The integumentary system

Al-Farabi Kazakh National University
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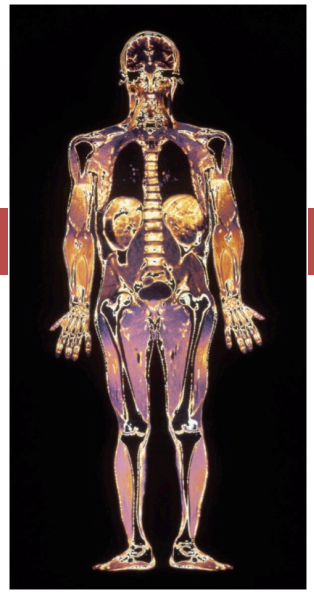

LEARNING OUTCOMES

As a result of the lesson you will be able to:

- *List the functions of the skin and relate them to its structure;*
- *Identify and name the following skin structures: epidermis, dermis (papillary and reticular layers), hair and hair follicle, sebaceous gland, and sweat gland.*
- *Describe the distribution and function of the epidermal appendages—sebaceous and ceruminous glands, sweat glands, hair, and nails.*
- *Describe the normal and pathological colors that the skin can have, and explain their causes;*
- *Describe the role of dermal circulation;*

Overview

- **Integumentary System** – consists of the skin and its accessory organs
  - hair, nails, and cutaneous glands
- most visible system and more attention paid to this organ system
- inspection of the skin, hair, and nails is significant part of a physical exam
- skin is the most vulnerable organ
  - exposed to radiation, trauma, infection, and injurious chemicals
- receives more medical treatment than any other organ system
- **dermatology** – scientific study and medical treatment of the integumentary system

Structure of the Skin

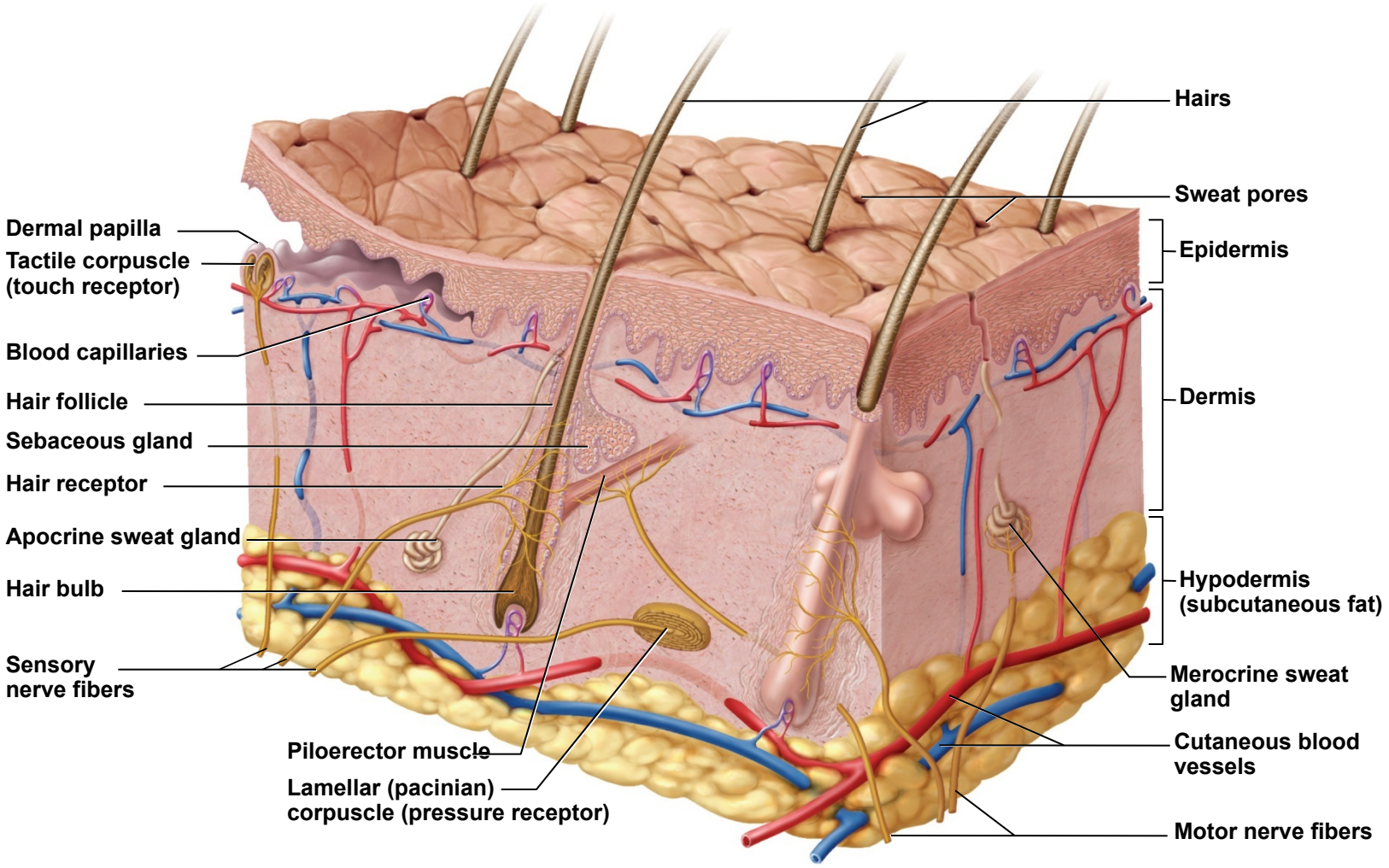

Figure 6.1

Skin and Subcutaneous Tissue

- the body's largest and heaviest organ
  - covers area of 1.5 -2.0 m^2
  - 15 % of body weight
- consists of two layers:
  - **epidermis** – stratified squamous epithelium
  - **dermis** – connective tissue layer
- **hypodermis** – another connective tissue layer below the dermis
- most skin is 1 – 2 mm thick
- ranges from 0.5 mm on eyelids to 6 mm between shoulder blades
- **thick skin** – on palms and sole, and corresponding surfaces on fingers and toes
  - has sweat glands, but no hair follicles or sebaceous (oil) glands
  - epidermis 0.5 mm thick
- **thin skin** – covers rest of the body
  - epidermis about 0.1 mm thick
  - possesses hair follicles, sebaceous glands and sweat glands

Functions of the Skin

- **resistance to trauma and infection**
  - keratin
  - acid mantle
- **other barrier functions**
  - waterproofing
  - UV radiation
  - harmful chemicals
- **vitamin D synthesis**
  - skin first step
  - liver and kidneys complete process
- **sensation**
  - skin is our most extensive sense organ
- **thermoregulation**
  - thermoreceptors
  - vasoconstriction / vasodilation
- **nonverbal communication**
  - acne, birthmark, or scar
- **transdermal absorption**
  - administration of certain drugs steadily through thin skin – adhesive patches

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Figure 6.2a

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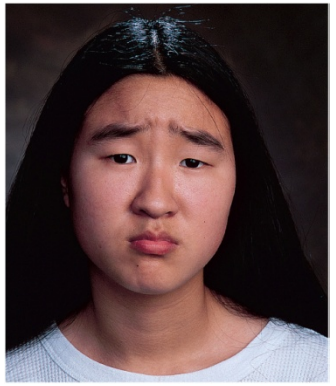

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Figure 6.2b

Epidermis

- **epidermis** – keratinized stratified squamous epithelium
  - dead cells at the surface packed with tough protein – **keratin**
  - lacks blood vessels
  - depends on the diffusion of nutrients from underlying connective tissue
  - sparse nerve endings for touch and pain

Cells of Epidermis

- five types of cells of the epidermis
  - **stem cells**
    - undifferentiated cells that give rise to keratinocytes
    - in deepest layer of epidermis (stratum basale)
  - **keratinocytes**
    - great majority of epidermal cells
    - synthesize **keratin**
  - **melanocytes**
    - occur only in stratum basale
    - synthesize pigment **melanin** that shields DNA from ultraviolet radiation
    - branched processes that spread among keratinocytes
  - **tactile (merkel) cells**
    - in basal layer of epidermis
    - touch receptor cells associated with dermal nerve fibers
  - **dendritic (langerhans) cells**
    - macrophages originating in bone marrow that guard against pathogens
    - found in stratum spinosum and granulosum
    - stand guard against toxins, microbes, and other pathogens that penetrate skin

