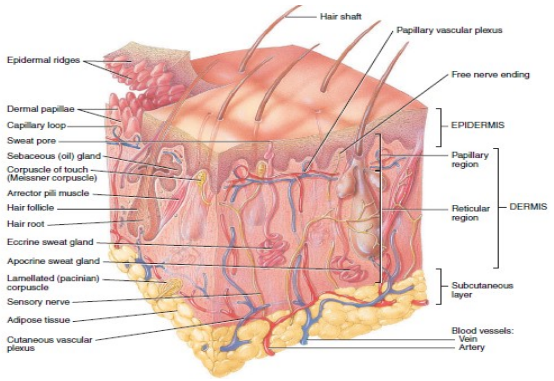
THE INTEGUMENTARY SYSTEM



Course Name: Anatomy and Physiology 1

Course Code: 0521122

Lecturer: Ms. Asma El-Shara'. MPH

Faculty Of Pharmacy,

Philadelphia University-Jordan

جامعة فيلادلفيا
Philadelphia University

INTRODUCTION

The **skin**, also known as the **cutaneous** membrane (ku¯-TA¯ - ne¯-us), covers the external surface of the body and is the largest organ of the body in weight. In adults, the skin covers an area of about 2 square meters and weighs 4.5–5 kg, about 7% of total body weight.

The **integumentary system** (in-teg-u¯-MEN-tar-e¯; *in-* inward; *-tegere* to cover) is composed of:

- Skin
- Hair
- Oil (sebaceous) and sweat glands (sudoriferous)

→ The ***ceruminous*** glands in the skin of the human external auditory canal are **modified apocrine glands**, which, together with sebaceous glands, produce the cerumen, the ear wax.

- Nails
- Sensory receptors.

INTRODUCTION (continued)

- **Dermatology** (der-ma-TOL-o¯-je¯; *dermato-* skin; *-logy* study of) is the medical specialty that deals with the structure, function, and disorders of the integumentary system.

Components Of The Integumentary System

The skin consists of two functional layers:

✓A superficial, thin ***epidermis***

→ Outer layer consisting stratified squamous epithelium waterproofed and hardened by keratin (epithelium = avascular)

✓A deep thicker ***dermis***

→ Dense connective tissue containing blood vessels, nerve endings, sweat and oil glands, and hair follicles and associated structures.

Not part of the skin !!

✓A ***subcutaneous*** layer (***SubQ***) also called ***hypodermis***

→Deep to the skin which attaches the dermis to underlying fascia.

→Consists of areolar and adipose tissues.

Functions Of Integumentary System

1. Regulates body temperature

→ (Sweat and blood flow adjustment)

2. Stores blood

→ (Dermis houses an extensive network of blood vessels that carry 8–10% of the total blood flow in a resting adult).

3. Protects body from external environment

→ (Keratin, lipids, oily sebum, acidic pH of perspiration, melanin صبغة الجلد, intraepidermal macrophages and macrophages).

pH=5.5– Normal flora --- Melatonin= هرمون تفرزه الغدة الصنوبرية

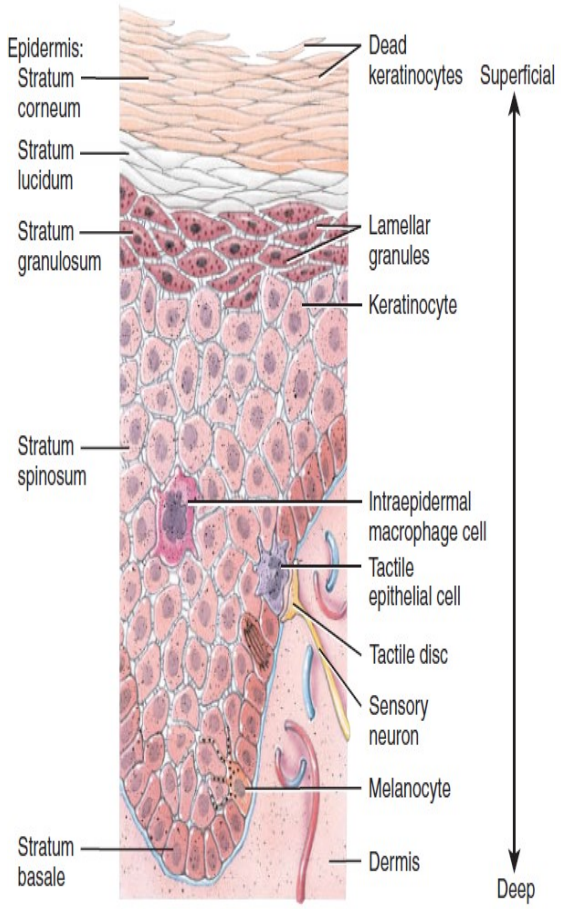
Functions Of Integumentary System (continued-1)

4. Detects cutaneous sensations (***tactile sensations***—touch, pressure, vibration, and tickling—as well as ***thermal sensations*** such as warmth and coolness. Another ***cutaneous sensation***, pain, usually is an indication of impending or actual tissue damage).

→ There is a wide variety of nerve endings and receptors distributed throughout the skin:

a- Superficial sensory receptors: including the tactile discs of the epidermis, the corpuscles of touch in the dermis, and hair root plexuses around each hair follicle.

b- Deep sensory receptors: including lamellated corpuscles.



