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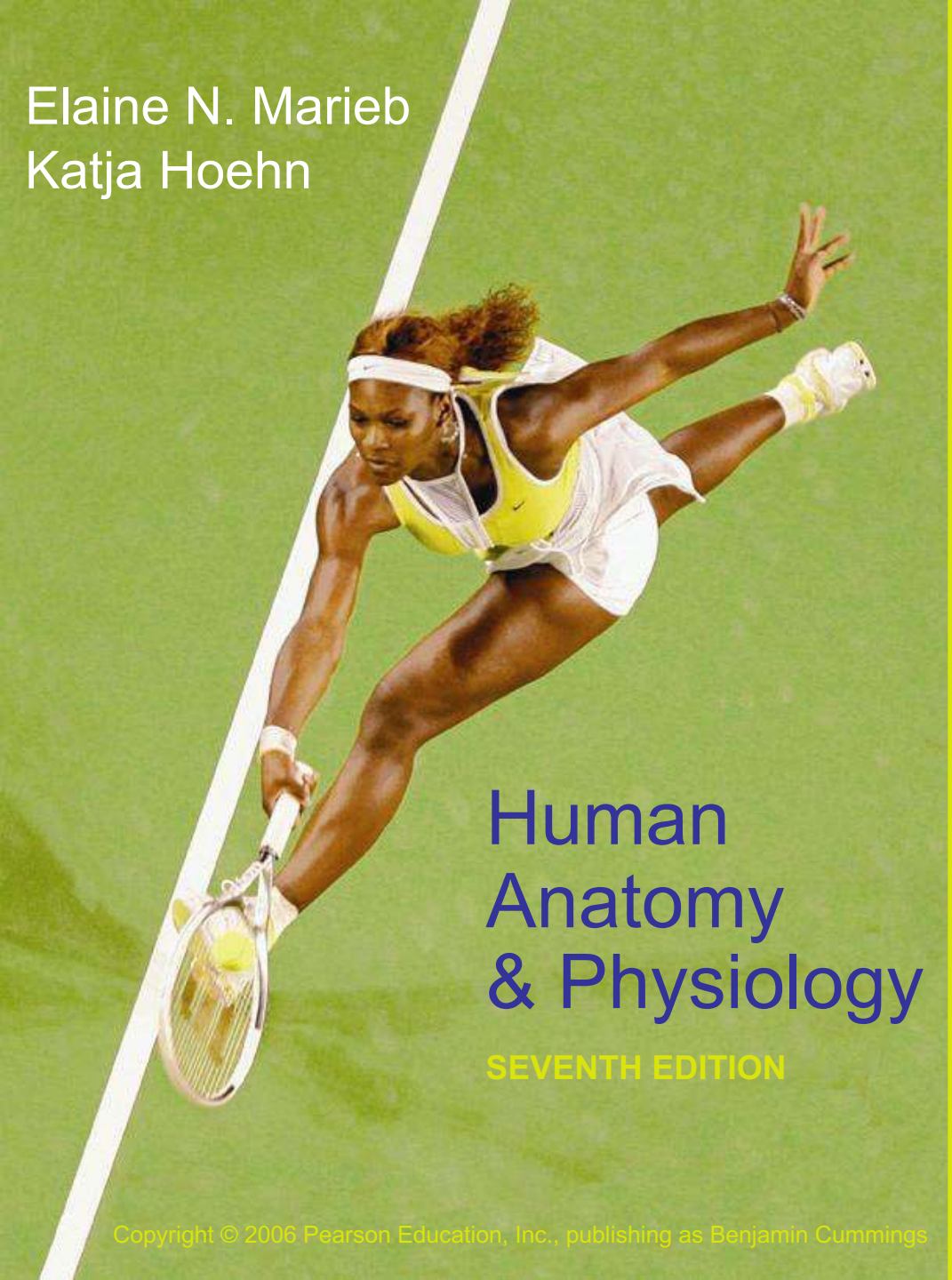


Human Anatomy & Physiology

SEVENTH EDITION

PowerPoint® Lecture Slides
prepared by Vince Austin,
Bluegrass Technical
and Community College

CHAPTER 5

The Integumentary System

System Overview

- The integumentary system is comprised of the skin and its accessory components including hair, nails, and associated glands.
- The integumentary system performs several vital functions:
  - Protection from pathogens
  - Balances fluid levels
  - Stores fatty tissue for energy supply
  - Produces vitamin D (with help from the sun)
  - Provides sensory input
  - Helps to regulate body temperature

Skin (Integument)

- The skin is the largest organ, weighing approximately 20 pounds and covering an area about 20.83 square feet on an adult.
- A cross section of skin reveals three layers:
  - Epidermis
  - Dermis
  - Subcutaneous Fascia