Cell Types and Layers of the of the Epidermis

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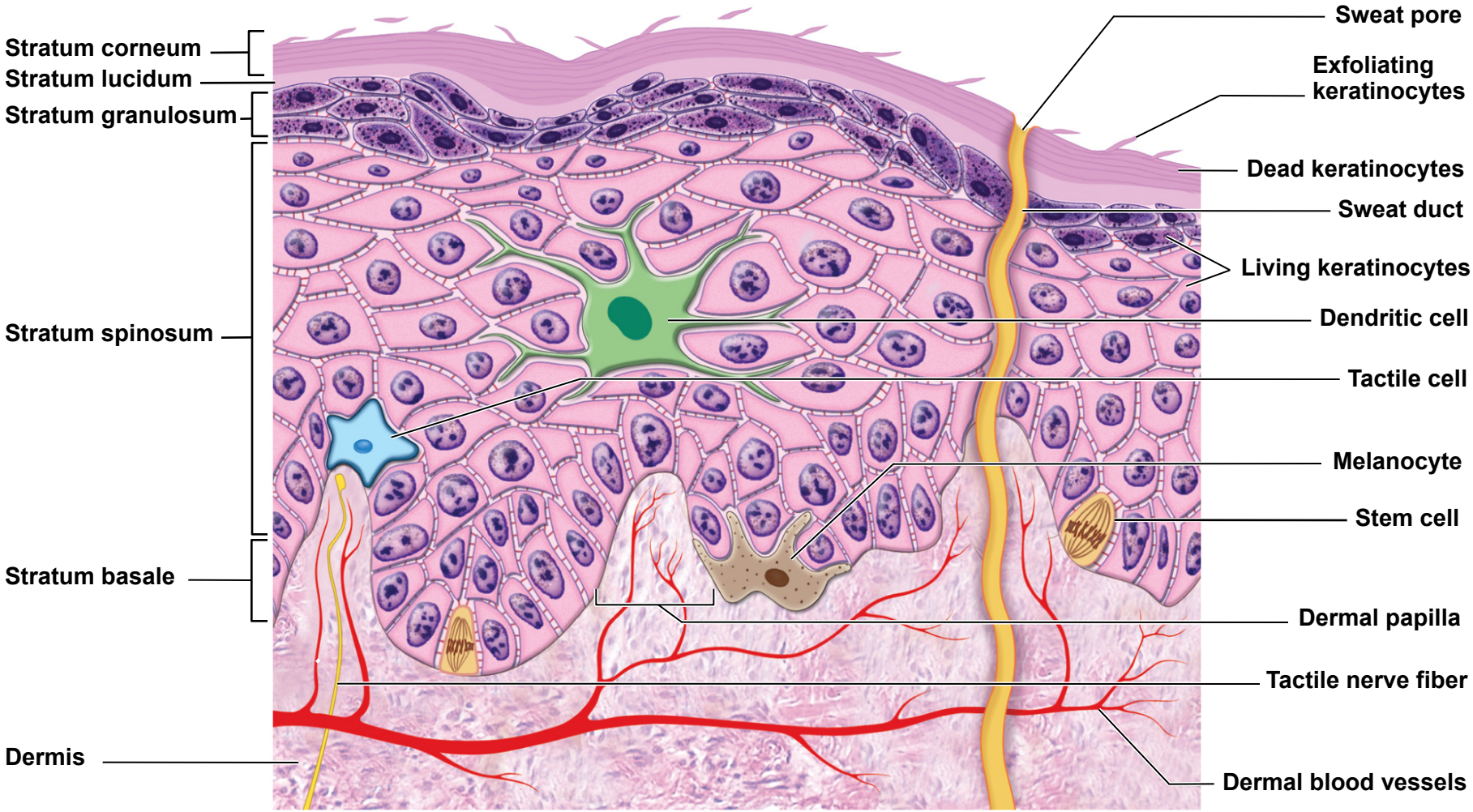

Figure 6.3

Stratum Basale

- a single layer of cuboidal to low columnar **stem cells** and **keratinocytes** resting on the basement membrane
  - **melanocytes** and **tactile cells** are scattered among the stem cells and keratinocytes

- **stem cells of stratum basale divide**
  - give rise to keratinocytes that migrate toward skin surface
  - replace lost epidermal cells

Stratum Spinosum

- consists of **several layers of keratinocytes**
- **thickest stratum in most skin**
  - in thick skin, exceeded by stratum corneum
- **deepest cells remain capable of mitosis**
  - cease dividing as they are pushed upward
- produce more and more **keratin filaments** which causes cell to flatten
  - higher up in this stratum, the flatter the cells appear
- **dendritic cells** found throughout this stratum
- named for artificial appearance created in histological section
  - numerous desmosomes and cell shrinkage produces spiny appearance

Stratum Granulosum

- consists of **3 to 5 layers** flat keratinocytes
- contain coarse dark-staining **keratohyalin granules**

Stratum Lucidum

- seen **only in thick skin**
- **thin translucent zone** superficial to stratum granulosum
- keratinocytes are densely packed with **eleidin**
- cells have no nucleus or other organelles
- zone has a pale, featureless appearance with indistinct boundaries

Stratum Corneum

- up to 30 layers of dead, scaly, keratinized cells
- form durable surface layer
  - surface cells flake off (exfoliate)
- resistant to abrasion, penetration, and water loss

Life History of Keratinocytes

- **keratinocytes** are produced deep in the epidermis by stem cells in **stratum basale**
  - some deepest keratinocytes in stratum spinosum also multiply and increase their numbers
- **mitosis requires an abundant supply of oxygen and nutrients**
  - deep cells acquire from blood vessels in nearby dermis
  - once epidermal cells migrate more than two or three cells away from the dermis, their mitosis ceases
- newly formed keratinocytes push the older ones toward the surface

- in **30 - 40 days** a keratinocyte makes its way to the skin surface and flakes off
  - slower in old age
  - faster in skin injured or stressed
    - **calluses** or **corns** – thick accumulations of dead keratinocytes on the hands or feet
- cytoskeleton proliferates as cells are shoved upward
- cells grow flatter
- produce lipid-filled **membrane-coating vesicles** (lamellar granules)
- in **stratum granulosum** three important developments occur
  - keratinocyte nucleus and other organelles degenerate, **cells die**
  - **keratohyalin** granules release a protein **filaggrin**
    - binds the keratin filaments together into coarse, tough bundles
  - membrane-coating vesicles release lipid mixture that spreads out over cell surface and **waterproofs** it

Epidermal Water Barrier

- **epidermal water barrier** - forms between stratum granulosum and stratum spinosum

- consists of:
  - **lipids** secreted by keratinocytes
  - **tight junctions** between keratinocytes
  - thick layer of **insoluble protein** on the inner surfaces of the keratinocyte plasma membranes

- critical to retaining water in the body and **preventing dehydration**

- cells above the water barrier quickly die
  - barrier cuts them off from nutrients below
  - dead cells **exfoliate (dander)**
  - **dandruff** – clumps of dander stuck together by sebum (oil)

Dermis

- **dermis** – connective tissue layer beneath the epidermis
- ranges from 0.2 mm (eyelids) – 4 mm (palms & soles)
- composed mainly of collagen with elastic fibers, reticular fibers, and fibroblasts
- well supplied with **blood vessels**, **sweat glands**, **sebaceous glands**, and **nerve endings**
- **hair follicles** and **nail roots** are embedded in dermis
- smooth muscle (**piloerector muscles**) associated with hair follicles
  - contract in response to stimuli, such as cold, fear, and touch – **goose bumps**

Dermis

- **dermal papillae** – upward fingerlike extensions of the dermis
  - **friction ridges** on fingertips that leave fingerprints
- **papillary layer** – superficial zone of dermis
  - thin zone of areolar tissue in and near the dermal papilla
  - allows for mobility of leukocytes and other defense cells should epidermis become broken
  - rich in small blood vessels
- **reticular layer** – deeper and much thicker layer of dermis
  - consists of dense, irregular connective tissue
  - **stretch marks (striae)** – tears in the collagen fibers caused by stretching of the skin due to pregnancy or obesity

