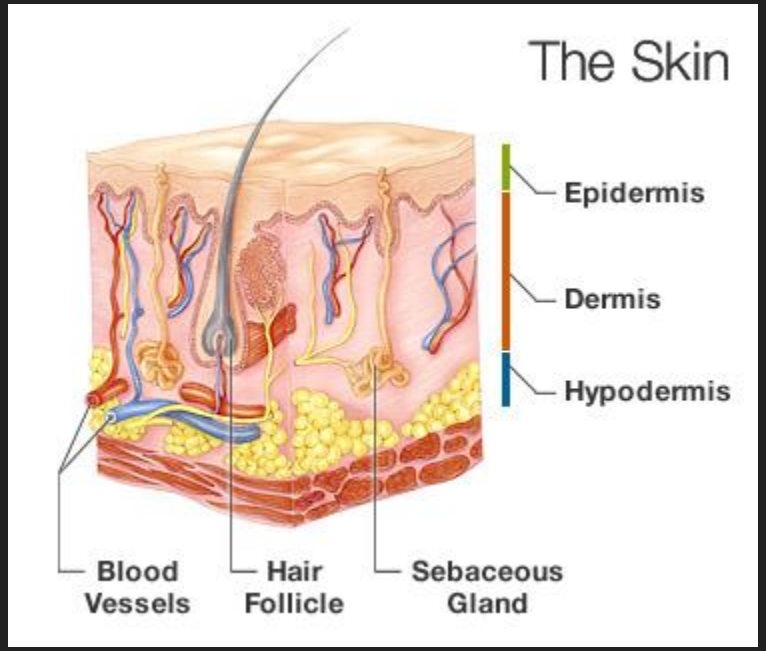
# Unit 3 – The Integumentary System

# The Integumentary System

- Integument is skin
- Skin and its appendages make up the integumentary system
  - Skin, hairs, nails, vessels, nerves, and glands
- A fatty layer (hypodermis) lies deep to it



# The Integumentary System

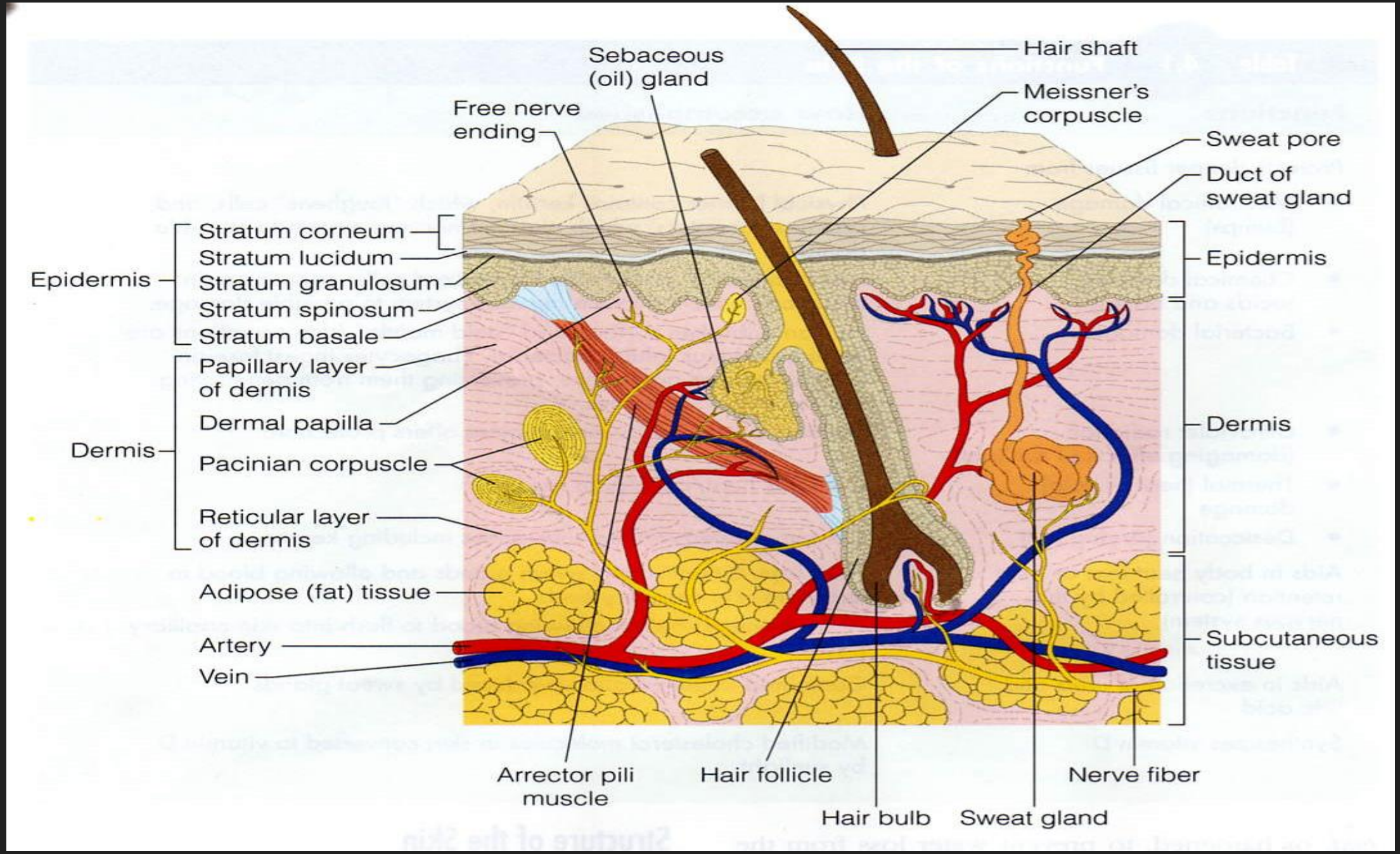
- Two major components:
  1. Cutaneous Membrane
     - Epidermis/Superficial Epithelium
     - Dermis/Underlying Connective Tissue
  2. Accessory Structures
     - Located in dermis
     - Hair, nails, exocrine glands, blood vessels
     - Sensory receptors for touch, pressure, temperature and pain
- Deep to the dermis, the loose connective tissue of the subcutaneous layer/superficial fascia/hypodermis separates the integument from the deep fascia around other organs

# Functions of the Skin

- Protection
  - Covering to protect deeper tissues from dehydration, trauma, and germ invasion
- Regulate Body Temperature
  - Controls heat loss
  - Evaporation of water from the skin, in the form of perspiration
  - Helps rid the body of excess heat
- Helps manufacture Vitamin D
  - The sunshine vitamin
  - Ultraviolet light on the skin is necessary for the first stages of vitamin D