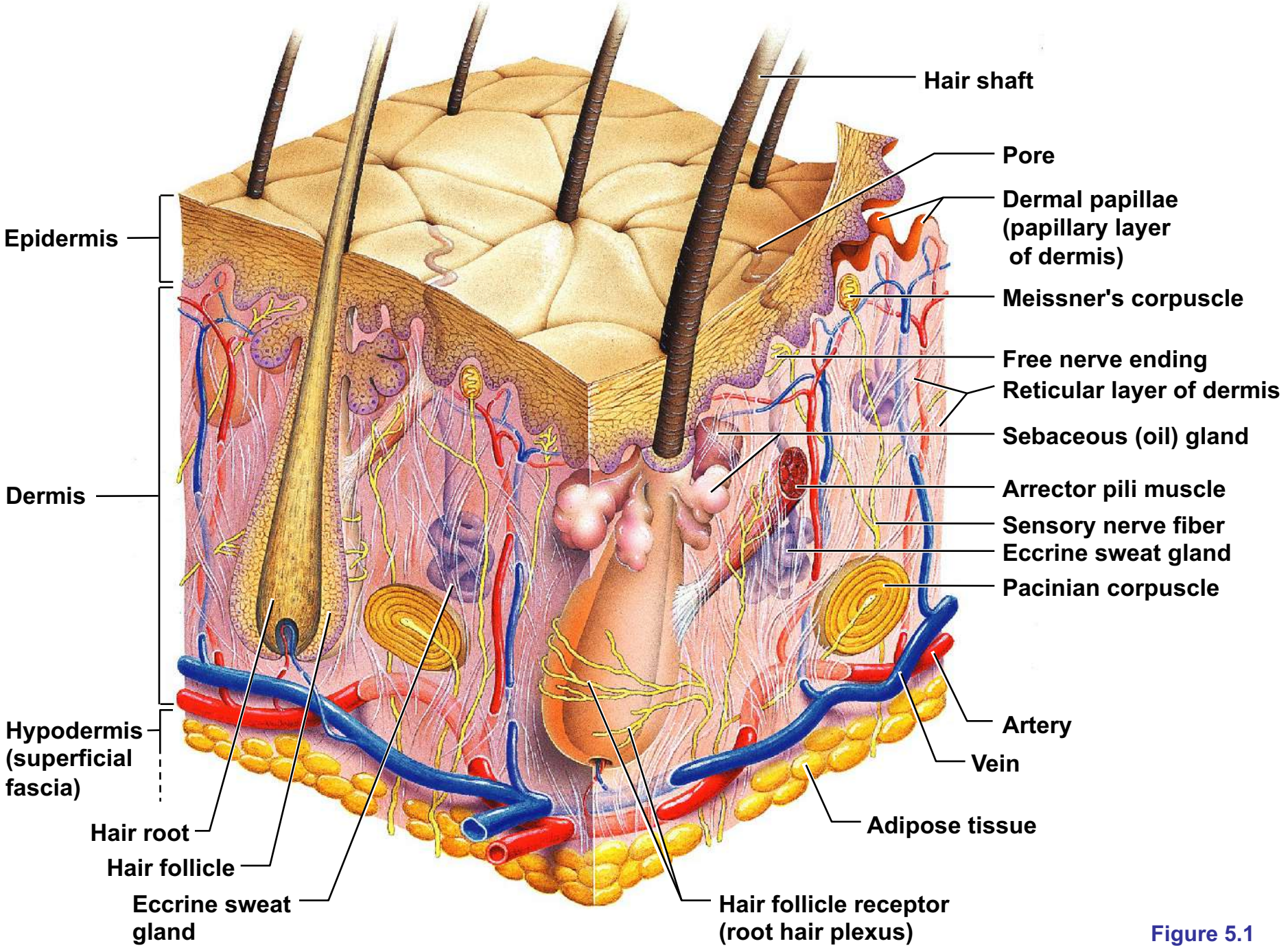

Hair shaft
Pore
Dermal papillae (papillary layer of dermis)
Meissner's corpuscle
Free nerve ending
Reticular layer of dermis
Sebaceous (oil) gland
Arrector pili muscle
Sensory nerve fiber
Eccrine sweat gland
Pacinian corpuscle
Artery
Vein
Adipose tissue
Hair follicle receptor (root hair plexus)
Epidermis
Dermis
Hypodermis (superficial fascia)
Hair root
Hair follicle
Eccrine sweat gland

Figure 5.1

Functions of the Integumentary System

- Protection – chemical, physical, and mechanical barrier
- Body temperature regulation is accomplished by:
  - Dilation (cooling) and constriction (warming) of dermal vessels
  - Increasing sweat gland secretions to cool the body
- Cutaneous sensation – exoreceptors sense touch and pain

Functions of the Integumentary System

- Metabolic functions – synthesis of vitamin D in dermal blood vessels
- Blood reservoir – skin blood vessels store up to 5% of the body's blood volume
- Excretion – limited amounts of nitrogenous wastes are eliminated from the body in sweat

I. Epidermis

- The epidermis is the layer of skin that we see on the outside. It is made up of five or six even smaller layers of tissue.
- There are no blood vessels or nerve endings in this layer.
- The cells on the surface of the epidermis are constantly shedding, being replaced with new cells that grow and arise from the deeper region called the stratum basale every 2–4 weeks.

Epidermis

- Composed of keratinized stratified squamous epithelium, consisting of four distinct cell types and four or five layers
- Cell types include keratinocytes, melanocytes, Merkel cells, and Langerhans' cells
- Outer portion of the skin is exposed to the external environment and functions in protection

Cells of the Epidermis

- Keratinocytes – produce the fibrous protein keratin
- Specialized cells called melanocytes are located deep in the epidermis and are responsible for skin color.
  - Melanocytes produce melanin, a substance that causes skin color
- Langerhans' cells – epidermal macrophages that help activate the immune system
- Merkel cells – function as touch receptors in association with sensory nerve endings

Layers of the Epidermis

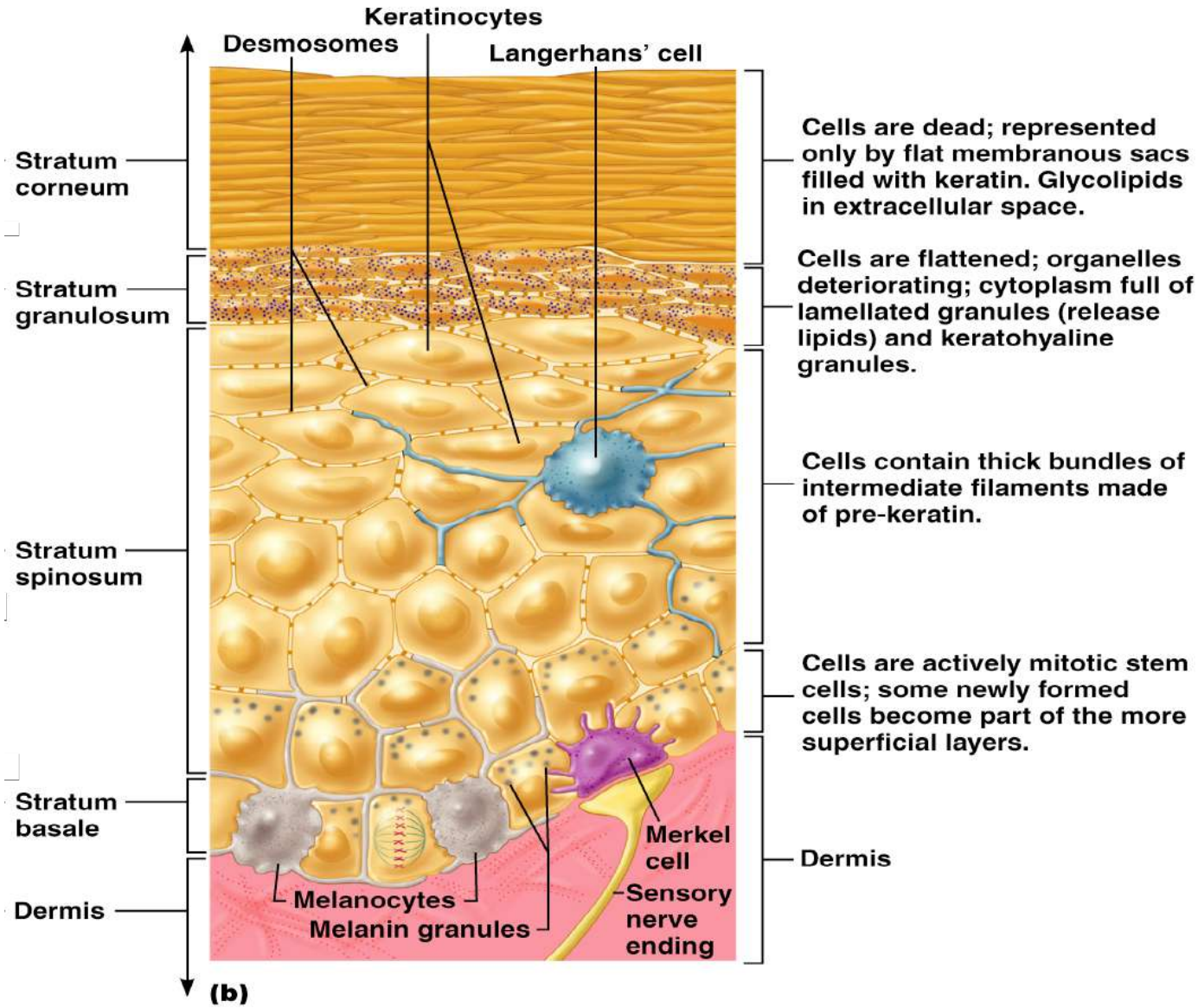


Figure 5.2b

Layers of the Epidermis: 1. Stratum Basale (Basal Layer)

- Deepest epidermal layer firmly attached to the dermis
- Consists of a single row of the youngest keratinocytes
- Cells undergo rapid division, hence its alternate name, **stratum germinativum**