Functions Of Integumentary System (continued-2)

5. Excretes and absorbs substances.

→Sweat also is the vehicle for excretion of small amounts of salts, carbon dioxide, ammonia and urea.

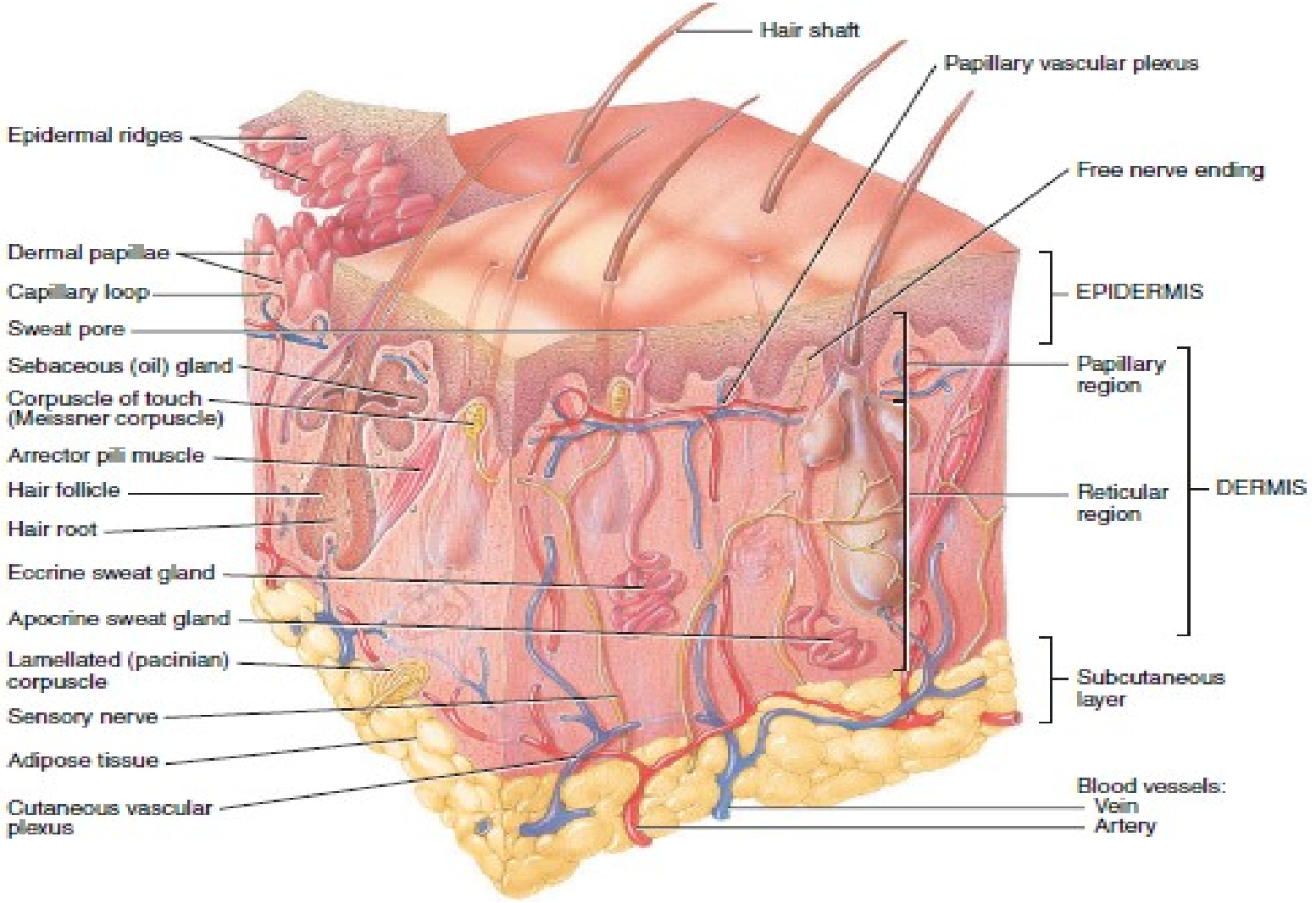
- The absorption of certain lipid-soluble materials fat-soluble vitamins (A, D, E, and K), certain drugs (topical corticosteroids and adhesive patches), and the gases oxygen and carbon dioxide. Toxic materials e.g.: acetone, carbon tetrachloride (dry-cleaning fluid); salts of heavy metals, the substances in poison ivy and poison oak.

6. Synthesizes vitamin D.

→Ultraviolet (UV) rays in sunlight activates the precursor molecule. Enzymes in the liver and kidneys then modify the activated molecule produce ***calcitriol***, aids in the absorption of calcium from foods.

→ Most cells of the immune system have vitamin D receptors → Vitamin D is believed to **enhance phagocytic activity**, increase the production of antimicrobial substances in phagocytes, regulate immune functions, and help reduce inflammation.

The integumentary system includes the skin, hair, oil and sweat glands, nails, and sensory receptors.



EPIDERMIS

The epidermis is composed of keratinized stratified squamous epithelium. It contains four principal types of cells:

1- **Keratinocytes** → produce the protein keratin (protects underlying tissues), and lamellar granules (contain a waterproof sealant).

