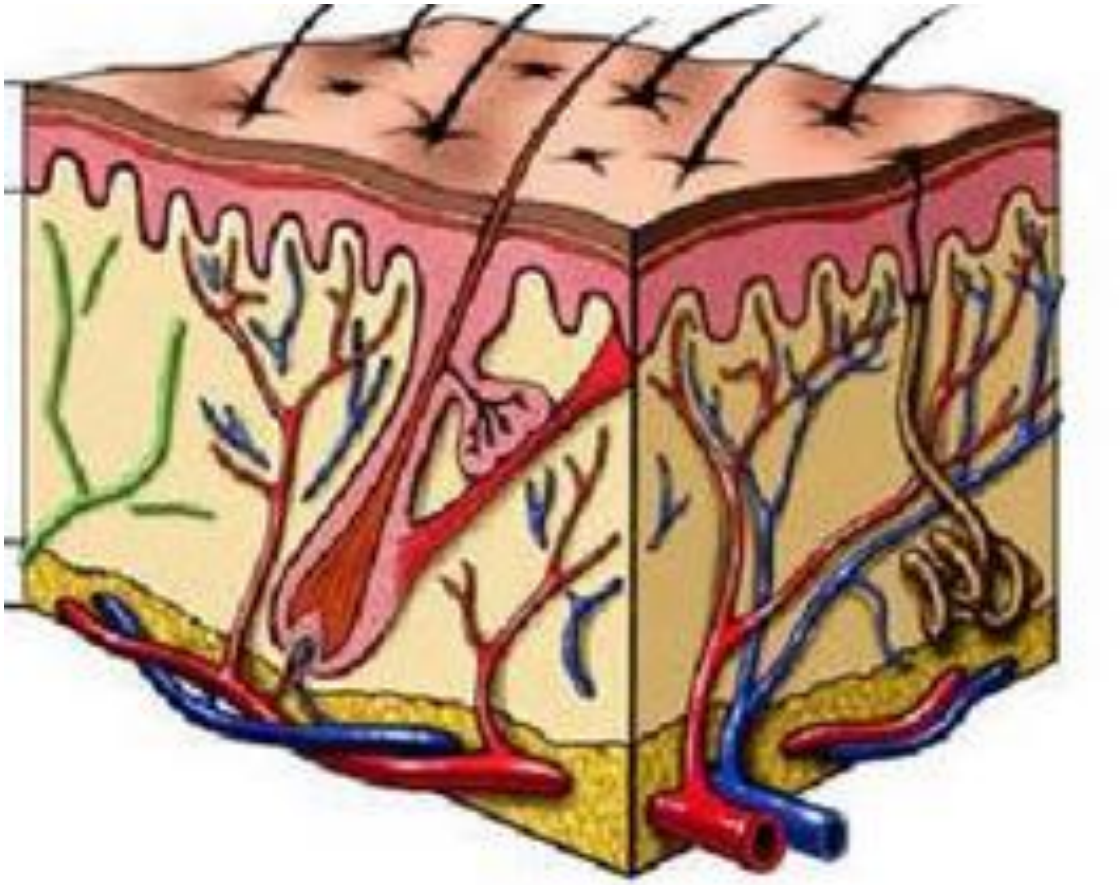
skin / Integument system



Objectives

- list the functions of the skin.
- describe the structure of the thick skin.
- list the differences between thick skin and thin skin.
- describe the blood supply and nerve supply of the skin.
- describe briefly the structure and the functions of the following appendages of the skin
  - ★ sebaceous glands & sweat glands
  - ★ hair follicles
  - ★ nail

Basic facts about Skin

- Heaviest single organ (16% total body weight)
- Surface area : 1.2 to 2.3 m^2
- Consists of 2 layers
  - Superficial epithelial layer of ectodermal origin – **epidermis**
  - deep connective tissue layer of mesodermal origin – **dermis**
- Rests on *subcutaneous tissue / subcutis / hypodermis / superficial fascia* (loose connective tissue with variable amount of adipose tissue)

Skin Functions

- protection to underling tissue
  - thickest over areas exposed to greatest friction
  - barrier against entry of microorganisms
  - Prevents loss of water from the body: dehydration
  - protects against UV rays
- regulation of body temperature
- excretion of various substances
- synthesis of vitamin D with UV absorption
- sensory organ

Skin structure

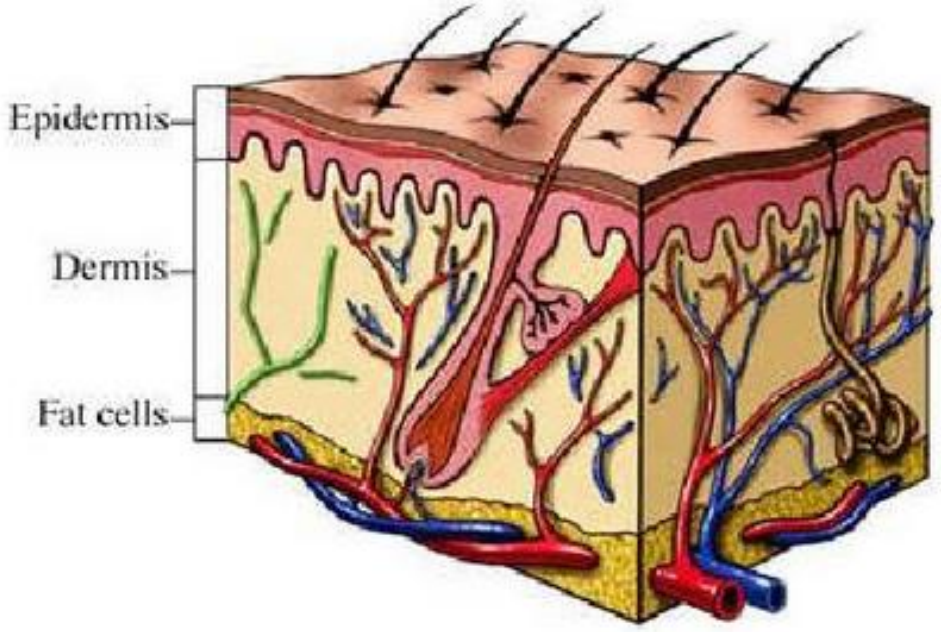
- Two distinct types
  - *Thick skin*
  - *Thin skin*

  Names refer only to the proportional **thickness of the epidermis &** not to the total thickness of the skin

- Skin appendages
  - *Hairs*
  - *Nails*
  - *Eccrine / merocrine sweat glands*
  - *Apocrine sweat glands*
  - *Sebaceous glands*

Skin layers

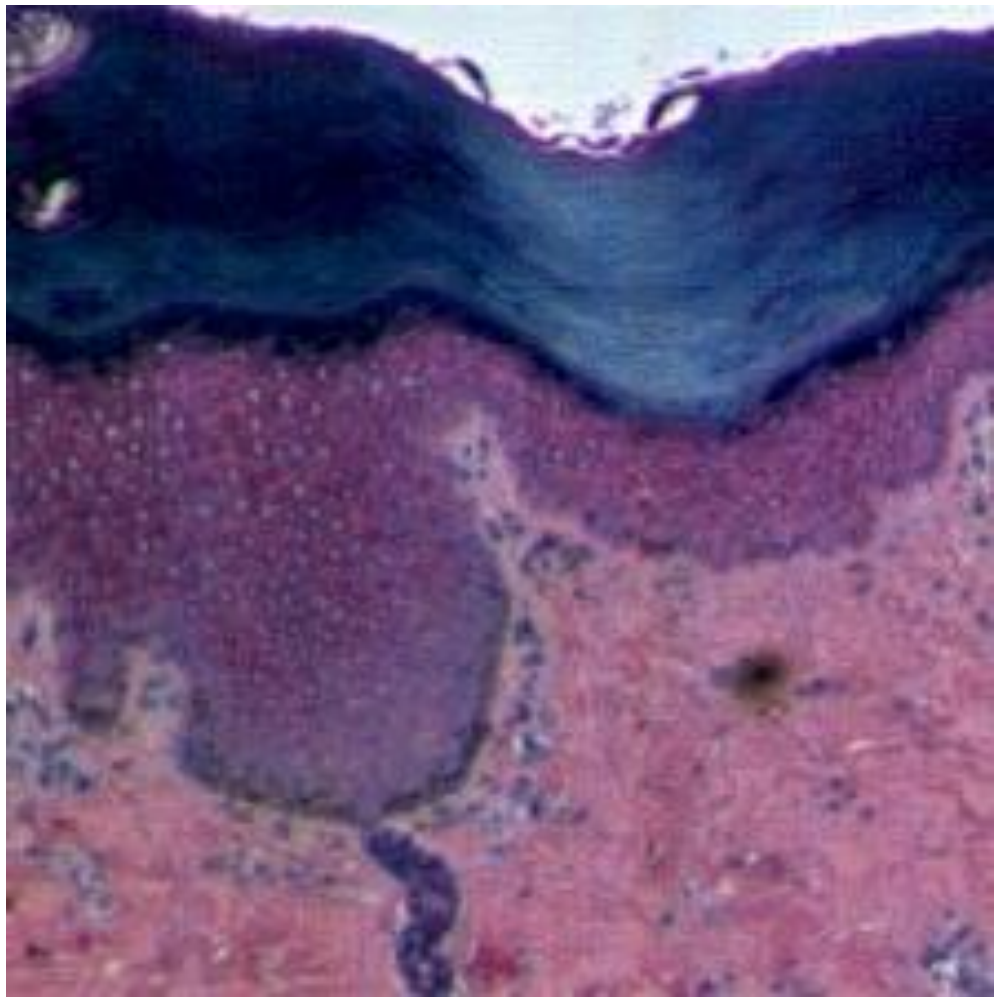
- **Epidermis**
  - Stratified squamous keratinized epithelium
- **Dermis**
  - dense fibro-elastic connective tissue with glands and hair



