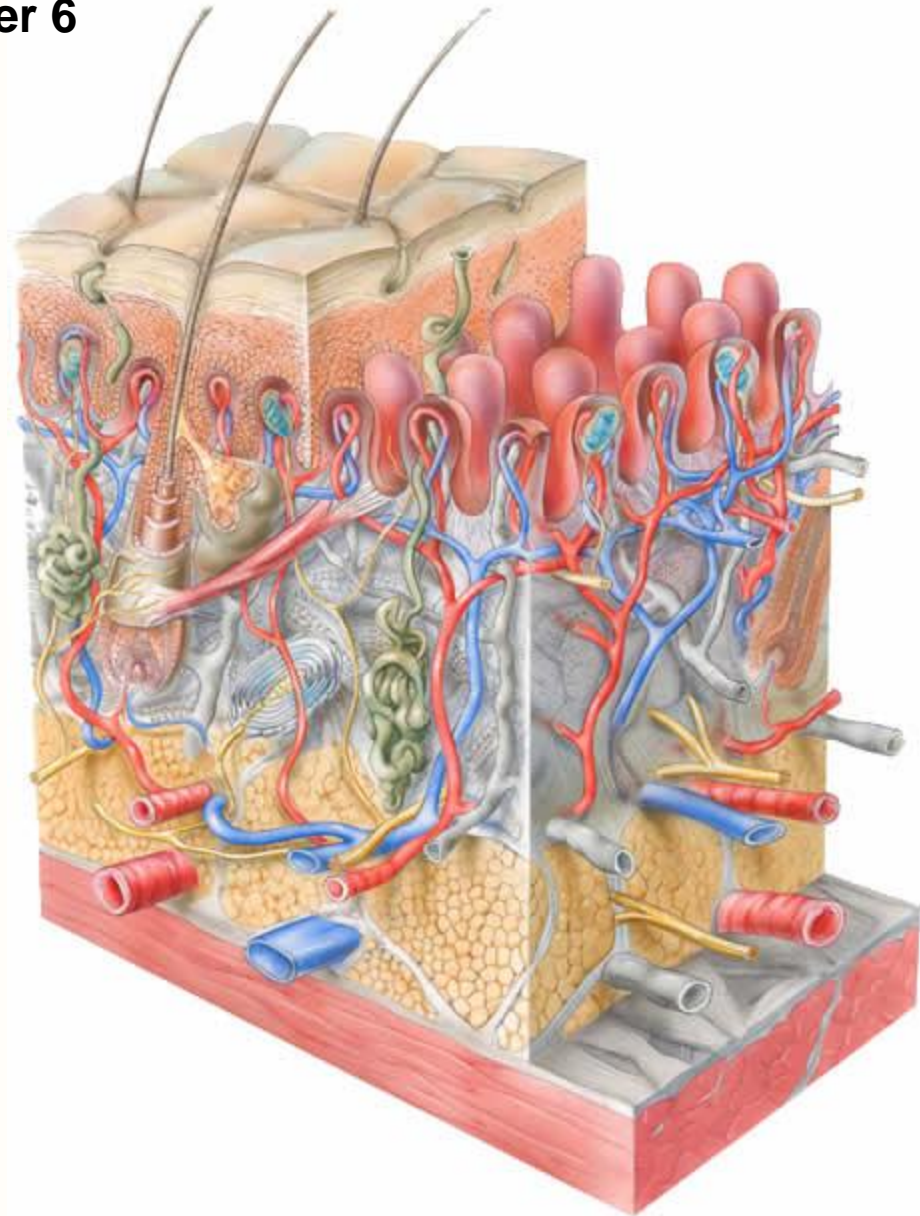


The Integumentary System

Chapter 6

- Skin Functions
- Skin Layers
- Skin Color
- Hair
- Nails
- Cutaneous Glands
- Burns



Functions of the Skin

- Skin is a barrier to microbes, chemical irritants, water loss.
- Vitamin D synthesis begins in skin exposed to UV light. Vitamin D helps calcium absorption from intestines.
- Sensory functions of skin include receptors for heat, cold, touch, itch, pressure and pain
- Thermoregulation by skin is accomplished through regulatory centers in the hypothalamus of the brain that regulates blood flow through the skin and controls secretions of sweat glands to conserve or dissipate heat.
- Psychological and social functions of skin:
 - the appearance and smell of skin can have a significant psychological impact

Overview of the Skin as an Organ

- Skin is the largest organ of the body (15% of body weight).
- Skin is composed of two distinct tissues: Epidermis and Dermis
 - hair, nails and skin glands are modified epidermal structures
- Hypodermis is fatty connective tissue under the skin.
- Skin thickness varies 1-6 mm depending on location and use.
 - Thin Skin (1-2 mm) covers most of the body and has hair follicles, sweat glands and oil glands.
 - Thick Skin (up to 6 mm) is much thicker and has no hair follicles.
 - found on palms of hands and soles of feet
 - can be thickened by repeated pressure or friction (calluses or corns)

Gross Anatomy of the Tissues of the Skin



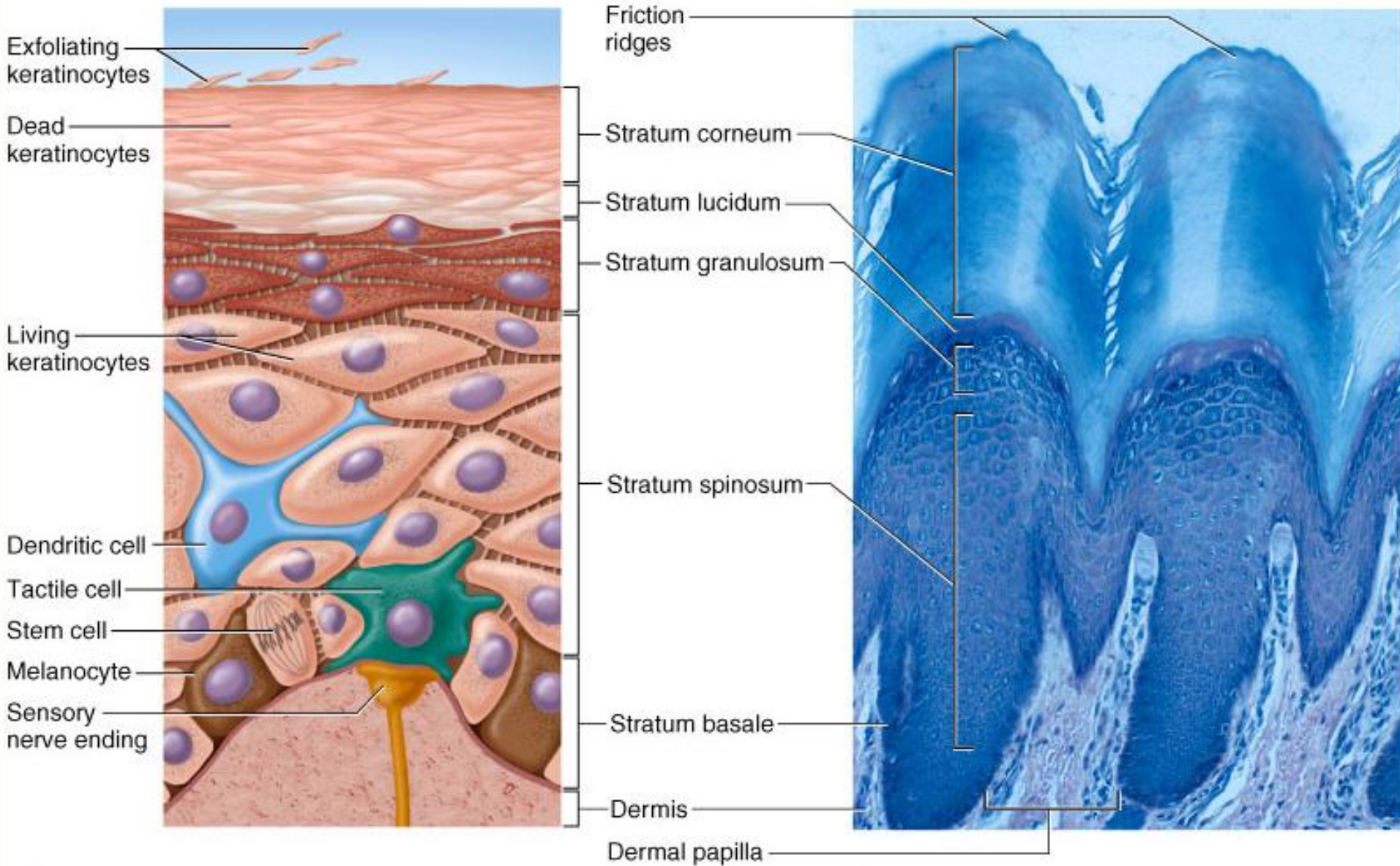
Figure 4.2 The gross structure of the skin and underlying fascia.