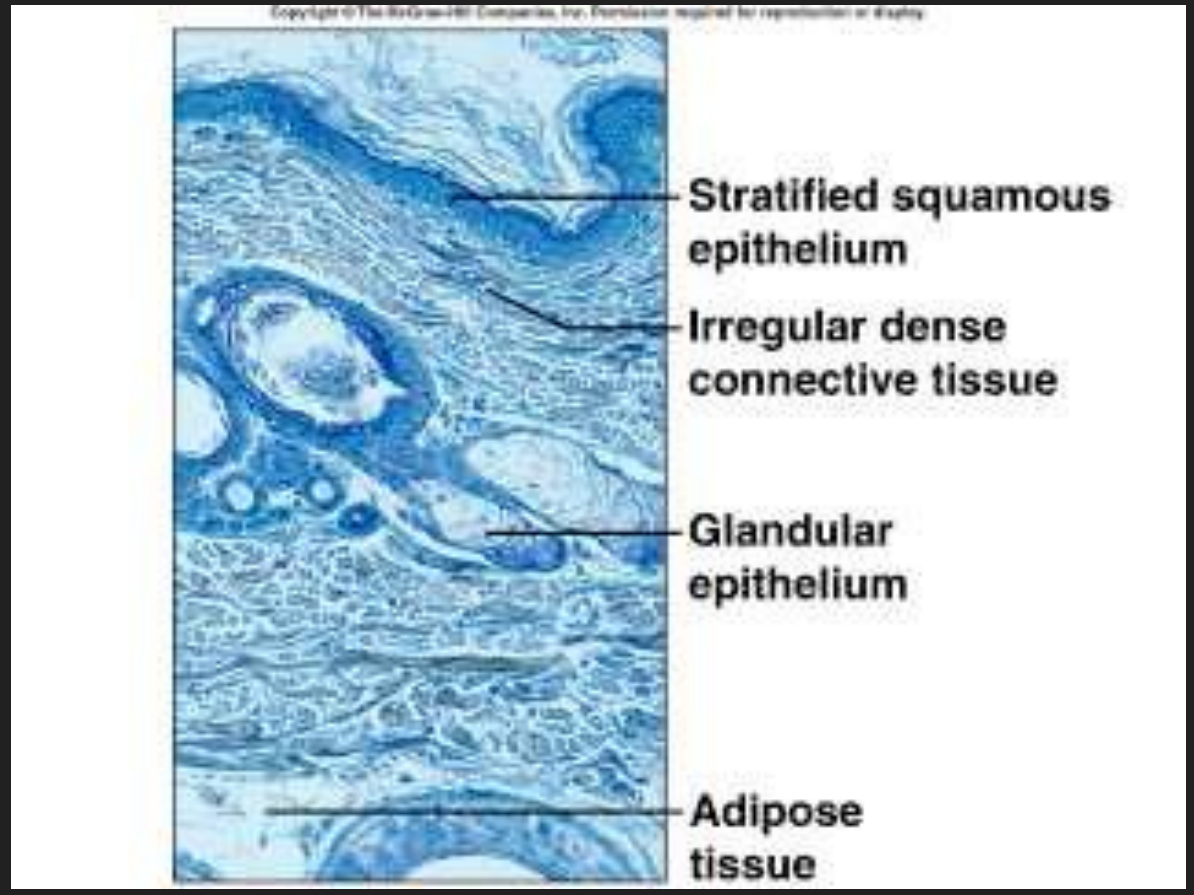
# Functions of the Skin

- Storage
  - Fat, glucose, water, and salt
- Absorption
  - Can absorb certain medications and chemicals
- Screens out harmful ultraviolet radiation and eliminates wastes
- Site of many receptors and nerve endings for sensory information
  - Touch, pressure, pain, and temperature


Hair shaft
Sebaceous (oil) gland
Meissner's corpuscle
Free nerve ending
Sweat pore
Duct of sweat gland
Epidermis
Stratum corneum
Stratum lucidum
Stratum granulosum
Stratum spinosum
Stratum basale
Epidermis
Papillary layer of dermis
Dermal papilla
Dermis
Pacinian corpuscle
Reticular layer of dermis
Dermis
Adipose (fat) tissue
Artery
Vein
Subcutaneous tissue
Arrector pili muscle
Hair follicle
Nerve fiber
Hair bulb
Sweat gland

# Layers of Skin

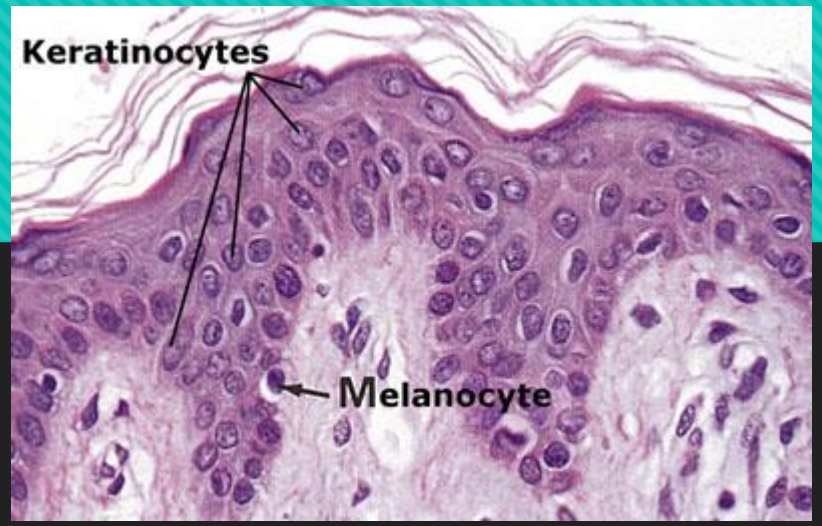
- Epidermis
- Dermis
- Subcutaneous Membrane
  - Hypodermis



# Epidermis

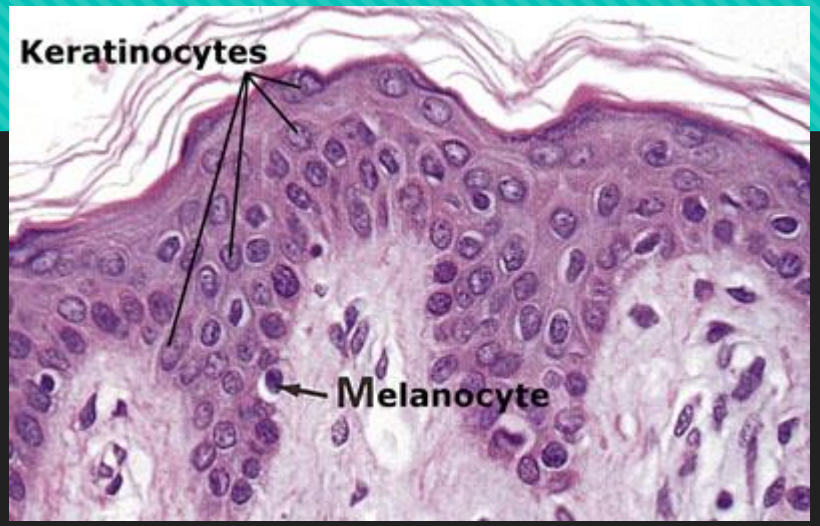
- Outer layer of the skin
- Renews itself ~ every 45 days

