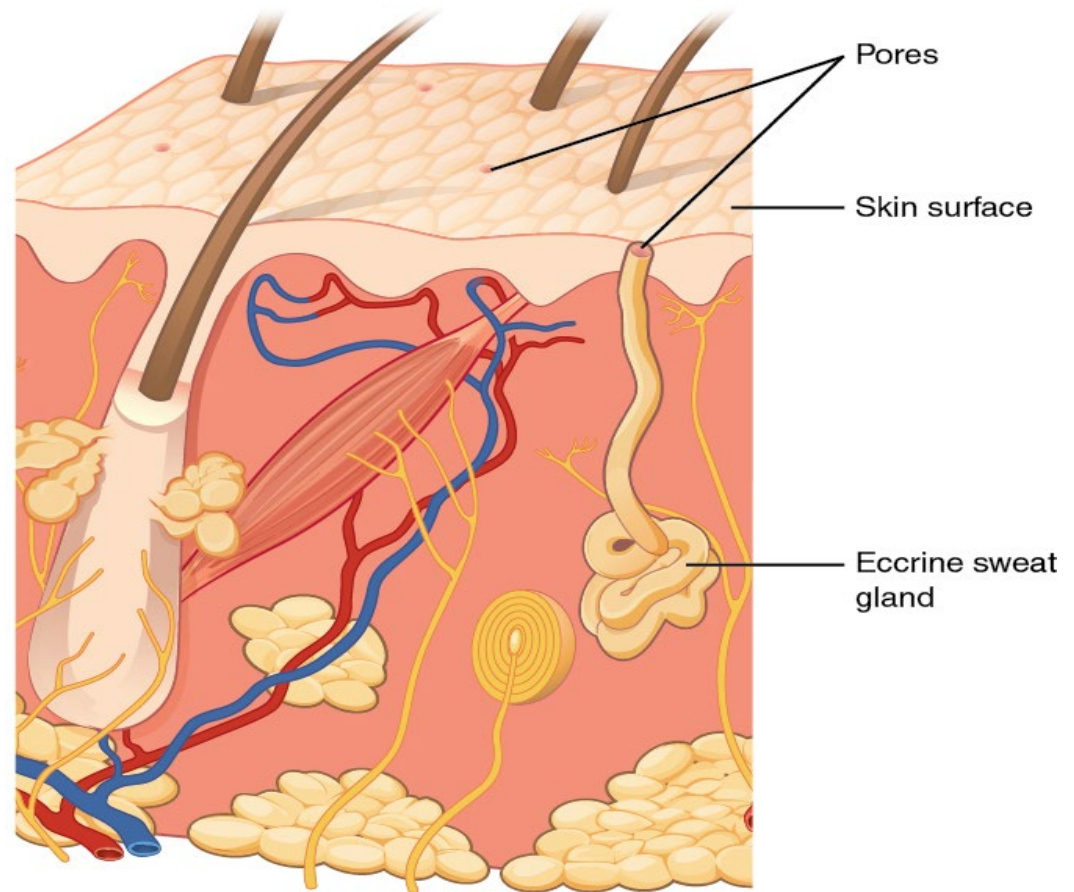


# BIOLOGY 1103/1109

## Human Anatomy and Physiology I

### UNIT 11

### Integumentary system



# Integumentary system

## Objectives

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1. Identify and describe the components of the integumentary system.
2. Identify and describe the five layers of the epidermis of the skin, including the location and function of keratinocytes and melanocytes.
3. Specify the function(s) of epidermal derivatives, including hair, sebaceous glands, sudoriferous glands, ceruminous glands, nails.
4. Describe five major functions of the integumentary system.

# The integumentary system

## components

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- Skin

- Hair

- Glands

- Sebaceous
- Sudoriferous (sweat)
- Ceruminous

- Nails

- Sensory receptors

- Mechanoreceptors (touch, pressure)
- Thermoreceptors (temperature)
- Nociceptors (pain)

# The skin components

- Skin is 7 % of your body weight and is one of the largest and heaviest organs

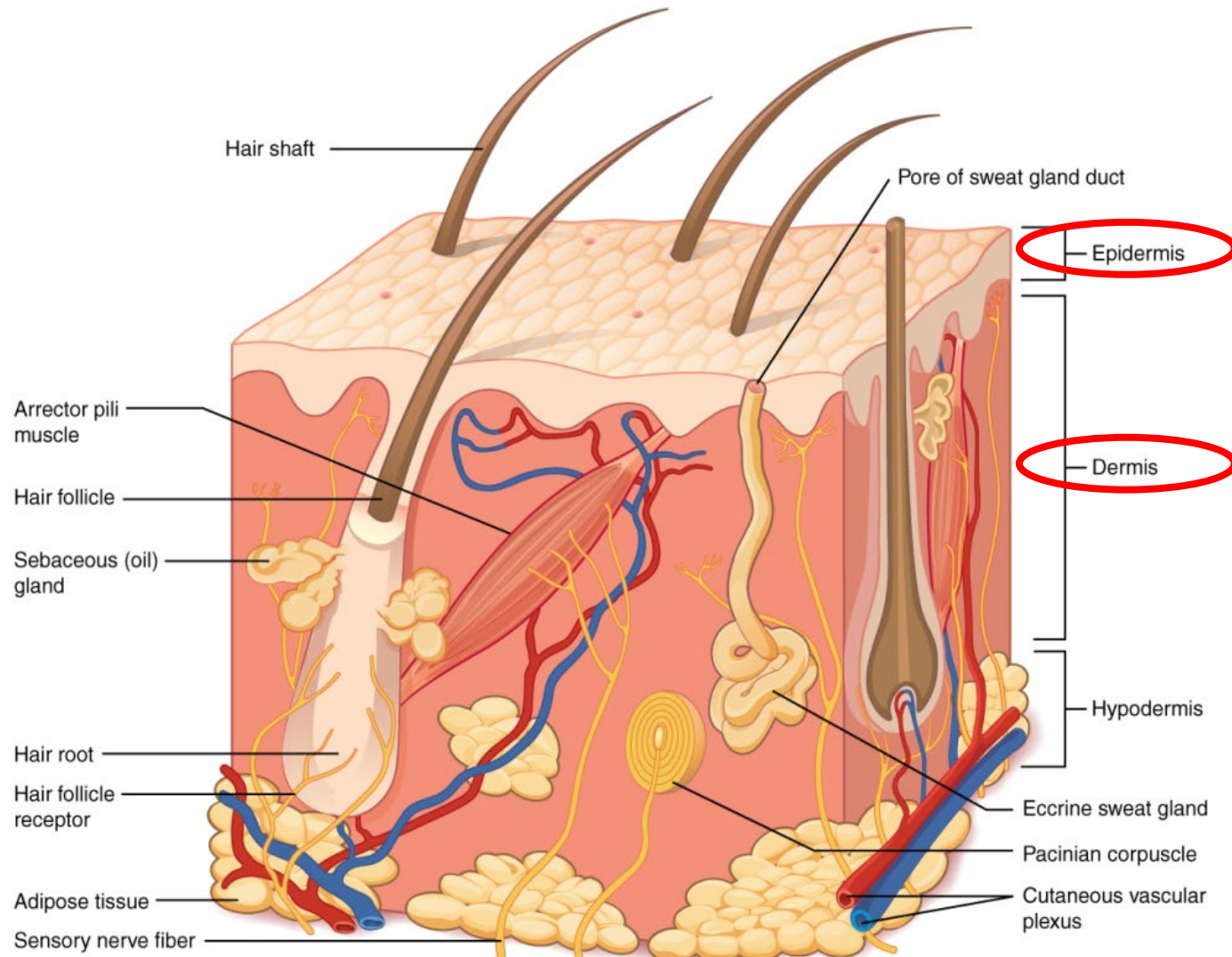


Figure 1

Why is skin an organ?

# Functions of the skin

## 1. protection

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•Mechanical protection

○Keratin in the outermost layer

•Prevents dehydration

○Lipid secretions from skin cells and glands

•UV light protection

○Melanin in melanocytes absorbs UV radiation

•Antimicrobial

○Sebaceous glands

○Langerhans cells

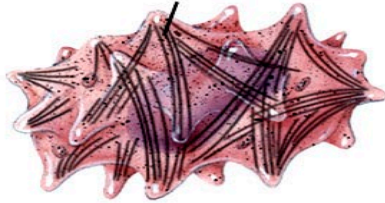
○Macrophages

Immunity to disease

# Functions of the skin

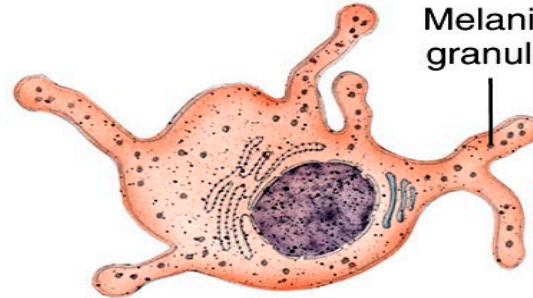
## 2. immunity

Intermediate filament (keratin)

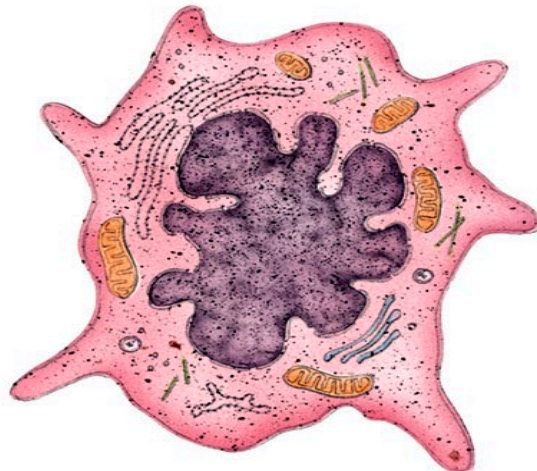


(a) Keratinocyte

Melanin granule

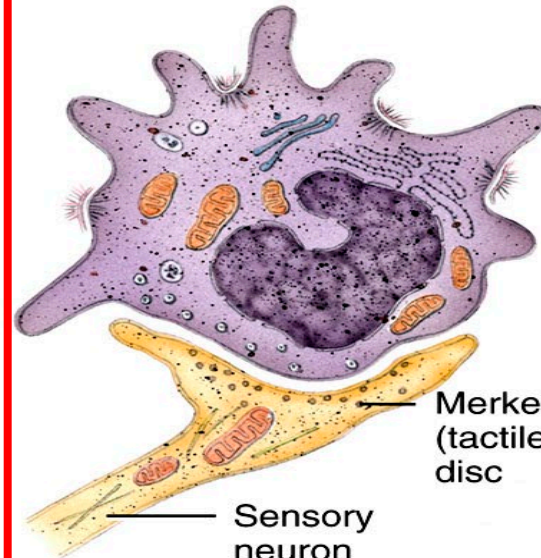


(b) Melanocyte



Alters immune system of a pathogen

(c) Langerhans cell



Merkel (tactile) disc

Sensory neuron

(d) Merkel cell

# Functions of the skin

## 3. thermoregulation

---

•Sweat glands

{  
○Secrete sweat in response to heat

•Blood vessels

{  
○Dilate in response to heat;  
constrict in response to cold

# Functions of the skin

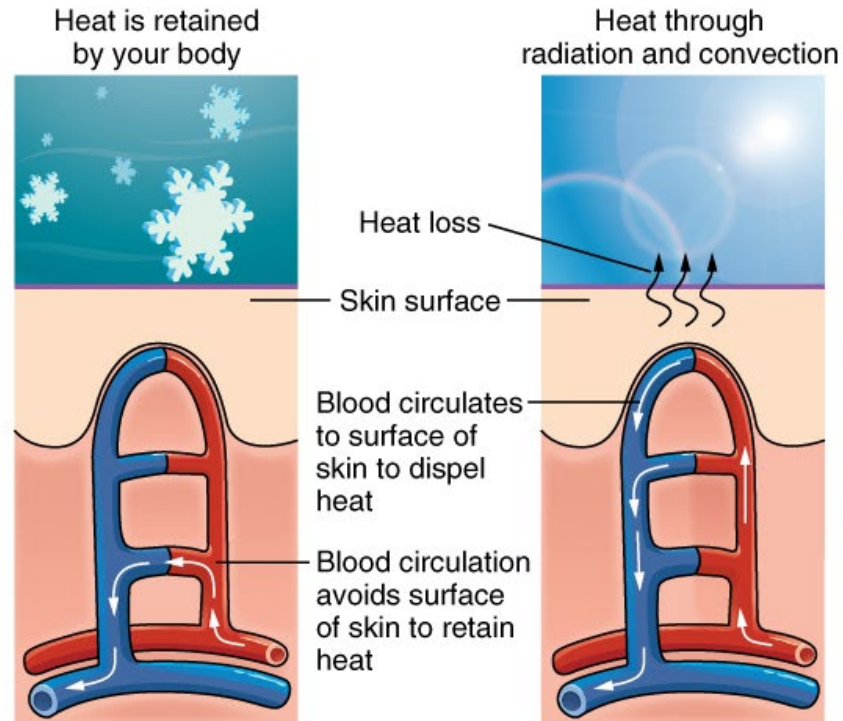
## 4. excretion

Salts
Urea
Ammonia
CO <sub>2</sub>

# thermoregulation



(a)



