

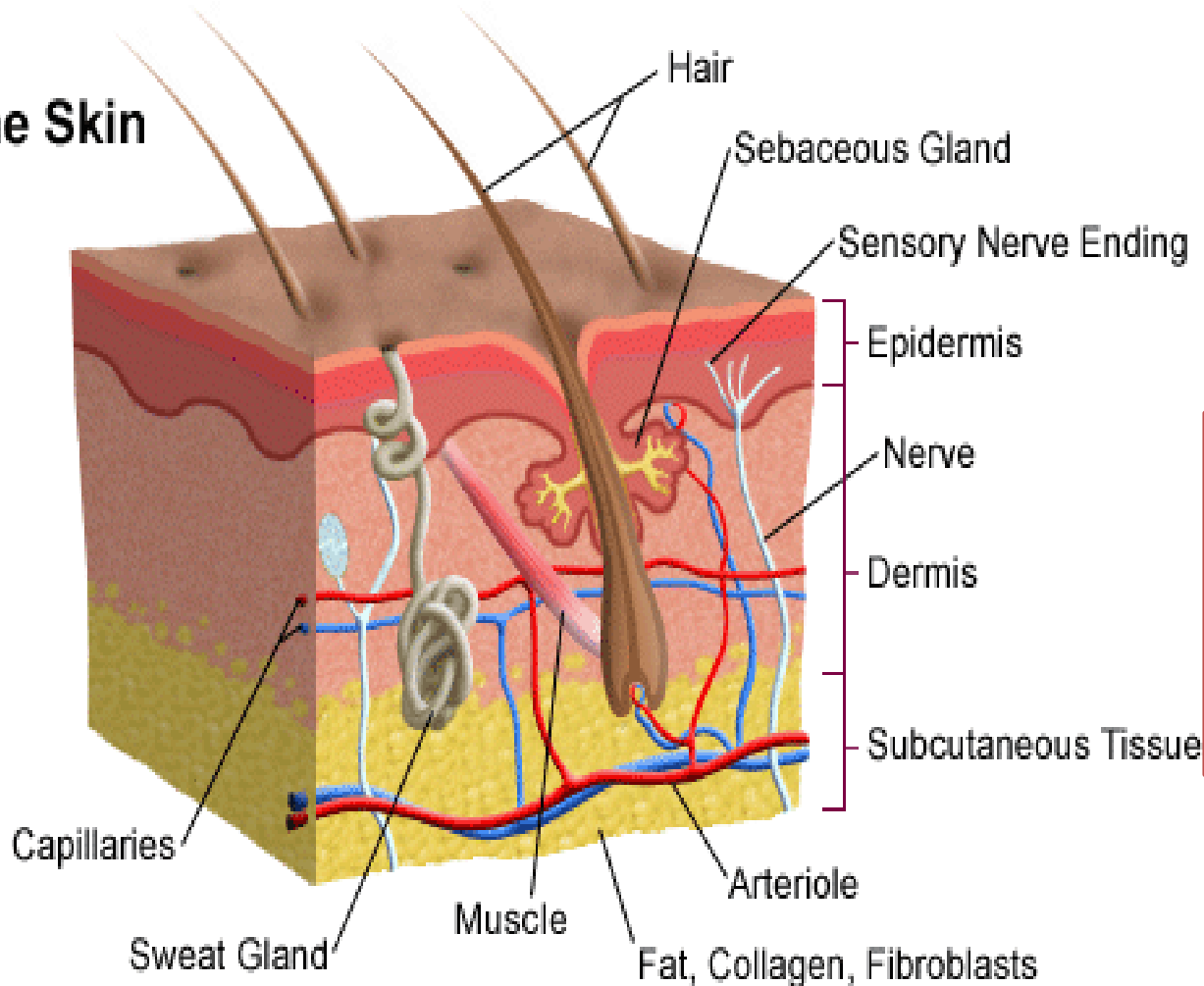
# Integumentary system (Skin)

# Basic Skin Histology

The skin is considered the largest organ of the body and has many different functions.

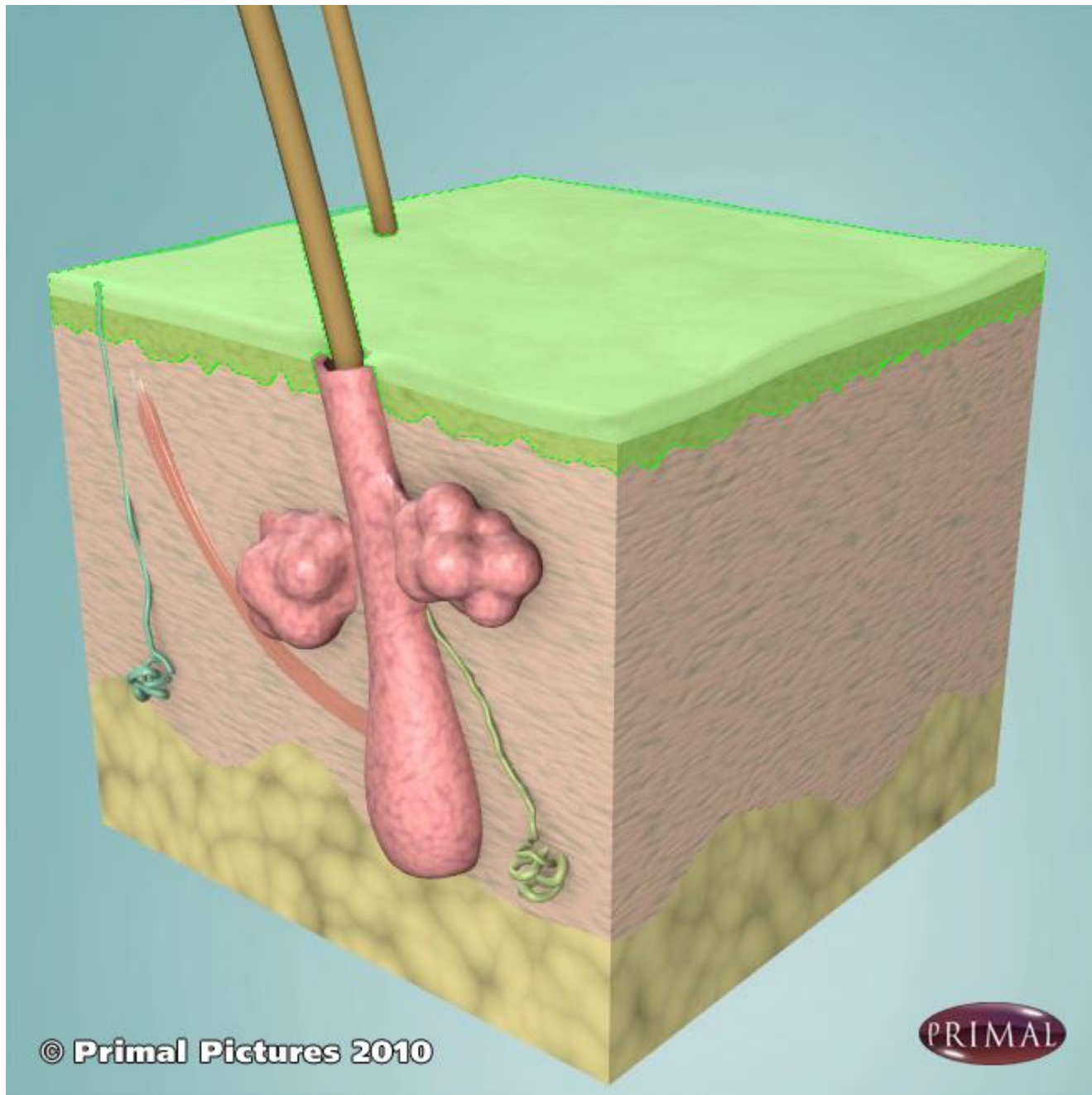
The skin is composed of two layers: the outer epidermis and the deeper dermis, both of which rest on the hypodermis.

## The Skin



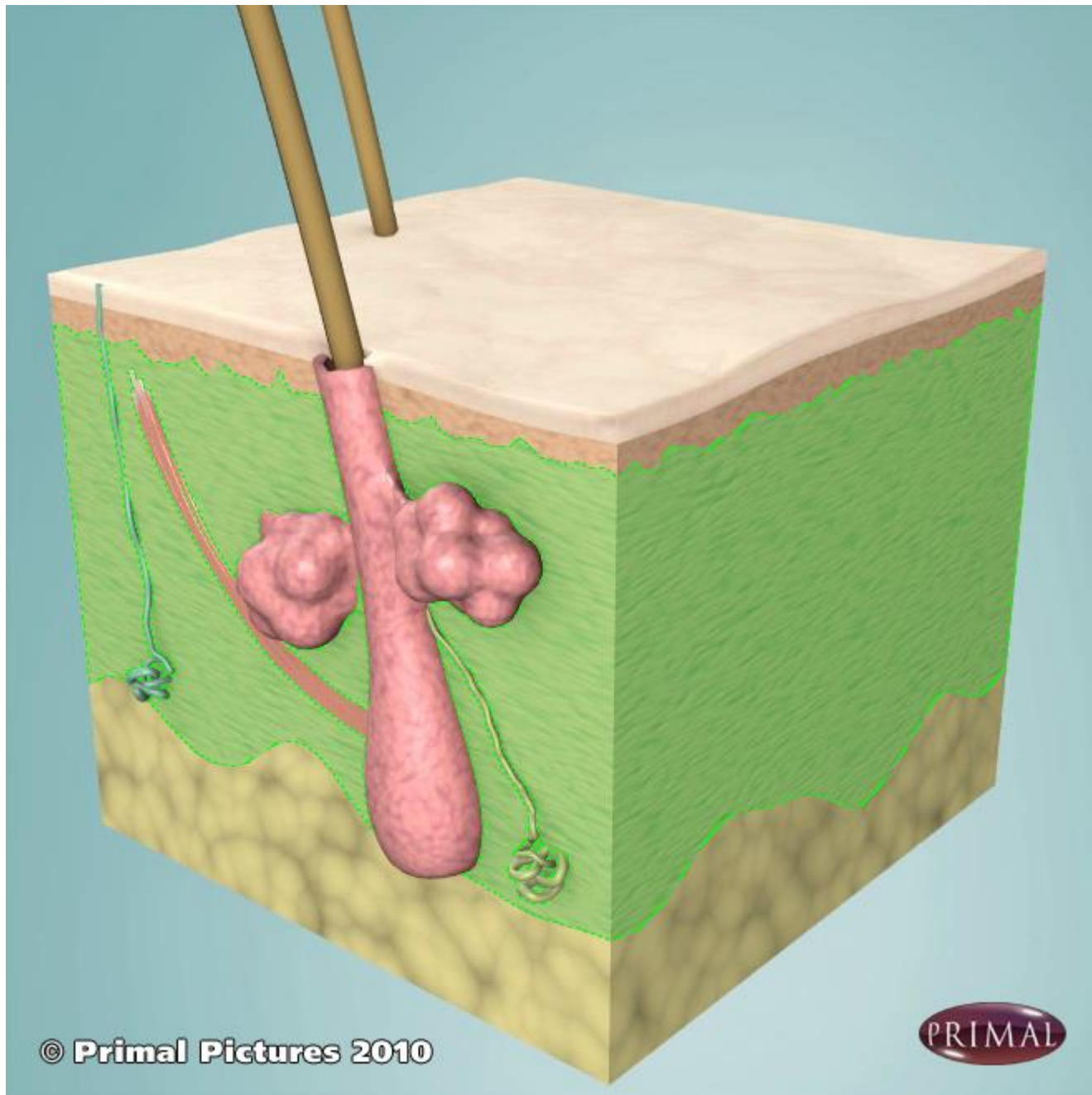
### Major Skin Functions

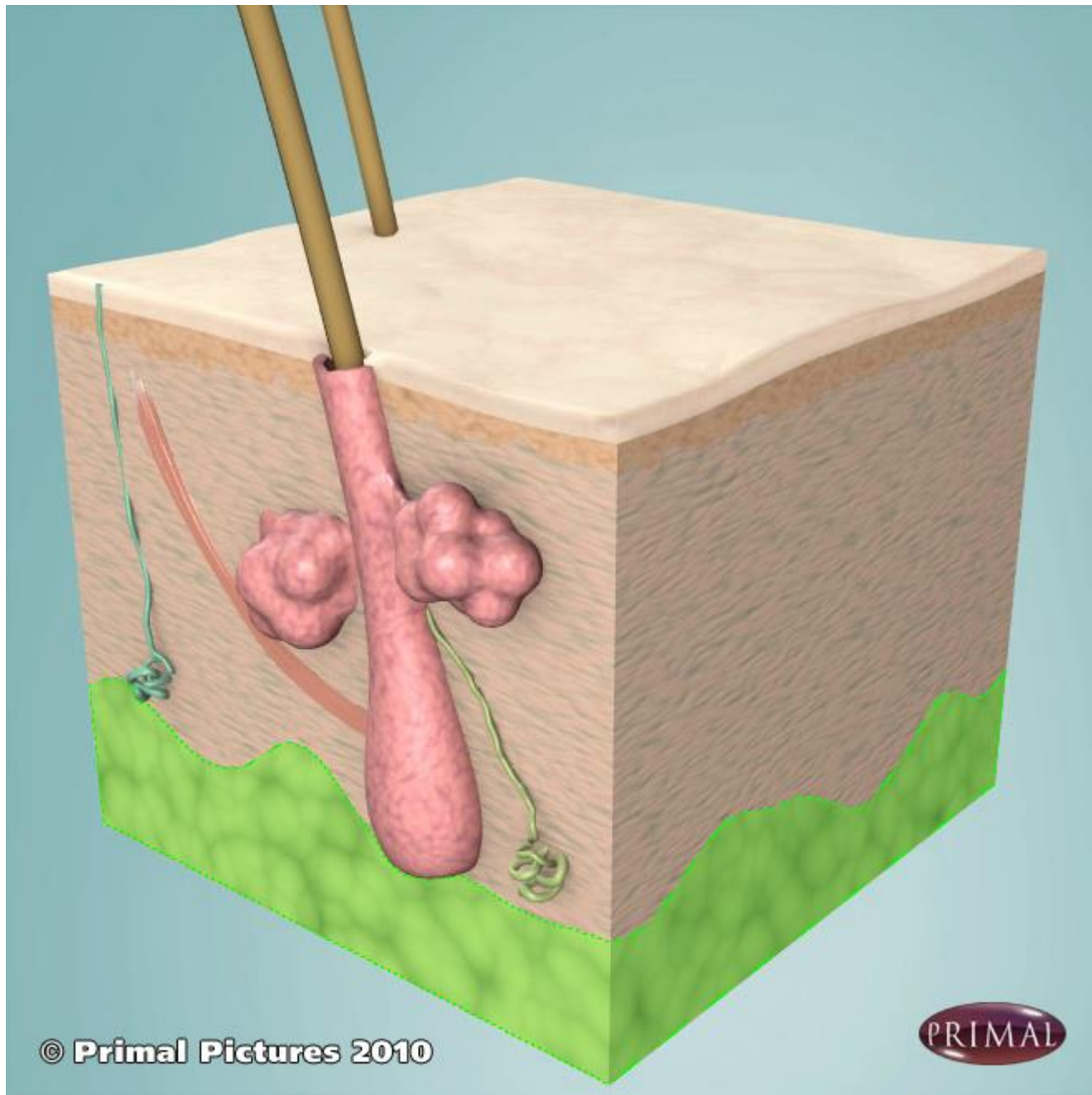
- Protection
- Temperature Regulation
- Sensory Perception
- Excretion
- Formation of Vitamin D



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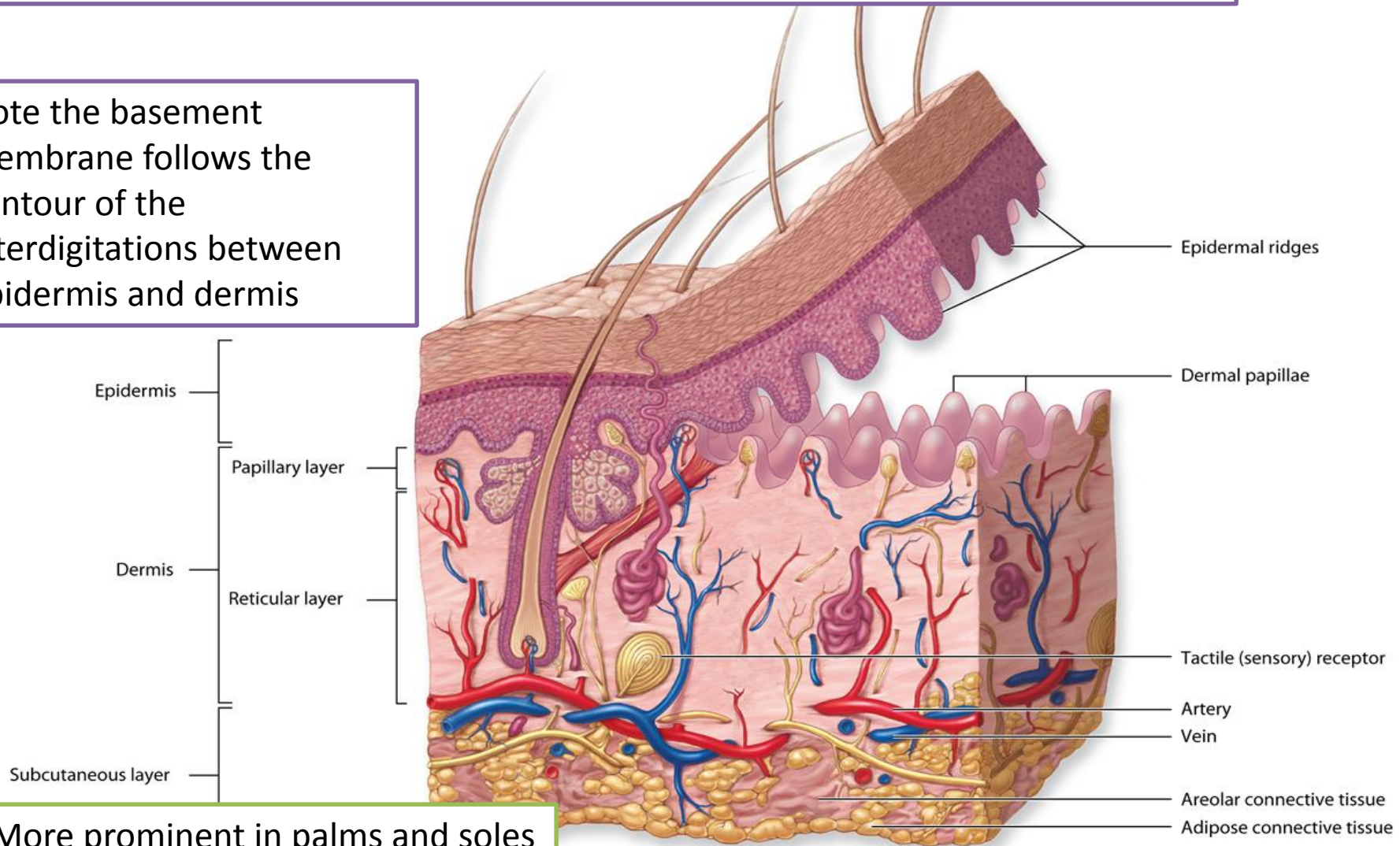




The **dermal papillae** are small, nipple-like extensions (or interdigitations) of the dermis into the epidermis

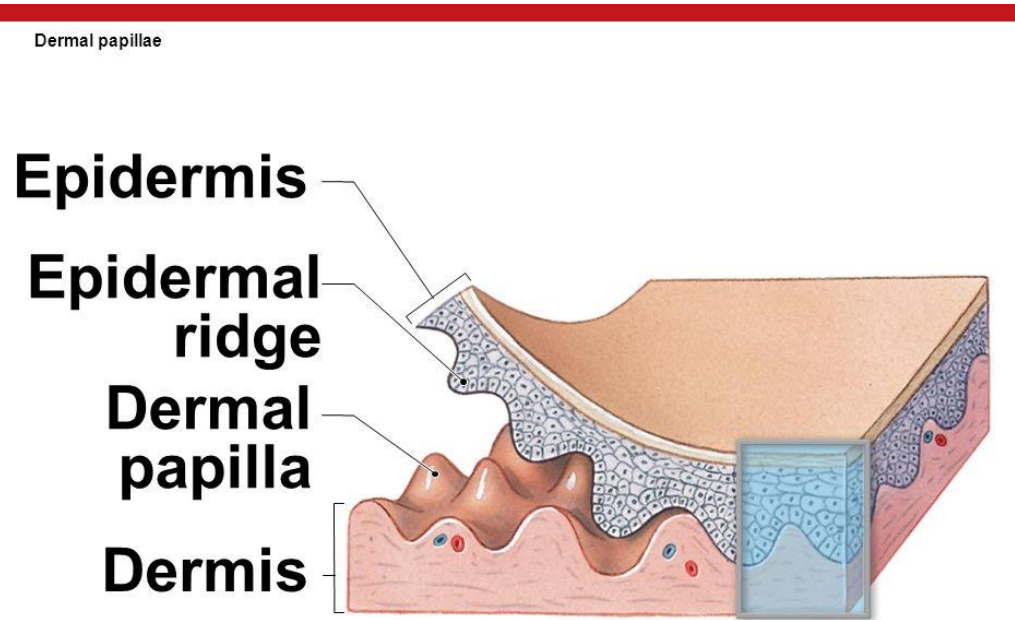
The epidermis conforms to the contours of the underlying dermal papillae forming **epidermal ridges**

Note the basement membrane follows the contour of the interdigitations between epidermis and dermis



More prominent in palms and soles

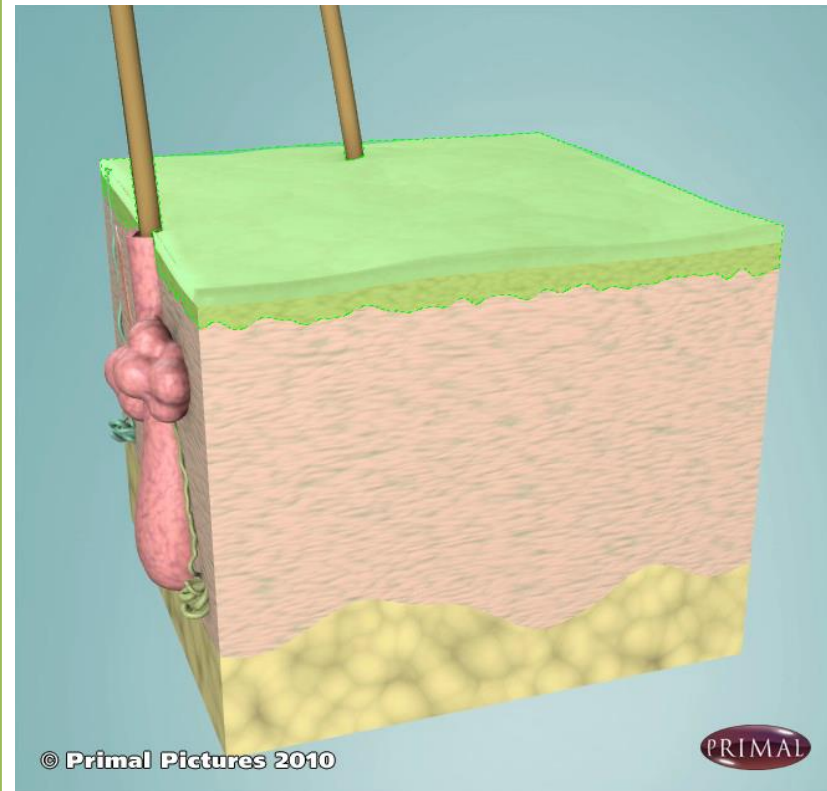
These interdigitations form distinctive patterns unique for each individual  
(fingerprints and footprints)