1. Epidermis
2. Dermis
3. Hypodermis
4. Fascia
5. Muscle

Histology of the Skin



Epidermis: Cell Types and Layers



Cells of the Epidermis

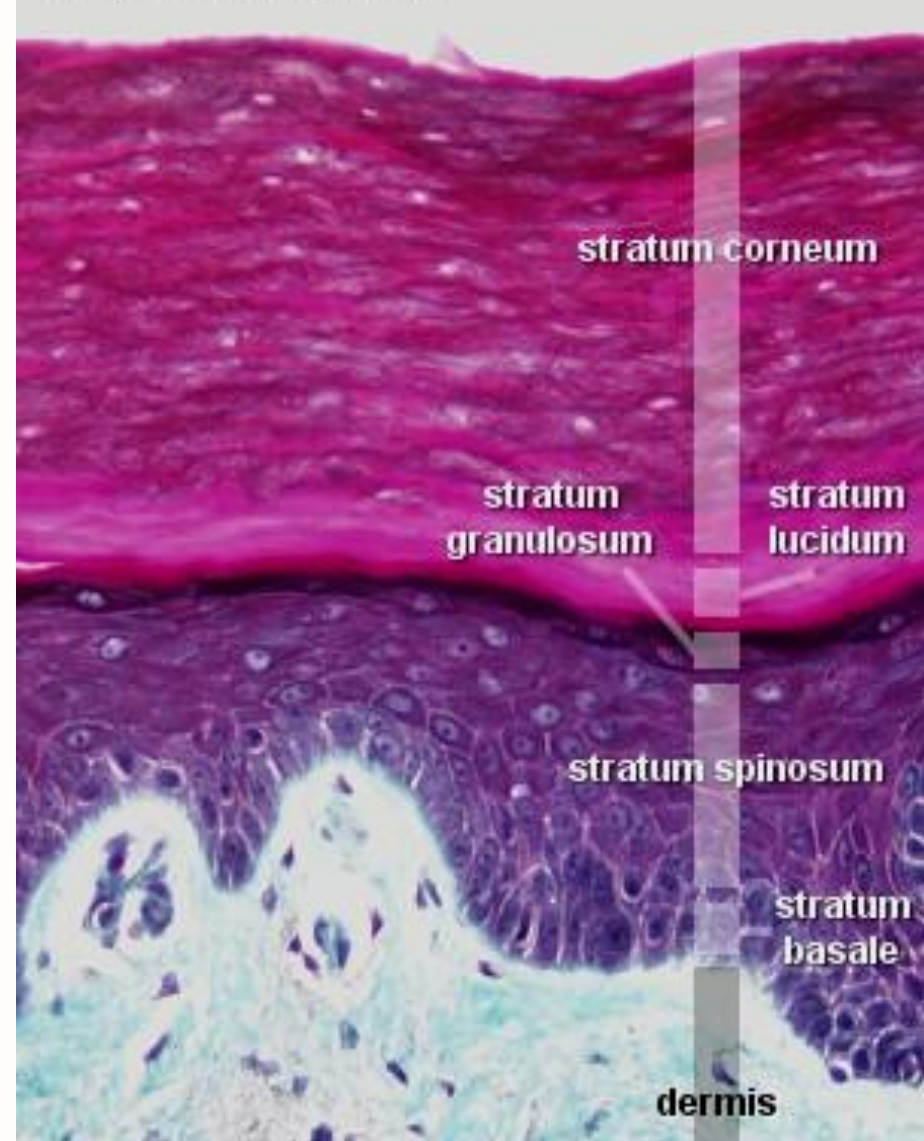
- **Keratinocytes:** Up to 30 layers of keratinocytes continuously move up through the epidermis and ultimately flake off (exfoliate).
 - Keratinocytes are bound to each other with many desmosomes, especially in the stratum spinosum layer.
 - Maturing keratinocytes fill with granules of keratin (for strength) and vesicles of glycolipid (for waterproofing).
 - Exocytosis of the glycolipid forms a barrier around each keratinocyte that cuts off surface cells from diffusion of nutrients from deeper layers of the skin.
 - Stratum Lucidum is a prominent transition point in thick skin only.
 - Maturation of keratinocytes from the stratum basale to exfoliation at stratum corneum normally takes about 15-30 days.
 - In the common skin disease, psoriasis, the rate of cell proliferation (mitosis) increases so cells move to the surface in about 7 days resulting in a thicker epidermis and greater shedding of dead keratinocytes (scaly skin or dandruff).

Thin Skin and Thick Skin

Skin, thin H&E

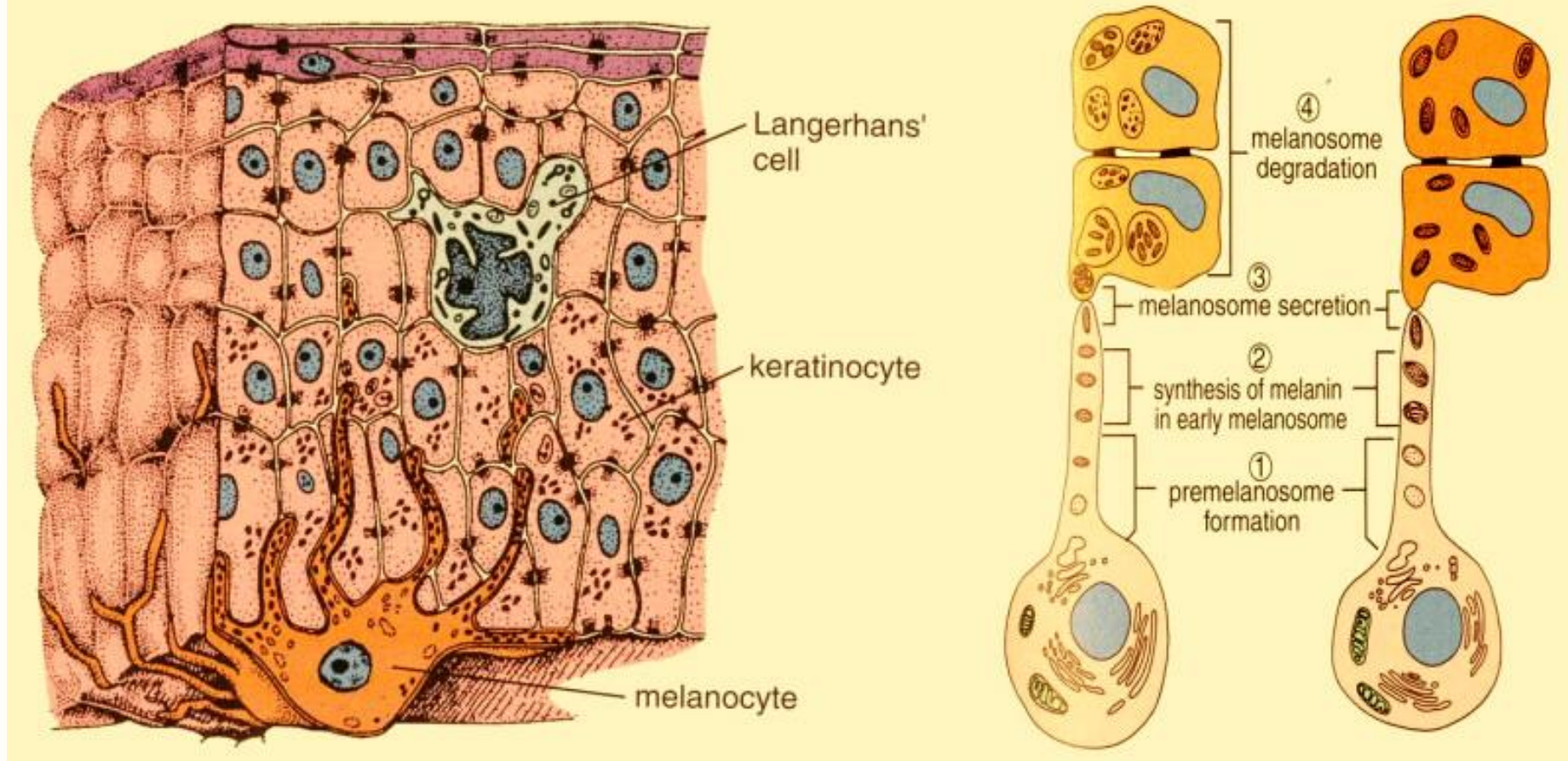


Skin, thick trichrome



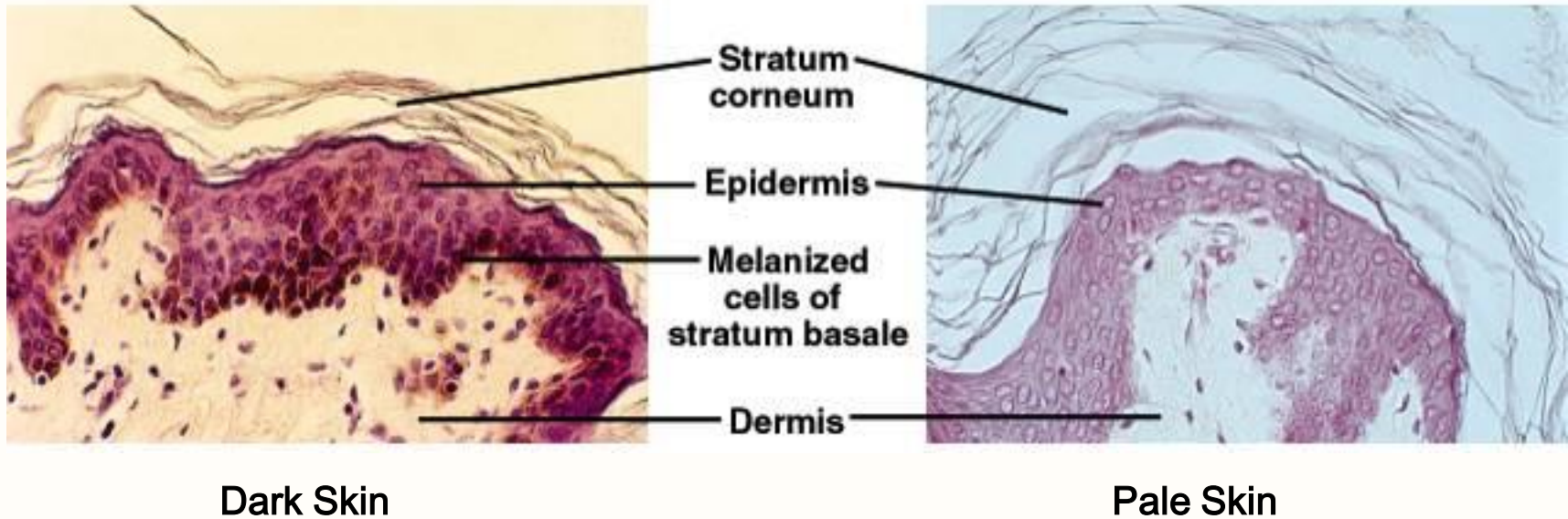
Other Cells of the Epidermis

- **Tactile Cells (Merkel Cells)** are touch receptors associated with nerve fibers.
- **Dendritic Cells (Langerhans Cells)** are macrophages (a type of white blood cell) from bone marrow that migrate into the epidermis and help protect against pathogens by engulfing antigens and then “presenting” the antigens to other cells in the immune system.
- **Melanocytes** synthesize melanin pigment and inject it into surrounding keratinocytes. Melanin colors skin, hair and the iris of the eyes. Melanin protects tissues from the damaging effects of UV radiation.