# Epidermis – Cell Types




- Keratinocytes
  - Produce keratin → waterproofing protein
  - Originate in deeper layers & get pushed to surface
  - Connected to each other by desmosomes & tight junctions
  - Cell production & keratinization are accelerated in areas of friction
    - Think callus → thickened skin

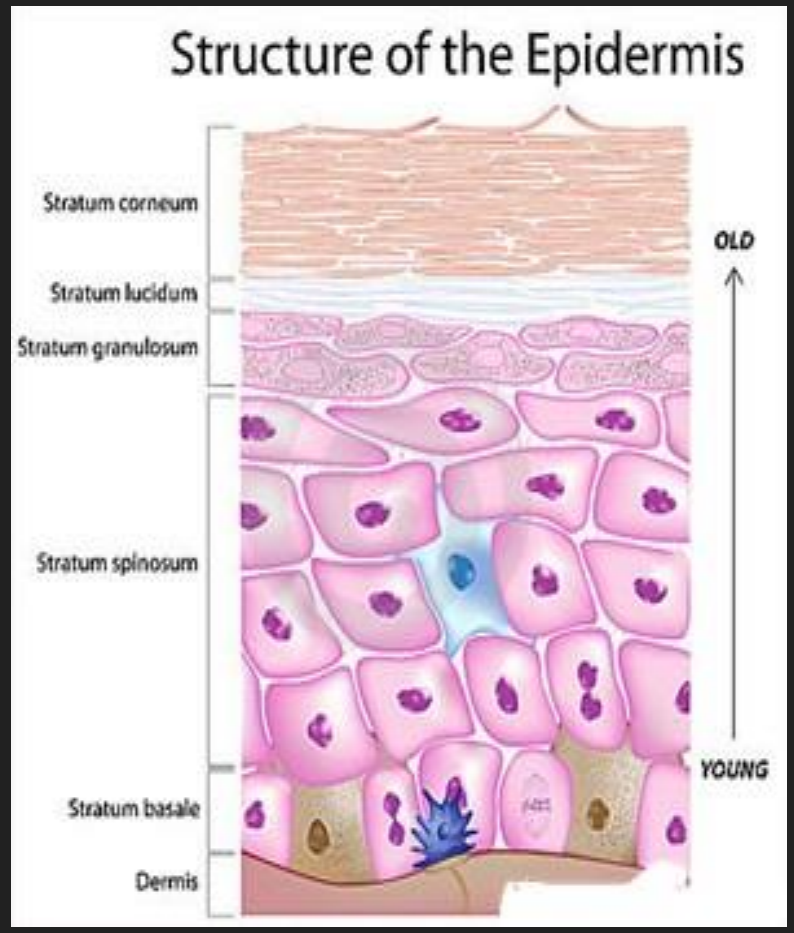
# Epidermis – Cell Types

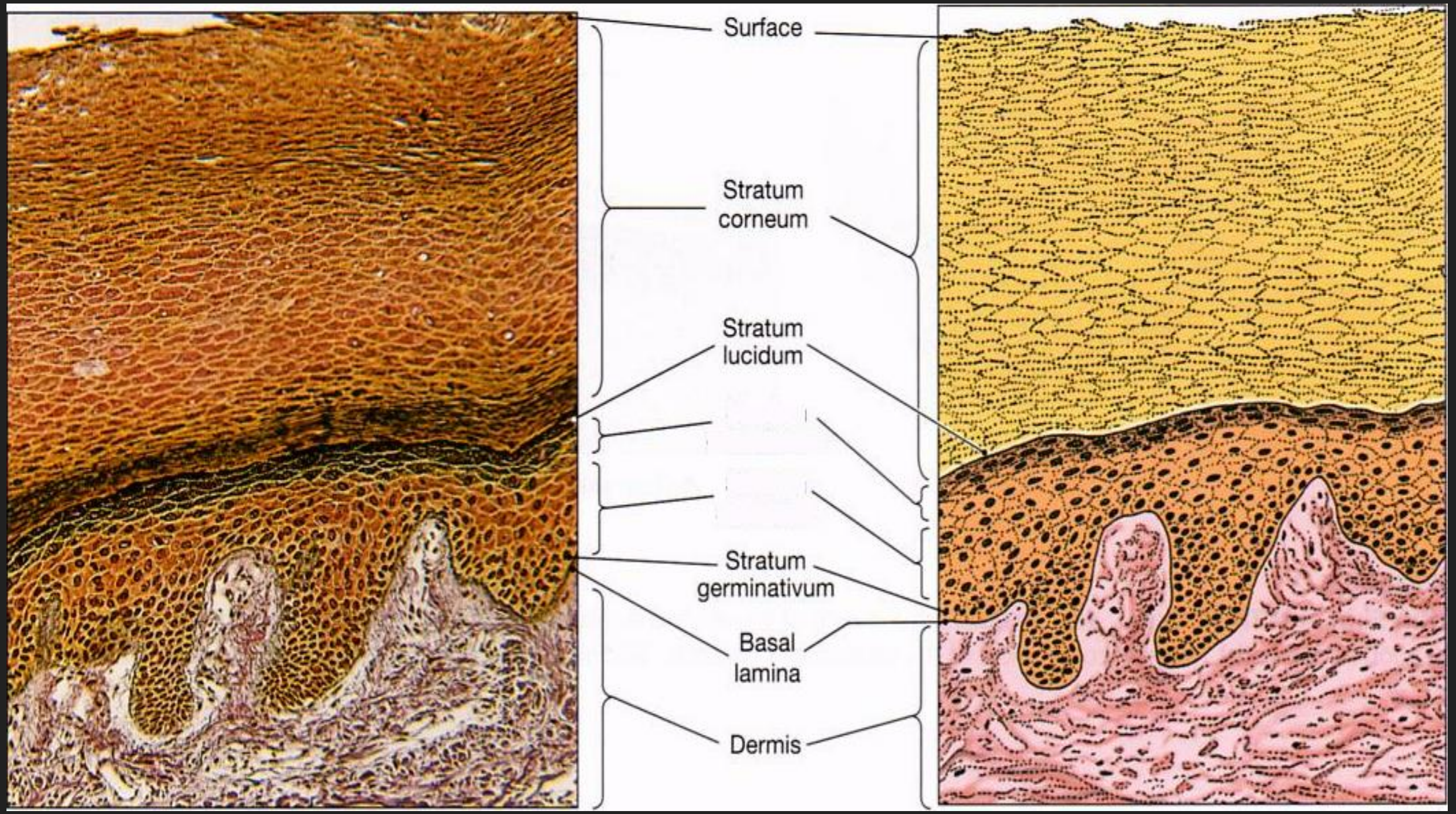



- Melanocytes
  - Produce melanin
  - Prevents DNA mutation from UV radiation
  - UV increases melanin production
  - Same number in everyone but different amount of pigment produced
  - Accumulation of melanin results in freckles and moles