# **\*\*Epidermis**

Keratinized stratified squamous epithelium

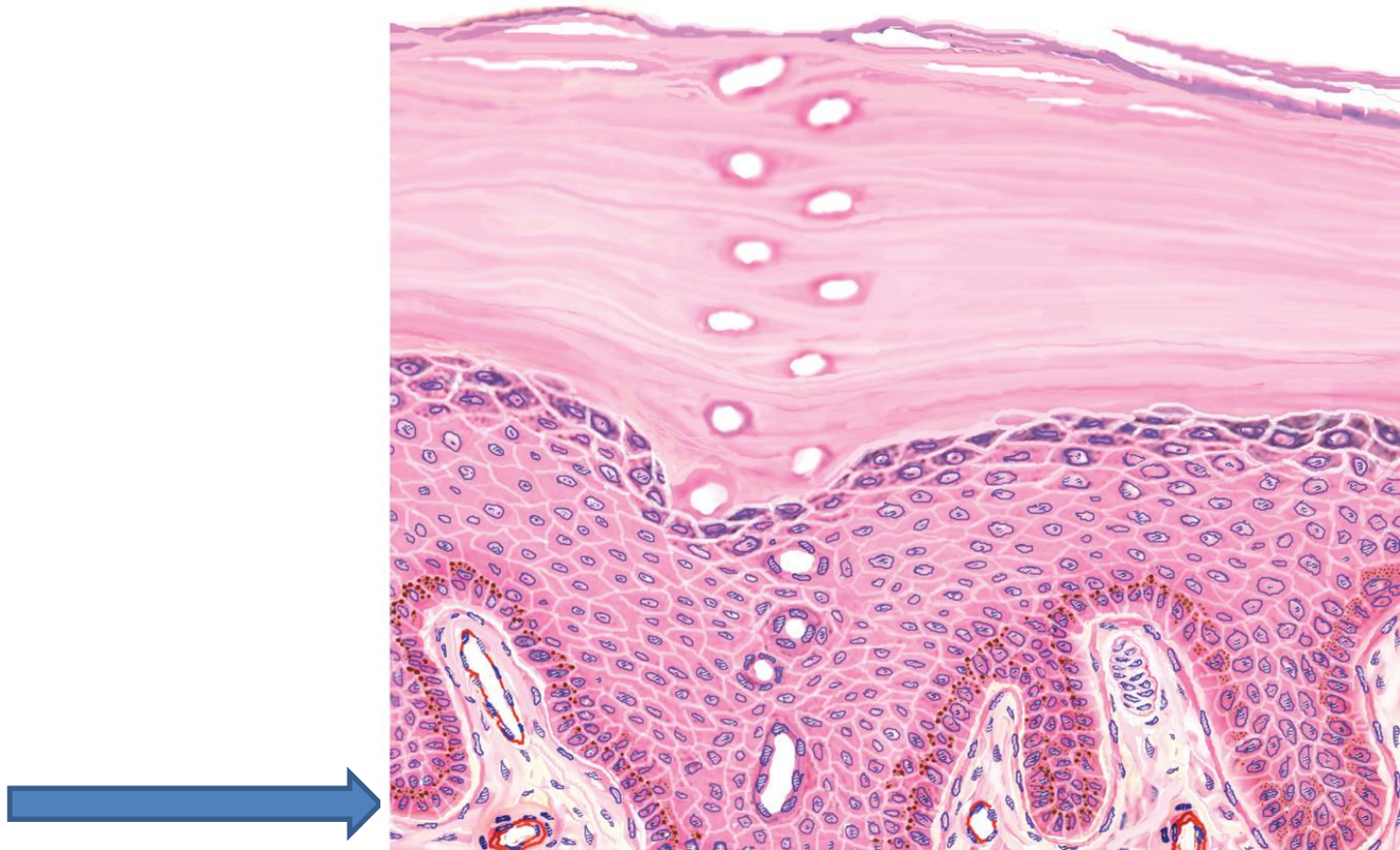
- The epidermis is the outermost layer of the skin.
- It is composed of four or five layers, depending on the type of skin.
- It is rich in a tough protein called keratin
- Contains four different cell types: keratinocytes, melanocytes, Langerhans cells, and Merkel cells.
- The epidermis itself does not contain any blood vessels, but receives nourishment instead from the capillaries in the dermis below.
- As cells of the outer surface of the epidermis are continually being sloughed off, some cells in the stratum basale (the bottom layer) of the epidermis divide continuously, replenishing the epidermis.
- The epidermis forms a waterproof barrier between the body and the external environment, which resists friction and microbial invasion and prevents water loss.





# (1) Stratum basale

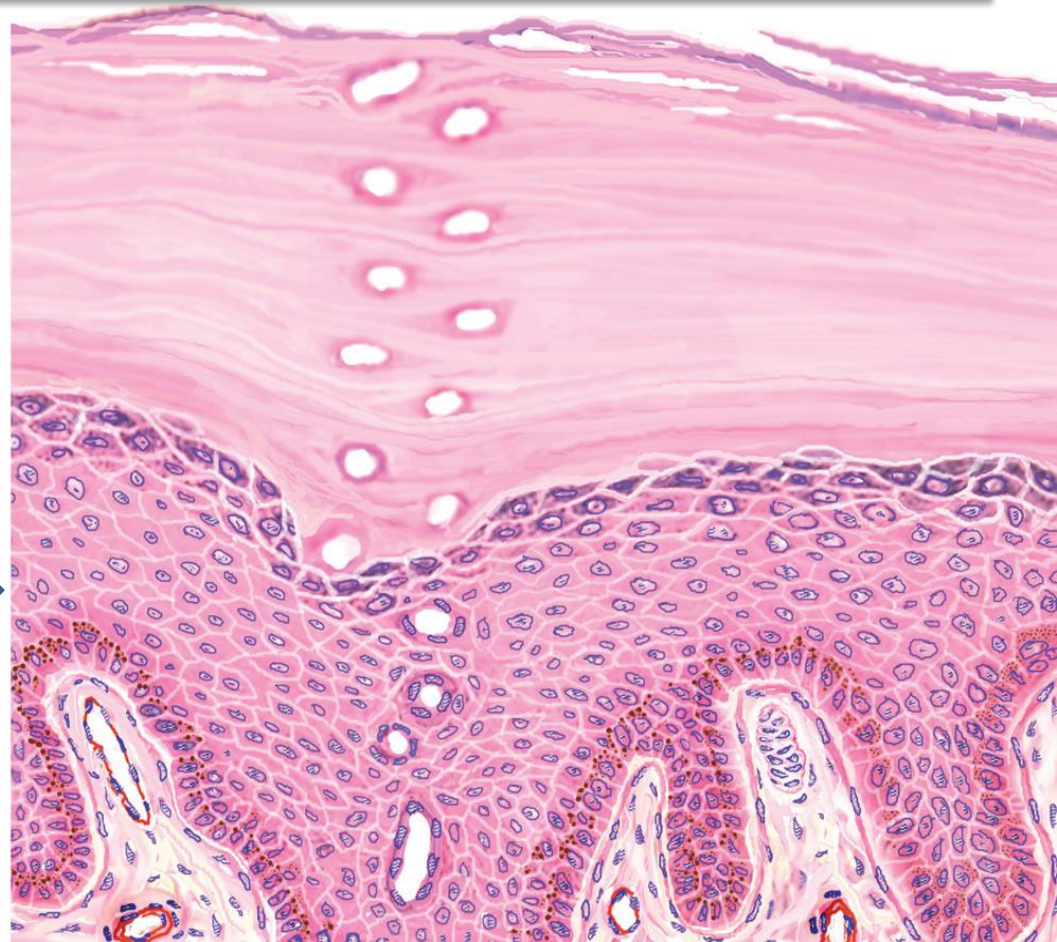
- The stratum basale is the deepest layer in the epidermis.
- It consists of a single layer of basophilic columnar to cuboidal cells that rest on a basement membrane
- The cells are attached to one another by desmosomes, and to the underlying basement membrane by hemidesmosomes.
- Cells are characterized by intense mitotic activity



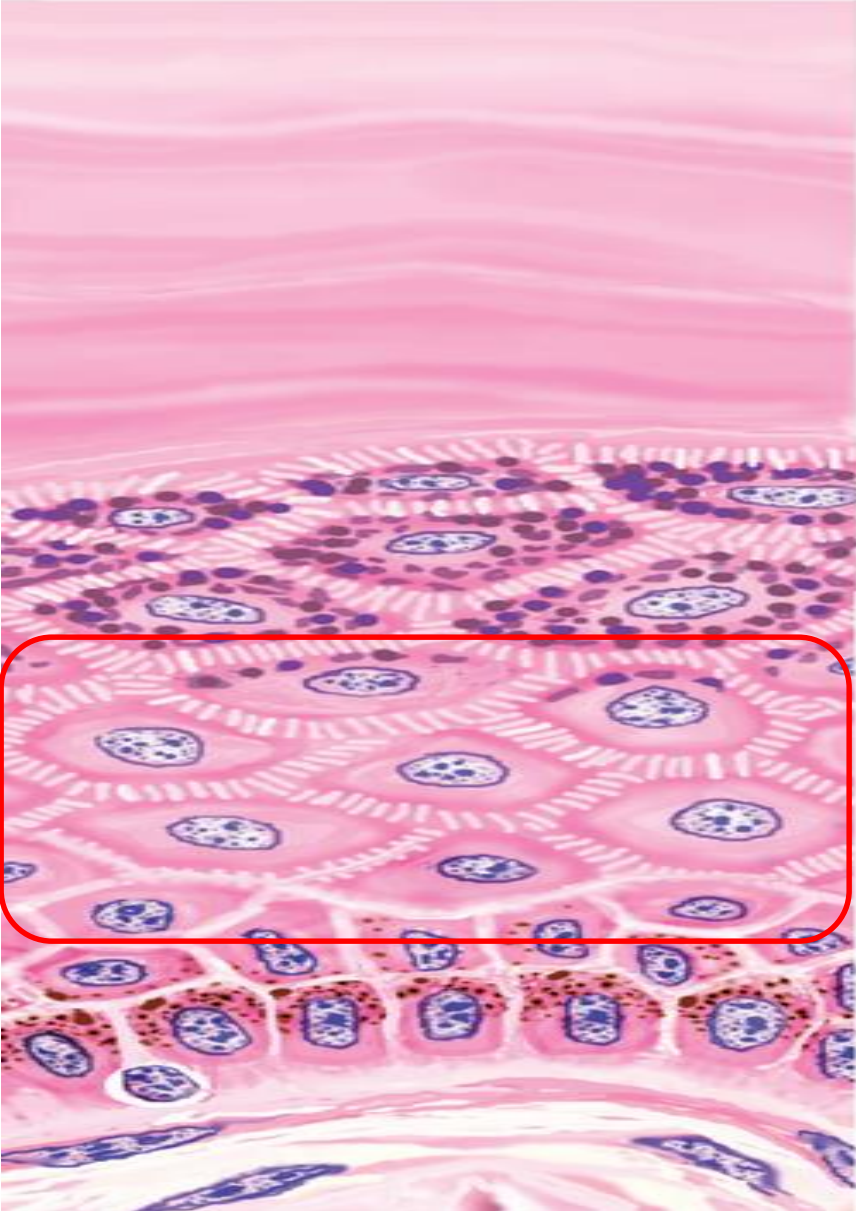
## (2)Stratum spinosum

- Is the layer above the stratum basale
- Consists of 8-10 rows of cells
- Cells synthesize keratin filaments that become assembled into tonofilaments
- During histologic preparation, cells shrink and intercellular spaces appear as spines
- Spines represent sites of desmosome attachments to keratin tonofibrils

Stratum basale along with the deepest part of stratum spinosum is called **Stratum germinativum**



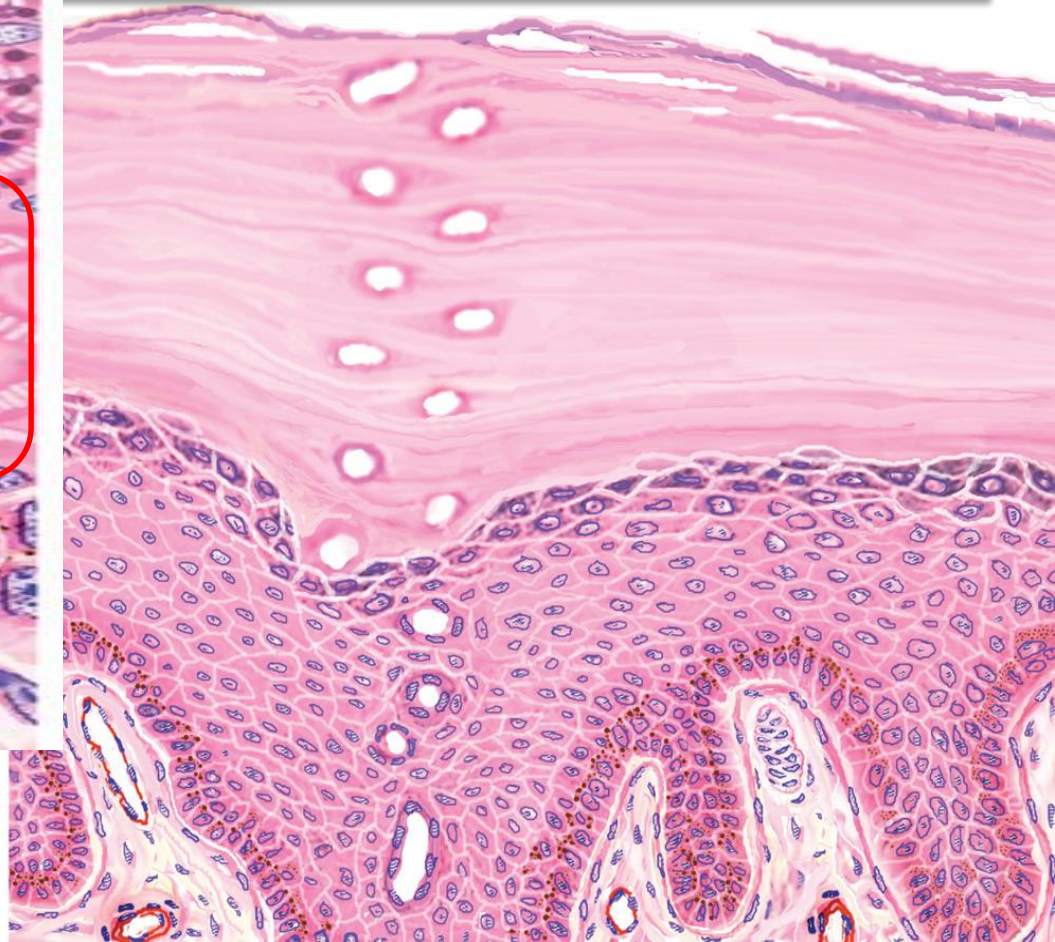




become assembled into tonofilaments  
rink and intercellular spaces appear as spines  
attachments to keratin tonofibrils

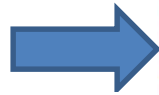
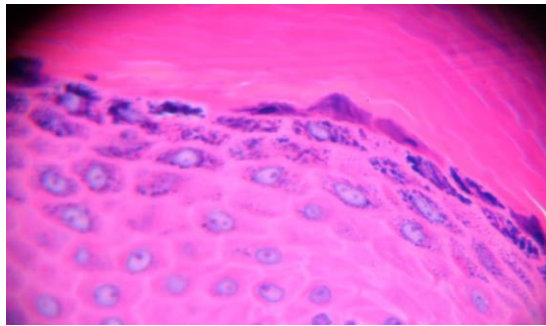


deepest part of stratum spinosum  
is called **Stratum germinativum**

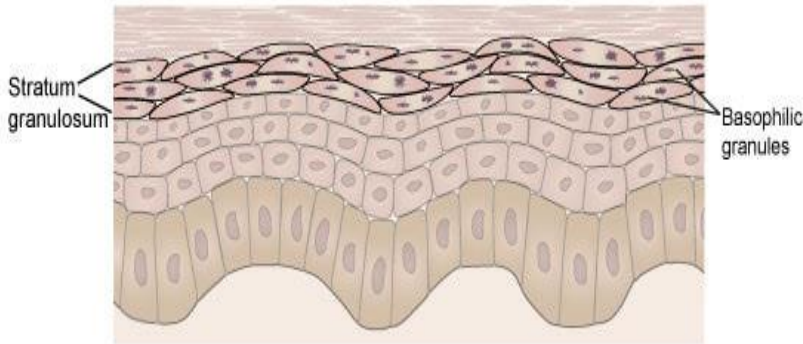


### (3)Stratum granulosum

- Cells above the stratum spinosum
- Consists of 3-5 cell layers of flattened cells
- Cells filled with dense basophilic keratohyalin granules and membrane- bound lamellar granules



Stratum Granulosum



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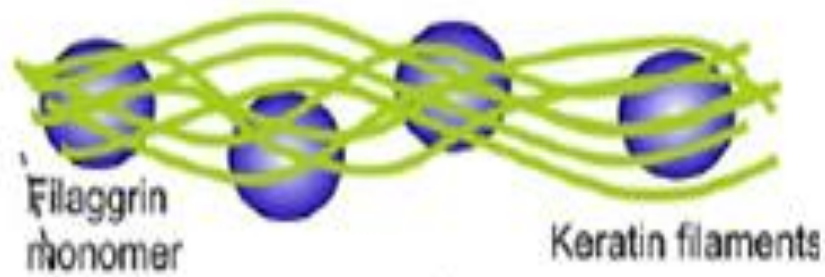


5  
alin granules and membrane- bound lamellar

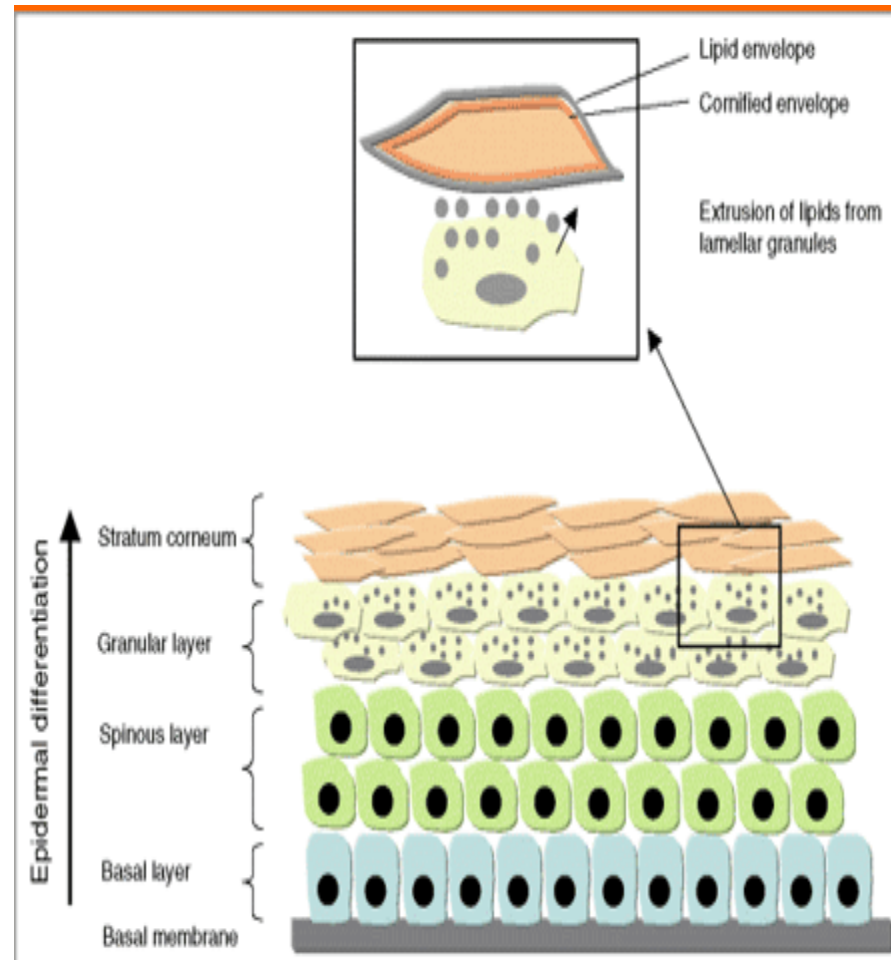
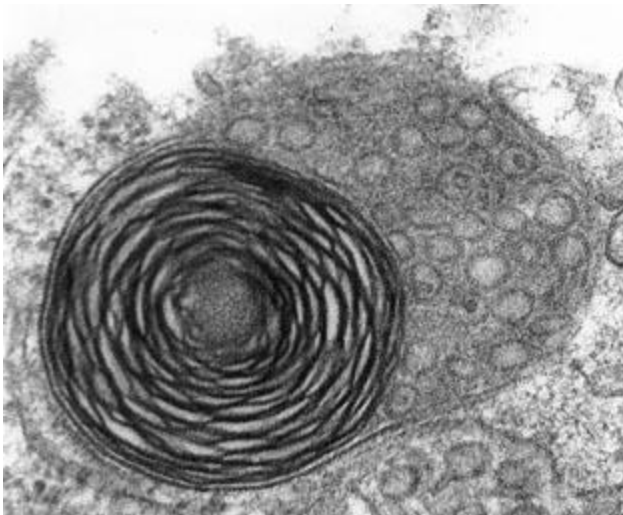




**Keratohyalin granules** are intensely basophilic, non membranous bound masses of filaggrin cross-links with keratin tonofibrils

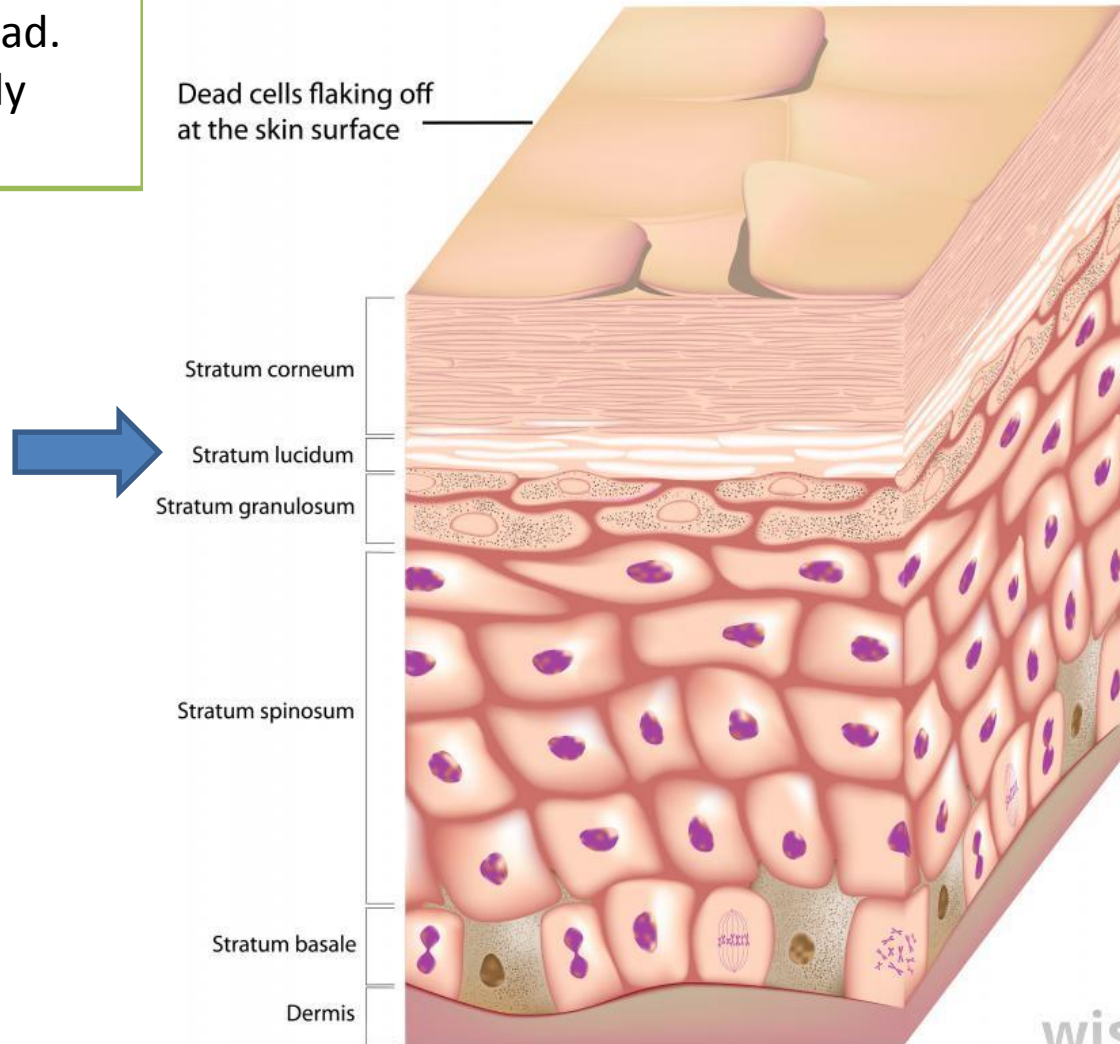


**Lamellar granules** discharge lipid material between cells and waterproof the skin



## (4)Stratum Lucidum

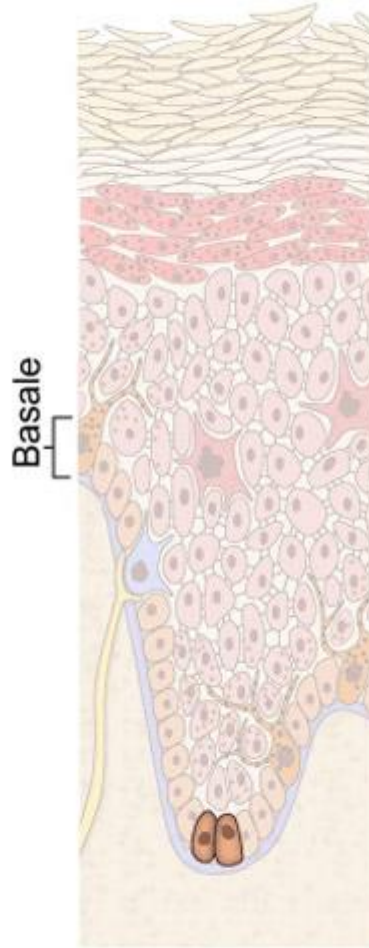
- In thick skin only
- Is translucent and barely visible
- The tightly packed cells (desmosomes) lack nuclei or organelles and are dead.
- The flattened cells contain densely packed keratin filaments.



