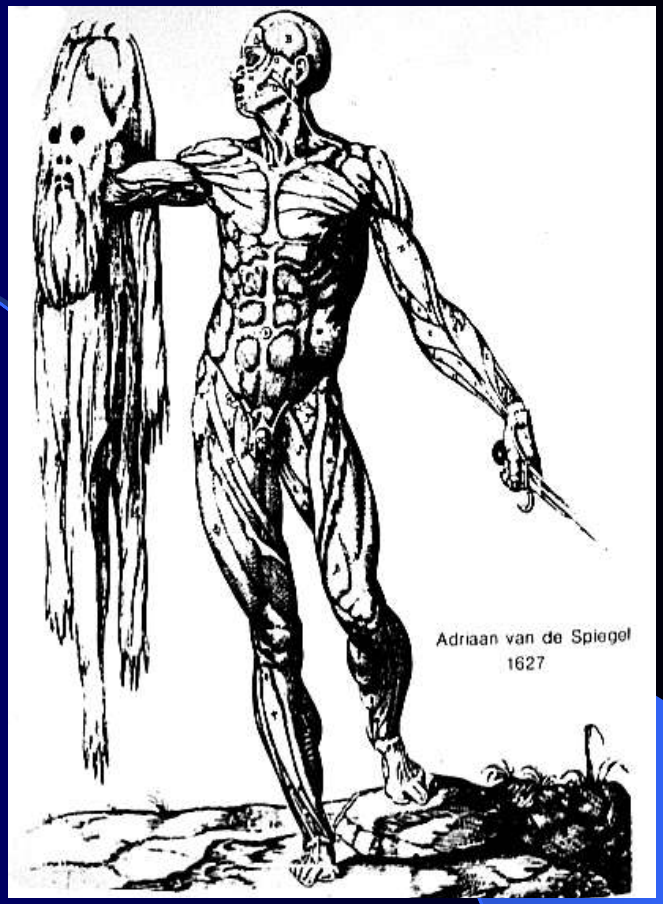
The Integumentary System

Anatomy and Physiology

A) General Anatomy

- consists of the skin (cutaneous membrane) + all the appendages (accessory structures) of the skin:
  - sweat glands
  - sebaceous glands (oil glands)
  - hair
  - nails

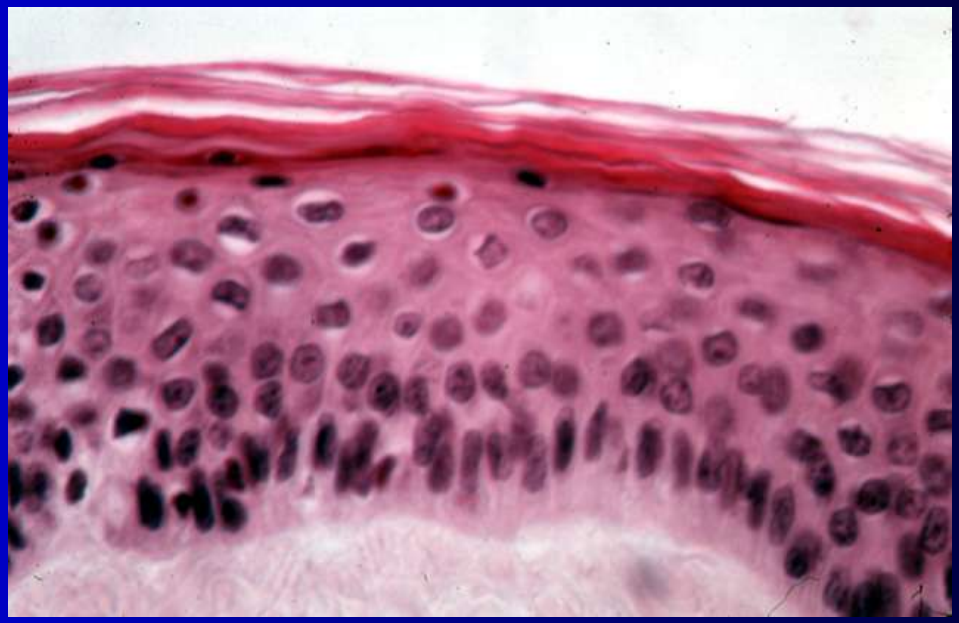


B) General Functions

- Protection from mechanical injury
- Physical protection of pathogen entry
- Chemical prevention of pathogen entry
- Sensation
- Thermoregulation
- Metabolic functions (e.g. Vitamin D production
- Looking good ☺

Major characteristics

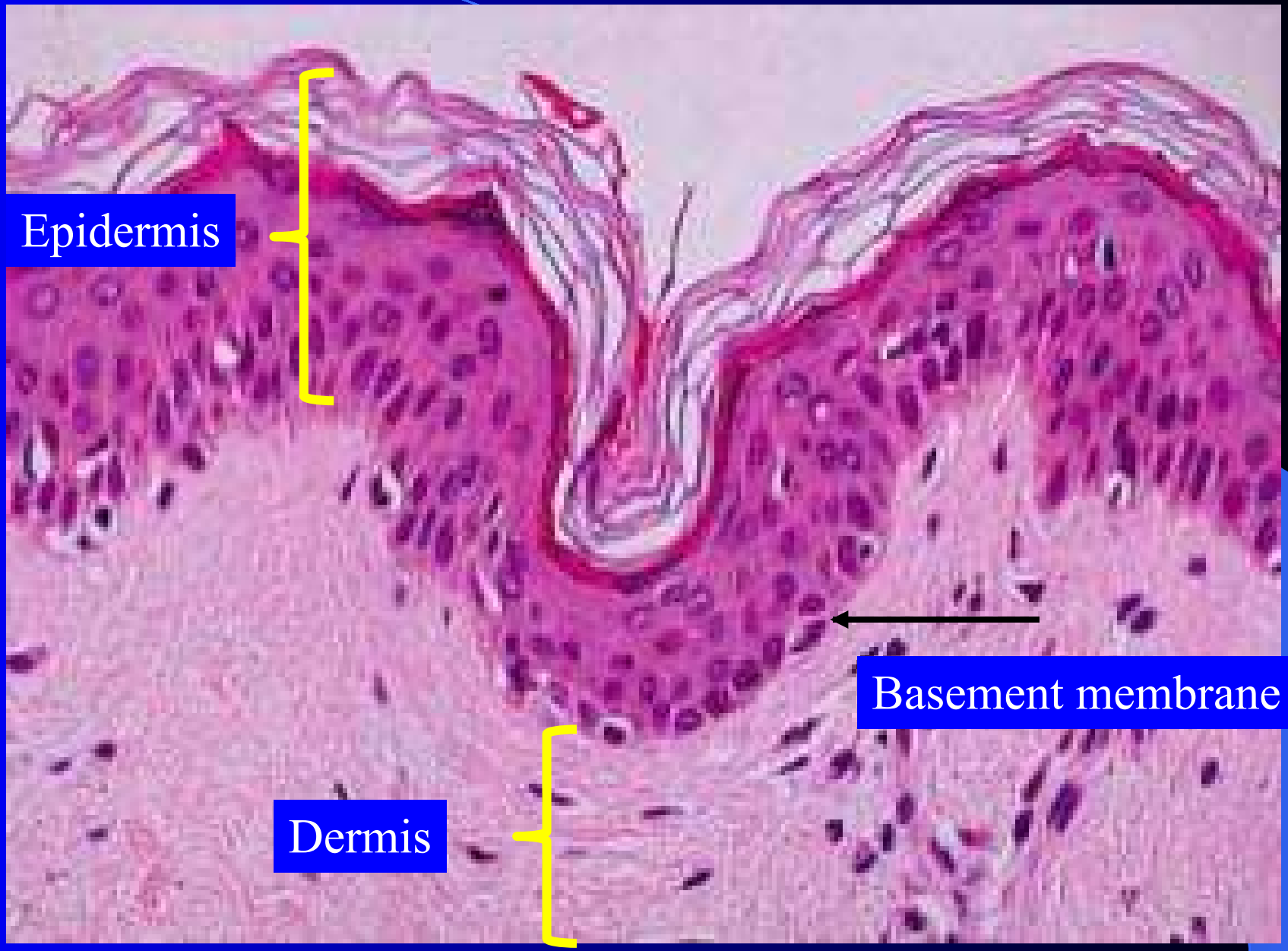
- Waterproof, stretchable, washable, repairs small cuts, rips and burns, guaranteed for a lifetime.
- Surface area of up to 2.2 square meters
- 11 pounds (7% of total body weight)



Skin layers: Overview

1. Epidermis (surface)
   - made of epithelial tissue (stratified squamous); 4-5 layers
   - Non-vascularized
2. Dermis (under epidermis)
   - Tough leathery layer of fibrous connective tissue
   - vascularized
   - contains accessory structures

3. Hypodermis (under dermis, not considered skin)
   - adipose and areolar tissue
   - stores fat, anchors skin, protects against blows