(b)



(c)

Figure 14

# Functions of the skin

## 4. sensation

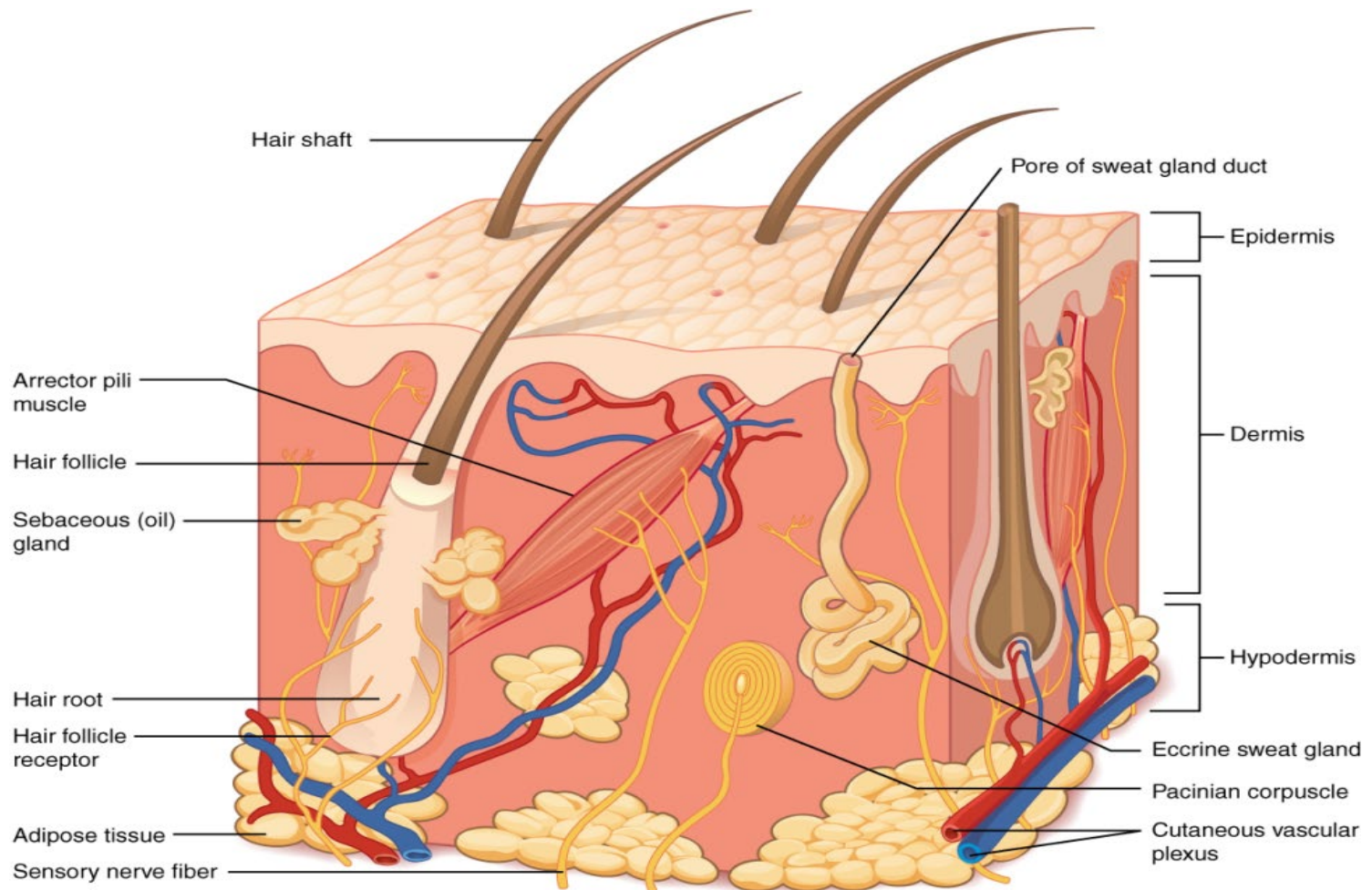


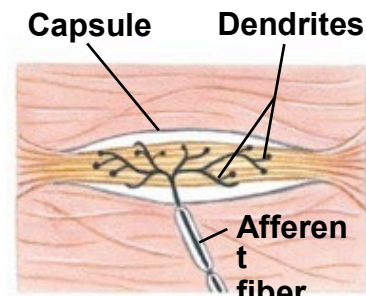
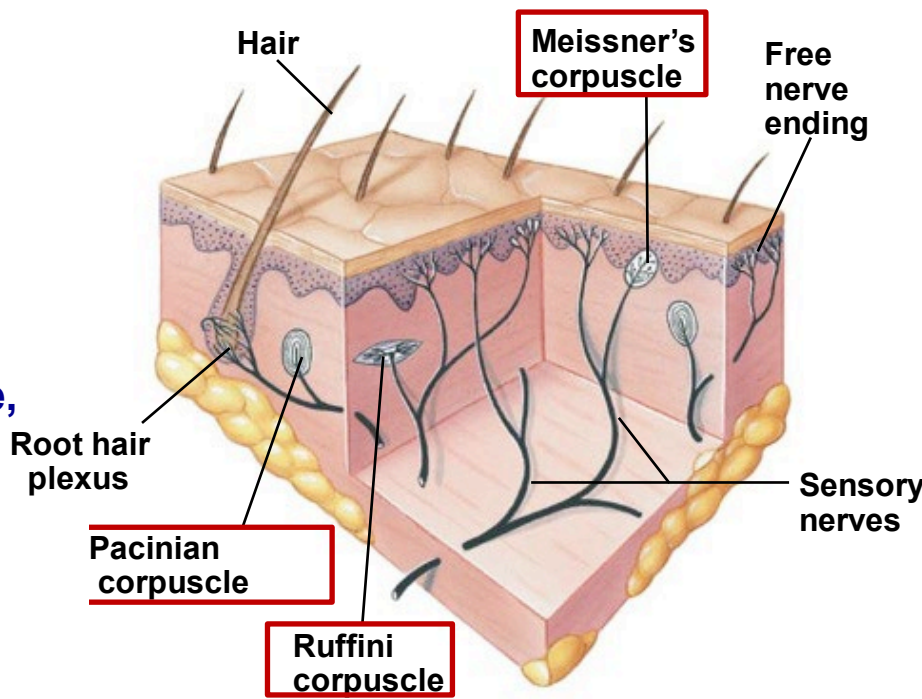
Figure 1

# General cutaneous receptors — free and encapsulated nerve endings

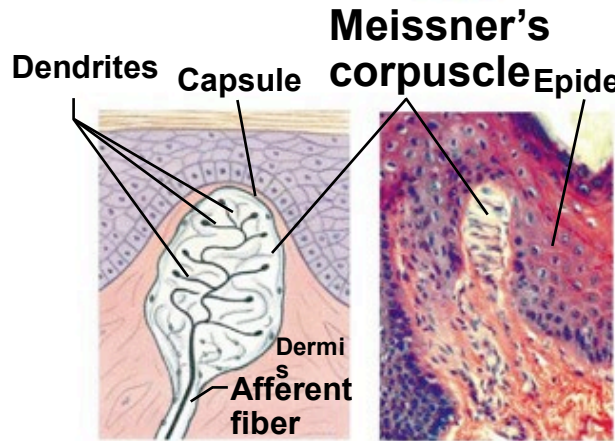


(a) Free nerve endings

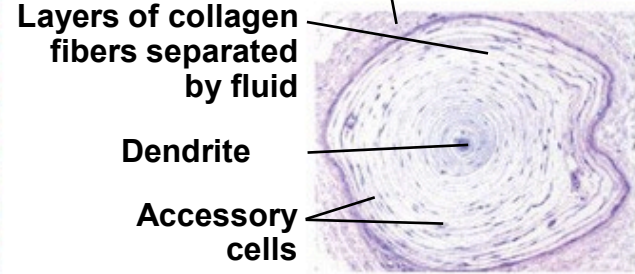
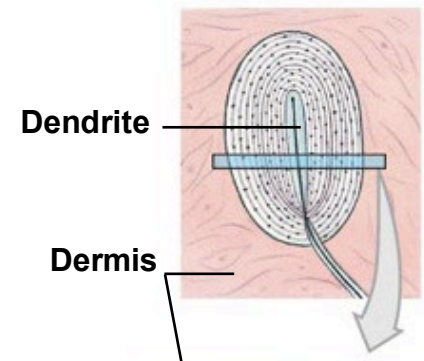
- Pain, temperature, touch



(f) Ruffini corpuscle  
- Firm pressure and stretch



(d) Meissner's corpuscle  
LM x 330



(e) Pacinian corpuscle  
- Heavy pressure and vibration (Merkel cells)  
LM x 75

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- Light touch and low vibration

## Receptors

# in skin

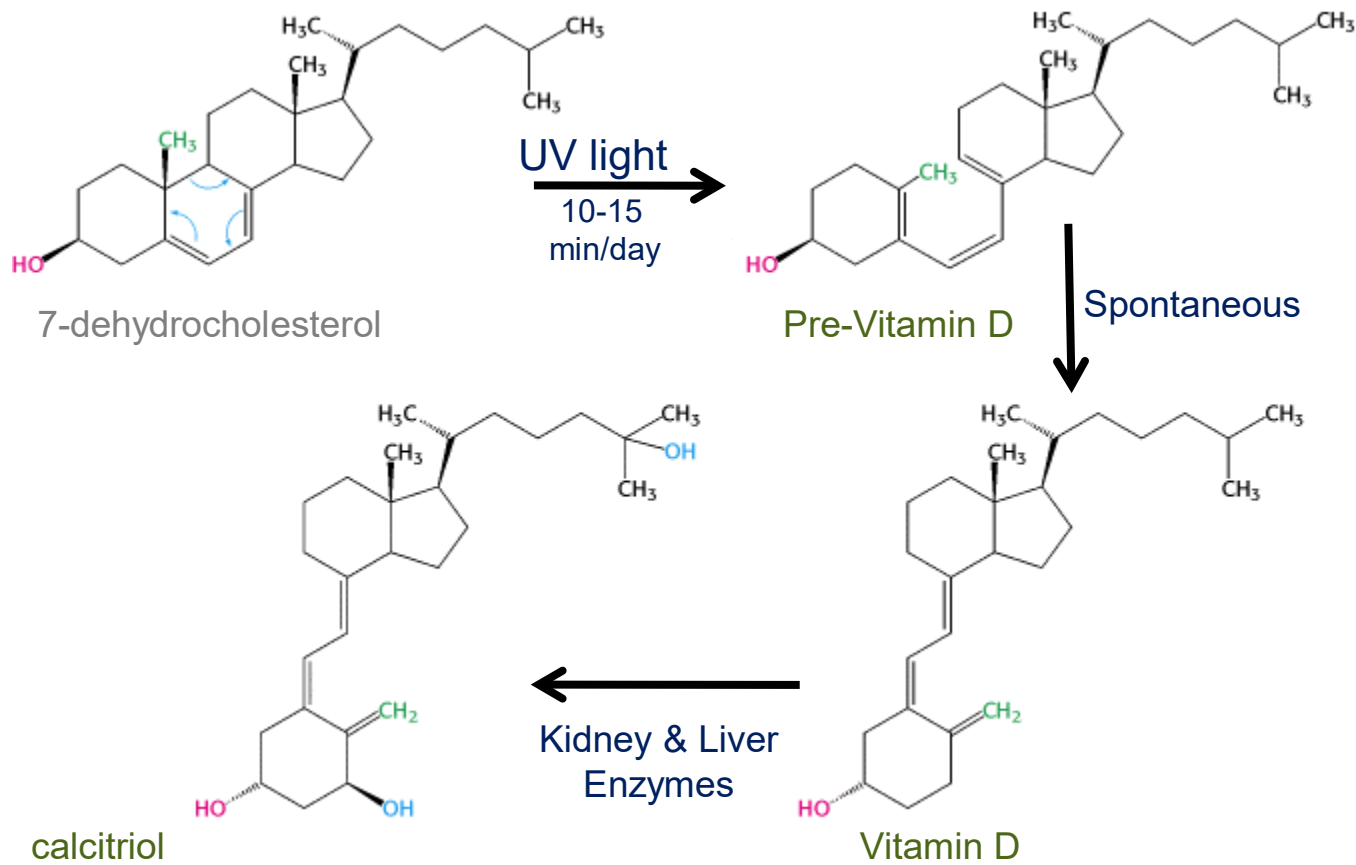
\*No corresponding eponymous name.