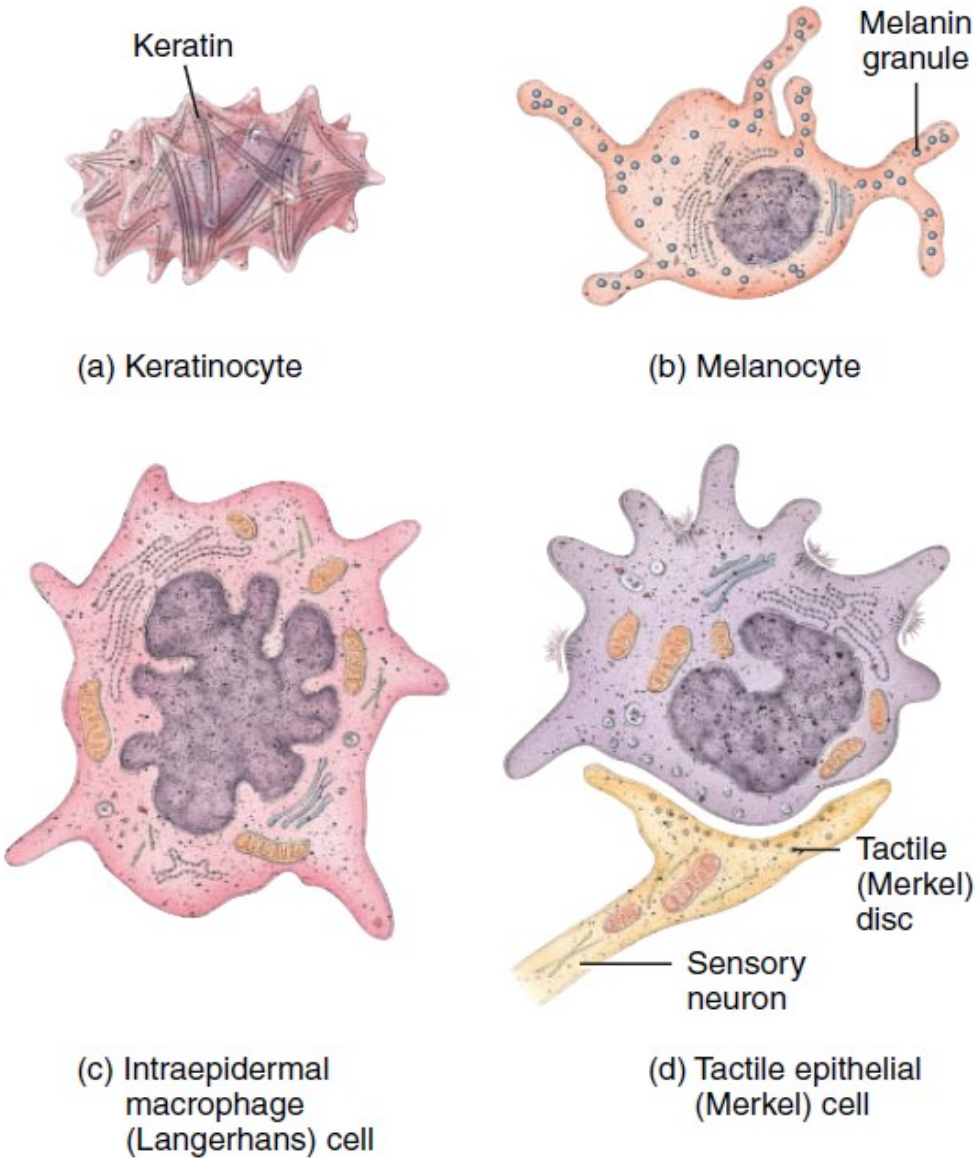
2- **Melanocytes** → which produce the pigment melanin which is yellow-red or brown-black pigment that contributes to skin color and absorbs damaging ultraviolet (UV) light.

→ *Melanin, hemoglobin, and carotene are responsible for skin color*

3- **Intraepidermal macrophages** → participate in immune responses

4- **Tactile epithelial cells** → function in the sensation of touch.

Epidermis contains four principal types of cells



Epidermal Strata !!

In most regions of the body the epidermis has four strata (STRA¯ -ta) or layers **(THIN SKIN)**

- Stratum basale
- Stratum spinosum
- Stratum granulosum
- And a thin stratum corneum