Structure of the Dermis

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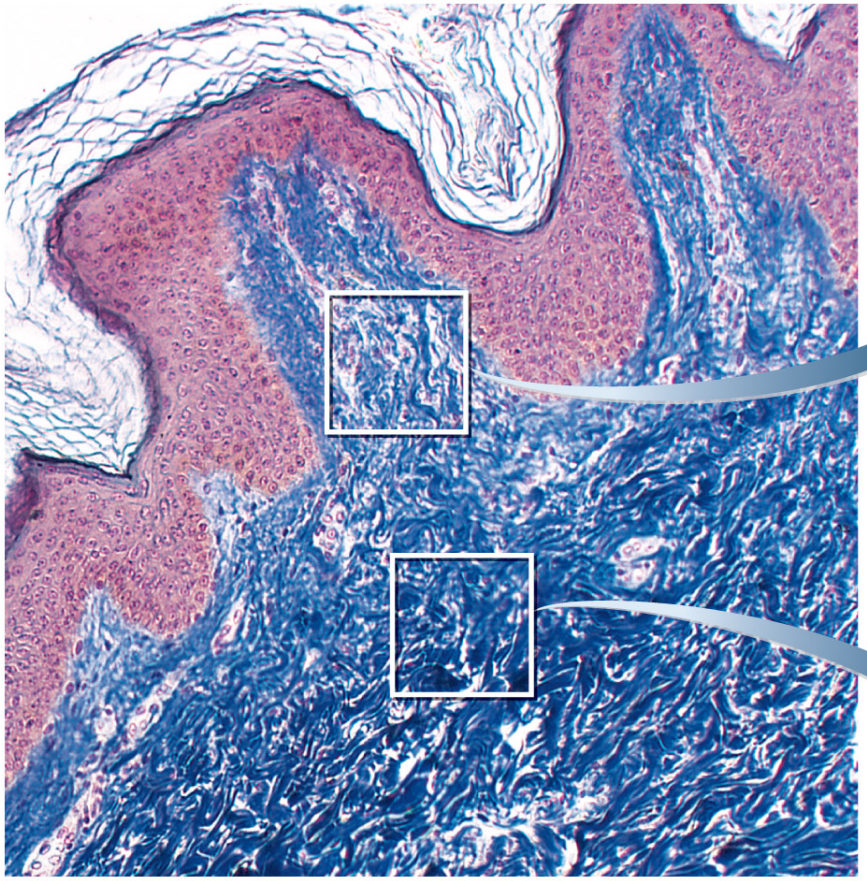

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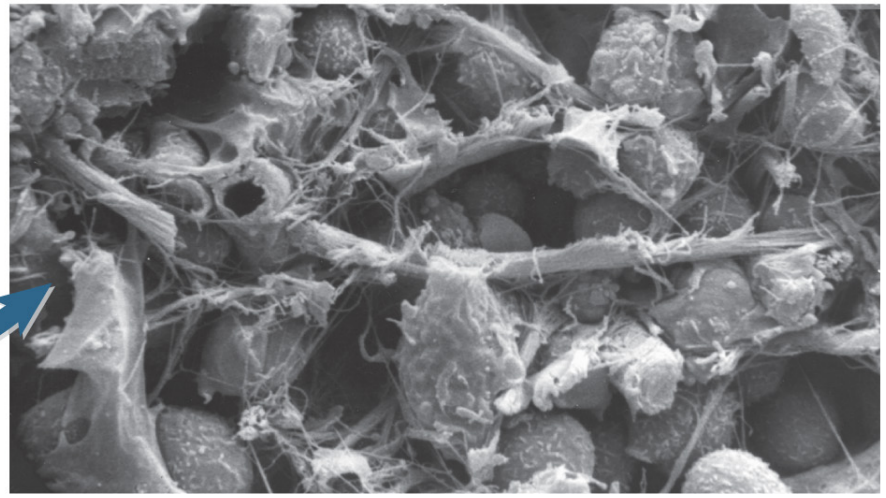
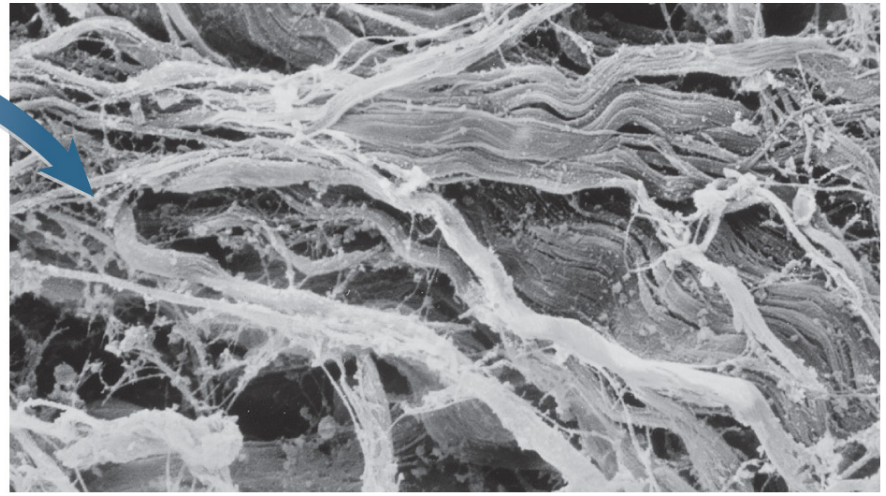


(b) Papillary layer of dermis



(c) Reticular layer of dermis

Figure 6.5

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Layers of Dermis

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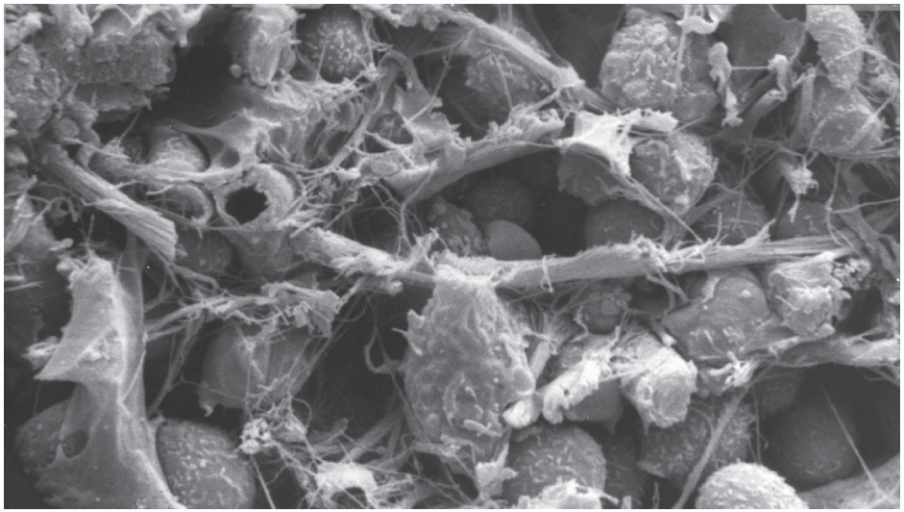
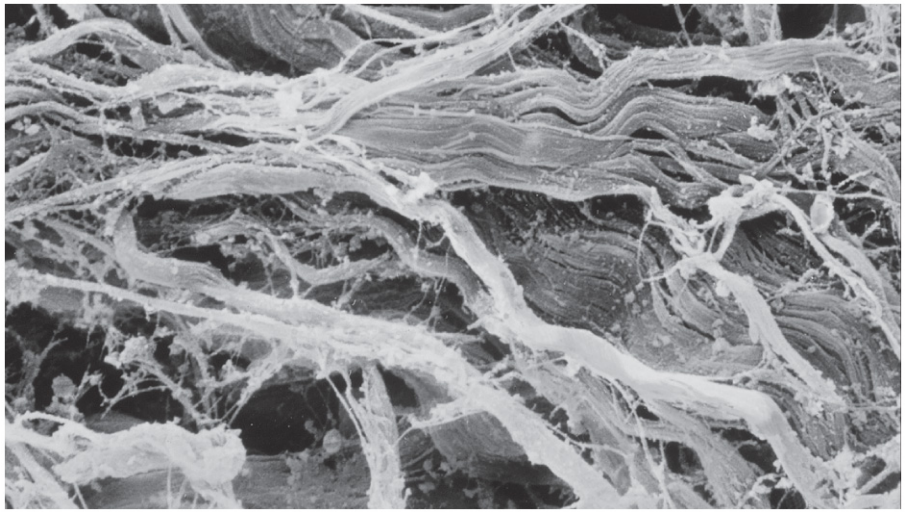