Melanocytes are pigment cells in stratum basale layer of the epidermis that do not form desmosomes with keratinocytes. Melanocytes produce and transfer melanin pigment granules (melanosomes) to adjacent keratinocytes by the process of cytotrine injection (melanosome secretion). Rate of melanin production and degradation is primarily controlled by genes. Number of melanocytes among humans is relatively constant, but melanin production varies with skin color. In some individuals, exposure to UV can accelerate melanin production and darken the skin (tanning).

Skin Color (Pigmentation)



Dark Skin

Pale Skin

- **Melanin** produced by melanocytes can be brown, black or reddish depending on the chemical composition of the melanin. **Eumelanin** is black or brown. **Pheomelanin** is reddish.
- **Hemoglobin** is the red pigment of red blood cells. Dermal blood vessels can be visible through a pale epidermis.
- **Carotene** is a yellow-orange pigment found in vegetables and egg yolks that can become concentrated in the stratum corneum and in subcutaneous fat.

Abnormal Skin Colors

- Albinism is a genetic lack of melanin.
- Vitiligo is a patterned albinism thought to be caused by an autoimmune disorder that kills melanocytes in specific regions of the skin.
- Hematoma is a bruise caused by clotted blood that escaped into the connective tissue of the dermis and hypodermis.

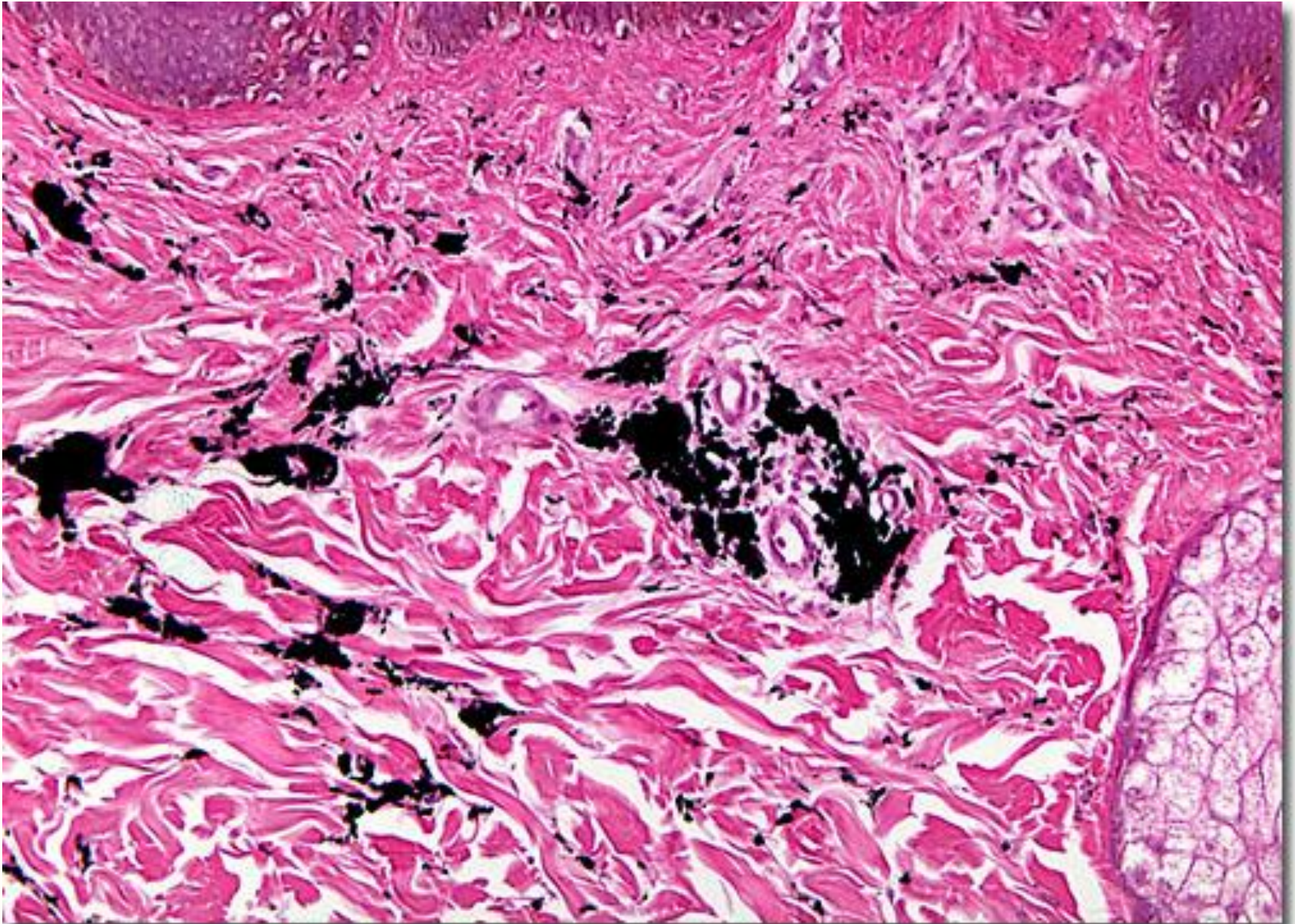


Skin Markings

- Hemangiomas (birthmarks)
 - discolored skin caused by benign tumors of dermal blood capillaries
 - strawberry birthmarks usually disappear in childhood
 - port wine birthmarks last for life
- Freckles and Moles
 - aggregations of melanocytes
 - freckles are flat; moles are elevated



