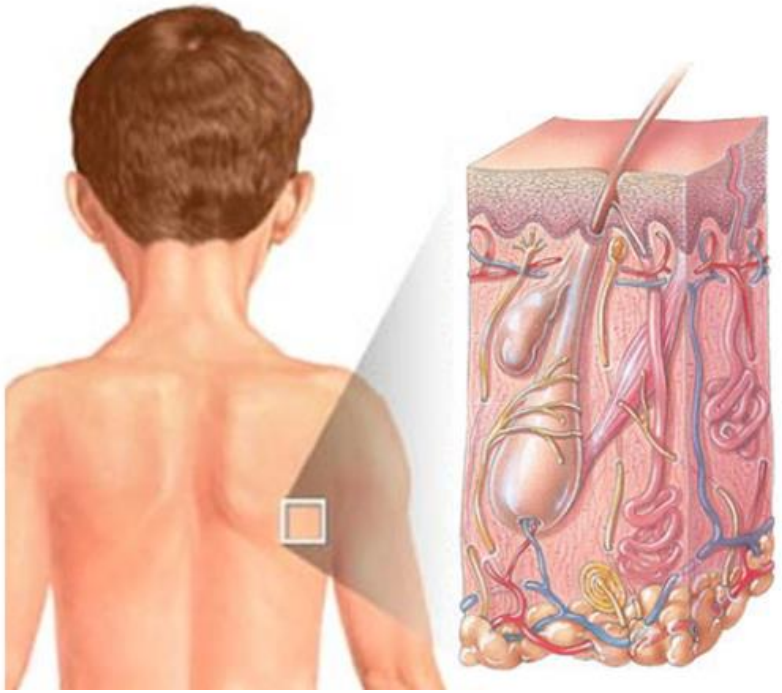
ANATOMY

DONE BY : Lana Al natour

Histology of the Skin



Dr. Mustafa Saad (2020)

التلخيص عبارة عن محاضرة 1+2 ((بعد كل سلايد رح يكون في سلايد لحكي الدكتورأو نوتس بسيطة ممكن تكون على نفس سلايد))

شرح الدكتور **باللون الأزرق

اي شرح خارجي **باللون الأخضر

موفقين يا رب ☺

The Skin

- The skin is the largest organ in the body, accounting for about 20% of total body weight with a surface area of about $2m^2$.

- Also called the **cutaneous layer and integument**, it's the boundary between the internal and external environment of the body.

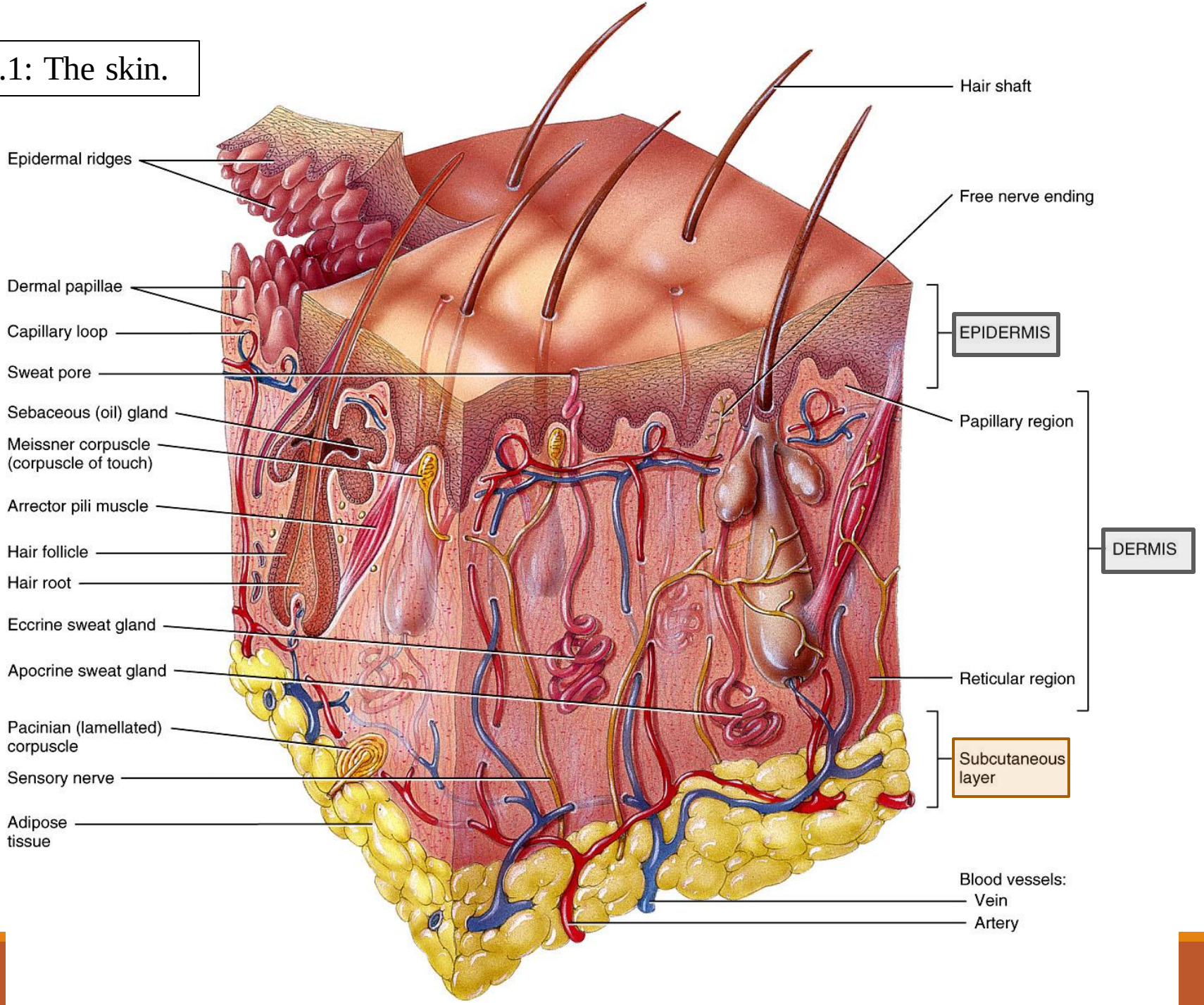
- It's **formed of the epidermis and dermis**. A fatty layer called the hypodermis (subcutaneous layer) connects the skin to the underlying tissues. Other structures found in the skin include:
  - Sensory organs
  - Arrector pili muscle
  - Hair
  - Nail
  - Sebaceous and sweat gland
  - Mammary glands

Epidermal derivatives

-Integument means the outer covering of an organ (so the skin is the outer covering of the human being)

-epidermal derivatives : means that they are derived from the epidermis (hair ,nails, sebaceous and sweat glands, mammary glands)

Fig.1: The skin.



This is an image for the skin as we can see the skin is formed of: ((respectively))
1-epidermis(superficial layer)
2-dermis (the deeper layer)
3-hypodermis(the subcutanous layer)
In addition to that there are other structures found in the skin

Functions of the skin

1) *Protective function:*

- Physical barrier against thermal and mechanical stresses and against harmful substances.**((solid boundary))**
- Protection against microorganisms.**((because there are immunological factors found in the skin))**
- Protection against ultraviolet light.**((as we know there are 2 types of UV light: harmful and beneficial so the skin protects the body from the harmful effects of the UV))**
- Prevent the excessive loss of water through the skin.**((how ?))**

The answer:

Skin has a **lipid-rich layer** making it a selectively permeable membrane. It allows the passage of lipophilic substance (like drugs) through the skin, but prevents water loss. This has permitted life to be terrestrial. Without this function of the skin, the organism must spend a lot of time submerged in water.

What is the first step in the treatment of extensive burns?

In burns the skin has been lost (the lipid layer) many fluids will be lost **so the first step of treatment is to replace the water and fluids that have been lost**

Selectively permeable means that only the fatty substance can pass the skin so that that the lipophilic substances like creams can be absorbed easily but the skin preserve the water ((cannot pass through the skin)),this allow to live in terrestrial life(without water)

2) *Sensory function:*

- Mechanical, thermal, pain.

((Because the skin is in contact with the external environment and it is quick to receive stimuli from the outside and there are many sensory receptors ((pain and thermal))))

3) *Thermoregulatory function:* ***((Regulates the body temperature))***

- Insulation.**(by the subcutaneous fat layer that preserve heat for the body)**
- Sweating.**(sweat is mostly water when it goes in the surface of the skin it evaporates cooling the body)**
- Superficial microvasculature.**(arrange in specific way)**

2) *Metabolic function:*

- Synthesis of vitamin D_3 through the action of UV light.

(so we need UV light to synthesize vitamin D3)

- Excretion of excess electrolytes with the sweat.
- Storage of energy as fat in the **subcutaneous layer**.

The Epidermis

- ***Stratified squamous keratinized epithelium*** formed mainly of **epithelial cell** called ***keratinocytes*** arranged in **strata (layers)** and connected with each other by **desmosomes.**

- Other cells found in the epidermis are ***melanocytes***, ***Merkel cells***, and ***Langerhans cells***.**((non-epithelial cells))**

- Histologically, the skin can be classified into *thin* and *thick* skin *according to the thickness of the epidermis*. In the palms and soles we have thick skin with a much thicker epidermis formed of 5 strata; elsewhere, we have thin skin with a thinner epidermis formed of only 4 strata.