**Table 8.1: Mechanoreceptors of Somatosensation**

Name	Historical (eponymous) name	Location(s)	Stimuli
Free nerve endings	*	Dermis, cornea, tongue, joint capsules, visceral organs	Pain, temperature, mechanical deformation
Mechanoreceptors	Merkel's discs	Epidermal–dermal junction, mucosal membranes	Low frequency vibration (5–15 Hz)
Bulbous corpuscle	Ruffini's corpuscle	Dermis, joint capsules	Stretch
Tactile corpuscle	Meissner's corpuscle	Papillary dermis, especially in the fingertips and lips	Light touch, vibrations below 50 Hz
Lamellated corpuscle	Pacinian corpuscle	Deep dermis, subcutaneous tissue	Deep pressure, high-frequency vibration (around 250 Hz)
Hair follicle plexus	*	Wrapped around hair follicles in the dermis	Movement of hair
Muscle spindle	*	In line with skeletal muscle fibers	Muscle contraction and stretch

# Functions of the skin

## 5. synthesis of Vitamin D

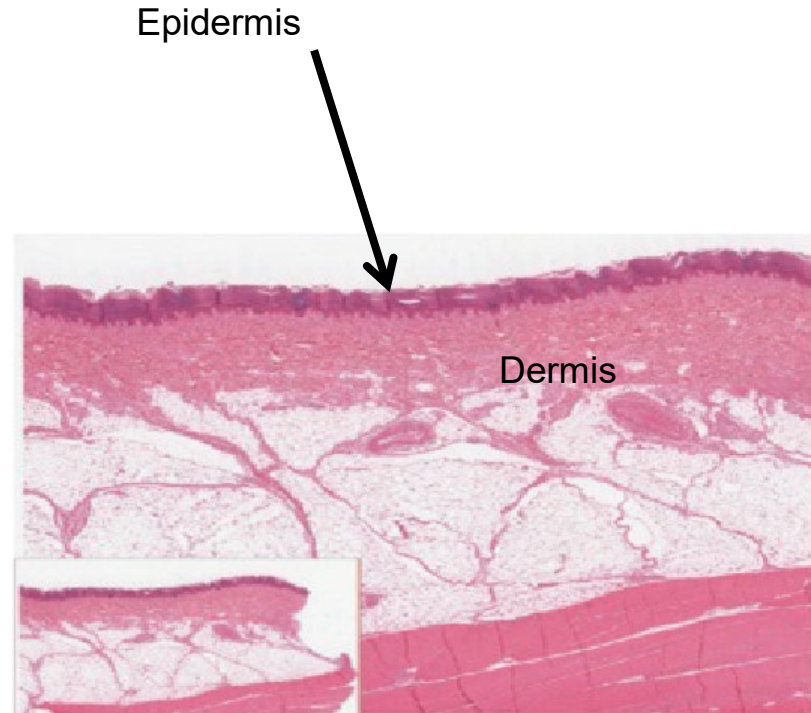


Vitamin D increases absorption of Ca and  $\text{PO}_4$  in the intestine

# Structure of skin

Two layers of skin	Tissue type
1) Epidermis	<u>Epithelial</u> tissue
2) Dermis	Mostly <u>connective</u> tissue Some muscle tissue Some nervous tissue

Layer under skin	Tissue type
Hypodermis ("subcutaneous")	Adipose & areolar connective tissue

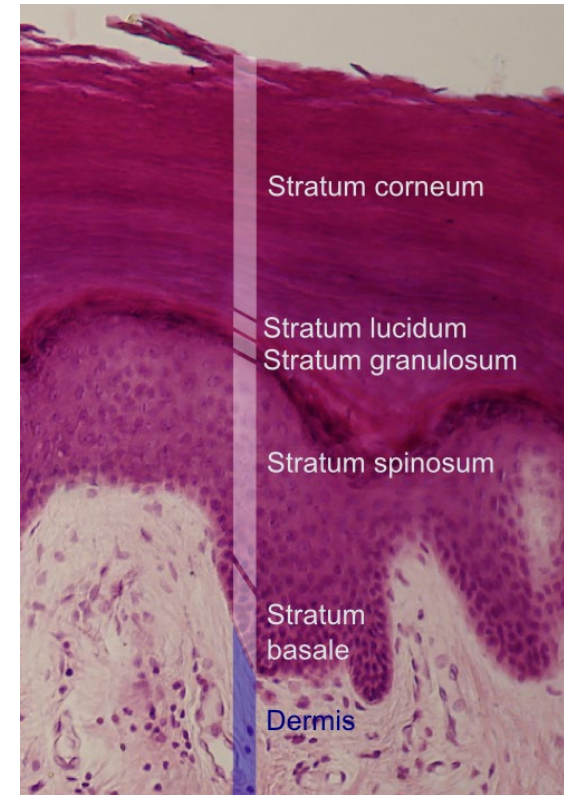


# Structure of epidermis

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## Main characteristics

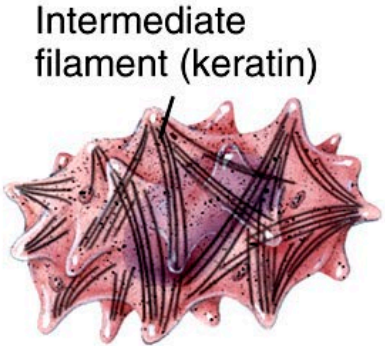
- Keratinized stratified squamous epithelium
- No blood vessels
- 4 types of cells
- 4 or 5 distinct strata (layers) of cells



Wikimedia Commons

# Epidermis

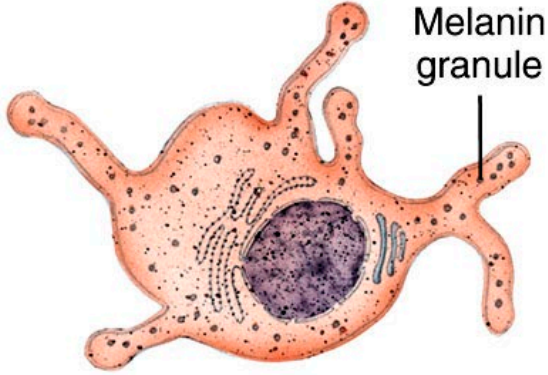
## Cell types



Intermediate filament (keratin)

(a) Keratinocyte

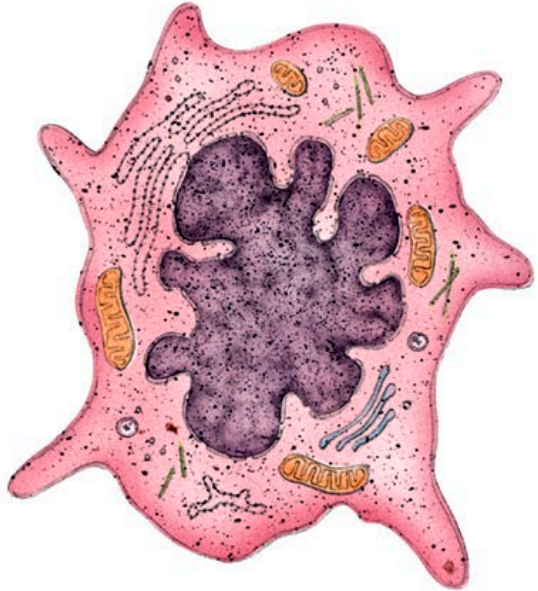
Produce keratin



Melanin granule

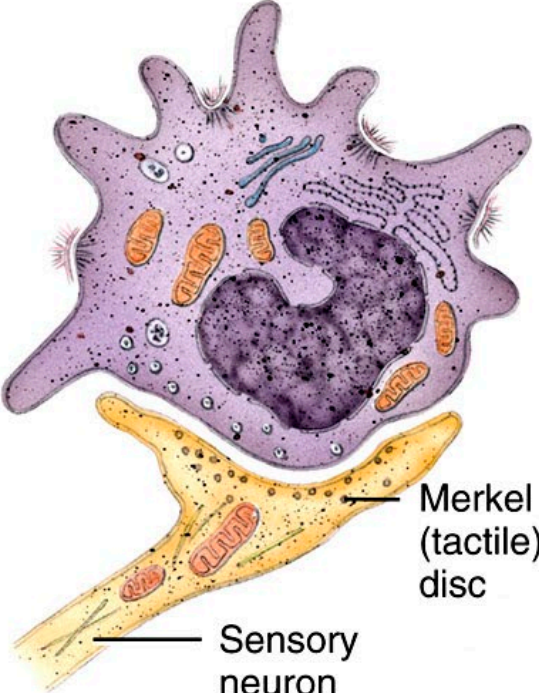
(b) Melanocyte

Produce melanin



Aid in immune response

(c) Langerhans cell



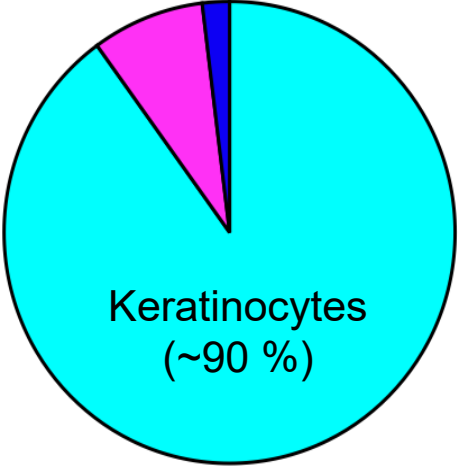
Merkel (tactile) disc

Sensory neuron

Involved in sensing

(d) Merkel cell

Melanocytes (~8%)  
Langerhans & Merkel cells (~2%)

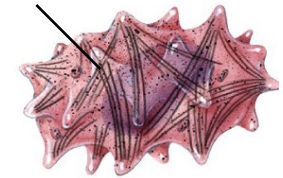


# Description of epidermal cells

## Keratinocytes

Produce **keratin** (a fibrous protein)  
Most numerous epidermal cells

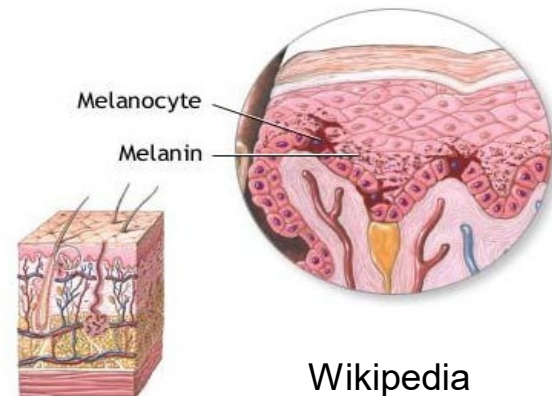
Keratin



## Melanocytes

Synthesize **melanin pigment**

- Melanin transferred to keratinocytes via long cellular processes
- Melanin protects from UV radiation & contributes to skin color