Skin Structure

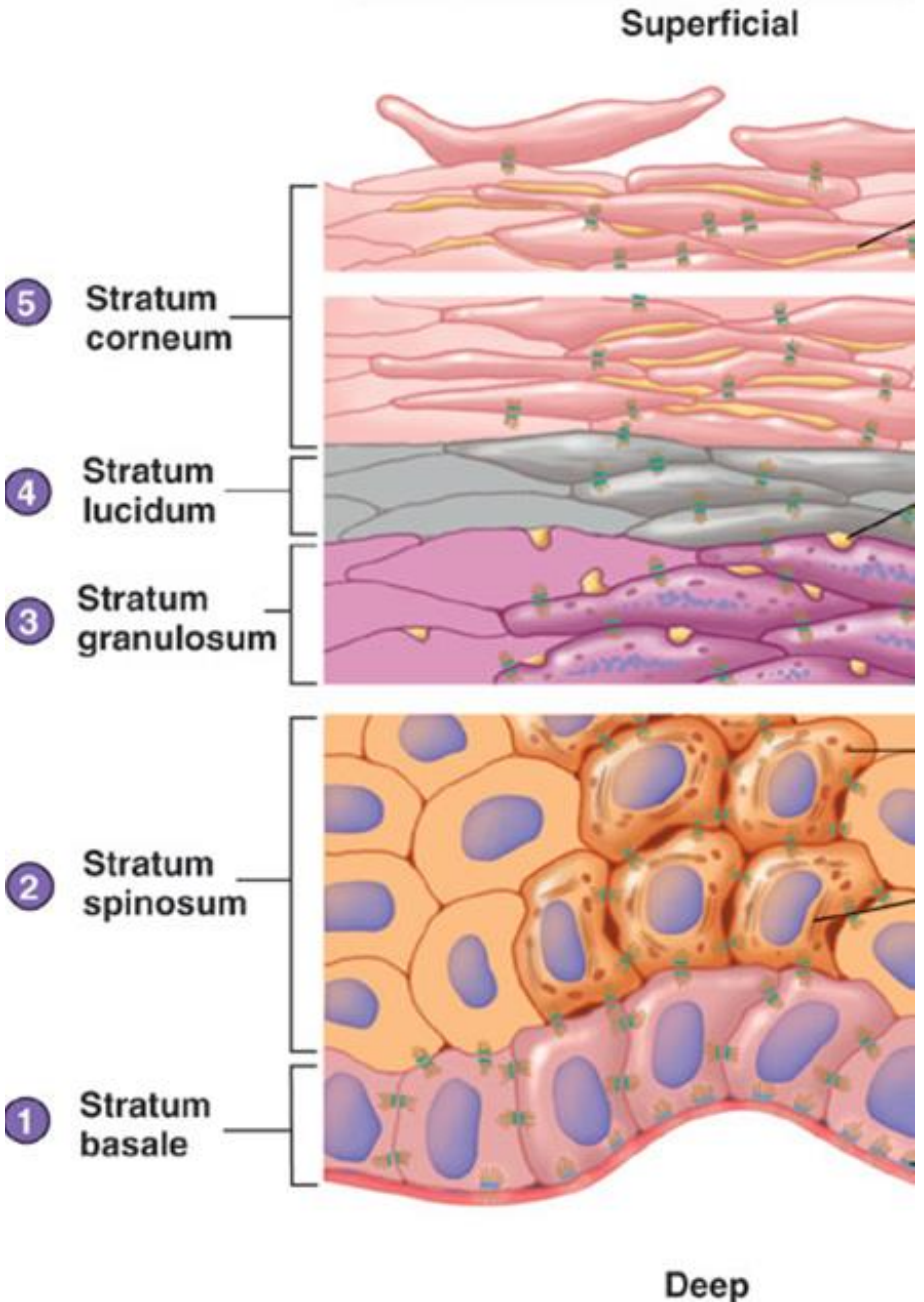
Epidermis

Dermis

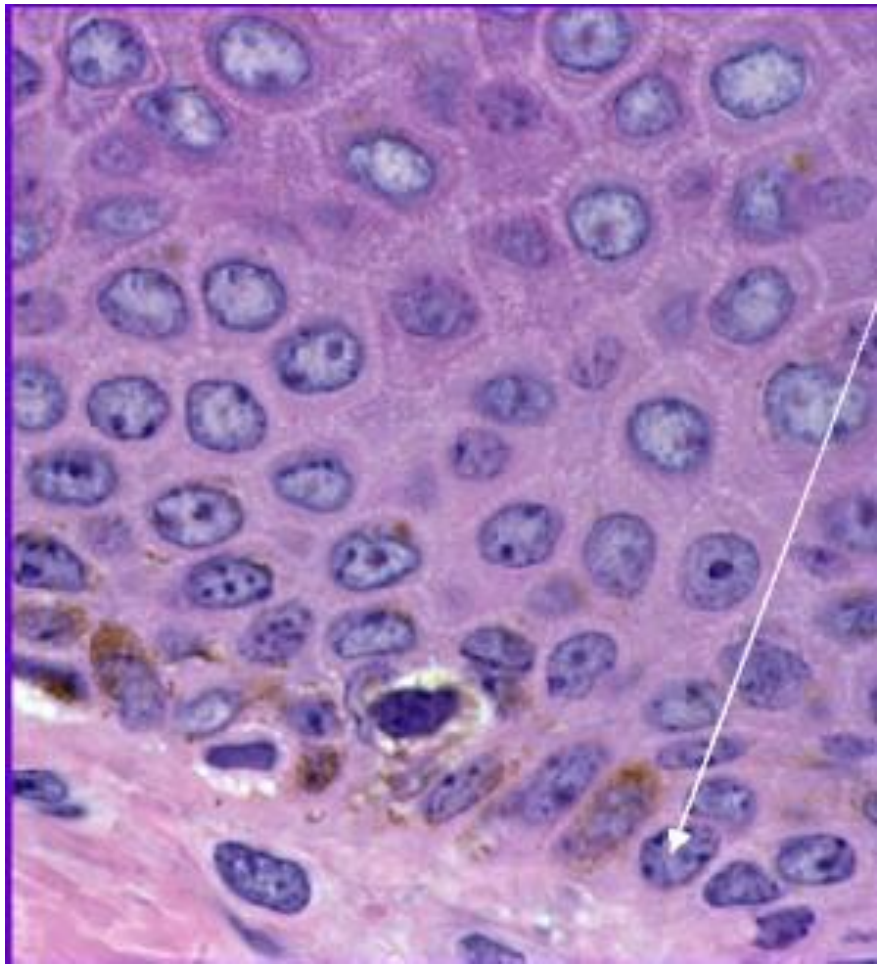


Epidermal Layers

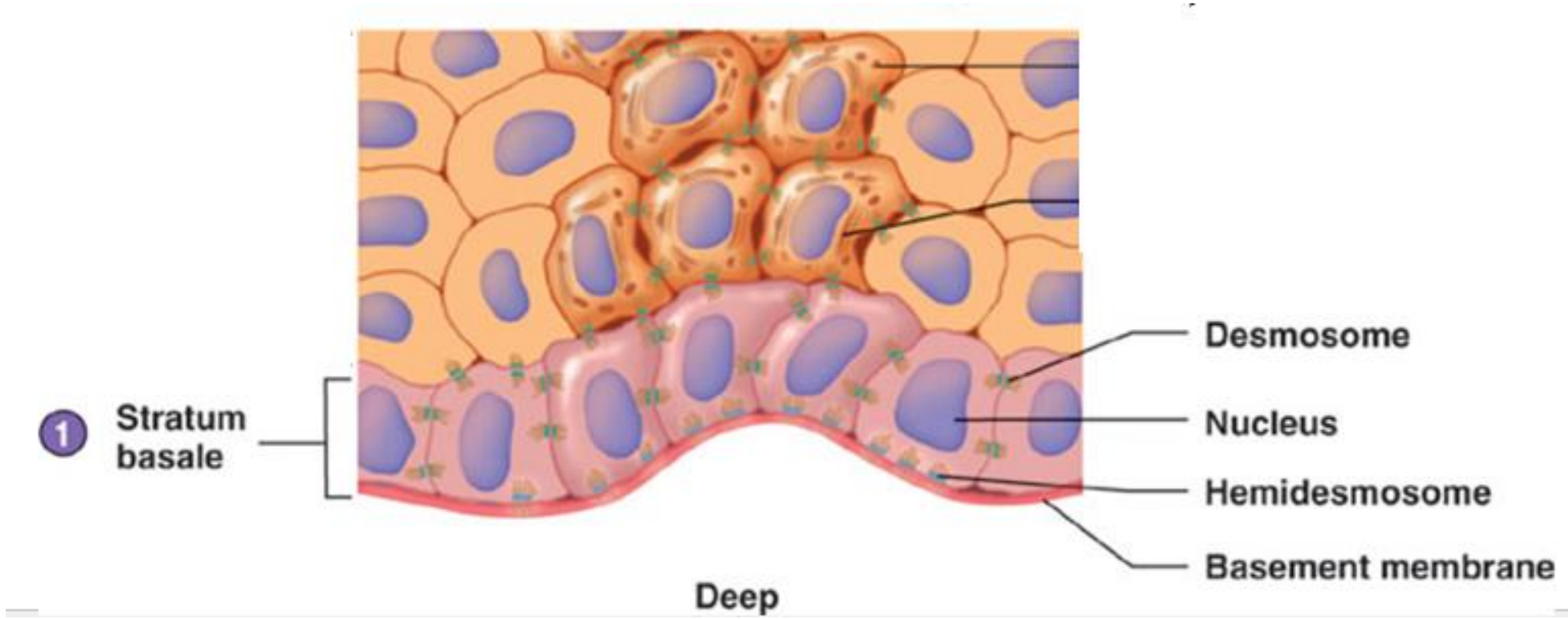
- consists of 5 layers / strata
  - stratum basale
  - stratum spinosum
  - stratum granulosum
  - stratum lucidum
  - stratum corneum



Stratum Basale



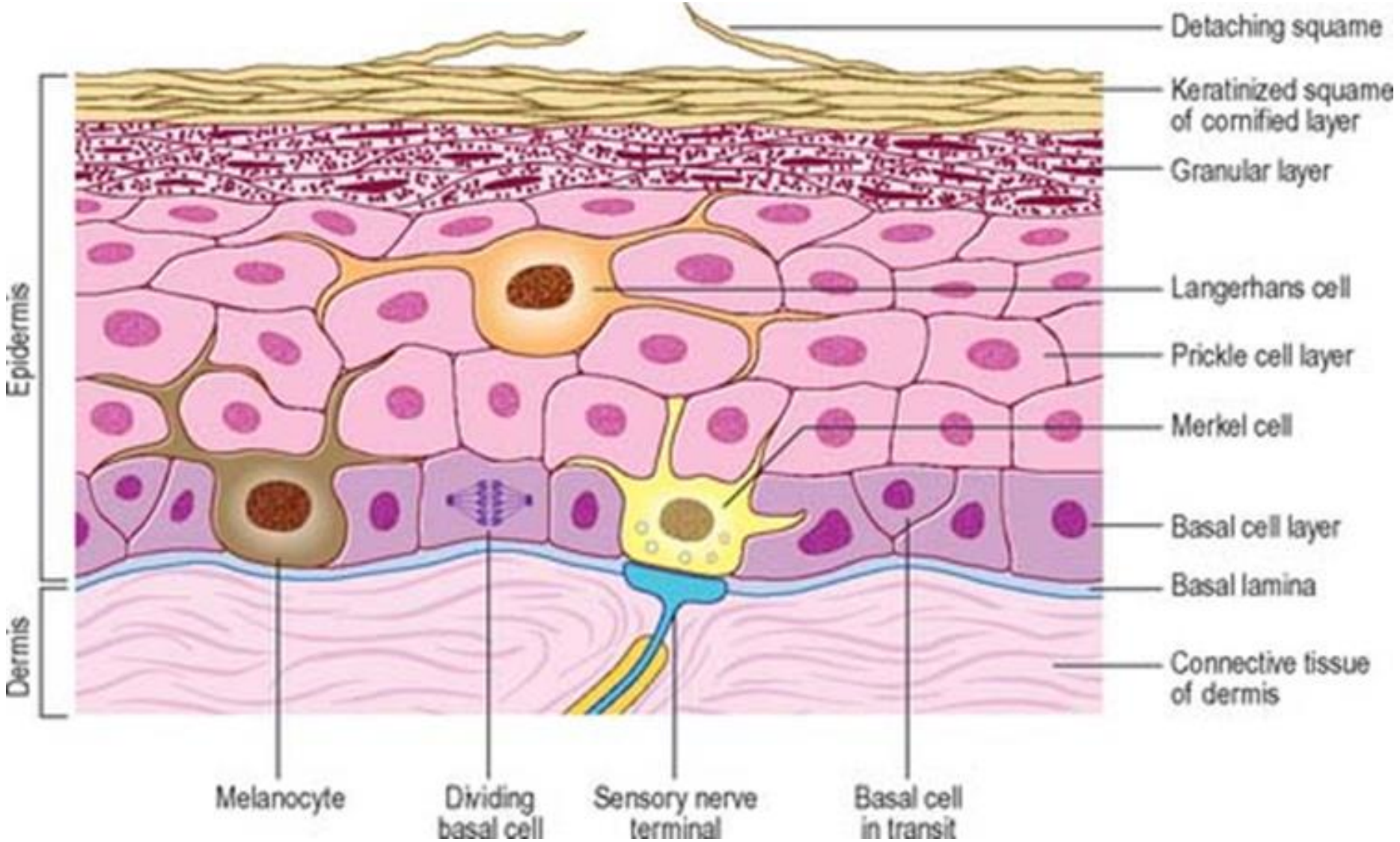
Stratum Basale



Cell types

Keratinocyte stem cells / Melanocytes / Merkel cells

Stratum Basale



Stratum Basale

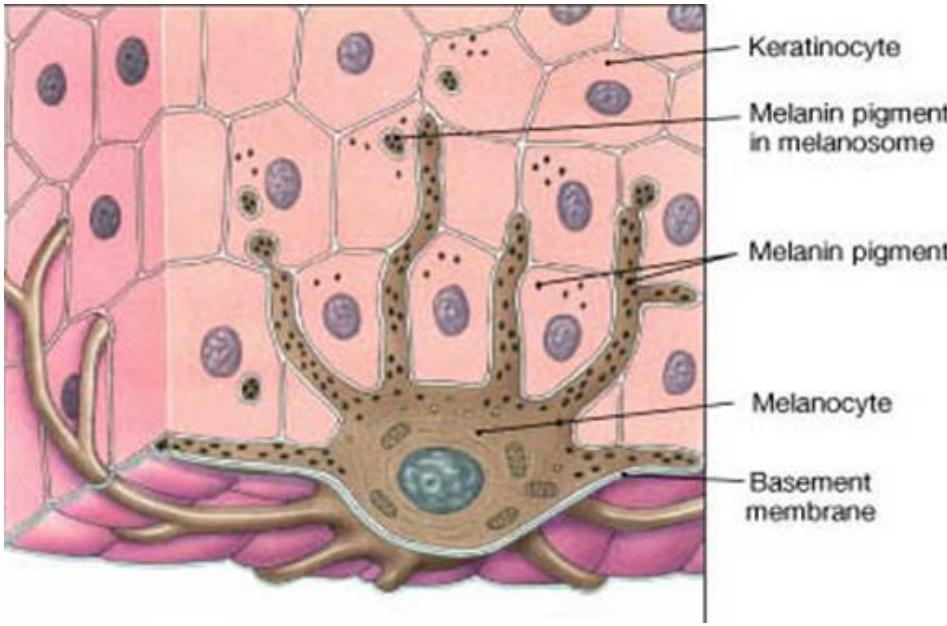
- deepest layer
- single basophilic layer – columnar or cuboidal
- keratinocyte stem cells – mitotically active.
- cells contain intermediate keratin filaments
- attached to basement membrane by hemidesmosomes.
- attached to each other with desmosomes.
- melanocytes and Merkel cells present.

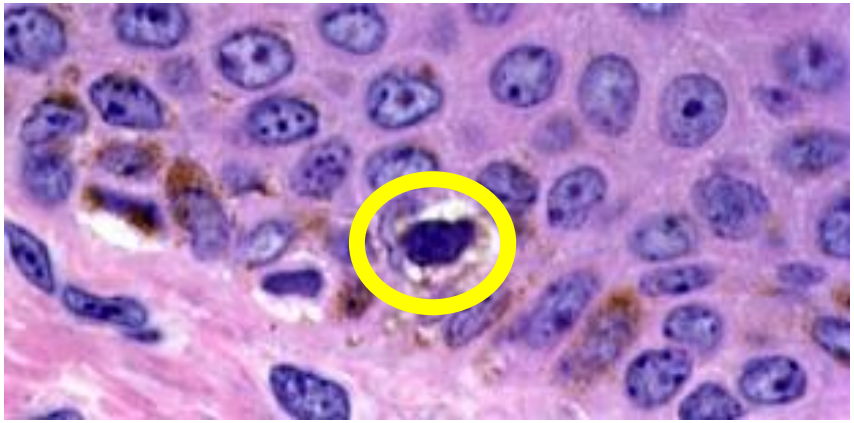
Merkel's cells

- present in the stratum basale
- in thick skin (palm & soles)
- contain small dense granules
- functions
  - Disk like expanded afferent nerve endings attached to Merkels cells. These nerve endings are pressure sensitive touch receptors / sensory mechano-receptors
  - act as neuroendocrine cells (discharge granules through exocytosis which behave like paraneurons which capable of short signaling)

Melanocytes

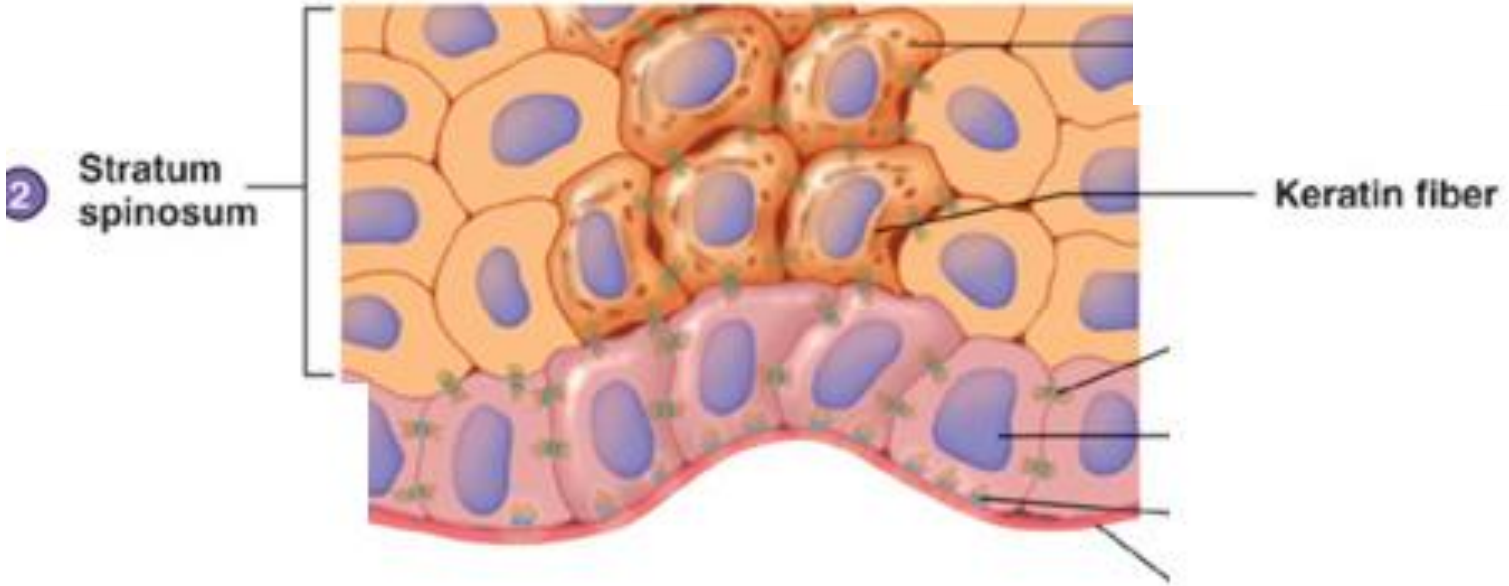
- found in the stratum basale
- derived from neural crest
- pale staining cytoplasm
- long cytoplasmic extensions
- numerous mt, Golgi, r-ER
- produce melanin and pass it to nearby keratinocytes
- skin color depends on activity of cells, rather than number