Layers of the Epidermis: 2. Stratum Spinosum (Prickly Layer)

- Cells contain a weblike system of intermediate filaments attached to desmosomes
- Melanin granules and Langerhans' cells are abundant in this layer

Layers of the Epidermis: 3. Stratum Granulosum (Granular Layer)

- Thin; three to five cell layers in which drastic changes in keratinocyte appearance occurs
- Keratohyaline and lamellated granules accumulate in the cells of this layer

Layers of the Epidermis: 4. Stratum Lucidum (Clear Layer)

- Thin, transparent band superficial to the stratum granulosum
- Consists of a few rows of flat, dead keratinocytes
- Present only in thick skin

Layers of the Epidermis: 5. Stratum Corneum (Horny Layer)

- Outermost layer of keratinized cells
- Accounts for three quarters of the epidermal thickness
- Functions include:
  - Waterproofing
  - Protection from abrasion and penetration
  - Rendering the body relatively insensitive to biological, chemical, and physical assaults

Layers of the Epidermis

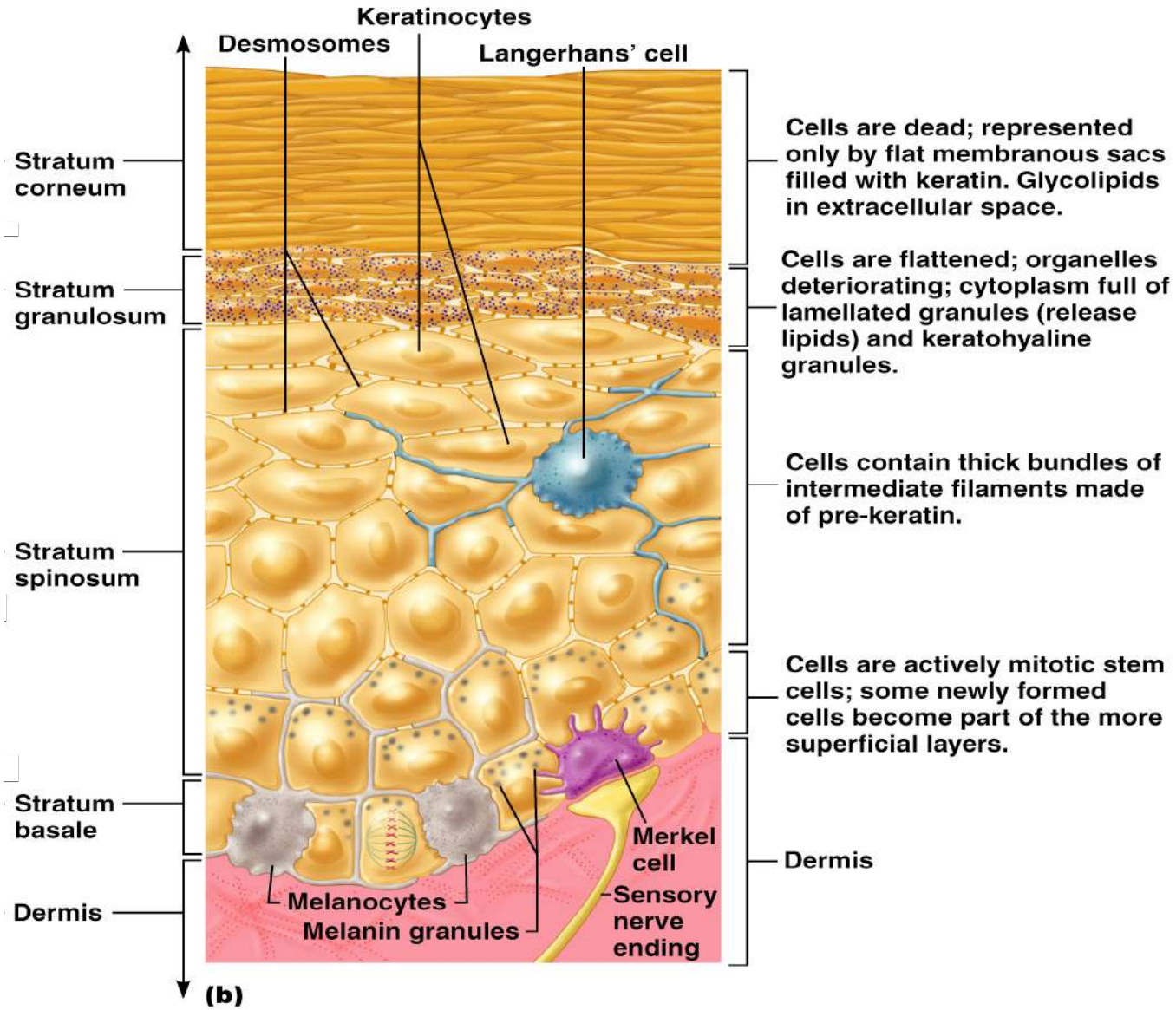


Figure 5.2b

Skin Color

- Specialized cells called **melanocytes** are located deep in the epidermis and are responsible for skin color.
- Melanocytes produce two pigments
- Melanin, a substance that causes skin color.
- Carotene, another form of pigment, gives a yellowish hue to skin

Skin Color (cont'd)

- Everyone contains the same amount of melanocytes, but the variation in skin color is the result of the amount of melanin produced and how it is distributed.
- Hemoglobin is the third pigment that derives the pinkish hue which is found in the blood

Affects of Disease on Skin Color

- Color of skin can indicate disease.
- When liver disease occurs, the body can't breakdown bilirubin. The buildup of bilirubin gives the skin a deeper, yellow color.
- A malfunctioning adrenal gland can cause the skin to turn bronze due to excessive melanin.