# 5 Layers of the Epidermis

- In order from deep to superficial
  1. *Stratum germinative (basale)*
  2. *Stratum spinosum*
  3. *Stratum granulosum*
  4. *Stratum lucidum*
  5. *Stratum corneum*
- Takes 15-30 days for a cell to move through all five levels




Surface
Stratum corneum
Stratum lucidum
Stratum germinativum
Basal lamina
Dermis

# Stratum Germinative/Basale

- Highly mitotic (goes through mitosis quickly)
  - Produces new skin layer
  - ~25% melanocytes

# Stratum Spinosum

- Slightly mitotic – one of the daughter cells from the stratum germinativum is pushed into the stratum spinosum
- Consists of 8-10 layers of cells
- Contains Langerhans macrophages
  - Stimulate a defense against:
    - Microorganisms that manage to penetrate the superficial layers of the epidermis
    - Superficial skin cancers

# Stratum Granulosum

- Not mitotic but begin making keratin and keratohyalin
  - Keratin = tough fibrous protein component of hair and nails
  - Keratohyalin = forms dense granules that dehydrate the cell and aggregate cross-linking of the keratin fibers
- Also contains Langerhans cells
- Nuclei and other organelles disintegrate = Cell Death

# Stratum Lucidum

- ONLY found in thicker epidermis – palms, soles, callus
- Completely keratinized (and dead!)
- Contains closely packed, clear cells that contain gel-like substance eleiden

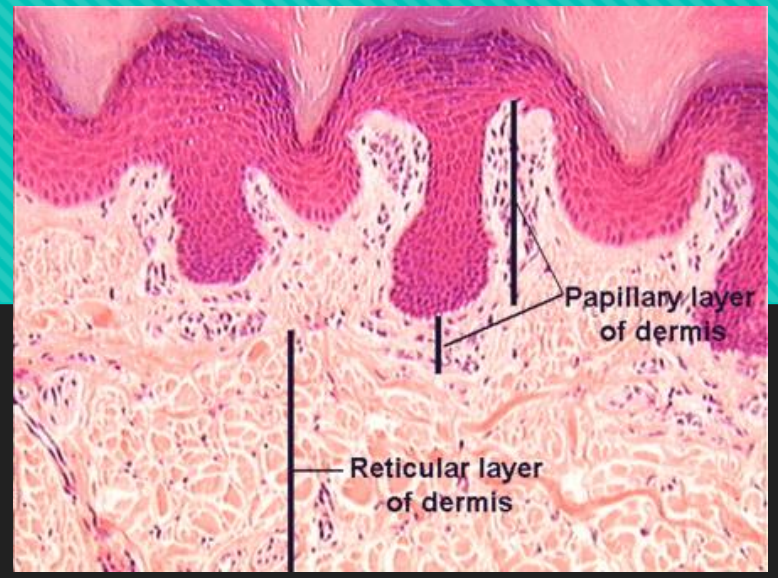
# Stratum Corneum

- Outermost layer – Exposed Skin
- Also completely keratinized
- Dead cells
  - Remain in this layer for two weeks before they are shed
- Tough, waterproofing protection

# Dermis

- Middle layer of skin – your "hide" – like leather
- Contains hair follicles, glands, nerves, vessels, and muscle

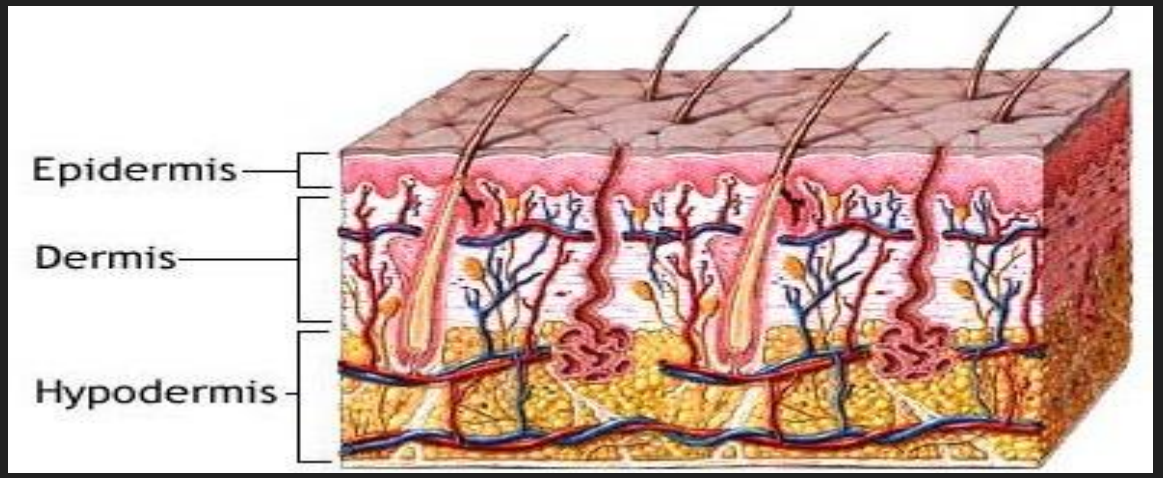
# Layers of the Dermis




- Mainly strong, flexible connective tissue – 2 layers
  1. Papillary Layer
     - Upper region
     - Uneven and has fingerlike projections called dermal papillae that create fingerprints and are important for grip
     - Contain capillaries, pain receptors (free nerve endings), and touch receptors called *Meissner's corpuscles*
  2. Reticular Layer
     - Deepest skin layer
     - Contains blood vessels, adipose (fat) sweat and oil glands, and deep pressure receptors

# Hypodermis

- Not usually part of the skin
- Also called subcutaneous layer
  - Site of subcutaneous injections – absorbed directly into the blood stream
- Anchors skin to underlying organs, bones, and muscles
- Shock absorption and insulation
- Composed mostly of adipose tissue
- Very vascular