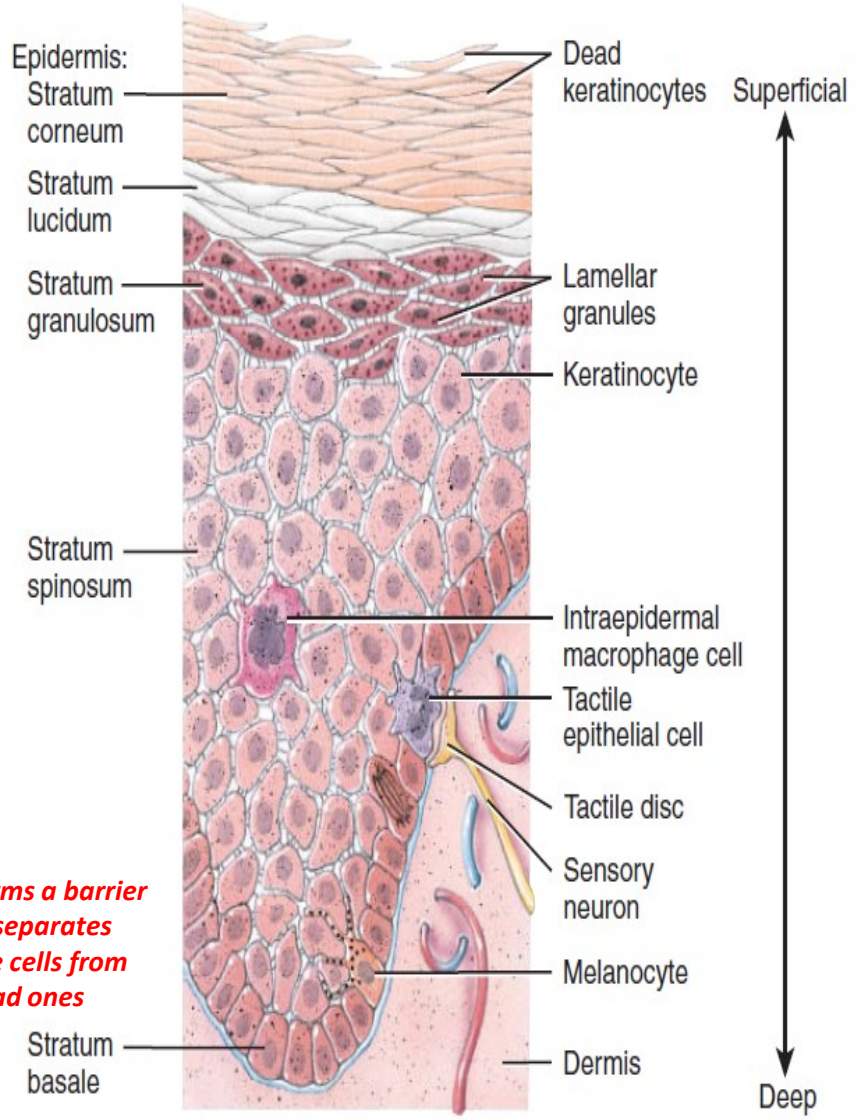
- While where exposure to friction is greatest, such as in the fingertips, palms, and soles, the epidermis has five layers **(THICK SKIN)**
- Stratum basale
- Stratum spinosum
- Stratum granulosum
- Stratum lucidum
- And a thick stratum corneum

Epidermal Strata !!

Summary of Epidermal Strata (see Figure 5.3)

STRATUM	DESCRIPTION
Basale	Deepest layer, composed of single row of cuboidal or columnar keratinocytes that contain scattered keratin intermediate filaments (tonofilaments); stem cells undergo cell division to produce new keratinocytes; melanocytes and tactile epithelial cells associated with tactile discs are scattered among keratinocytes.
Spinosum	Eight to ten rows of many-sided keratinocytes with bundles of keratin intermediate filaments; contains projections of melanocytes and intraepidermal macrophages.
Granulosum	Three to five rows of flattened keratinocytes, in which organelles are beginning to degenerate; cells contain the protein keratohyalin (converts keratin intermediate filaments into keratin) and lamellar granules (release lipid-rich, water-repellent secretion).
Lucidum	Present only in skin of fingertips, palms, and soles; consists of four to six rows of clear, flat, dead keratinocytes with large amounts of keratin.
Corneum	Few to fifty or more rows of dead, flat keratinocytes that contain mostly keratin.

Forms a barrier to separates live cells from dead ones



Comparison of Thin and Thick Skin

FEATURE	THIN SKIN	THICK SKIN
Distribution	All parts of body except areas such as palms, palmar surface of digits, and soles.	Areas such as palms, palmar surface of digits, and soles.
Epidermal thickness	0.10–0.15 mm (0.004–0.006 in.).	0.6–4.5 mm (0.024–0.18 in.), due mostly to a thicker stratum corneum.
Epidermal strata	Stratum lucidum essentially lacking; thinner strata spinosum and corneum.	Stratum lucidum present; thicker strata spinosum and corneum.
Epidermal ridges	Lacking due to poorly developed, fewer, and less-well-organized dermal papillae.	Present due to well-developed and more numerous dermal papillae organized in parallel rows.
Hair follicles and arrector pili muscles	Present.	Absent.
Sebaceous glands	Present.	Absent.
Sudoriferous glands	Fewer.	More numerous.
Sensory receptors	Sparser.	Denser.