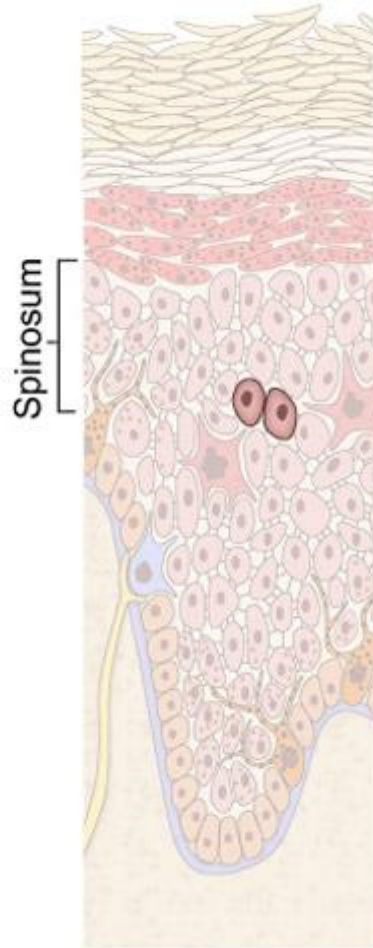
## (5)Stratum corneum

- Most superficial layer of the skin.
- Is composed of 15-20 layers of flattened cells with no nuclei and cell organelles
- The keratinized cells contain keratin filaments with plasma membranes surrounded by lipid-rich layer
- The cells from this layer are continually shed, or desquamated, and are replaced by new cells arising from the deep stratum basale.
- During the keratinization process, the hydrolytic enzymes disrupt the nucleus and all cytoplasmic organelles, which disappear as the cells fill with keratin.

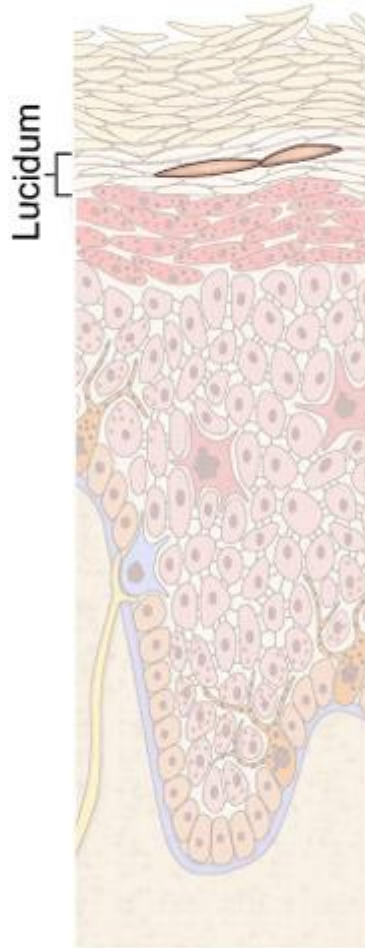




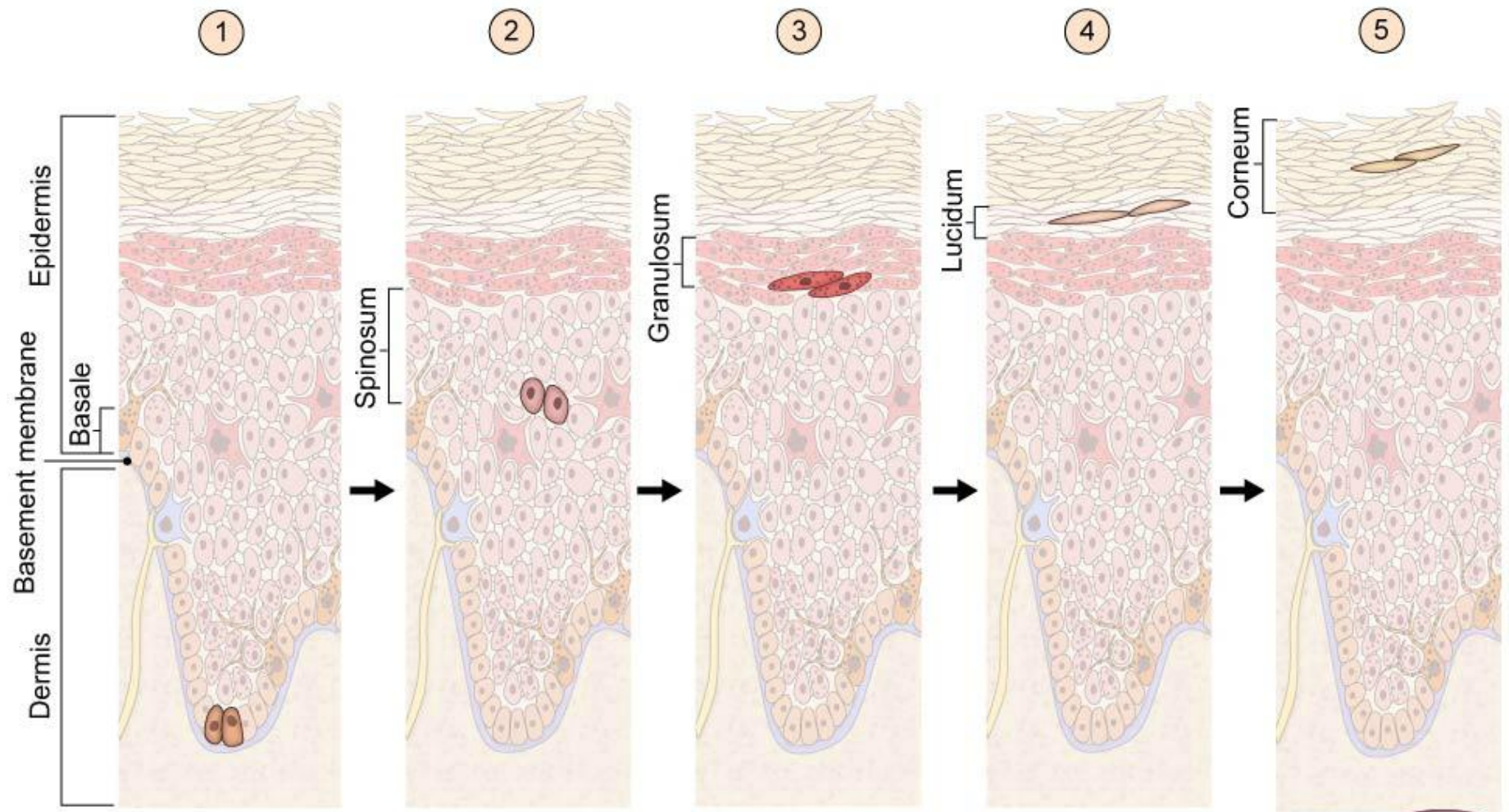














Dead cells flaking off  
at the skin surface

Stratum corneum

Stratum lucidum

Stratum granulosum

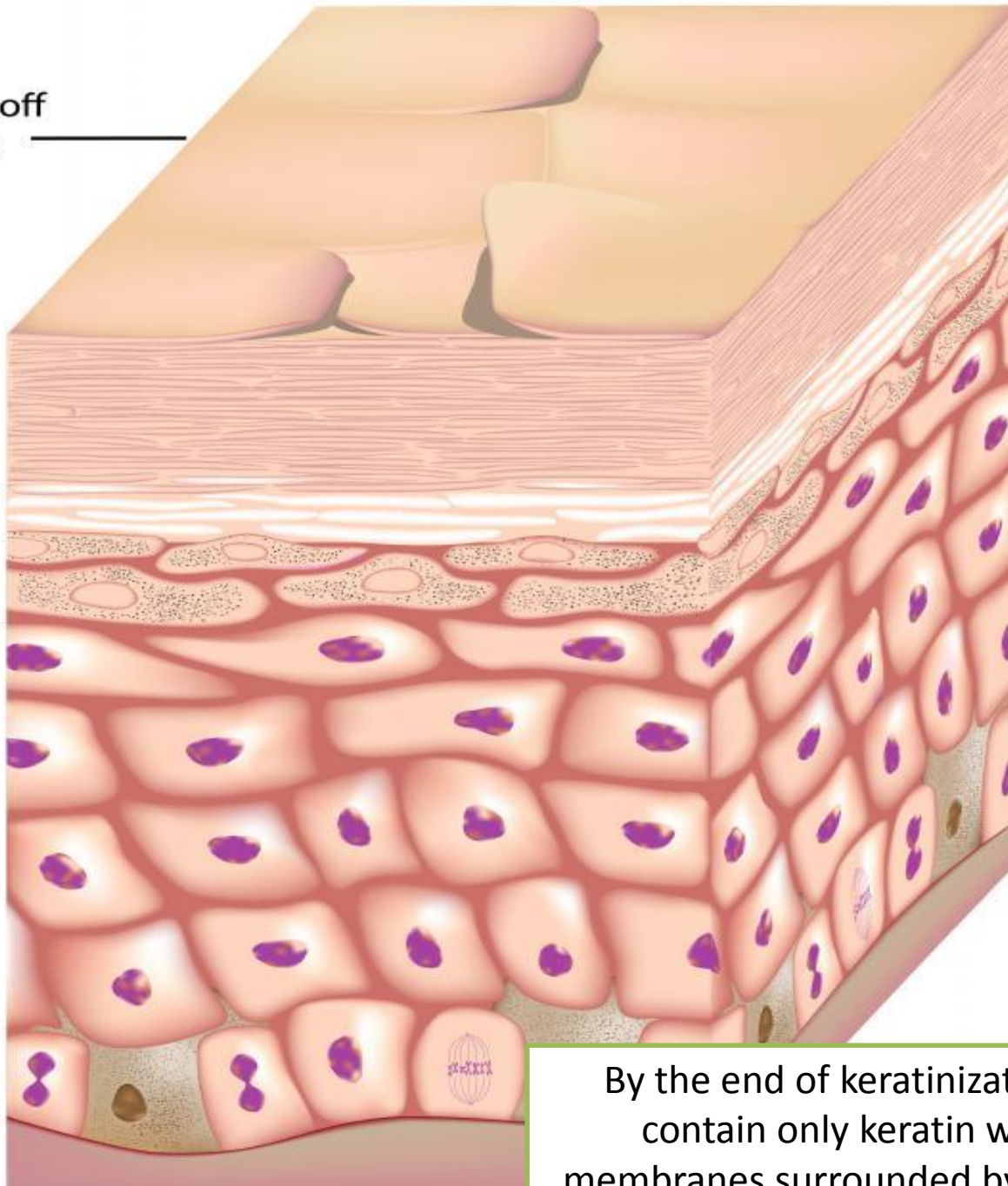
Stratum spinosum

Stratum basale

Dermis

Keratinocytes  
move up as  
they age

By the end of keratinization, the cells  
contain only keratin with plasma  
membranes surrounded by lipid rich layer

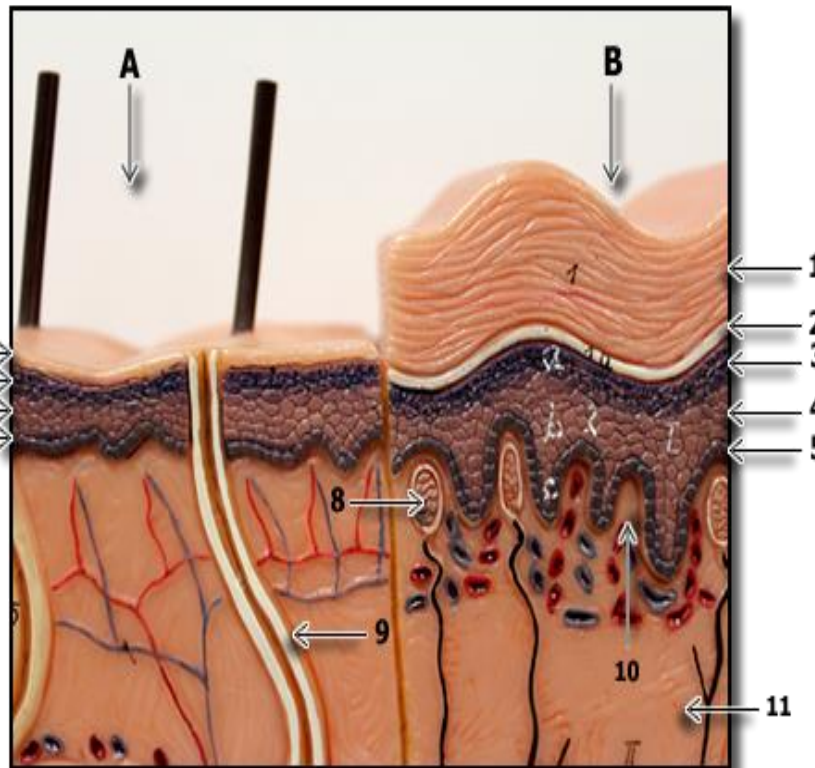


# Types of skin

Thin skin

Thick skin

Thin vs. Thick skin



\* Dominant and lines most of the body surface

\* Palms of the hands and soles of the feet

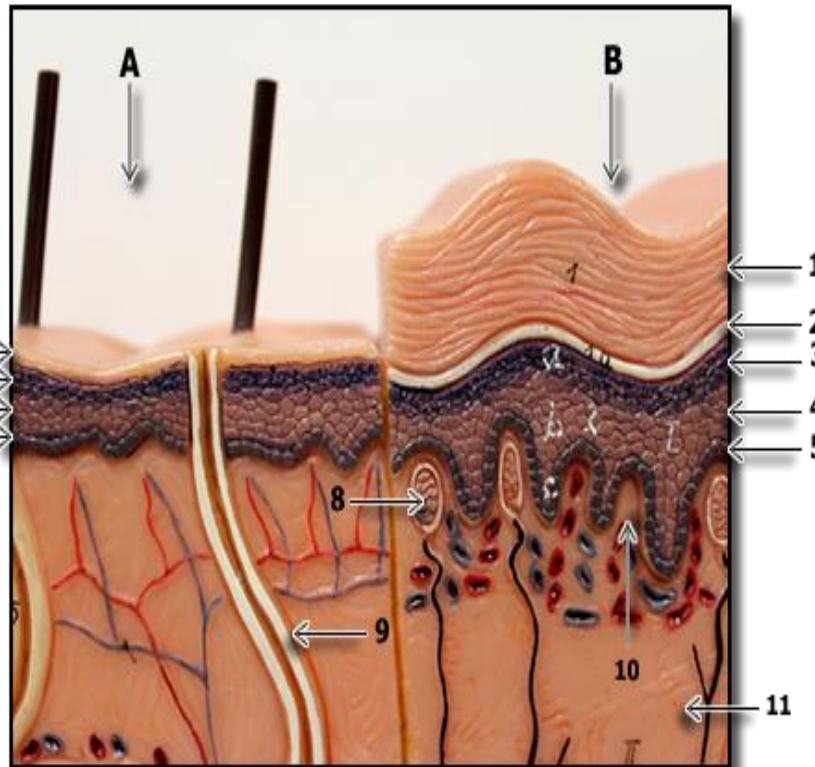
# Types of skin

Thin skin

*Note that the thin and thick refer to the thickness of epidermal layer*

Thick skin

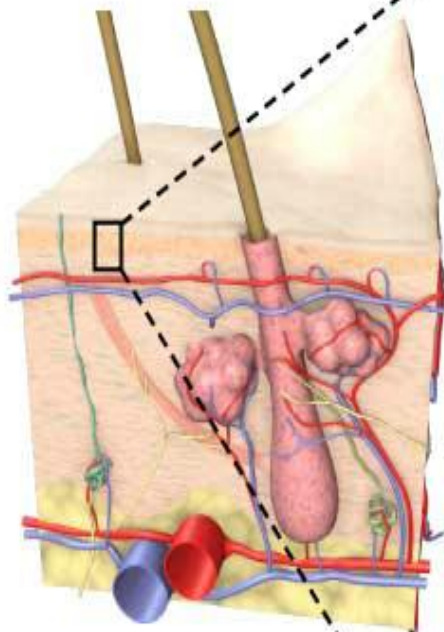
Thin vs. Thick skin



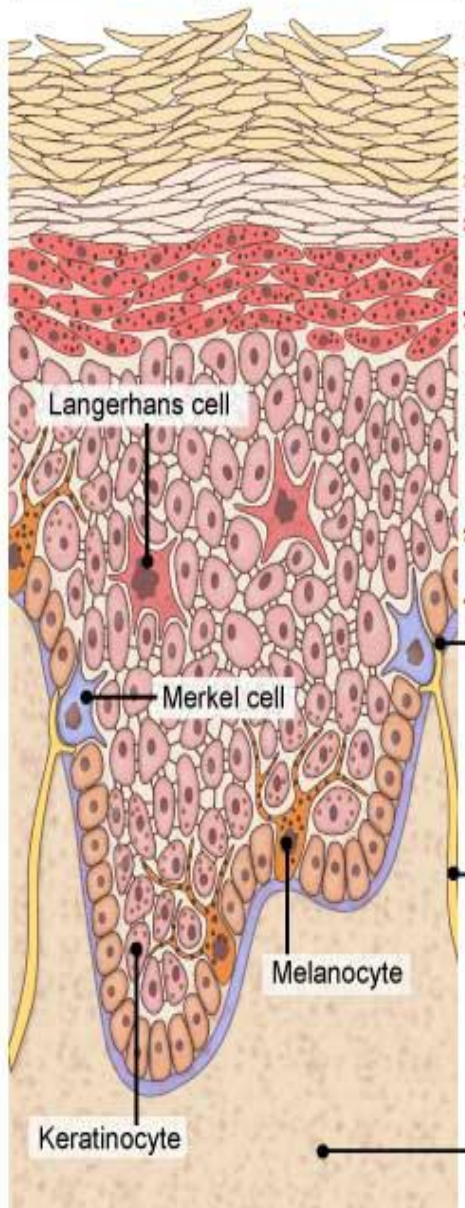
\* Dominant and lines most of the body surface

\* Palms of the hands and soles of the feet

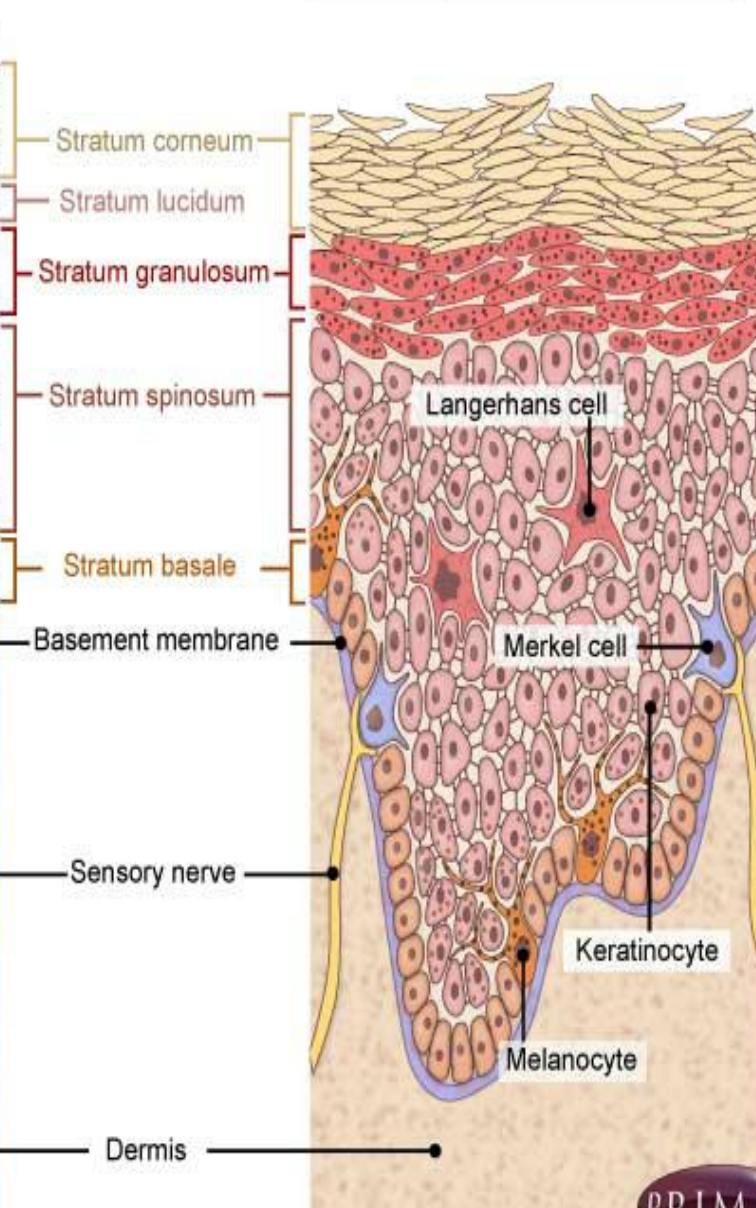




Non-hairy skin 1.5mm



Hairy skin 0.1mm



# Types of skin

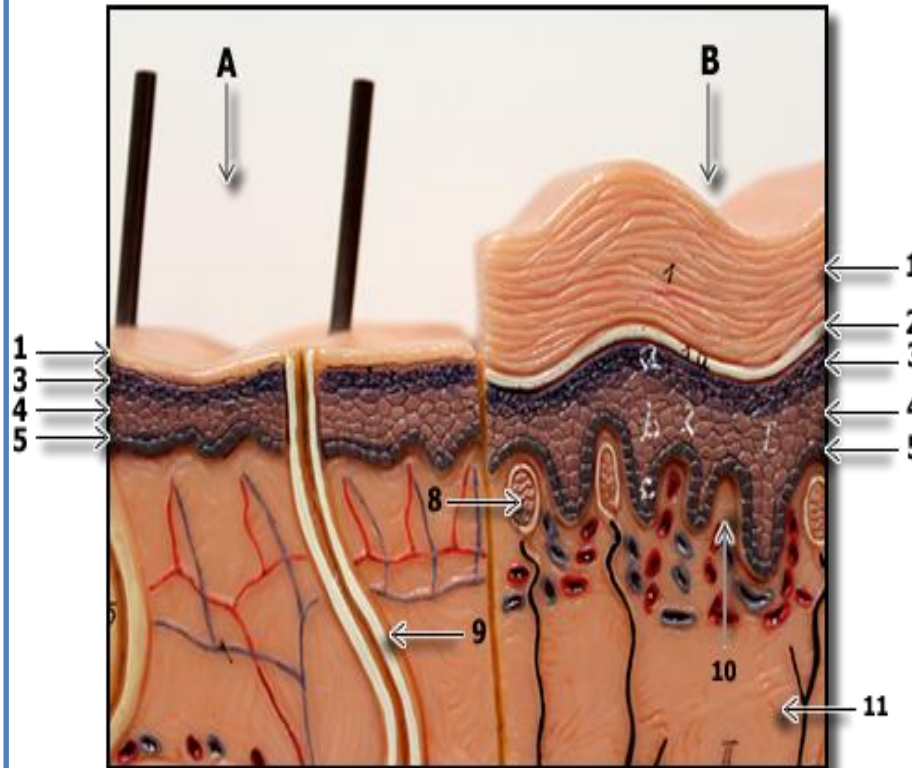
## Thin skin

- \* 4 layers
- \* less Prominent stratum corneum
- \* Less developed stratum granulosum
- \* Dominant and lines most of the body surface
- \* Thicker dermis
  - \* hair and sebaceous glands