# Skin Color

- Skin color is determined by 3 factors:
  1. 3 Types of pigments present
     1. Melanin
        - Brown, black, or yellow
     2. Carotene
        - Orange-yellow pigment from some vegetables
        - Vitamin A precursor – vitamin A forms retinal which is needed for sight
        - Accumulates in adipose and stratum corneum cells
     3. Hemoglobin
        - Red, oxygen-carrying pigment in erythrocytes
        - More obviously detected in fair skin
  2. Blood circulation
  3. Stratum corneum thickness

# Skin Color

- People who produce a lot of melanin have brown-toned skin
- The crimson color of oxygen-rich hemoglobin gives the skin a rosy color
- When hemoglobin is poorly oxygenated, the skin appears blue – a condition called cyanosis
  - Common during heart failure and severe breathing disorders

# Skin Color Signals Disease States

- Rubor
  - Redness or erythema
    - Embarrassment (Blushing)
    - Fever
    - Hypertension
    - Inflammation
    - Allergy

# Skin Color Signals Disease States

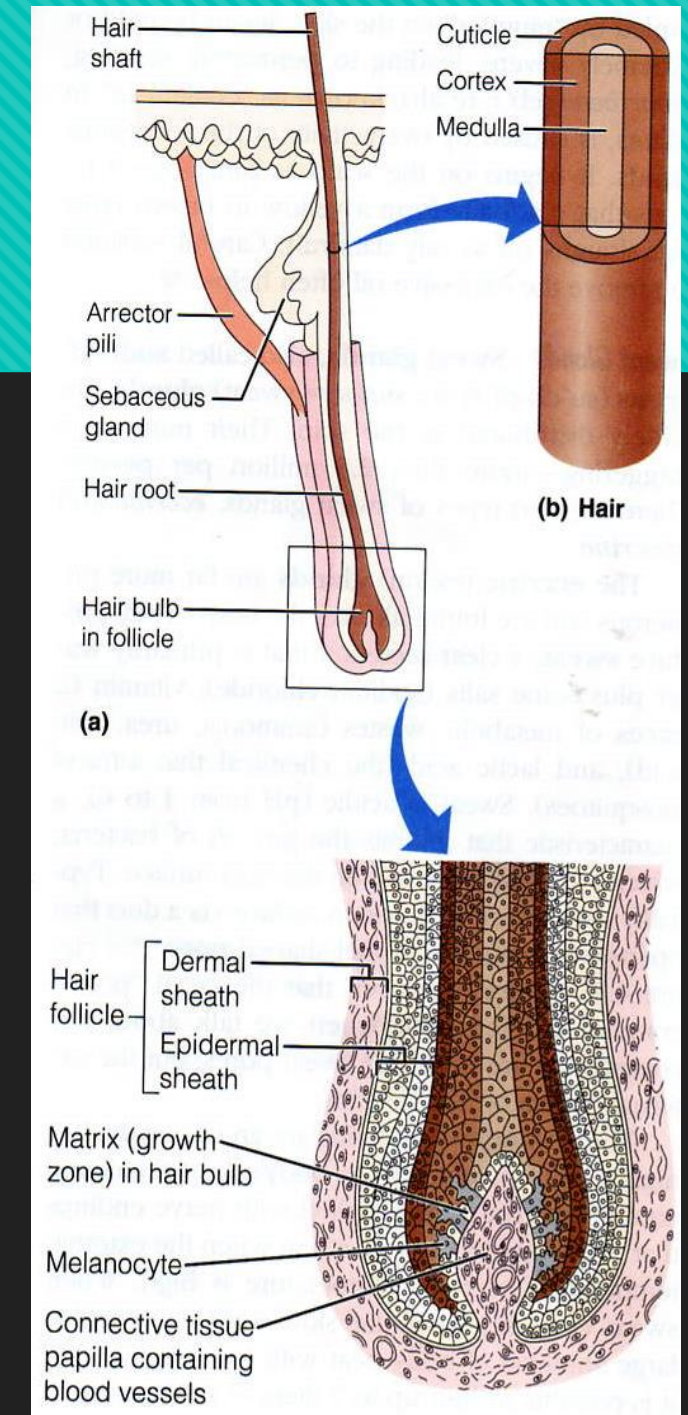
- Pallor or Blanching
  - Emotional stress (fear, anger, and others)
  - Pale skin may also signify anemia , low blood pressure, or impaired blood flow into the area
- Jaundice
  - A yellow-case
  - Liver disorder in which excess bile pigments is in the blood
- Bruises
  - Sites where blood has escaped and has clotted in the tissue spaces
    - Called hematomas
  - Unusual bruising may signify a deficiency of vitamin C or hemophilia

# Hair

- Millions of hairs all over the body
  - Guards head
  - Shields eyes (eyelashes)
  - Keeps foreign particles out of the respiratory tract (nose hairs)

# Hair

- A hair is produced by a hair follicle
- Structure of Hair
  - Shaft – protects skin
  - Follicle – extends into dermis
  - Root – lies within the follicle
  - Bulb – growth zone at the inferior end of the follicle
  - Sebaceous Gland – lubricates hair
  - Arrector Pili Muscle – attached to follicle and contracts to move hair (growth or goosebumps)



# Hair Growth

- Influenced by (in this order)
  - Nutrition – main influence
  - Hormones
  - Blood flow
- Baldness (alopecia)
  - Male pattern baldness – sex-linked recessive genetic trait
  - Thinning – can be caused by medications, nutrition, stress

# Hair Pigment

- Caused by proportions of 3 melanin types:
  1. Dark Hair = true melanin
  2. Blonde & Red Hair = melanin with iron and sulfur
  3. Gray/White Hair = melanin replaced by air bubbles in shaft

# Nails

- Scale-like modification of the epidermis
- Heavily keratinized
- Stratum basale extends beneath the nail bed to form the nail matrix
  - Responsible for growth (matrix region)
- Lack of pigment makes them colorless
- Lunula “little moon” – area of cell growth (white semicircle at base of nail)
- Cuticle – area of skin that covers base of nail