DERMIS

- The second, deeper part of the skin, the *dermis*, is composed of **dense irregular connective tissue** containing collagen and elastic fibers.
- This woven network of fibers has great tensile strength (resists pulling or stretching forces). The dermis also has the ability to stretch and recoil easily.
- It is much thicker than the epidermis, and this thickness varies from region to region in the body, reaching its greatest thickness on the palms and soles.
- The few cells present in the dermis include predominantly fibroblasts, with some macrophages, and a few adipocytes near its boundary with the subcutaneous layer.
- Blood vessels, nerves, glands, and hair follicles (*epithelial invaginations* of the epidermis) are embedded in the dermal layer. The dermis is *essential to the survival of the epidermis,* and these adjacent layers form many important structural and functional relations.
- ***Based on its tissue structure, the dermis can be divided into a thin superficial papillary region and a thick deeper reticular region.***

Summary of Papillary and Reticular Regions of the Dermis

REGION	DESCRIPTION
Papillary	Superficial portion of dermis (about one-fifth); consists of areolar connective tissue with **thin collagen** and **fine elastic fibers**; contains dermal ridges that house blood capillaries, corpuscles of touch, and free nerve endings.
Reticular	Deeper portion of dermis (about four-fifths); consists of dense irregular connective tissue with bundles of **thick collagen** (more regular arrangement than those in the papillary region) and some **coarse elastic fibers**. Spaces between fibers contain some adipose cells, hair follicles, nerves, sebaceous glands, and sudoriferous glands.

Accessory Structures Of The Skin

- **Accessory structures of the skin**—hair, skin glands, and nails.

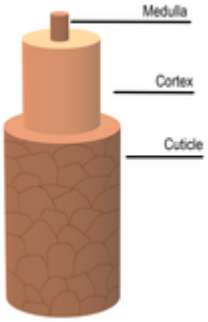
They have a host of important functions.

For example, hair and nails protect the body, and sweat glands help regulate body temperature.

1- HAIR

- Present on most surface except the palms, anterior surfaces of fingers, and the soles of the feel.
- Composed of dead, keratinized epidermal cells.
- Genetics and hormonal influences determines thickness and distribution.

Anatomy of a Hair



- The shaft (above the skin surface)
- The root (penetrates into the dermis and sometimes into the subcutaneous layer)

1- Medulla
2- Cortex
3- Cuticle

- The follicle (below the level of the skin, surrounds the root)

→Includes: A- Epithelial root sheath (internal and external)

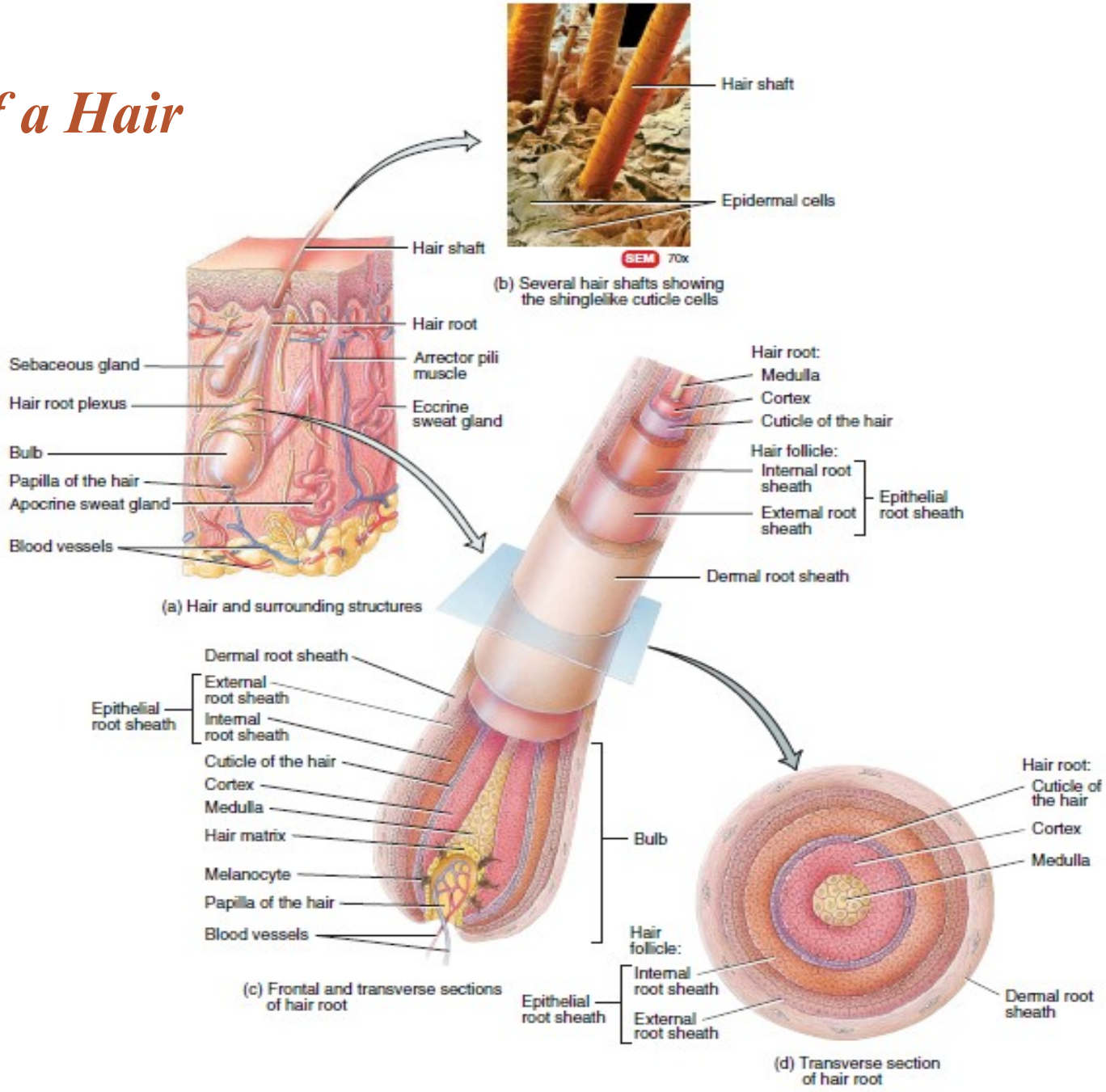
B- Dermal root sheath (dense dermis surrounding the hair)