- Total skin thickness, however, is the thickness of both the epidermis and dermis. **It's thickest on the back and thinnest on the eyelids.**

-According to thickness of the epidermis we classified the skin ((into thick and thin))so for example when we say the thick skin that is found in soles and palms the epidermis is thicker and it is formed of 5 layers while in another place of the body we have thinner skin and it is formed of 4 layers

-total skin thickness means the combined thickness of both dermis and epidermis

يعني بس نقول thin or thick skin منحكي عن epidermis ولكن اذا total thickness منكون نحكي عن dermis +epidermis

-total thickness varies according to the region of the body(thickest in the back and thinnest on the eyelids)

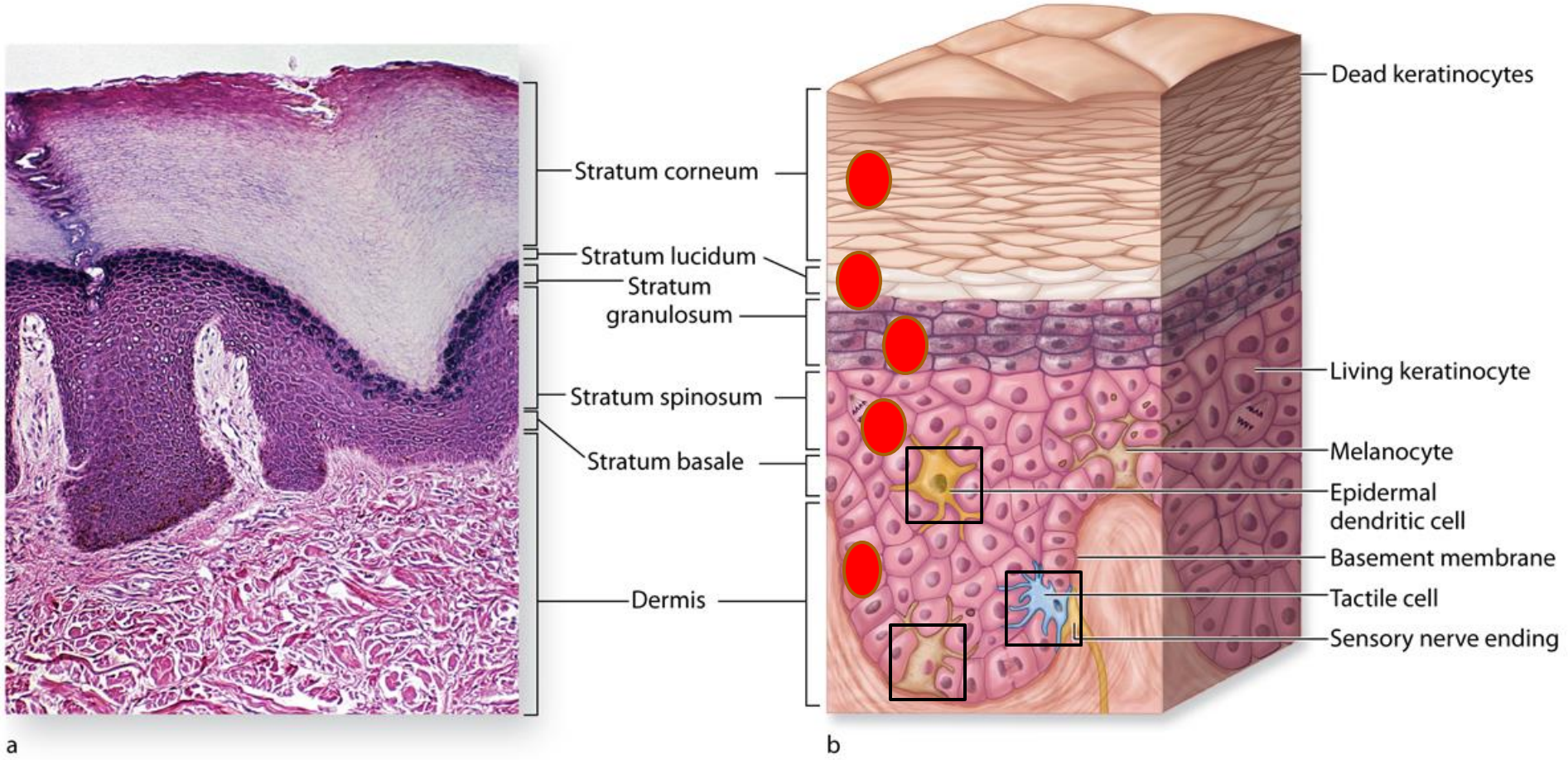


Fig.2: The epidermis.

As we can see the red circles are the layers of the epidermis

Also there are many types of cells like melanocytes(brown) /merkel cells (blue) / langerhans cells (yellow)

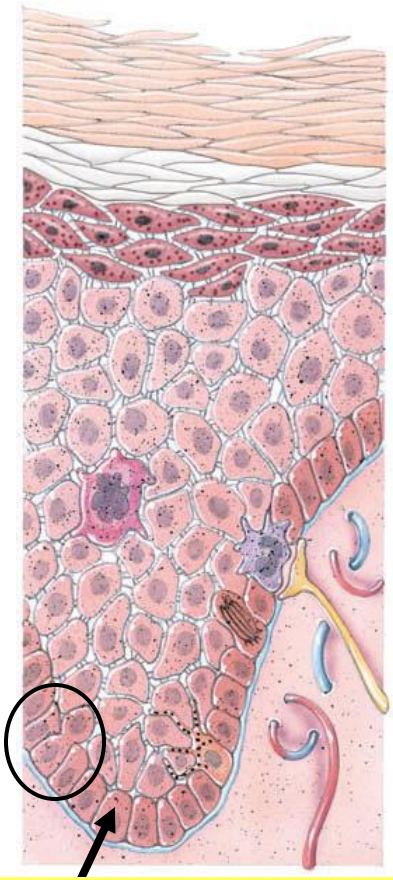
The layers of the epidermis

i. Stratum basale

- The deepest layer lying directly on the basal lamina.
- Formed of a **single layer of basophilic cuboidal cells.**
- Cells are connected to basal lamina by **hemidesmosomes** and to adjacent keratinocytes in the stratum basale and spinosum by **desmosomes.**

(it is important to keep the cells of the epidermis connected together so that they will not seperate)

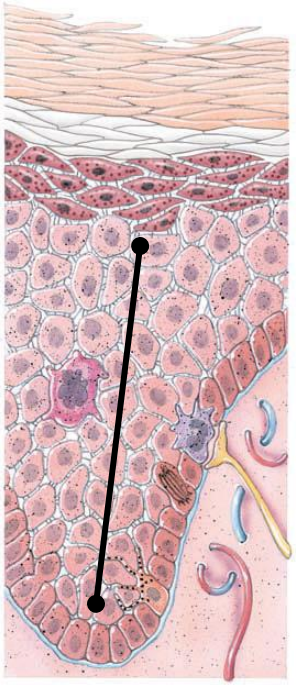
- The cells are **highly mitotic and are the progenitor cells of all epidermal layers.** As these keratinocytes mature they migrate upwards (superficially) until they reach the surface where they are shed. Renewal of the epidermis takes about 15-30 days.**(the turnover of the cell)(meaning that the epidermis is renewed during this time)**
- A characteristic intermediate filament called ***keratin*** is found in all keratinocytes.**(this is why they are called kertainocytes)**

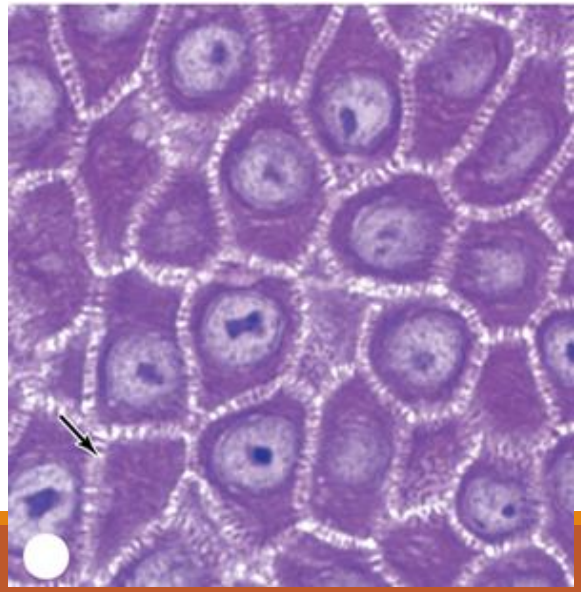


The circle represents a cell that is divided from the stratum basale and when the cell becomes mature it reaches the superficial layer

ii. Stratum spinosum

- The thickest epidermal layer. It's **thickest in thick skin**.
- Formed of polyhedral cells active in keratin synthesis.
- The cells close to the stratum basale are also mitotically active and together they're called the *stratum germinativum*.
- Keratin filaments become thick tonofibrils attached to desmosomes. When the tissue is prepared, the cells shrink and these desmosomes and tonofibrils appear as spines on the surface of the cell, hence the name.





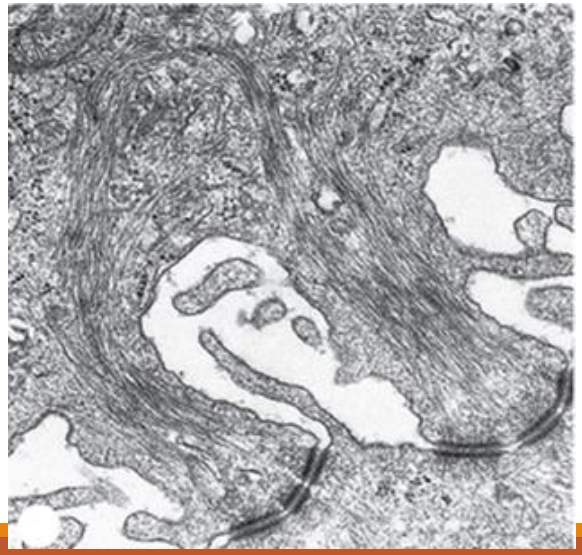


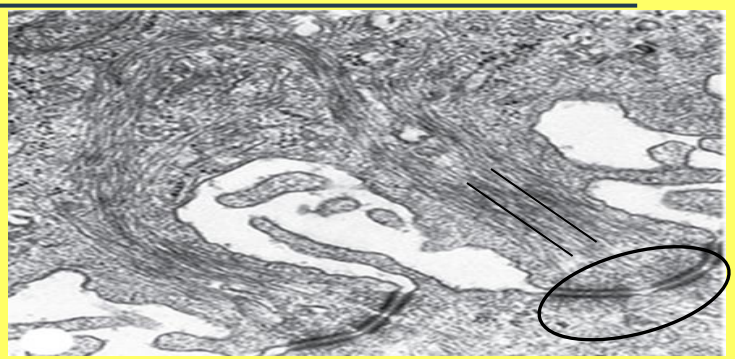
Fig.3: The spines of the stratum spinosum. Left, light microscope. Right, electron microscope. Note the tonofibrils attached to the desmosomes.