(b) Papillary layer of dermis



(c) Reticular layer of dermis

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Figure 6.5b

Figure 6.5c

Hypodermis

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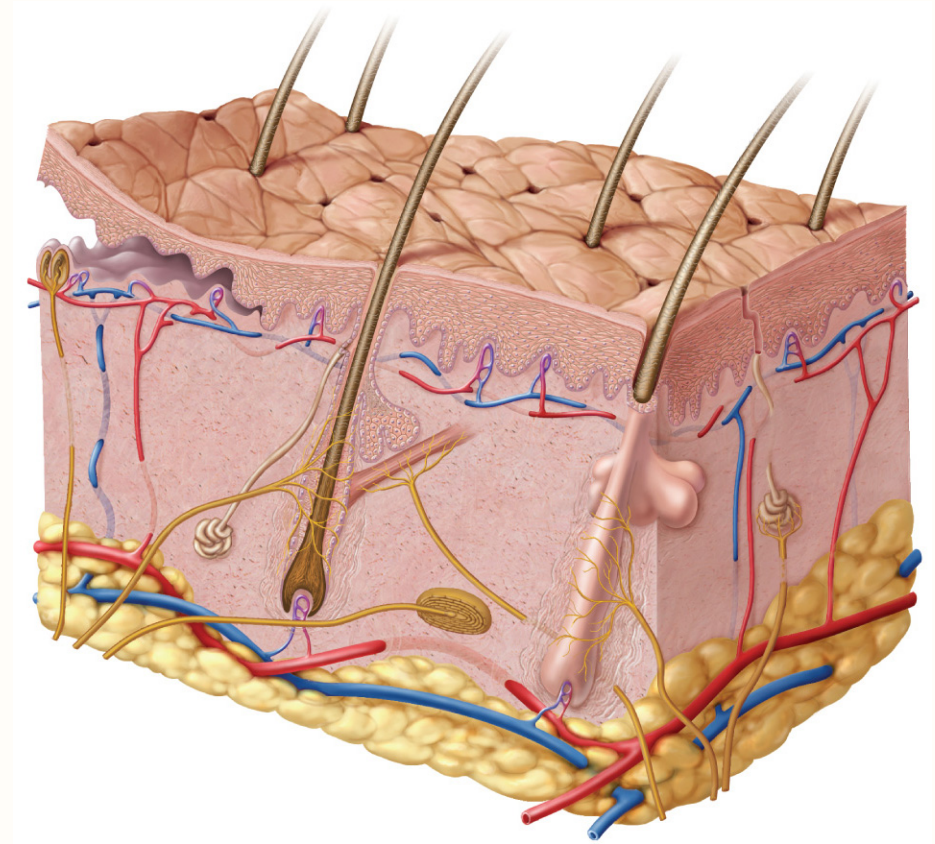

- subcutaneous tissue
- more areolar and adipose than dermis
- pads body
- binds skin to underlying tissues
- drugs introduced by injection
  - highly vascular & absorbs them quickly
- subcutaneous fat
  - energy reservoir
  - thermal insulation
  - 8% thicker in women

Skin Color

- **melanin** – most significant factor in skin color
  - produced by **melanocytes**
  - accumulate in the **keratinocytes** of stratum basale and stratum spinosum
  - **eumelanin** – brownish black
  - **pheomelanin** - a reddish yellow sulfur-containing pigment
- people of different skin colors have the **same number of melanocytes**
  - **dark skinned people**
    - produce greater quantities of melanin
    - melanin granules in keratinocytes more spread out than tightly clumped
    - melanin breaks down more slowly
    - melanized cells seen throughout the epidermis
  - **light skinned people**
    - melanin clumped near keratinocyte nucleus
    - melanin breaks down more rapidly
    - little seen beyond stratum basale
- amount of melanin also varies with exposure to **ultraviolet (UV) rays of sunlight**

Other Factors in Skin Color

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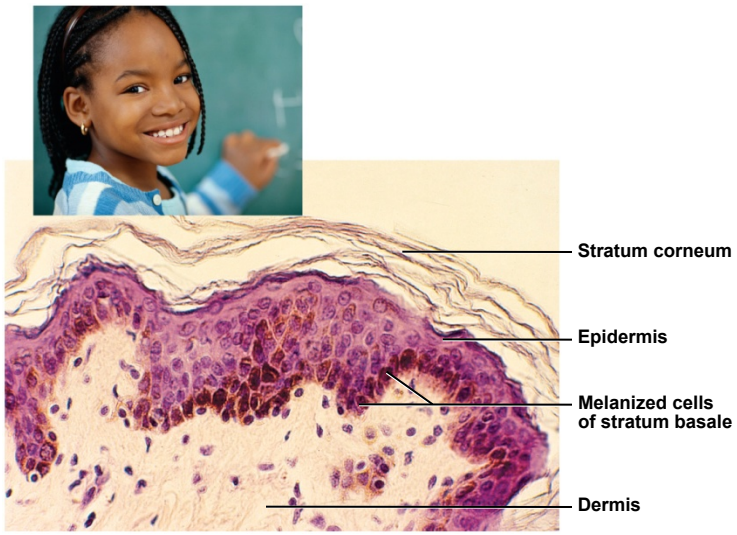

(a) Dark skin

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Figure 6.6a

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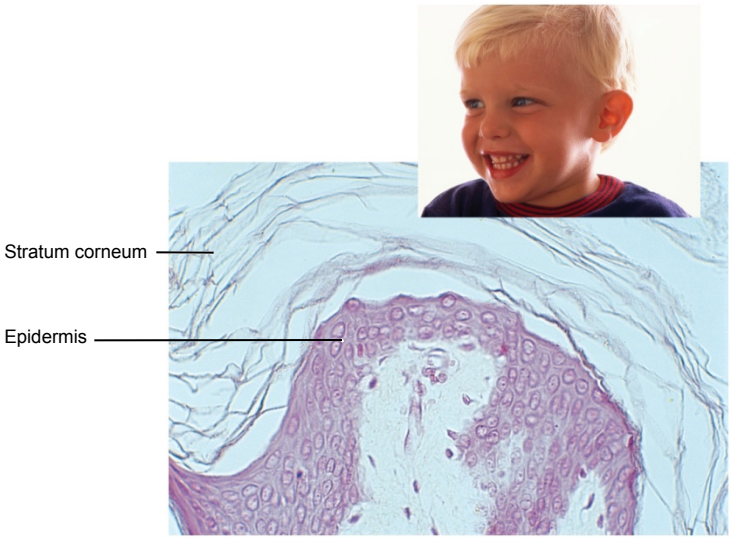

(b) Light skin

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Figure 6.6b

- **hemoglobin -** red pigment of red blood cells
  - adds reddish to pinkish hue to skin
- **carotene -** yellow pigment acquired from egg yolks and yellow/orange vegetables
  - concentrates in stratum corneum and subcutaneous fat

Abnormal Skin Colors

- **cyanosis** - blueness of the skin from deficiency of oxygen in the circulating blood
  - airway obstruction (drowning or choking)
  - lung diseases (emphysema or respiratory arrest)
  - cold weather or cardiac arrest
- **erythema** – abnormal redness of the skin due to dilated cutaneous vessels
  - exercise, hot weather, sunburn, anger, or embarrassment
- **pallor** – pale or ashen color when there is so little blood flow through the skin that the white color of dermal collagen shows through
  - emotional stress, low blood pressure, circulatory shock, cold, anemia
- **albinism** – genetic lack of melanin that results in white hair, pale skin, and pink eyes
  - have inherited recessive, nonfunctional tyrosinase allele
- **jaundice** - yellowing of skin and sclera due to excess of bilirubin in blood
  - cancer, hepatitis, cirrhosis, other compromised liver function
- **hematoma – (bruise)** mass of clotted blood showing through skin

Evolution of Skin Color

- **skin color** – one of the most conspicuous sign of human variation
- results from combination of evolutionary selection pressures
  - especially differences in **exposure to ultraviolet radiation (UVR)**
- **UVR has two adverse effects:**
  - causes **skin cancer**
  - **breaks down folic acid** needed for normal cell division, fertility, and fetal development
- **UVR has a desirable effect:**
  - stimulates **synthesis of vitamin D** necessary for dietary calcium absorption
- populations native to the **tropics** and their descendants tend to have **well-melanized skin** to screen out excessive UVR
- populations native **to far northern or southern latitudes** where the sunlight is weak, tend to have **light skin** to allow for adequate UVR penetration

Evolution of Skin Color

- ancestral skin color is a compromise between vitamin D and folic acid requirements
- women have skin averaging about 4% lighter than men
  - need greater amounts of vitamin D and folic acid to support pregnancy and lactation
- high altitude and dry air increases skin pigmentation
  - Andes, Tibet, Ethiopia
- UVR accounts for up to 77% of variation in human skin color
- other exceptions:
  - migration, cultural differences in clothing and shelter
  - intermarriage of people of different geographic ancestries
  - darwinian sexual selection – a preference in mate choice for partners of light or dark complexion