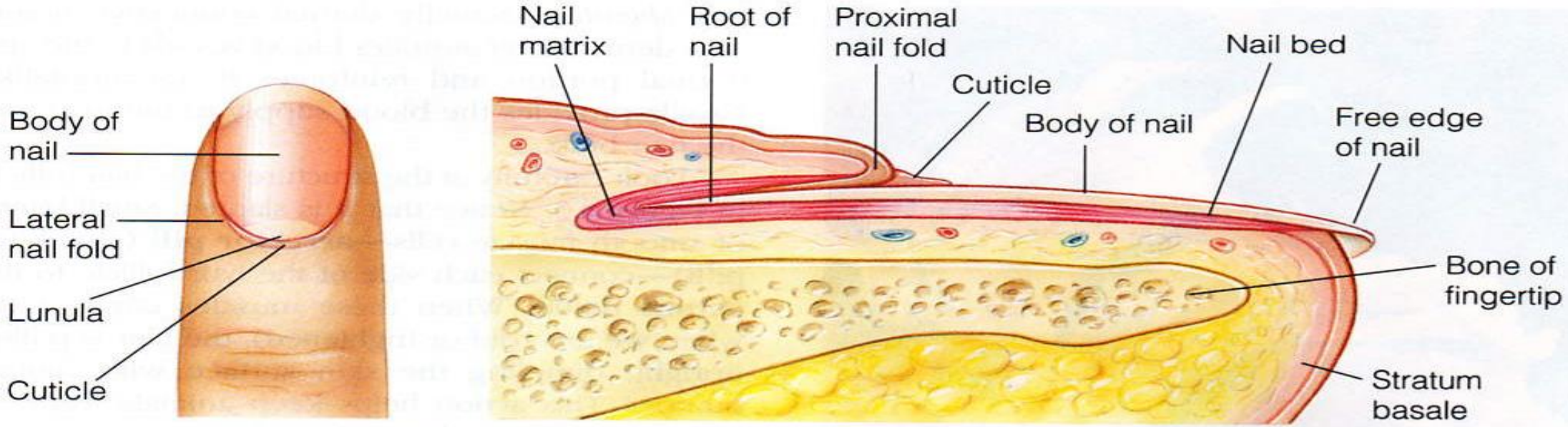


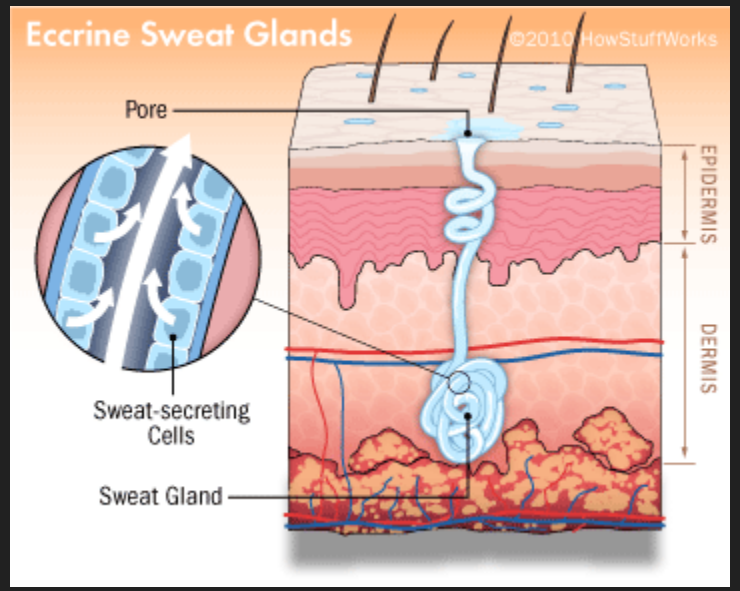

**Figure 4.7** **Structure of a nail.** Surface view (left) and longitudinal section of the distal part of a finger (right), showing nail parts and the nail matrix that forms the nail.

# Glands of the Body

- Cutaneous Glands
  - All are exocrine glands
- Exocrine Glands
  - Release secretions to surface via ducts
- 2 Groups:
  1. Sweat Glands
  2. Sebaceous Glands
- Both formed by stratum basale and push into dermis

# Sweat Glands

- More than 2.5 million per person
- 2 Primary Types
  - Eccrine Glands
    - Widely distributed in skin; abundant on palms, soles, and forehead
    - Sweat composition: mostly water with a slightly acidic 4-6 pH
    - Function: thermoregulation

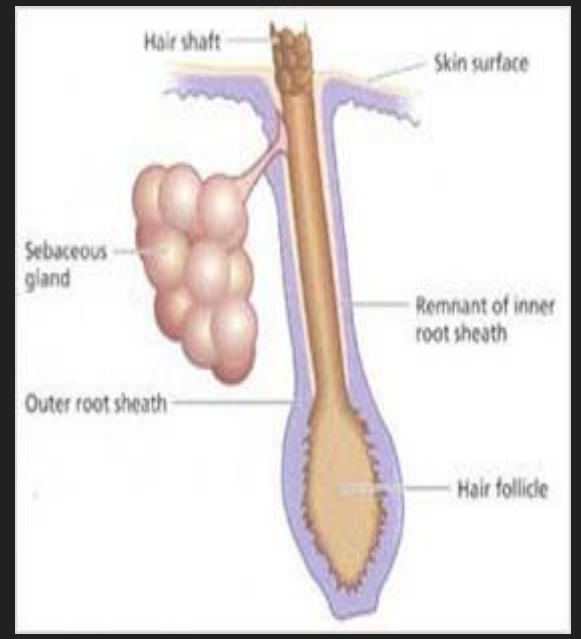


# Sweat Glands

- Apocrine Glands
  - Ducts empty into hair follicles
  - Found mainly in anogenital and axillary region
  - Begin to function at puberty due to hormones/pheromones
  - Organic contents: fatty acids and proteins – can have a yellowish color that stains clothes
  - Odor is from associated bacteria
  - Ceruminous Glands
    - Modified apocrine gland
    - Found in outer 1/3 of ear canal
    - Produce ear wax to trap "invaders"