-The thick skin that have thick epidermal layer because of stratum spinosum

- This layer is made from cells that they are vey active in protein synthesis and they have all the features of cells that they similar to the all cells synthesize proteins

- The cells that are adjacent to stratum Basale are also mitotically active (the 2 layers together are called stratum germinativum

- As we see in the right image (microscopic image) the black lines are keratin filaments ((tonofibrils)) attached to desmosomes((circle))



- When we prepare a tissue for histological study ,the cell will shrink because mostly the cytoplasm is made from water and it will evaporate but the desmosomes and tonofibrils are protein structures and they are intact so they will not shrink ((they will appear as spine under the microspcope and that's why they are given a name stratum spinosum))

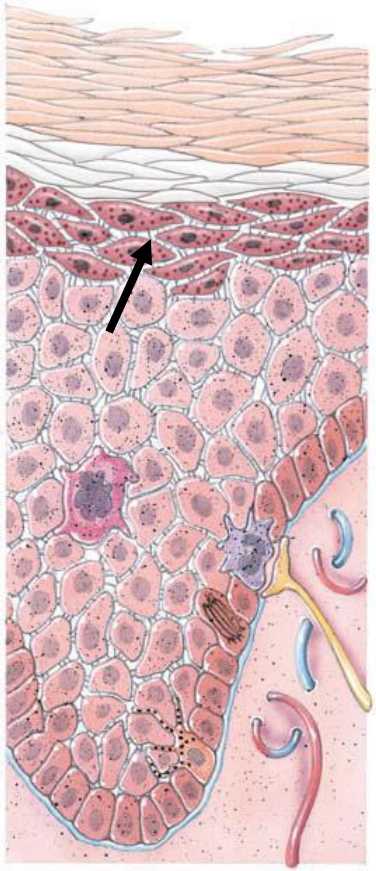
We have cell with shrinkage cytoplasym and projections look like spine ((stratum spinosum))

iii. Stratum granulosum

- Formed of 3-5 layers of cells.
- Cells **contain two types of granules**:

(that's why it is called granulosum (the cells appear granulated under the microscope)

Keratohyaline Granules	Lamellar Granules
Contain keratin tonofilaments associated with proteins	Contain various lipids(lipids can't be free inside the cytoplasym(water) so lipids must be surrounded by membrane and then have to be release outside the membrane)
Non-membranous(not surrounded by membrane because the contents remain in the cells)	Membranous (why?because the contents of these granules are release outside the cell by exocytosis)
Contents remain in cell	Contents are released to the outside of the cell
Appear as basophilic structures under the light microscope	Seen as oval structures with several lamellae(this is why called lamellar) under the electron



- The lipids of the lamellar granules are released **to the outside by exocytosis filling the intercellular space with lipid.** This **creates a hydrophobic barrier that prevents water loss**.

So this is the layer where lipid layer is formed (the only lipid protective layer that preserve water)

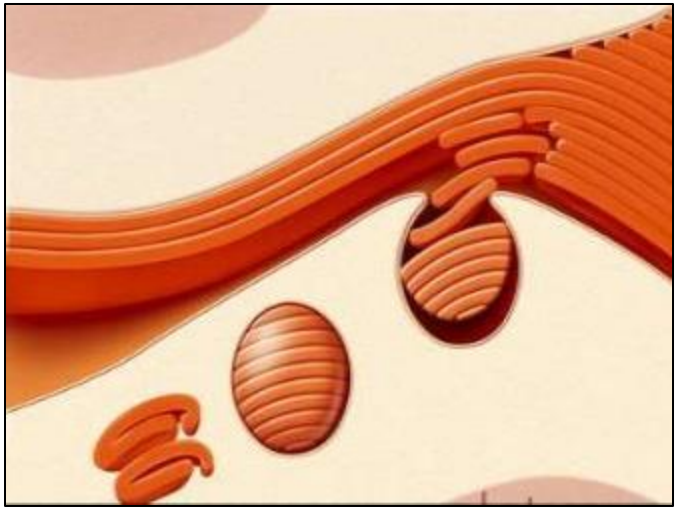


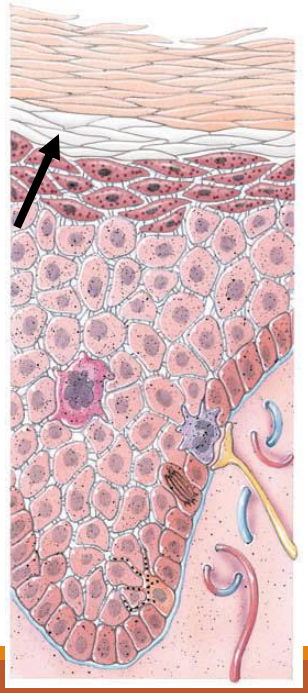
Fig.4: The lamellar granules of the stratum granulosum and the lipid-rich intercellular barrier.

iv. Stratum lucidum

- A **translucent layer found only in thick skin.**

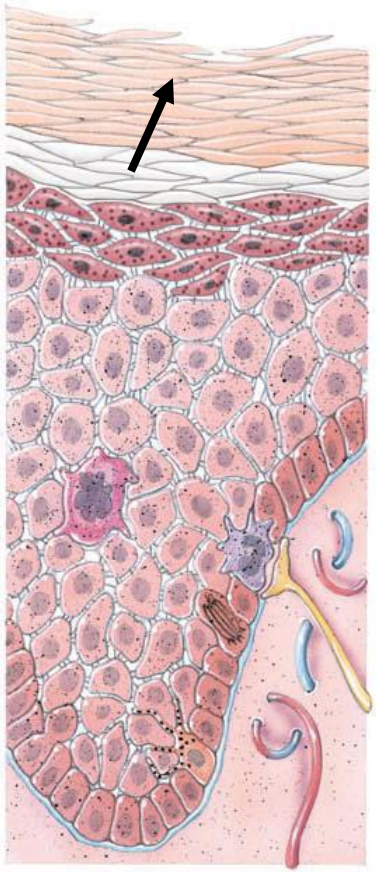
****Very thin colorless region found only in thick skin**

- Formed of eosinophilic squamous cells **with no nuclei and organelles**.**(dead cells)**
- Cytoplasm filled with keratin. **(this is why they are eosinophilic because of keratin)**



v. ***Stratum corneum***

- Most superficial layer. Thicker in thick skin.
- Formed of 15-20 layers of **thin squamous cells which are called *squames*.** These are nothing more than cell membranes filled with keratin**.(no nuclei and no organelles)(dead cells)**
- The cells of the deeper layers of the stratum corneum are surrounded by the lipid-rich barrier and the most superficial cells are continuously shed.



The lipid is formed in stratum granulosum but it surrounds the cells of stratum corneum in the deep and the superficial cells in this layer are shed to outside and renewed from deeper layers

Calluses are areas of **thickened stratum corneum** due to repeated friction. (you may already have one in your middle finger from excessive use of pens/pencils).

Other cells of the epidermis (non-epithelial cells and non- keratinocytes)

Melanocytes

- Neural crest derived cells **found in the stratum basale** and the hair follicle and produce the dark (or red) pigment *melanin*.
- The pale-staining cell body is found between the keratinocytes of the stratum basale but is not attached to them. The cell body, however, is attached to the basal lamina by hemidesmosomes.
- The cytoplasm contains mitochondria, rough endoplasmic reticulum, and Golgi apparatus. Several processes extend between the cells of the stratum basale and spinosum.
- **Melanin inside melanocytes is stored in granules called *melanosomes***. These are transported to the processes. The tips of these processes are engulfed by keratinocytes and the melanosomes form a supranuclear cap to protect DNA from the harmful effects of UV light.

- Although produced by melanocytes, **there's more melanin in keratinocytes than in melanocytes.**
- A melanocyte and its associated keratinocytes are called an ***epidermal-melanin unit***. The density of these units is the same in all individuals. It's the rate and amount of production that differs.

Color of the skin is the result of several factors, the most important are (1)melanin pigment ((usually black)), (2)carotene pigment((usually orange)), and (3)blood in the vessels.