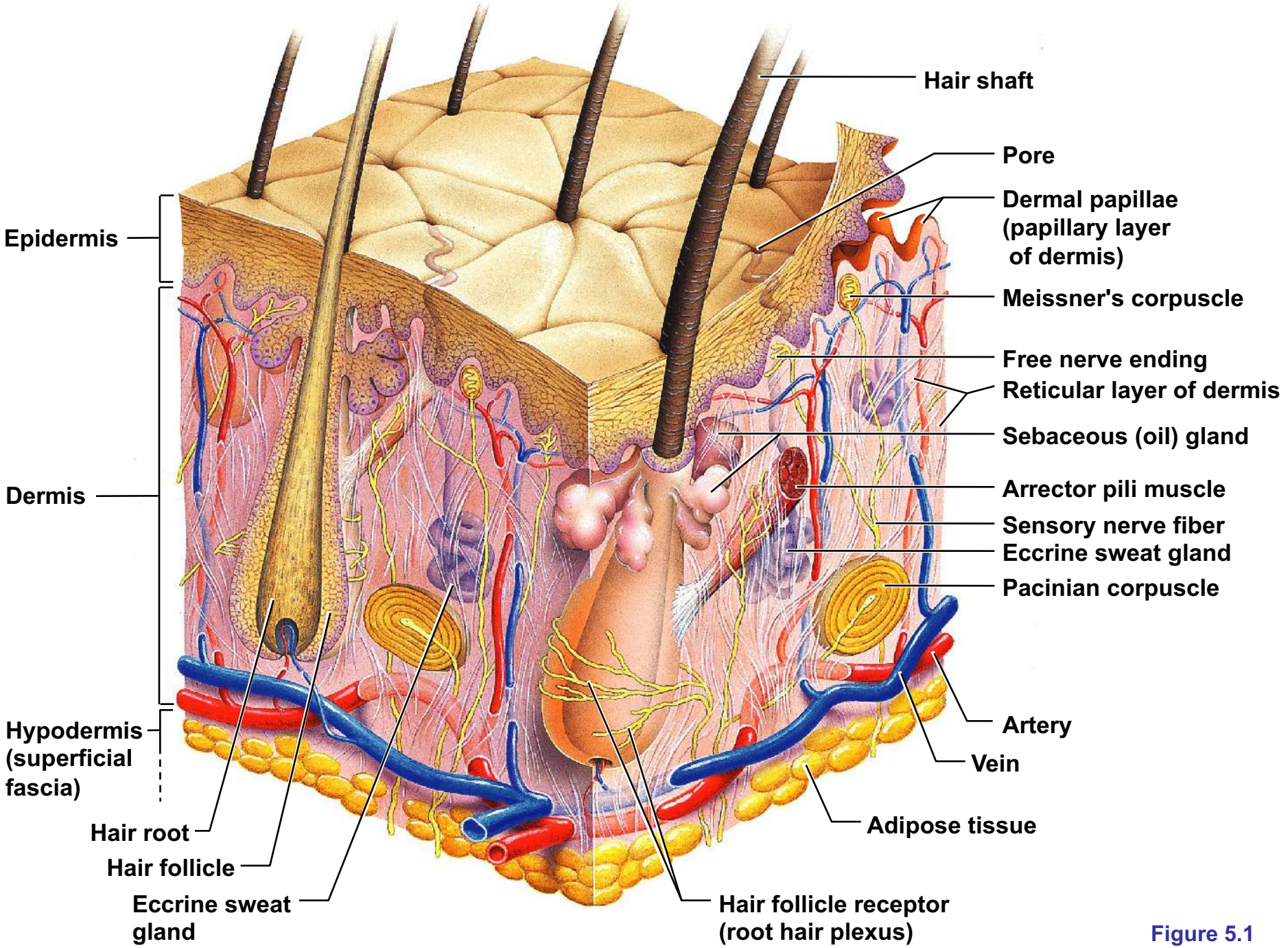
Affects of Disease on Skin Color (cont'd)

- Excessive bruising could indicate skin, blood, or circulatory problems.
- Cyanosis, or a blue coloring, results from a drop in oxygenation.

II. Dermis

A thicker layer that is inferior to the epidermis.

- This layer contains the following:
  - Capillaries
  - Collagenous/elastic fibers
  - Involuntary muscles
  - Nerve endings
  - Lymph vessels
  - Hair follicles
  - Sudoriferous glands (sweat)
  - Sebaceous glands (oil)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Adipose tissue
Hair follicle receptor (root hair plexus)
Epidermis
Dermis
Hypodermis (superficial fascia)
Hair root
Hair follicle
Eccrine sweat gland

Figure 5.1

Dermis

- Second major skin region containing strong, flexible connective tissue
- Cell types include fibroblasts, macrophages, and occasionally mast cells and white blood cells
- Composed of two layers – papillary and reticular

Layers of the Dermis: 1. Papillary Layer

- Small "fingers" of tissue project from the surface of the dermis called dermal papillae. It anchors dermis to the epidermal layer.
- **Finger and toe prints arise from this layer**.
- Dermal papillae contain capillary loops, Meissner's corpuscles, and free nerve endings to allow you to sense what is happening in your environment.

Papillary Layer (cont'd)

- Contains areolar connective tissue with collagen and elastic fibers preventing the tearing of skin with movement. They allow skin to return to normal shape during periods of rest. Older people lose some of this elasticity, leading to wrinkles.

Layers of the Dermis: 2. Reticular Layer

- Accounts for approximately 80% of the thickness of the skin
- Collagen fibers in this layer add strength and resiliency to the skin
- Elastin fibers provide stretch-recoil properties

III. Hypodermis (Subcutaneous Facia)

- It is the innermost layer of the skin.
- Hypodermis is composed of elastic and fibrous connective tissue and fatty tissue.
- Lipocytes, or fat cells, produce the fat needed to provide padding to protect the deeper tissues of the body and act as insulation for temperature regulation.
- Fascia attaches to the muscles of the body.

Sweat (Sudiferous) Glands

- There are four types that; prevent overheating of the body; secrete cerumen and milk
  - Eccrine sweat glands – found in palms, soles of the feet, and forehead and upper lip. Regulates Temperature. Become active around puberty
  - Apocrine sweat glands – found in axillary and anogenital areas
  - Ceruminous glands – modified apocrine glands in external ear canal that secrete cerumen
  - Mammary glands – specialized sweat glands that secrete milk

Sweat Glands (cont'd)

- The body has 3 million sweat glands.
- Sweat has no odor, but bacteria degrades the substances in the sweat over time into chemicals that give off strong smells commonly known as body odors.

Sebaceous Glands

- Simple alveolar glands found all over the body
- Soften skin when stimulated by hormones
- Secrete an oily secretion called sebum
- Sebum keeps the skin from drying out and (due to its acidic nature) helps destroy some pathogens on the skin's surface.