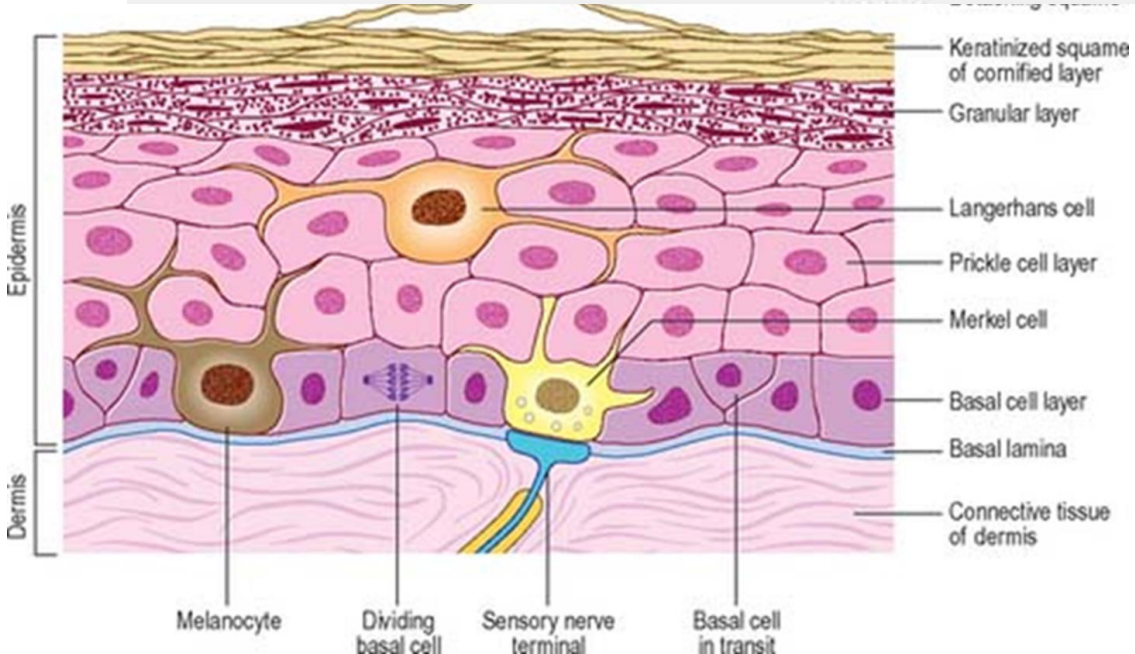


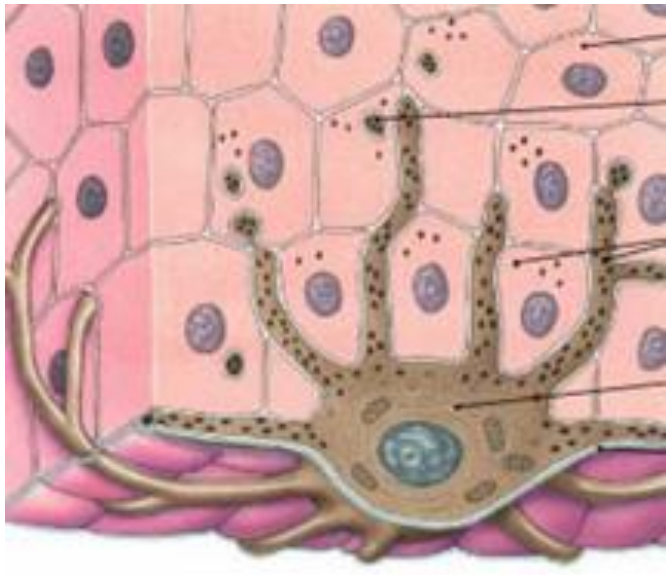
Stratum Spinosum

Stratum Spinosum



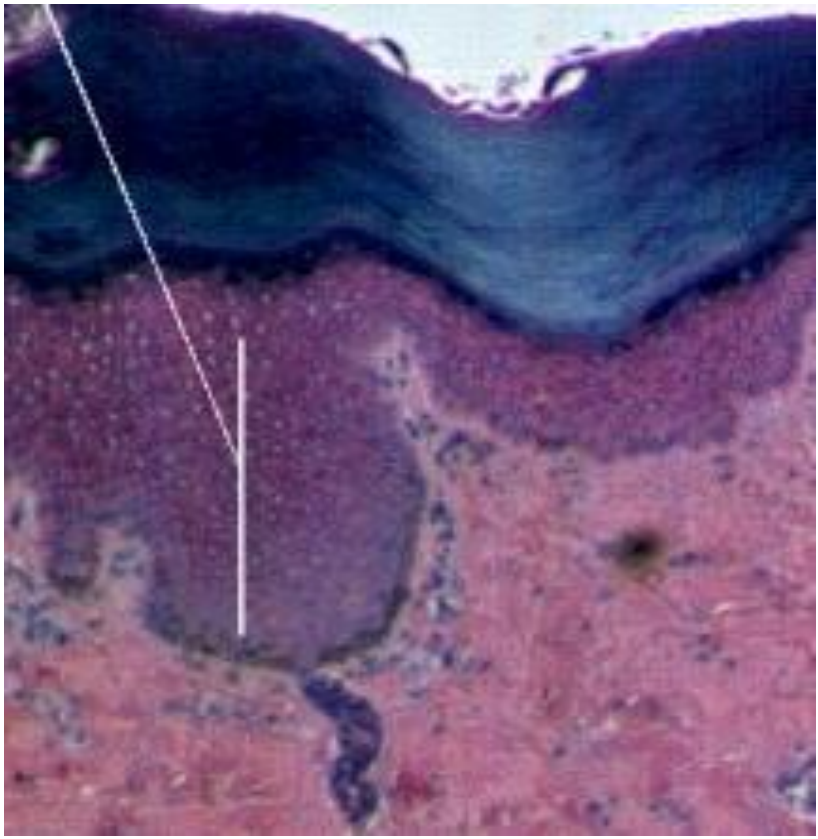
Deep





Stratum Spinosum

- several layers of cuboidal or polygonal cells
- mitotically active
- concentrated tonofilaments (keratin bundles)
- Langerhans cells
- projections of melanocytes



Stratum Spinosum

- many desmosomal junctions hold cells together

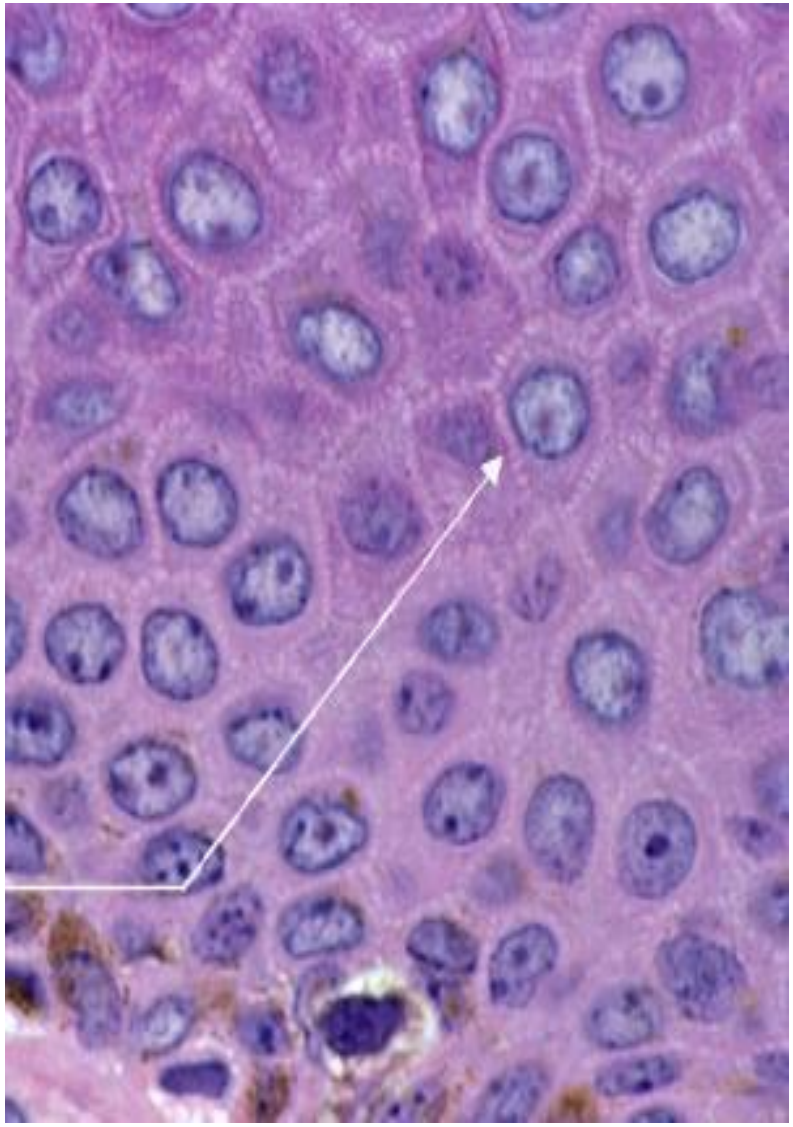
- Tonofilaments are inserted into desmosomes

- protect from skin abrasions

- shrinkage of cells

↓

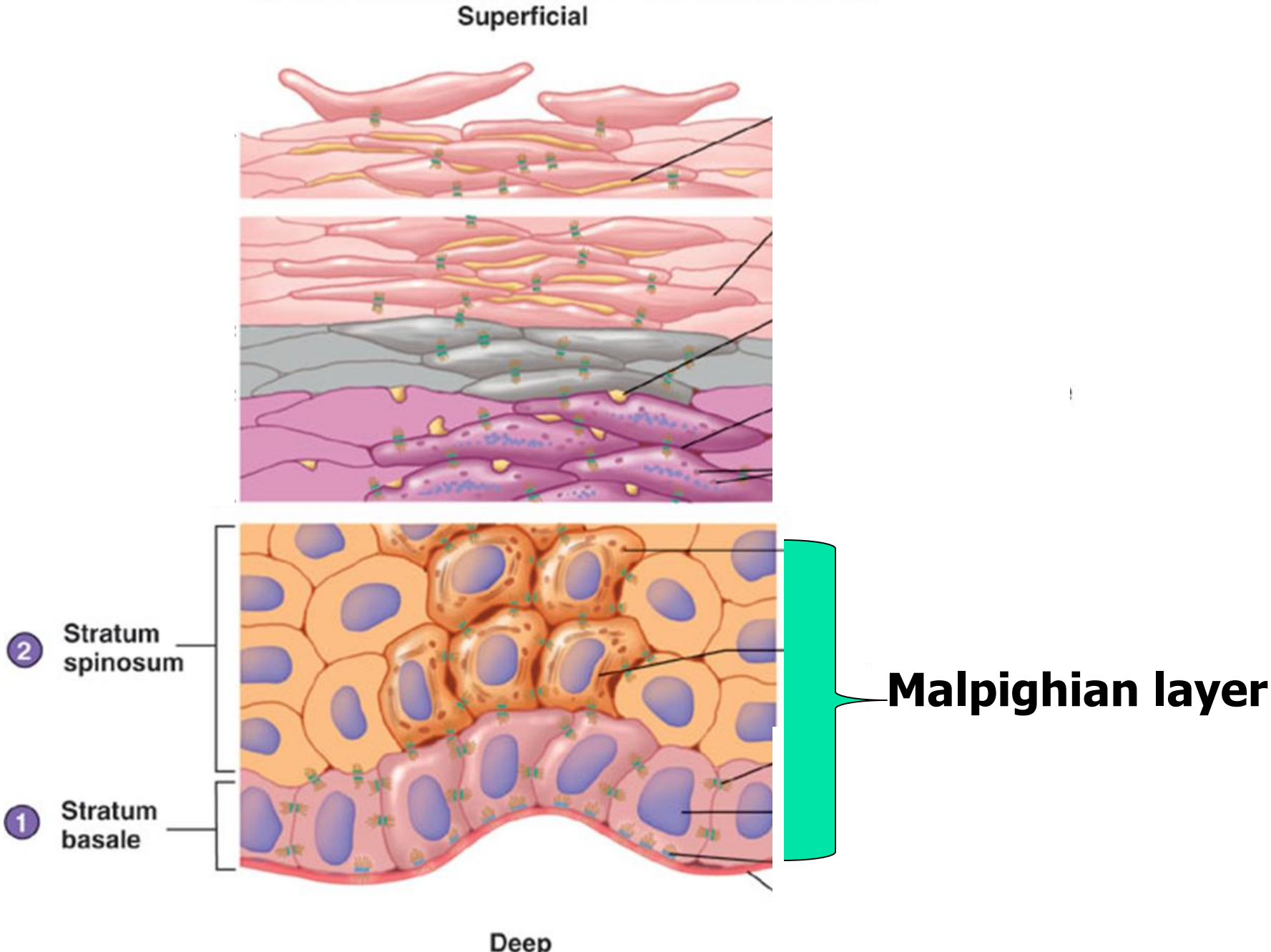
spines



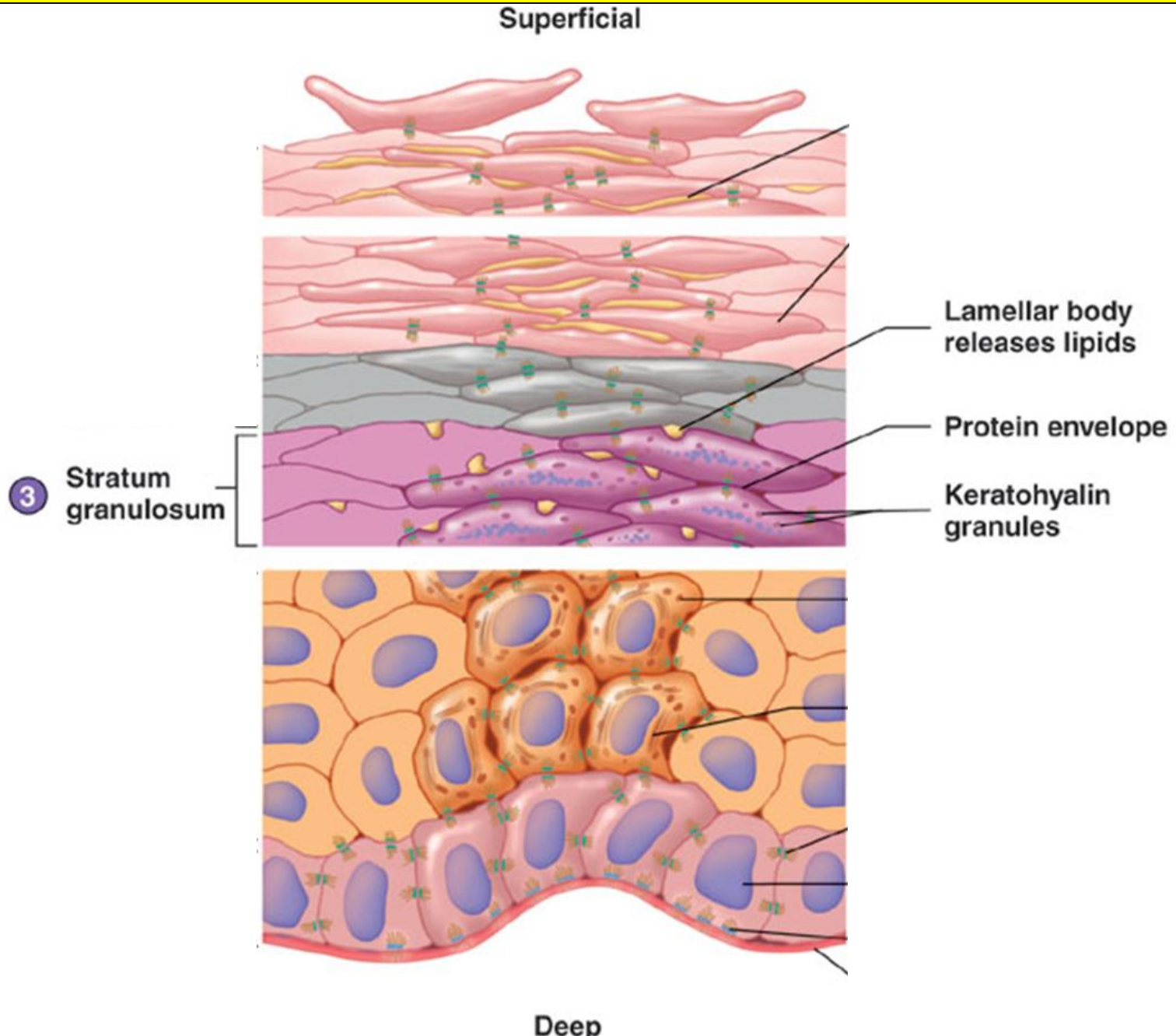
Langerhans cells

- bone marrow derived monocyte / macrophage
- antigen-presenting cell
- present in all layers, but predominantly in stratum spinosum.
- pale nuclei, granular cytoplasm.
- increases in chronic inflammatory skin diseases