****remember there are no blood vessels in the epidermis they are in the dermis**

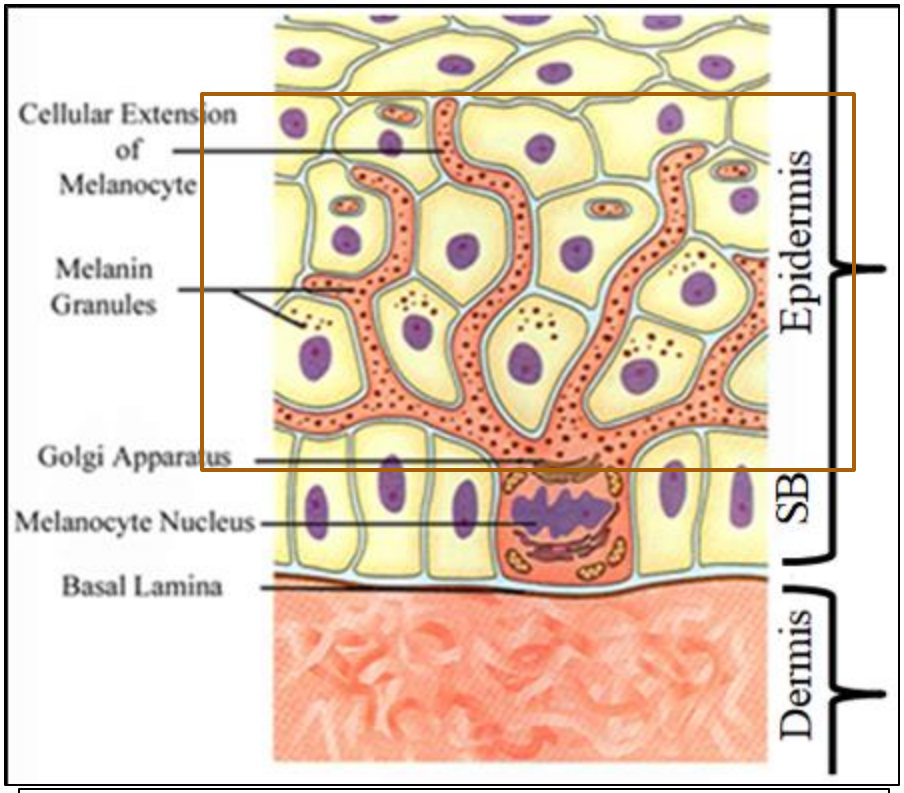


Fig.5: Melanocytes. Note how the cell body is found within the stratum basale (SB) and the processes extend into the stratum spinosum.**((square represents the processes extending to different layers))**

Melanocytes have melanin in their body and they are transported through the processes in order to be taken by keratinocytes

-Melanin pigment is dark in some induvial and sometimes is red in certain induvials ((so people in red hair actually produce red melanin))

-the cell body of melanocytes is pale staining //as we remember the cells of stratum basale are attached to the adjacent cells by desmosomes but melanocytes are attached by hemidesmosmes to the basal lamina not attached to the cells of stratum basale

-melanosomes are found inside the body of melanocytes

-the melanosomes are going to transport to process and these process will be engulfed by the keratinocytes to form a layer such above the nucleus (so this layer is derived from the dark pigment melanin)to protect the DNA keratinocytes from UV light because such pigment doesn't allow the UV light to pass(((the function of melanosomes))

-melanin is produced by melanocytes but it is mostly found in keratinocytes

-the epidermal unit :is the melanocyte and the adjacent keratinocytes //it is the same density in all people whether African people or white people but the rate and amount of production of melanin differs
For example: white person goes to the beach and exposes to the sun the production of melanin will increase but the density of the unit will remain the same

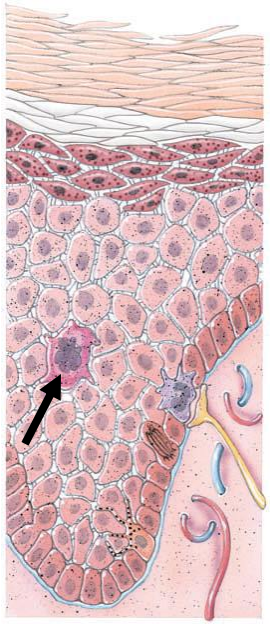
Note :the state of oxygenation in the blood is one of the factor that effects the color of the skin

Langerhans cells

- Antigen-presenting cells found **mainly in the stratum spinosum** with processes extending between keratinocytes of all the layers.

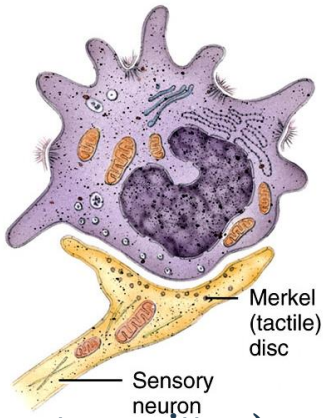
Any foreign body is picked up by these cells and represented to lymphoctyes

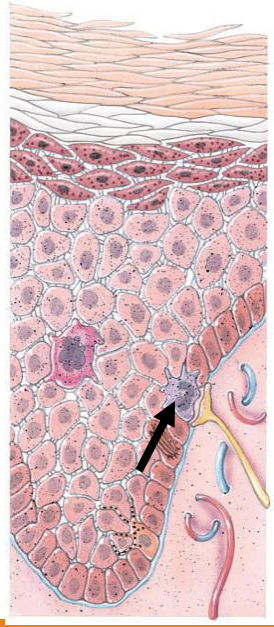
- They bind and present antigens to lymphocytes, thus playing an important immune role.



Merkel cells

- Mechanoreceptors for light touch. Most abundant in fingertips.
- Found between the cells of the stratum basale. Cell body and processes attached to adjacent cells by desmosomes.





- Cytoplasm contains neurosecretory granules.**((neurotransmitters)**
- Basal surface in contact **with an expanded terminal of an unmyelinated nerve fiber.**

Dermal-epidermal junction

- ✓ A basement membrane is found between the epidermis and dermis. Hemidesmosomes attach the stratum basale of the epidermis to this membrane and collagen anchoring fibrils attach the dermis to it.
- ✓ The surface of the dermis in contact with the epidermis is irregular with several dermal projections (***dermal papillae***) interdigitating with projections of the epidermis (***epidermal ridges***).
- ✓ This interdigitation is very prominent in thick skin that it shows on the surface of the skin as a **pattern of grooves and ridges which are the basis of fingerprints.**

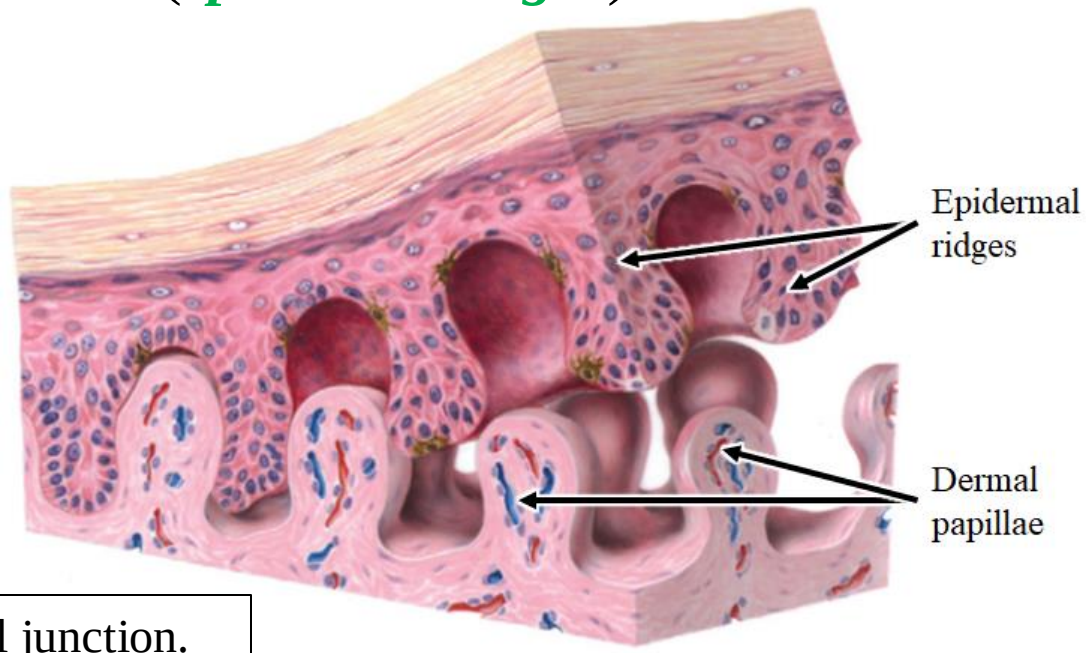
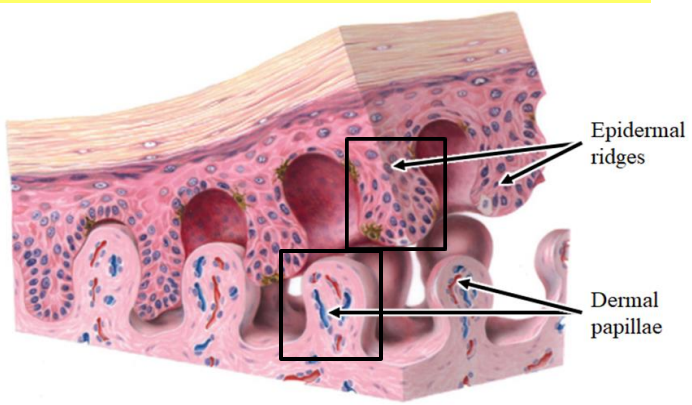


Fig.6: The dermal-epidermal junction.

-The place where the epidermal and dermal become in contact is called dermal – epidermal junction

-the epidermis is attached to the basement membrane by hemidesmosomes and the dermis is Attached to the basement membrane by collagen anchoring fibrils so each part of the is attach to the basement membrane to make the junction stronger

-as we can see in the picture the surface of the dermis is irregular with several projections interlock with epidermal projections



✓ Importance of the jigsaw-like epidermal ridges-dermal papillae arrangement:

1. **Increase surface area of contact** between epidermis and dermis reinforcing the junction between them.
2. **Increase the number of Merkel cells and Meissner corpuscles increasing tactile sensitivity.**
3. Reflection of this pattern on the surface increases the surface area of the grip of the hand or foot by increasing friction.
4. The ducts of sweat glands open on the tops of the surface epidermal ridges as sweat pores. The sweat and ridges form fingerprints (or footprints) when a smooth object is touched. Since the pattern of the ridges is genetically determined, this can be used to identify an individual.