Epidermis
Basement membrane
Dermis

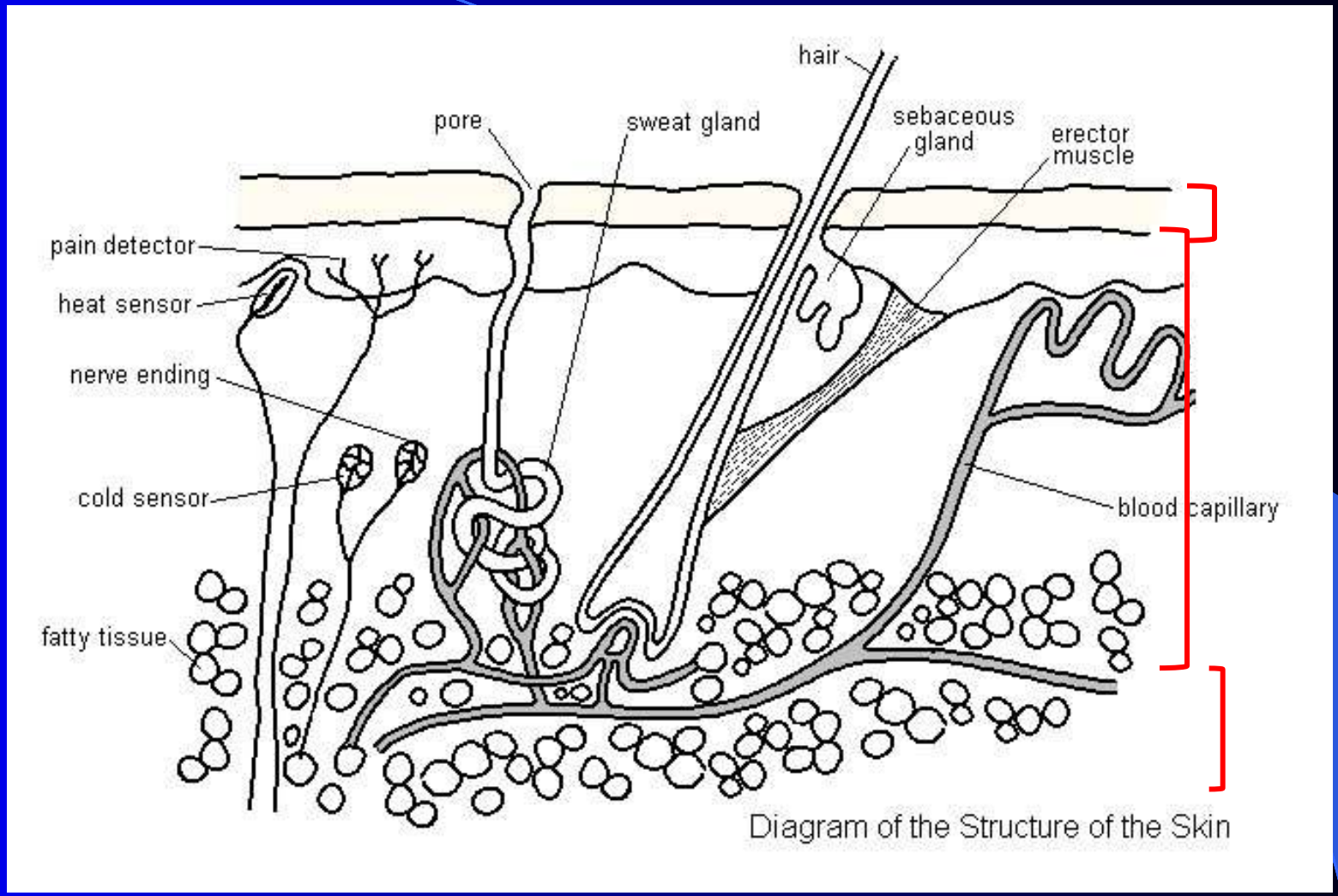
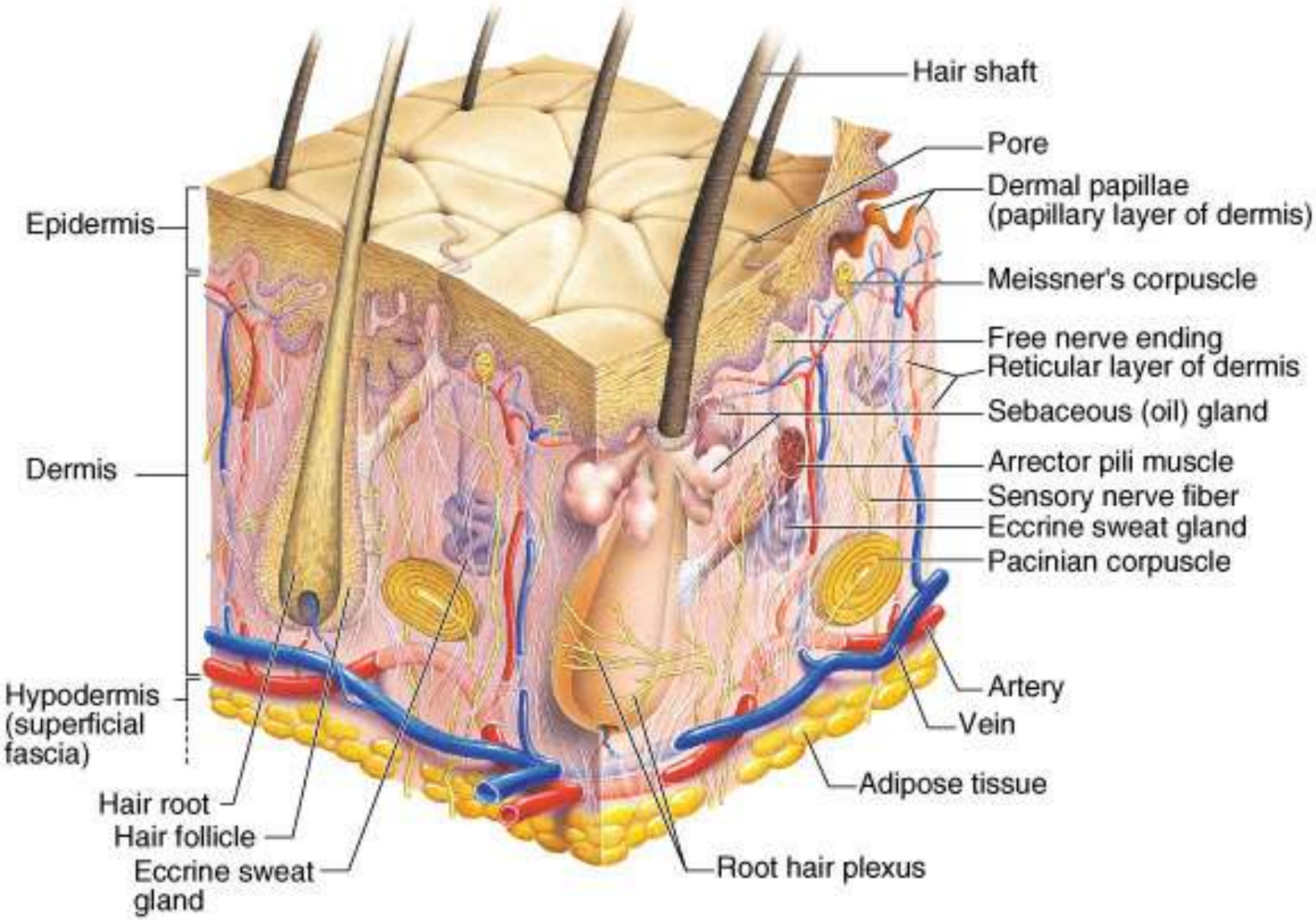
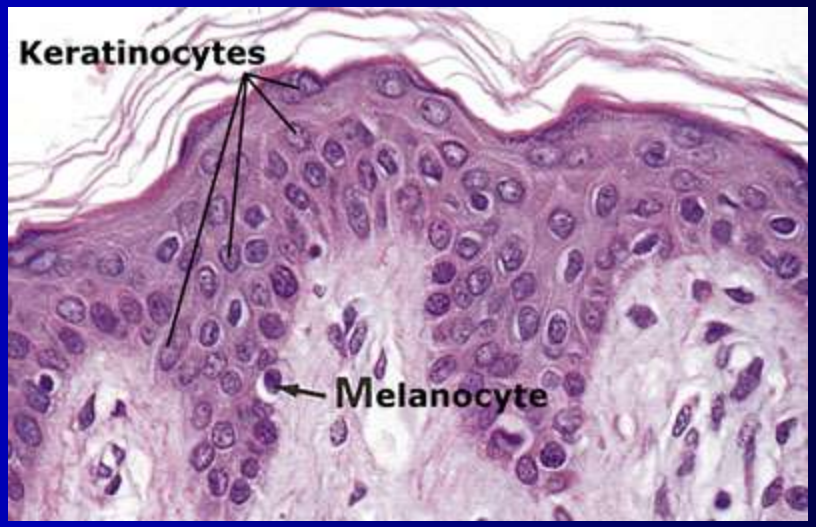