## Thick skin

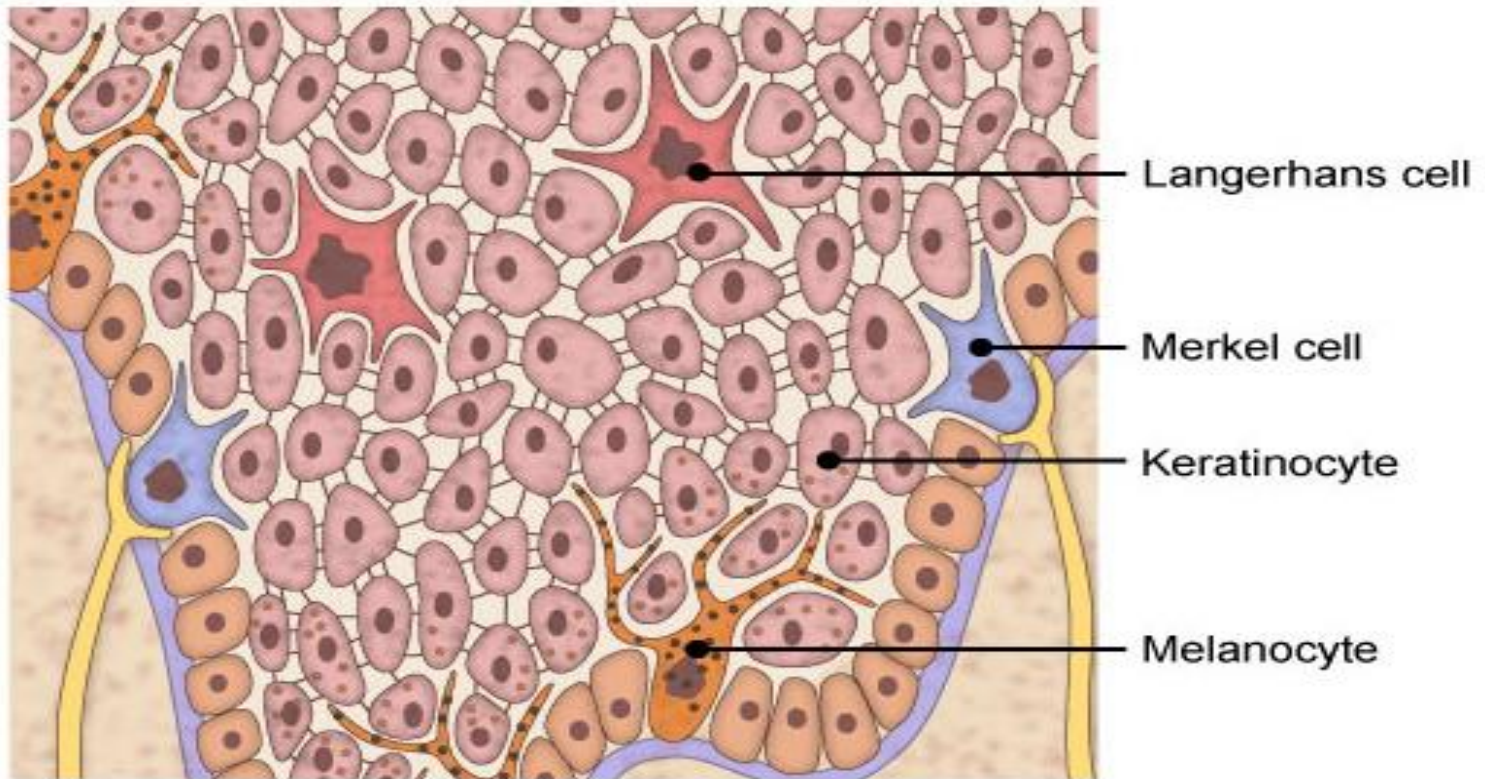
- \* 5 layers
- \* Prominent stratum corneum
- \* Well developed stratum granulosum
- \* Palms of the hands and soles of the feet
- \* Thinner dermis
  - \* No hair and sebaceous glands

Thin vs. Thick skin





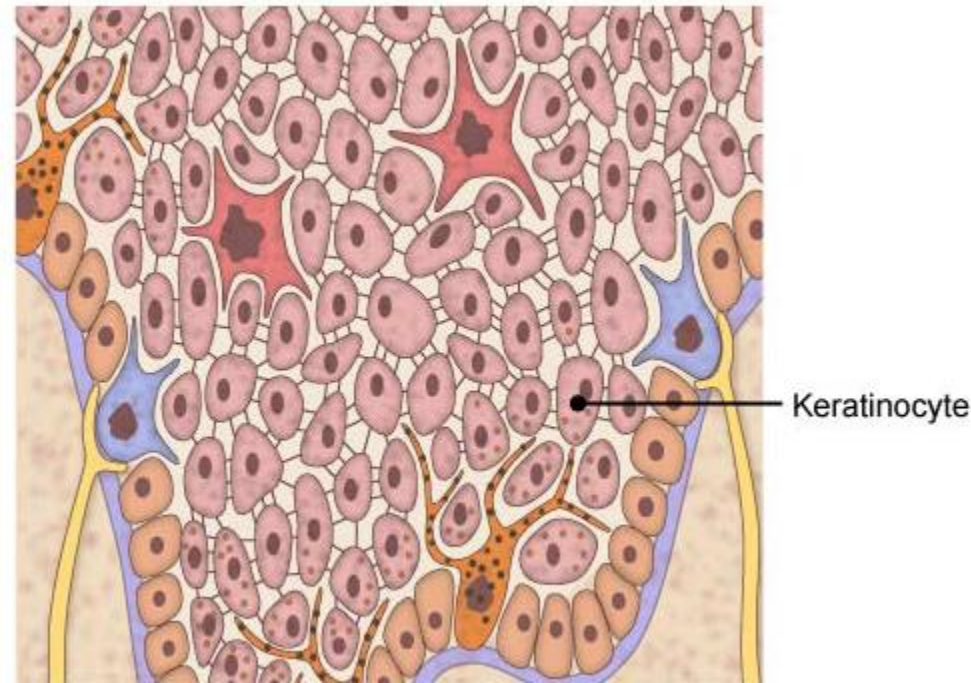
# TYPES OF EPIDERMAL CELLS



## (1)-keratinocytes:

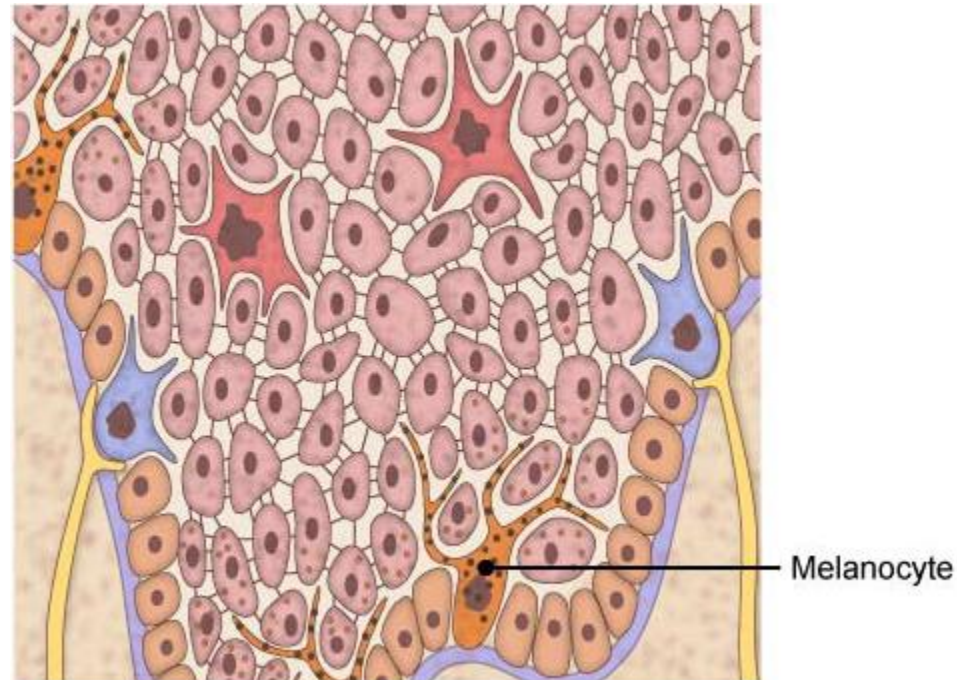
- Approximately 90% of epidermal cells are keratinocytes.
- They produce a substance called *keratin*, which is a tough and fibrous protein that serves to protect the skin.
- Keratinocytes also produce *lamellar granules that helps waterproof the skin*.
- The structure of keratinocytes changes dramatically as they mature: they change from square-shaped cells to flat cells.
- Throughout their life they become engorged with keratin before eventually dying, losing all of their internal structures.

**keratinocytes continuously shed and regenerate every 2-4 weeks**



## (2)-Melanocytes:

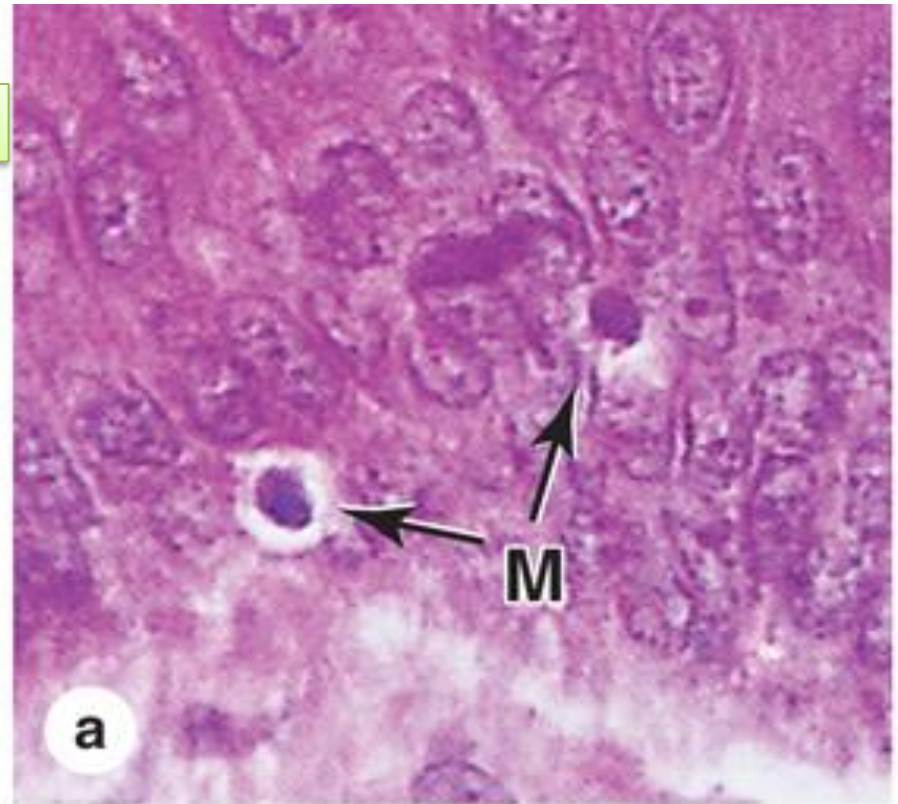
- Melanocytes are derived from the neural crest cells.
- Melanocytes have processes that transfer melanin granules to the keratinocytes
- Melanocytes are located in the stratum basale
- Synthesize the dark brown pigment melanin.
- Melanin is synthesized from the amino acid tyrosine by melanocytes.
- Melanin imparts a dark color to the skin, and exposure of the skin to sunlight promotes increased synthesis of melanin.
- The main function of melanin is to protect the skin from the damaging effects of ultraviolet radiation.





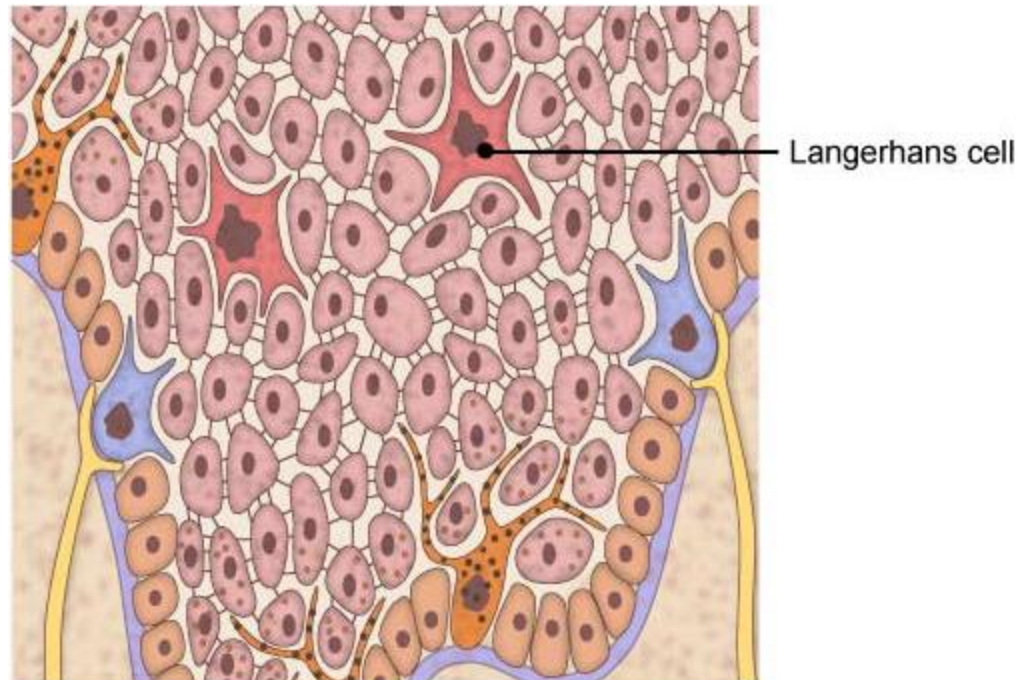
- attached to basal lamina by hemidesmosomes
- Not attached to neighboring keratinocytes
- Lightly stained cytoplasm

1 melanocyte for every 5-6 basal keratinocytes



### (3)- Langerhans cells:

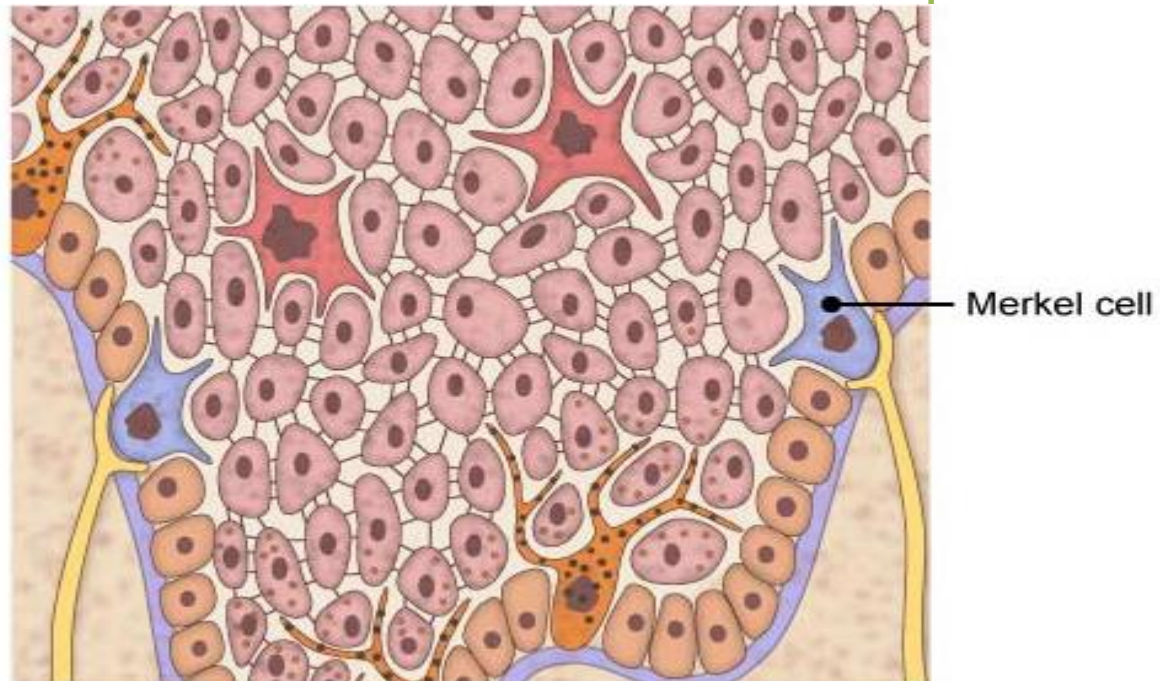
- Langerhans cells originate from bone marrow (monocytes)
- Mainly in the stratum spinosum
- Are part of the immunologic defense of the skin
- Langerhans cells recognize, phagocytose, and process foreign antigens
- Represent 2-8% of epidermal Cells





## (4)- Merkel cells:

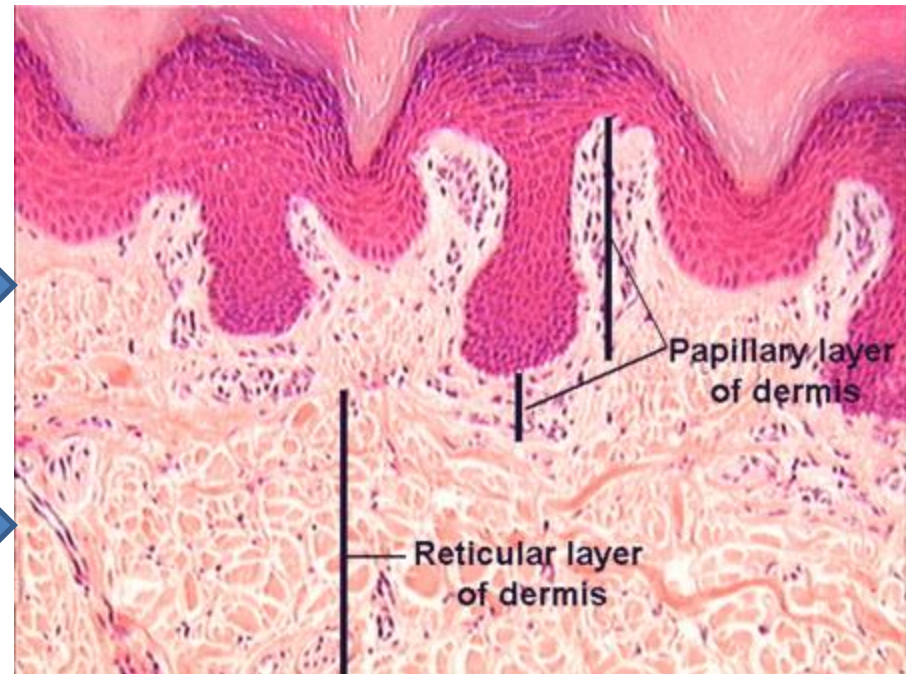
- Merkel cells are found in the stratum basale
  - Originate from the same cells as keratinocytes
  - Are most abundant in the fingertips
- Attached to neighboring keratinocytes by desmosomes
  - Are closely associated with afferent (sensory) neurons
  - Function as light touch receptors (mechanoreceptors)
  - Sensory nerve fibers form terminal disk under Merckels cells



## **\*\*Dermis**

- The dermis lies immediately beneath the epidermis and is much thicker
- It is responsible for the elasticity and strength of skin
- It supplies the epidermis with nutrients, and plays an important role in thermoregulation

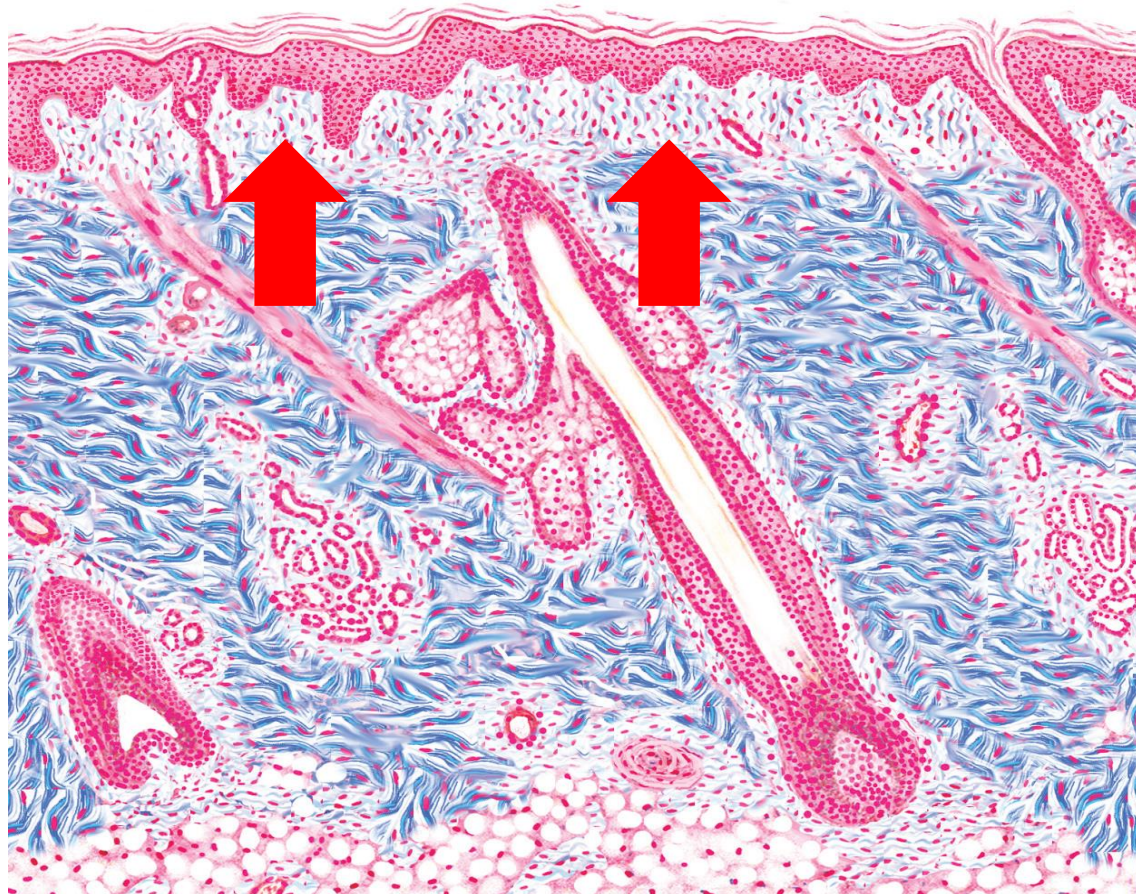
The dermis can be divided into two sub-layers:





## (1)-Papillary dermis

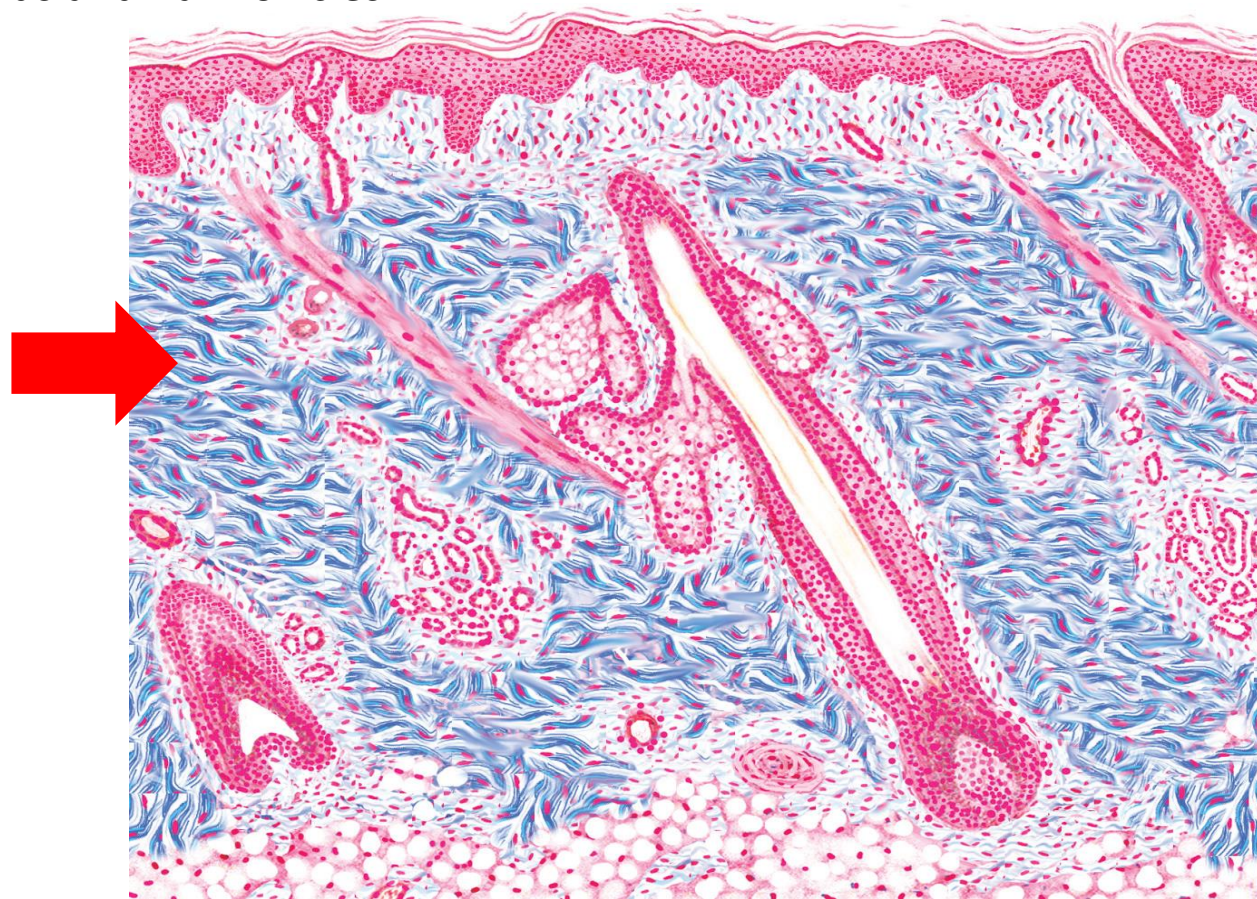
The papillary dermis consists of loose type of c.t





## (2)Reticular dermis

- The reticular layer of the dermis (RD) consists of mainly dense irregular connective tissue
- The reticular layer of the dermis is important in giving the skin its overall strength (collagen1) and elasticity (elastic fibers), and an extracellular gel-like substance primarily composed of glycosaminoglycans (most notably hyaluronan and dermatan sulfate), proteoglycans, and glycoproteins) as well as housing other important epithelial derived structures such as glands and hair follicles.



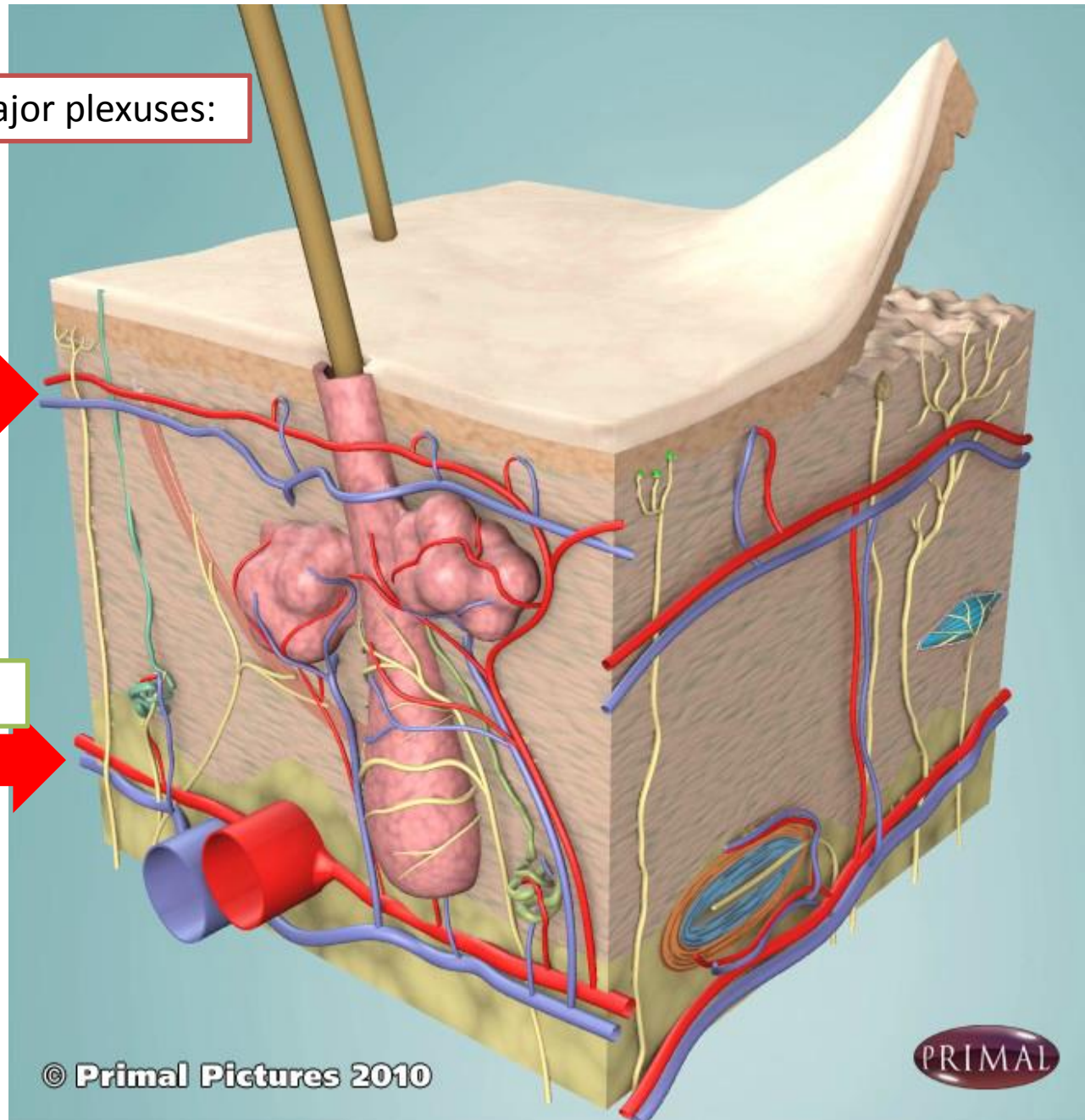


The blood vessels form two major plexuses:

Subpapillary plexus

Dermal-hypodermal plexus

➤ Thermoregulation



# Sensory receptors

## Unencapsulated nerve receptors

### 1- Merkel disc :

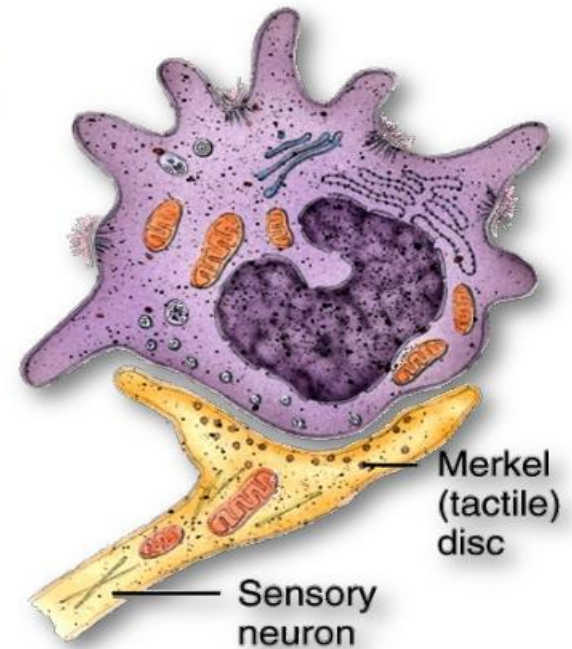
- for light touch and sensing an object texture
- expanded nerve endings associated with merkel cell

### 2- Free nerve endings

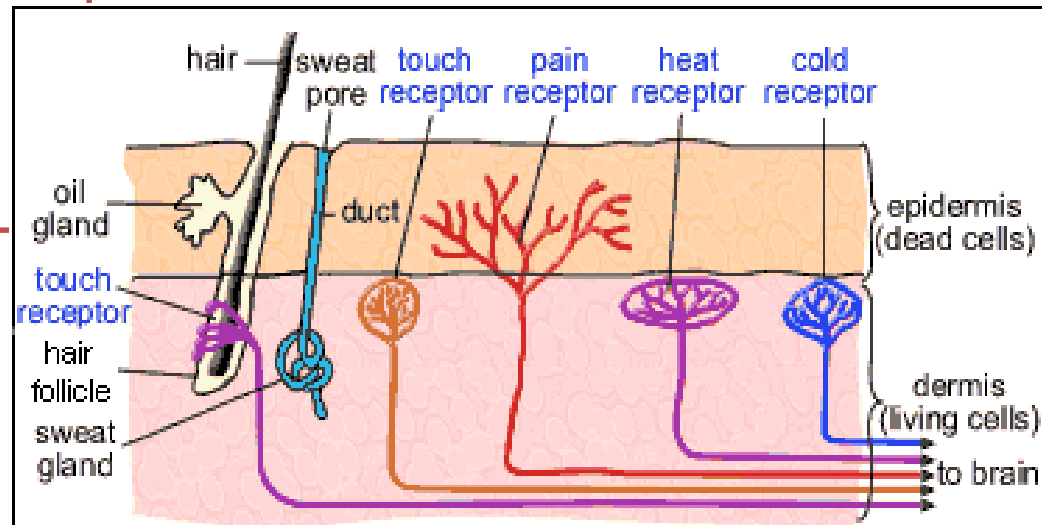
- In papillary dermis
- Temperature, pain, itching, tactile sensation

### 3- Root hair plexuses

- Surround the bases of hair follicles in reticular dermis
- Detect movements of hair



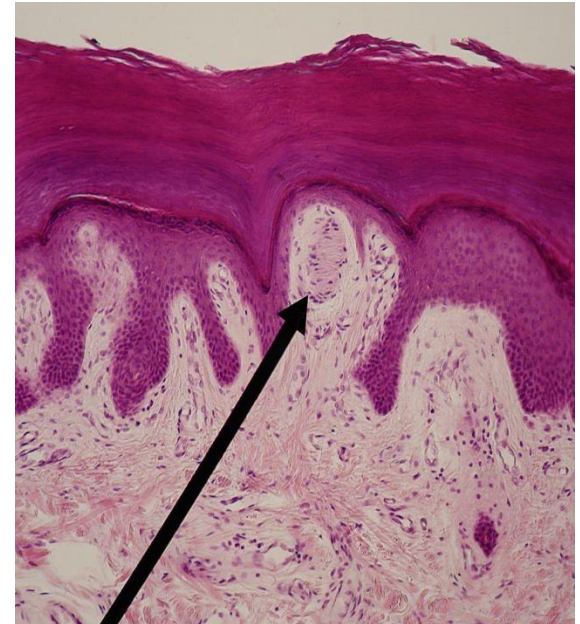
18



**The structure of human skin**

### Meissner corpuscles:

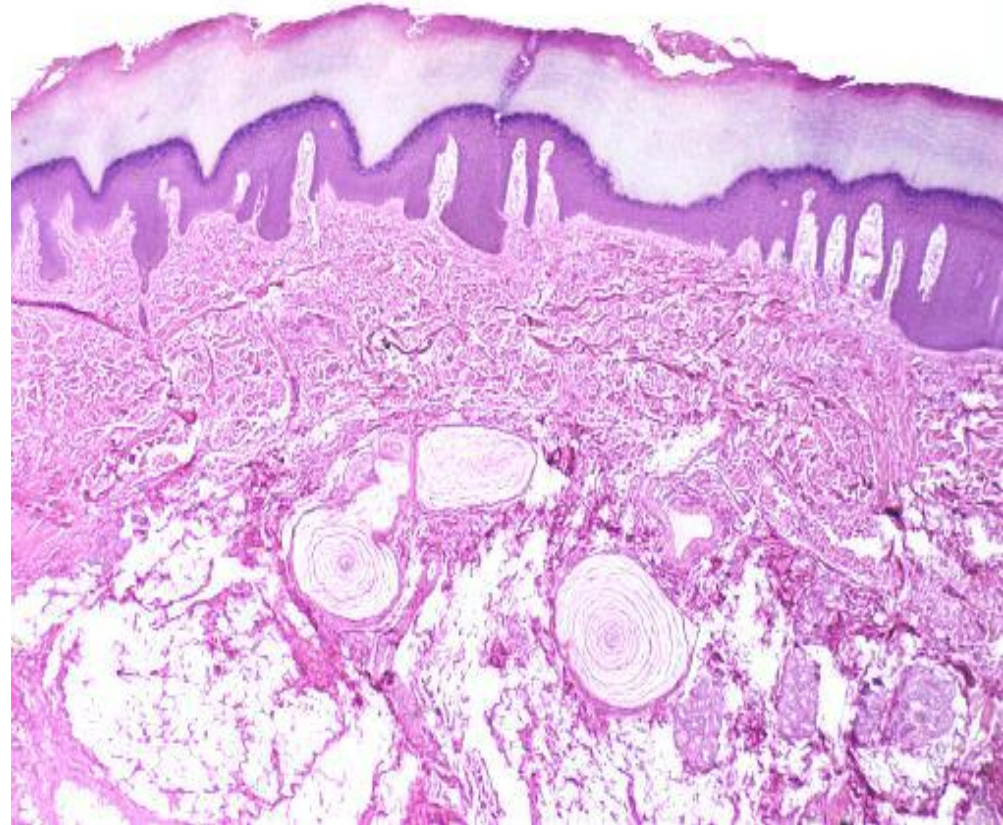
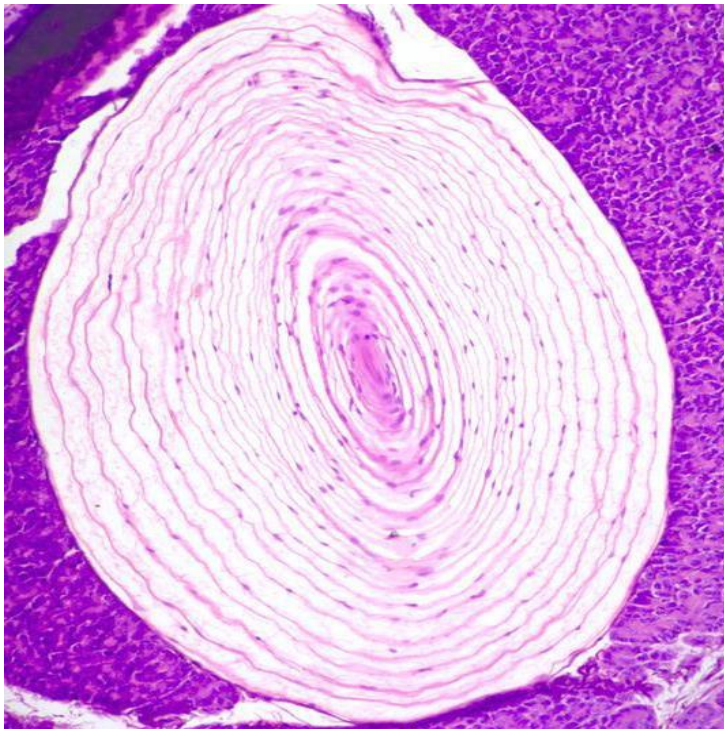
- Encapsulated
- In the dermal papilla
- Light touch
- Are numerous in fingertips, palms and soles
- Decline in number with aging





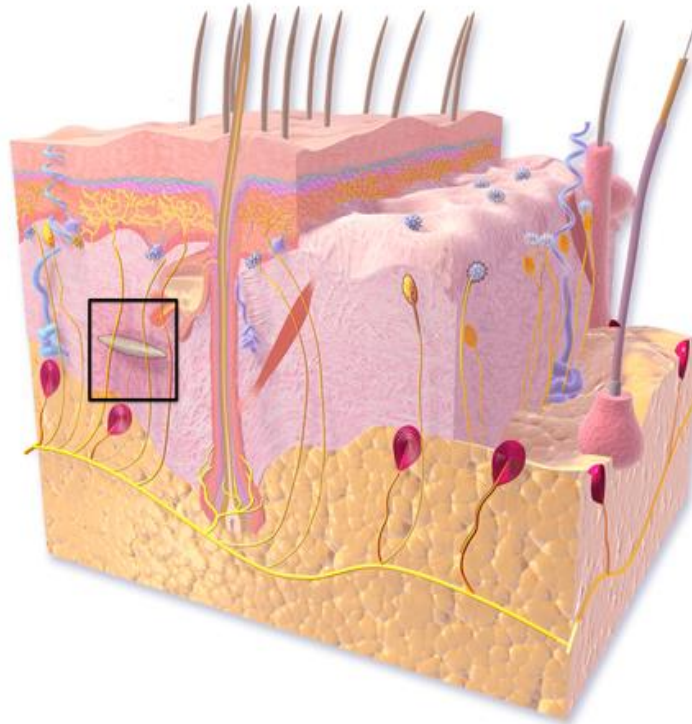
## Pacinian corpuscles

- Encapsulated
- Found deep in reticular dermis and hypodermis
- Coarse touch, pressure (sustained touch) and vibrations

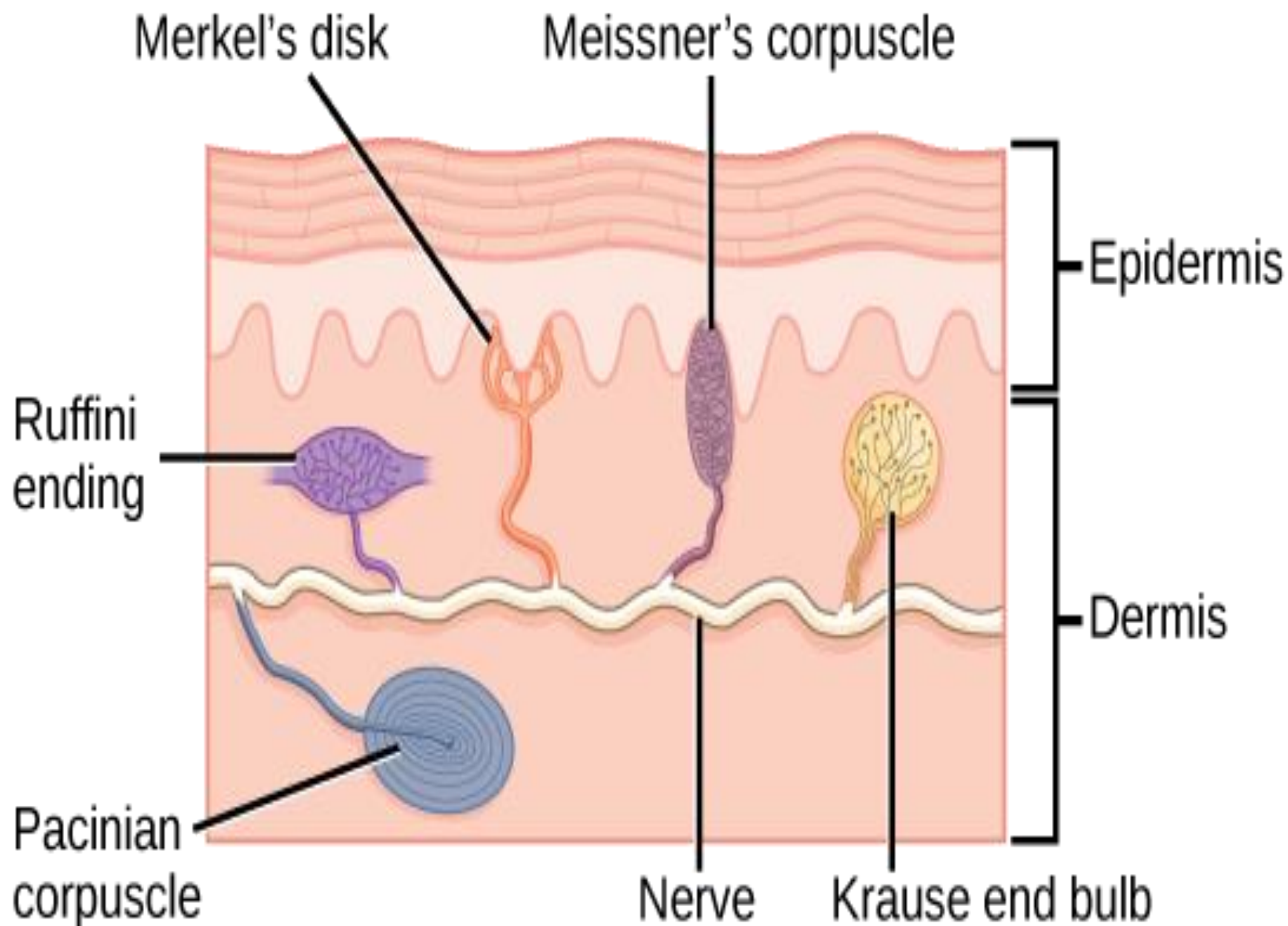


## Ruffini corpuscles

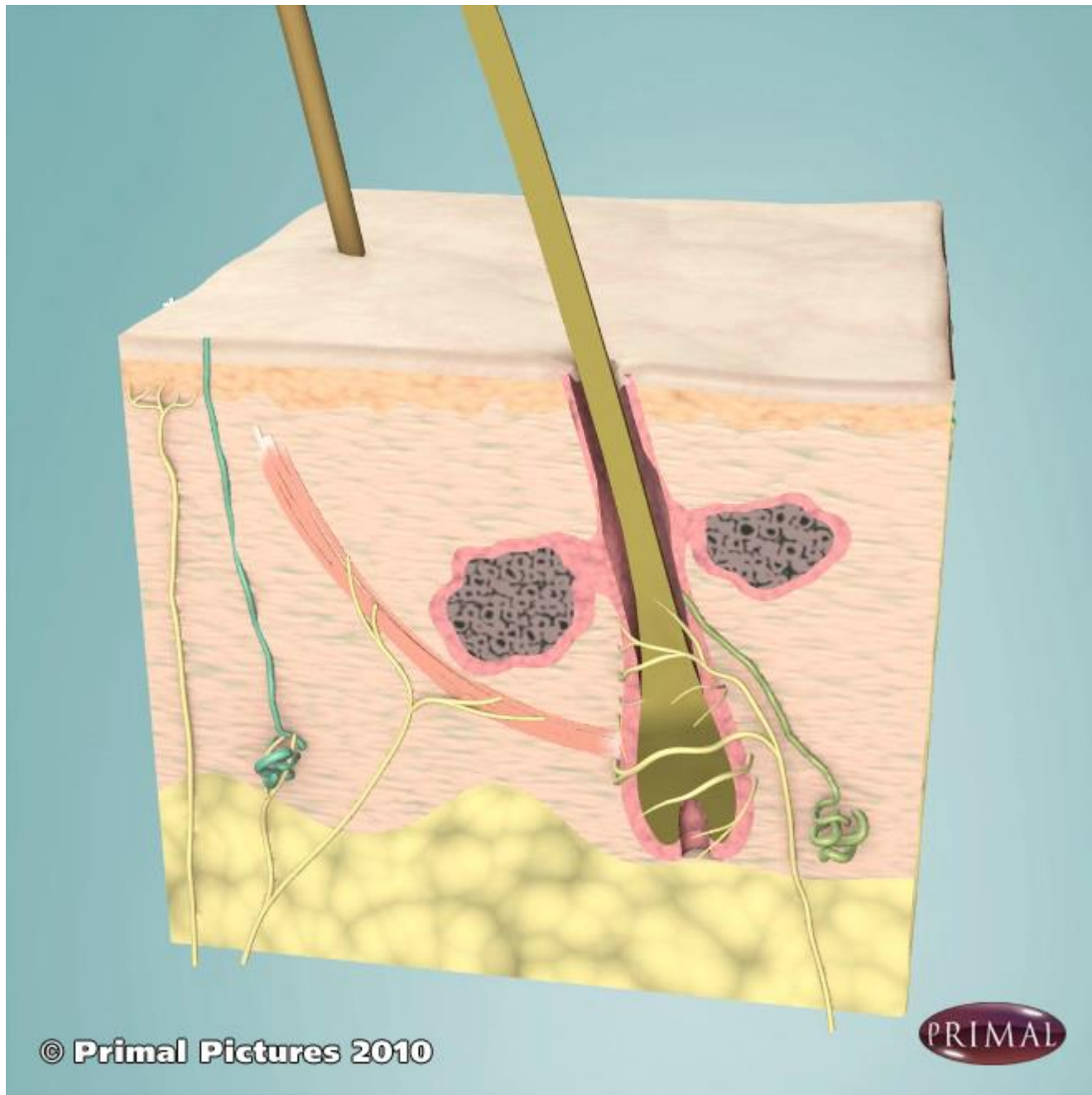
- Encapsulated
- Stretch (tension) and twisting (torque)