Epidermal Layers

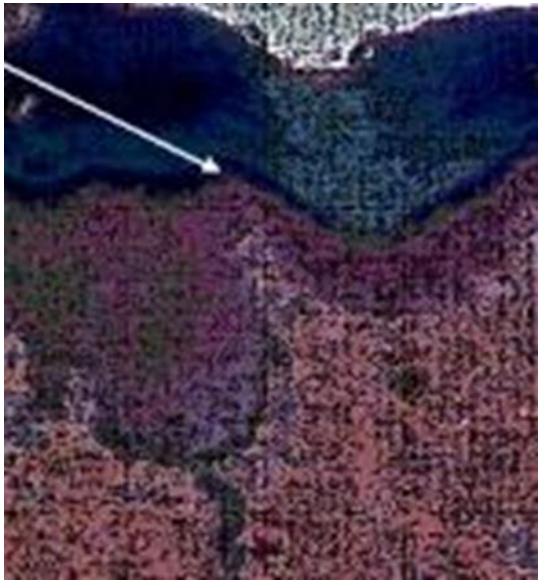


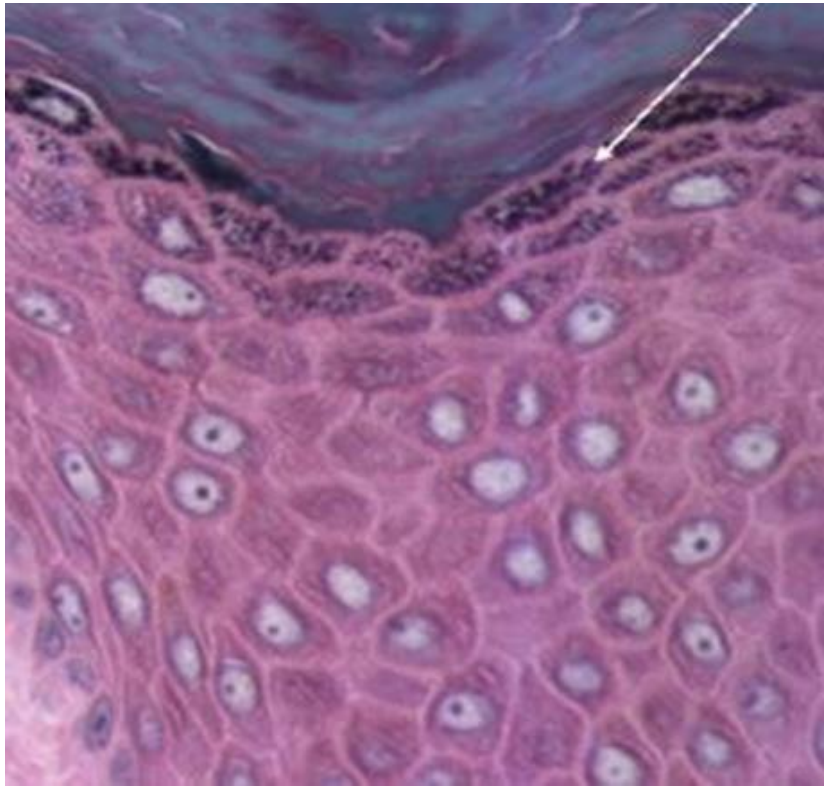
Stratum Granulosum



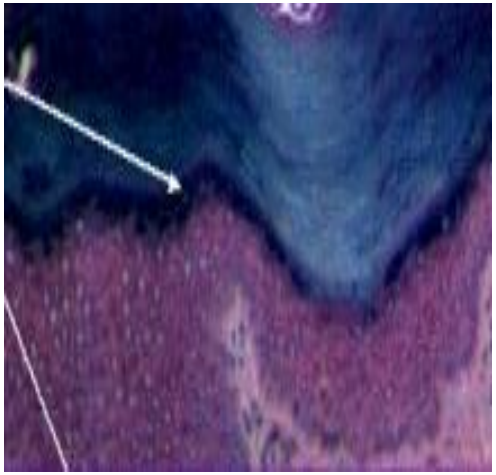
Stratum Granulosum

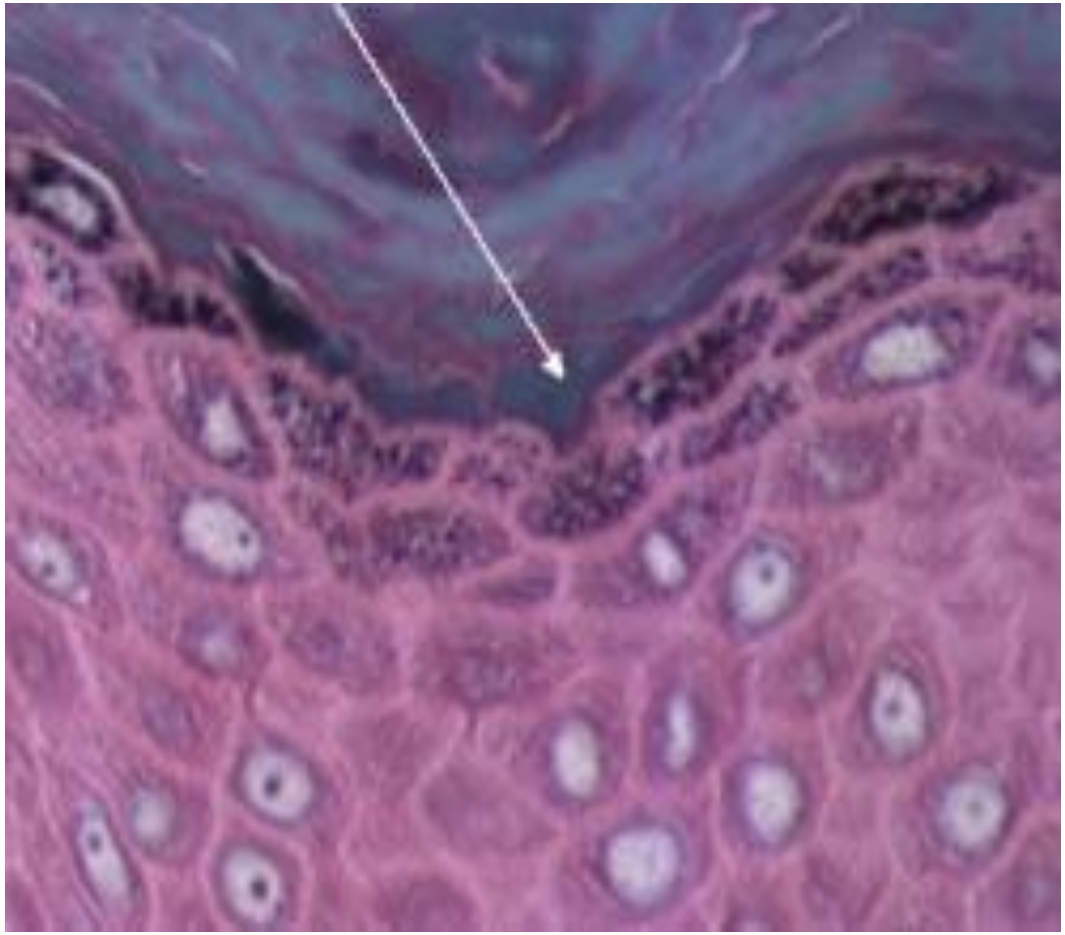
- 3 -5 layers of flattened polygonal cells.
- contain basophilic keratohyalin granules
- Membrane-coated **lamellar granules**
  discharge into intercellular spaces – lipid sheets barrier
- no cell division occurs





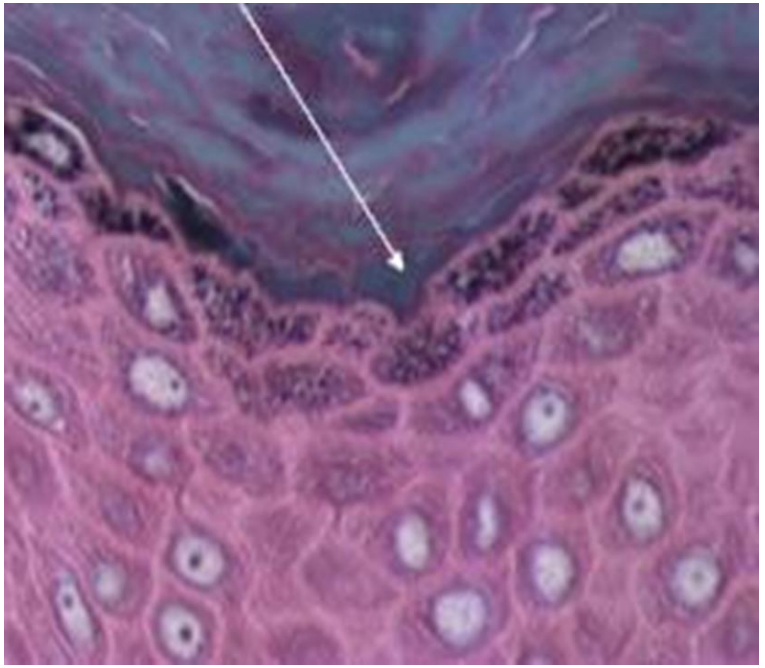
Stratum Lucidum



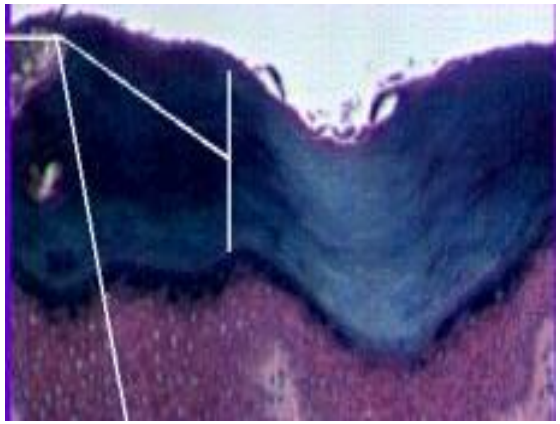


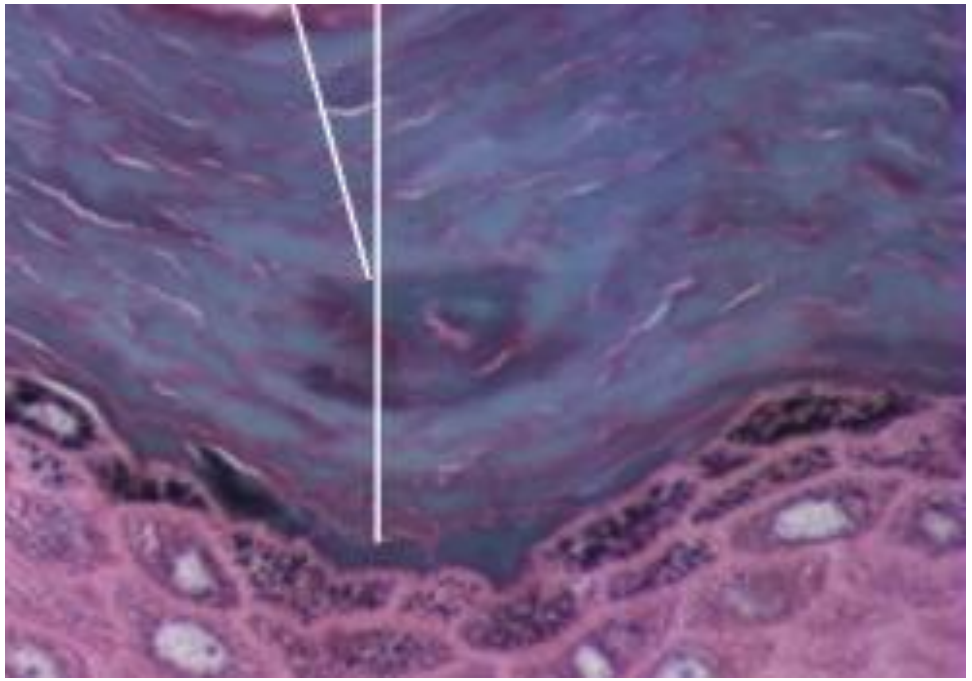
Stratum Lucidum

- Thick skin
- a translucent thin layer of extremely flattened eosinophilic cells.
- nuclei and organelles not present.
- densely packed keratin filaments
- desmosomes are still evident



Stratum Corneum

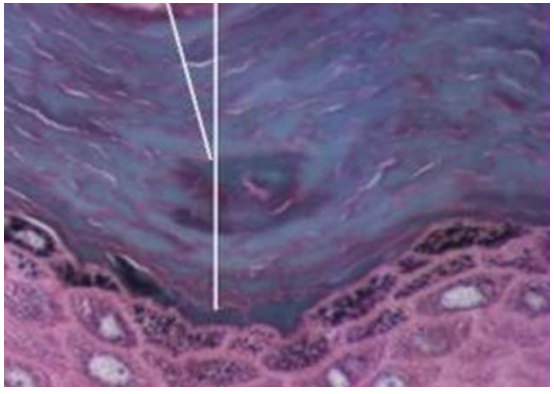




Stratum Corneum

- outermost layer
- composed of 15 to 20 layers of cells
- flattened, non-nucleated, keratinized cells.
- filled with filaments of keratin
- Fillaments are packed in a matrix contributed by keratohyalin granules.
- surface cells continuously desquamated
- Broad in thick skin

turnover from basal to superficial: 25 –50 days



Skin Color

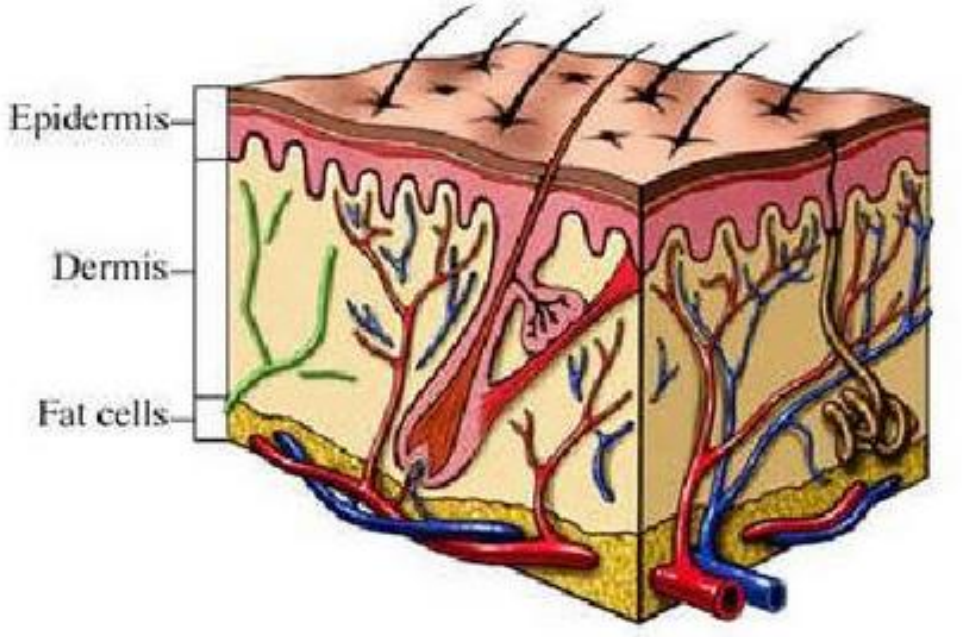
Depends on 3 pigments

1. Hemoglobin (dermal blood supply)
2. Melanin
   - Produced by melanocytes of stratum basale
3. Carotene
   - Obtained from plant foods

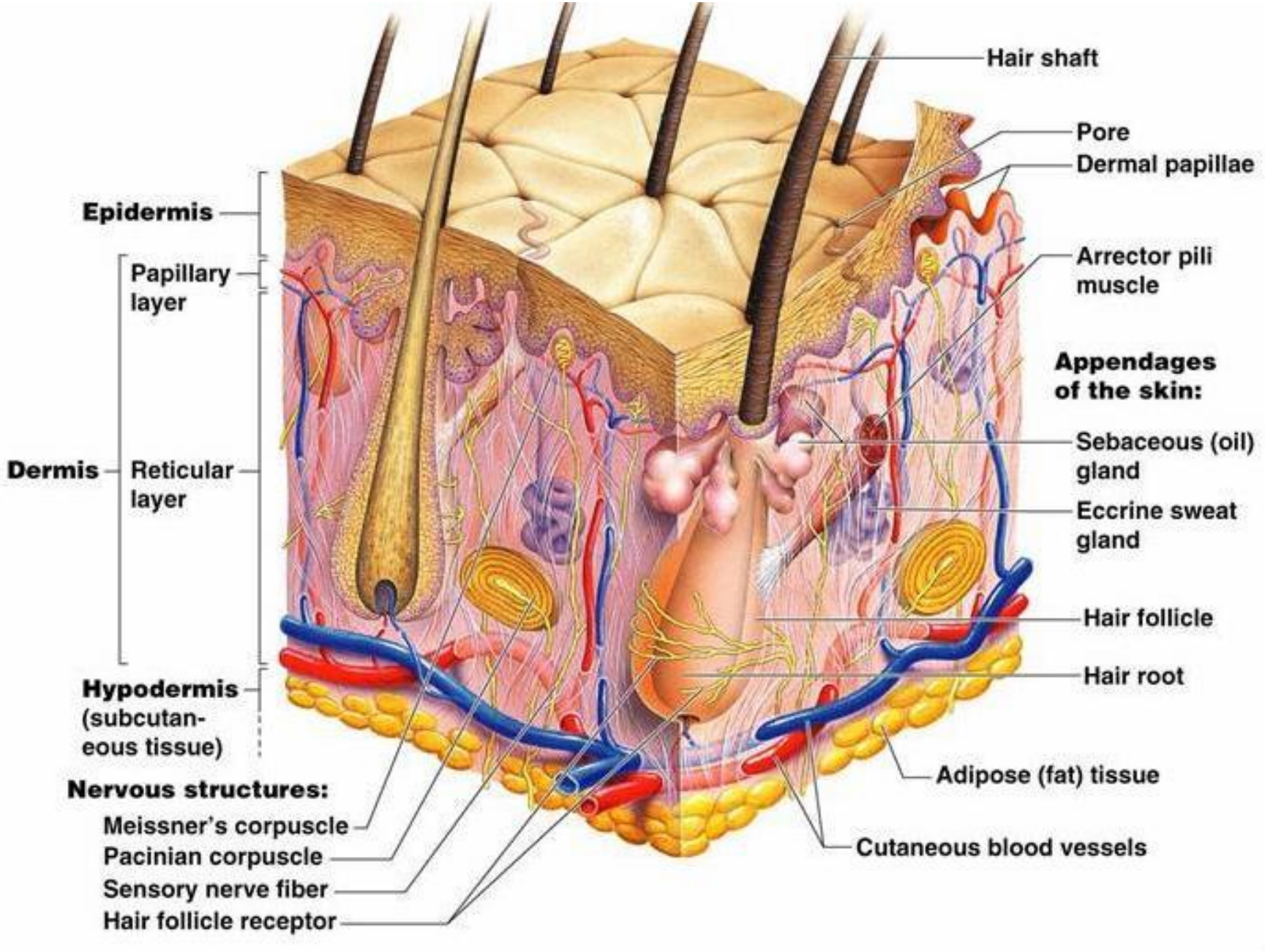
Dermis

Skin layers

- **Epidermis**
  - Stratified squamous keratinized epithelium
- **Dermis**
  - dense fibro-elastic connective tissue with glands and hair