# Description of epidermal cells

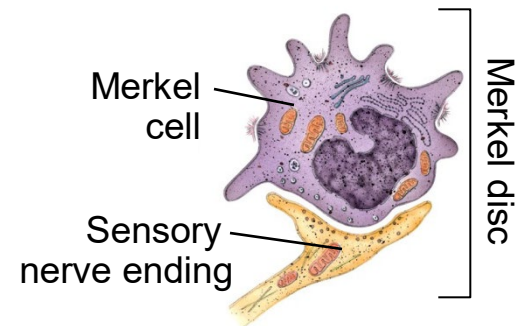
## Langerhans cells (also called dendritic cells)

From red bone marrow  
Provide **immunity** by ingesting foreign substances



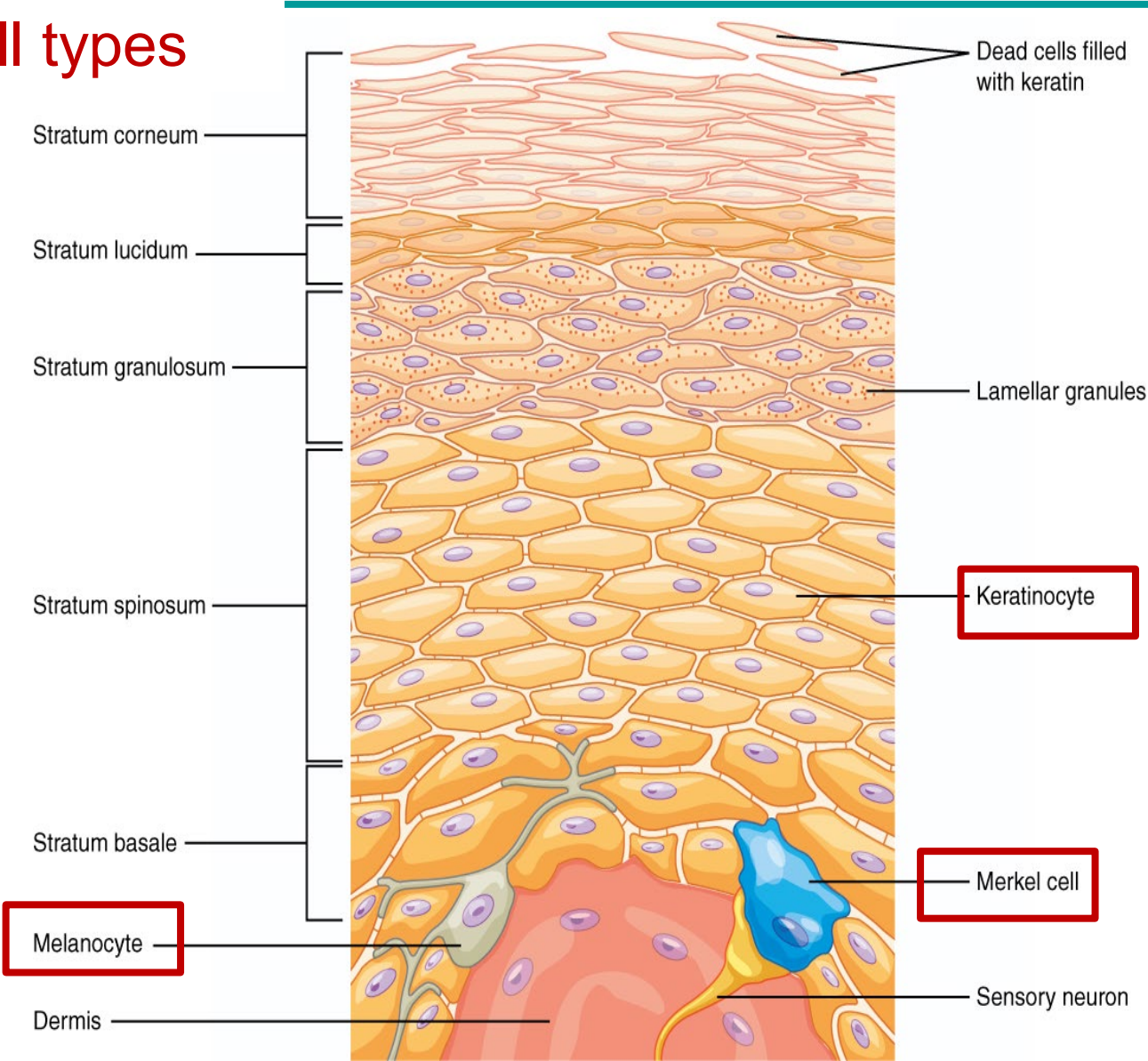
## Merkel cells

Only found in deepest layer  
Form **touch receptor** with **sensory neuron**

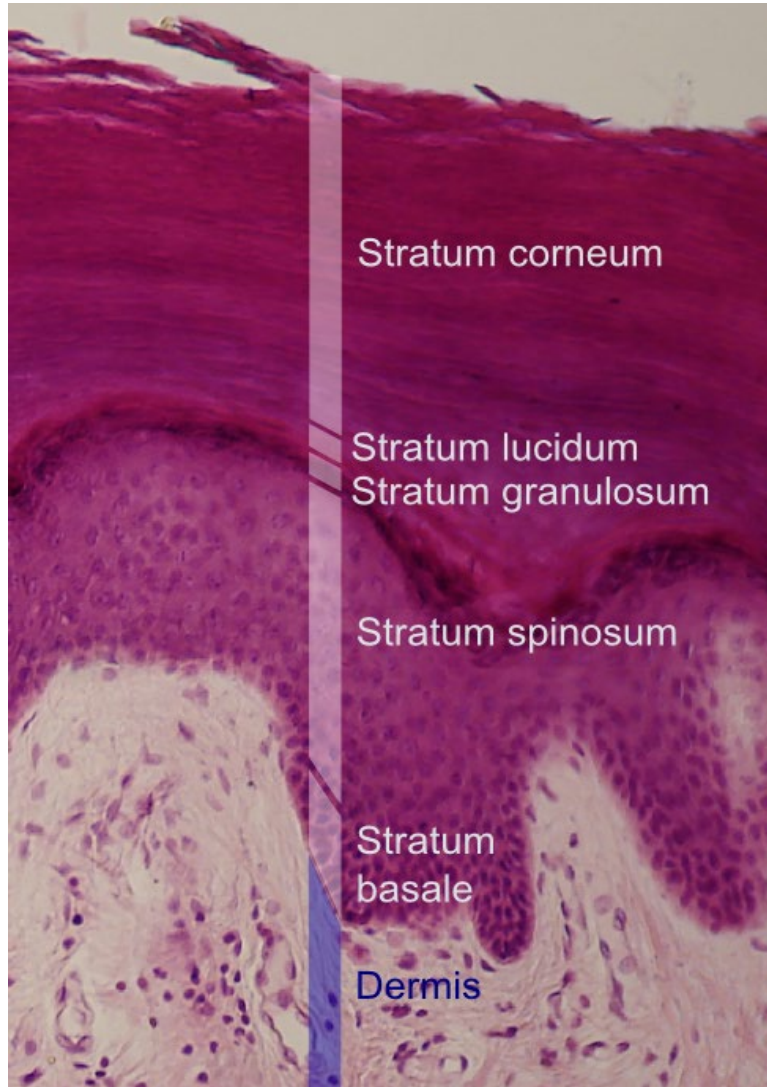


# Epidermis

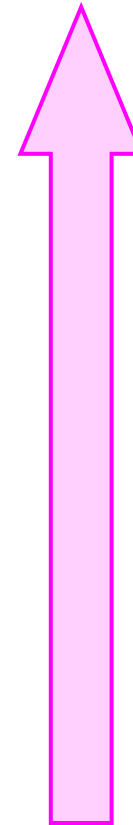
## Location of the different cell types



# Differentiation of keratinocytes



Wikimedia Commons



**Cells are full of keratin**

**Cells progressively die**  
**Cells accumulate keratin**

**New cells move upwards**

**New cells produced in  
deepest layer**

(Process stimulated by friction)

# Stratum basale

## Number of cell layers

Single layer

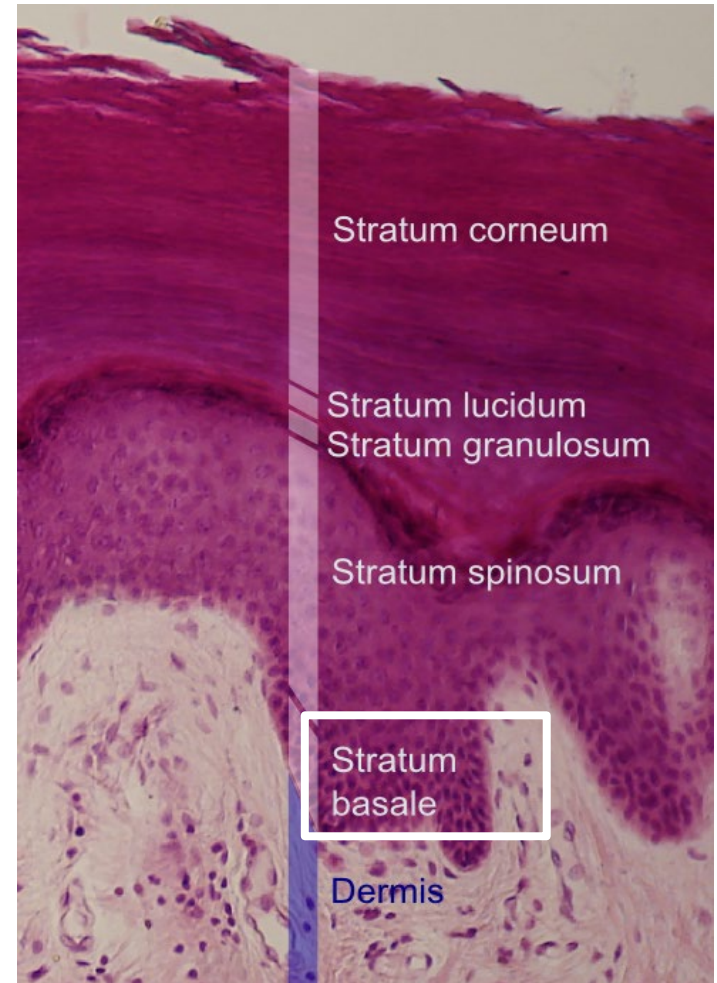
## Main characteristics

- Most active cells in epidermis
- Mostly keratinocytes with melanocytes & Merkel cells
- Keratinocyte stem cells that **divide repeatedly & replenish layers above**