**Ruffini Corpuscle**





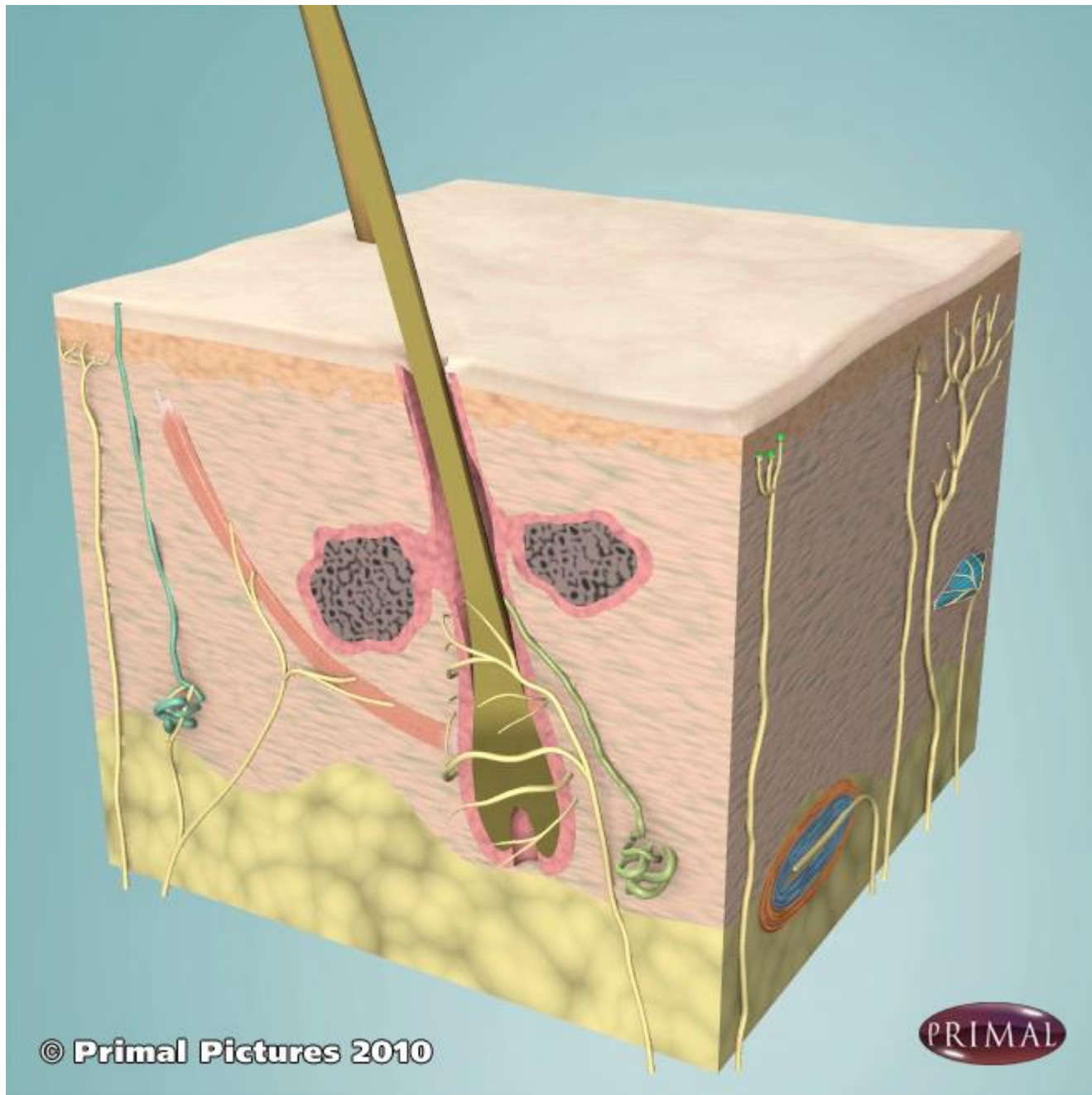


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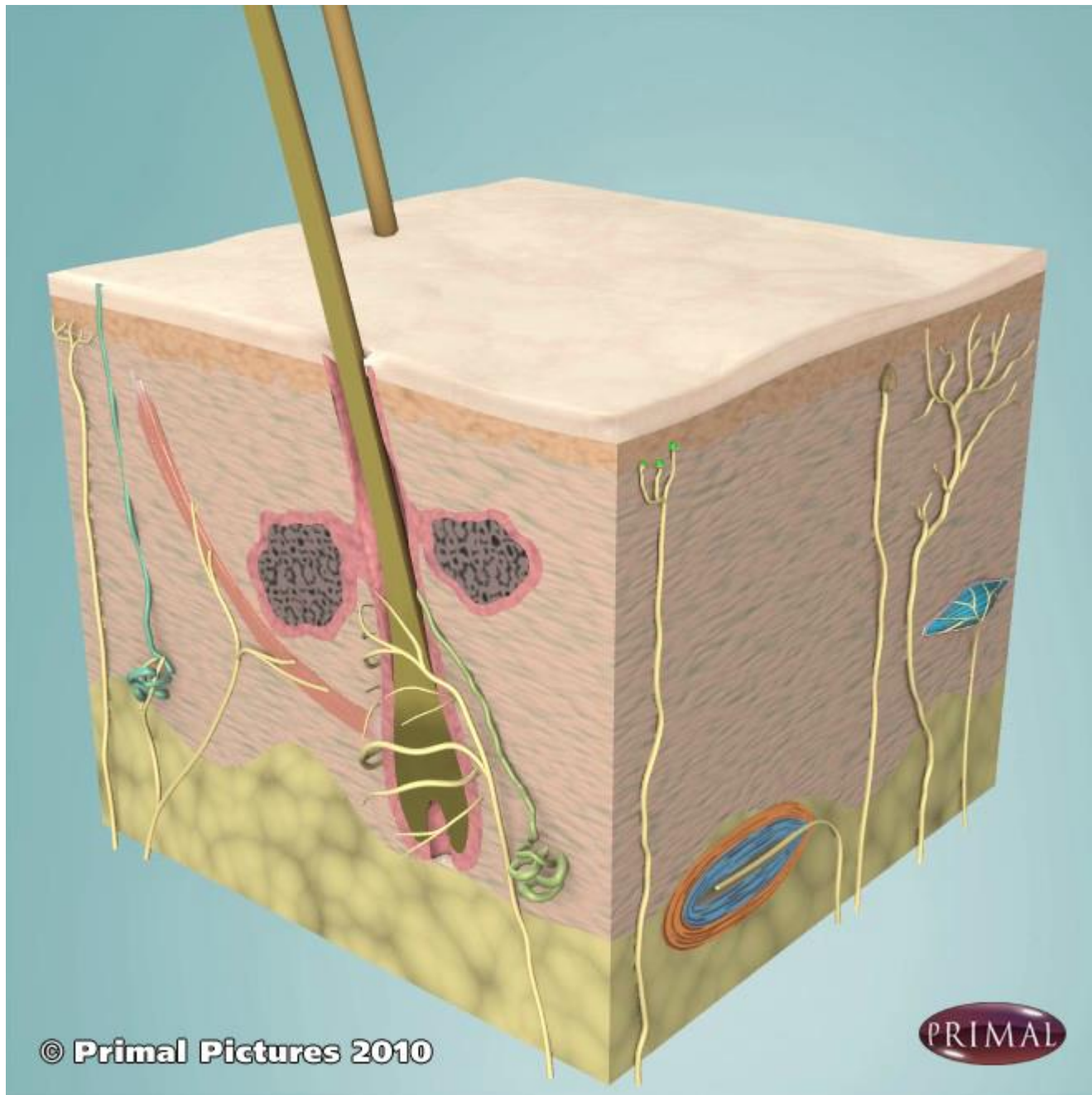






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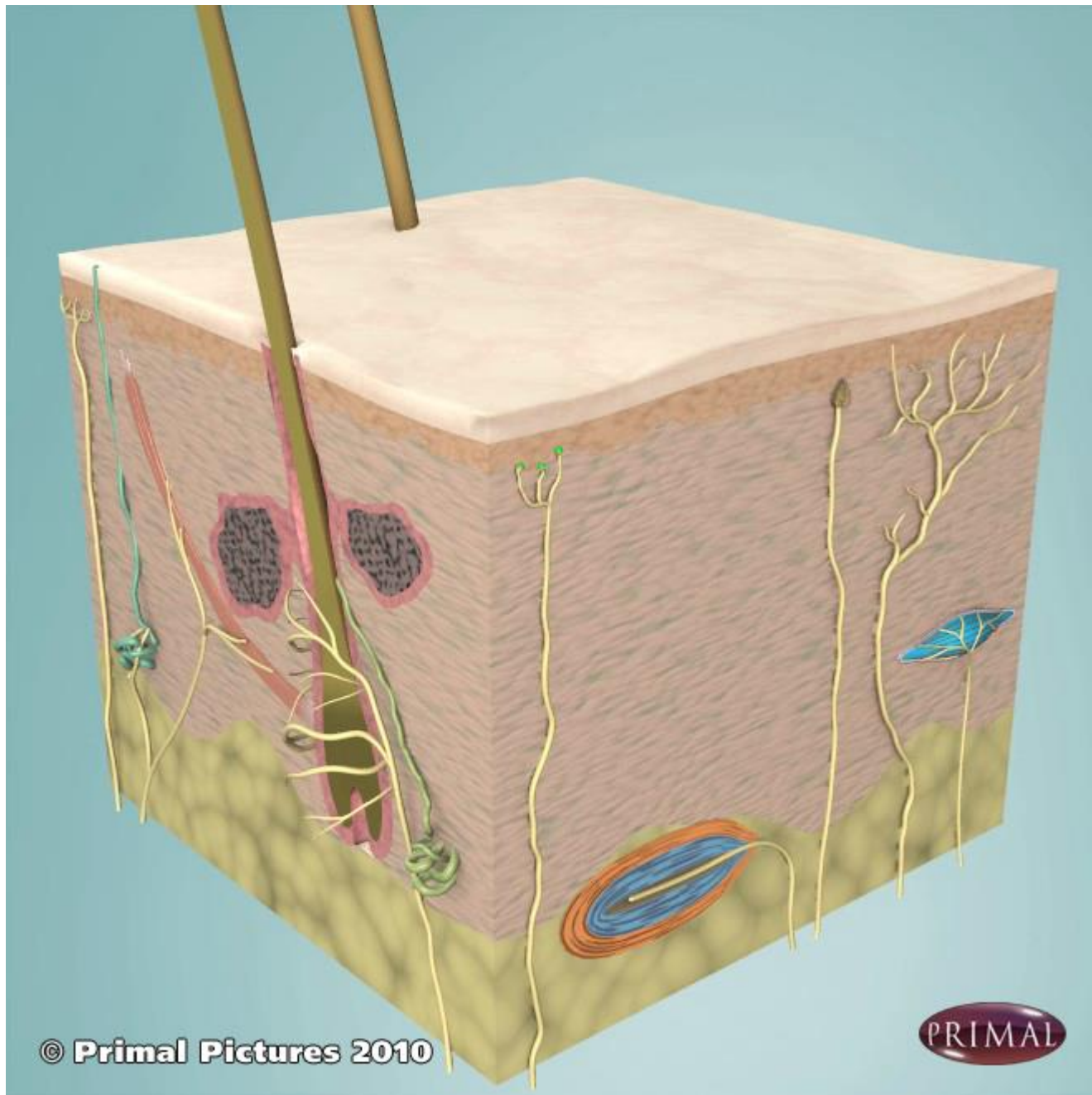




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# Skin Appendages

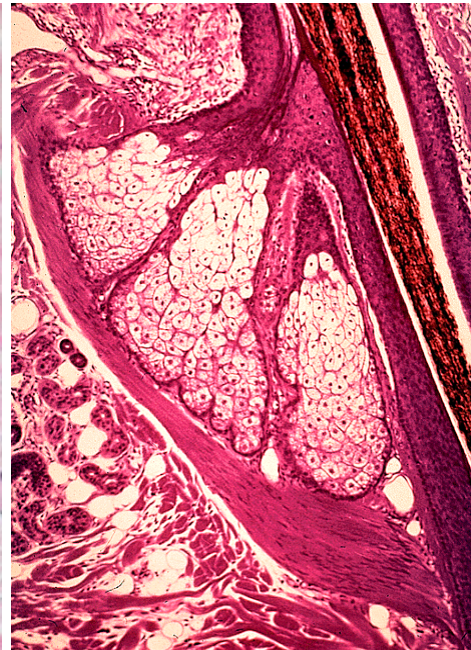
## 1-Hair Follicles and hair

## 2-Sweat Glands

- Eccrine or merocrine sweat glands
- Apocrine sweat glands

## 3-Sebaceous glands

## 4-Nails



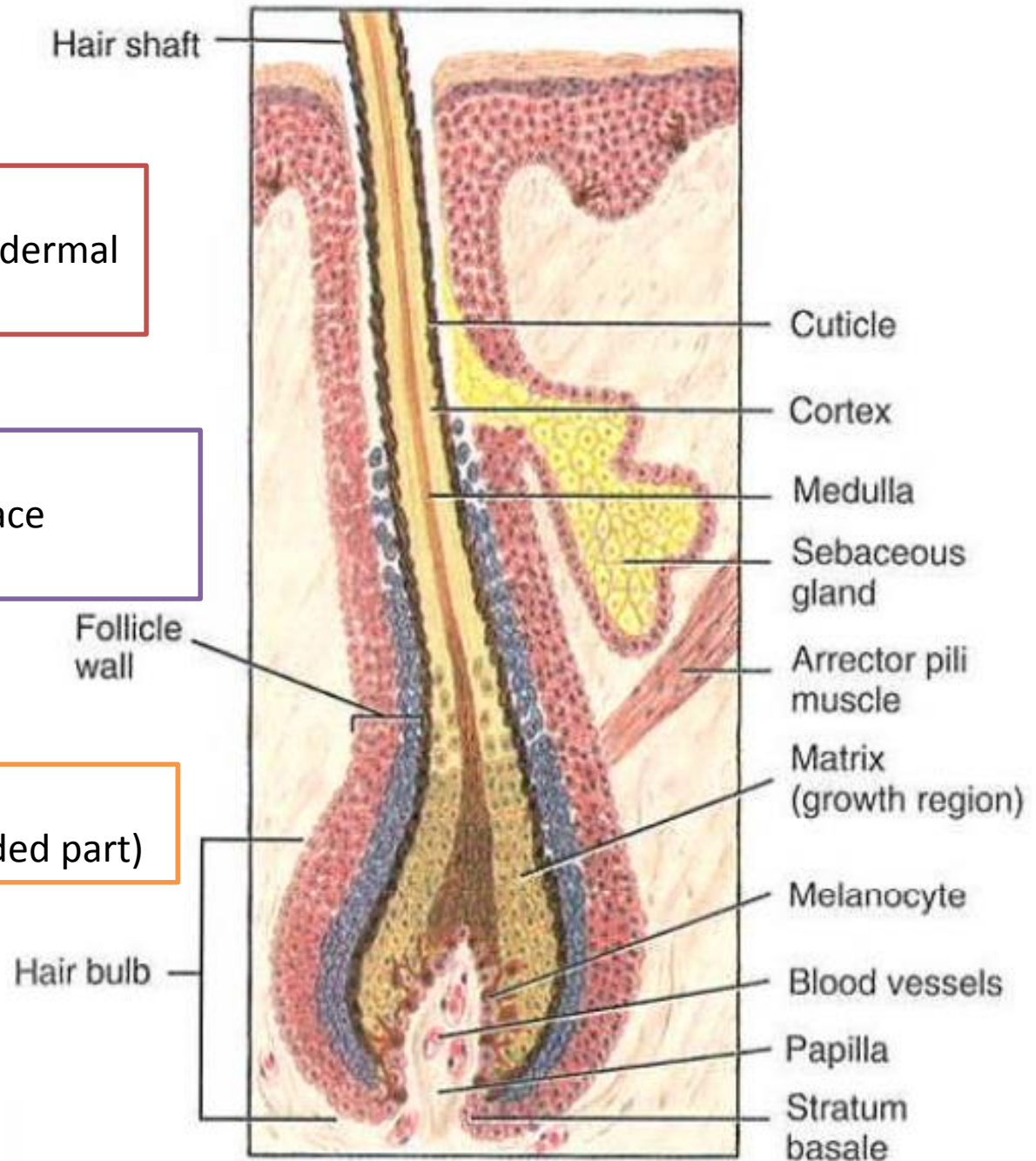
Hair



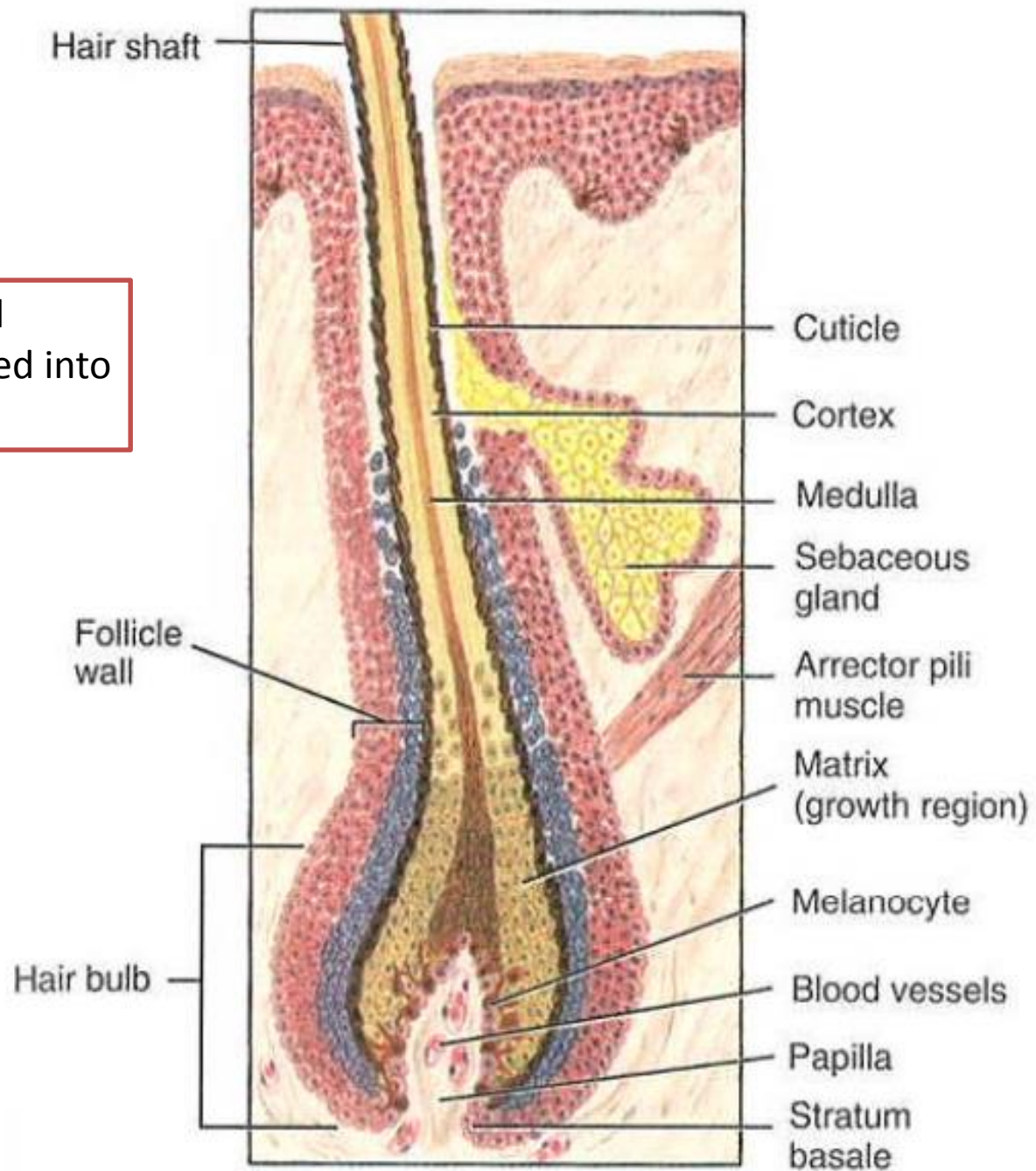
**Hairs** are elongated keratinized structures that form within epidermal invaginations (hair follicles)