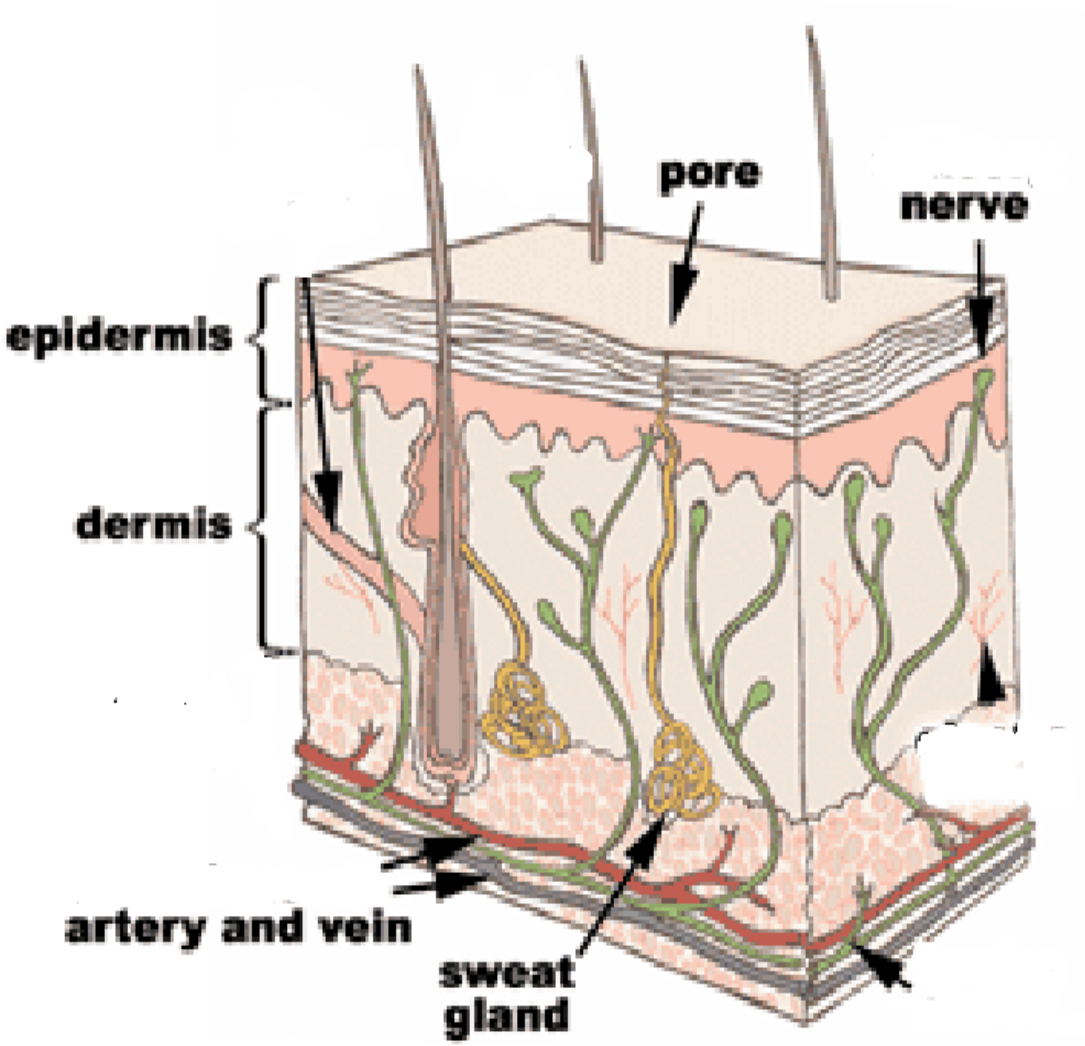
Dermis


Hair shaft
Pore
Dermal papillae
Epidermis
Papillary layer
Arrector pili muscle
Appendages of the skin:
Dermis
Reticular layer
Sebaceous (oil) gland
Eccrine sweat gland
Hair follicle
Hypodermis (subcutaneous tissue)
Hair root
Adipose (fat) tissue
Nervous structures:
Meissner's corpuscle
Pacinian corpuscle
Sensory nerve fiber
Hair follicle receptor
Cutaneous blood vessels

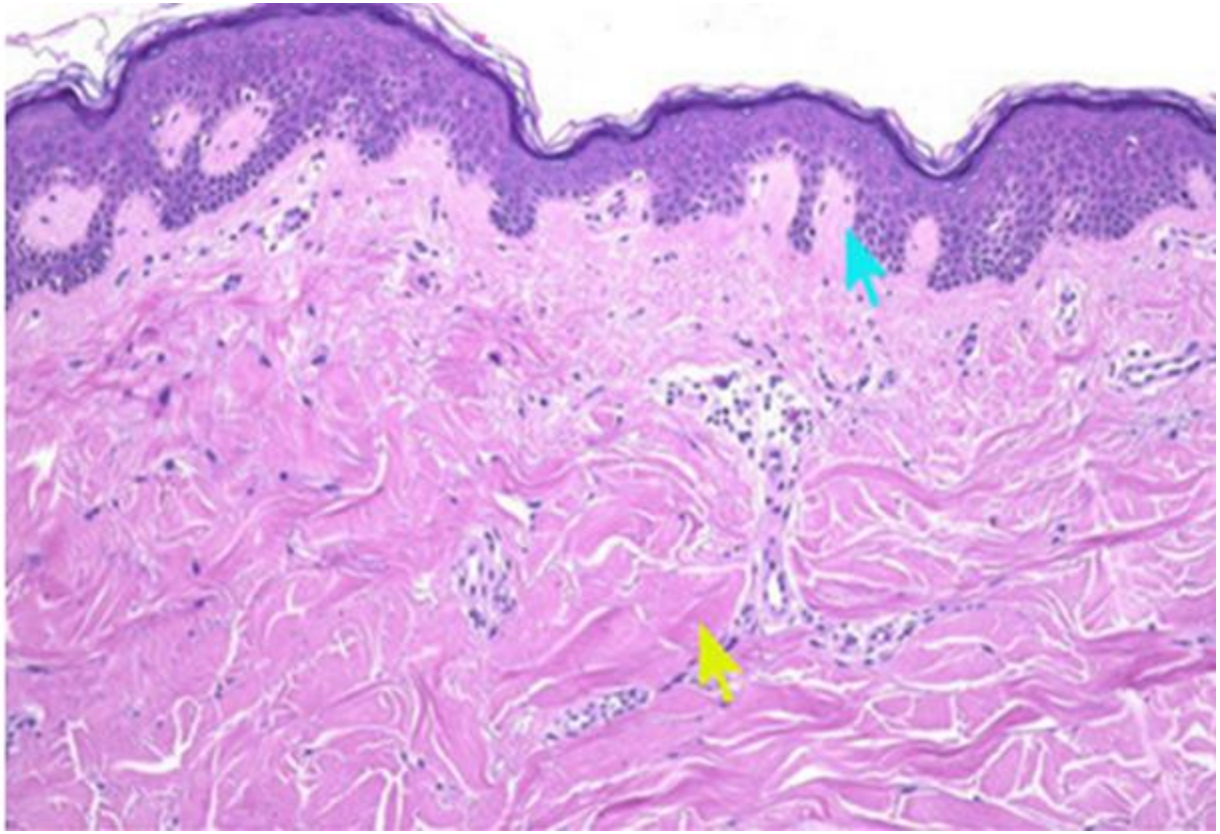
Dermis

- Thick layer under the epidermis

- Connective tissue
- blood vessels
- Oil glands
- Sweat glands
- Hair follicles
- Fat tissue
- Nerves



Dermis



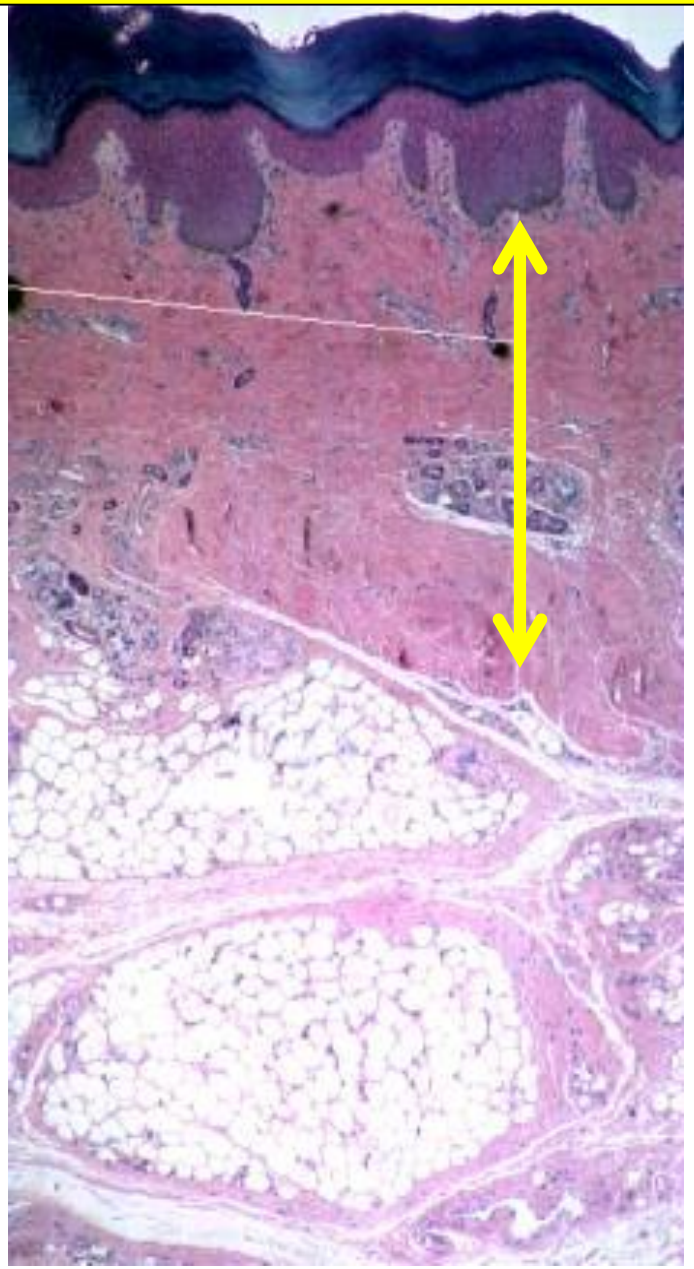
papillary layer – *loose connective tissue that forms the dermal papillae, loops of small blood vessels and capillaries, nerve endings*

reticular layer - *dense irregular CT that forms bulk of dermis, with blood vessels and a-v shunts, lymphatics and nerves*

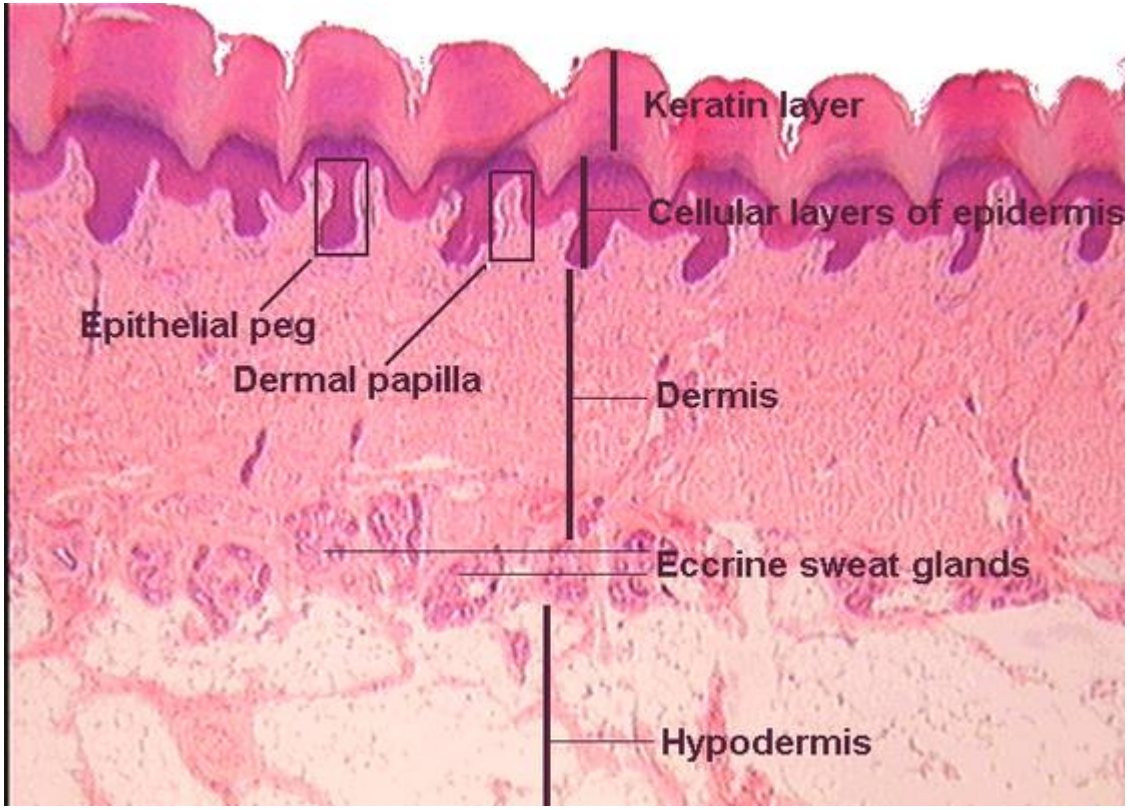
Dermis

Dense irregular connective tissue

- type I collagen
- networks of elastic fibers
- blood vessels nerves & nerve endings
- in old age cross linking of fibers increase and number of elastic fibers decreases
- blood vessels - important in temperature and blood pressure regulation



Dermal Papillae



- interdigitations of the dermis and the epidermis which counteract shearing force between the two layers –

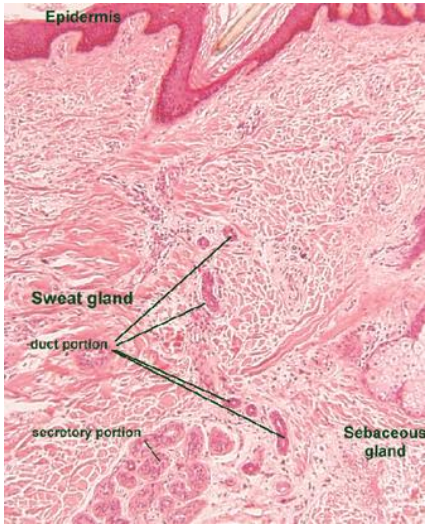
- prominent in areas that grip or experience friction e.g. fingertips, palms, soles of feet

Dermis – sweat gland

- **Eccrine sweat glands (merocrine)**

  - distributed in skin throughout the body,
  - particularly abundant on forehead, scalp, axillae, palms and soles
  - simple coiled tubular
  - sweat is hypotonic, watery, neutral or slightly acidic

Dermis – sweat gland



ducts

- do not divide
- lined by stratified cuboidal epithelium
- pass through dermis and epidermis