→ Onion-shaped structure, the **bulb**, (responsible for hair growth), contains:

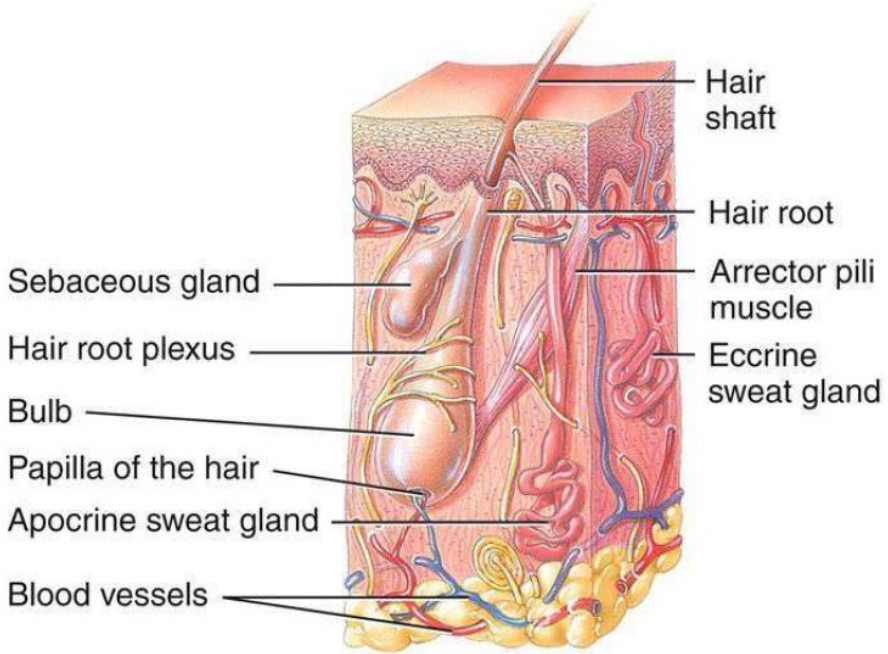
A- **Papilla of the hair**, which contains areolar connective tissue and many blood vessels that nourish the growing hair follicle.