**Hair shaft:** The part of a hair extending beyond the skin surface (visible part)

**Hair root:** The part of a hair below the skin surface (embedded part)



**Hair follicle** is a tube of stratified squamous epithelium, invaginated into the dermis

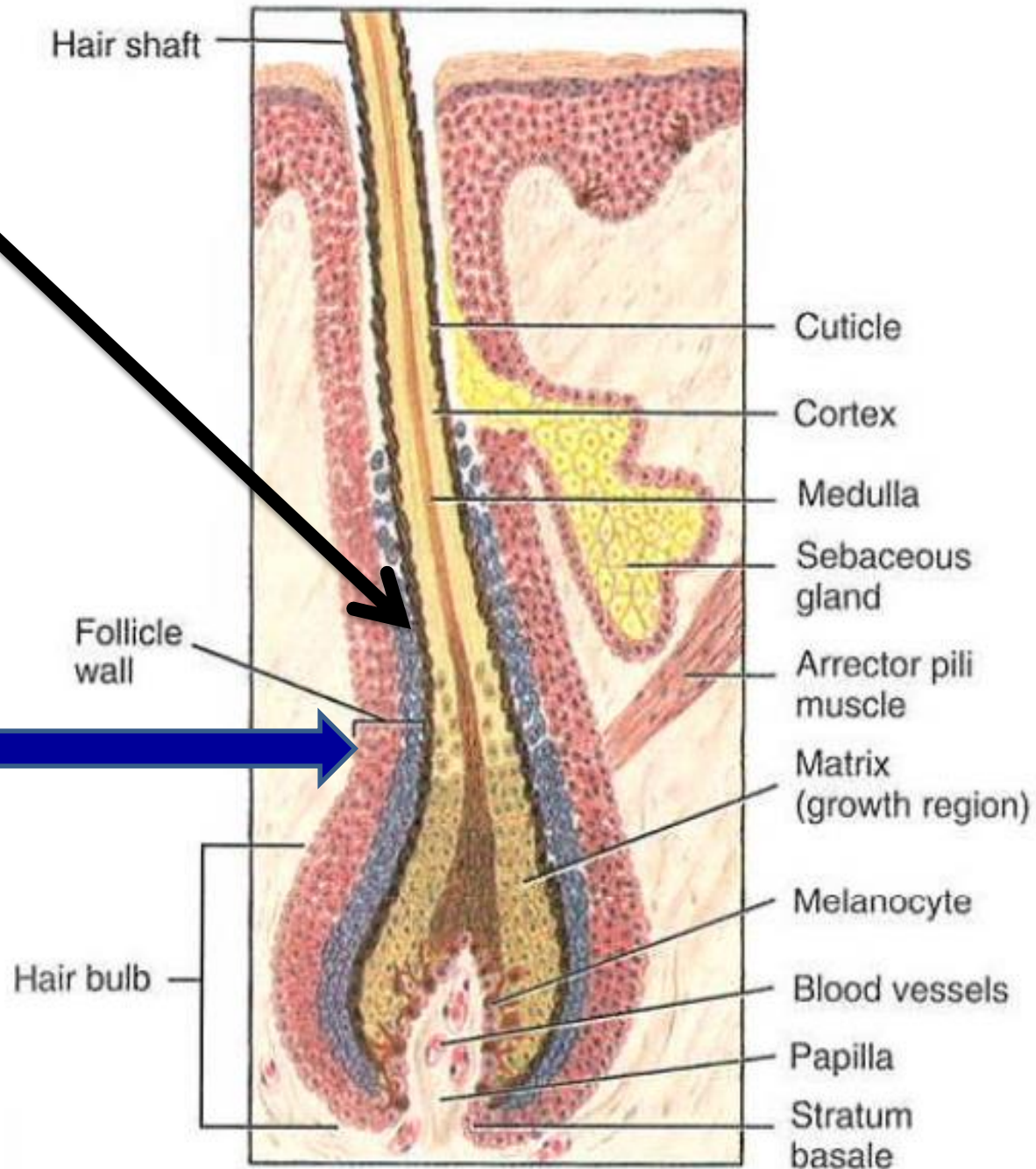


### INNER ROOT SHEATH

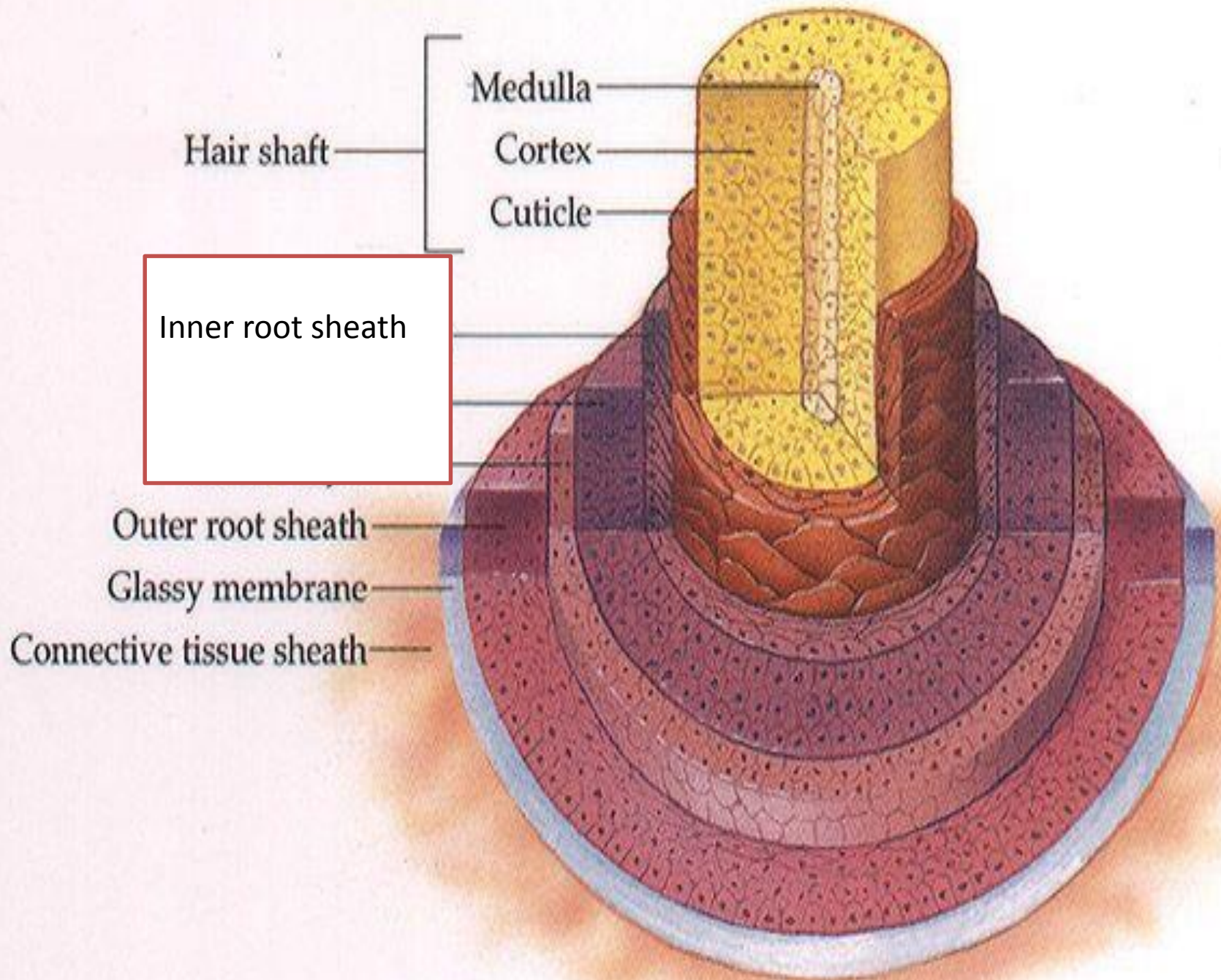
Disintegrates at the level of the sebaceous gland

### OUTER ROOT SHEATH

- Is continuous with the epidermis
- It does not take part in hair formation.
- Surrounded by a glassy basement membrane
- Basement membrane is surrounded by a connective tissue sheath.

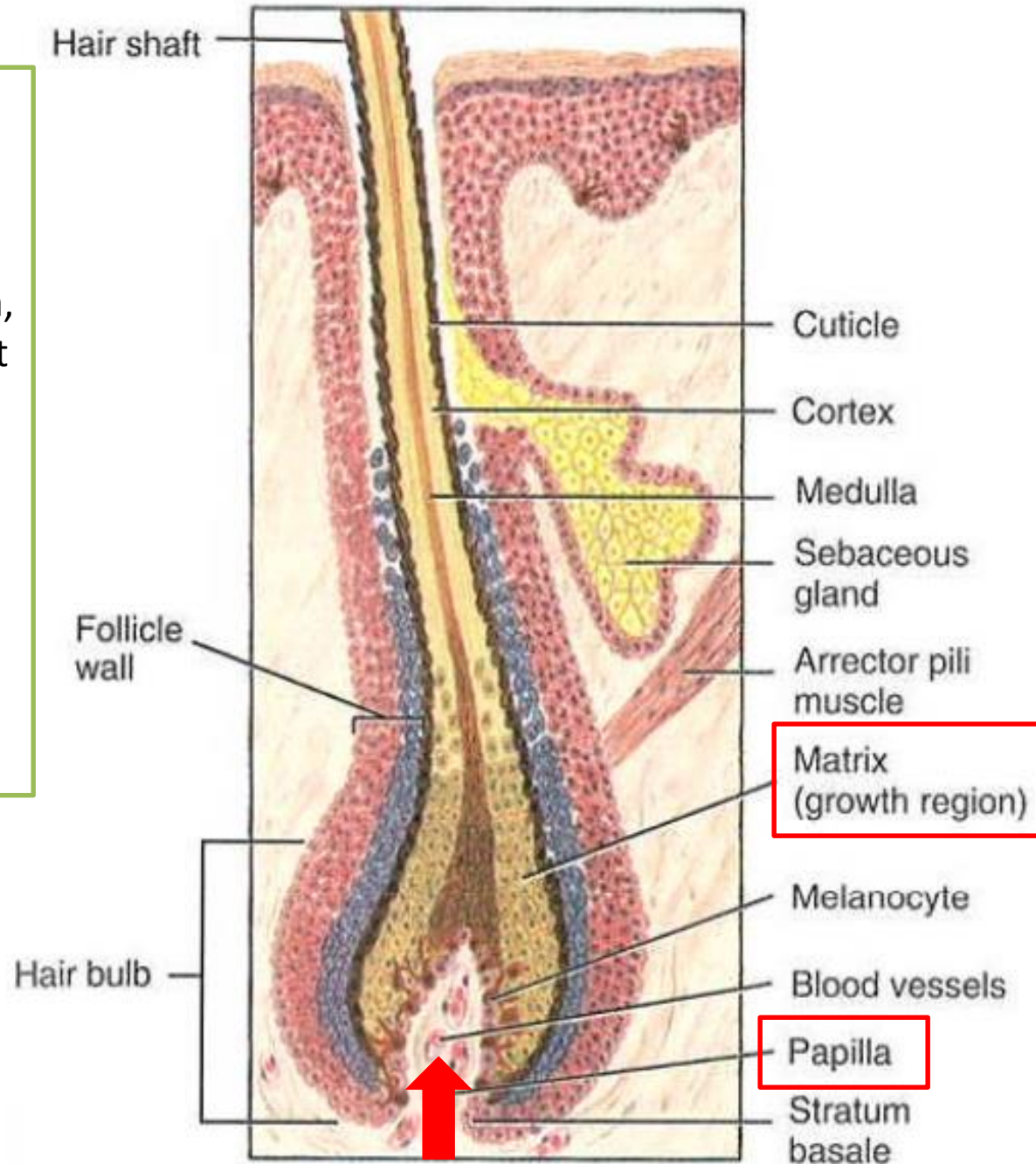






## Hair matrix

- contains the proliferating cells that generate the hair and the internal root sheath
- is just above the dermal papilla,
- separated from it by a basement membrane.
- the cells in the hair matrix proliferate and move upwards, gradually becoming keratinized to produce the hair.
- Melanocytes located in the matrix produce hair color.



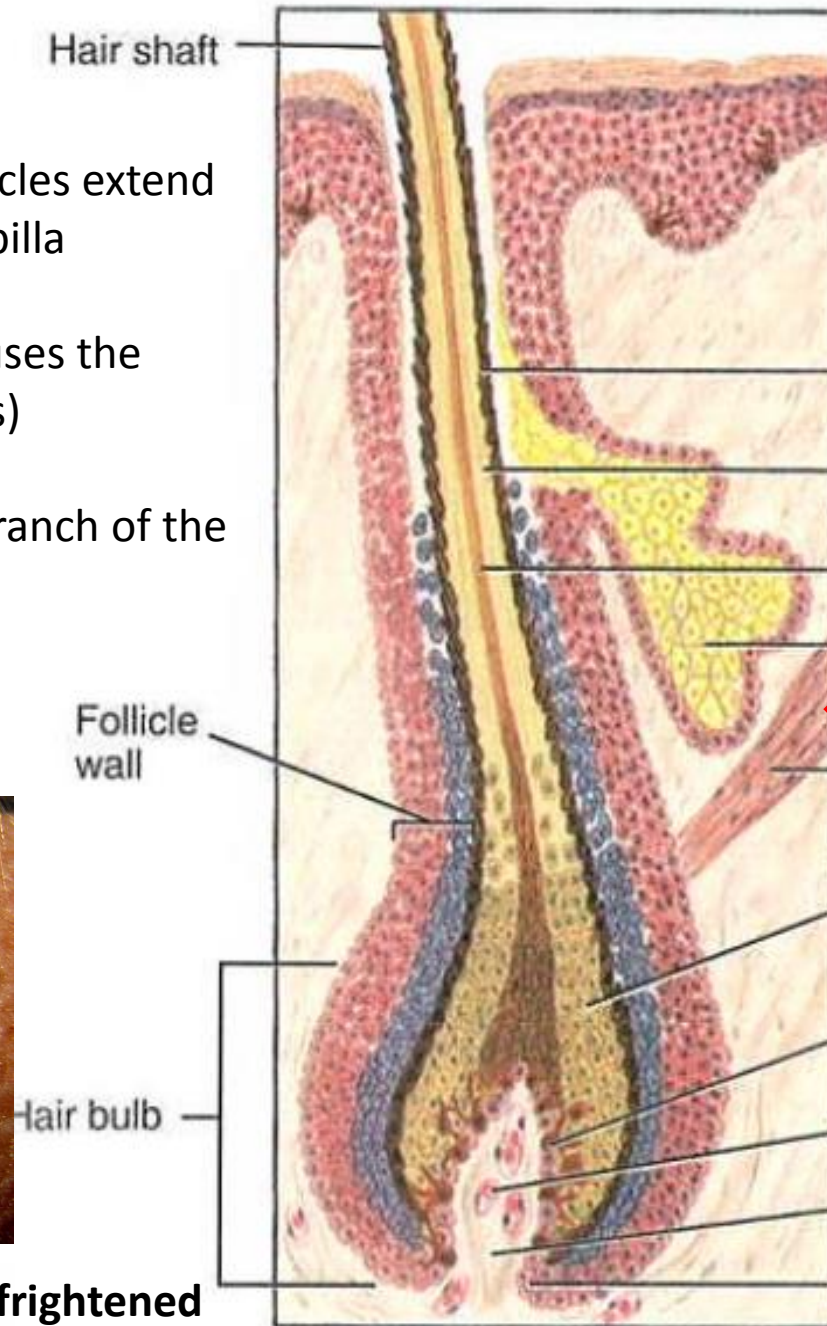


**Arrector pili muscles** are small muscles extend from hair follicles to the dermal papilla

- Contraction of these muscles causes the hairs to stand on end (goose bumps)
- Innervated by the sympathetic branch of the autonomic nervous system



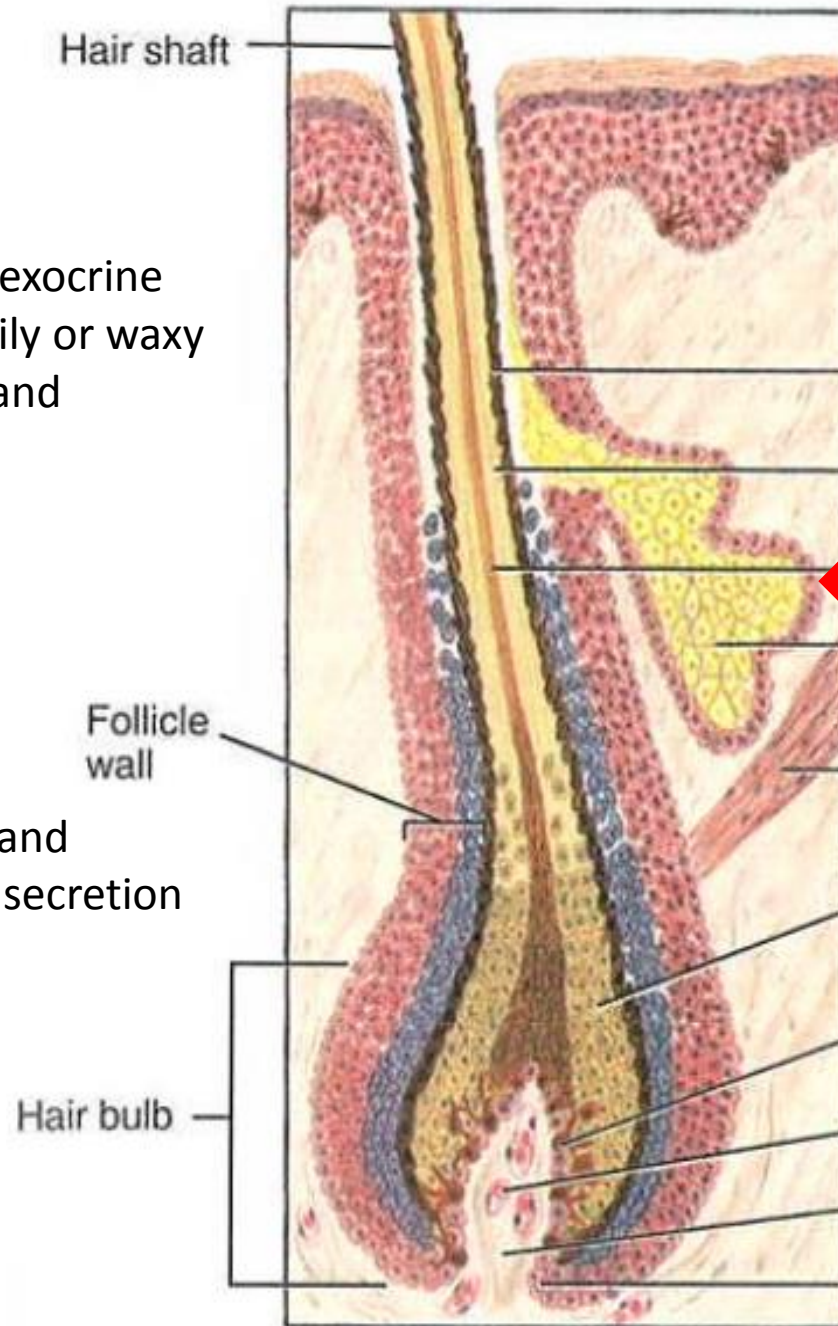
**Pulls hairs upright when cold or frightened**





**Sebaceous glands** are microscopic exocrine glands in the skin that secrete an oily or waxy matter, called **sebum**, to lubricate and waterproof the skin and hair

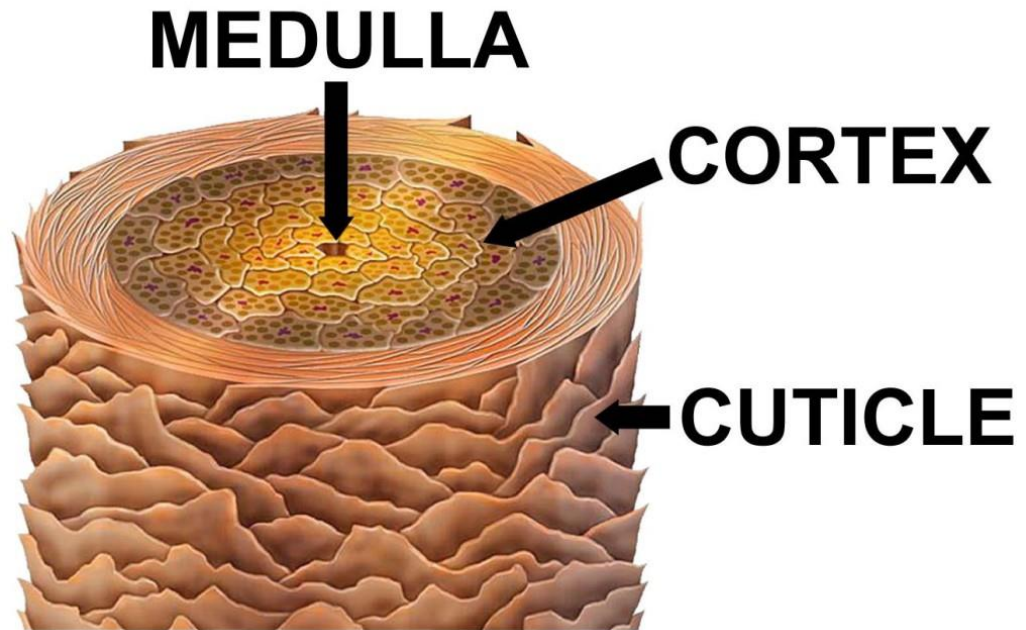
- Are simple branched acinar gland
- Secrete by holocrine mode of secretion



**Medulla:** large vacuolated and moderately keratinized cells

**Cortex:** heavily keratinized and densely packed cells

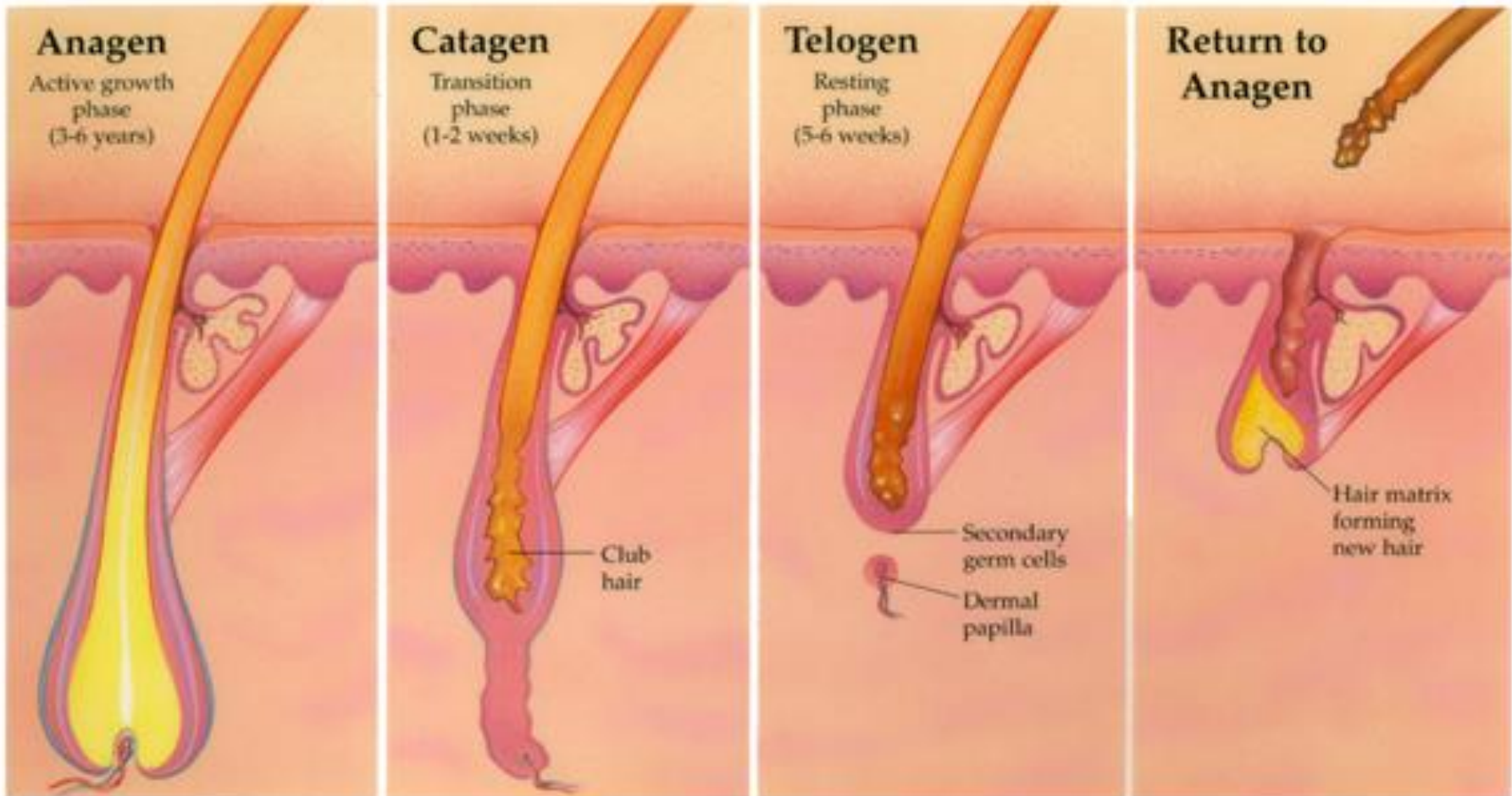
**Cuticle:** thin layer heavily keratinized squamous cells covering the cortex



## Structure of the hair shaft

Hairs grow discontinuously, with periods of growth followed by periods of rest and this growth does not occur synchronously in all regions of the body or even in the same area