Tattoo Ink in Dermis

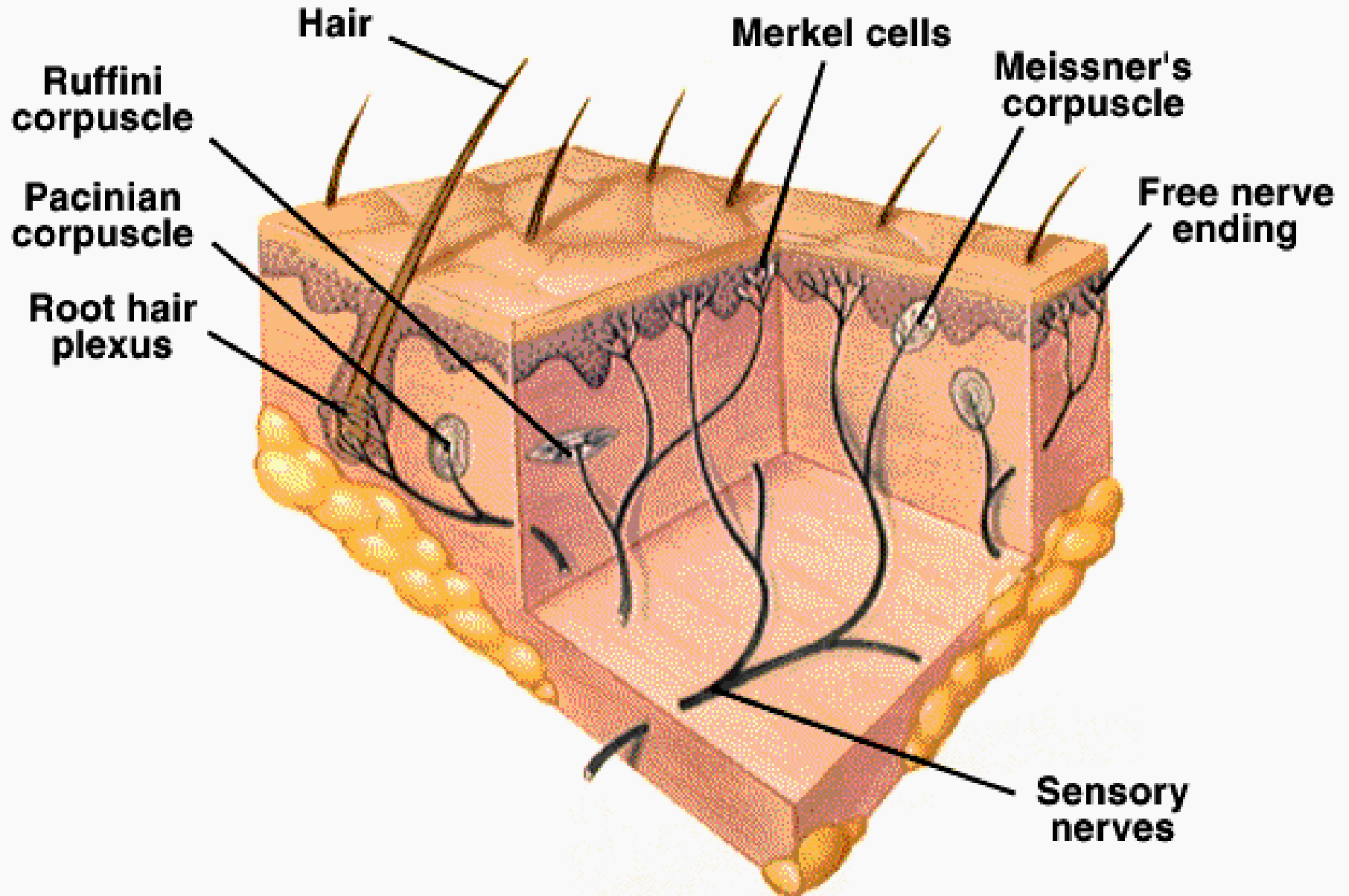


Skin Cancers

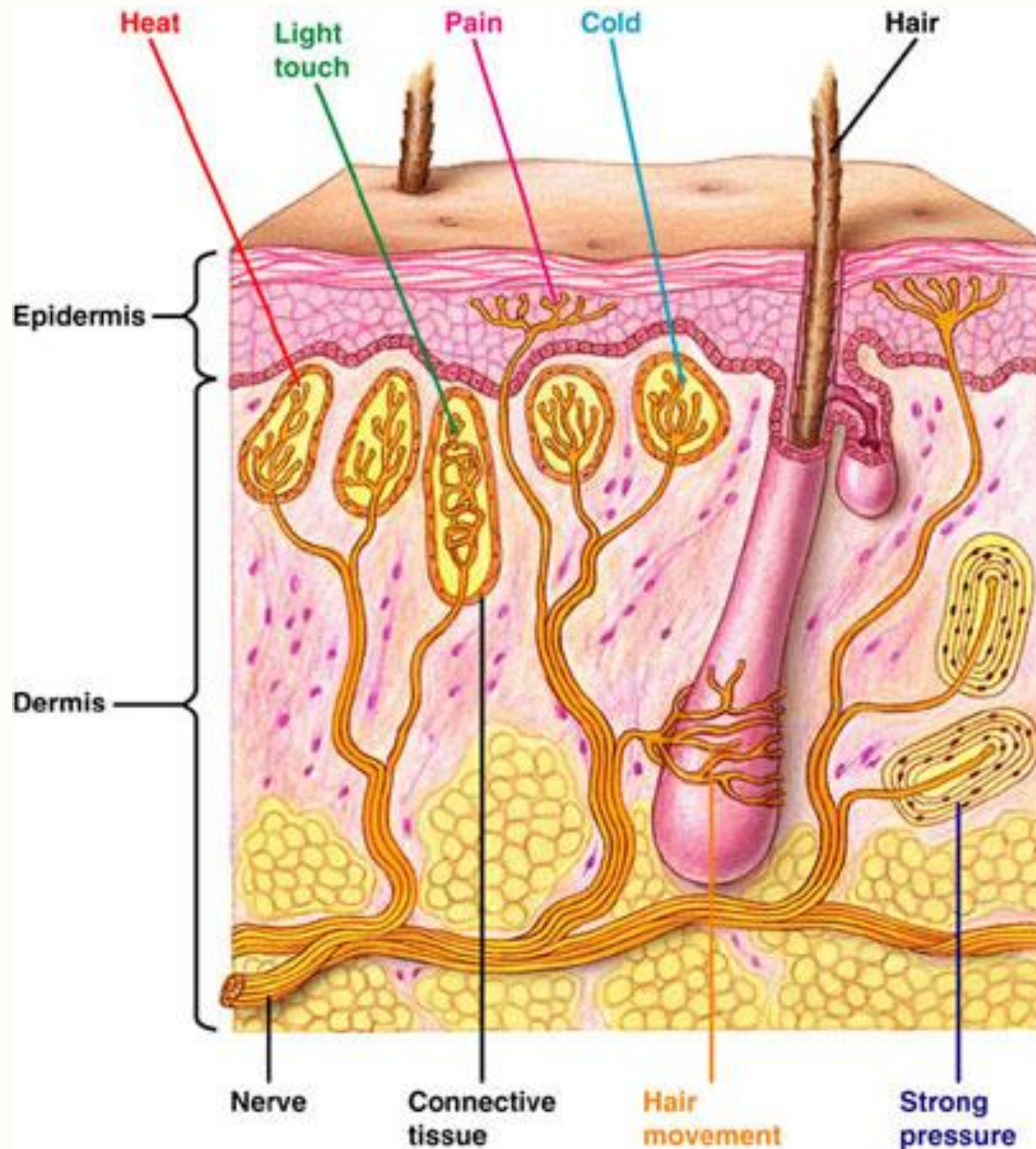
- Skin cancer can be induced by UV rays of the sun and is most common in fair-skinned and elderly people.
- Basal Cell Carcinoma →
 - arises from keratinocytes in the stratum basale that transform and invade the dermis
 - treated by surgical removal and/or radiation
- squamous cell carcinoma →
 - arises from keratinocytes in the stratum spinosum
 - metastasis to the lymph nodes can be lethal
- melanoma (most deadly skin cancer) →
 - arises from melanocytes
 - ABCD: asymmetry, border irregular, color mixed, diameter over 6 mm



Sensory Receptors of the Skin



Sensory Receptors of the Skin



Sensory Receptors of the Skin

a) **Free Nerve Endings** are the tips of neuron processes that are sensitive to **pain** (nociceptors) or change in temperature (hot and cold). Commonly found in epithelia and connective tissue.

b) **Merkel's (tactile) Endings** are free nerve endings associated with a Merkel's cell. This is a sensitive mechanoreceptor for sensing textures, edges and shapes.

Encapsulated Nerve Endings:

c) **Pacinian (Lamellated) Corpuscles** sense deep pressure, stretch, and vibration. Nerve ending is wrapped in a capsule of many layers of Schwann cells. Found in dermis of hands, feet, breasts and genitals.

d) **Krause's End Bulbs** are similar to Merkel's disks, but are found in mucus membranes of the mouth and are cold temperature receptors.

e) **Meissner's Corpuscles** sense light touch and texture. Located in dermal papillae and are abundant in the lips.

f) **Ruffini's Corpuscles** are sensitive to stretch or compression of skin.