Skin Markings

- **friction ridges –** the markings on the fingertips that leave oily fingerprints on surfaces we touch
  - everyone has a unique pattern formed during fetal development and remain unchanged throughout life
  - not even identical twins have identical fingerprints
  - allow manipulation of small objects
- **flexion lines (flexion creases)** – lines on the flexor surfaces of the digits, palms, wrists, elbows
  - marks sites where the skin folds during flexion of the joints
- **freckles** and **moles** – tan to black aggregations of melanocytes
  - **freckles** are flat, melanized patches
  - **moles** (**nevus**) are elevated melanized patches often with hair
    - moles should be watched for changes in color, diameter, or contour
    - may suggest malignancy (skin cancer)
- **hemangiomas (birthmarks) –** patches of discolored skin caused by benign tumors of dermal blood capillaries
  - some disappear in childhood -- others last for life
  - capillary hemangiomas, cavernous hemangiomas, port-wine stain

Hair and Nails

- **hair**, **nails**, and **cutaneous glands** are accessory organs of the skin
- **hair** and **nails** are composed of mostly of dead, keratinized cells
  - pliable **soft keratin** makes up stratum corneum of skin
  - compact **hard keratin** makes up hair and nails
    - tougher and more compact due to numerous cross-linkages between keratin molecules
- **pilus** – another name for hair
- **pili** – plural of pilus
- **hair** – a slender filament of keratinized cells that grows from an oblique tube in the skin called a **hair follicle**

Distribution of Human Hair

- hair is found almost everywhere on the body except:
  - palms and soles
  - ventral and lateral surface of fingers and toes
  - distal segment of the finger
  - lips, nipples, and parts of genitals

- limbs and trunk have 55 – 70 hairs per cm^2
  - face about 10 times as many
  - 30,000 hairs in a man's beard
  - 100,000 hairs on an average person's scalp
  - number of hairs does not differ much from person to person or even between sexes
    - differences in appearance due to texture and pigmentation of the hair

Types of Human Hair

- Three kinds of hair grow over the course of our lives
  - **lanugo** – fine, downy, unpigmented hair that appears on the fetus in the last three months of development
  - **vellus** – fine, pale hair that replaces lanugo by time of birth
    - two-thirds of the hair of women
    - one-tenth of the hair of men
    - all of hair of children except eyebrows, eyelashes, and hair of the scalp
  - **terminal** – longer, coarser, and usually more heavily pigmented
    - forms eyebrows, eyelashes, and the hair of the scalp
    - after puberty, forms the axillary and pubic hair
    - male facial hair and some of the hair on the trunk and limbs

Structure of Hair and Follicle

- Hair is divisible into three zones along its length
  - **bulb** – a swelling at the base where hair originates in dermis or hypodermis
    - only living hair cells are in or near bulb
  - **root** – the remainder of the hair in the follicle
  - **shaft** – the portion above the skin surface
- **dermal papilla** – bud of vascular connective tissue encased by bulb
  - provides the hair with its sole source of nutrition
- **hair matrix** – region of mitotically active cells immediately above papilla
  - hair's **growth center**

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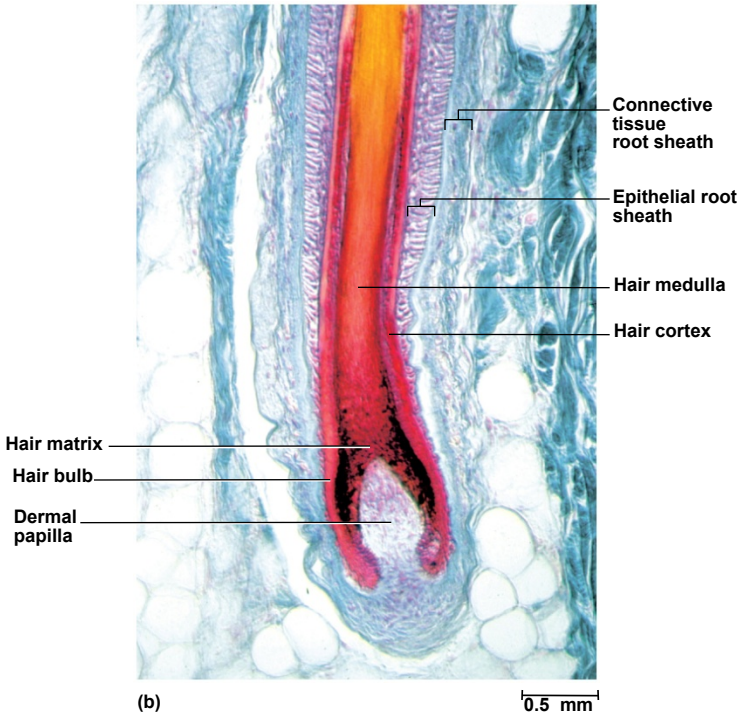

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Figure 6.7b

Structure of Hair and Follicle

- three layers of the hair in cross-section from inside out
  - **medulla**
    - core of loosely arranged cells and air spaces
  - **cortex**
    - constitutes the bulk of the hair
    - consists of several layers of elongated keratinized cells
  - **cuticle**
    - composed of multiple layers of very thin, scaly cells that overlap each other
    - free edges directed upward

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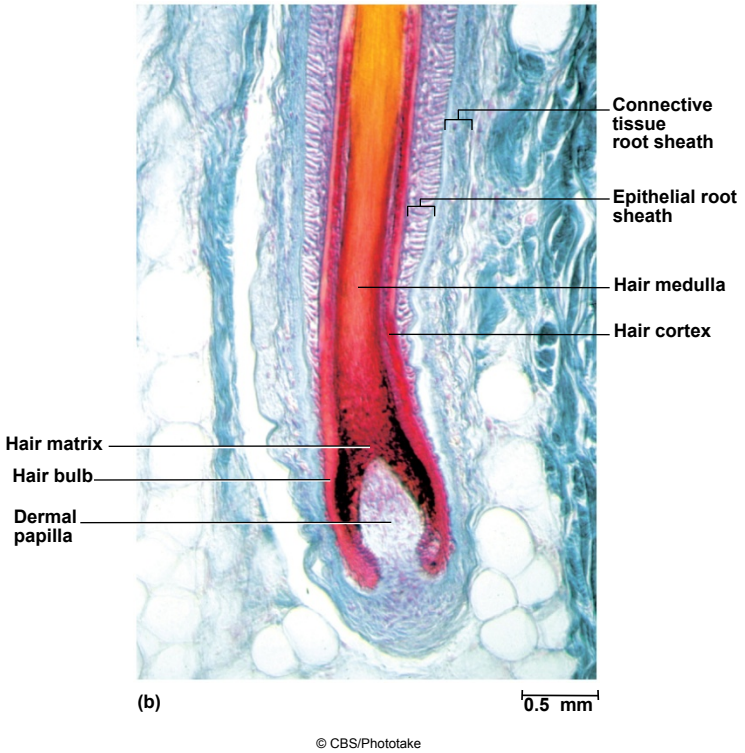

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Figure 6.7b

Structure of Hair Follicle

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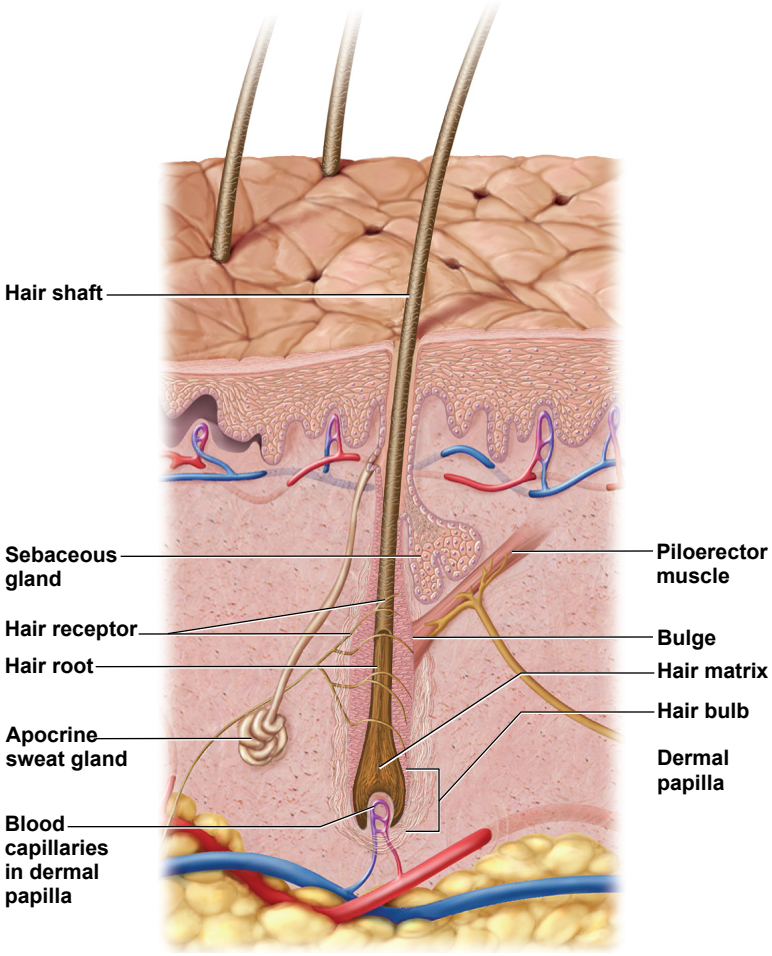