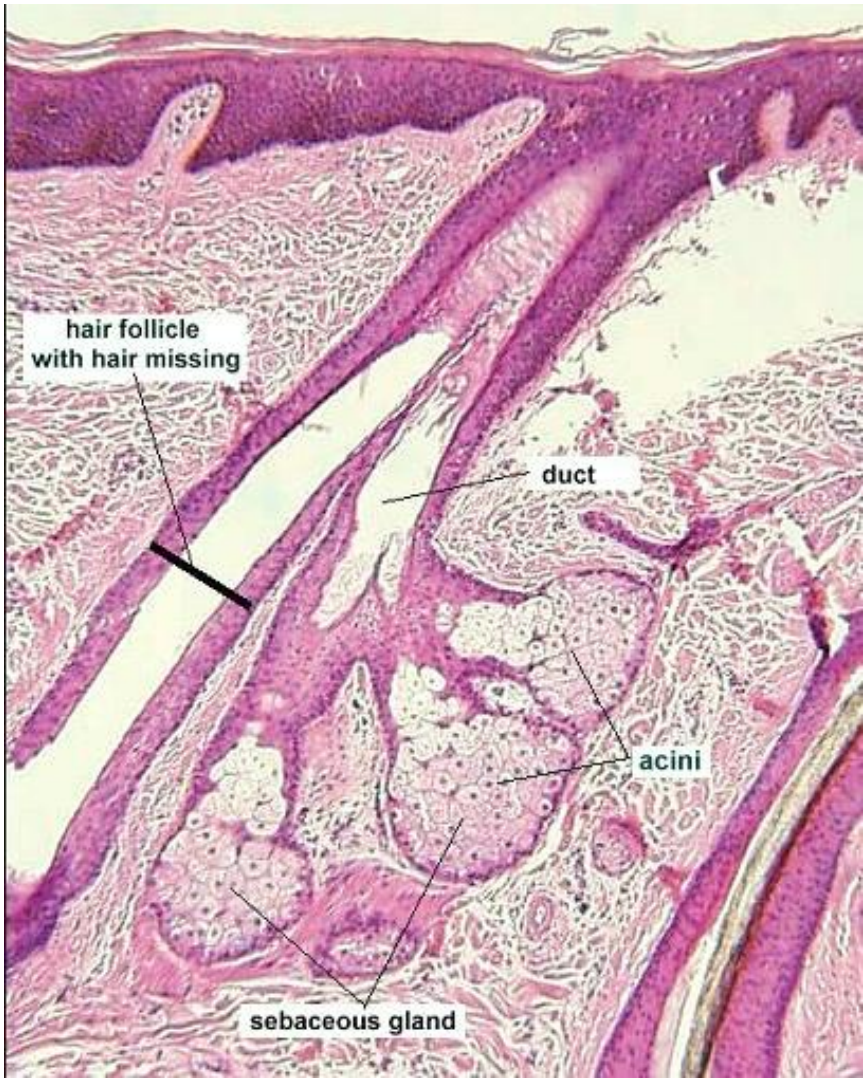
secretory portion

- in dermis
- surrounded by myoepithelial cells which help discharge secretion
- *dark cells*
  - line the luminal surface of gland
  - Secretory granules
- *clear cells*
  - No granules
  - numerous invaginations of plasma membrane

Dermis – sweat gland

- **Apocrine sweat glands**
  - large specialized sweat glands localized in axilla, areola, anal/circumanal region
  - begin to function in puberty and respond to hormones
  - large coiled secretory portion: myoepithelial cells present but not prominent
  - empty into hair follicles
  - innervated by adrenergic fibers
  - produce viscid milky secretions in response to external stimuli such as fear or sexual excitement

Dermis – Sebaceous gland



Simple branched acinar glands

Dermis – Sebaceous glands

- distributed over most of the body
- more on face, forehead and scalp
- acinar glands with several sacs
- most have short ducts that empty into neck of hair follicle
- onto the skin directly in eyelids, lips, glans penis and glans clitoridis

Dermis – Sebaceous glands

•acini consist of basal layer of undifferentiated flattened epithelium

• cells divide, differentiate, and then break down to release their fat droplets into the lumen of the gland forming sebum, which is then released by the gland

•sebum is a complex mix of triglycerides, waxes, cholesterol and esters, with mild anti-bacterial and anti-fungal activity

•activity controlled by sex-hormones

Nerve supply of the skin

Cutaneous Sensory Receptors

Functional classification

Mechanoreceptors – pressure or touch

Thermoreceptors – temperature

Nocieptors – pain

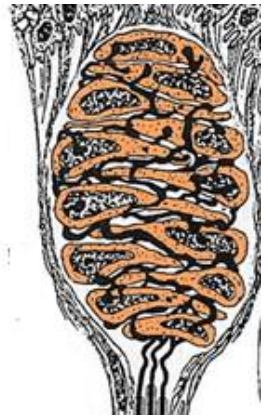
Morphological classification

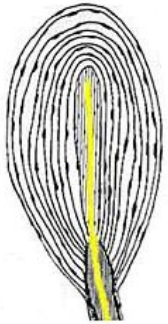
Free nerve endings (pain +tem+itching+)

Encapsulated nerve endings

Meissner's corpuscle

- a specialized structured nerve ending
- light touch receptor/low frequency stimuli
- confined to dermal papillae
- most numerous: fingertips, palms, soles





Pacinian/lamellated corpuscle

- pressure receptor
- Coarse touch
- found in deep dermis or hypodermis

Cutaneous Sensory Receptors

Encapsulated nerve endings

Ruffini corpuscle

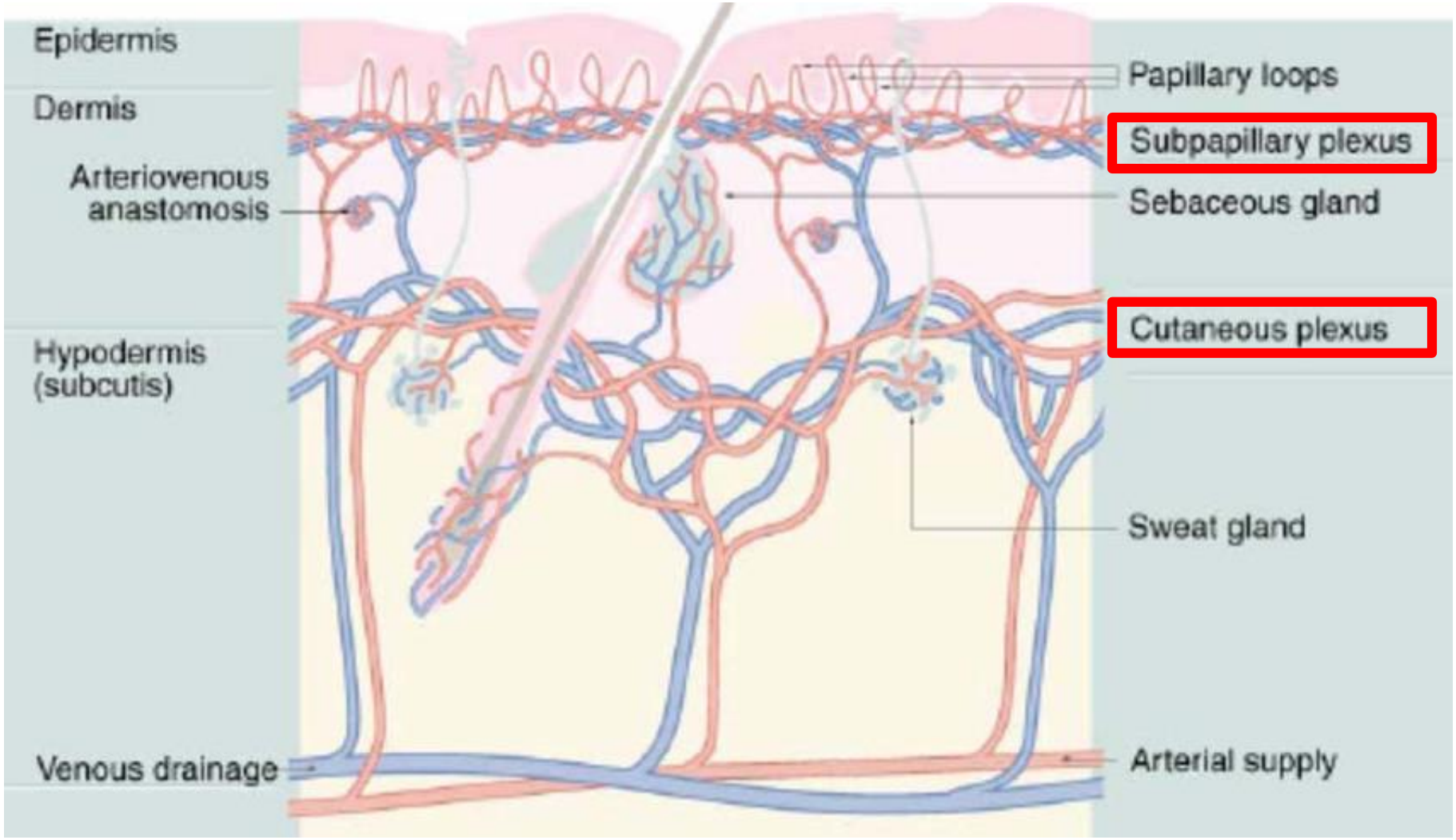
- fusiform capsule
- stimulated by stretch , tension or twisting

Krause end bulbs

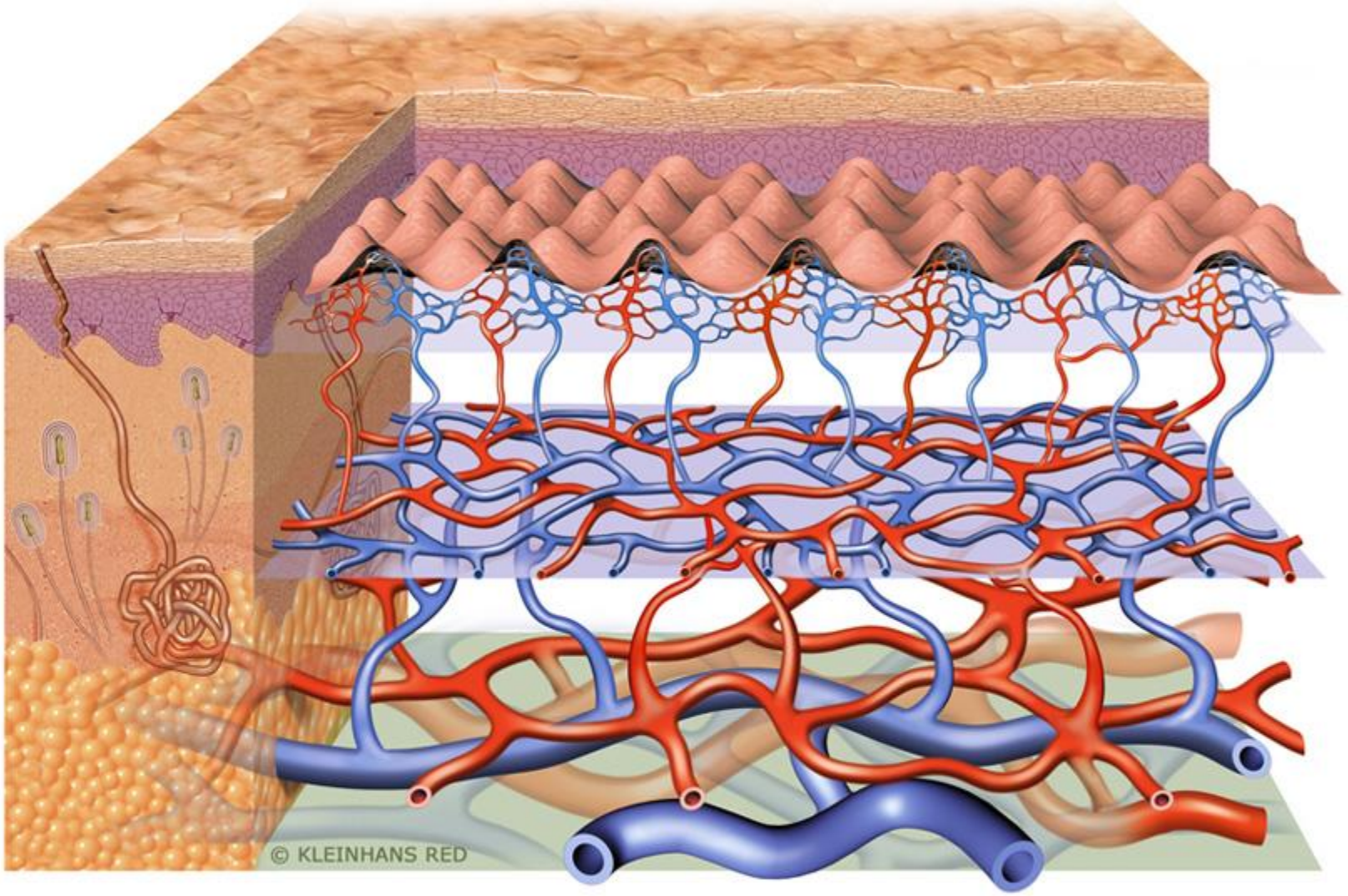
- Ovoid structure
- found in skin of penis, clitoris
- sense low frequency vibrations

Blood supply of the skin

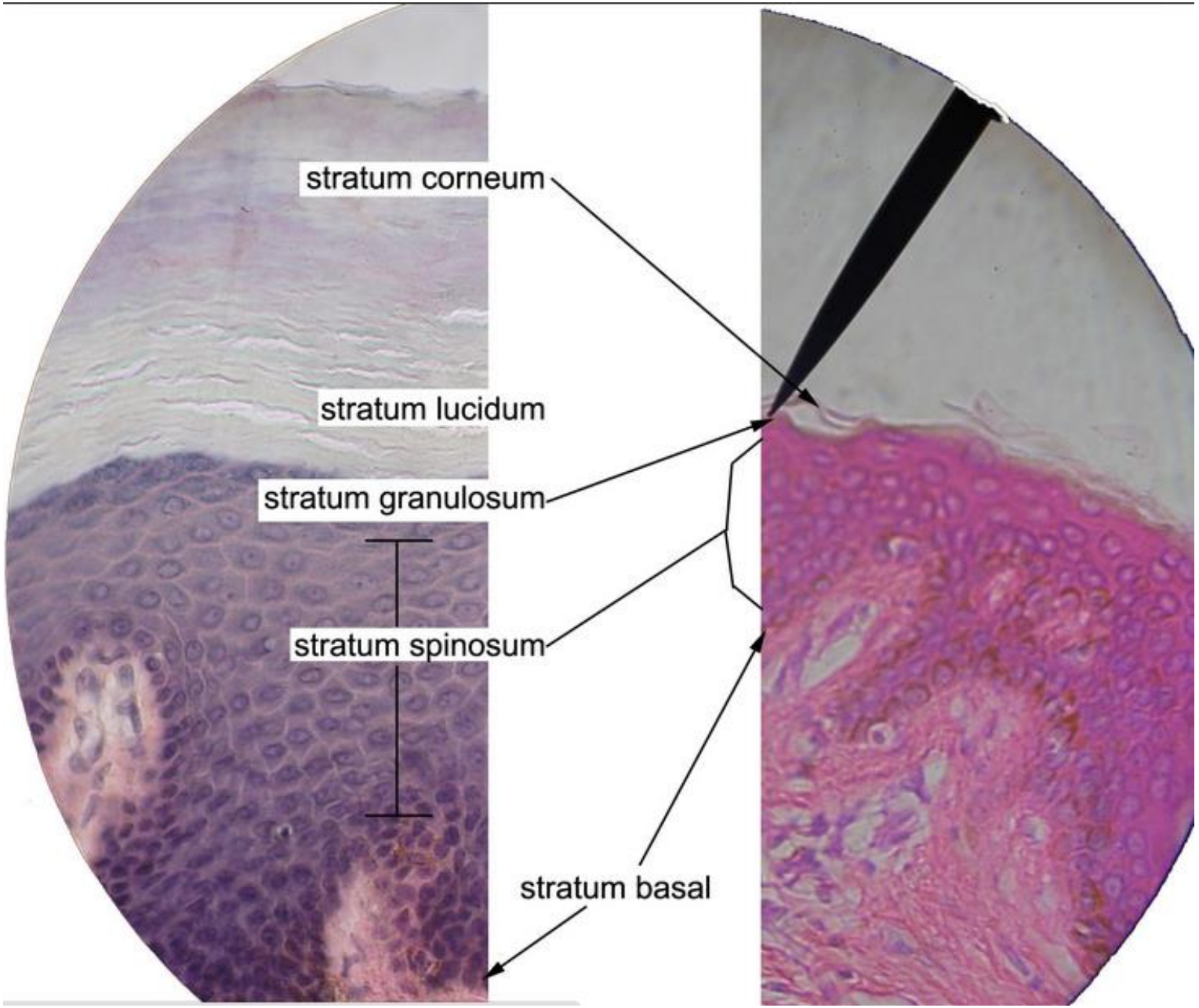
Blood supply of the skin



Blood supply of the skin



Thick vs Thin skin



Thick vs Thin skin

Thick skin:

- palms, fingertips or soles of the feet
- lacks hair follicles, sebaceous glands, arrector pili muscles
- Thick epidermis

In contrast thin skin:

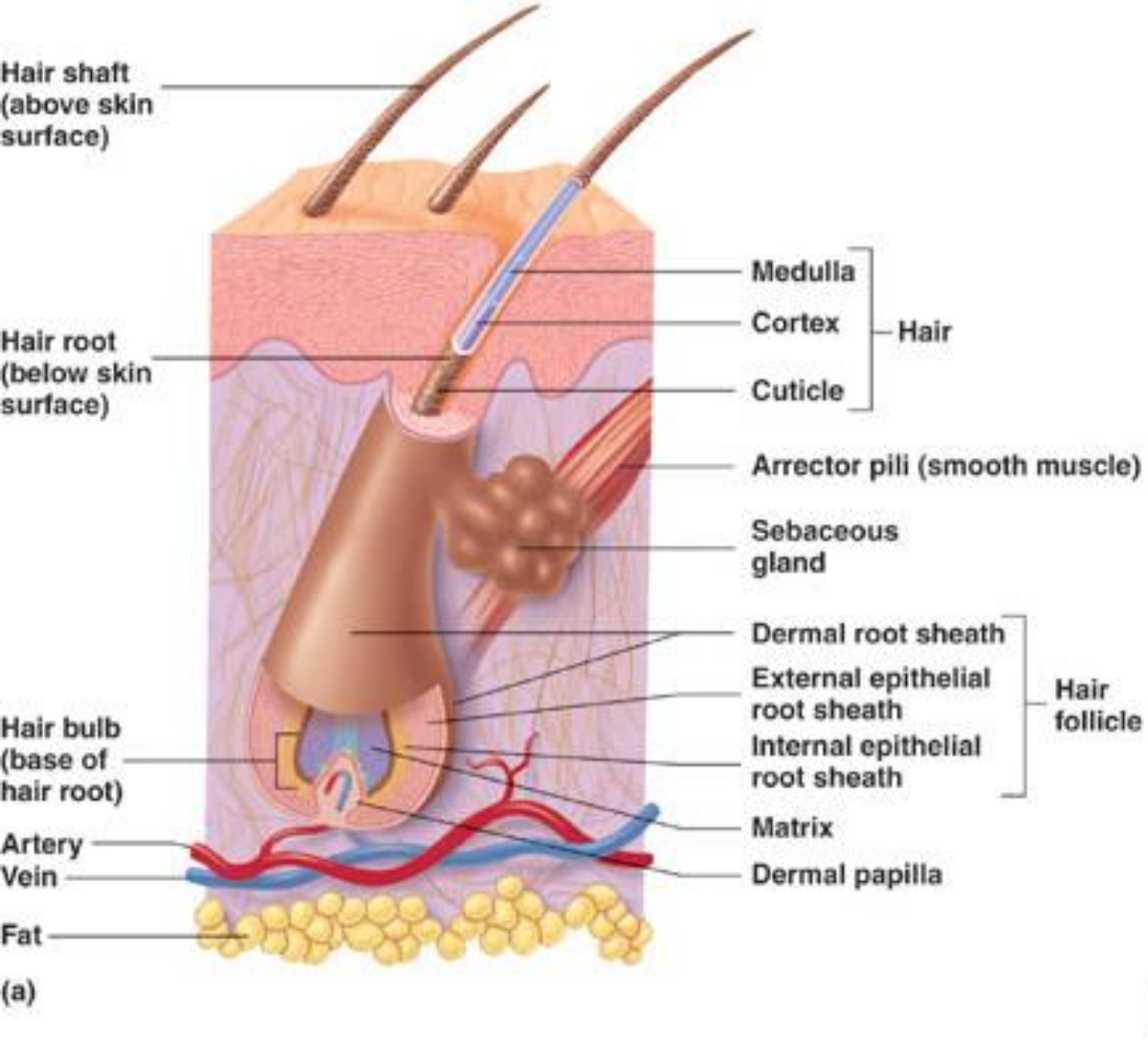
- over most of the body, contains hair follicles, sebaceous glands and arrector pili muscles
- thinner epidermis
- less well developed strata granulosa and lucida,
- quite thin stratum corneum

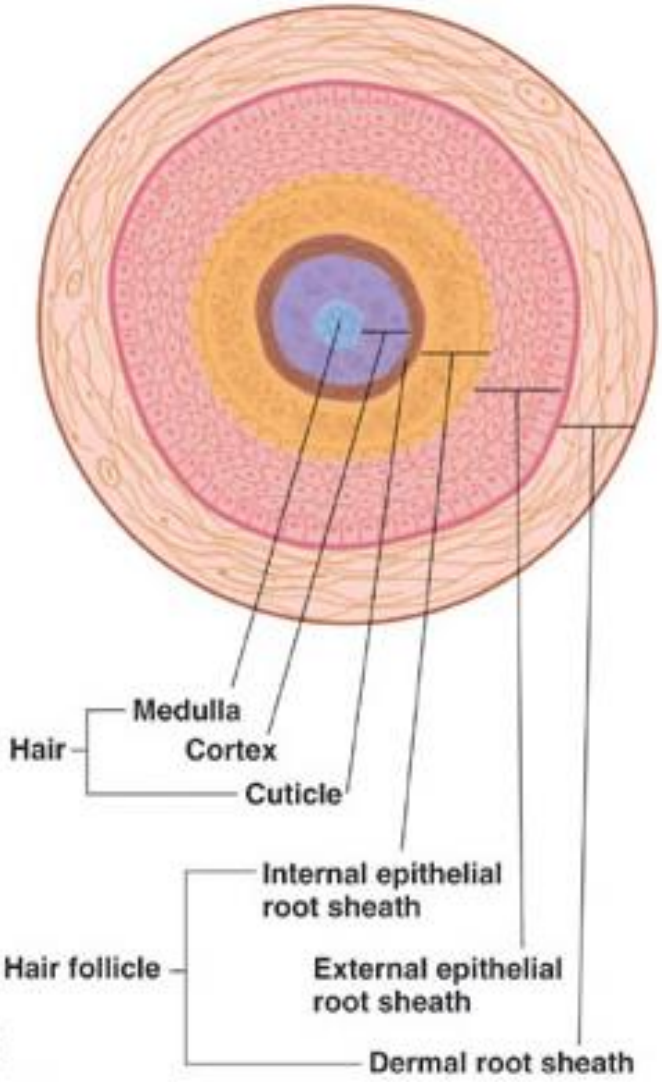
Hair Structure

Xie Qiuping
Hair Length = 18’ 5.54”

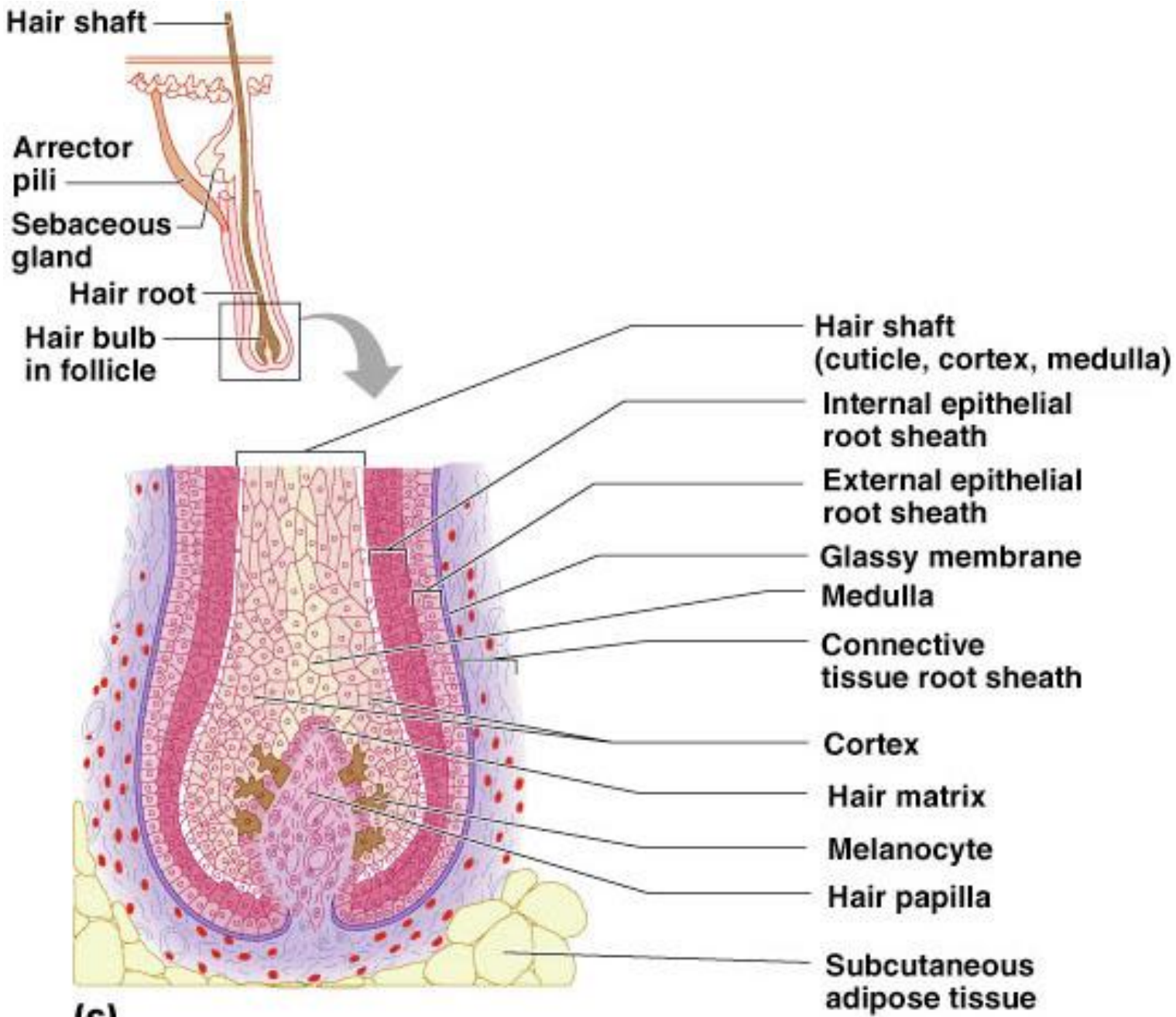
Tran Van Hay
Hair Length = 20’ 3.6”

Hair Structure

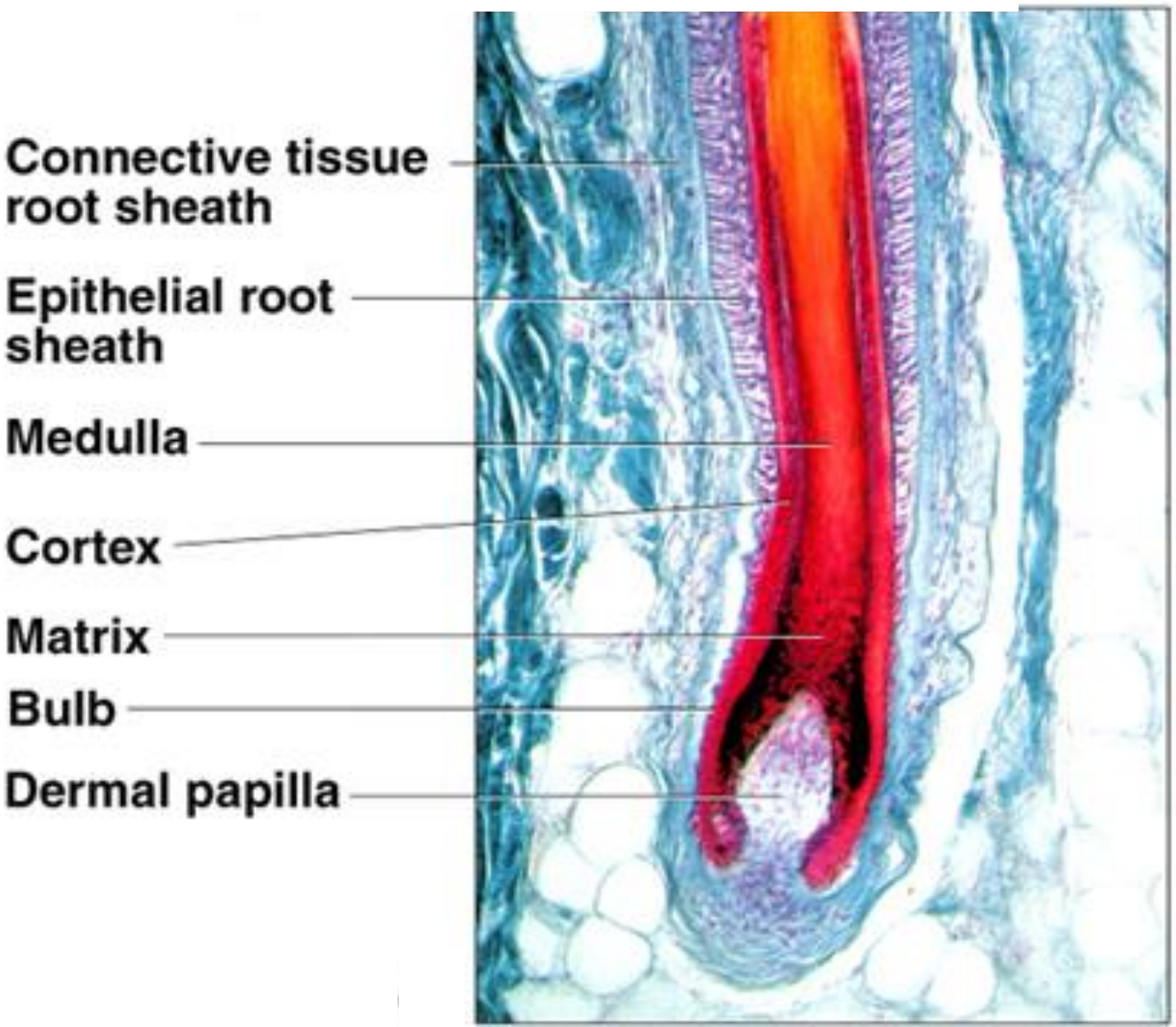




Hair Follicle



Hair Follicle



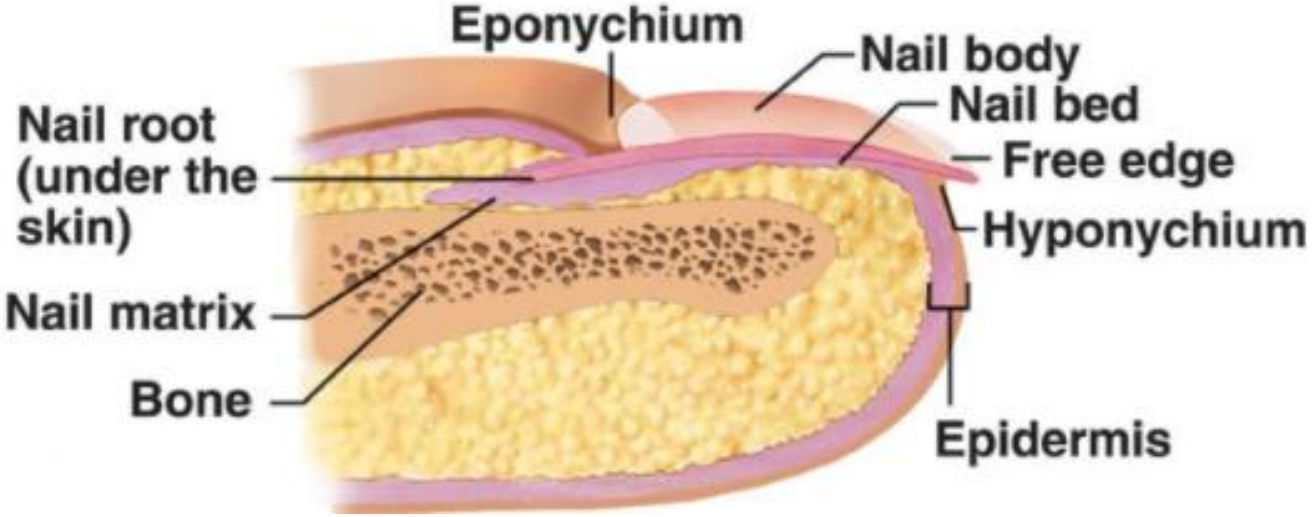
Hair Structure

Hair - thin skin only

- made of keratin
- follicle derived from epidermal epithelium
- begins deep in dermis
- connective tissue sheath
- sebaceous glands
- medulla, cortex and cuticle
- arrector pili muscle -bundles of smooth muscle attached to hair follicles in dermis and papillary layer of dermis
- contraction elevates hairs - **goose bumps**