Sensory Receptors of the Skin

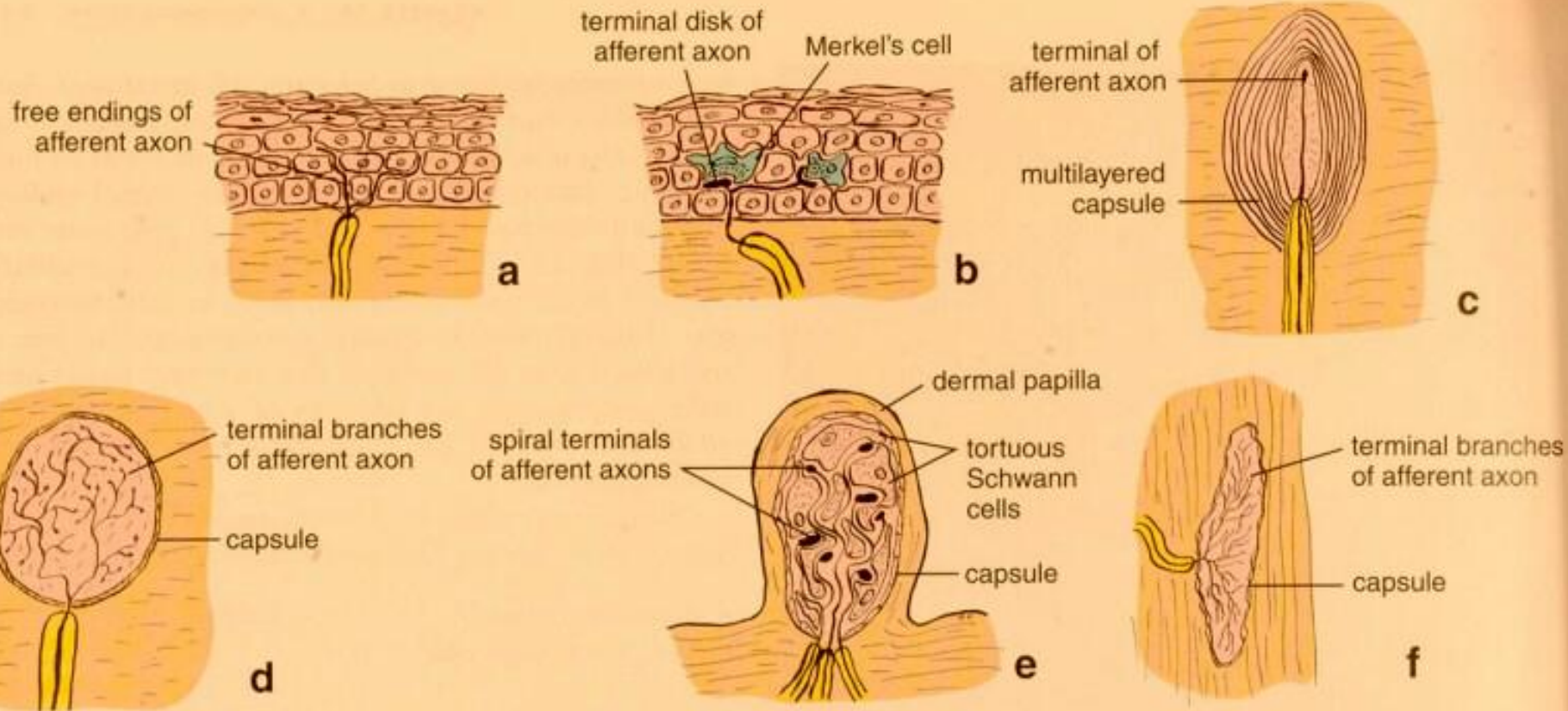


FIGURE 14.12

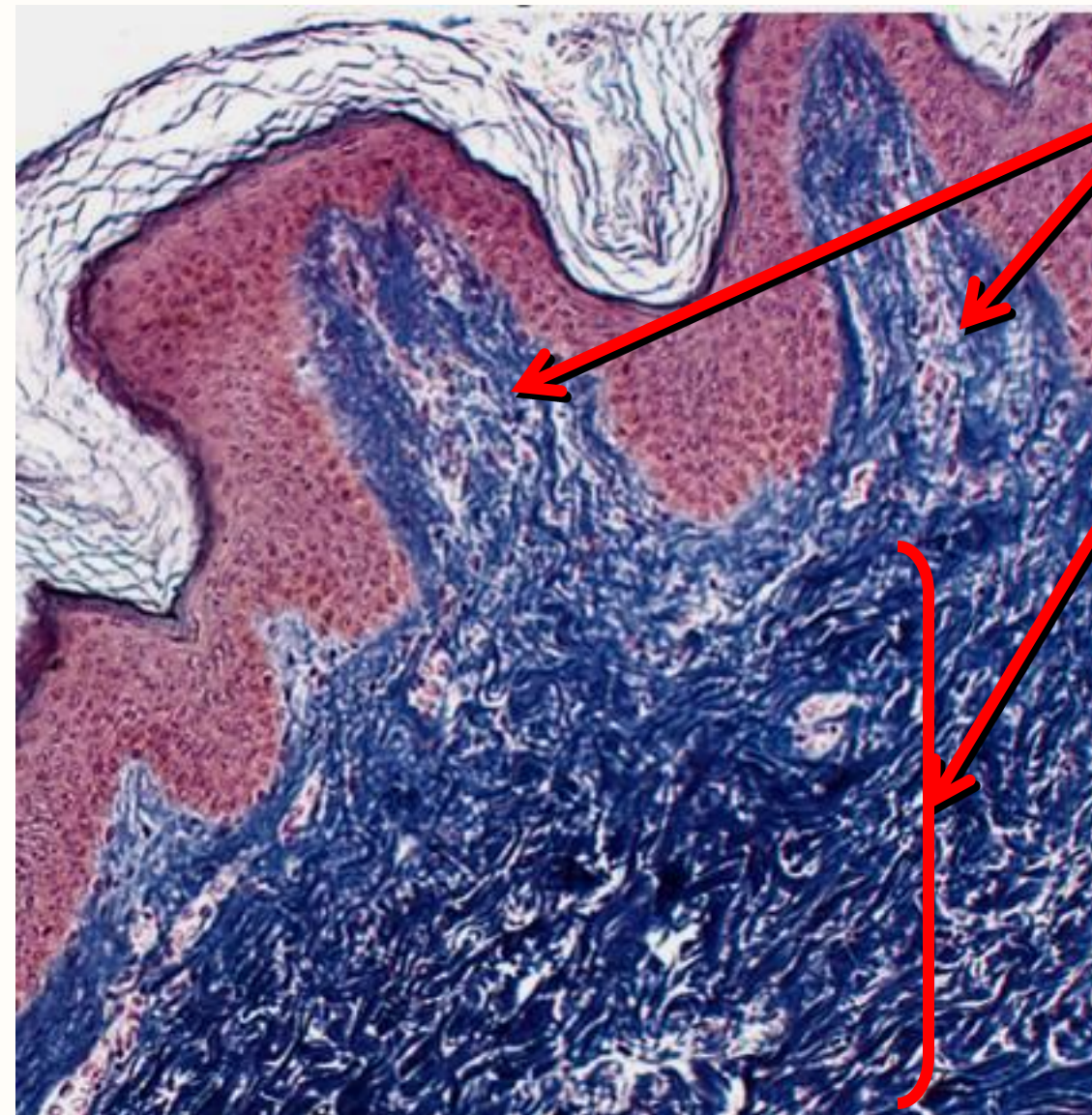
Diagram of the sensory receptors in skin. a. Epidermal free ending. b. Merkel's ending. c. Pacinian corpuscle. d. Krause's end bulb.

e. Meissner's corpuscle. f. Ruffini's corpuscle. Note that axons c to f are encapsulated, i.e., surrounded by a capsule of connective tissue.

The Dermis

Dermal Papillae (also called dermal ridges) form the Papillary Layer of the Dermis and is composed of loose connective tissue

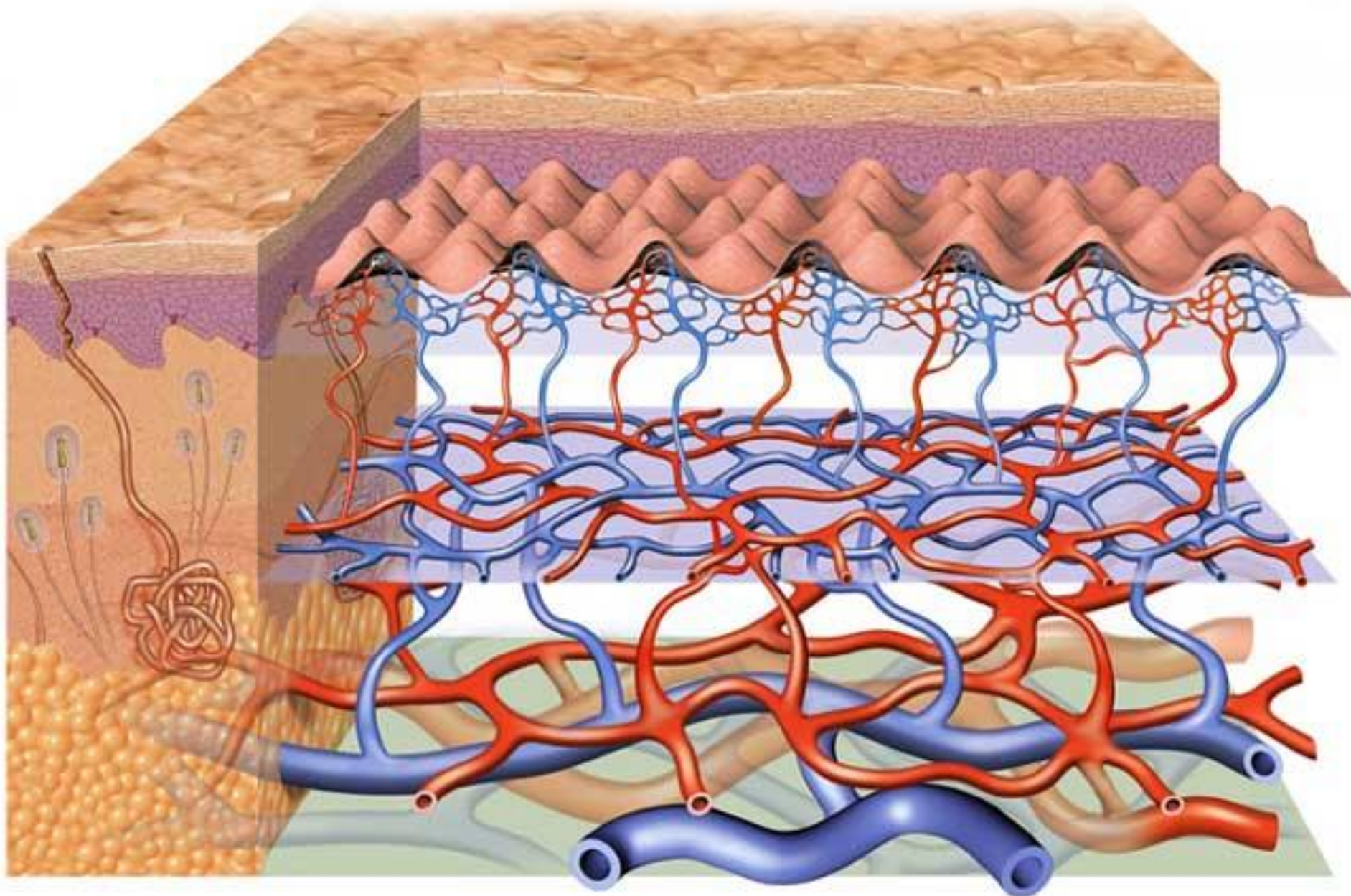
Collagen Fibers of the Reticular Layer of the Dermis form a dense irregular connective tissue



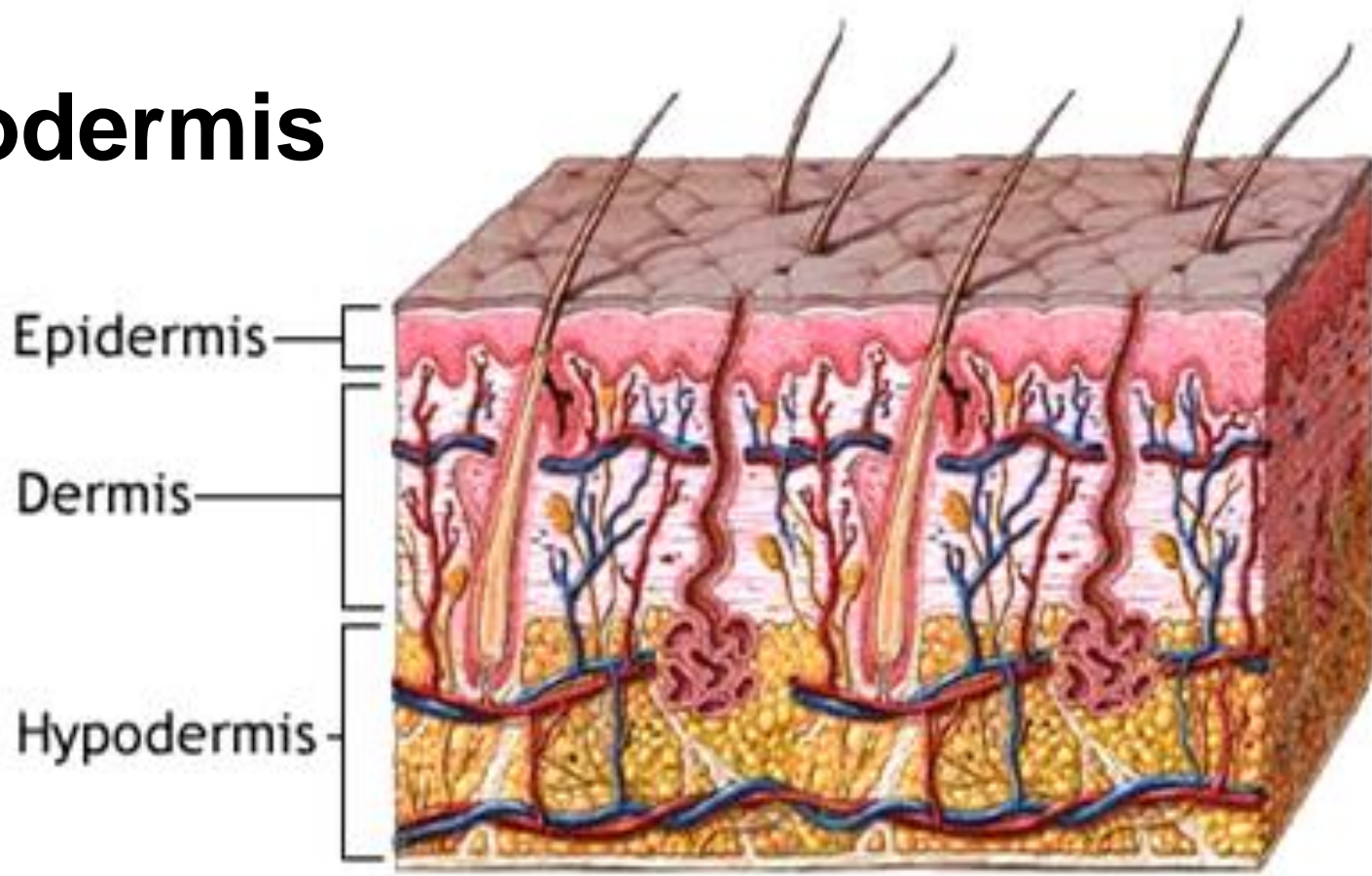
The Dermis

- Thickness = 0.6mm to 3mm
- Composition
 - fibroblasts, collagen fibers, elastic fibers, reticular fibers, blood vessels, nerves, hair follicles and glands
- Layers
 - the dermal papillae of the papillary layer are composed of areolar connective tissue.
 - reticular layer is the deeper part of dermis and is composed of dense irregular connective tissue.
- Dermal papillae are upward extensions of the dermis that interdigitate with the epidermis and correspond to the ridges of the fingerprints.