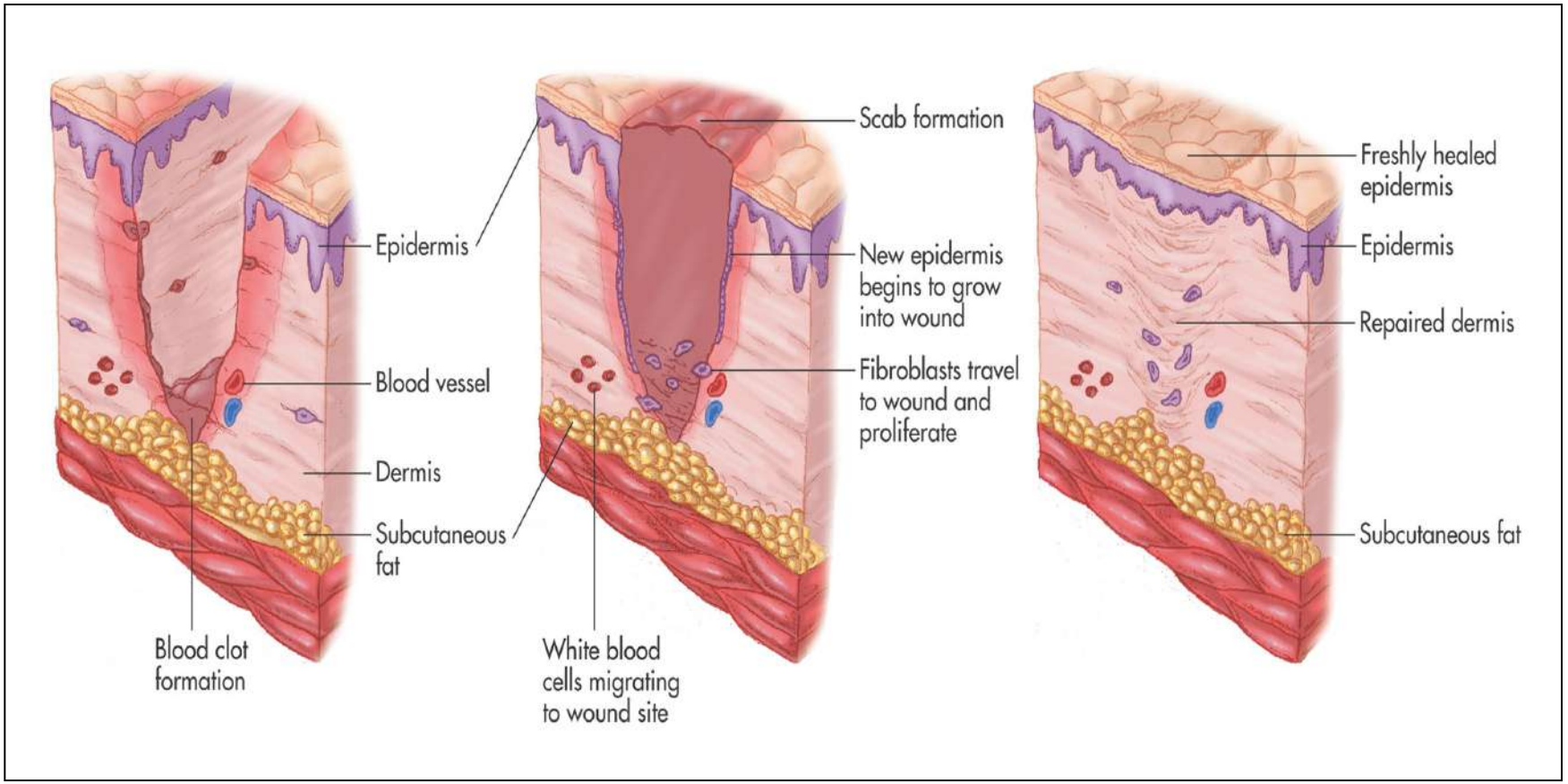
How Skin Heals

- Everyone has skin injuries from time to time.
- If skin is punctured and the wound damages blood vessels, the wound fills with blood. Blood contains substances that cause clotting. The top part of the clot exposed to air hardens to form a scab, nature's band-aid, forming a barrier and preventing pathogens from entering.

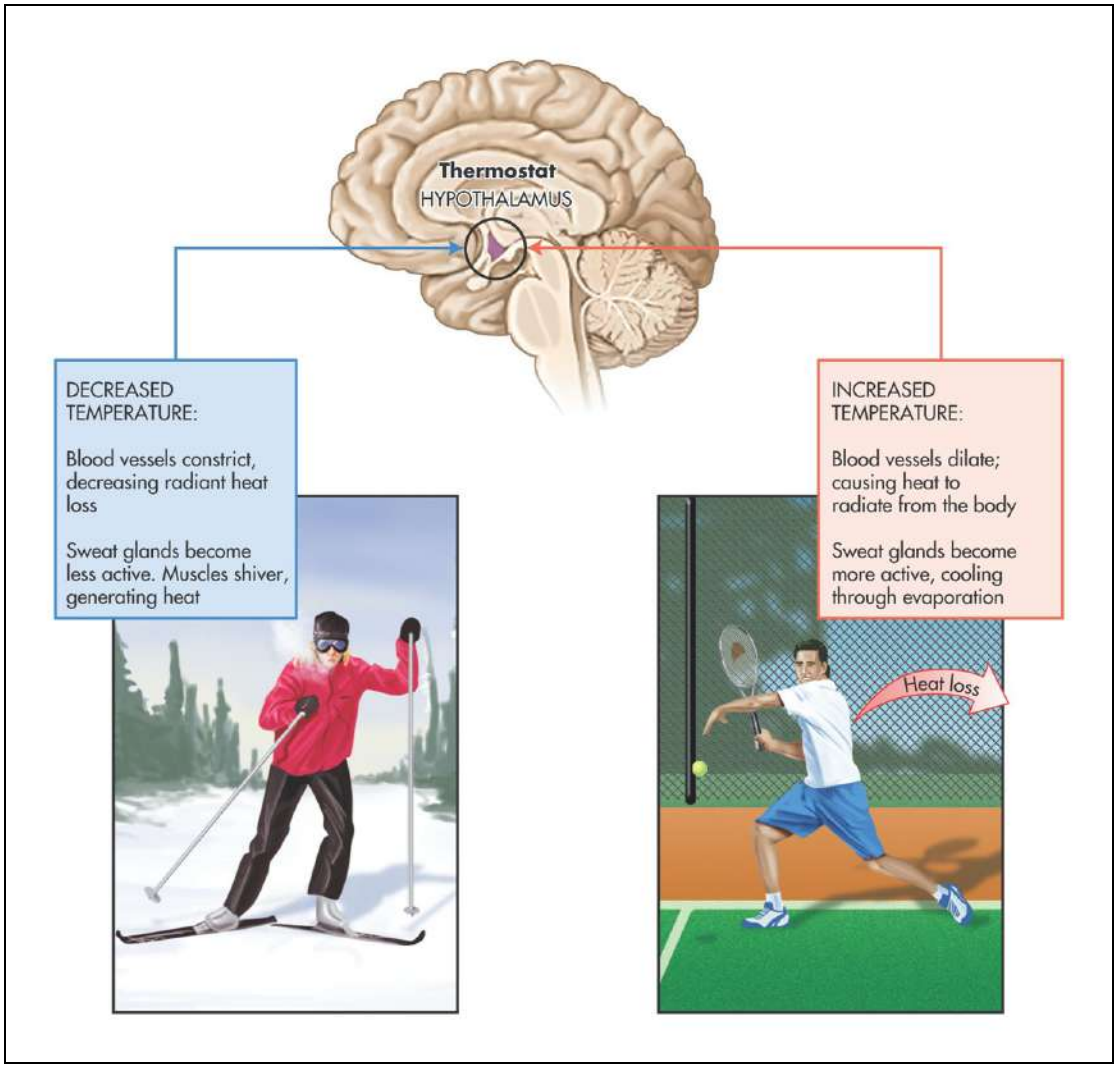
How Skin Heals (cont'd)

- Next, white blood cells enter and destroy any pathogens, while fibroblasts come and begin pulling the edges of the wound together. The basale layer hyperproduces cells for repair of the wound.