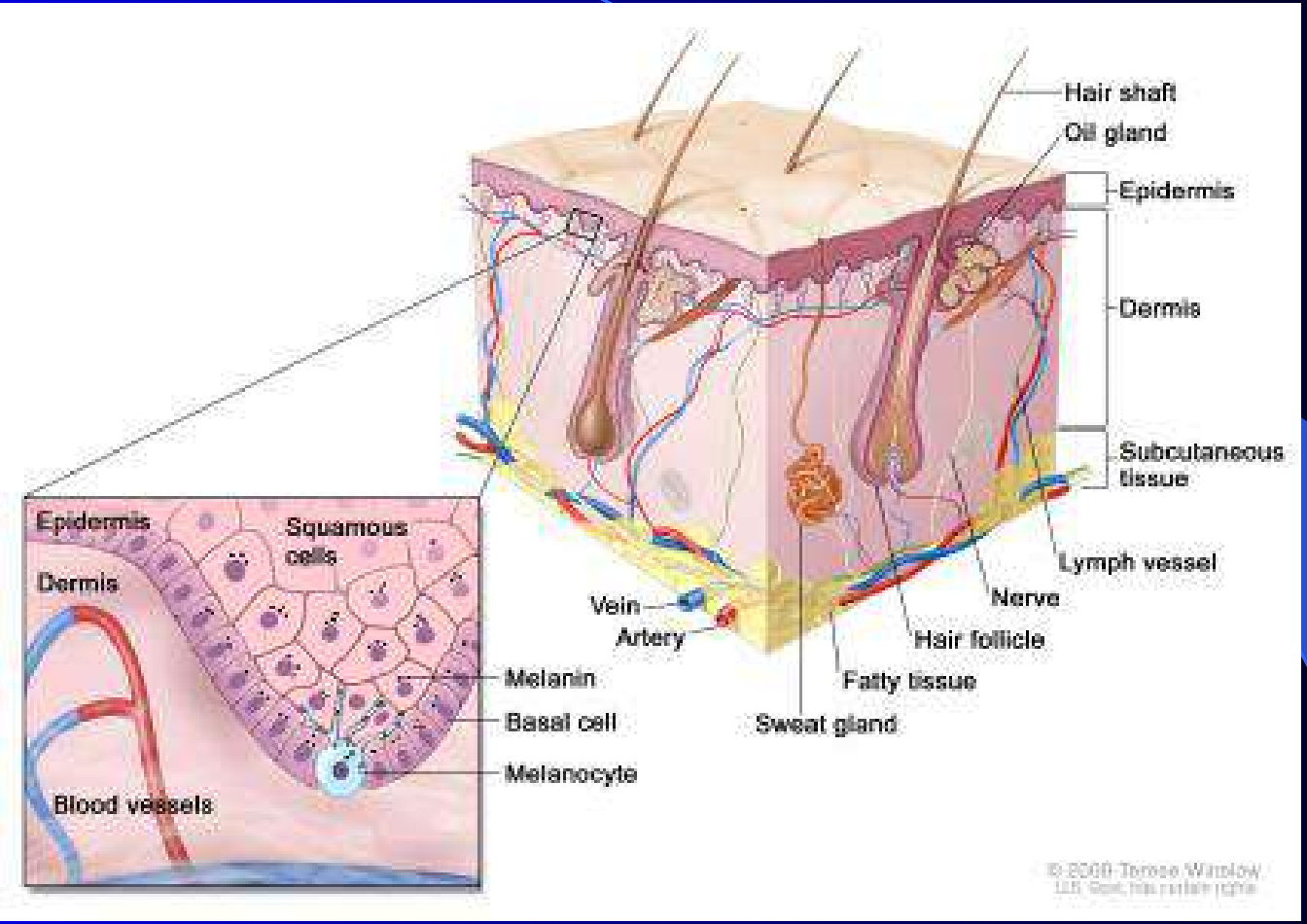
Diagram of the Structure of the Skin



Types of cells in the epidermis

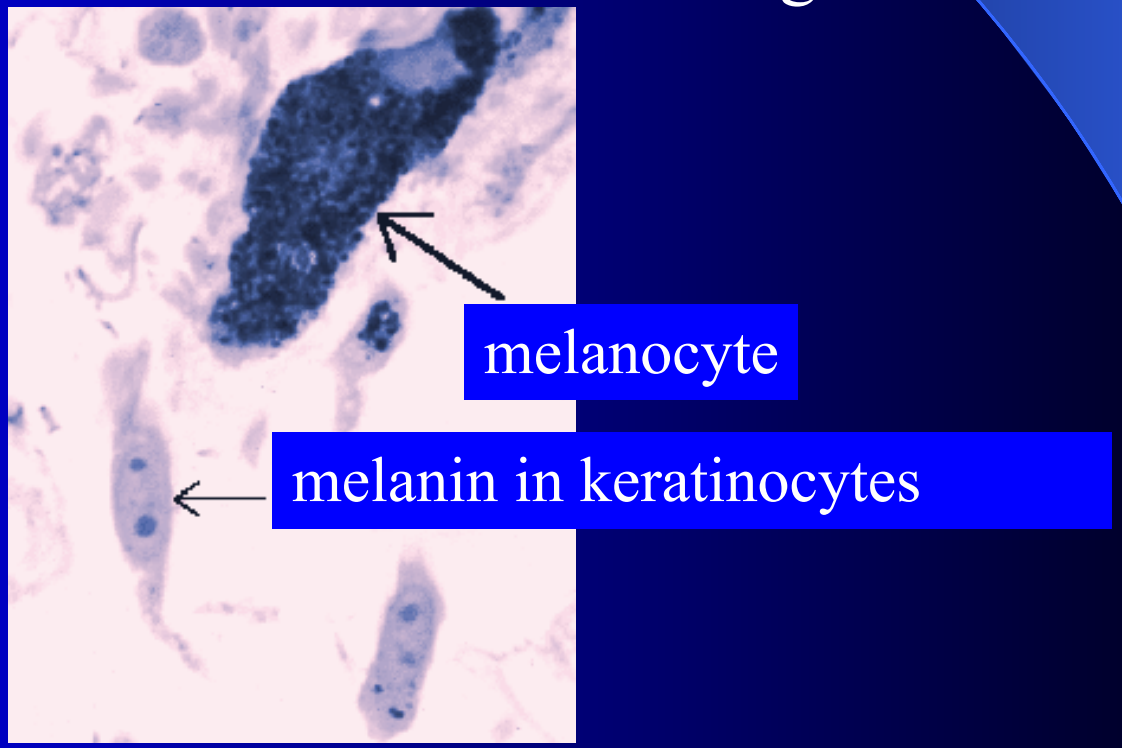
1. Keratinocytes
   - Produce a fibrous protein called keratin
   - formed in the lowest levels of the epidermis.
   - Pushed upward by the production of new cells beneath them.
   - Become dead and scale-like



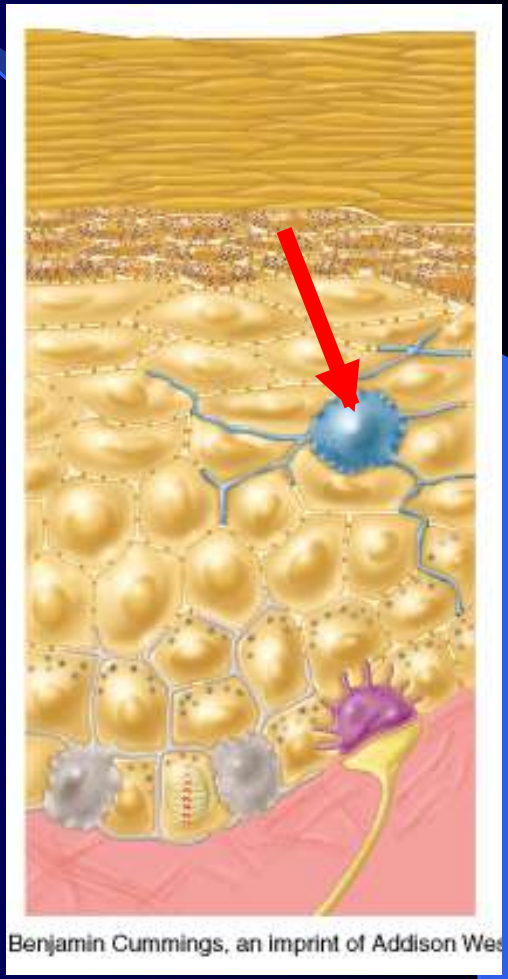

Hair shaft
Oil gland
Epidermis
Dermis
Subcutaneous tissue
Lymph vessel
Nerve
Hair follicle
Fatty tissue
Sweat gland
Vein
Artery
Epidermis
Squamous cells
Dermis
Melanin
Basal cell
Melanocyte
Blood vessels