Blood Vessels of the Dermis and Hypodermis



The Hypodermis



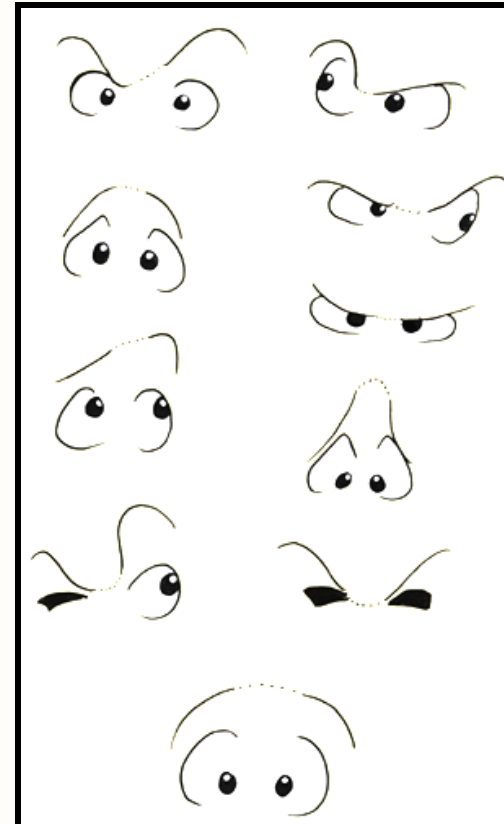
- The hypodermis is also called the subcutaneous tissue or the superficial fascia.
- The adipose of the hypodermis is called the subcutaneous fat.
- Hypodermis functions to store energy (in fat) and to thermally insulate
- Hypodermic injections deliver substances into the highly vascular tissue of the hypodermis.

Human Hair

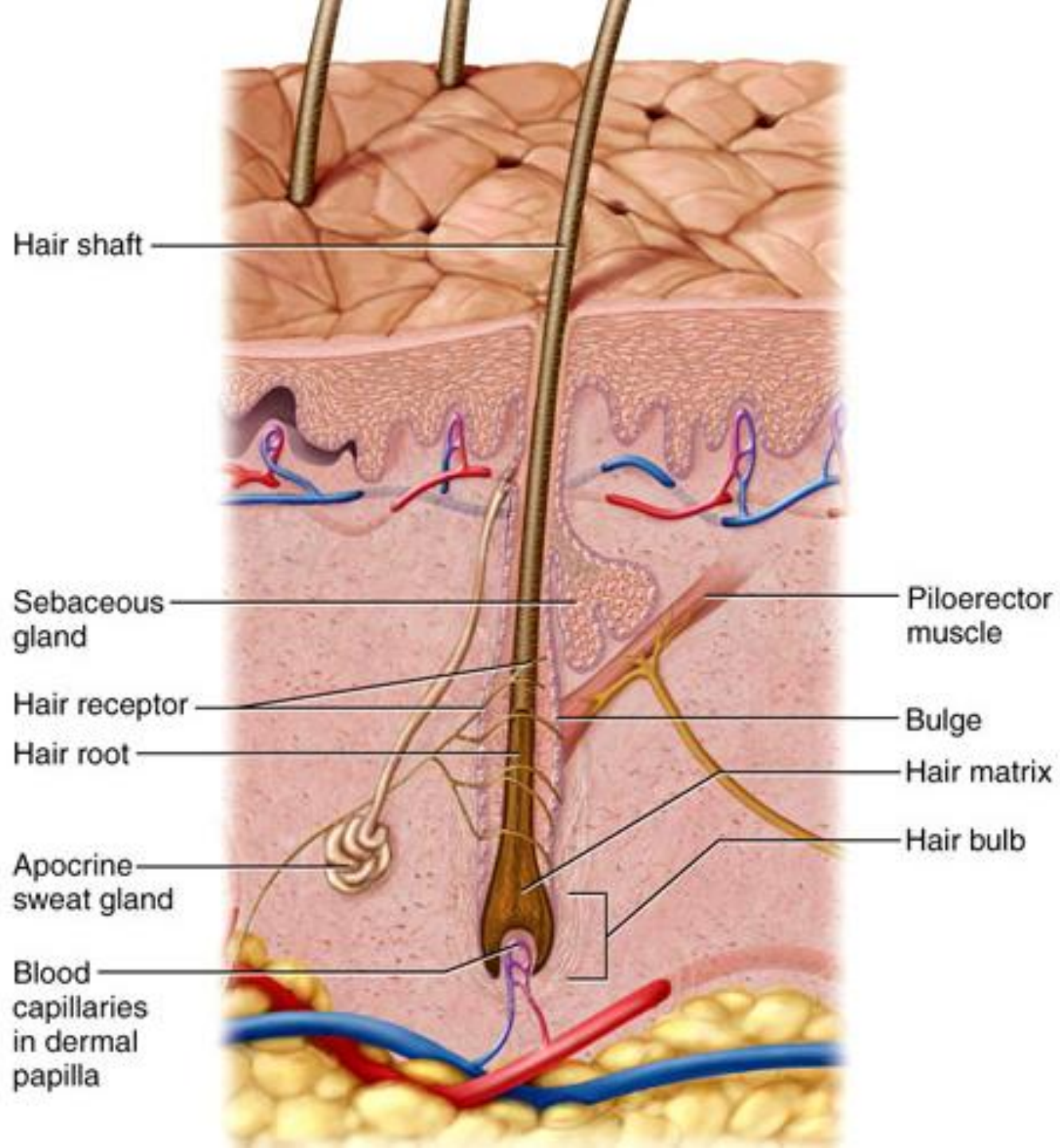
- Hair is composed of keratinocytes filled with keratin that is toughened by disulfide bridges between the keratin molecules
 - sulfur from the disulfide bridges is given off when hair is burned
- Hair is found almost everywhere on the body
 - differences in the hair distribution of males and females is really a difference in texture and color of hair
- 3 different body hair types:
 - **lanugo** is fine, unpigmented fetal hair
 - **vellus** is fine, unpigmented hair (peach fuzz) that covers much of the bodies of children and adults – its growth is not affected by hormones
 - **terminal hair** is coarse, long, pigmented hair – its growth can be affected by hormones

Functions of Hair

- Body Hair
 - enhances sense of touch (can alert us to an insect crawling on our skin)
- Scalp Hair provides heat retention in cold weather and protection from sunburn.
- Development of Facial, Pubic and Axillary Hair indicate gender and sexual maturity.
- Nose Hairs, ear hairs and eyelashes prevent foreign objects from getting into nostrils, ear canals or eyes.
- Eyebrows reinforce or exaggerate expression of emotions.