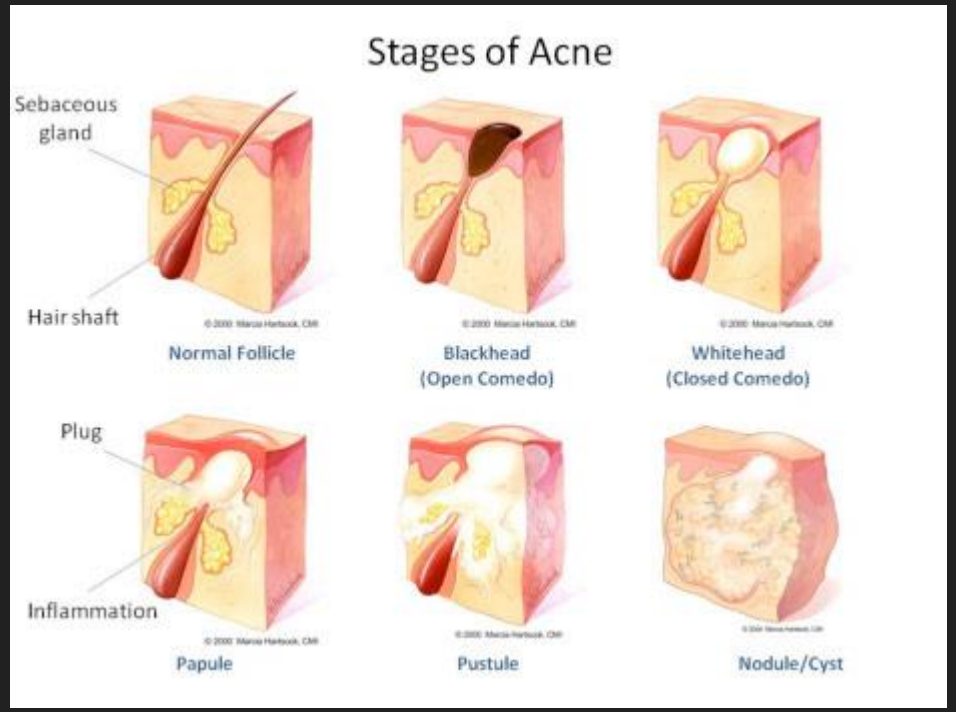
# Sebaceous (Oil) Glands

- All over except palms and soles of feet
- Produce oil for waterproofing
- Lubricant for skin and kills bacteria
- Most with ducts that empty into hair follicles
  - Some open onto skin surface in lips, eyelids, genitalia
- Sebum (seb = grease)
  - Mixture of oily substances and fragmented cells
- Glands are activated at puberty → stimulated by hormones



# Sebaceous (Oil) Glands

- Acne
  - Active infection of sebaceous glands
  - Can be mild or extremely severe
- Whitehead
  - A sebaceous gland's duct becomes blocked by sebum
- Blackhead
  - Accumulated material oxidized, dries, and darkens



# Skin Diseases & Disorders

- The most common skin disorders result from allergies or bacterial, viral, or fungal infections.
- Homeostatic imbalances of the skin

# Common Skin Disorders

- Acne = disease of sebaceous glands
- Alopecia = hair loss
- Tinea pedis = athletes foot
- Carbuncle = bacterial infection like a boil but subcutaneous
- Cyst = liquid filled sac
- Dermatitis = inflammation
- Eczema = non-contagiuous skin rash
- Impetigo = contagious bacterial infection causes eruption
- Moles = (nevi) tumors that are pigmented
- Pediculosis = lice
- Pruritis = itching without eruption
- Scabies = mites
- Shingles = (Herpes Zoster) virus causes blisters at nerve path

# Contact Dermatitis

- Itching, redness, and swelling of the skin, &blistering.
- Caused by exposure of the skin to chemicals
- Ex: poison ivy
  - Provokes an allergic response

# Psoriasis

- Chronic condition
- Reddened epidermal lesion- covered with dry, silvery scales
- When severe, may be disfiguring
- Cause unknown; may be hereditary in some cases
- Attacks often triggered by trauma, infection hormonal changes, and stress.


# Athlete's Foot

- *tinea pedis*
- Itchy, red, peeling skin between the toes, resulting from a fungal infection
- Athlete's Foot Tips From The APMA
  - Avoid walking barefoot; use shower shoes
  - Reduce perspiration by using talcum powder
  - Wear light and airy shoes
  - Wear socks that keep your feet dry, and change them frequently if you perspire heavily

# Boils and Carbuncles

- Inflammation of hair follicles and sebaceous glands,
- Common on the dorsal neck
- Carbuncles are composite boils
- Typically caused by the bacterial infection (*Staphylococcus aureus)*

# Cold Sores

- Fever blisters
- Small fluid-filled blisters that itch and sting
- Caused by herpes simplex virus
  - Virus localizes in a cutaneous nerve
- Remains dormant until activated by emotional upset, fever, or UV radiation
- Cold sores usually occur around the lips and in the oral mucosa of the mouth

# Impetigo

- Pink, water-filled, raised lesions
- Common around the mouth and nose
- Develop a yellow crust and eventually rupture
- Caused by a highly contagious staphylococcus infection
- Common in elementary school-aged children

# Necrotizing Fasciitis

- Severe type infection that involves the skin, subcutaneous fat, and muscle fascia
- Caused by several bacteria both aerobic and anaerobic
- The most severe kind is caused by a virulent *streptococcus* species
- Infection usually enters through the skin and releases toxins that:
  1. Directly kill tissue
  2. Interfere with blood flow to tissue
  3. Digest materials in tissue and allows bacteria to spread rapidly
  4. Cause widespread effects, i.e. shock

# Necrotizing Fasciitis Symptoms

- Infection begins as a small reddish painful spot or bump on the skin
- It quickly changes to a brown or purplish patch, the center of the wound will begin to turn black (dead cells)
- The wound will visibly expand in less that 1 hour
- Symptoms include sweating, chills, nausea, dizziness, profound weakness, and finally shock.  Without treatment death occurs rapidly
- Many times the patient requires a surgeon to diagnose by culture of wound drainage

# Necrotizing Fasciitis Treatment

- Powerful, broad spectrum anti-biotic administered IV immediately and immediate surgery required to open and drain infection and debride dead material
- Skin grafts are required after infection is cleared
- Infection in a limb and is not containable = amputation
- Prognosis
  - Outcomes vary, depending on organism, rate of spread, susceptibility to antibiotics and how early infection is diagnosed
- Complications
  - Sepsis, scarring and disfigurement, loss of limb, and death
- The disease untreated has 100% mortality

# Basal Cell Carcinoma

- Least malignant
- Most common skin cancer
- Cells of the stratum basale are altered so that they cannot form keratin & no longer honor the boundary between epidermis and dermis
  - They proliferate, invading the dermis and subcutaneous tissue.
- Lesions occur most often on sun-exposed areas of the face
- Appear as shiny, dome-shaped nodules that later develop a central ulcer with a "pearly" beaded edge
- Relatively slow-growing
- Metastasis seldom occurs before it is noticed
- Full cure is the rule in 99 percent of cases where the lesion is removed surgically

# Squamous Cell Carcinoma

- Arises from the cells of the stratum spinosum
- The lesion appears as a scaly, reddened papule (small, rounded elevation) that gradually forms a shallow ulcer with a firm, raised border
- Scalp, ears, dorsum of the hands, and lower lip
- Grows rapidly
- Metastasizes to adjacent lymph nodes if not removed
- Believed to be sun-induced
- If it is caught early and removed surgically or by radiation therapy, the chance of complete cure is good