B- **Germinal layer** of cells called the **hair matrix**

Anatomy of a Hair



Anatomy of a Hair -A



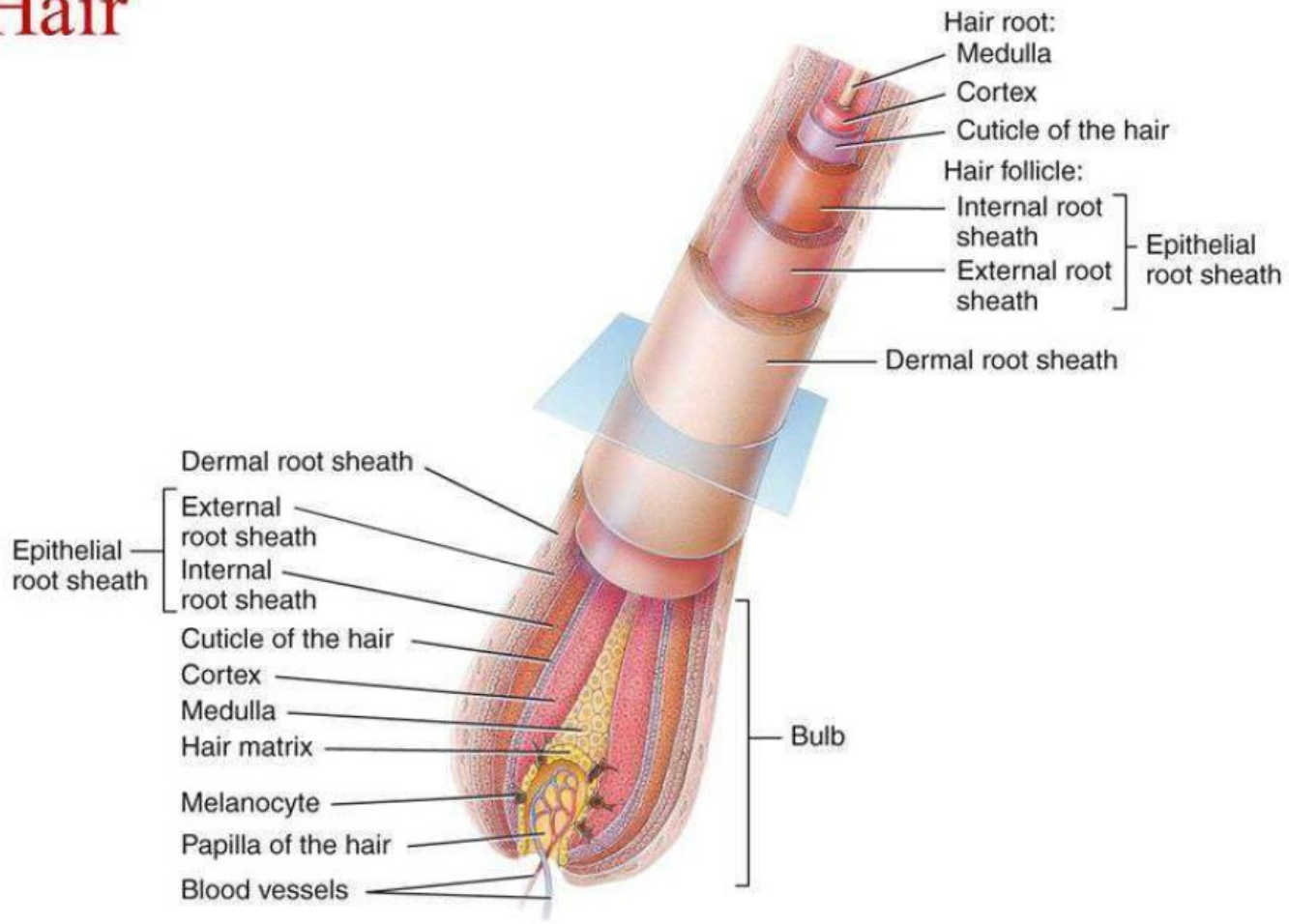
(a) Hair and surrounding structures

Anatomy of a Hair-B

(b) Several hair shafts showing the shinglelike cuticle cells

Anatomy of a Hair-C

Hair



(c) Frontal and transverse sections of hair root

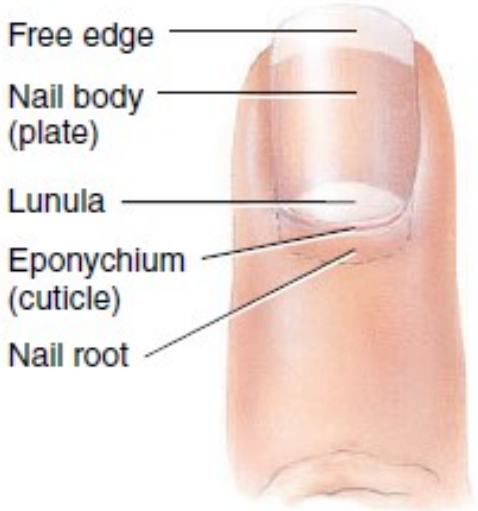
2- SKIN GLANDS

FEATURE	SEBACEOUS (OIL) GLANDS	ECCRINE SWEAT GLANDS (Merocrine)	APOCRINE SWEAT GLANDS	CERUMINOUS GLANDS
Distribution	Largely in lips, glans penis, labia minora, and tarsal glands; small in trunk and limbs; absent in palms and soles.	Throughout skin of most regions of body, especially skin of forehead, palms, and soles.	Skin of axillae, groin, areolae, bearded regions of face, clitoris, and labia minora.	External auditory canal.
Location of secretory portion	Dermis.	Mostly in deep dermis (sometimes in upper subcutaneous layer).	Mostly in deep dermis and upper subcutaneous layer.	Subcutaneous layer.
Termination of excretory duct	Mostly connected to hair follicle.	Surface of epidermis.	Hair follicles.	Surface of external auditory canal or into ducts of sebaceous glands.
Secretion	Sebum (mixture of triglycerides, cholesterol, proteins, and inorganic salts).	Perspiration, which consists of water, ions (Na^+, Cl^-), urea, uric acid, ammonia, amino acids, glucose, and lactic acid.	Perspiration, which consists of same components as eccrine sweat glands plus lipids and proteins.	Cerumen, a waxy material.
Functions	Prevent hairs from drying out, prevent water loss from skin, keep skin soft, inhibit growth of some bacteria.	Regulation of body temperature, waste removal, stimulated during emotional stress.	Stimulated during emotional stress and sexual excitement.	Impede entrance of foreign bodies and insects into external ear canal, waterproof canal, prevent microbes from entering cells.
Onset of function	Relatively inactive during childhood; activated during puberty.	Soon after birth.	Puberty.	Soon after birth.