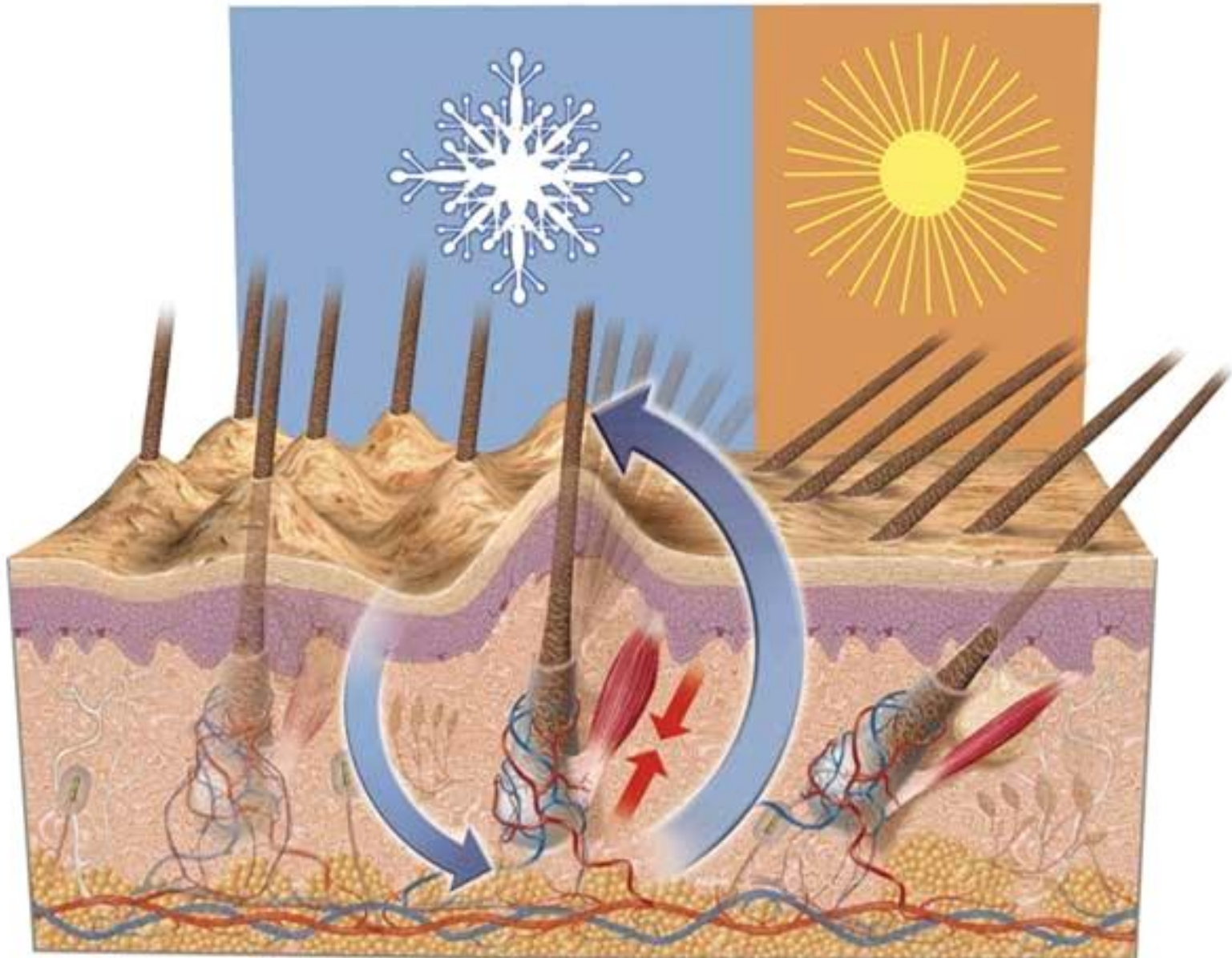
Hair Follicle and Associates Structures



Hair Follicle and Associates Structures

- **Hair Follicles** are tubes of epidermis that a hair grows out of.
- The **hair shaft** is composed of dead keratinocytes that emerge out of the skin
 - A hair shaft has three layers: **Cuticle, Cortex and Medulla.**
- The **hair root** is composed of living cells below the surface of the skin within the hair follicle.
- The **hair bulb** is a swelling in the base of the root where a hair originates
- The **dermal papilla** is vascular tissue that provides nutrients to the hair bulb
- **Hair receptors** are sensory nerves that wrap around each follicle

Piloerector muscle (arrector pili) can lift up hairs and depress the skin around it (causing goose bumps).

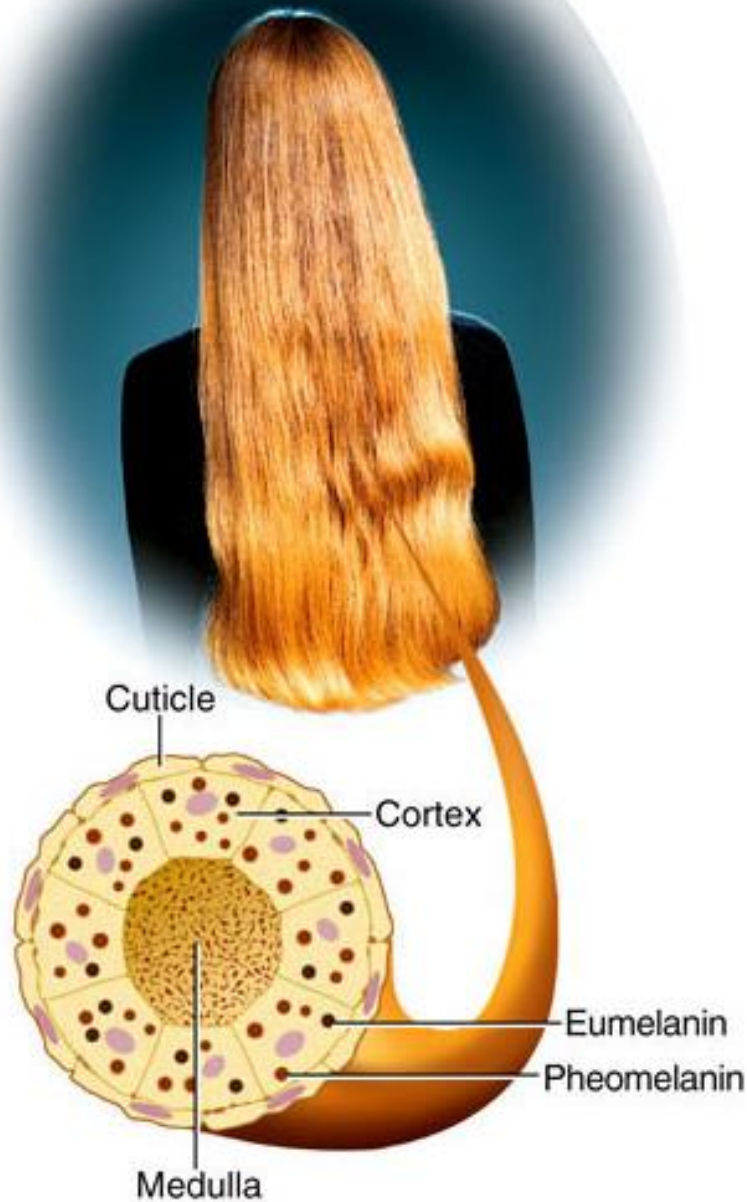


Hair shafts have 3 layers of dead keratinocytes: cuticle, cortex and medulla.

Hair color is due to pigment deposited in cells of the cortex layer.

Blond hair contains a mixture of a small amounts of black or brown eumelanin and red pheomelanin pigments.

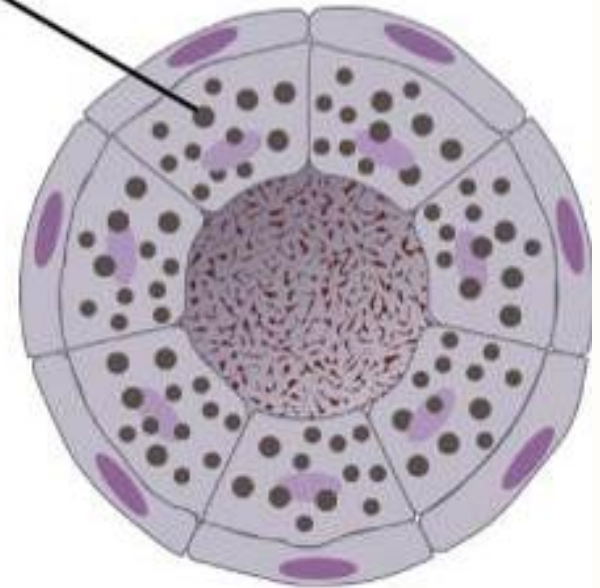
Straight hair has a round cross section



(a) Blond, straight



Melanin

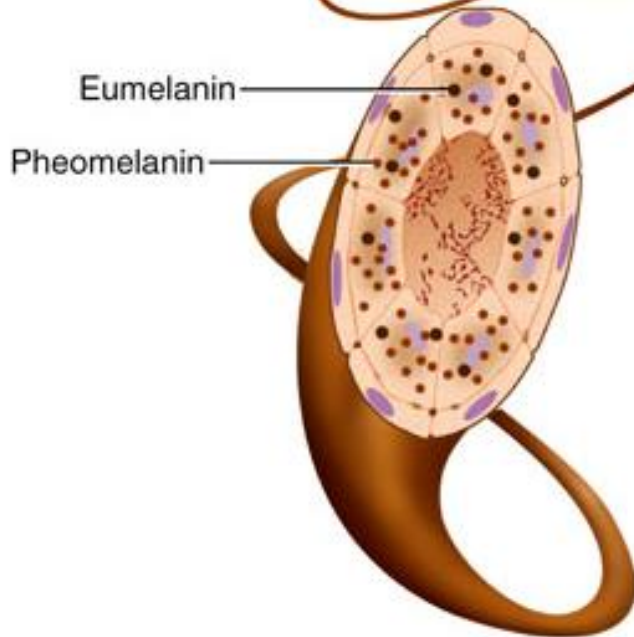


Black and dark brown hair contains eumelanin pigment.



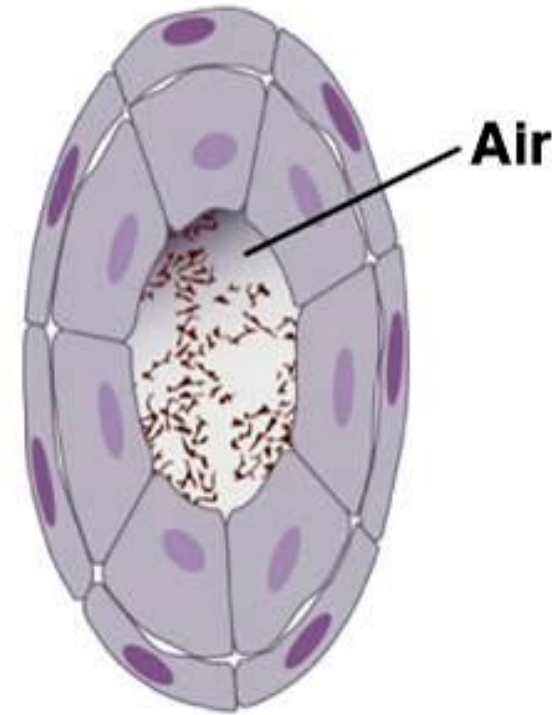
Red hair contains some eumelanin, but mostly pheomelanin pigment.

Wavy or curly hair is flattened in cross section.