Skin healing



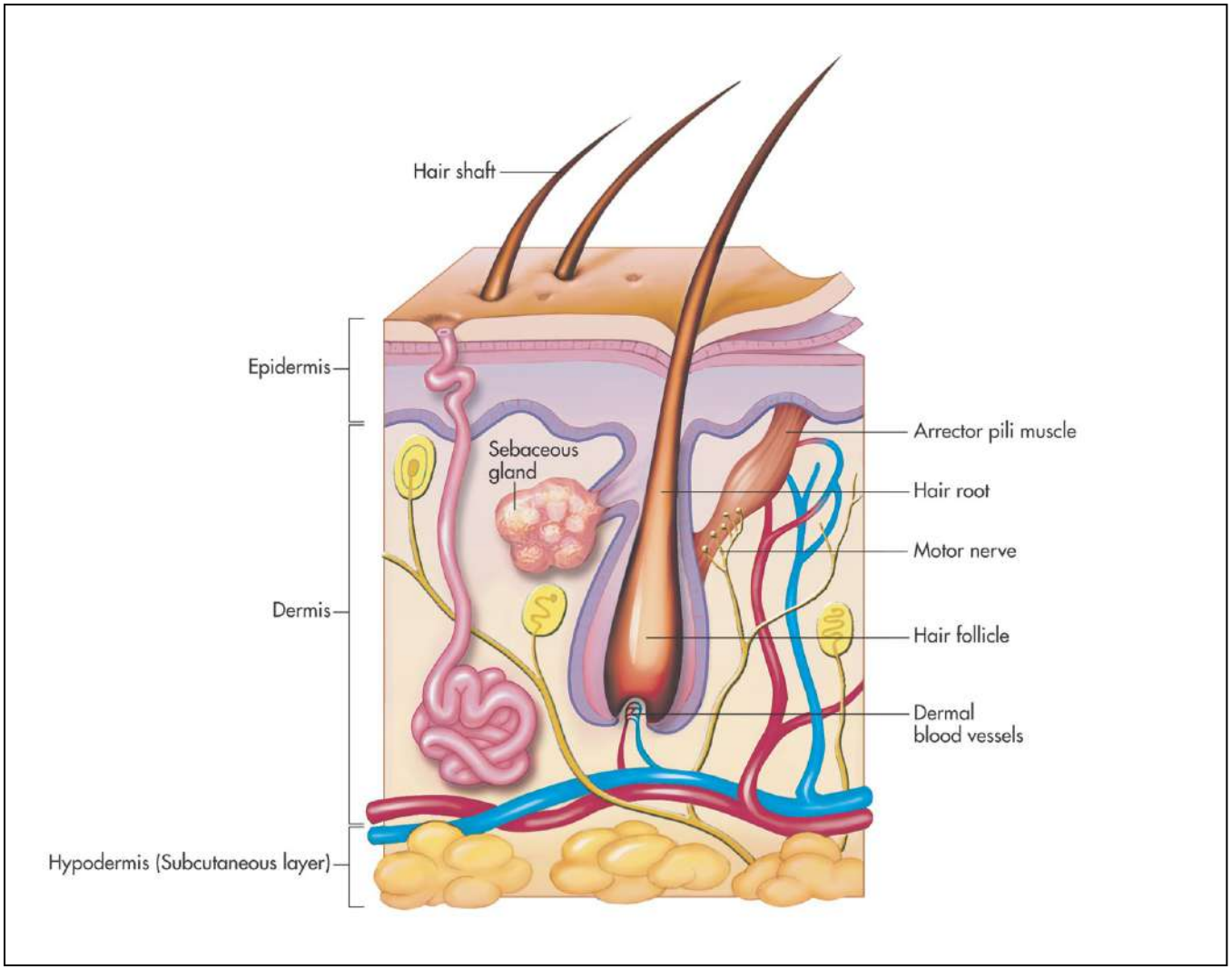
Integumentary regulation of body temperature



Hair

- Filamentous strands of dead keratinized cells produced by hair follicles
- Contains hard keratin which is tougher and more durable than soft keratin of the skin
- Made up of the shaft projecting from the skin, and the root embedded in the skin
- Consists of a core called the medulla, a cortex, and an outermost cuticle
- Pigmented by melanocytes at the base of the hair

Diagram of a hair follicle



Hair Function and Distribution

- Functions of hair include:
  - Helping to maintain warmth
  - Alerting the body to presence of insects on the skin
  - Guarding the scalp against physical trauma, heat loss, and sunlight

Hair Function and Distribution

- Hair is distributed over the entire skin surface except:
  - Palms, soles, and lips
  - Nipples and portions of the external genitalia

Hair Follicle

- Root sheath extending from the epidermal surface into the dermis
- Deep end is expanded forming a hair bulb
- A knot of sensory nerve endings (a root hair plexus) wraps around each hair bulb
- Bending a hair stimulates these endings, hence our hairs act as sensitive touch receptors