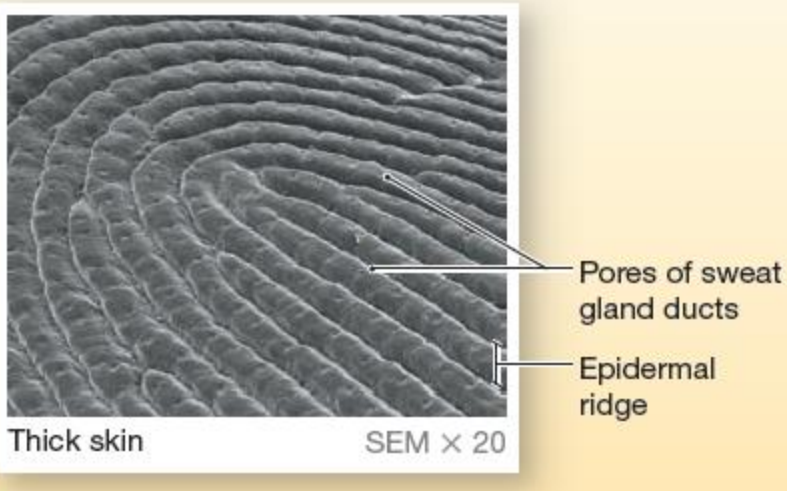


Fig.7: Epidermal ridges on surface of thick skin.

-As we have said the merkel cells are found in stratum basale and Meissner corpuscles found in dermal pappilae because of such an arrangement there is an increase in the surface area so we that means that we have increased in the number of such cells making the region more sensitive to tactile regions ((explaining point 2))

-this integration is reflected on the surface of the skin this will increases the surface area of the grip of the hand or feet by increasing friction because we have series of ridges and grooves on the surface so the surface area that is used for gripping objects by the hand is increasesd this means there is a friction between the object and the skin so we will have firmer grip

- the sweaty glands open on the top of the surface epidermal ridges (sweat pores) ((the sweat and the ridges will from the finger print))// so when we press our fingers on an object because the sweat and the patterns, the will pattern be printed on the surface that we have touched since the pattern of the ridges is genetically determine ,this can be used to identify individual so fingerprints are unique only in twins the fingerprints are identical but in different individuals they are not the same

The Dermis

- A connective tissue layer found under the epidermis.
- Variable in thickness. Thickest on the back.

When we said that the total skin thickness is thickest in the back because of the dermis

- Formed of two sublayers with indistinct boundary.**((no boundary between them))**

i. Papillary region:

- Thin superficial part of the dermis corresponding to the dermal papillae.
- Formed of **loose areolar connective tissue**.
- Contains:
  - Blood capillary loops
  - Lymphatic vessels
  - Nerves
  - Meissner's corpuscles (of touch)

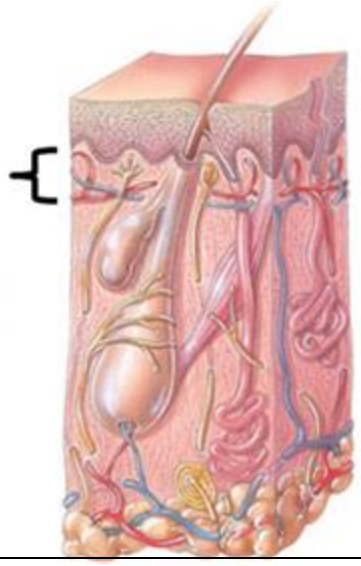


Fig.8: Papillary region of the dermis.
Papillary region is attached to the corresponds to the dermal papillae

ii. Reticular region:

- Thicker deep part of the dermis.
- Formed of **dense collagenous irregular connective tissue**.
- Contains:
  - Collagen and elastic fibers
  - Lymphatic and blood vessel plexuses
  - Sensory receptors and nerves
  - Hair follicle
  - Arrector pili muscle
  - Glands

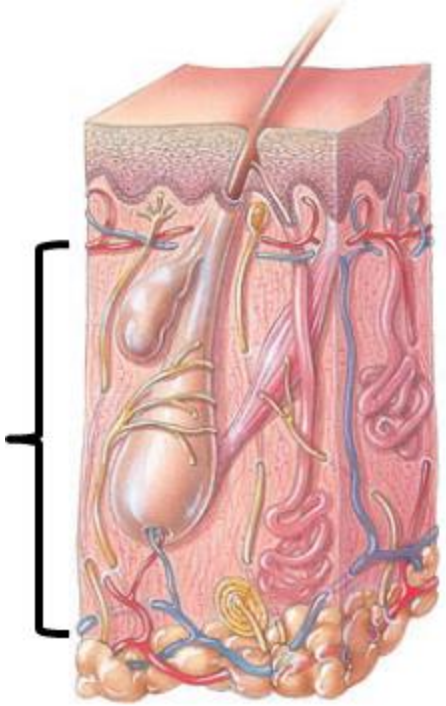


Fig.9: Reticular region of the dermis.

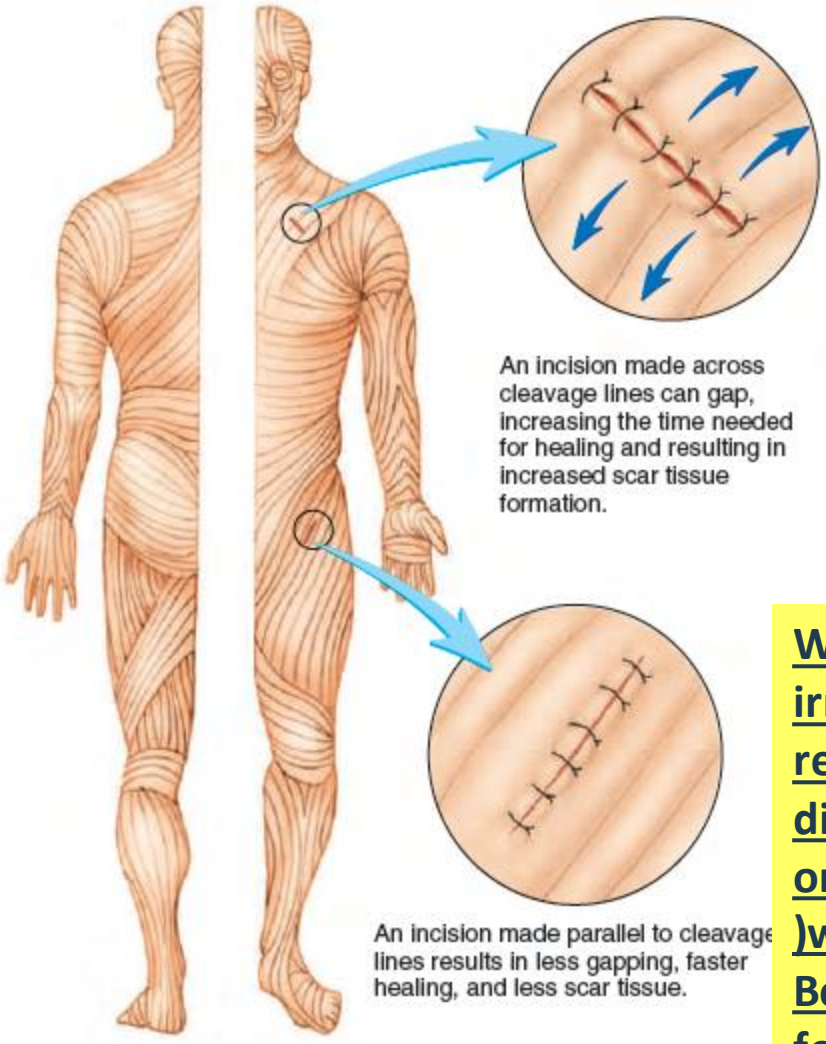


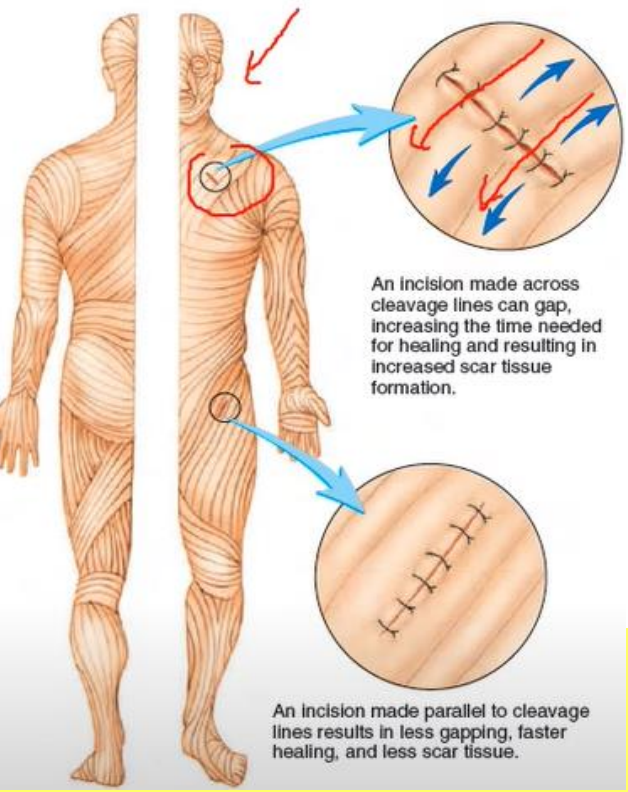
Fig.10: Tension lines.