Superficial



Deep



# Stratum spinosum

## Number of cell layers

8-10 layers

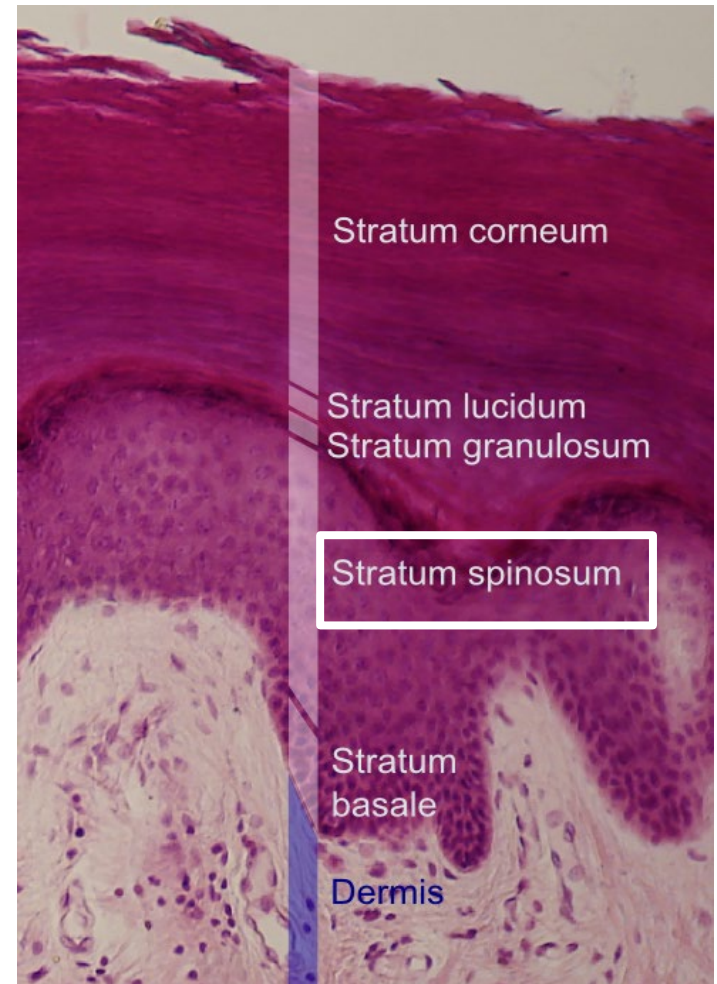
## Main characteristics

- Mostly keratinocytes
- A few Langerhans cells & cellular projections of melanocytes
- Keratinocytes contain pre-keratin filaments

Superficial



Deep



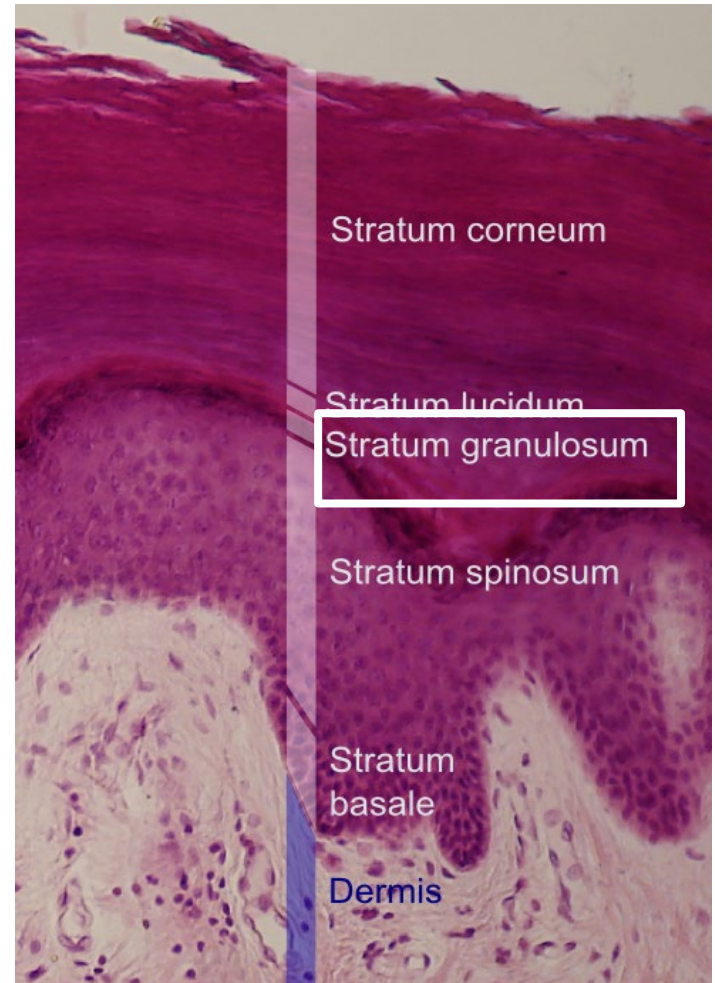
# Stratum granulosum

Number of cell layers
3-5 layers
Main characteristics
<ul style="list-style-type: none"><li>- Flat <u>dying</u> keratinocytes</li><li>- <b>Nuclear degeneration</b></li><li>- Keratinization begins</li><li>- Cells contain dark-staining keratohyalin granules (help form keratin) &amp; secrete contents of lamellar granules (glycolipids that prevent H<sub>2</sub>O loss &amp; repel H<sub>2</sub>O)</li></ul>

Superficial



Deep



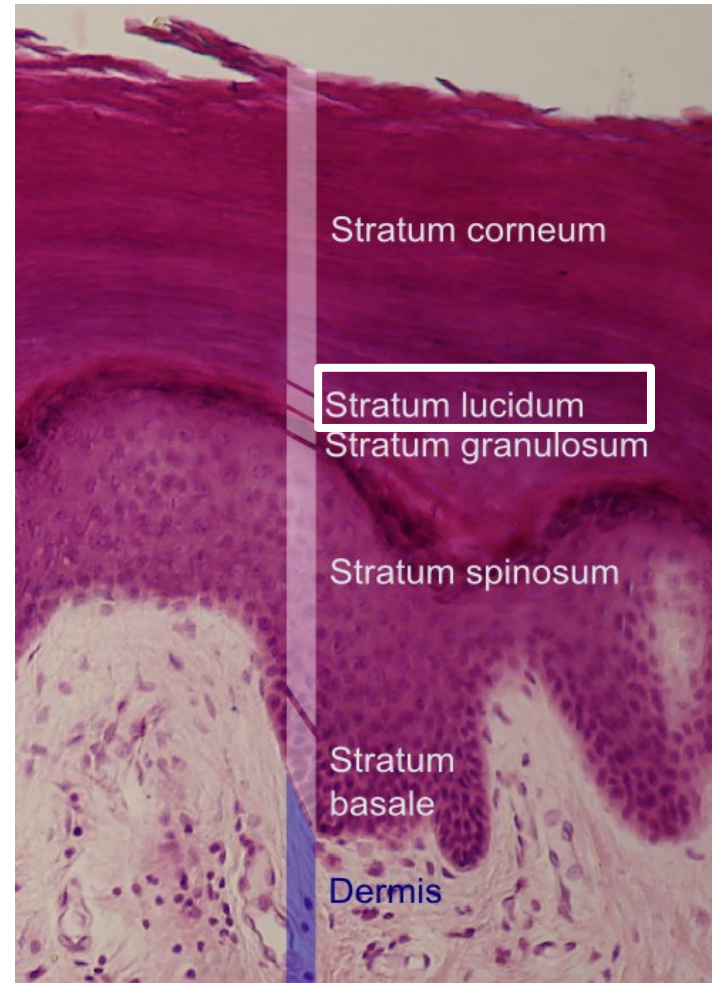
# Stratum lucidum

Number of cell layers
3-6 layers
Main characteristics
<ul style="list-style-type: none"><li>- Stratum only present in <u>thick</u> skin</li><li>- Clear, flat, dead keratinocytes packed with eleiden</li><li>- Cells contain lots of keratin</li></ul>

Superficial



Deep



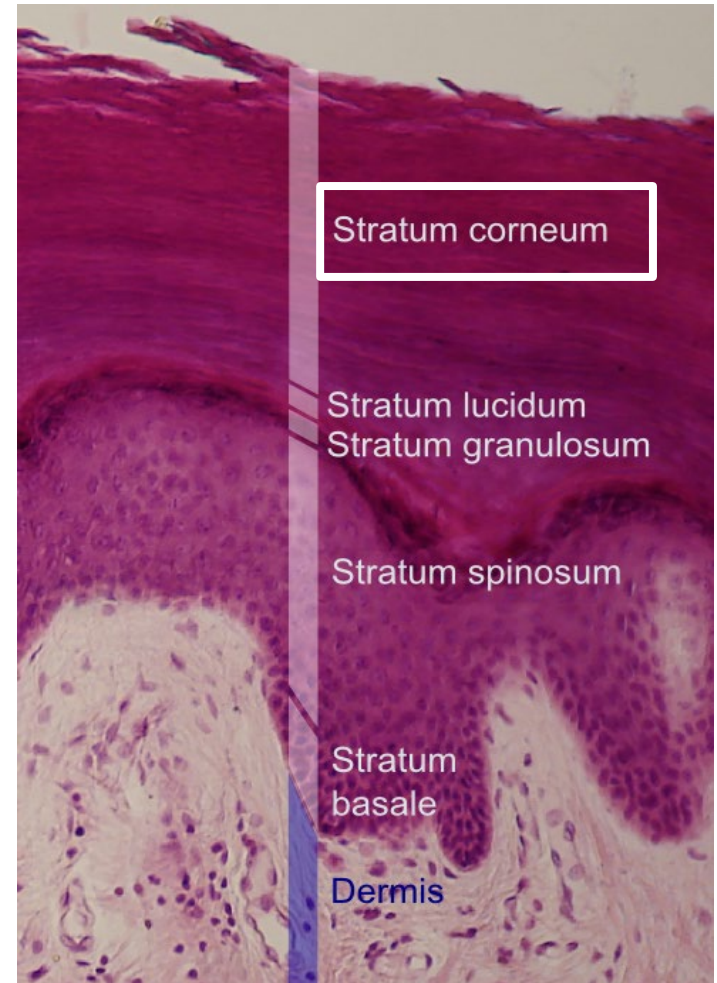
# Stratum corneum

Number of cell layers
20-50 layers
Main characteristics
<ul style="list-style-type: none"><li>- Very thin dead keratinocytes</li><li>- Cells filled with keratin</li><li>- Cells are continuously <u>shed</u></li><li>- Stratum serves as barrier to light, heat, H<sub>2</sub>O, chemicals, bacteria</li><li>- Friction stimulates production of new cells in Stratum basale</li></ul>

