be connected to the Internet and in Slideshow Mode to run this animation.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Wound Healing

Two kinds of wound-healing processes can occur, depending on the depth of the injury.

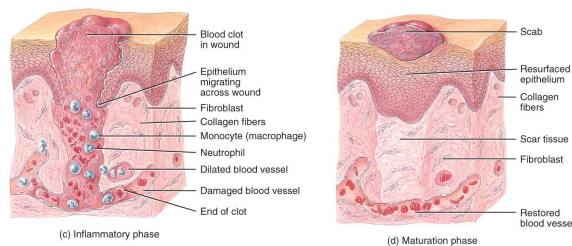
- **Epidermal wound healing** occurs following superficial wounds that affect only the epidermis.



Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Wound Healing

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

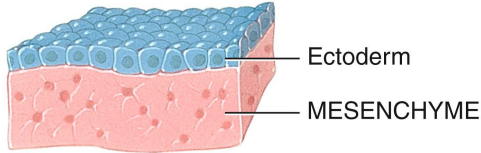


Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Development of the Integumentary System

The epidermis develops from the ectoderm.

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

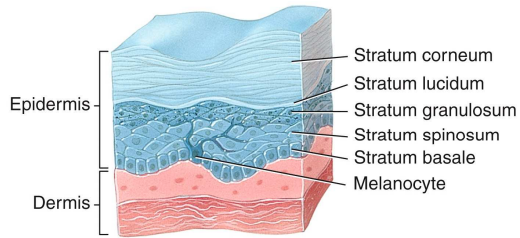


(a) Fourth week

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Development of the Integumentary System

The dermis develops from the mesoderm.



(h) At birth

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

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.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Aging

With age, there is also an increased susceptibility to pressure ulcers (“bed sores”).



Pressure ulcer on heel

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Skin Cancer

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.



(b) Malignant melanoma

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Burns

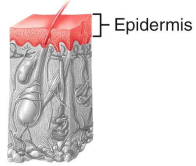
A **burn** is tissue damage caused by excessive heat, electricity, radioactivity, or corrosive chemicals that denature (break down) the proteins in the skin cells.

Burns are graded according to their severity.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Burns

A **first-degree burn** involves only the epidermis (sunburn).

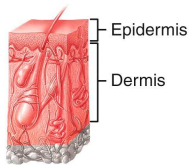


(a) First-degree burn (sunburn)

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Burns

A **second-degree burn** destroys the epidermis and part of the dermis (blister).

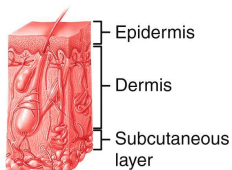


(b) Second-degree burn (note the blisters in the photograph)

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Burns

A **third-degree burn** is a full-thickness burn (destroys the epidermis, dermis, and subcutaneous layer).

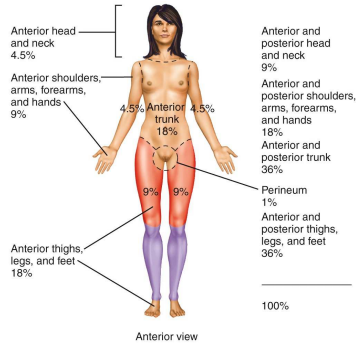


(c) Third-degree burn

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

Burns

The rule of nines is used to estimate the surface area of an adult affected by a burn.



Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.

End of Chapter 5

Copyright 2014 John Wiley & Sons, Inc.
All rights reserved. Reproduction or translation of this work beyond that permitted in section 117 of the 1976 United States Copyright Act without express permission of the copyright owner is unlawful. Request for further information should be addressed to the Permission Department, John Wiley & Sons, Inc. The purchaser may make back-up copies for his/her own use only and not for distribution or resale. The Publishers assumes no responsibility for errors, omissions, or damages caused by the use of these programs or from the use of the information herein.

Copyright © 2014 John Wiley & Sons, Inc. All rights reserved.