In certain regions of the body, collagen fibers within the reticular region of the dermis tend to orient more in one direction than another because of natural tension resulting from bony projections, orientation of muscles, and movements at joints. Surgical incisions made parallel to these ***tension lines*** are associated **with faster healing and less scarring.**

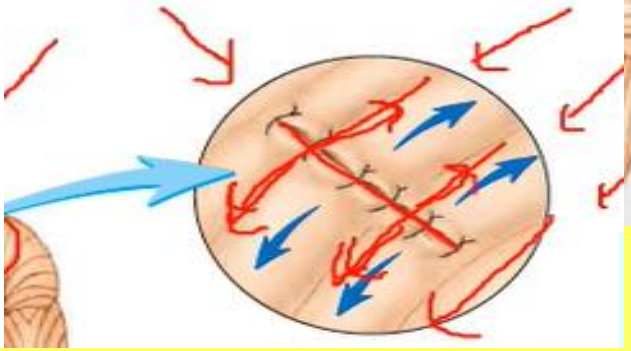
We said that the reticular region is formed from irregular dense collagenous region however in certain regions in the body the collagen fibers pass in all directions but many collagen fibers tend to pass in one direction more than the another (orientation)why ?

Because of the natural tension of that region ((the forces applied to that region are in that direction))

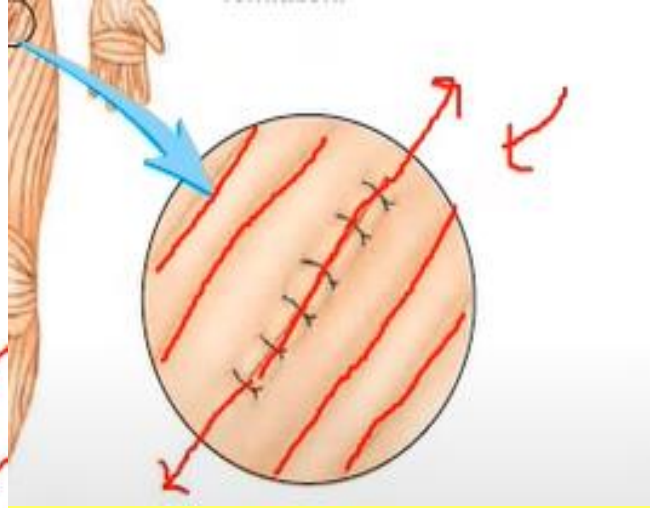
From where does orientation comes from (bony projections, Orientation of muscles, movements)



As we can see in the image that the collagen fibers are oriented in one way due to natural tension and the force will be as the red arrow is oriented ((because of that the collagen fibers run to this direction))
This form *tension lines *



If we make an incision perpendicular to the tension, the edge of the incision will be pulled in the direction of the force meaning they will be pulled apart so that will make the healing process take longer time resulting in scaring



If we make the incision parallel to the tension lines ,the edges of this incision will be closer to each other and tight to each other means that the healing process will be faster and less scars will be formed

Vascular plexuses of the dermis

- Two plexuses are found in the dermis:
  - ***Subpapillary plexus*** located between the papillary and reticular regions of the dermis. From it arise capillary loops that pass into the dermal papillae to supply nutrients to the epidermis.
  - ***Deep dermal plexus*** located deeper in the dermis.

- **Anastomoses** between the two plexuses are found and are important for the thermoregulatory function of the skin:
- **In cold conditions, blood flow to the subpapillary plexus is reduced to decrease heat loss.(the body will preserve its heat)**
  - **In hot conditions, blood flow to the subpapillary plexus is increased to facilitate heat loss.(therefore,the body will be cooled)**

- Lymphatic vessels begin in the dermal papillae and then form two plexuses located with the blood vessels.

Anastomosis between the 2 plexus

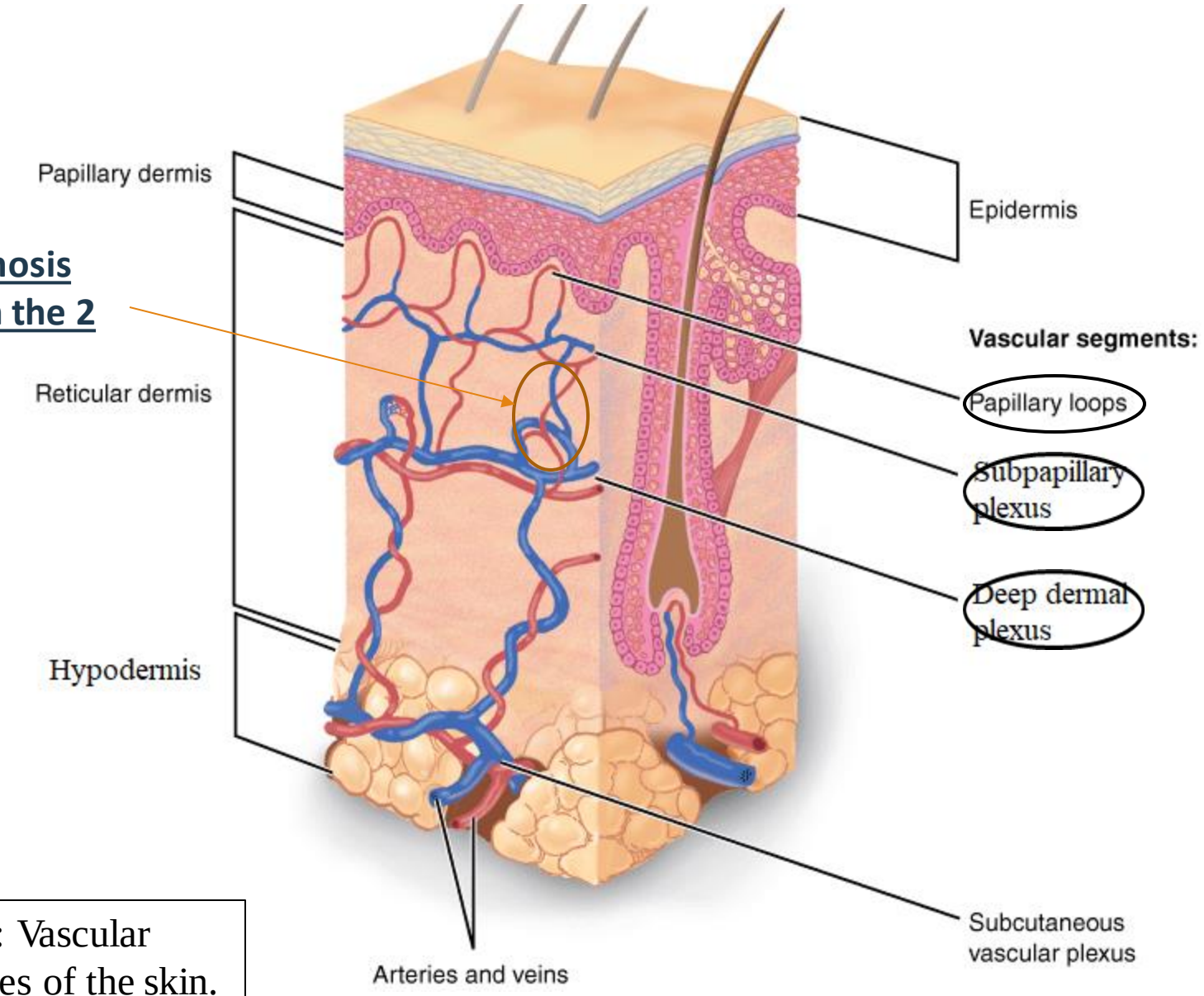


Fig.11: Vascular plexuses of the skin.

Nerve Supply and Sensory Receptors

- Afferent sensory nerves enter the skin and end at epithelial and dermal receptors.
- **Sweat glands, the arrector pili muscle, and blood vessels are supplied by postganglionic sympathetic nerves**.
- **No parasympathetic nerves supply the skin**.

- Due to its large surface area and external location, the skin functions as a receiver of various stimuli from the environment.

((can detect many stimuli from the environment))

- Various sensory receptors are found in the skin **to serve this function**. Some have glial and collagenous covering and some are unencapsulated.

((meaning that they are surrounded by capsules made of glial cells or connective tissue and some don't have capsule))