Hair Follicle

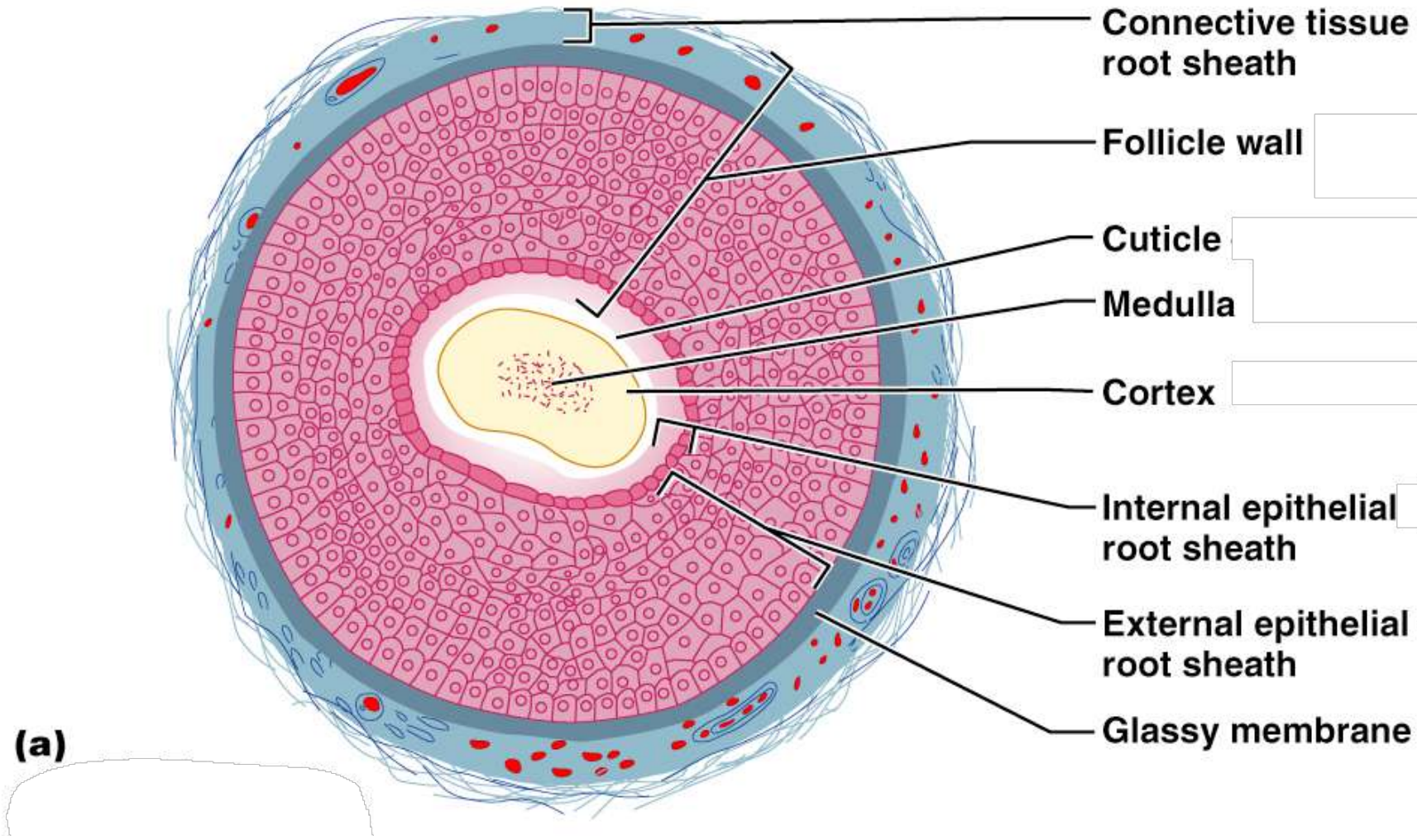


Figure 5.5a

Hair Follicle

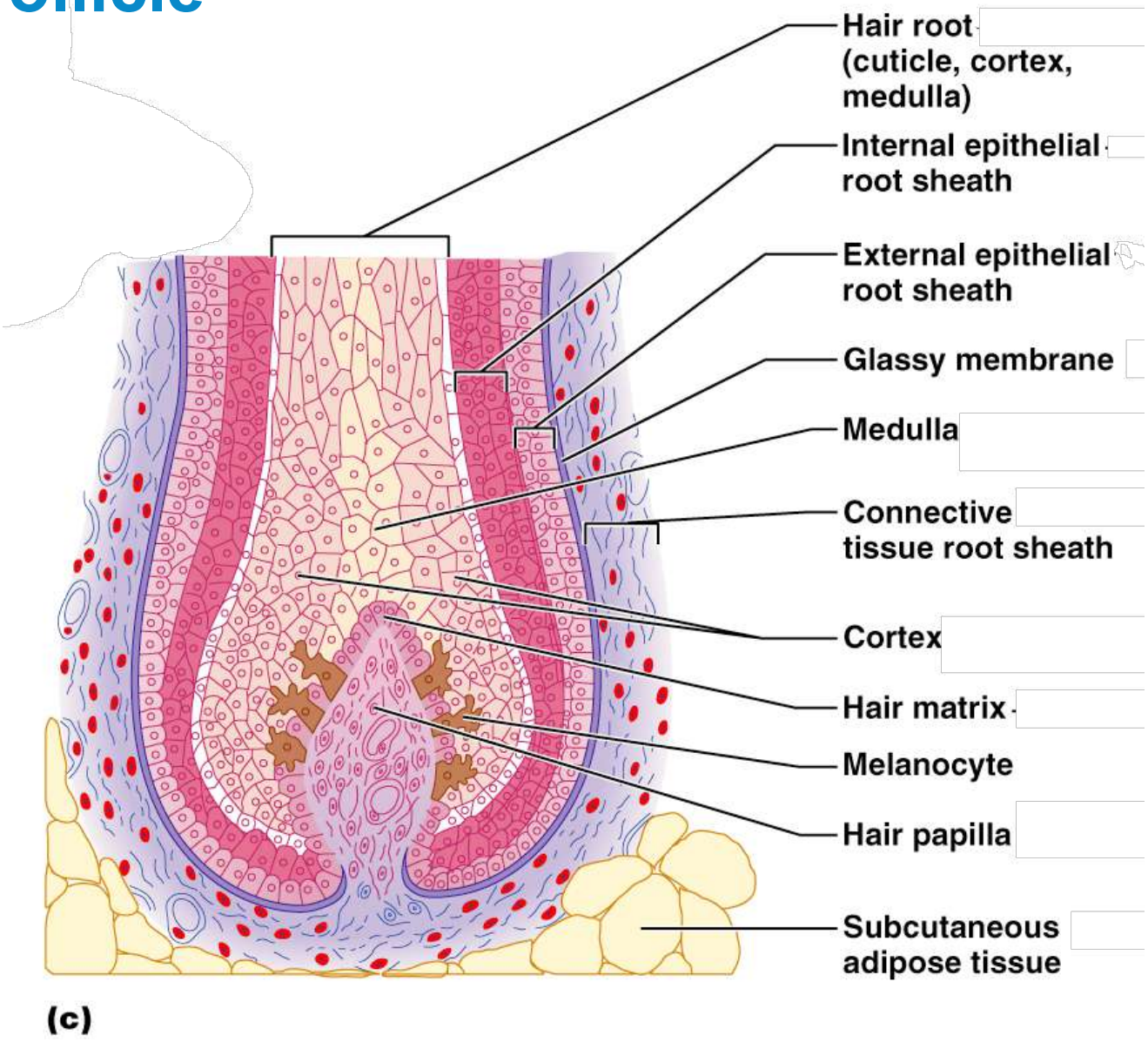


Figure 5.5c

Types of Hair

- Vellus – pale, fine body hair found in children and the adult female
- Terminal – coarse, long hair of eyebrows, scalp, axillary, and pubic regions

- Your hair color is dependent on the amount and type of melanin you produce.
- The more melanin, the darker your hair.
- White hair occurs in the absence of melanin.
- Red hair is the result of hair that has melanin with iron in it.
- Flat hair shafts produce curly hair, while round hair shafts produce straight hair.
- The life span of hair is dependent on location, with eyelashes lasting 3–4 months while the hair on your head lasts 3–4 years (**unless you're a teacher – we pull our hair out before then!).**

Hair Thinning and Baldness

- Alopecia – hair thinning in both sexes
- True baldness
  - Genetically determined and sex-influenced condition
  - Male pattern baldness – caused by follicular response to DHT

Nails

- Specialized epithelial cells originating from the nail root form your nails.
- As these cells grow out and over the nail bed, they become keratinized forming a substance similar to the horns on a bull.
- The cuticle is a fold of tissue that covers the nail root.

Nails (cont'd)

- The portion that we see is called the nail body.
- Nails normally grow 1 mm every week.
- The pink color of the nail comes from the vascularization of the tissue under the nails, while the white half-moon shaped area, or lunula is a result of the thicker layer of cells at the base.

Structure of a Nail

- Scalelike modification of the epidermis on the distal, dorsal surface of fingers and toes

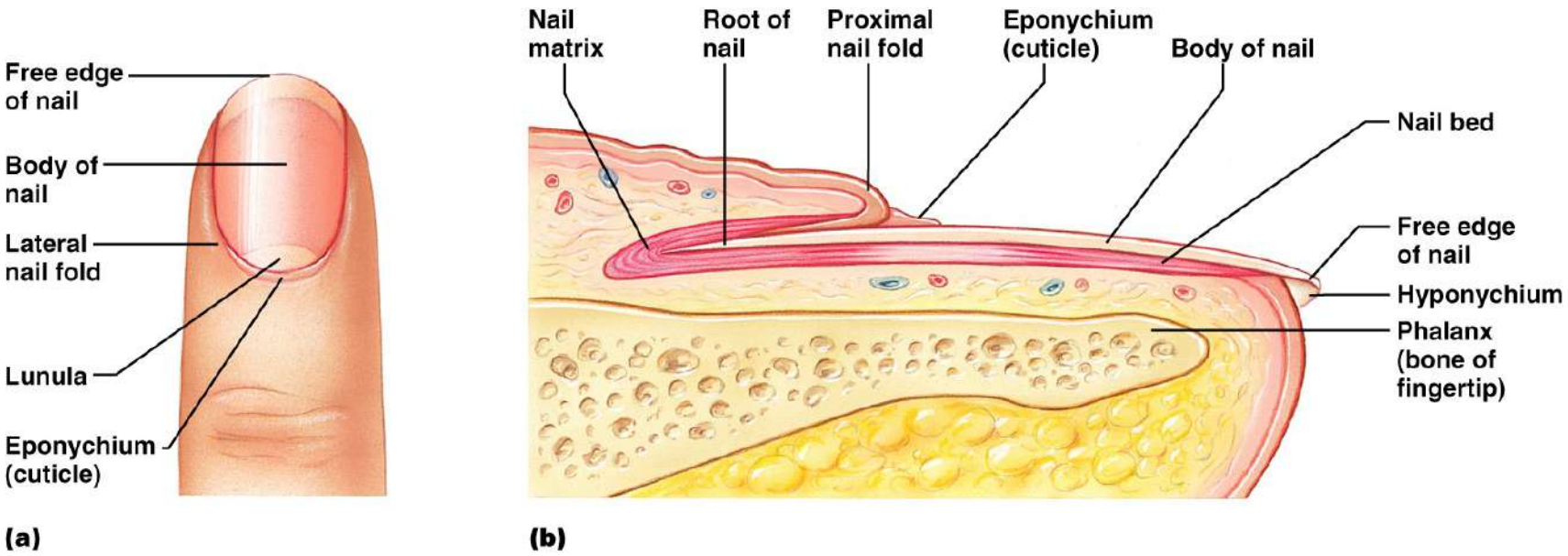


Figure 5.6

Skin Cancer

- Most skin tumors are benign and do not metastasize
- A crucial risk factor for nonmelanoma skin cancers is the disabling of the *p53* gene
- Newly developed skin lotions can fix damaged DNA