Superficial



Deep



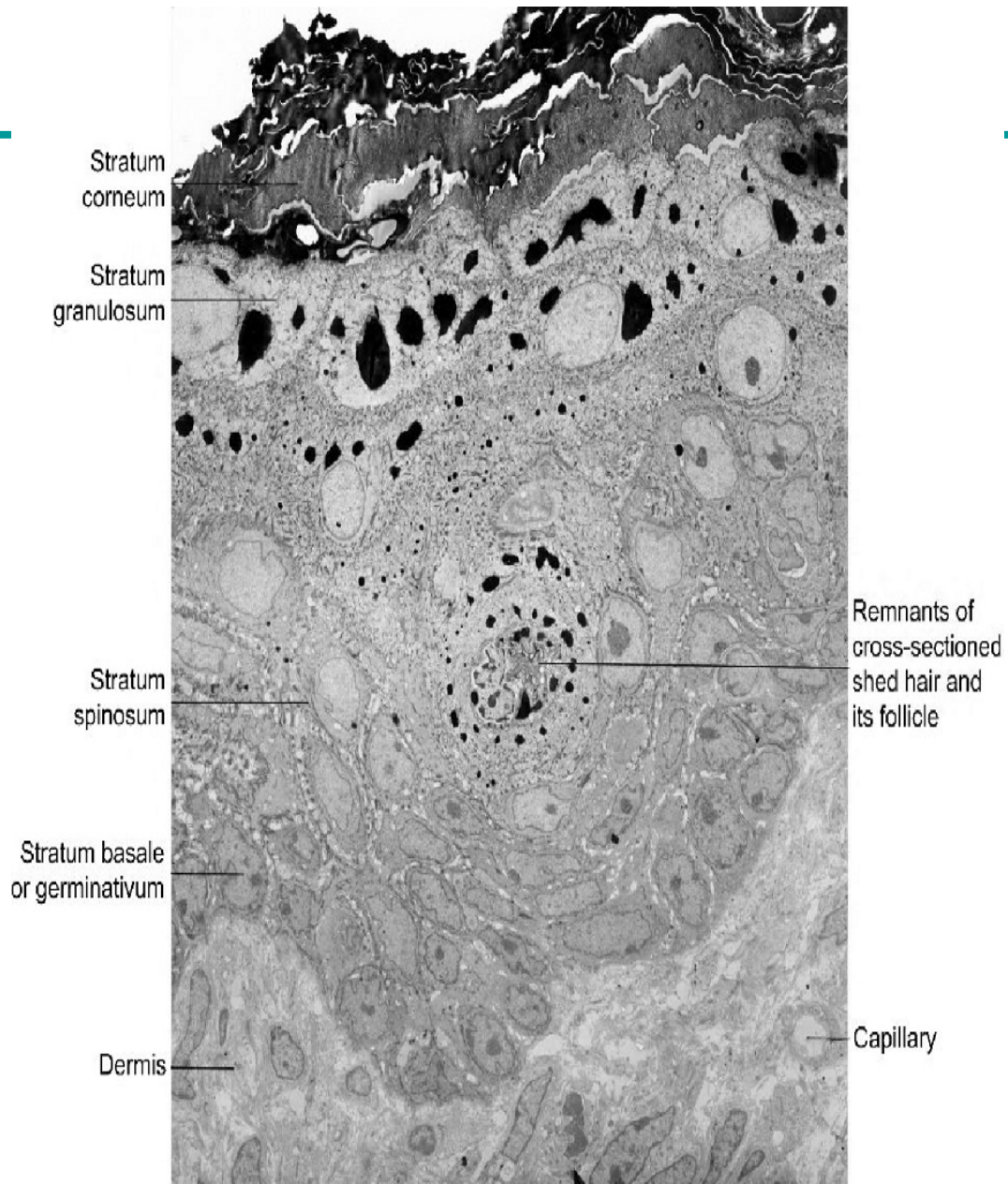


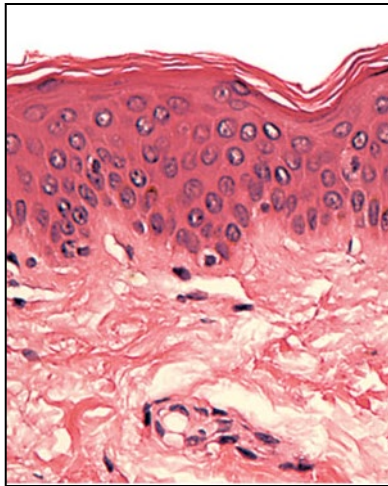
Figure 5

E/M Mag. 2,700 X

# Different types of skin

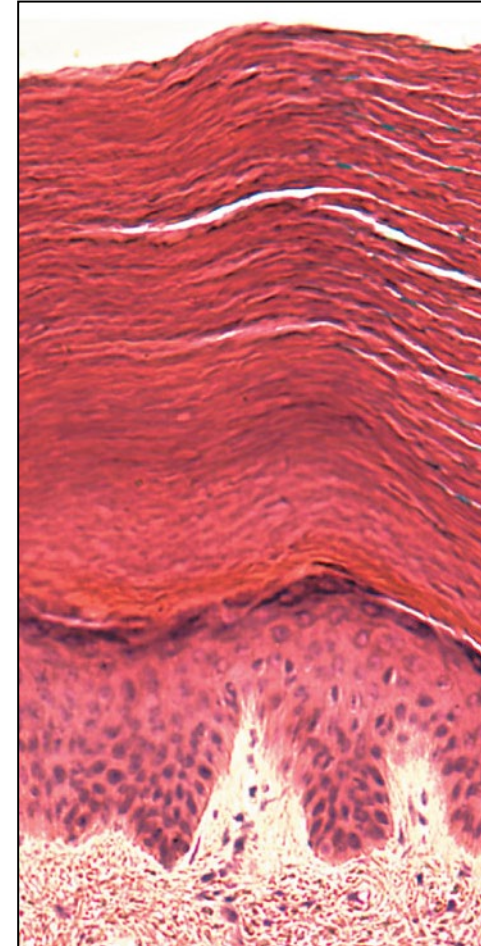
## THIN SKIN

(most of body surface)



## THICK SKIN

(palms, fingertips & soles)



Stratum  
corneum

Stratum  
granulosum,  
spinosum  
& basale

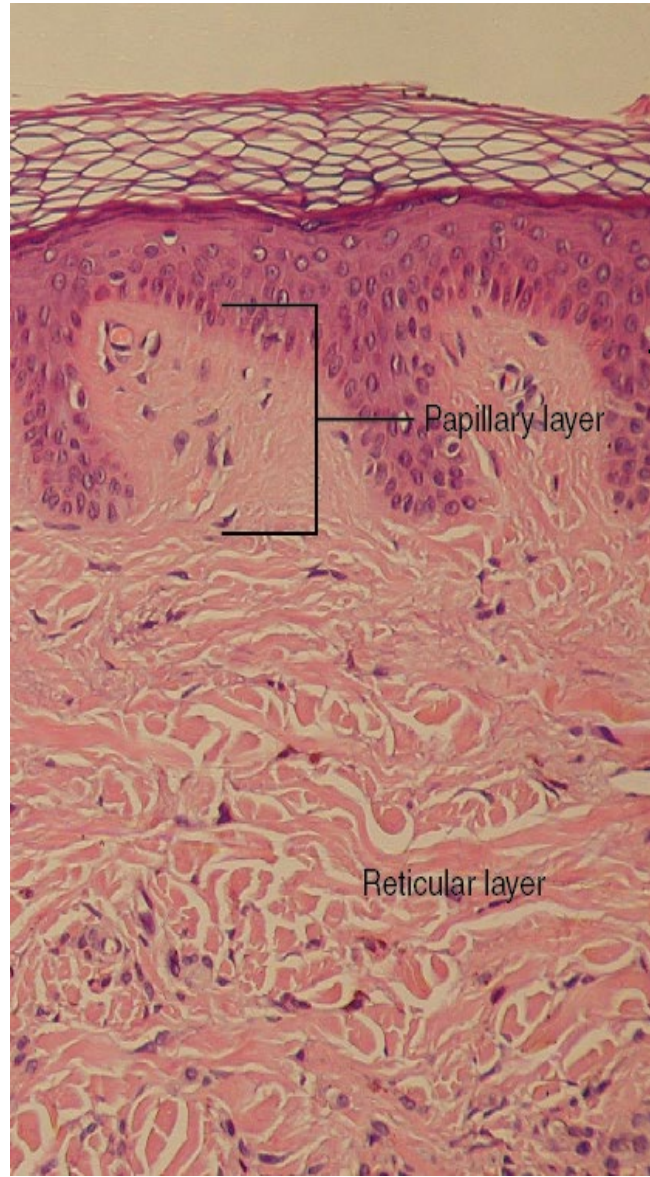
Stratum  
lucidum

Dermis

# Dermis

2 layers

- Papillary :  
Loose areolar connective tissue with elastic fibers
- Reticular :  
Dense irregular connective tissue containing collagen and elastic fibers



**Epidermis**

**Papillary layer**

**Dermis**

**Reticular layer**

# Papillary region

Top 20 % of dermis

---

## Structure

Loose connective tissue & elastic fibers  
Dermal papillae (finger-like projections)  
Meissner's corpuscles (touch receptors)  
Free nerve endings (pain & temperature receptors)

## Functions

Anchor epidermis to dermis  
**Blood support for epidermis** (blood capillaries)  
Sensory reception

# Reticular region

Bottom 80 % of dermis

---

## Structure

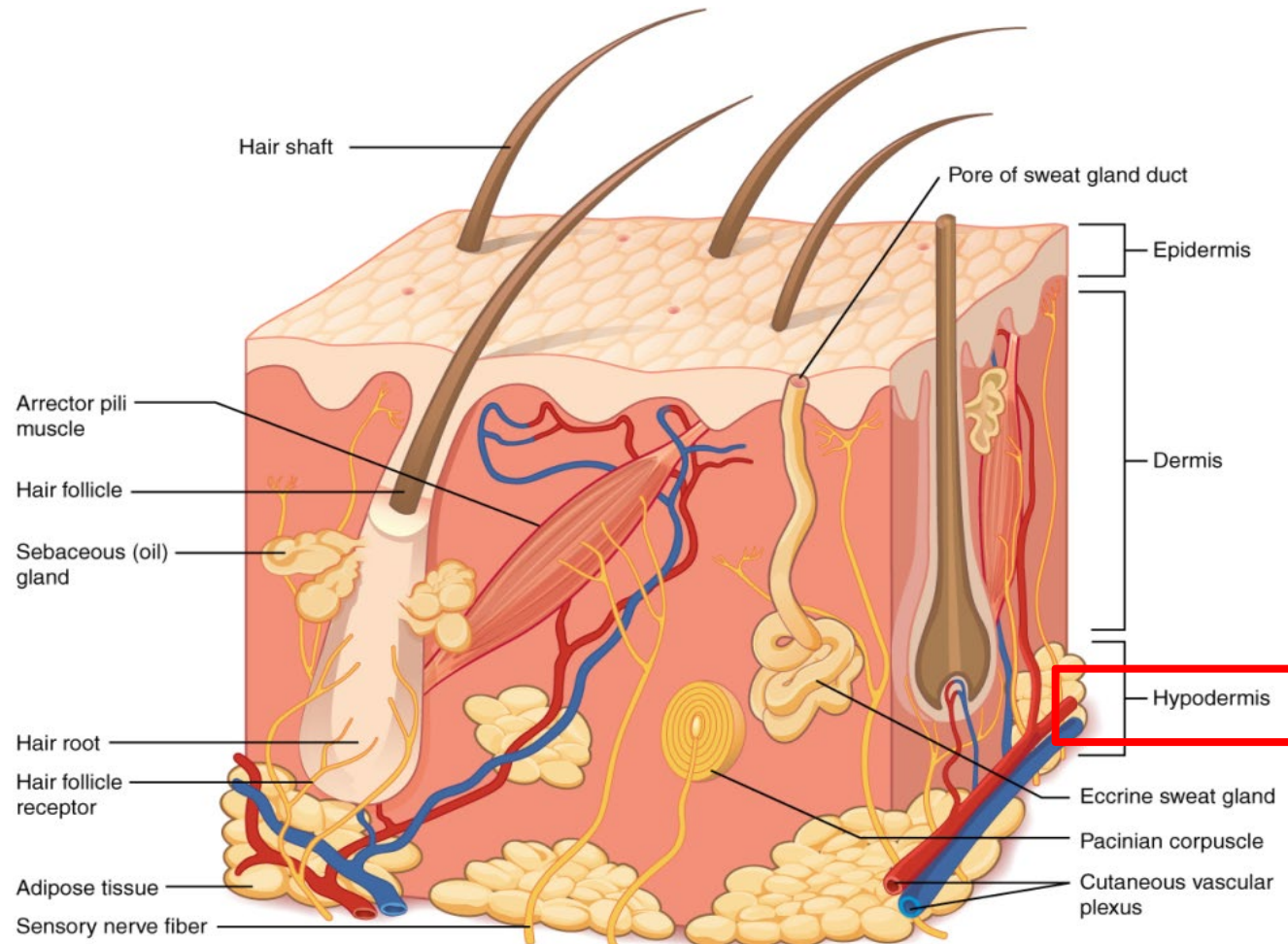
Dense irregular connective tissue  
Network of collagen & elastic fibers  
Fibroblasts & adipocytes  
Oil glands, sweat glands, fat & hair follicles

## Functions

Provide strength, extensibility & elasticity to skin  
Increase grip of hand

# Hypodermis

- Connect the skin to the underlying fascia
- It is well-vascularized, loose, areolar connective tissue and adipose tissue



# Pigmentation

- Pigments producing color including melanin, carotene, and hemoglobin
- **Melanin** is produced by cells called melanocytes and is transferred into the keratinocytes via a cellular vesicle called a melanosome
- Dark-skinned individuals produce more melanin than those with pale skin