Uncapsulated receptors

Capsulated receptors

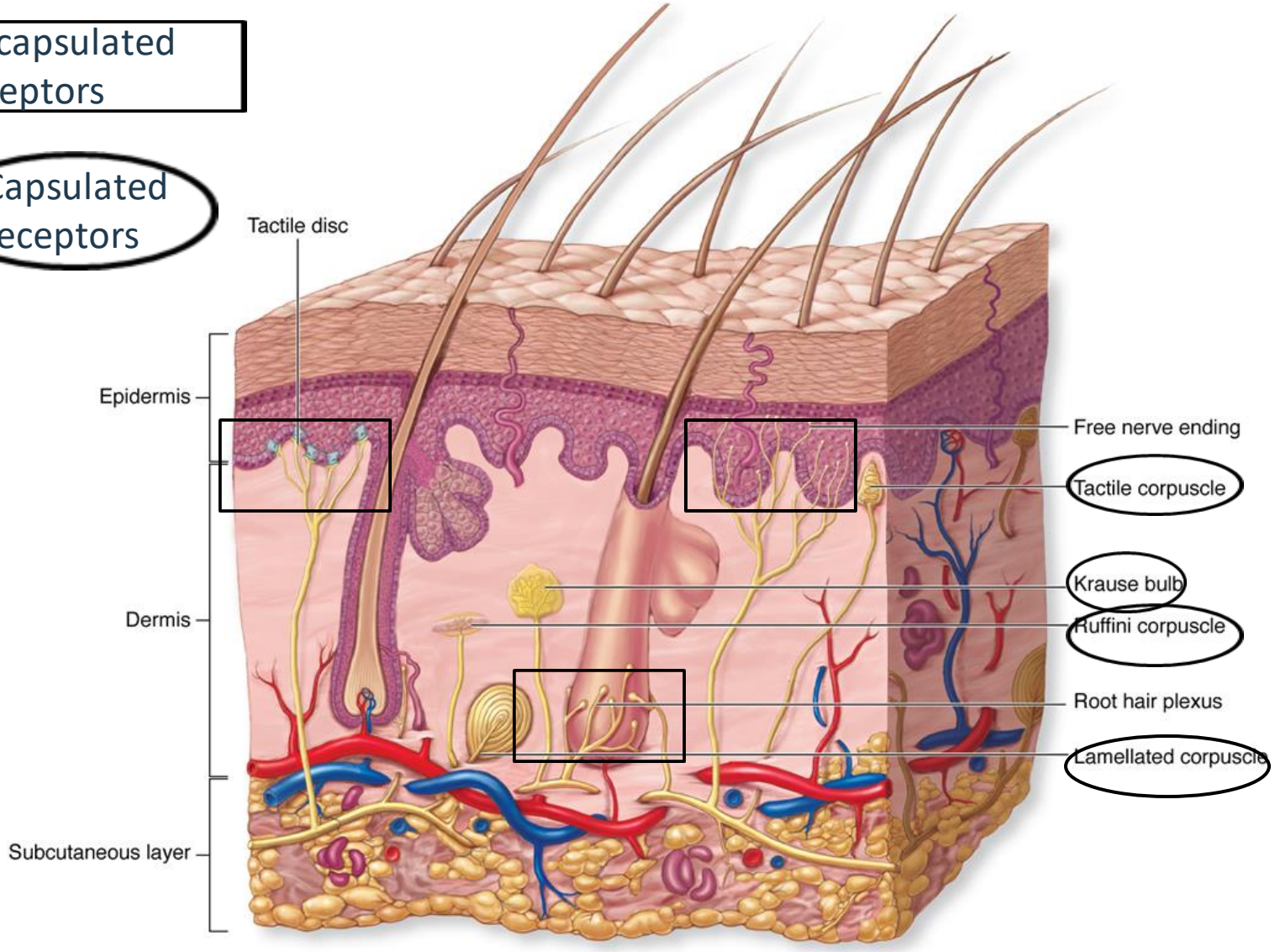


Fig.12: Sensory receptors of the skin.

Unencapsulated receptors

- These **are not covered by a glial or collagenous capsule.**

- They include:

1. ***Tactile discs*** associated with the epidermal tactile (Merkel) cells, which function as receptors for light touch.
2. ***Free nerve endings*** in the papillary dermis and extending into lower epidermal layers, which respond to temperature, pain, and itching.
3. ***Root hair plexuses***, a web of sensory fibers surrounding the bases of hair follicles in the reticular dermis that detects movements of the hairs.**((when the hair move for any reason these nerves will detect this movement))**

Encapsulated receptors

Meissner corpuscles

- Elliptical structure located in the dermal papillae perpendicular to the epidermis.
- Formed of:
  - Fibrous capsule
  - Several flattened Schwann cells arranged as lamellae
  - Unmyleinated nerve ending that winds among the Schwann cells until it reaches the tip of the receptor
- Responsible for the sensation of light touch.
- **Most numerous in the fingertips, palms, and soles.**

((remember that merkel cells are also in the fingertips because we use our fingertips to sense objects and know their features so that's why we need a lot of receptors for light touch))

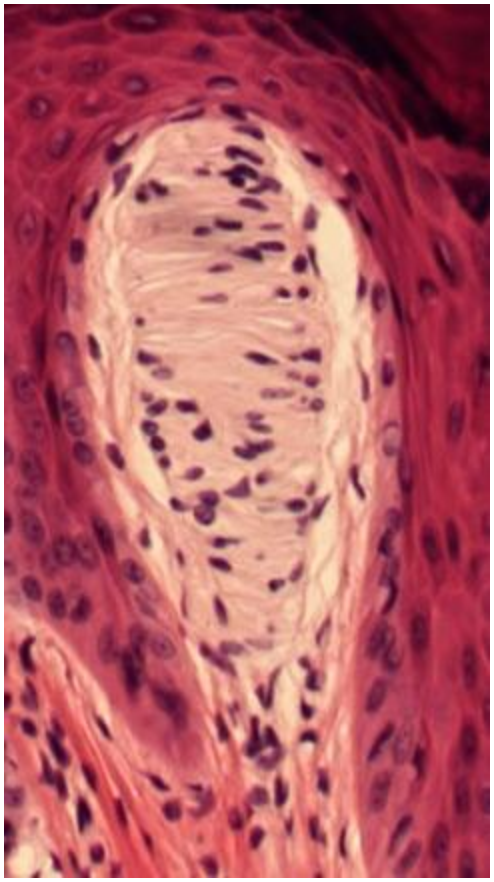
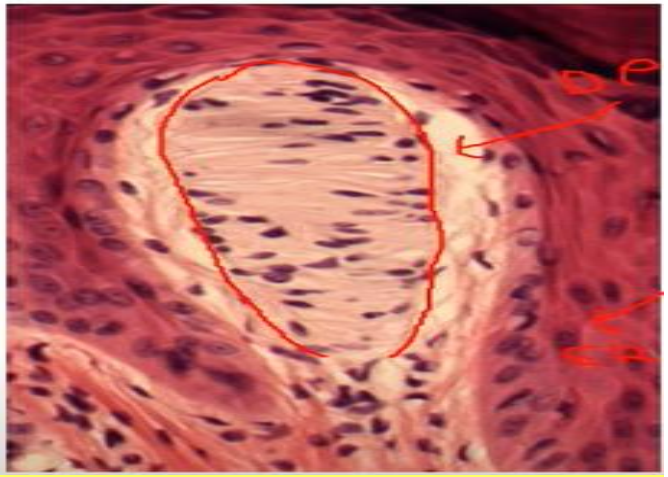
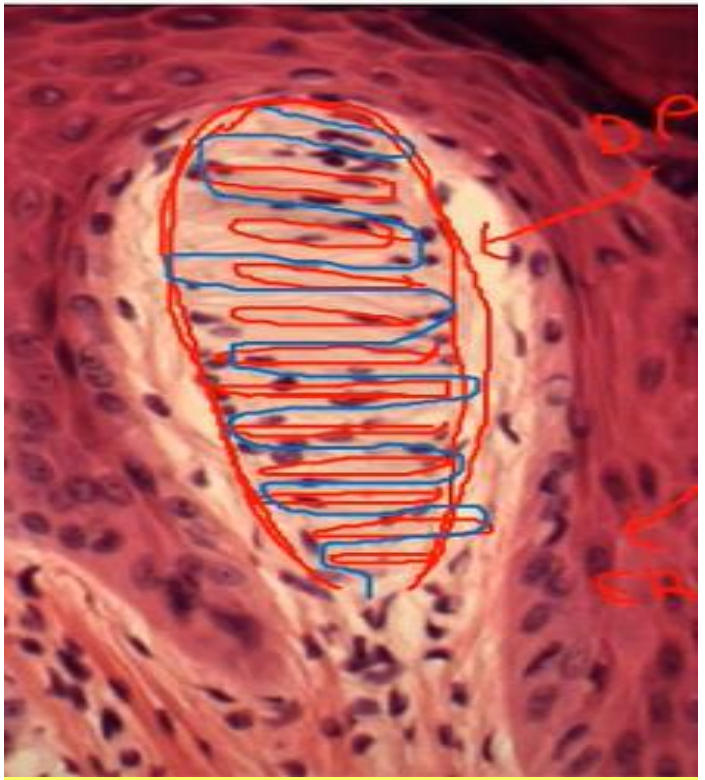


Fig.13: A Meissner's corpuscle in dermal papilla.



DP: dermal papillae
EB: basophilic region which is an epidermal bridge

In the middle there is Meissner corpuscles which is perpendicular to the direction of the epidermis as is shown below if the direction of the epidermis will be to the left the corpuscles will be like that …



The corpuscles is surrounded by fibrous capsule and it is made from SCWANN cells as it is shown in the figure and unmyelinated nerve fibers pass between the cell in order to reach the tip of the receptor(the blue color)

Lamellated (Pacinian) corpuscles

- Large oval structures located deep in the reticular dermis and hypodermis.
- Formed of:
  - Fibrous capsule
  - Several concentric layers of flattened Schwann cells surrounded by layers of connective tissue
  - Sensory axon in the center
- Responsible for the sensation of deep touch, pressure, and vibration.
- May be found in other organs.