- **follicle** – diagonal tube that dips deeply into dermis and may extend into hypodermis
  - **epithelial root sheath**
    - extension of the epidermis
    - lies immediately adjacent to hair root
    - toward deep end widens into **bulge** - a source of stem cells for follicular growth
  - **connective tissue root sheath**
    - derived from dermis
    - surrounds epithelial root sheath
    - denser than adjacent connective tissue
- **hair receptors**
  - nerve fibers that entwine each follicle
  - respond to hair movement
- **piloerector muscle (arrector pili)**
  - bundles of smooth muscle cells
  - extends from dermal collagen to connective tissue root sheath
  - goose bumps

Figure 6.7a

Hair Texture and Color

- **texture** – related to differences in cross-sectional shape
  - **straight hair** is round
  - **wavy hair** is oval
  - **curly hair** is relatively flat

- **color** – due to pigment granules in the cells of the cortex
  - **brown** and **black hair** is rich in eumelanin
  - **red hair** has a slight amount of eumelanin but a high concentration of pheomelanin
  - **blond hair** has an intermediate amount of pheomelanin and very little eumelanin
  - **gray** and **white hair** results from scarcity or absence of melanin in the cortex and the presence of air in the medulla

Hair Color and Texture

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Figure 6.8

Hair Growth and Loss

- **hair cycle** – consists of three developmental stages
  - **anagen** - growth stage - 90% of scalp follicles at any given time
    - stem cells multiply and travel downward
    - pushing dermal papilla deeper into skin forming epidermal root sheath
    - root sheath cells directly above dermal papilla form the hair matrix
    - sheath cells transform into hair cells, synthesize keratin, and die as they are pushed upward
    - new hair grows up the follicle, often alongside of an old **club hair** from the previous cycle
  - **catagen** - degenerative stage - mitosis in the hair matrix ceases and sheath cells below the bulge die
    - the follicle shrinks and the dermal papilla is drawn up toward the bulge
    - base of hair keratinizes into a hard club, and hair is now known as **club hair**
      - loses its anchorage
      - easily pulled out by brushing
  - **telogen** - resting stage - when papilla reaches the bulge

Hair Growth and Loss

- **club hair** may fall out during catagen or telogen
  - or pushed out by new hair in the next anagen phase
- we lose about 50 – 100 scalp hairs daily
- in young adult the scalp follicles spend:
  - 6 – 8 years in anagen, 2 – 3 weeks in catagen, 1 - 2 months in telogen
- **hair growth** - scalp hairs grow at a rate of 1 mm per 3 days (10 -18 cm/yr)
- **alopecia** – thinning of the hair or baldness
- **pattern baldness** – the condition in which hair loss from specific regions of the scalp rather than thinning uniformly
  - combination of genetic and hormonal influence
  - baldness allele is dominant in males and expressed only in high testosterone levels
  - testosterone causes terminal hair in scalp to be replaced by vellus hair
- **hirsutism** – excessive or undesirable hairiness in areas that are not usually hairy

Hair Cycle

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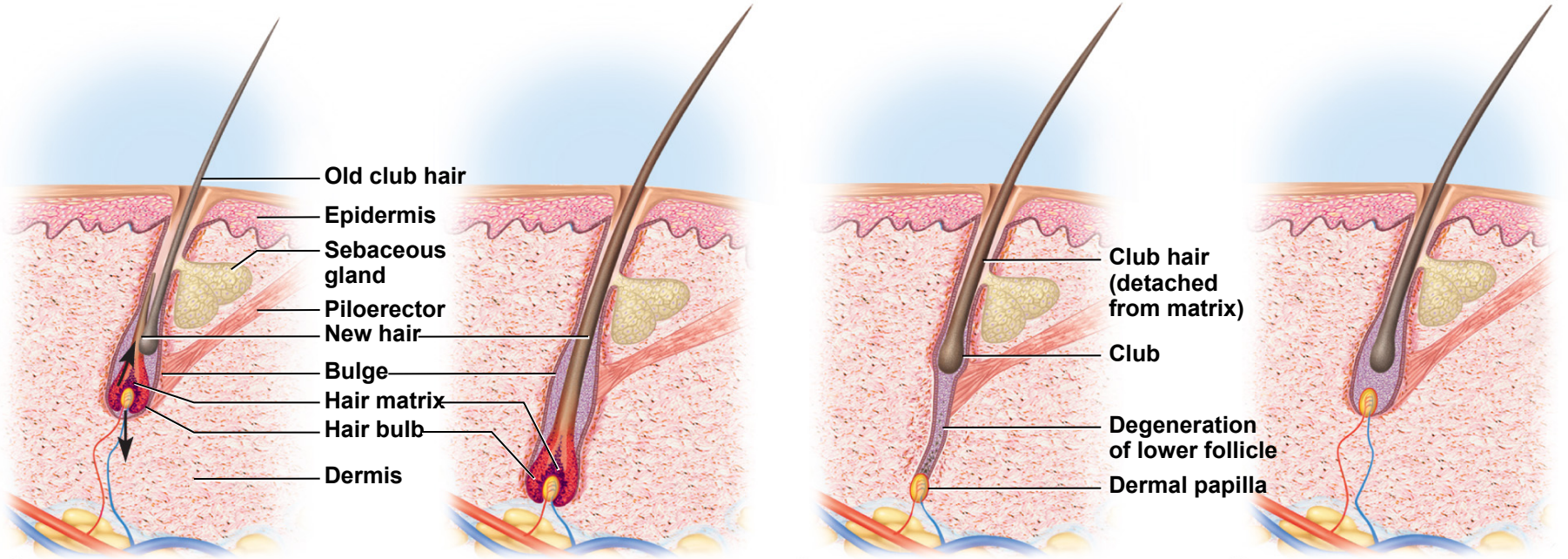

1 Anagen (early)
(Growing phase, 6–8 years)
Stem cells multiply and follicle grows deeper into dermis; hair matrix cells multiply and keratinize, causing hair to grow upward; old club hair may persist temporarily alongside newly growing hair.

Anagen (mature)

2 Catagen
(Degenerative phase, 2–3 weeks)
Hair growth ceases; hair bulb keratinizes and forms club hair; lower follicle degenerates.

3 Telogen
(Resting phase, 1–3 months)
Dermal papilla has ascended to level of bulge; club hair falls out, usually in telogen or next anagen.