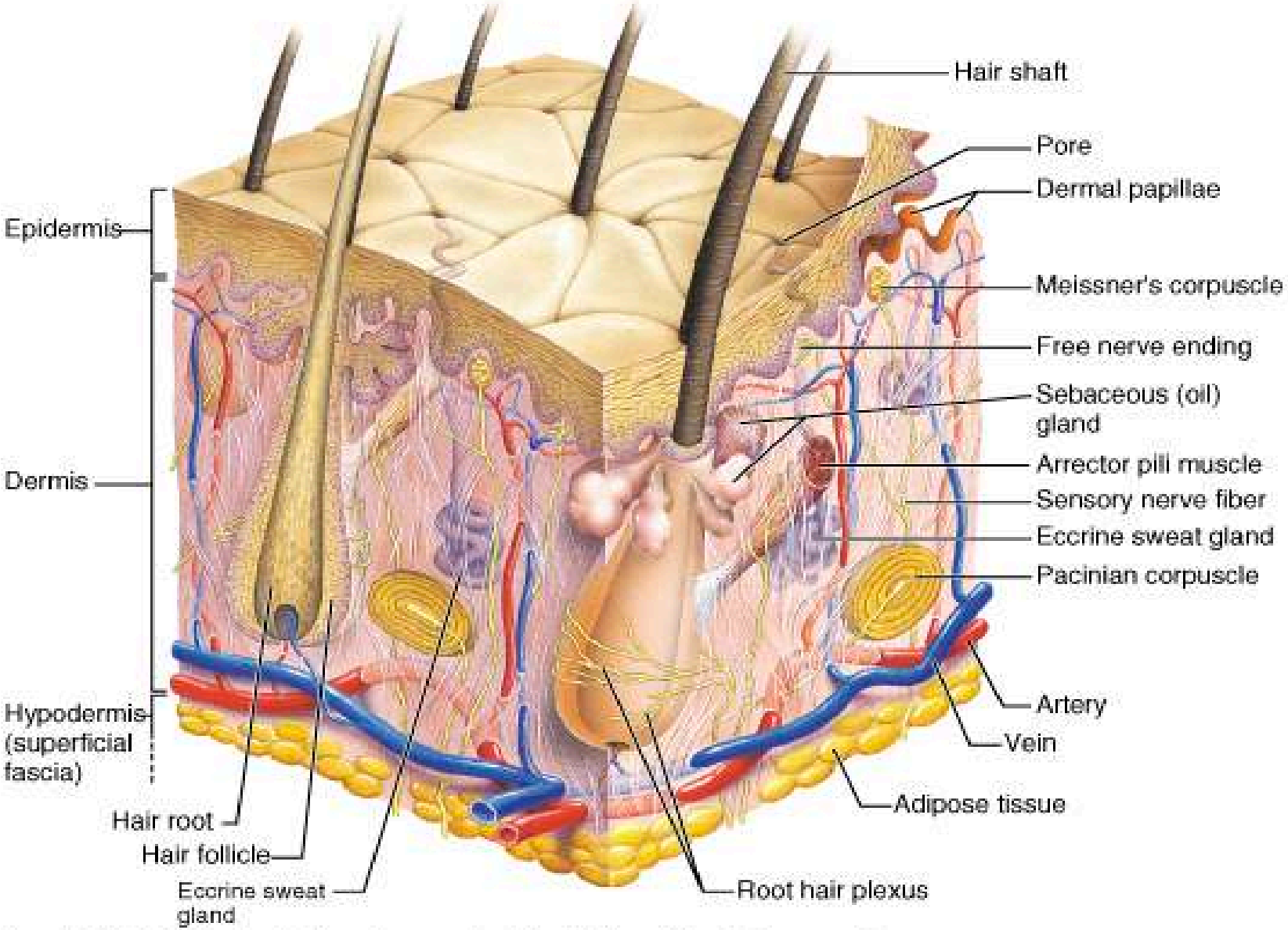
2. Melanocytes

- Synthesizes the pigment melanin (*"melan"* = black)
- Can transfer melanin to keratinocytes
- Protects skin from ultraviolet light.



3. Langerhans' cells
   - Formed in bone marrow and move to the skin
   - are macrophages
   - Serve as immune defense





Dermis

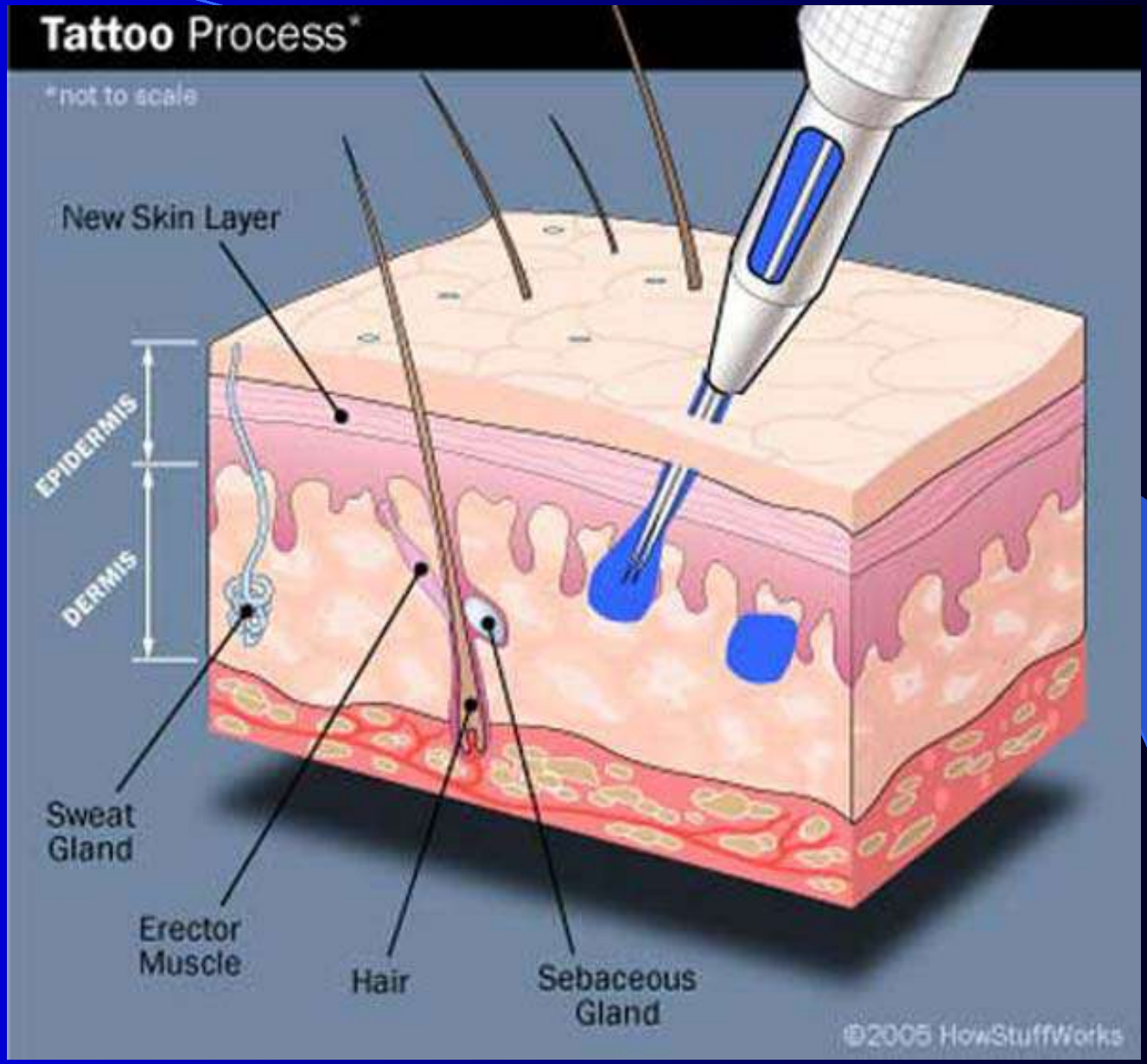
- Strong, flexible connective tissue
- Cell types: fibroblasts, macrophages
- Nerve fibers, blood and lymph vessels
- Location of the skin's appendages

a) papillary layer

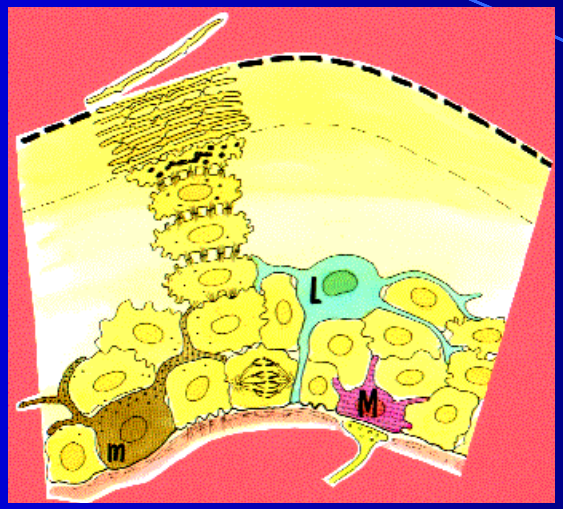
- superficial layer of dermis
- uneven due to ridges formed from the dermal papillae (= fingerprints)

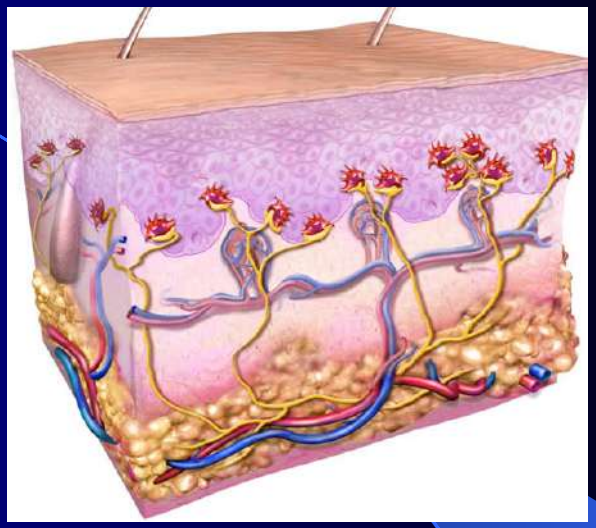
b) reticular layer

- deep (under) to papillary layer
- dense irregular fibrous connective tissue
- thick bundles of collagen fibers (for strength)


Tattoo Process*
*not to scale
New Skin Layer
EPIDERMIS
DERMIS
Sweat Gland
Erector Muscle
Hair
Sebaceous Gland
©2005 HowStuffWorks

Merkel cells are shown in red, and connect to nerves shown in yellow.