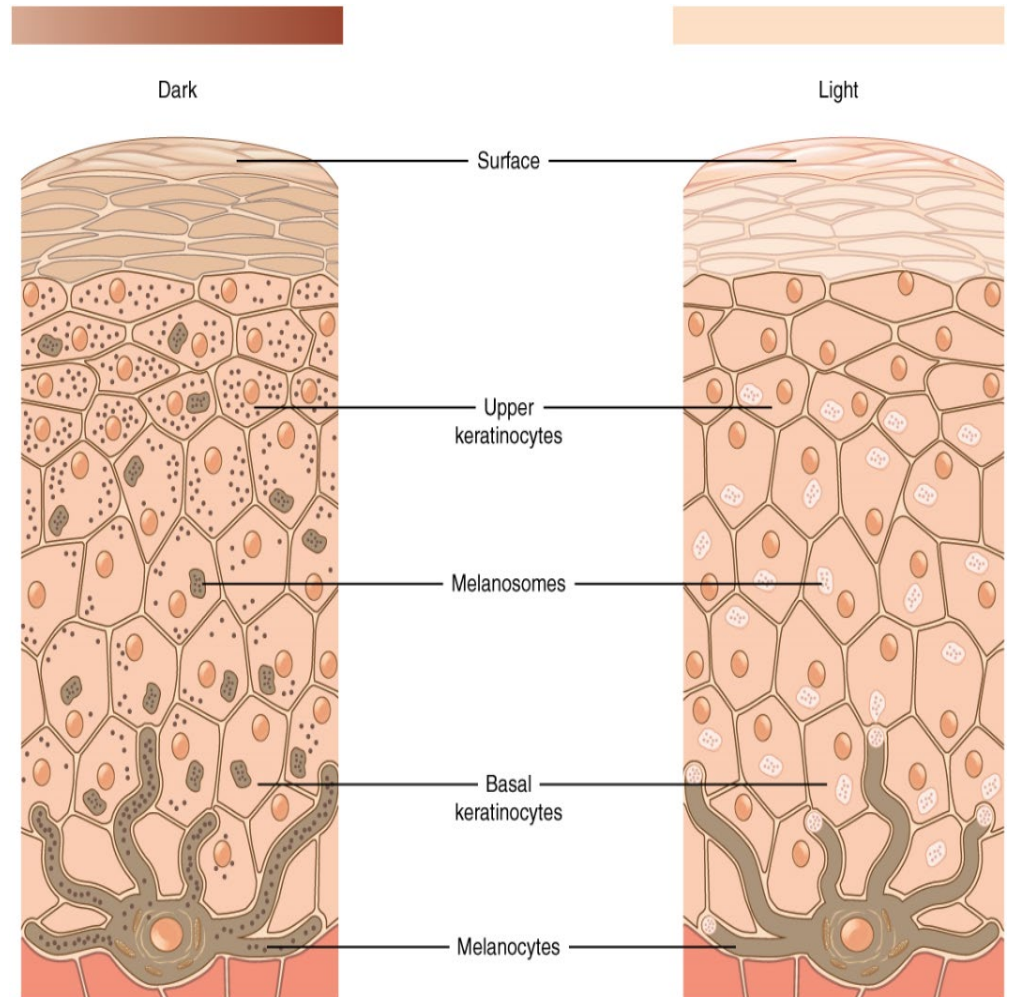


Figure 7

# Epidermis vs. dermis

## Summary

Region	Layer	Characteristics of the tissue
<b>Epidermis</b>	<u>Stratum corneum</u>	Flat, dead keratinocytes, surrounded by lipids
	<u>Stratum lucidum</u>	Flat, dead keratinocytes; only in palms, soles & fingers
	<u>Stratum granulosm</u>	Flat, dying keratinocytes with keratohyalin
	<u>Stratum spinosm</u>	Live keratinocytes and melanocytes
	<u>Stratum basale</u>	Rapidly dividing keratinocytes and melanocytes
<b>Dermis</b>	<u>Papillary region</u>	Dermal papillae with blood vessels and sensory receptors ( <i>loose areolar connective tissue</i> )
	<u>Reticular region</u>	Fibroblasts, collagen fibres and elastic fibres ( <i>dense irregular connective tissue</i> )

# Hair

- Functions in protection, sensation, thermoregulation and communication
- Hair is a keratinous filament growing out of the epidermis

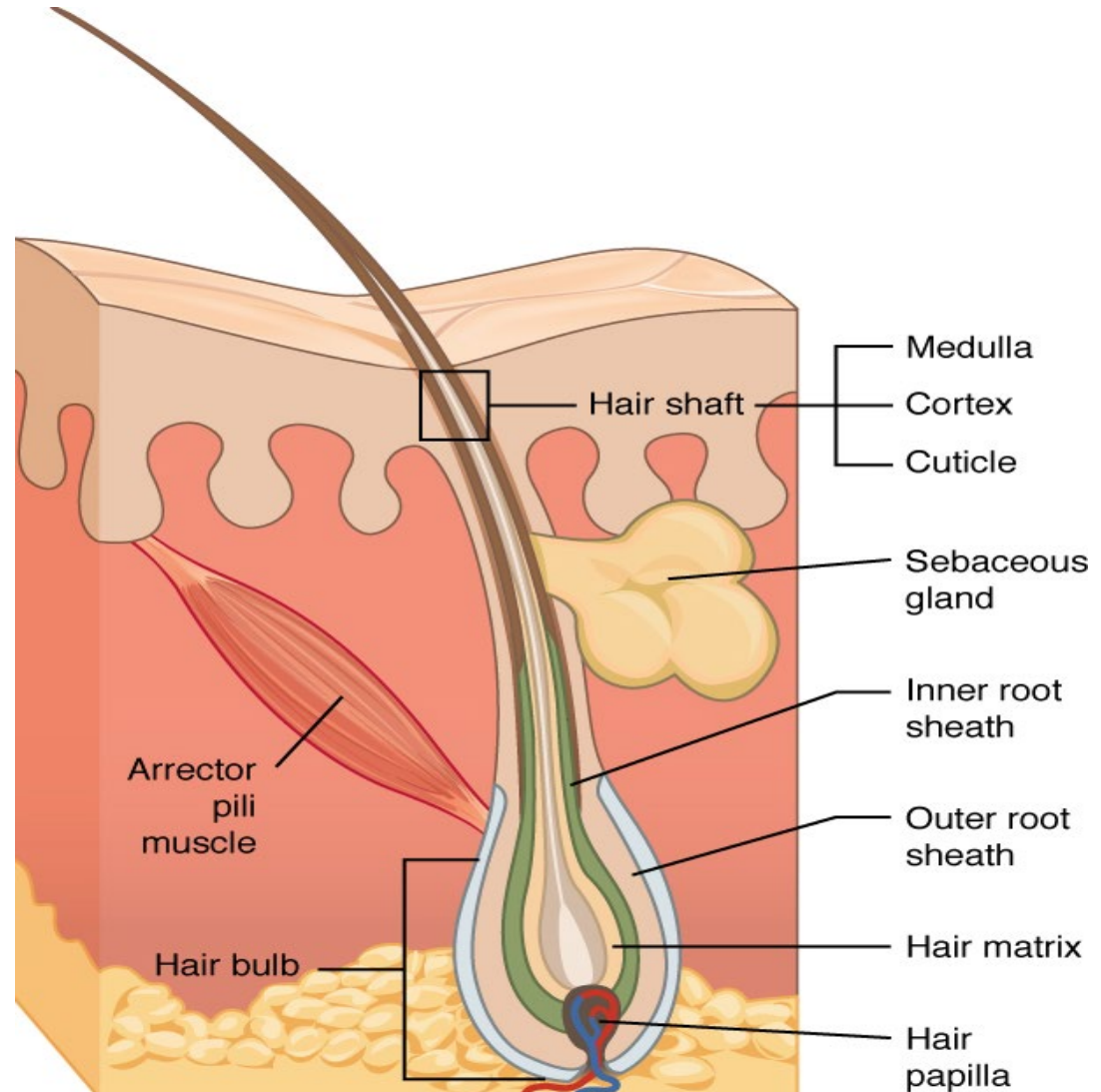
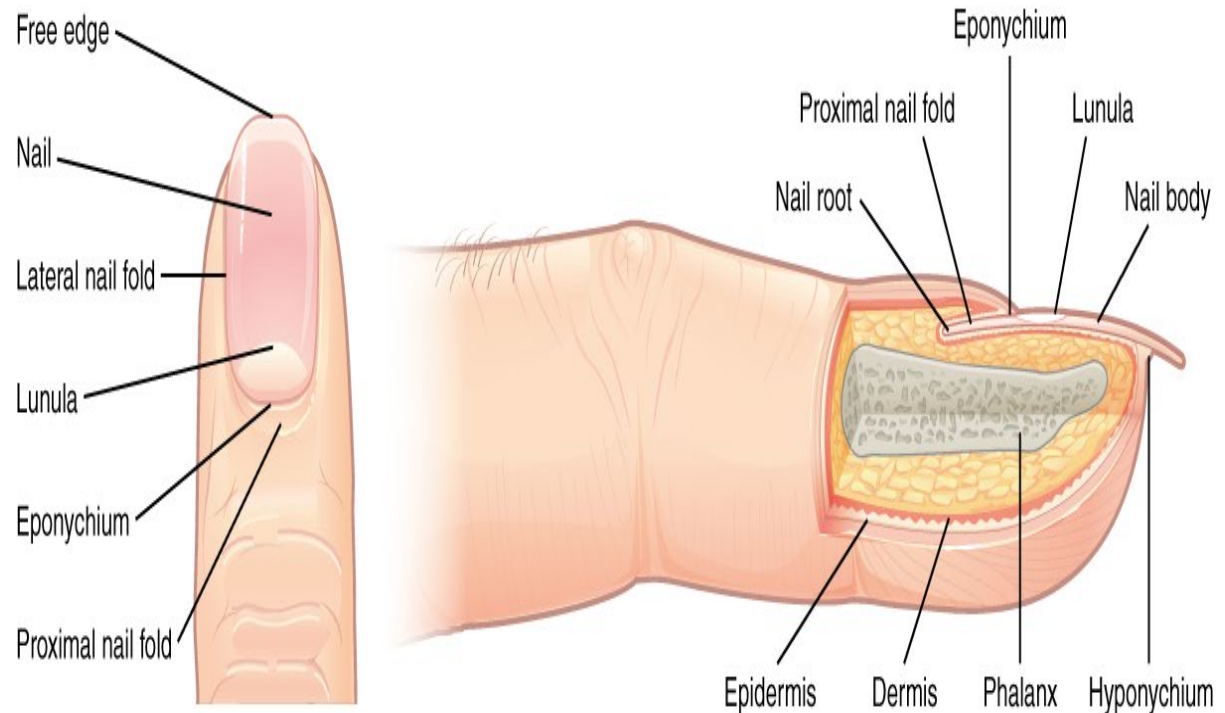


Figure 9

## Nail

- Hard keratinized masses of cells
- Functions in grasping and manipulating objects and protecting the end of digits

Figure 11



# Glands

## Glands

- **Sudoriferous** = sweat glands (Eccrine and Apocrine)
- **Sebaceous** = oil glands
- **Ceruminous** = modified sweat gland in ear canals