3- NAILS

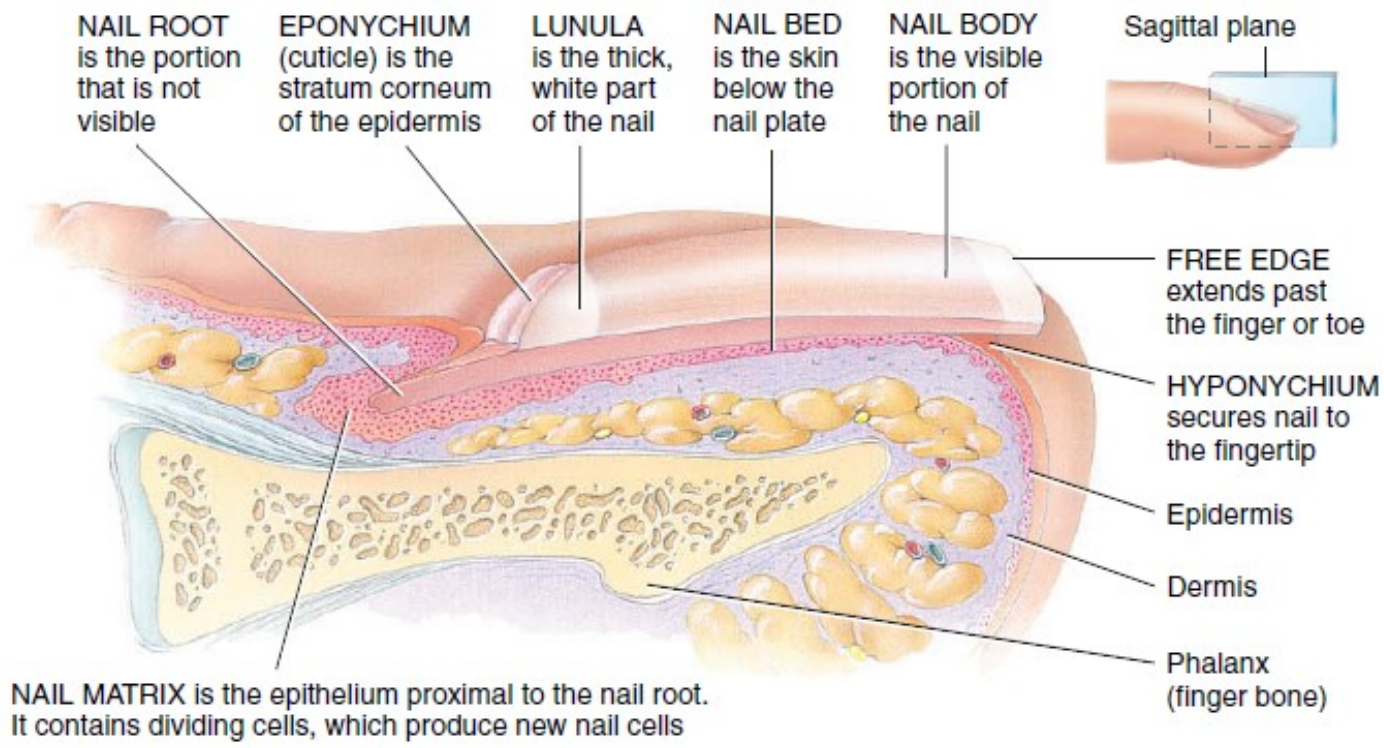
- Made of keratinized epidermal cells.

- Nail structure include:
  1. Free edge
  2. Transparent nail body (plate) with a whitish lunula at its base
  3. Nail root embedded in a fold of skin



(a) Dorsal view

Nail structure



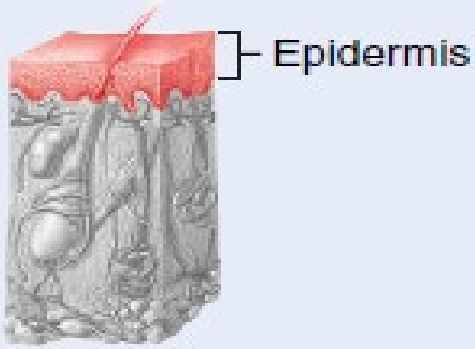
(b) Sagittal section showing internal detail

AGING OF INTEGUMENTARY SYSTEM

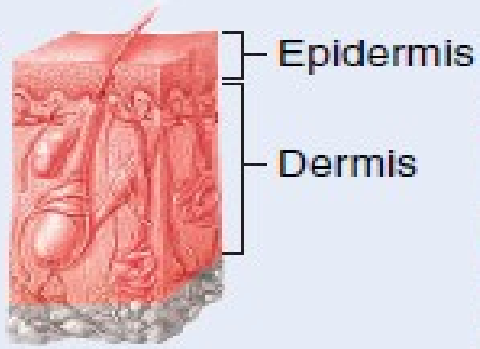
- Wrinkles.
- Dehydration and cracking of skin.
- Sweat production decreases.
- A decrease in the numbers of functional melanocytes results in gray hair and atypical skin pigmentation.
- Subcutaneous fat is lost, and there is a general decrease in skin thickness.
- Nails become brittle.
- Increased susceptibility to pressure ulcers (bed sore)

BURNS

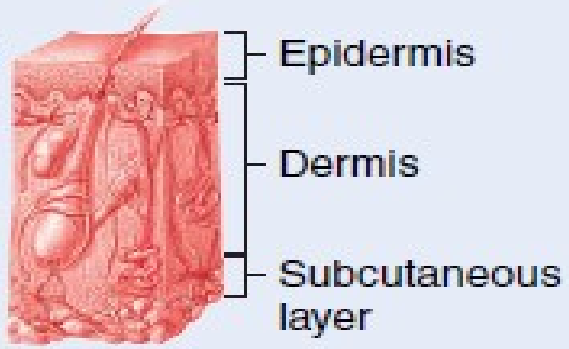
A burn is tissue damage caused by agents that destroy the proteins in the skin.



(a) First-degree burn (sunburn)



(b) Second-degree burn (note the blisters in the photograph)



(c) Third-degree burn