2. Cells in the Dermis

a) Merkel Cells

- have spiked appearance
- sensory receptors for touch & pressure (palms, soles, and lips)

b) Meissner's corpuscles

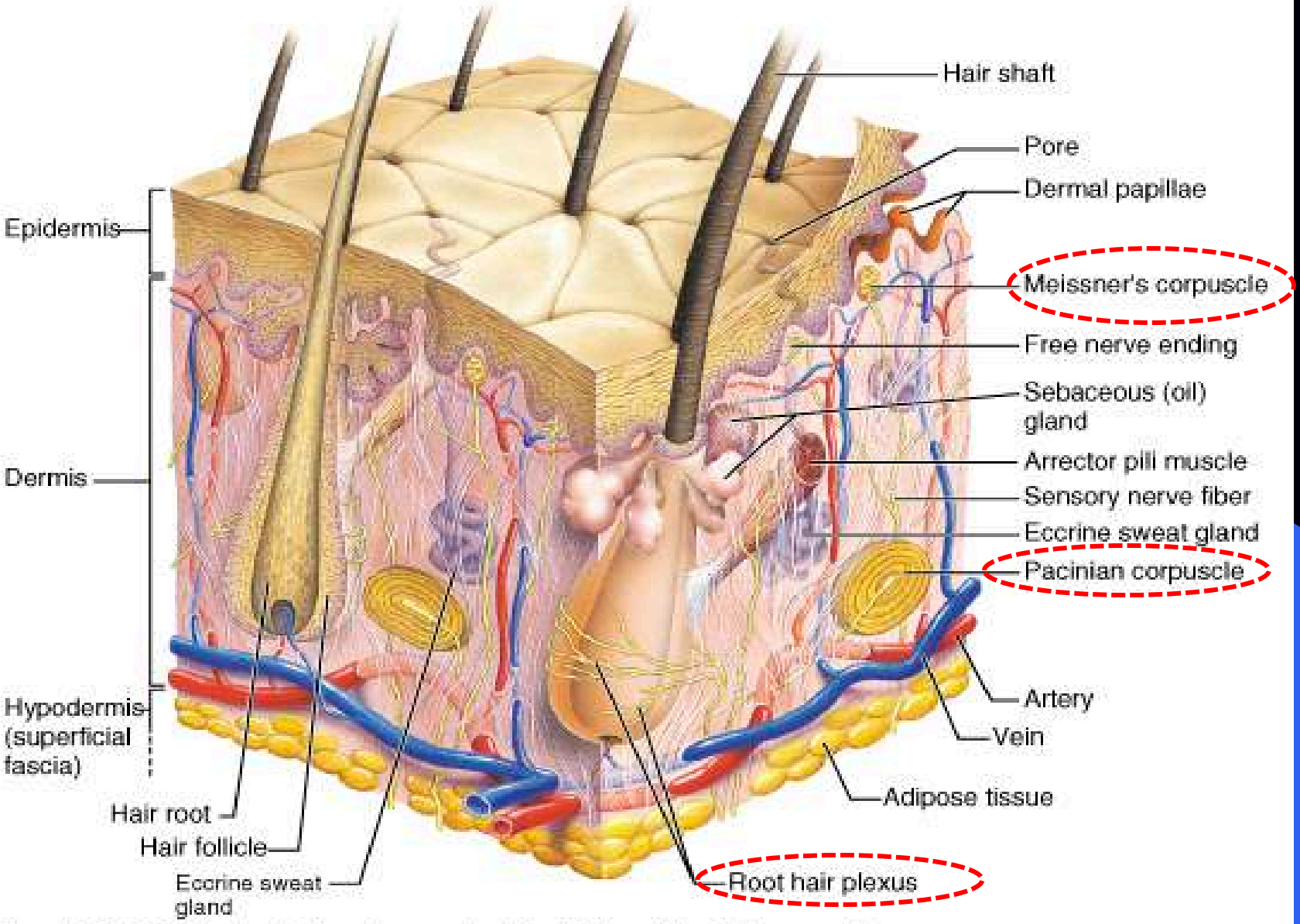
- receptors for light touch, vibration

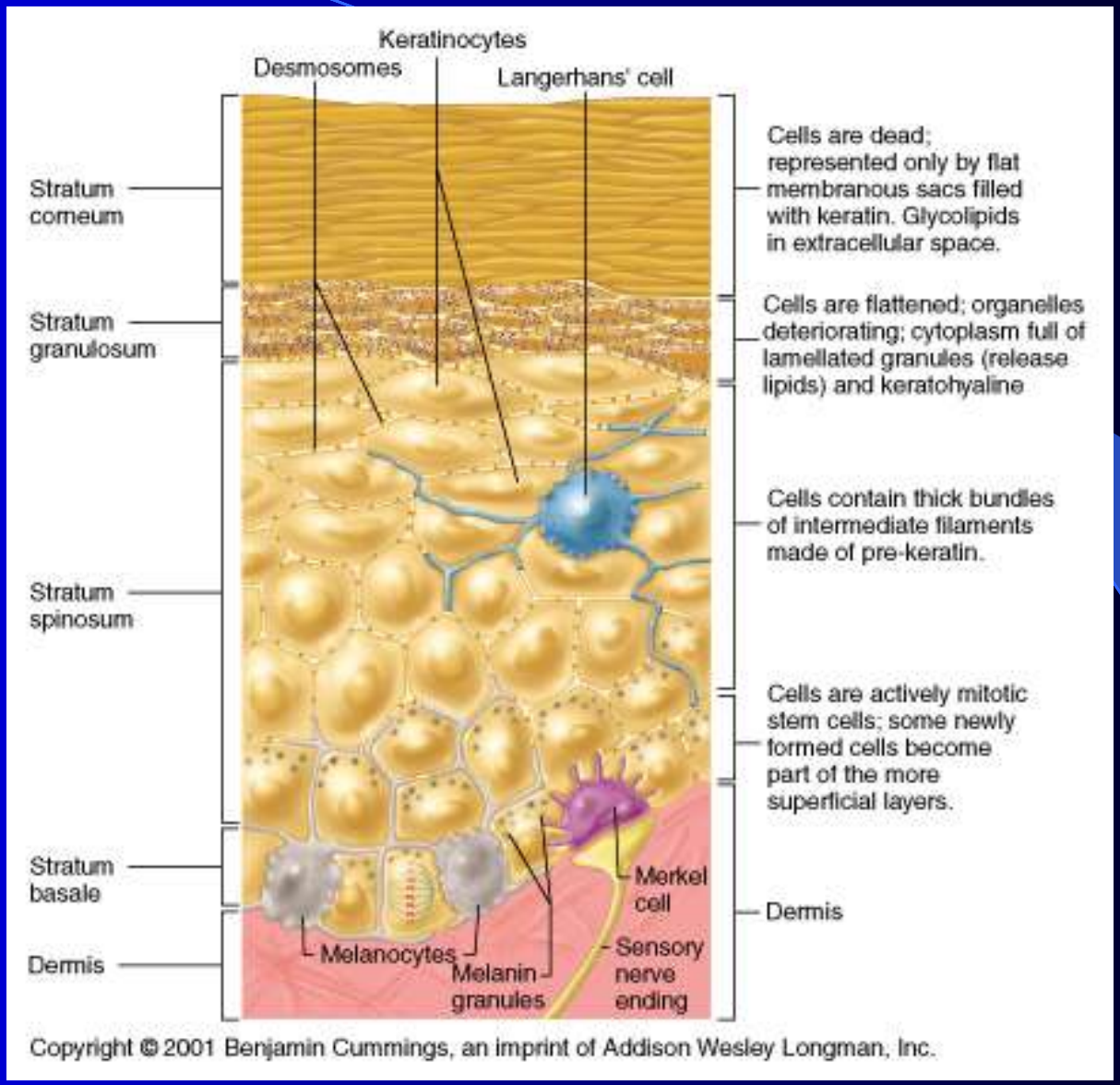
(dermal papillae of the fingertips, lips, eyelids, nipples, and genitalia)

c) Pacinian corpuscles (ellipsoidal shape)

– receptors for heavy pressure and vibration

(inner dermis and subcutaneous layers of fingertips, breast, and genitalia)