## Hair Growth Cycle



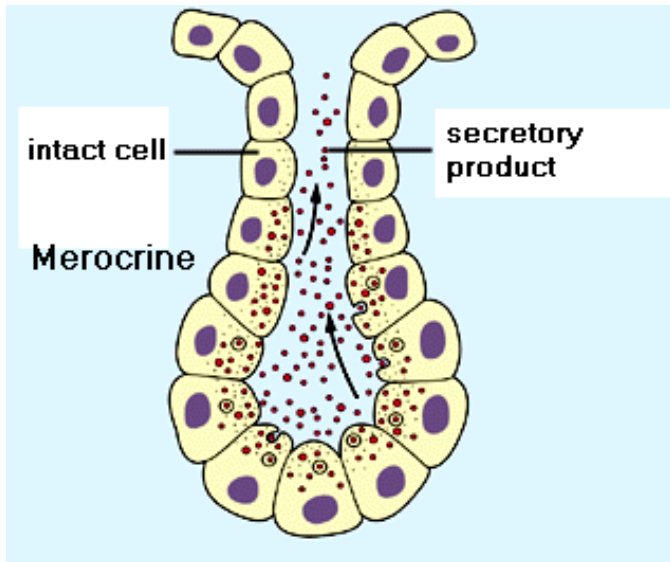


Sweat glands

# Sweat Glands

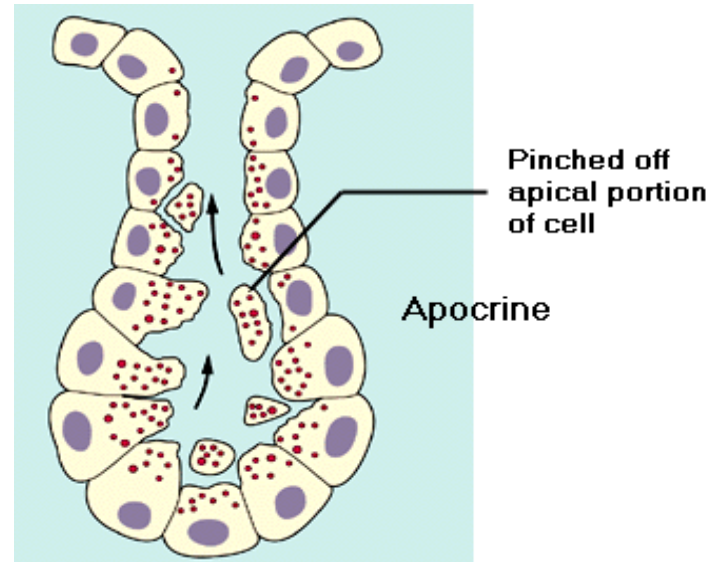
## Eccrine sweat gland

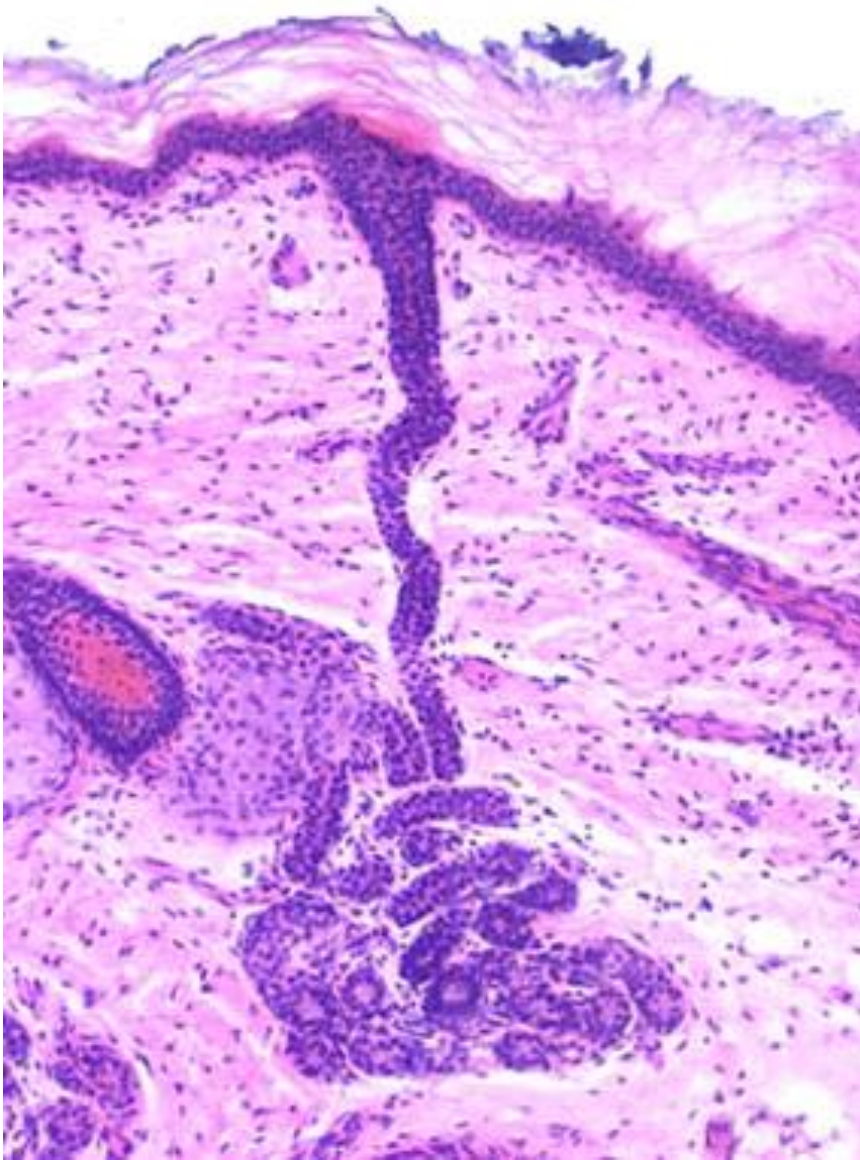
- Merocrine secretion
- Empty directly onto skin surface
- Location: most all over body (esp. abundant on palms & soles:  $\sim 500/\text{cm}^2$ )
- Clear, watery secretion (99%  $\text{H}_2\text{O}$ ; rest NaCl + some waste products)



## Apocrine sweat gland

- Empty into hair follicle
- Location: armpits, groin, nipples
- Viscous, cloudy secretion  $\rightarrow$  good nutrient source for bacteria (odor !!)
- Secretion may contain Pheromones
- Secretion begins at puberty and is stimulated during emotional distress

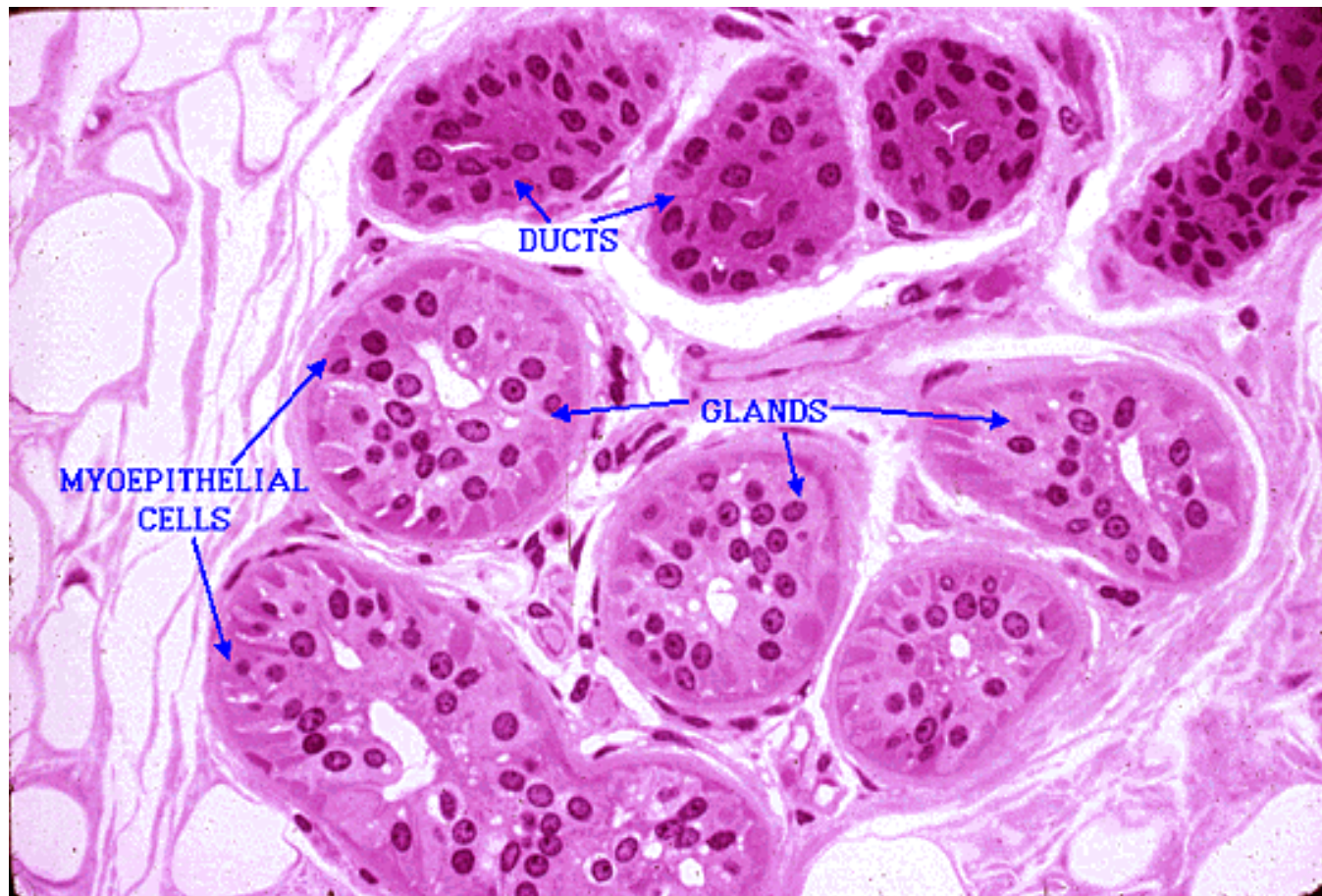




Sweat glands are simple coiled tubular



The secretory part is generally more pale-staining than the ducts



# Eccrine sweat glands

The secretory part consists of unusual stratified cuboidal with three cell types:

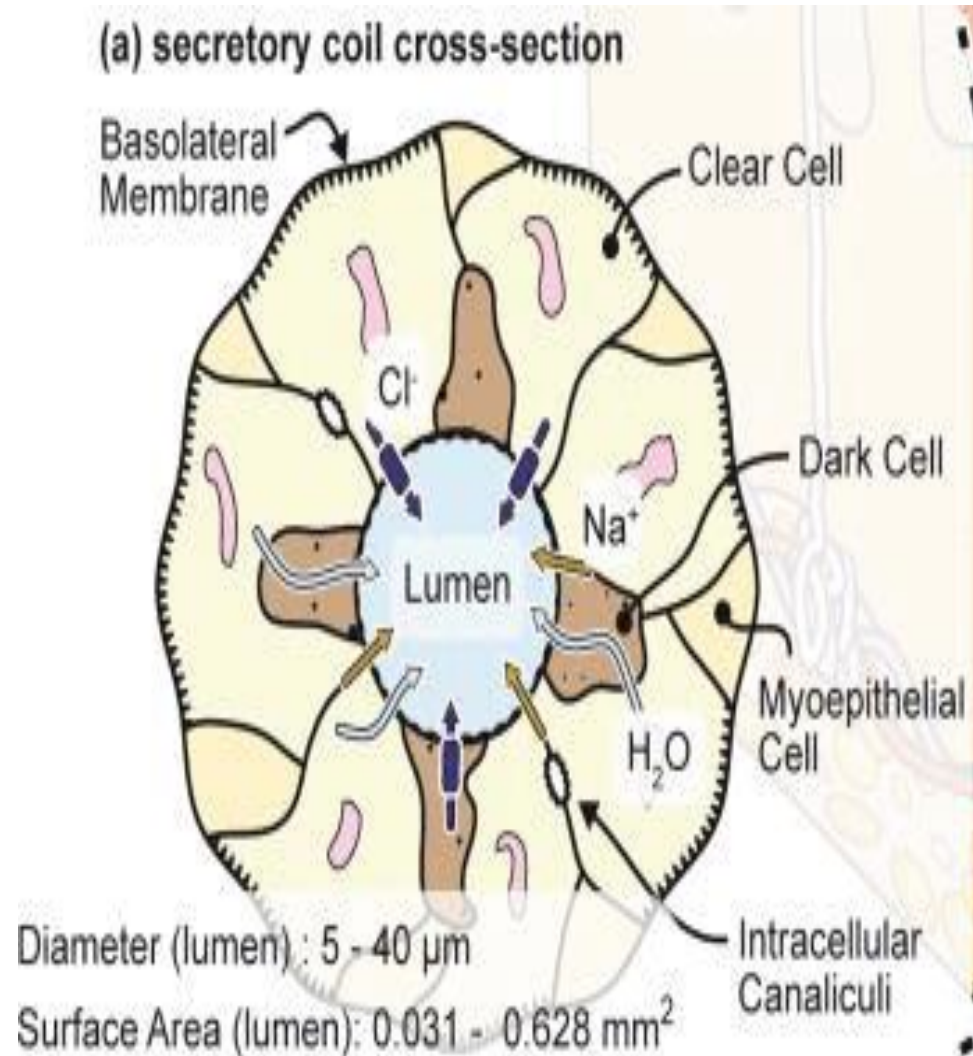
## 1. Clear cells:

- located in basal lamina
- Produce the sweat
- Pale staining ( have abundant mitochondria and microvilli)

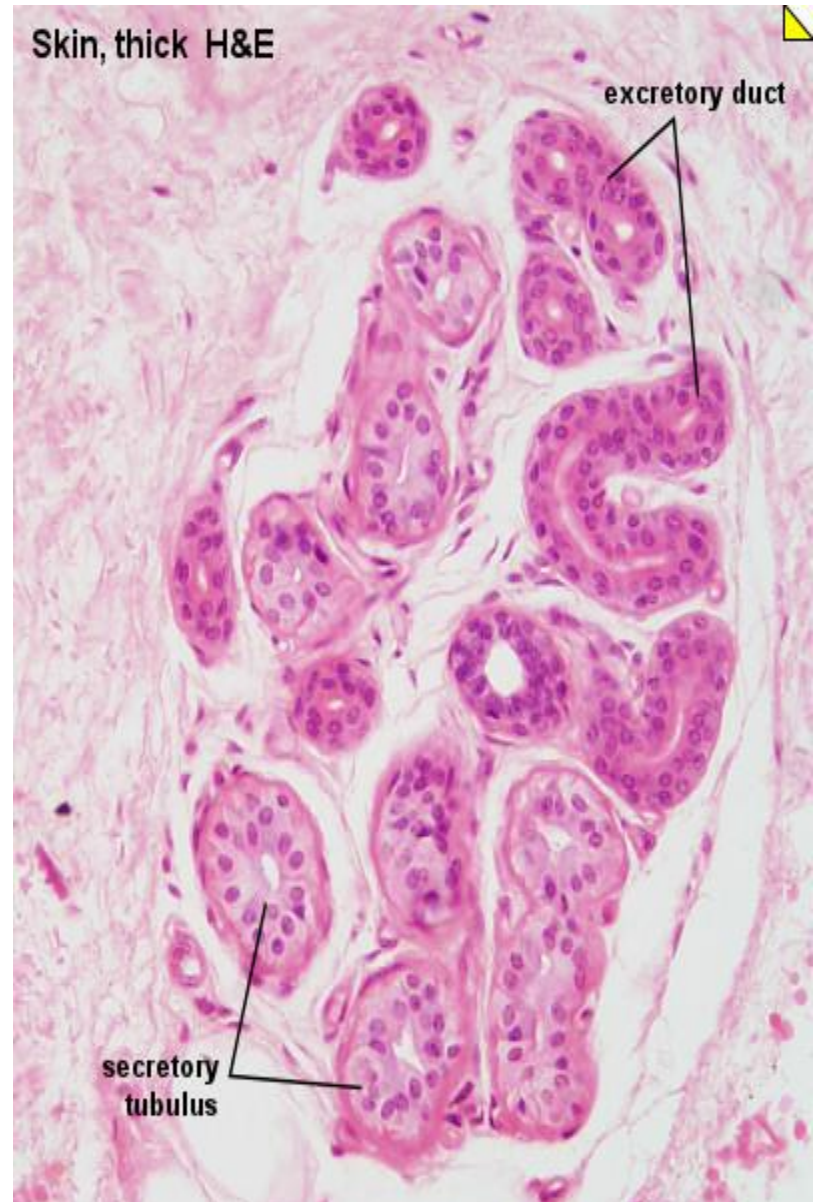
## 2. Dark cells

- Filled with strongly eosinophilic granules
- These granules contain mixture of glycoproteins
- Don't contact the basal lamina

## 3. Myoepithelial cells



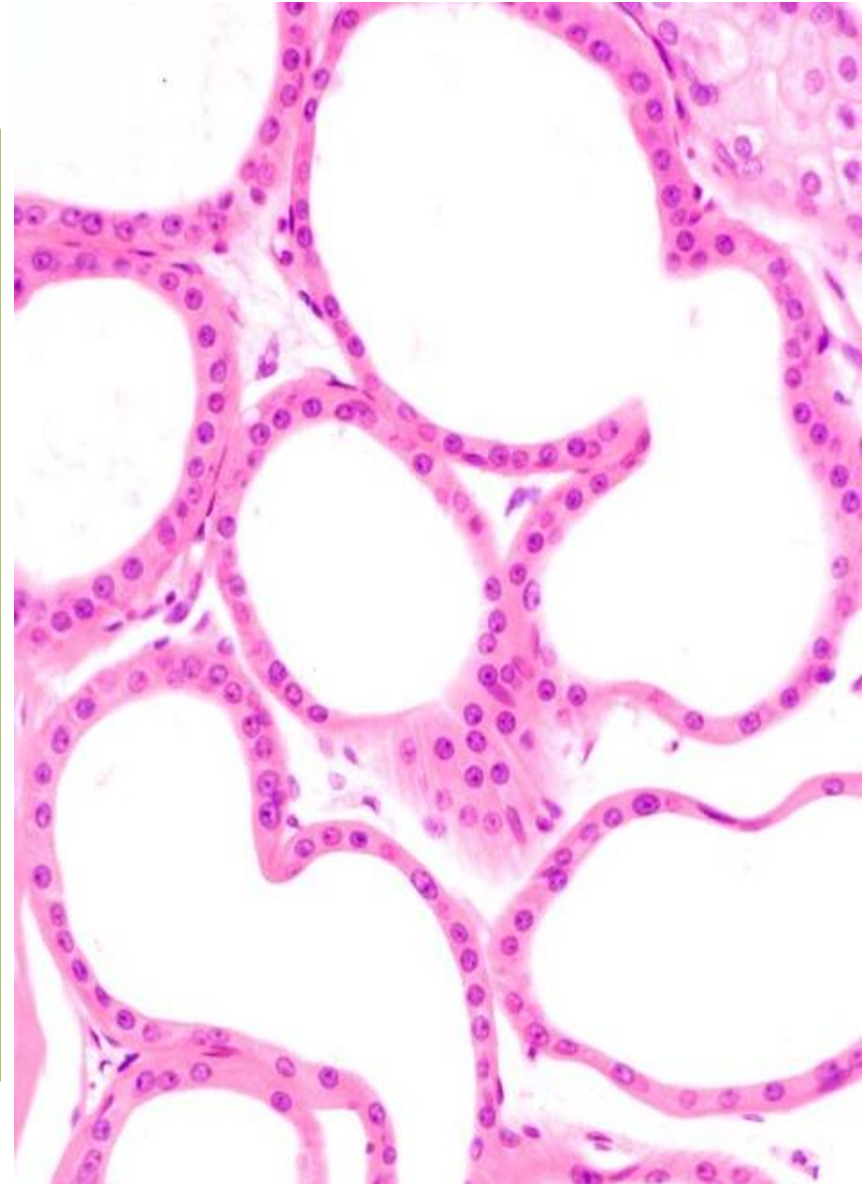
The **duct** of eccrine sweat glands is stratified cuboidal filled with mitochondria and have cell membranes rich in  $\text{Na}^+/\text{K}^+$  ATPase ( to preserve this salt)





### **Apocrine sweat glands**

- ✓ are typically larger and more productive than eccrine glands.
- ✓ secretory portions are characterized by a simple cuboidal epithelium and widely dilated lumen.
- ✓ Secretion from apocrine glands contains protein, lipid, carbohydrate, ammonium and other organic compounds.
- ✓ The ducts of the glands empty into an adjacent hair follicle.
- ✓ The bleb on the apical surface of the secretory cells suggested that the cell underwent apocrine secretion, but recent electron micrographs indicate that the cells use merocrine secretion (mixed!!!!)



# Nail

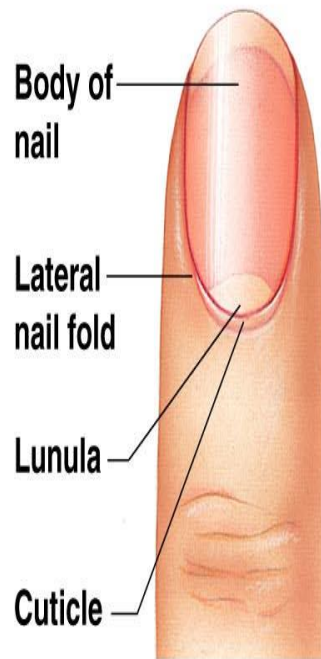
## Nails

Hard plates of keratin on the dorsal surface of each distal phalanx

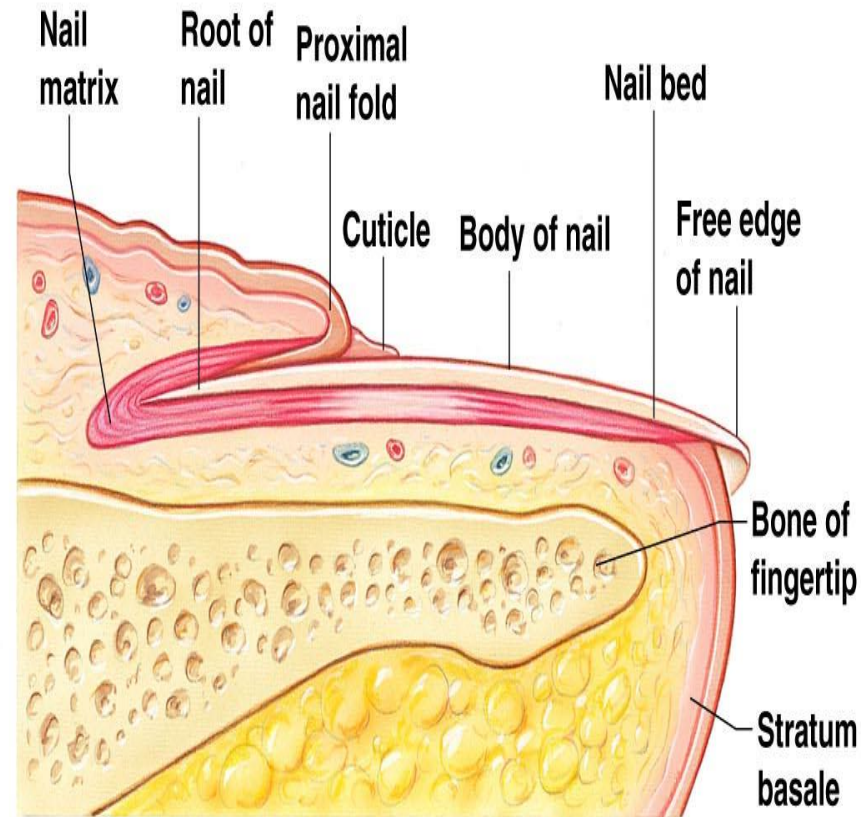
Lack of pigment makes them colorless

### Nail parts

1. **Free edge**: the part you cut
2. **Body**: pink part
3. **Lunula**: white semicircle area
4. **Eponychium**: proximal nail fold (cuticle)
5. **Hyponychium**: under the free edge where dirt accumulates
6. **Nail bed**: directly under the pink part
7. **Nail matrix**: growth



(a) Surface view



(b) Longitudinal section of the distal part of a finger