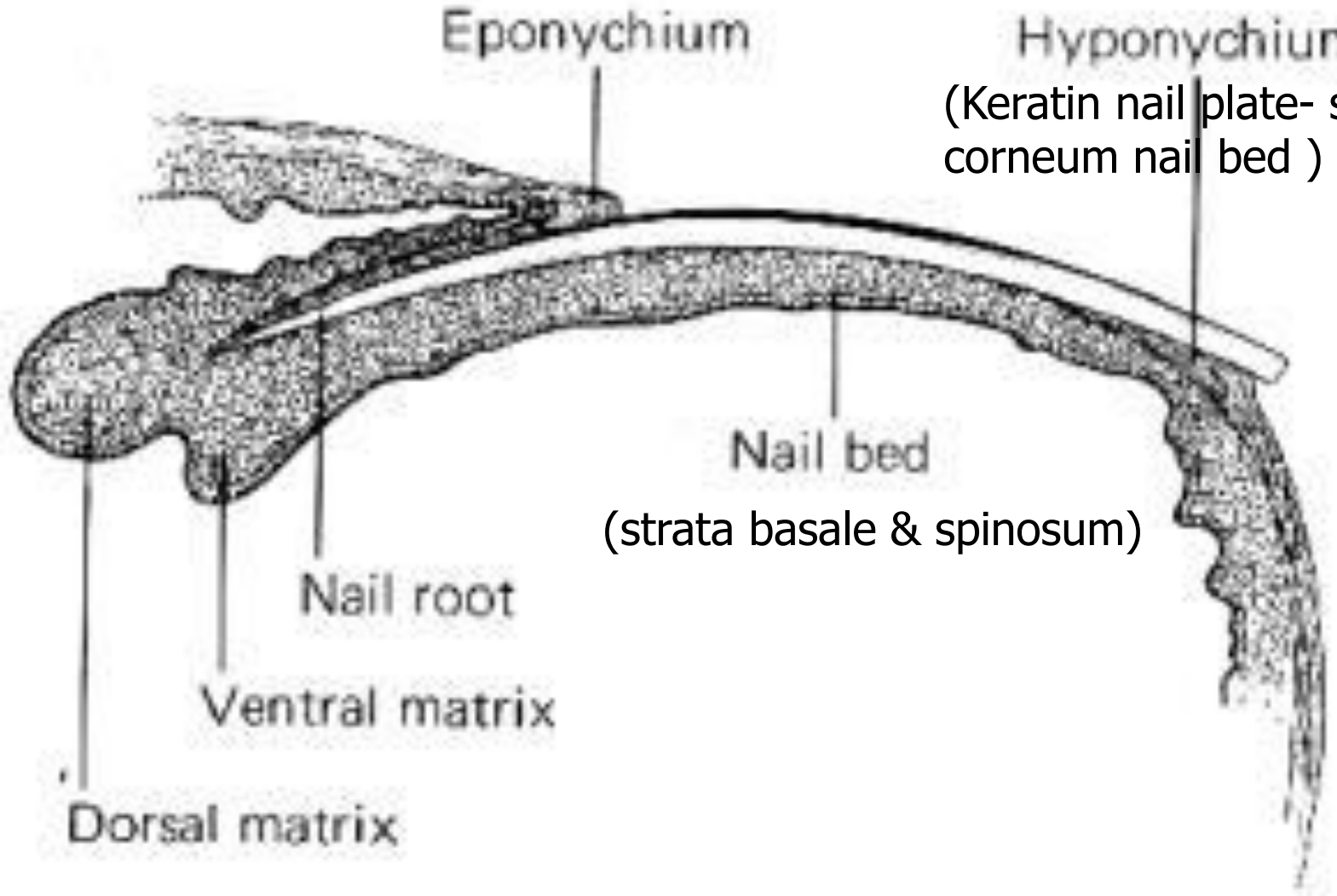
Nail Structure


Free edge
Nail body
Nail groove
Nail fold
Lunula
Eponychium
(cuticle)
Nail root


Eponychium
Nail body
Nail bed
Free edge
Hyponychium
Nail root
(under the
skin)
Nail matrix
Bone
Epidermis

Nail Structure

(stratum corneum overlies nail root)



Nail Structure

- located on dorsal distal phalanx of each finger and toe

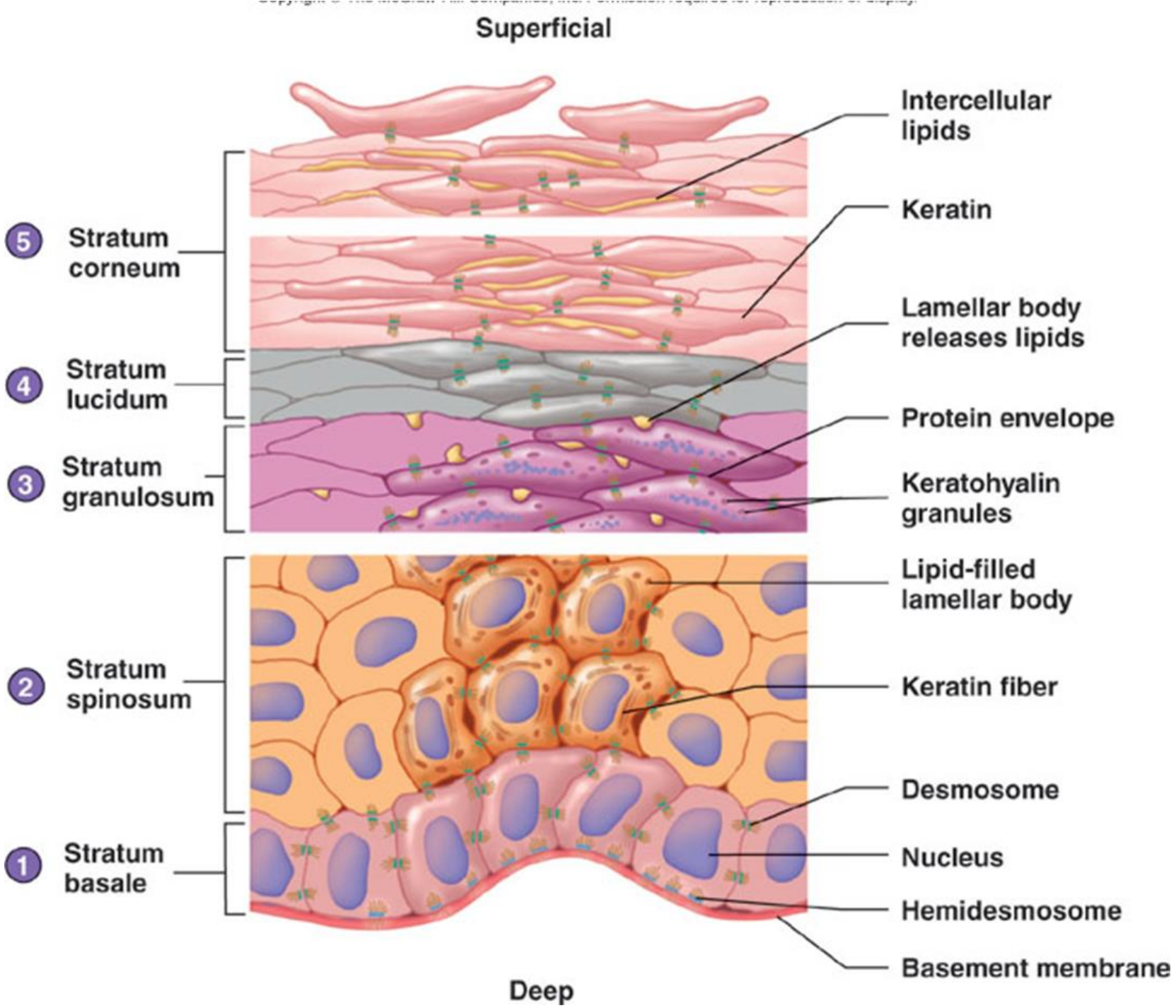
- nail plate composed of hard keratin lying on nail bed
- the stratum corneum of the epidermis that overlies the nail root forms the eponychium (cuticle)
- hyponychium or nail plate consists of the stratum corneum of the underlying nail bed, and so is a keratinized epithelial layer
- nail bed epidermis has only strata basale and spinosum
- growth due to cells in nail matrix at nail root

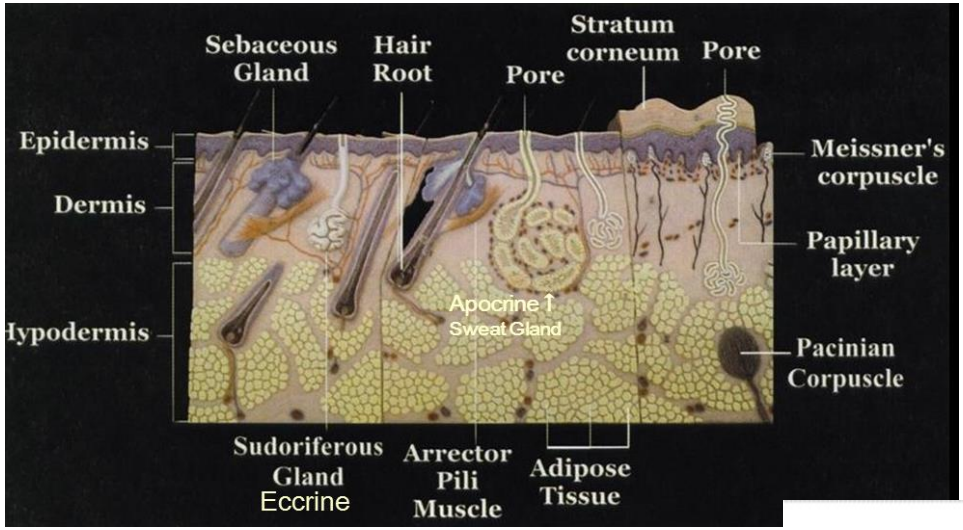
Clinical Aspects

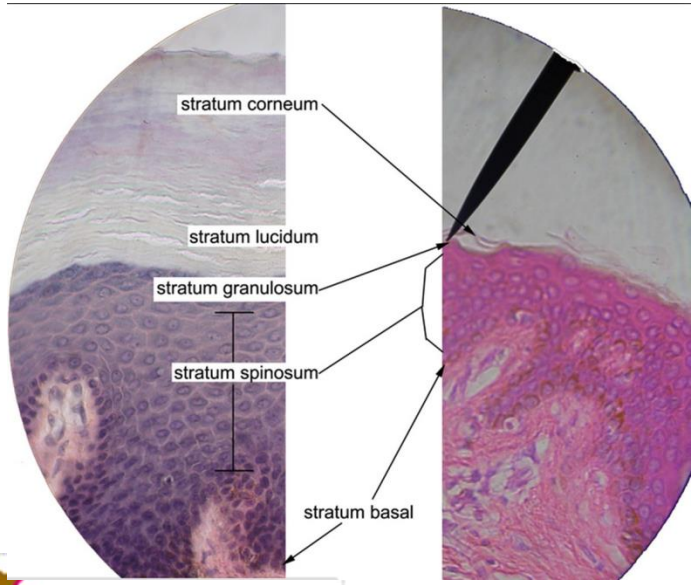
Clinical Aspects

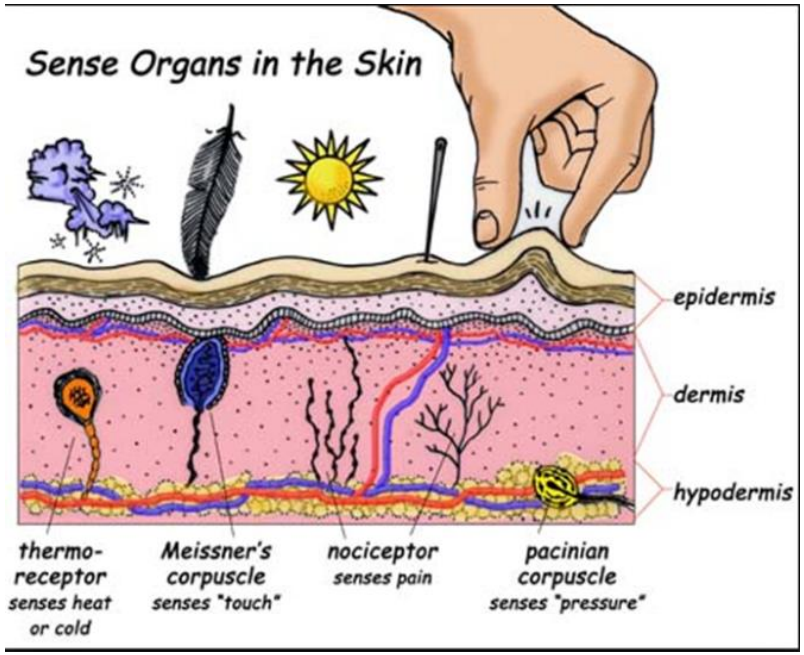
- **Psoriasis**
  skin disorder where excessive cell division leads to increased thickening of strata basale and spinosum
- **Blisters**
  an accumulation of fluid at dermo-epidermal junction due to excessive shearing force or heat
- **Dermatitis – rash**
  in response to viral infections or allergies
  epidermis thickens and disrupted by infiltration of leukocytes and accumulation of extracellular fluid
  blood vessels in upper dermis are dilated

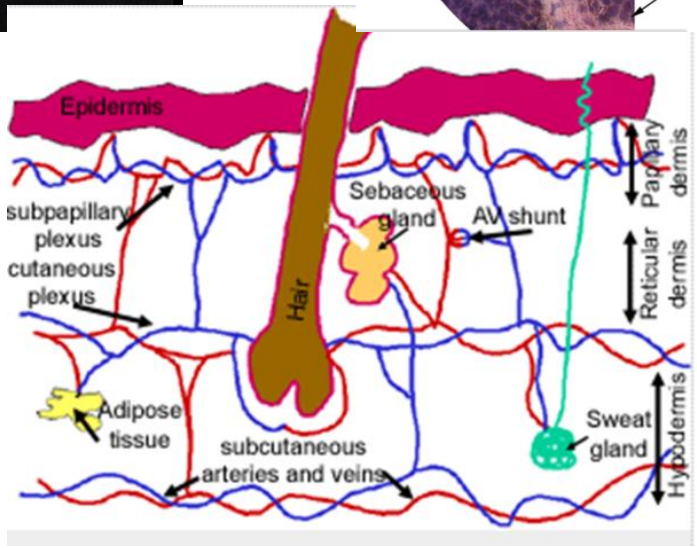
Summary

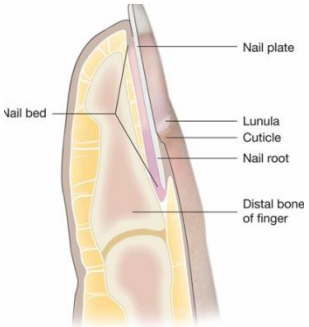

Superficial
5
Stratum corneum
4
Stratum lucidum
3
Stratum granulosum
2
Stratum spinosum
1
Stratum basale
Intercellular lipids
Keratin
Lamellar body releases lipids
Protein envelope
Keratohyalin granules
Lipid-filled lamellar body
Keratin fiber
Desmosome
Nucleus
Hemidesmosome
Basement membrane
Deep

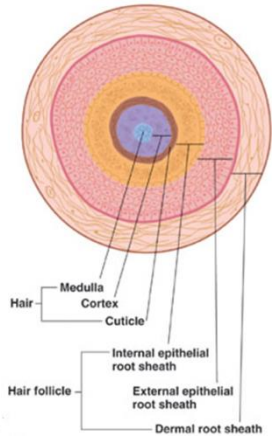

Sebaceous Gland
Hair Root
Pore
Stratum corneum
Pore
Epidermis
Dermis
Hypodermis
Meissner's corpuscle
Papillary layer
Apocrine
Sweat Gland
Pacinian Corpuscle
Sudoriferous Gland
Eccrine
Arrector Pili Muscle
Adipose Tissue


stratum corneum
stratum lucidum
stratum granulosum
stratum spinosum
stratum basal


Sense Organs in the Skin
epidermis
dermis
hypodermis
thermo-receptor senses heat or cold
Meissner's corpuscle senses "touch"
nociceptor senses pain
pacinian corpuscle senses "pressure"


Epidermis
subpapillary plexus
cutaneous plexus
Hair
Sebaceous gland
AV shunt
Papillary dermis
Reticular dermis
Adipose tissue
subcutaneous arteries and veins
Sweat gland
Hypodermis


Nail plate
Nail bed
Lunula
Cuticle
Nail root
Distal bone of finger


Hair
Medulla
Cortex
Cuticle
Hair follicle
Internal epithelial root sheath
External epithelial root sheath
Dermal root sheath

REFFERENCES

- Burkit, H.G, young, B. (1993). **Wheaters functional histology**. 4 th ed., london: Churchill livingstone

- **Junqueira**, L.C., Carneiro (1998). **Basic histology**. 9 th ed., stamford: Appleton & lange

Thank you .....