# Malignant Melanoma

- Cancer of melanocytes
- Accounts for 5 percent of skin cancers
- Incidence is increasing
- It is often deadly
- Melanoma can begin wherever there is pigment
- Appear spontaneously, but some develop from pigmented moles
- Appears as a spreading brown to black patch that metastasizes rapidly to surrounding lymph and blood vessels
- Chance for survival is about 50 percent
- Early detection helps – the American Cancer Society suggests that sun worshippers periodically examine their skin for new moles or pigmented spots

# Malignant Melanoma

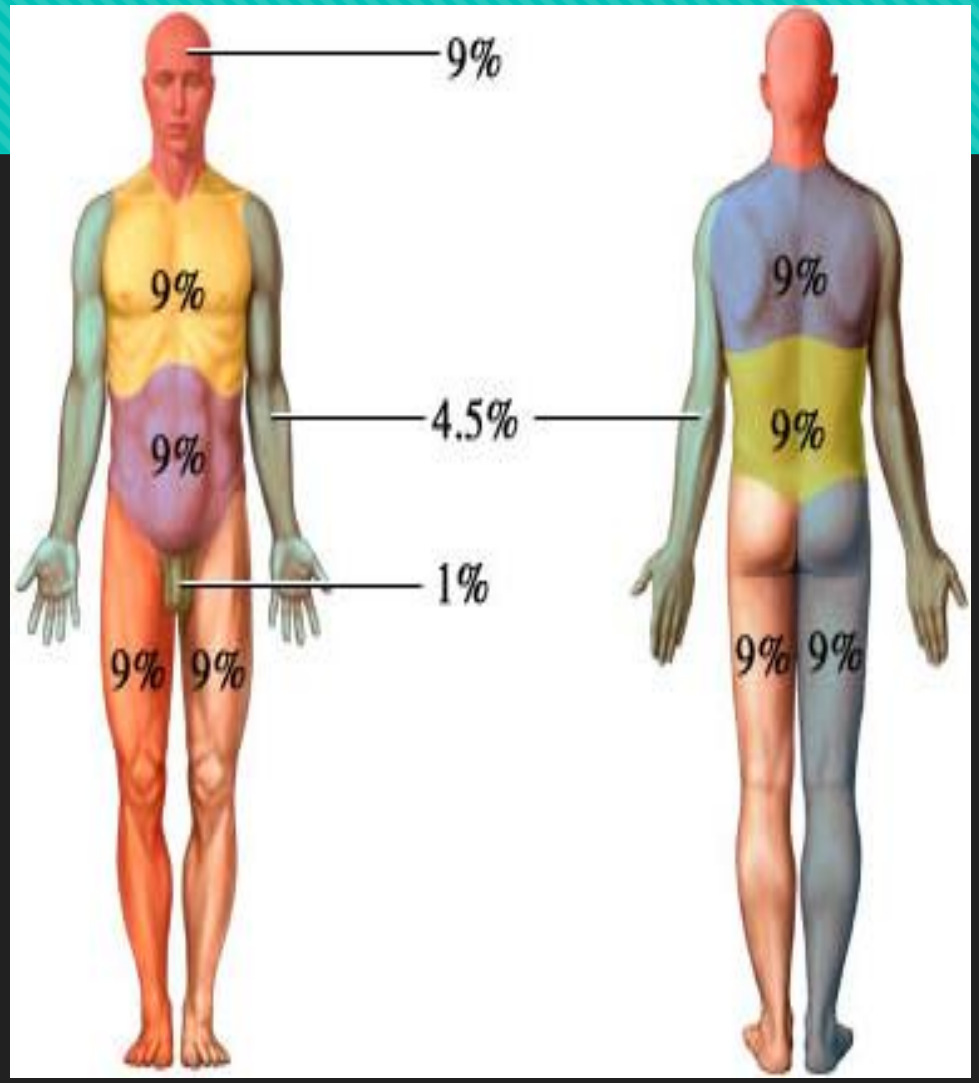
- Apply the **ABCD rule** for recognizing melanoma:
  - **Asymmetry:** the two sides of the pigmented spot or mole do not match.
  - **Border irregularity:** the borders of the lesion are not smooth but exhibit indentations.
  - **Color:** the pigmented spot contains areas of different colors (blacks, browns, tans, and sometimes blues and reds).
  - **Diameter:** the spot is larger than 6 rum in diameter (the size of a pencil eraser)
- The usual therapy for malignant melanoma is wide surgical excision along with immunotherapy

# Burns

- Protein denaturation and cell death caused by heat, electricity, UV radiation (sunburn), or chemicals
- 2 main dangers:
  1. Dehydration
     - Loss of fluids and electrolytes lead to
       - Renal shutdown
       - Circulatory shock
  2. Infection
     - Skin (mechanical) barrier lost
     - Immune system depresses

# Rules of Nines

- Way to determine extent of burns
  - Primary importance is to estimate fluids needed for rehydration
- Body is divided into 11 areas for quick estimation
  - Each area represents about 9%
- This along with cause of burn helps determine the severity



# First Degree Burns (Superficial Burns)

- Only epidermis is damaged
- Local redness, swelling, and pain
- Usually heal in 2-3 days (short time period) with NO scarring

# Second Degree Burns (Partial Thickness Burns)

- Epidermis, dermis, and structures within dermis are damaged
- Appearance of blisters of any size
- Skin regeneration in 3-4 weeks with some scarring
- There is a danger of infection
- Very painful

# Third Degree Burns (Full Thickness Burns)

- Epidermis, dermis, hypodermis, and all structures within are completely destroyed
- Usually painless at site of burn due to destruction of sense receptors
- Burn is gray-white, tan, brown, black, or deep cherry red
- Surrounded by areas of 1st & 2nd degree burns that are painful
- Treatments are numerous but will involve skin grafting of some sort, fluid replacement, and debridement

# Emergent Care

- Burning process stopped with removal of clothing & jewelry and covering affected area with cool water
- Increase blood volume with IV inserted in intact skin area
- Urinary catheter to monitor fluid output, indicates dehydration
- Intubation to secure an airway
- Vitals: BP, HR, BPM, Temp

# Complications of Major Burns

- Pulmonary injury; Stridor (whistling) with breathing
- Hypovolaemia – loss of plasma and decreased BP
- Hypothermia – with skin gone there is no thermoregulation
- Cardiac Arrhythmia – irregular heart beat
- Kidney Failure
- Death

# When Burns Are Critical…

- Any burn greater than 25% BSA
- Full or deep-partial-thickness burns greater than 10% BSA
- Burns complicated by a respiratory or airway injury
- Most burns involving the face, hands, feet or genitals
- Burns complicated by a fracture or major soft-tissue injury
- Electrical or deep-chemical burns
- Burns occurring in patients with serious pre-existing medical conditions