(c) Red, wavy

Hair Colour and Texture, Gray and White



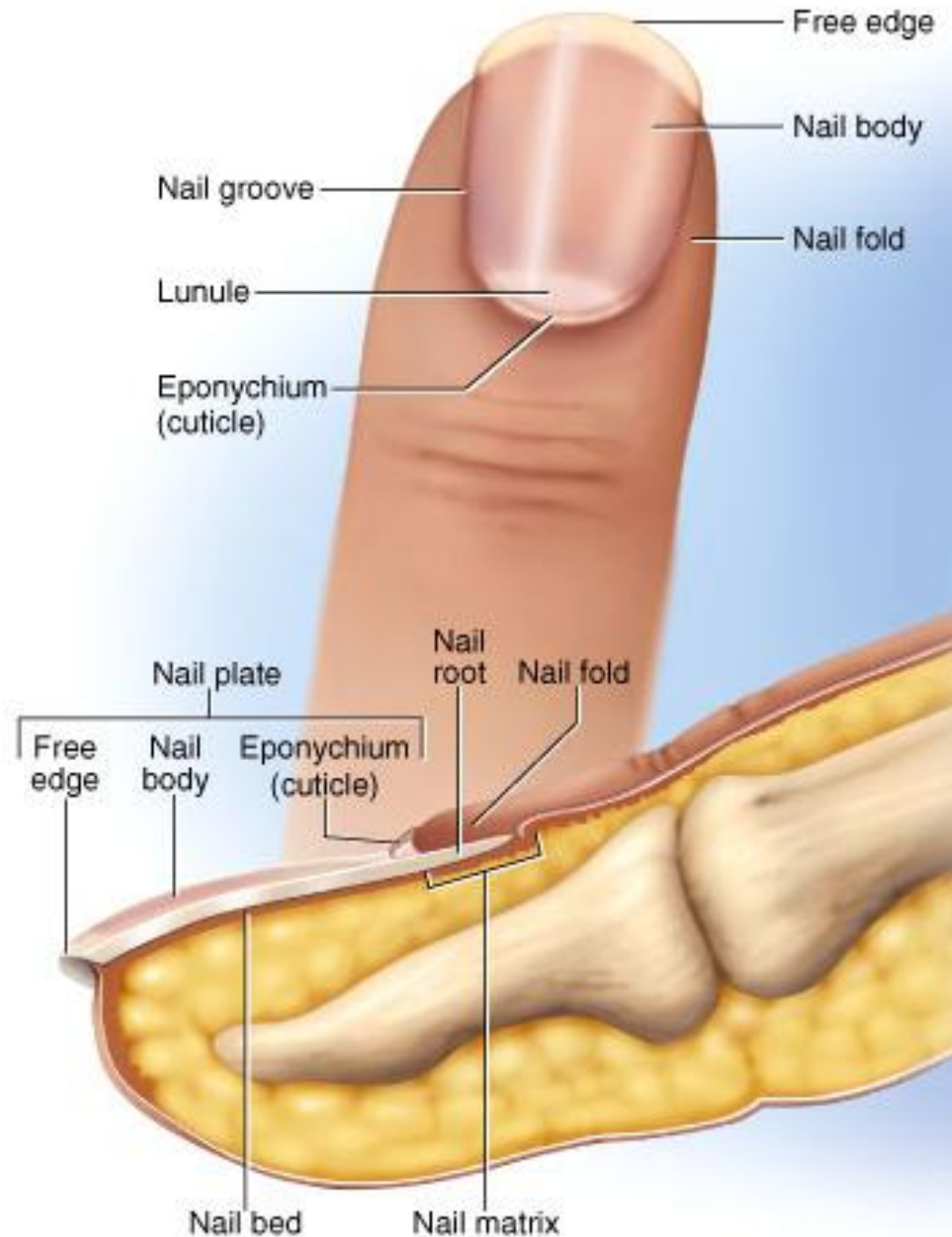
White hair lacks pigment, and the medulla may degrade into an air-filled space making the hair brittle. Gray hair is a mixture of white hairs and some pigmented hairs.

Hair Growth

- Scalp hairs take about 3 days to grow about 1mm
- On average hair scalp hair grows about 4-7 inches per year
- Scalp hairs grow for about 6-8 years and then the follicle rests for several months.
- Each hair goes through a growth phase followed by a resting phase. Hairs across the body are in various, asynchronous phases.

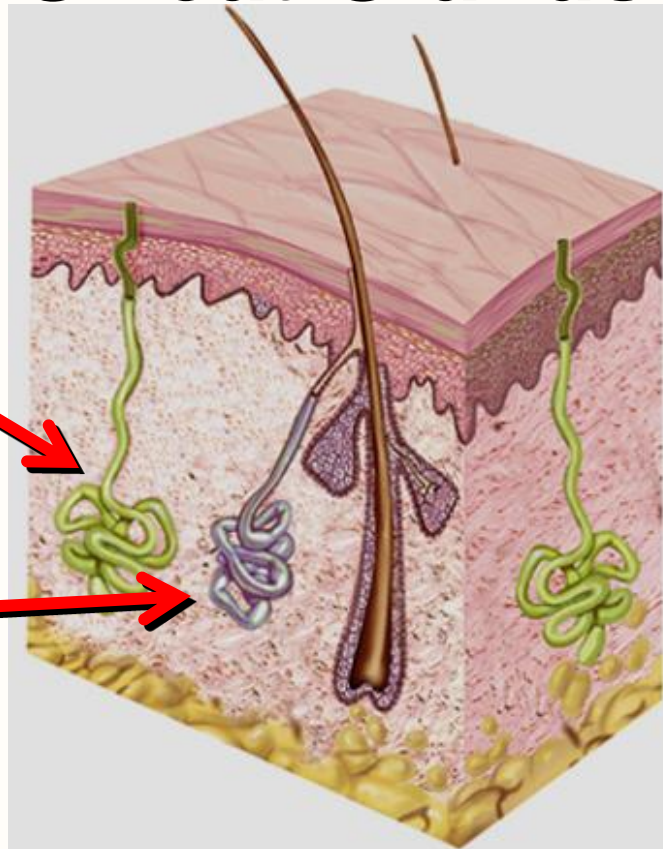
Finger Nails

- Nail Plate is a clear, hard derivative of the stratum corneum formed from densely packed keratinocytes filled with hardened keratin protein.
- Cuticle (eponychium) is where the skin and nail meet on the dorsal surface.
- Nail Root grows out of the nail matrix, which is equivalent to the stratum basale of the epidermis.
- Nail Bed is skin on which nail plate rests
- Growth from new cells added from the nail matrix is about 1 mm per week



Sweat Glands

- Sweat is derived from blood plasma and is a dilute solution of NaCl and urea
- Merocrine Glands
 - millions all over the body function to cool the skin
- Apocrine Glands
 - sweat contains fatty acids
 - found only near hair follicles
 - respond to stress or excitement
 - bromhidrosis is term for body odor produced by bacterial action on the fatty acids in apocrine sweat



Sebaceous Glands

- Sebaceous Gland ducts open into the hair follicle and release a secretion called sebum that softens the dead keratinocytes of hair shaft. (Lanolin is sebum collected from lamb wool and is used in some skin creams to soften the stratum corneum)



Ceruminous Glands

- Ceruminous glands are found only in the skin of the external auditory meatus (ear canal).
- Cerumin combines with sebum to produce earwax that:
 - repels water
 - keeps eardrum flexible
 - repels mites and other pests

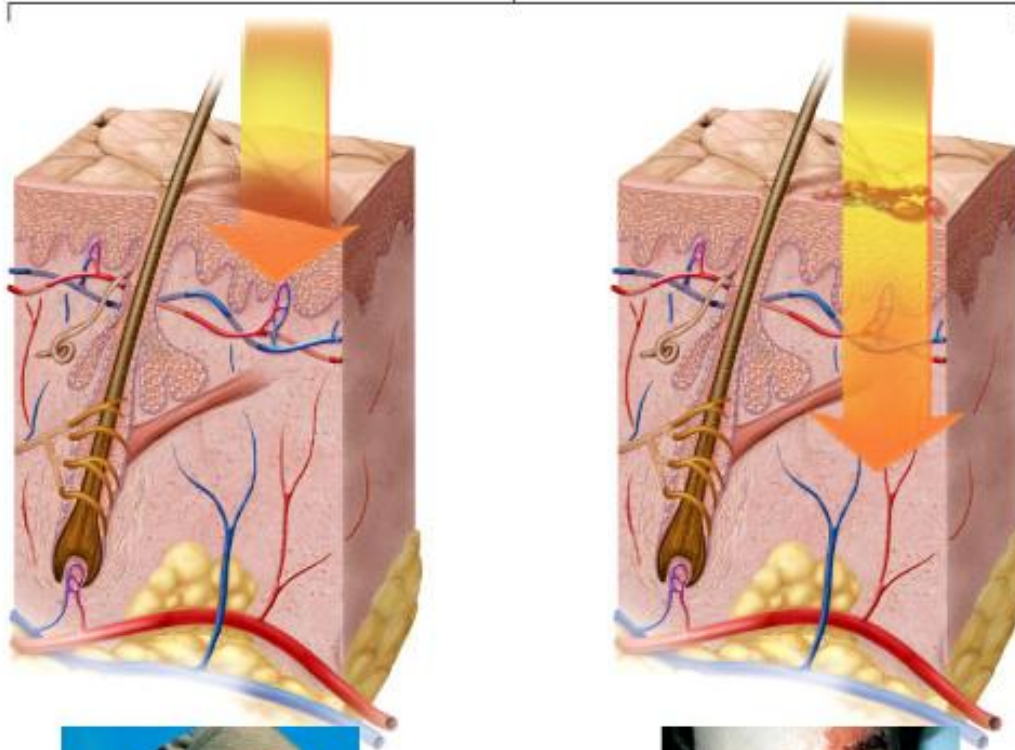


Burns

- Causes of burns include hot water, sunlight, radiation (including UV), electric shock, chemicals.
- Causes of death from burns are usually due to fluid loss or infection.
- Degrees of burns
 - 1st-degree = only the epidermis (red, painful, edema)
 - 2nd-degree = epidermis and part of dermis (blistered)
 - epidermis can regenerate from remaining hair follicles and sweat glands
 - 3rd-degree = epidermis and dermis are destroyed
 - often requires grafts or fibrosis scarring and disfigurement may occur
- Treatments can include fluid replacement, infection control, debridement, grafting, or IV replacement of proteins, nutrients and fluids

Burns

Partial thickness burns



Full thickness burns



(a) First degree



(b) Second degree



(c) Third degree

END