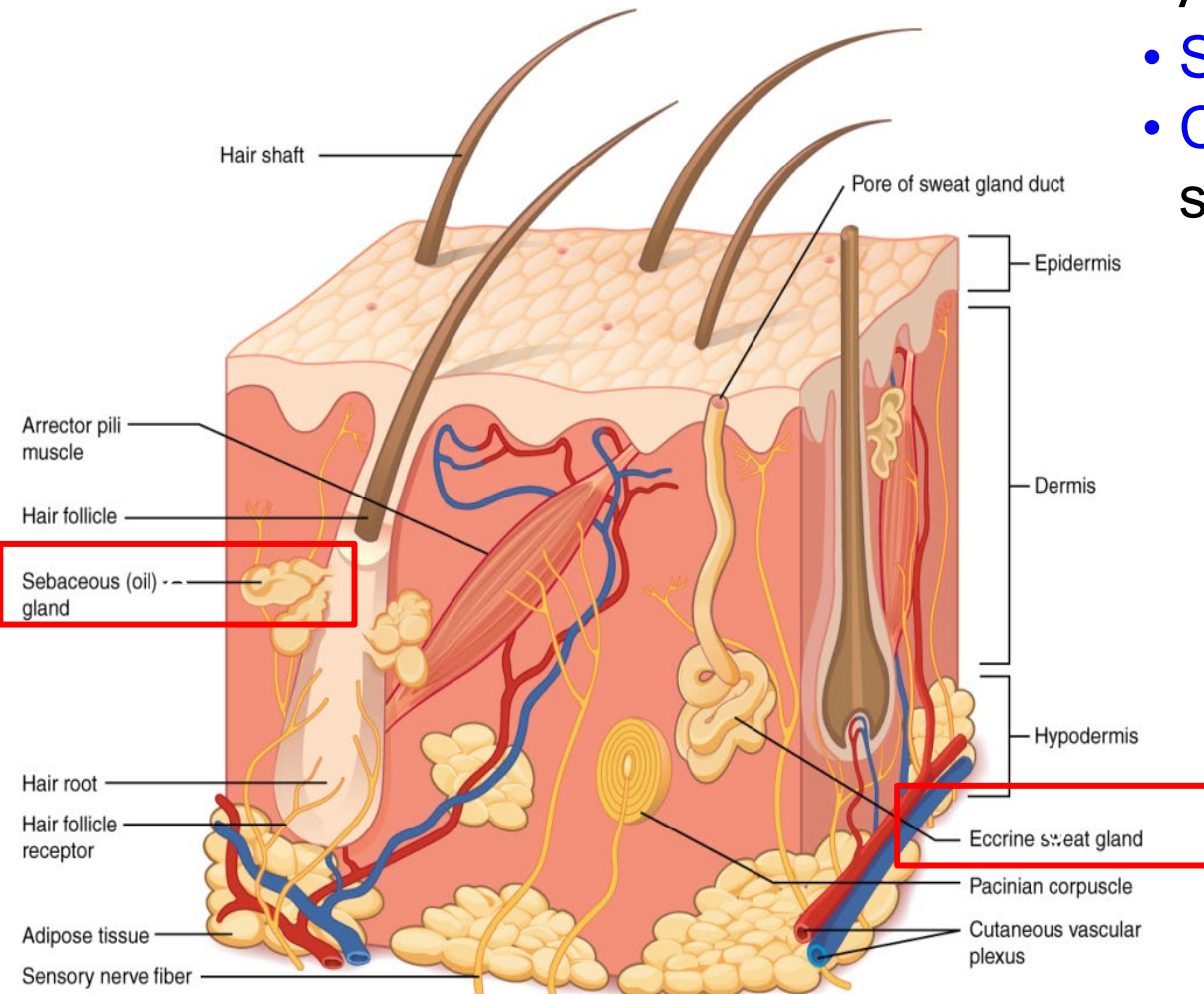
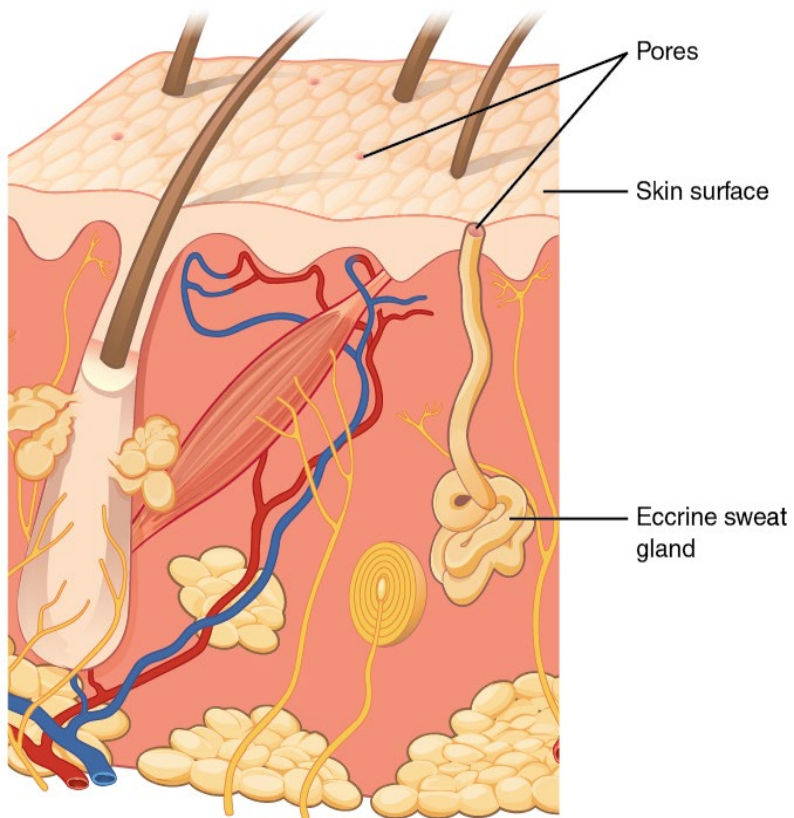


Figure 12

# Sudoriferous sweat glands



- Produce sweat to cool the body
- Eccrine **sweat** glands produces a hypotonic sweat for thermoregulation.
- These glands are found all over the skin's surface, but are especially abundant on the palms of the hand, the soles of the feet, and the forehead
- Apocrine **sweat** includes organic compounds that make the sweat thicker and subject to bacterial decomposition and subsequent sme
- These glands is associated with hair follicles in densely hairy areas, such as armpits and genital regions

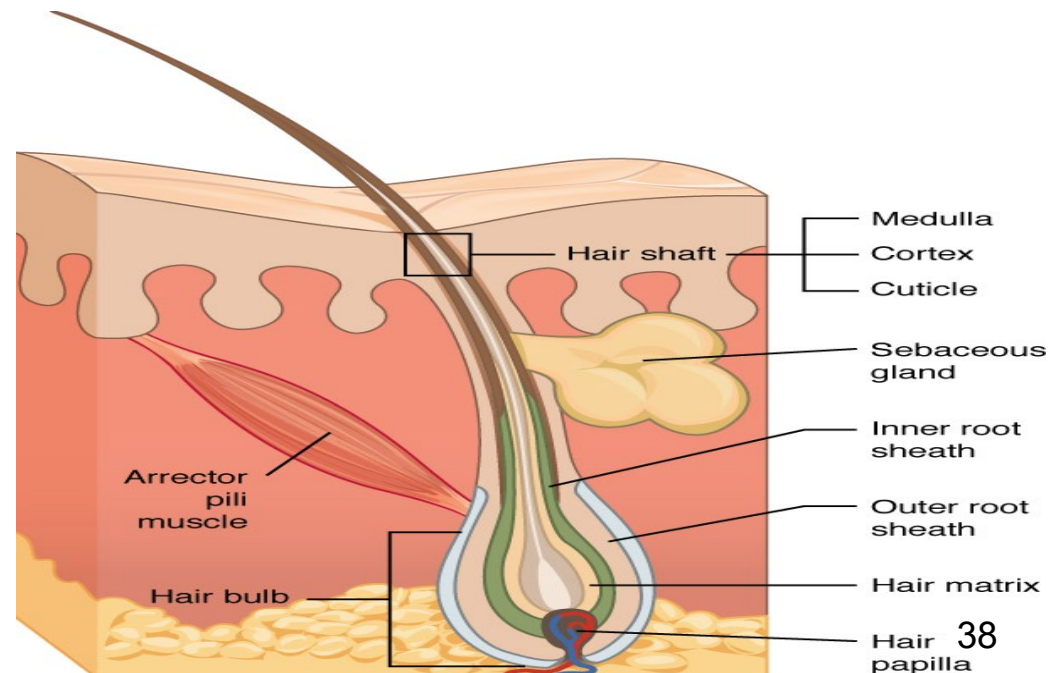
# Ceruminous gland

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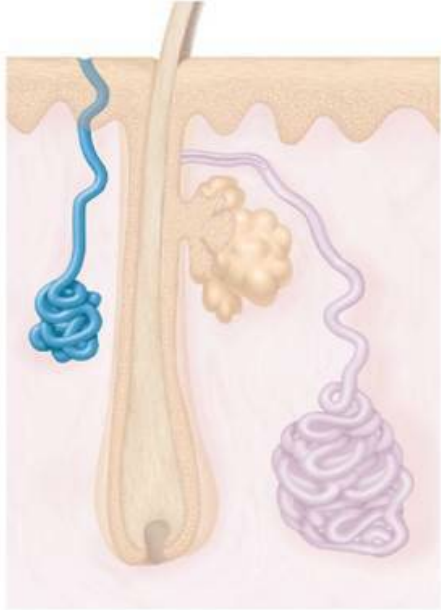
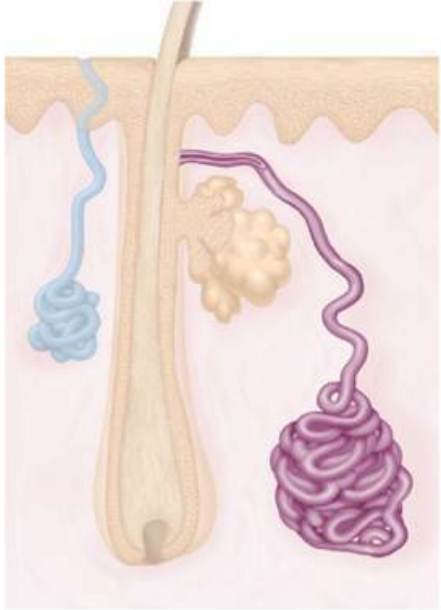

- Found in the external ear canal and secretes cerumen
- Cerumen is a pigmented mixture of lipids and proteins that combines with the sebum secreted from sebaceous glands and dead keratinocytes to form earwax.
- This sticky substance is used to trap small foreign bodies (e.g. dirt, small insects) and help prevent damage to the eardrum

# Sebaceous glands

- A **sebaceous gland** is found all over the body and helps to lubricate and waterproof the skin and hair.
- Most sebaceous glands are associated with hair follicles
- The fatty acids of sebum also have antibacterial properties, and prevent water loss from the skin in low-humidity environments



**Table 5.1 Summary of Cutaneous Glands**

	<b>ECCRINE SWEAT GLANDS</b>	<b>APOCRINE SWEAT GLANDS</b>	<b>SEBACEOUS GLANDS</b>
			
<b>Functions</b>	<ul style="list-style-type: none"> <li>• Temperature control</li> <li>• Some antibacterial properties</li> </ul>	May act as sexual scent glands	<ul style="list-style-type: none"> <li>• Lubricate skin and hair</li> <li>• Help prevent water loss</li> <li>• Antibacterial properties</li> </ul>
<b>Type of Secretion</b>	Hypotonic filtrate of blood plasma	Filtrate of blood plasma with added proteins and fatty substances	Sebum (an oily secretion)
<b>Method of Secretion</b>	Merocrine (exocytosis)	Merocrine (exocytosis)	Holocrine
<b>Secretion Exits Duct At</b>	Skin surface	Usually upper part of hair follicle; rarely, skin surface	Usually upper part of hair follicle; sometimes, skin surface
<b>Body Location</b>	Everywhere, but especially palms, soles, forehead	Mostly axillary and anogenital regions	Everywhere <i>except</i> palms and soles

# Function of the epidermal derivatives

## Hair, Nails and Glands

### Hair

- Protection of scalp and eyes
- Sensation (light touch receptors in hair root plexuses)

### Nails

- Protection of the end of the digits
- Help in grasping and handling
- Scratching

### Sebaceous Glands

- Protection of hair
- Prevention of dehydration
- Antimicrobial

### Sudoriferous Glands

- Thermoregulation
- Excretion

### Ceruminous Glands

- Protection of the ear canal against foreign bodies, microbes, and water

# Integumentary system

## Objectives

---

1. Identify and describe the components of the integumentary system.
2. Identify and describe the five layers of the epidermis of the skin, including the location and function of keratinocytes and melanocytes.
3. Specify the function(s) of epidermal derivatives, including hair, sebaceous glands, sudoriferous glands, ceruminous glands, nails.
4. Describe five major functions of the integumentary system.