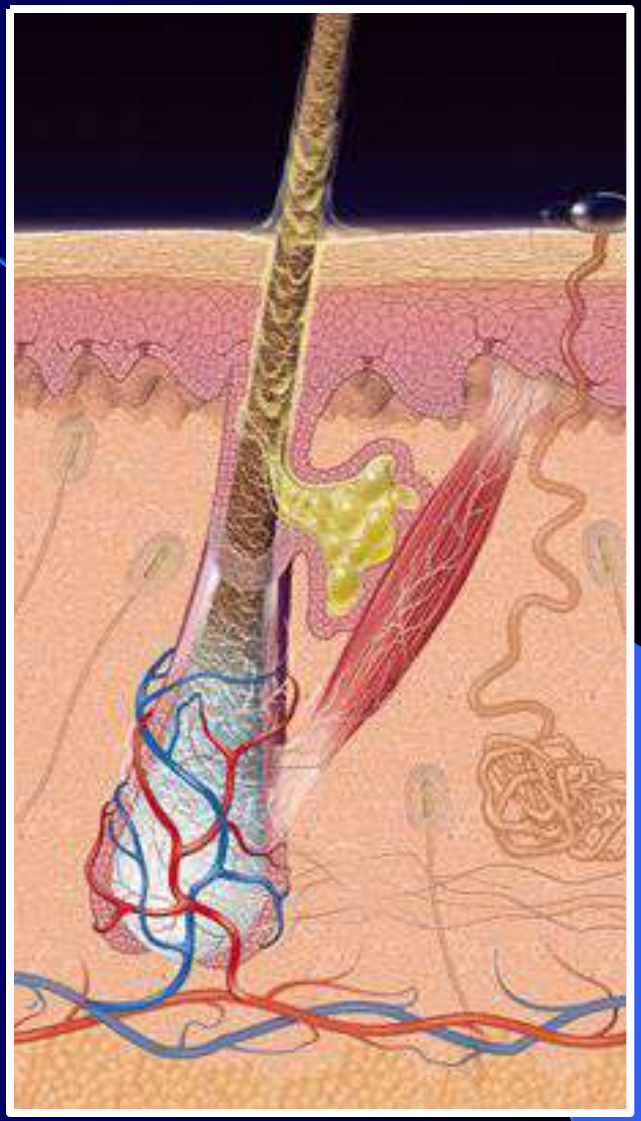




G) Appendages of the Skin

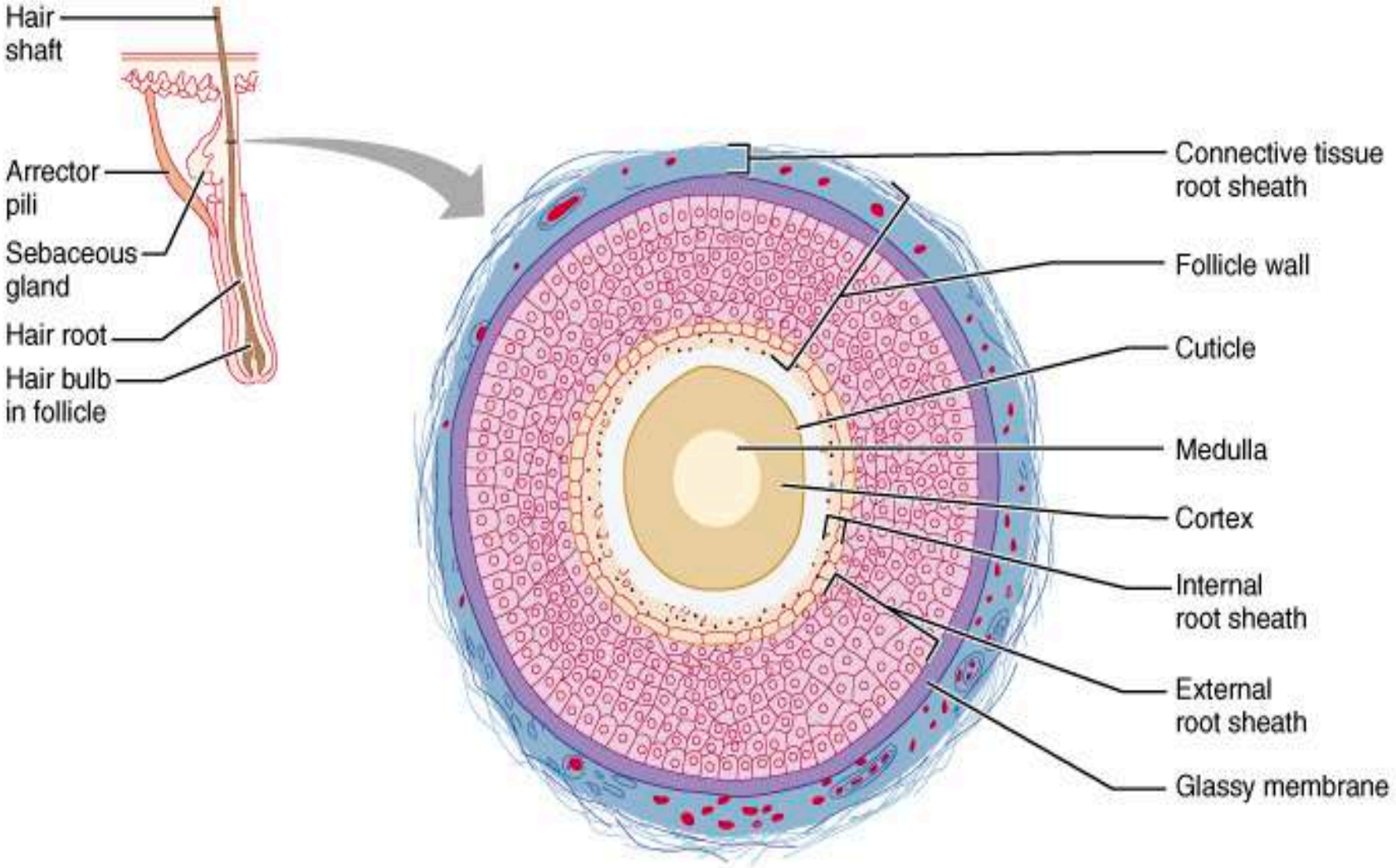
Overview

1. hair
2. nails
3. skin glands

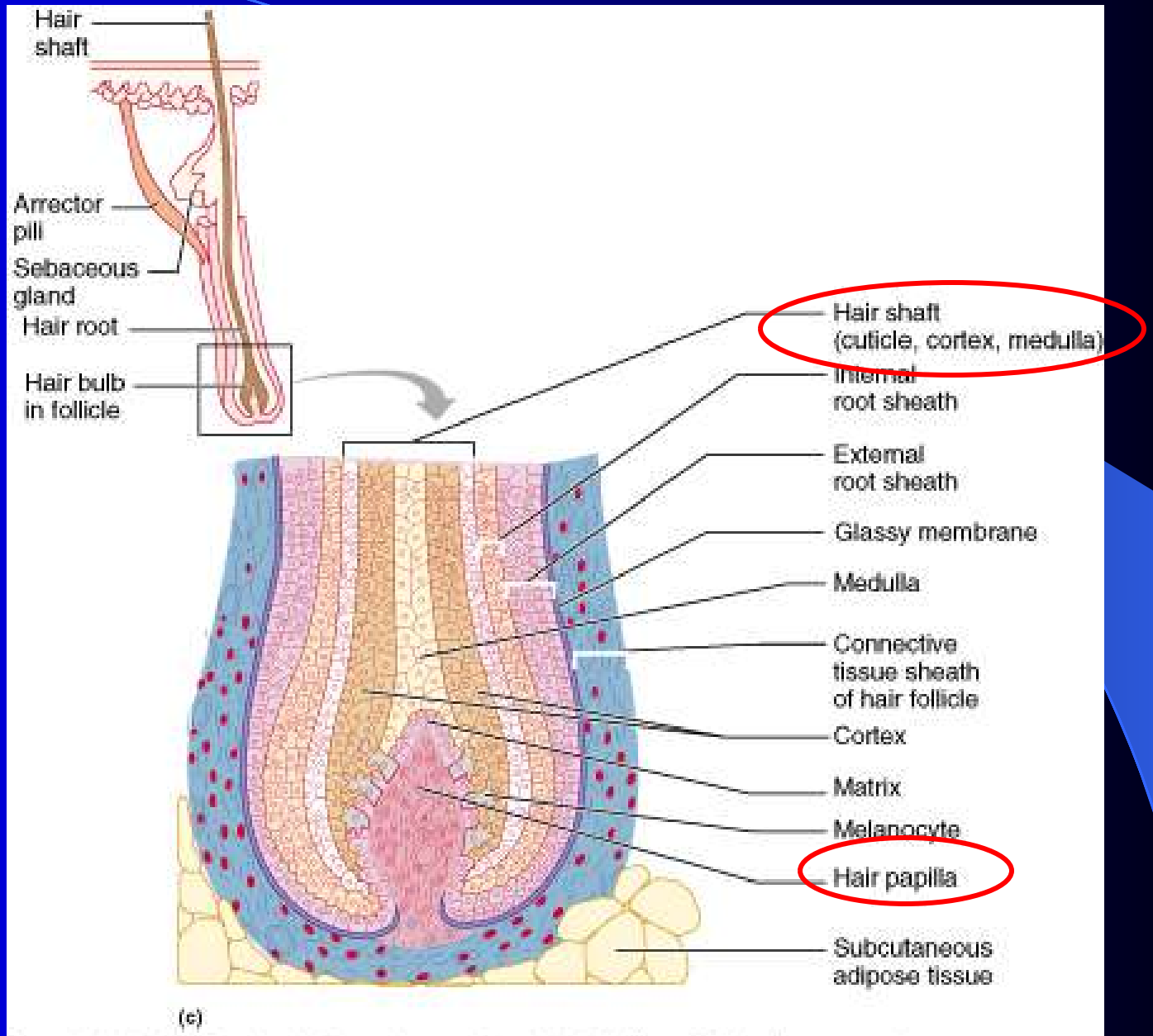


1) Hair

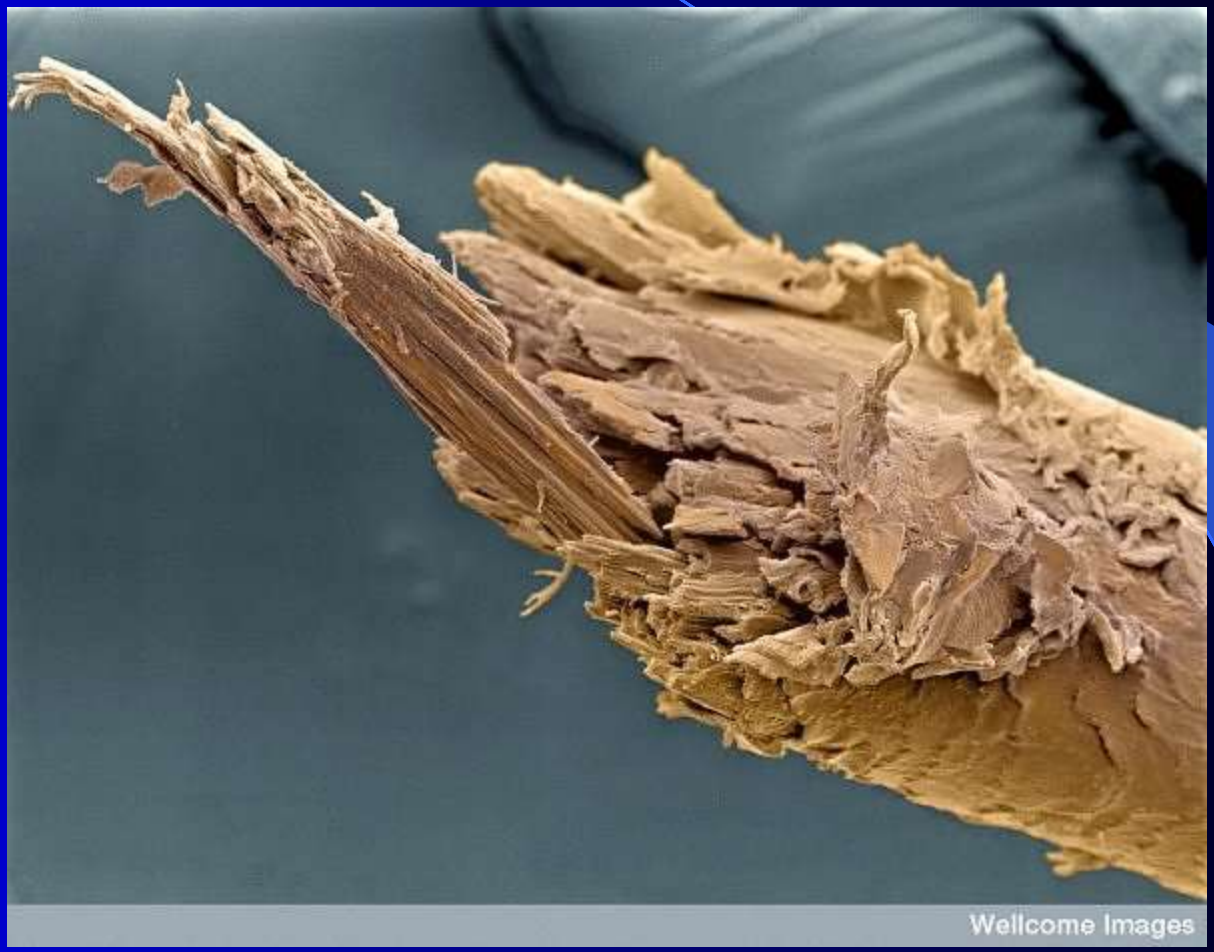
- location: hair follicles
- made of dead keratinized skin cells
- 2 parts: root and shaft