Skin Cancer

- The three major types of skin cancer are:
  - Basal cell carcinoma
  - Squamous cell carcinoma
  - Melanoma

Basal Cell Carcinoma

- Least malignant and most common skin cancer
- Stratum basale cells proliferate and invade the dermis and hypodermis
- Slow growing and do not often metastasize
- Can be cured by surgical excision in 99% of the cases

Squamous Cell Carcinoma

- Arises from keratinocytes of stratum spinosum
- Arise most often on scalp, ears, and lower lip
- Grows rapidly and metastasizes if not removed
- Prognosis is good if treated by radiation therapy or removed surgically

Melanoma

- Cancer of melanocytes is the most dangerous type of skin cancer because it is:
  - Highly metastatic
  - Resistant to chemotherapy

Skin Cancers

(a)

(b)

(c)

Figure 5.7a–c

Melanoma

- Melanomas have the following characteristics (ABCD rule)
  - A: Asymmetry; the two sides of the pigmented area do not match
  - B: Border is irregular and exhibits indentations
  - C: Color (pigmented area) is black, brown, tan, and sometimes red or blue
  - D: Diameter is larger than 6 mm (size of a pencil eraser)

Melanoma

- Treated by wide surgical excision accompanied by immunotherapy
- Chance of survival is poor if the lesion is over 4 mm thick

Burns

- First-degree – only the epidermis is damaged
  - Symptoms include localized redness, swelling, and pain
- Second-degree – epidermis and upper regions of dermis are damaged
  - Symptoms mimic first degree burns, but blisters also appear

Burns

- Third-degree – entire thickness of the skin is damaged

Burned area appears gray-white, cherry red, or black; there is no initial edema or pain (since nerve endings are destroyed)

Rule of Nines

- Estimates the severity of burns
- Burns considered critical if:
  - Over 25% of the body has second-degree burns
  - Over 10% of the body has third-degree burns
  - There are third-degree burns on face, hands, or feet

Rule of Nines

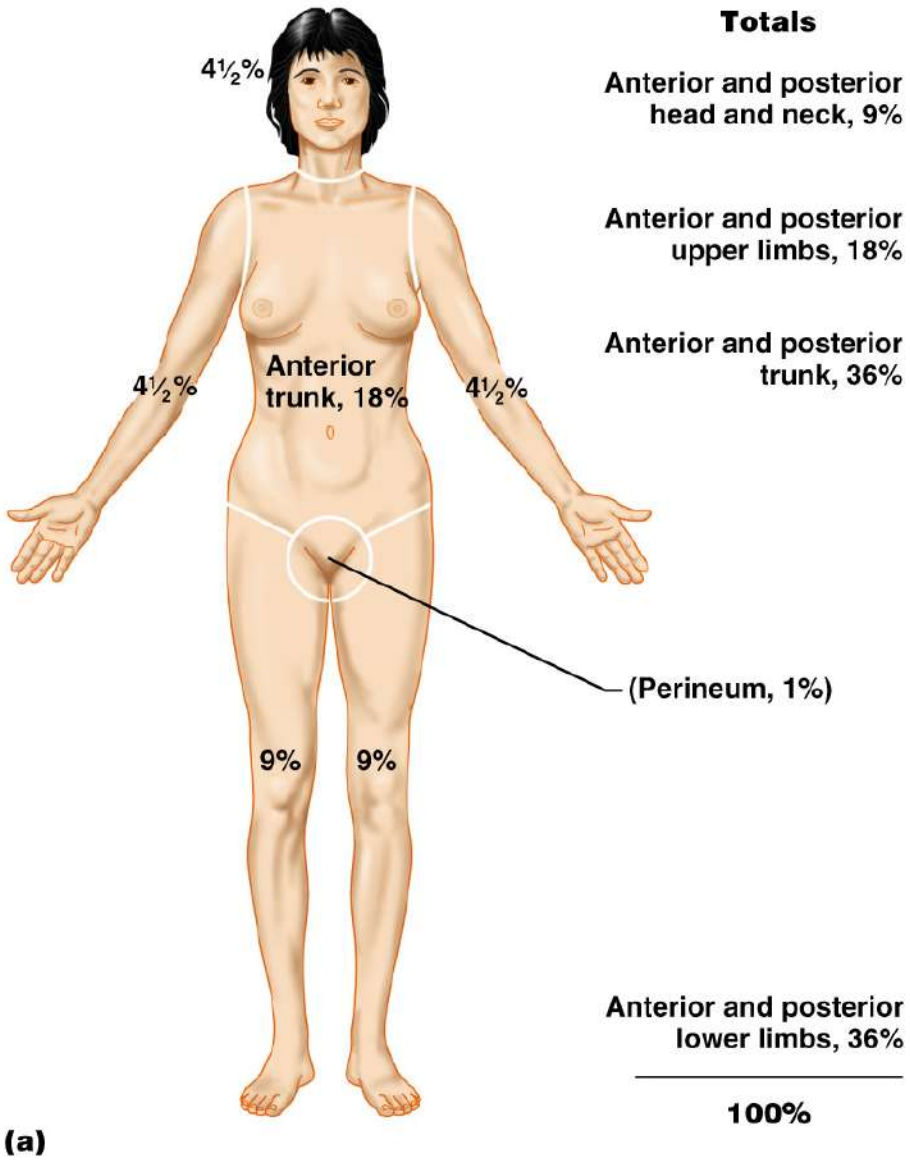


Figure 5.8a

Developmental Aspects of the Integument: Fetal

- Epidermis develops from ectoderm
- Dermis and hypodermis develop from mesoderm
- Lanugo – downy coat of delicate hairs covering the fetus
- Vernix caseosa – substance produced by sebaceous glands that protects the skin of the fetus in the amnion

Developmental Aspects of the Integument: Adolescent to Adult

- Skin and hair become oilier and acne may appear
- Skin shows the effects of cumulative environmental assaults around age 30
- Scaling and dermatitis become more common

Developmental Aspects of the Integument: Old Age

- Epidermal replacement of cells slows and skin becomes thinner
- Skin becomes dry and itchy
- Subcutaneous fat layer diminishes, leading to intolerance of cold
- Decreased elasticity and loss of subcutaneous tissue leads to wrinkles
- Decreased numbers of melanocytes and Langerhans' cells increase the risk of skin cancer