Figure 6.9

Functions of Hair

- most hair on trunk and limbs is **vestigial**
  - little present function
  - warmth in ancestors
- **hair receptors** alert us of parasites crawling on skin
- scalp helps retain heat
- scalp protects against sunburn
- gender identification
- pubic and axillary hair signify sexual maturity and aids in transmission of sexual scents
- **guard hairs (vibrissae) -** guard nostrils and ear canals
- eyelashes and eyebrows
- nonverbal communication

Fingernail Structure

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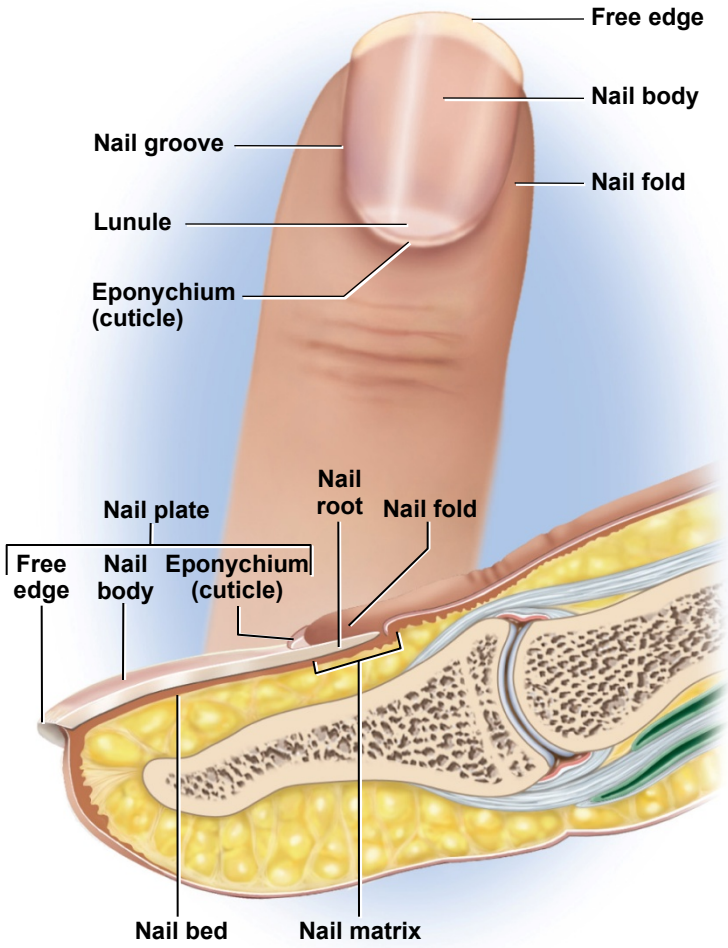

Figure 6.10

Nails

- **fingernails and toenails** - clear, hard derivatives of the stratum corneum
- composed of very thin, dead cells packed with **hard keratin**
- **flat nails** allow for more fleshy and sensitive fingertips
  - tools for digging, grooming, picking apart food, and other manipulations
- **nail plate** – hard part of the nail
  - **free edge** – overhangs the finger tip
  - **nail body** – visible attached part of nail
  - **nail root** – extends proximally under overlying skin
- **nail fold** – surrounding skin rising a bit above the nail
- **nail groove** – separates nail fold from nail plate
- **nail bed** – skin underlying the nail plate
- **hyponychium** – epidermis of the nail bed
- **nail matrix** – growth zone of thicken stratum basale at the proximal end of nail
  - mitosis here accounts for nail growth
  - 1 mm per week in fingernails, slightly slower on toenails
- **lunule** – an opaque white crescent at proximal end of nail
- **eponychium (cuticle)** – narrow zone of dead skin commonly

Cutaneous Glands

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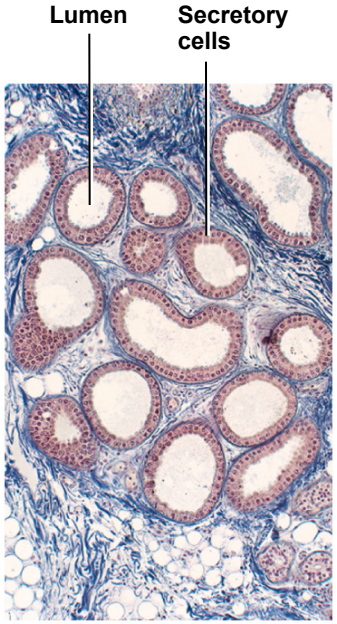

(a) Apocrine gland

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Figure 6.11a

the skin has five types of glands

- merocrine sweat glands
- apocrine sweat glands
- sebaceous glands
- ceruminous glands
- mammary glands

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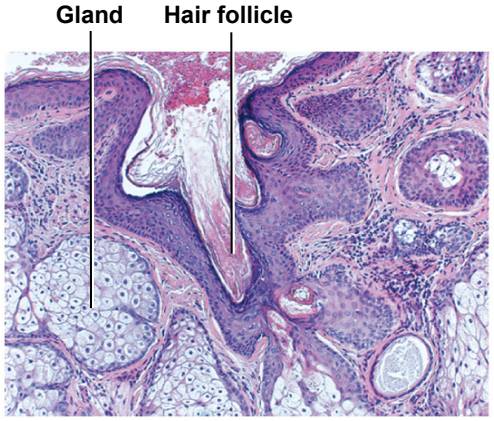

(c) Sebaceous gland

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Figure 6.11c

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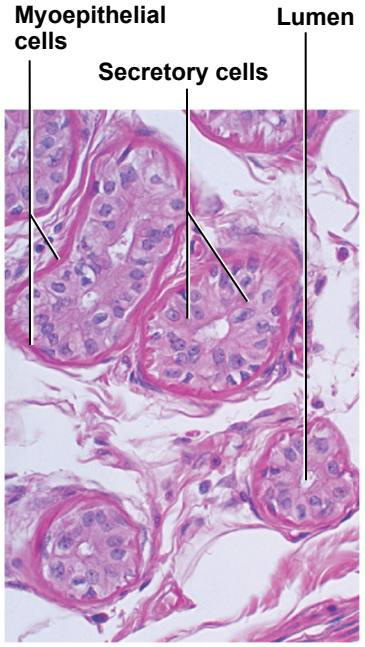

(b) Merocrine gland

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Figure 6.11b

Sweat Glands (Sudoriferous)

- two kinds of **sweat (sudoriferous) glands**
  - **merocrine (eccrine) sweat glands**
    - most numerous skin glands - 3 to 4 million in adult skin
    - are simple tubular glands
    - watery perspiration that helps cool the body
    - **myoepithelial cells** – contract in response to stimulation by sympathetic nervous system and squeeze perspiration up the duct
  - **apocrine sweat glands**
    - occur in groin, anal region, axilla, areola, bearded area in mature males
    - ducts lead to nearby hair follicles
    - produce sweat that is thicker, milky, and contains fatty acids
    - scent glands that respond to stress and sexual stimulation
    - develop at puberty
    - **pheromones** – chemicals that influence the physiology of behavior of other members of the species
    - **bromhidrosis** - disagreeable body odor produced by bacterial action on fatty acids

Sweat

- **sweat** - begins as a protein-free filtrate of blood plasma produced by deep secretory portion of gland
  - potassium ions, urea, lactic acid, ammonia, and some sodium chloride remain in the sweat, most sodium chloride reabsorbed by duct
  - some drugs are also excreted in sweat
  - on average, 99% water, with pH range of 4 to 6
    - **acid mantle** – inhibits bacterial growth
  - **insensible perspiration** – 500 ml per day
    - does not produce visible wetness of skin
  - **diaphoresis** – sweating with wetness of the skin
    - exercise – may lose one liter of sweat per hour

Sebaceous Glands

- **sebum** – oily secretion produced by sebaceous glands
- flask-shaped glands with short ducts opening into hair follicle
- **holocrine gland** – secretion consists of broken-down cells
  - replaced by mitosis at base of gland
- keeps skin and hair from becoming dry, brittle, and cracked
- **lanolin** – sheep sebum

Ceruminous Glands

- found only in **external ear canal**
- their secretion combines with sebum and dead epithelial cells to form **earwax (cerumen)**
  - keep eardrum pliable
  - waterproofs the canal
  - kills bacteria
  - makes guard hairs of ear sticky to help block foreign particles from entering auditory canal
- simple, coiled tubular glands with ducts that lead to skin surface

Mammary Glands

- **breasts (mammae)** of both sexes contain very little glandular material
- **mammary glands** – milk-producing glands that develop only during pregnancy and lactation
  - modified apocrine sweat gland
  - richer secretion released by ducts opening into the nipple
- **mammary ridges or milk lines**
  - two rows of mammary glands in most mammals
  - primates kept only anterior most glands
- additional nipples (**polythelia**)
  - may develop along milk line

Skin Cancer

- **skin cancer –** induced by the **ultraviolet rays of the sun**
  - most often on the head and neck
  - most common in fair-skinned people and the elderly
  - one of the most common cancers
  - one of the easiest to treat
  - has one of the highest survival rates if detected and treated early
  - **three types** of skin cancer named for the epidermal cells in which they originate
  - **basal cell carcinoma**, **squamous cell carcinoma**, and **malignant melanoma**