(a)



Split End of Human Hair

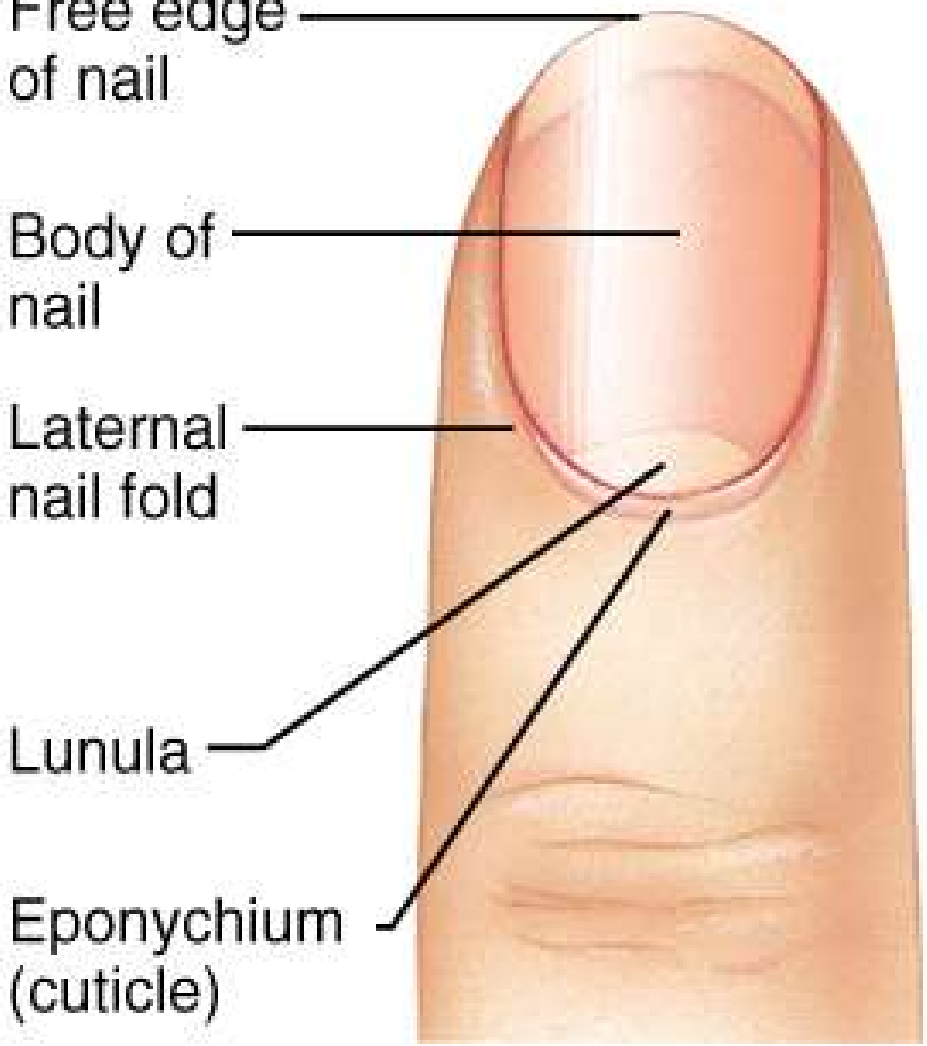


Functions of Hair

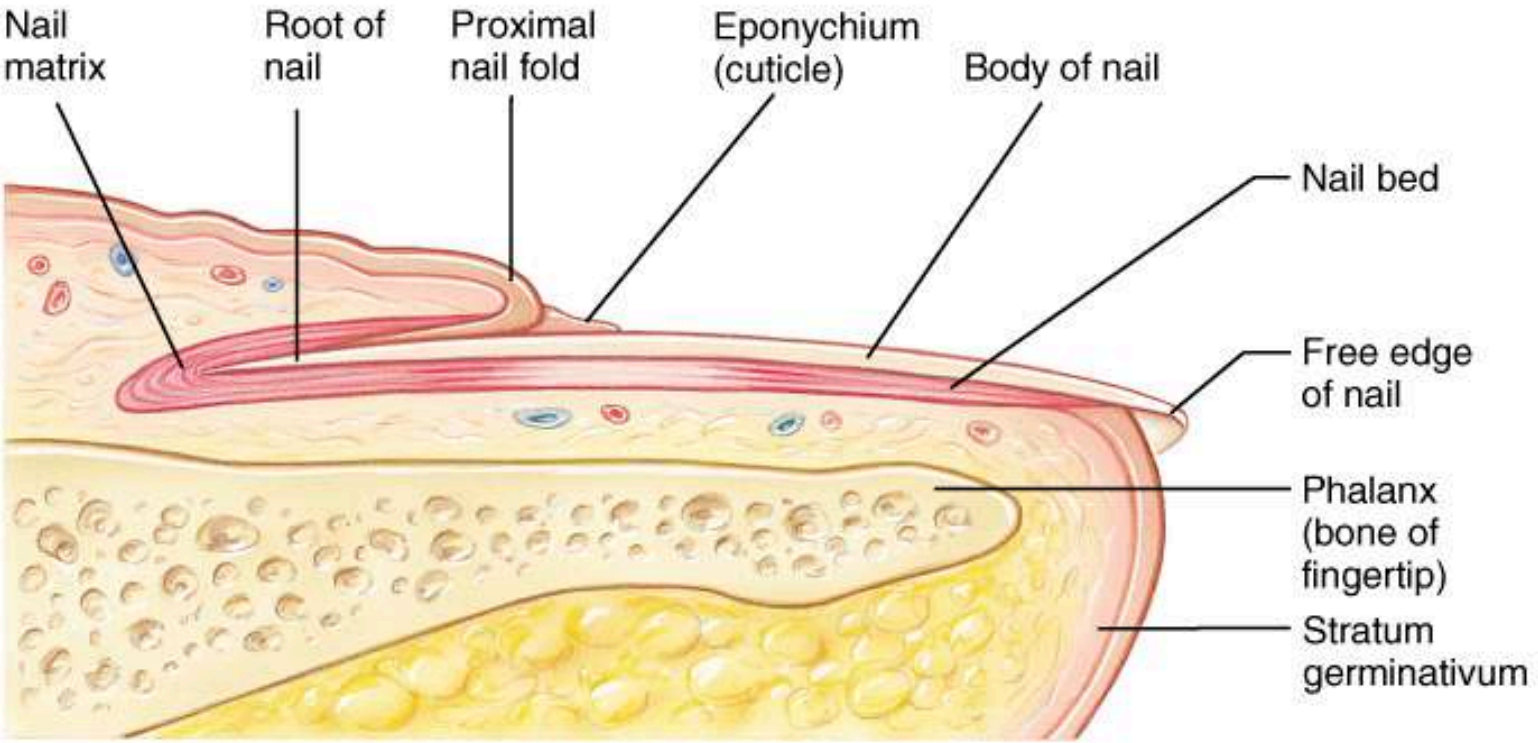
- Protects the head from a blow, sunlight, heat loss
- helps sense touch
- filters particulates
  - eyelashes, eyebrow, nose hairs

2) Nails

- A nail is a scalelike modification of the nail epidermis
- Made of tightly compressed keratinized cells arising from the nail bed lunula



(a)



(b)

3) Skin Glands

1) Sudoriferous (sweat) glands

Eccrine= common sweat glands (hot & cold sweats)