Basal Cell Carcinoma

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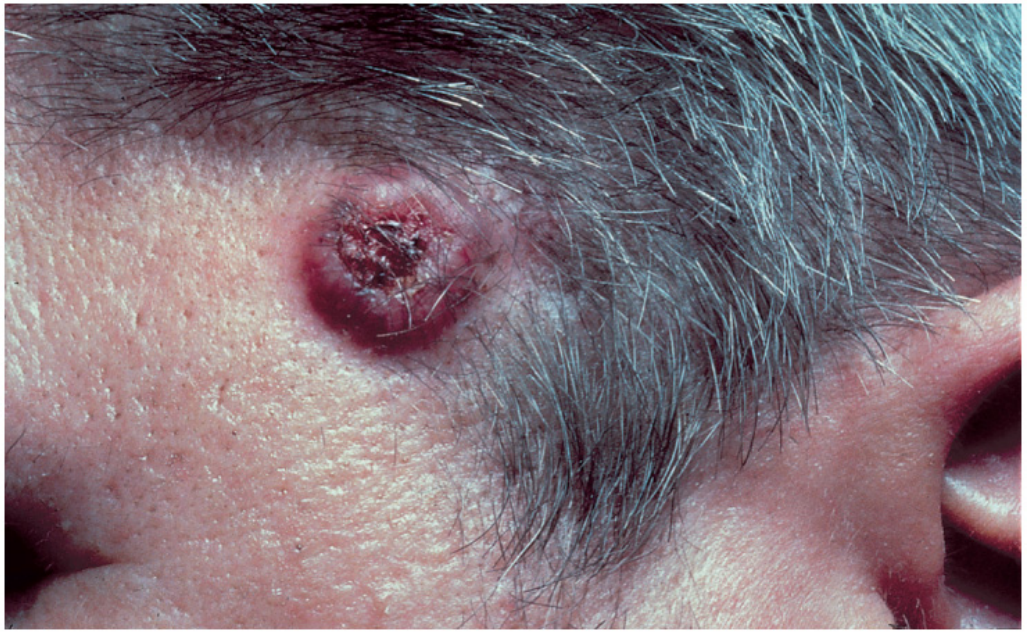

(a) Basal cell carcinoma

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- most common type
- least dangerous because it seldom metastasizes
- forms from cells in stratum basale
- lesion is small shiny bump with central depression and beaded edges

Squamous Cell Carcinoma

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(b) Squamous cell carcinoma

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- arise from keratinocytes from stratum spinosum
- lesions usually appear on scalp, ears, lower lip, or back of the hand
- have raised, reddened, scaly appearance later forming a concave ulcer
- chance of recovery good with early detection and surgical removal
- tends to metastasize to lymph nodes and may become lethal

Malignant Melanoma

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(c) Malignant melanoma

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- skin cancer that arises from melanocytes
- often in a preexisting mole
- less than 5% of skin cancers, but most deadly form
- treated surgically if caught early
- metastasizes rapidly - unresponsive to chemotherapy - usually fatal
- person with metastatic melanoma lives only 6 months from diagnosis
- 5% - 14% survive 5 years
- greatest risk factor – familial history of malignant melanoma
- high incidence in men, redheads, people who experience severe sunburn in childhood

UVA, UVB and Sunscreens

- UVA and UVB are improperly called "tanning rays" and "burning rays"
- both thought to initiate skin cancer
- sunscreens protect you from sunburn but unsure if provide protection against cancer
  - chemical in sunscreen damage DNA and generate harmful free radicals

Burns

- **burns** – leading cause of accidental death
  - fires, kitchen spills, sunlight, ionizing radiation, strong acids or bases, or electrical shock
  - deaths result primarily from fluid loss, infection and toxic effects of **eschar** – burned, dead tissue **debridement** – removal of eschar
- classified according to the depth of tissue involvement
  - **first-degree burns** – partial thickness burn - involve only the epidermis
    - marked by redness, slight edema, and pain
    - heal in a few days
    - most sunburns are first degree burns
  - **second-degree burns** – partial thickness burn - involve the epidermis and part of the dermis
    - leaves part of the dermis intact
    - red, tan, or white
    - two weeks to several months to heal and may leave scars
    - blistered and very painful
  - **third-degree burn** – full thickness burn – the epidermis and all of the dermis, and often some deeper tissues (muscles or bones) are destroyed
    - often require skin grafts
    - needs fluid replacement and infection control

Degrees of Burn Injuries

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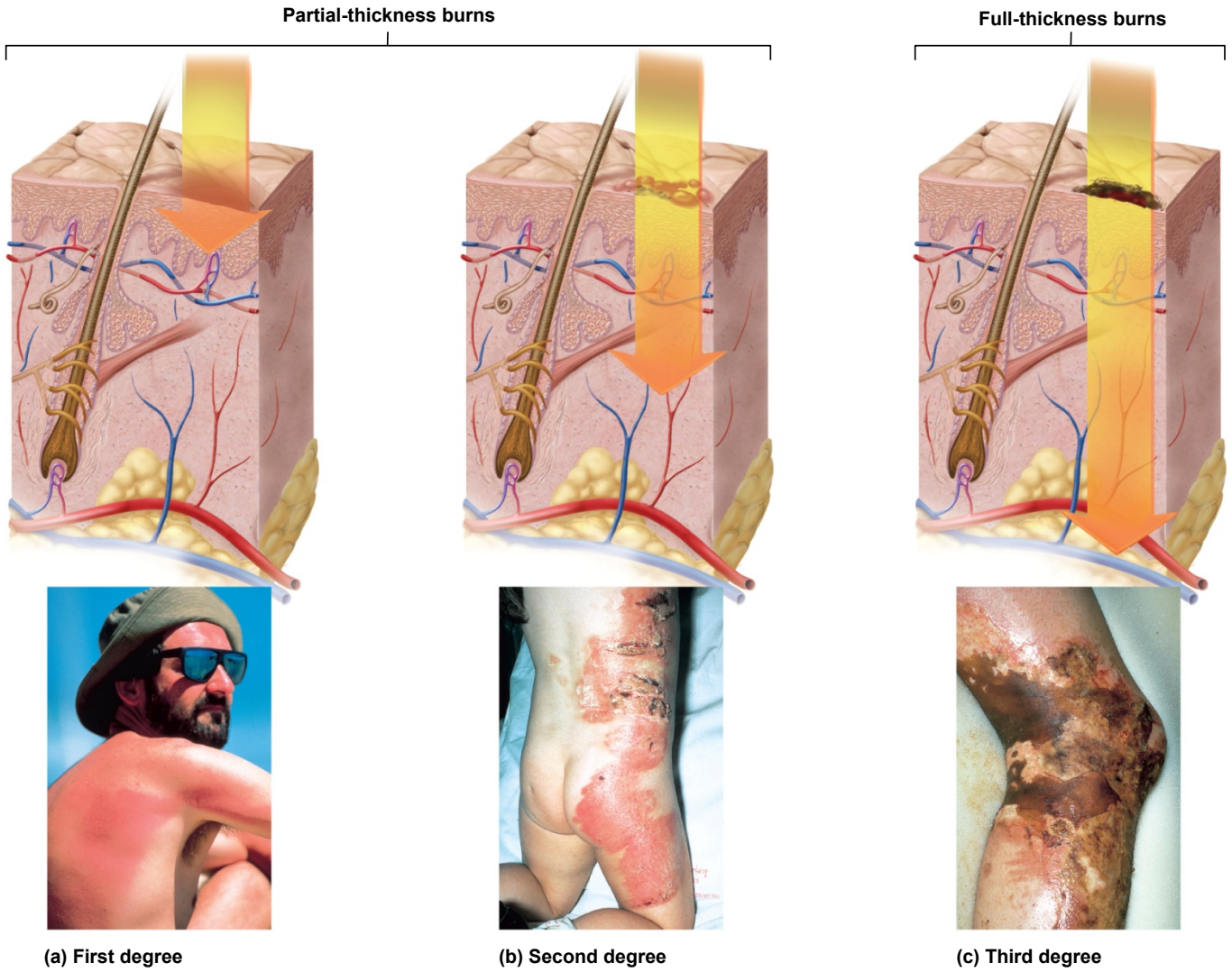

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Figure 6.13

Skin Grafts and Artificial Skin

- third-degree burns require skin grafts

- graft options
  - **autograft** - tissue taken from another location on the same person's body
    - **split-skin graft** – taking epidermis and part of the dermis from an undamaged area such as the thigh or buttocks and grafting it into the burned area
  - **isograft** - skin from identical twin

- temporary grafts (immune system rejection)
  - **homograft (allograft)** -- from unrelated person
  - **heterograft (xenograft)** -- from another species
  - amnion from afterbirth
  - artificial skin from silicone and collagen