* excreted via pores

* sweat = water, salts, urea, uric acid

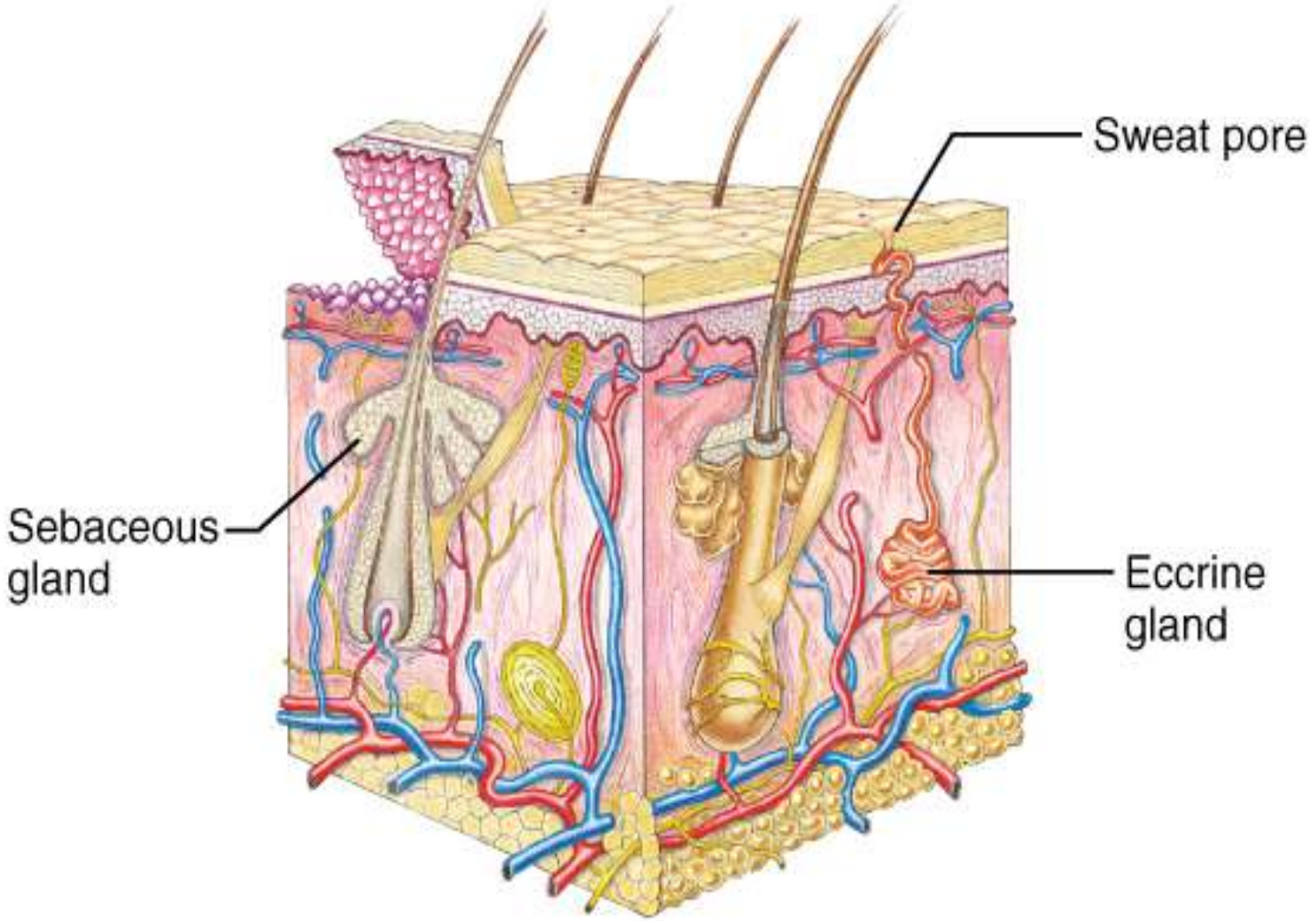
Apocrine gland- scent glands
location: axillary, genital

2) Sebaceous (oil) glands

- Secrete sebum = fatty material + cellular debris
  - acne = excess sebum stimulated by increased hormone levels
- Softens and lubricates hair and skin
- Slows water loss and kills bacteria

3) **Ceruminous glands**- produce cerumen (ear wax)

4) **Mammary glands**- produce milk



H) Skin color

Pigments

1. **Melanin** (a natural sunscreen)
   - yellow to reddish-brown to black
   - skin color depends varying amounts and colors
   - sunlight induces melanin production

2. **Carotene**-yellow to orange
   - often in the palms or soles; most intense with diet of carotene-rich foods
3. **Hemoglobin**- Red blood gives a pinkish hue to fair skin

I) Skin Cancer

- warts and moles are benign tumors
- malignant tumors can start on the skin and invade other body areas.
- overexposure to UV radiation increases risk

Types of Skin Cancer

1. basal cell carcinoma- most common
   - stratum basale layer
   - dome shaped nodules that form an ulcer in the center
   - 99% curable by surgical excision

Basal Cell Carcinoma

2. squamous cell carcinoma
   - –stratum spinosum keratinocytes
   - –grows rapidly and metastasizes
   - –small red rounded elevation on scalp, ears, hands, lips
   - –prognosis is good, if caught early

Squamous cell carcinoma

3. melanoma
   - melanocytes (very dangerous)
   - can arise from preexisting moles
   - spreading brown or black patch
   - prognosis is poor (50% survival)

Melanoma

What to look for . . .

- **A**symmetry: two sides of the mole do not match
- **B**order irregularity: not smooth
- **C**olor: multiple colors
- **D**iameter: >6 mm diameter (~ pencil eraser)

J) Burns

- 12,000 die from burns each year
- loss of body fluids (incl. proteins, electrolytes)
- danger of infection

3 types of burns

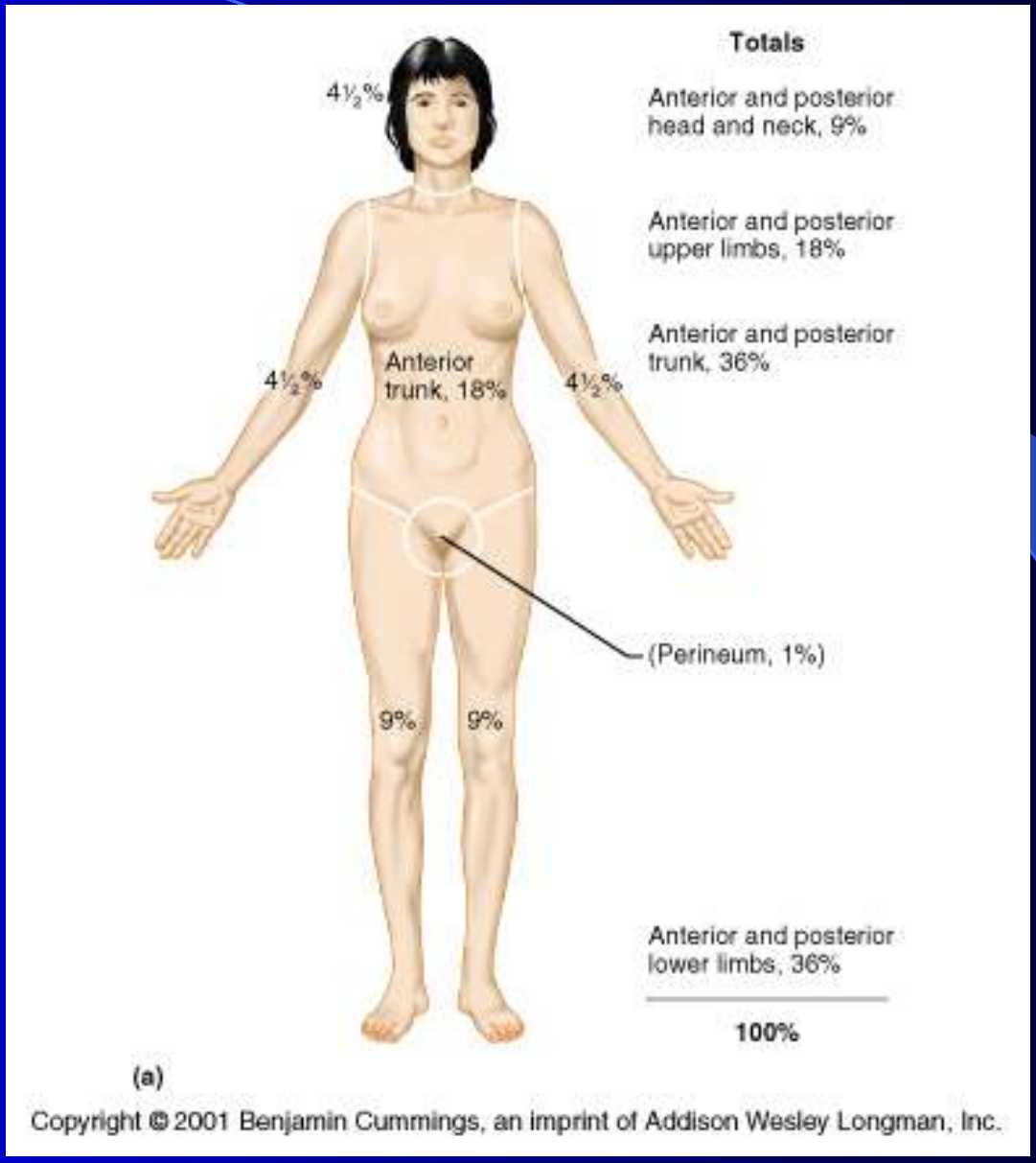
- **First-degree burns**: epidermis is damaged; redness, swelling and pain e.g. sunburn
  - 2-3 days to heal
- **Second-degree burns**: epidermis and upper layers of dermis; blistering
  - 3-4 weeks to heal
- **Third-degree burns**: entire thickness of the skin; skin grafts necessary

Second-degree burn

Third-degree burn

Rule of nines (body divided into 11 areas each covering 9% of the body)

* These % are used to estimate body fluid replacement



Sensory Perception

The skin acts as a sensory organ. There are receptors located throughout the dermis and the epidermis. Free nerve endings found in the dermal papillae and possibly in the stratum basale and stratum spinosum detect itch, pain hot, and cold. Merkel's disks in the dermal papillae and stratum basale of the palms, soles, and lips respond to light touch and pressure. Meissner's corpuscles also respond to light touch, but they are also sensitive to vibration. These are located in the dermal papillae of the fingertips, lips, eyelids, nipples, and genitalia. Vibration can also be detected by Pacinian corpuscles. These receptors also respond to heavy pressure. They are found in the inner dermis and subcutaneous layers of the fingertips, breast, and genitalia. Root hair plexuses respond to the movement of hair shafts.