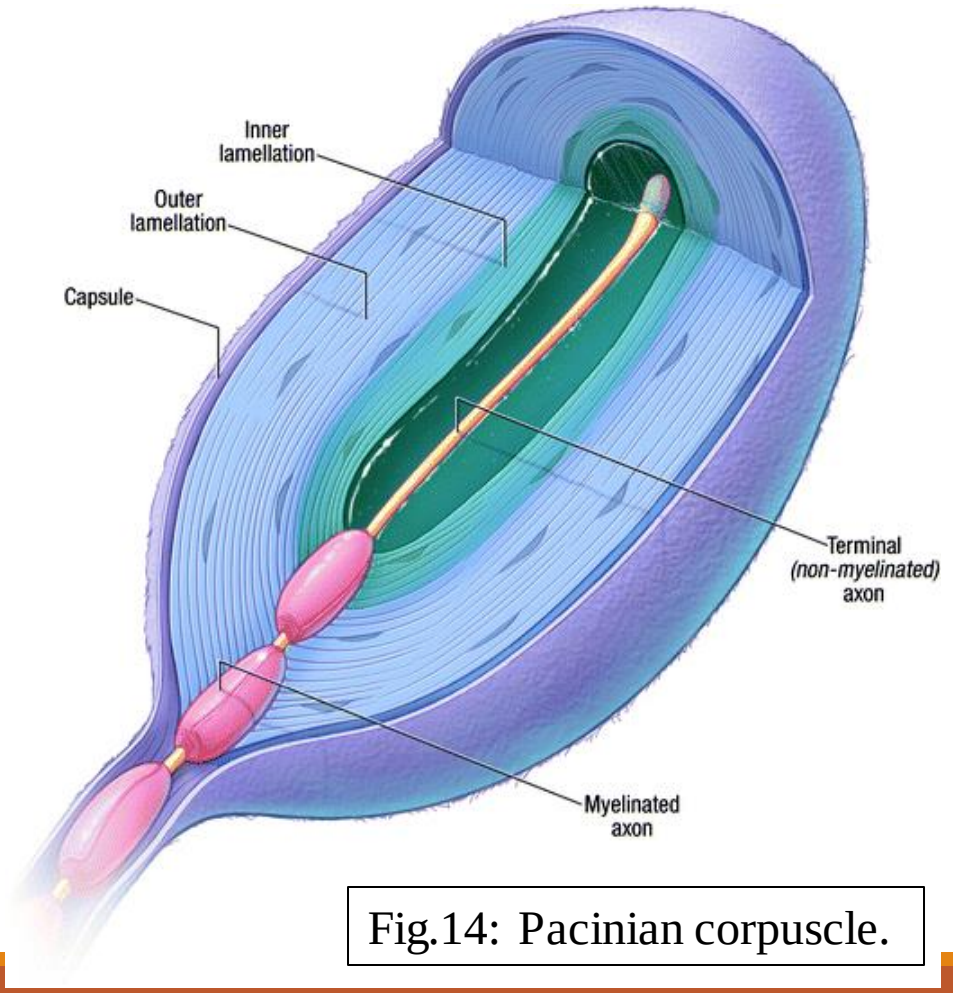
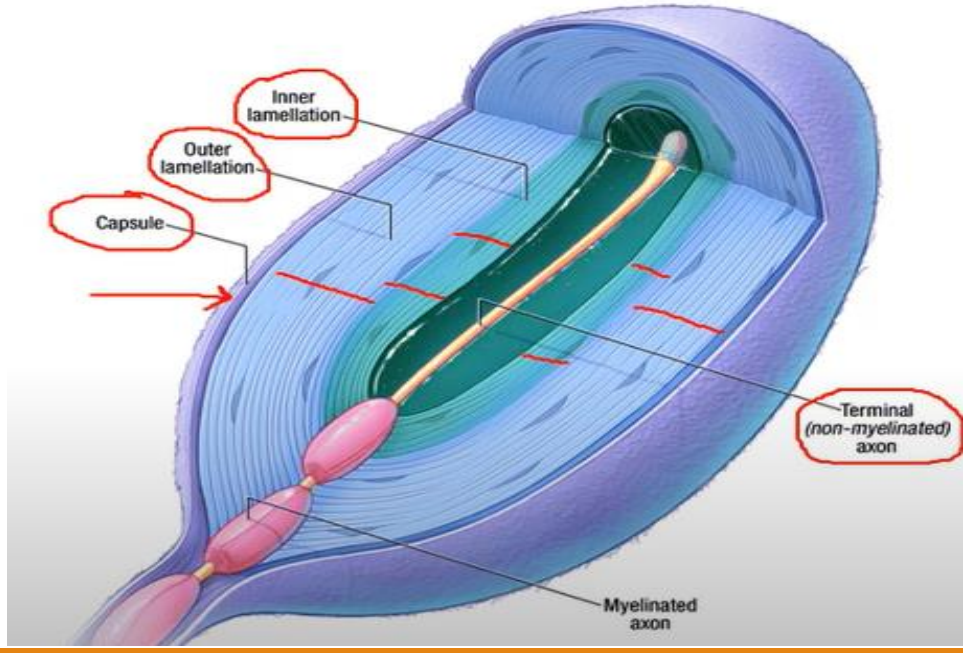


Fig.14: Pacinian corpuscle.

As we see in the figure the lamellated corpuscles is formed from capsule outside and in the middle there is an terminal(sensory fiber) non-mylinated axon which is surrounded by several lamealle and these lamealle are formed from 2 parts ((the one which is immediately surround the fiber is actually foemed from SCHWANN cells while the outer lamealle are layers of connective tissue))



Ruffini corpuscles

- Elongated fusiform structure found in the dermis.
- Formed of:
  - **Thin capsule** attached to surrounding tissue**(with several attachment attaching the capsule)**
  - Fluid-filled interior
  - Unmyelinated axon that branches profusely inside the capsule**(the fiber is inside)**
- Respond to stretch.**(when the dermis gets stretched,this receptor will respond by generating nerve impulse)**

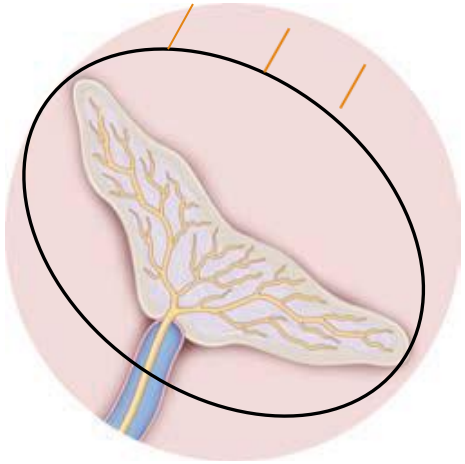


Fig.15: Ruffini corpuscle (above). Krause end bulbs (below)

Krause end bulbs

- Ovoid structures with extremely thin capsule.
- Found in **skin of penis and clitoris, several mucous membranes, and in the epineurium of nerves**
- Respond to vibration.

The Subcutaneous layer (hypodermis)

- Loose connective tissue layer that binds skin to underlying tissues.
- It contains adipocytes and a vascular plexus.

((has a fatty tissue))

- Functions:
  - Enables the skin to slide over underlying structures **(because it is loose)**
  - Fat in this layer acts as an energy storage site, insulator, and shock absorber **(has metabolic role)**
  - The rich vasculature enables rapid intake of drugs injected into this layer**((sometimes we inject drugs directly to the subcatonous layer in order to insure the rapid intake of such drugs to the circulation))**

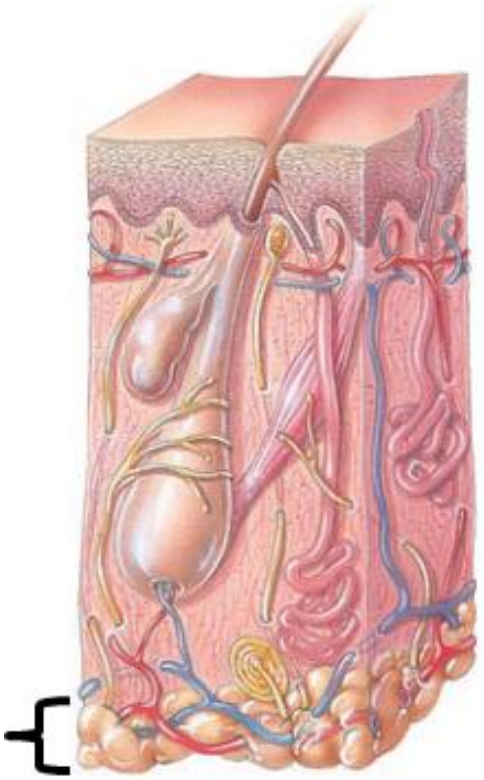


Fig.16: Subcutaneous tissue.

The Hair

- Hairs are elongated keratinized structures derived from epidermal invaginations.
- Found throughout the body, except in certain areas like the palms, soles, lips, glans penis, clitoris, and the labia minora.
- Hair distribution differs according to genetic factors, gender, and region of the body.

- Functions:
  - Protection (Hair on head protects scalp, eyelashes and eyebrows protect eye).
  - Reduction of heat loss.
  - Sensation of light touch.**((as we have said the root hair plexus of nerves that surround the hair follicle that detects movement of hair))**

Parts of the hair

- ***The shaft:*** the superficial part of the hair that extends beyond the surface of the skin.
- ***The Root:*** the deeper part of the hair that reaches down into the dermis. It's surrounded by the hair follicle.

- The hair is formed of 3 concentric layers:

1) *The medulla:* **The innermost layer of large, vacuolated cells**.
2) *The cortex:* **The middle layer of cuboidal cells.**
3) *The cuticle:* **The outermost layer.** Formed of heavily keratinized squamous cells arranged like shingles on house roofs.

يشبهون القرميد على سطح المنزل

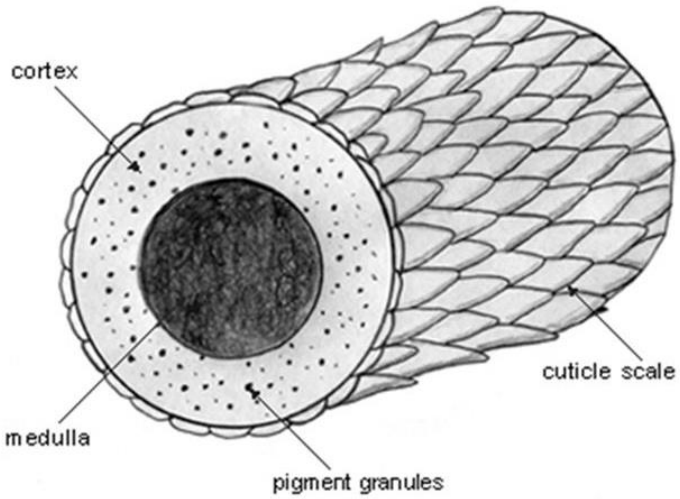


Fig.17: Layers of hair.

The hair follicle

- A downward extension of the epidermis that surrounds the hair root.**((so this is why we said that the hair is derived from the epidermis because the hair follicle is derived from the epidermis))**

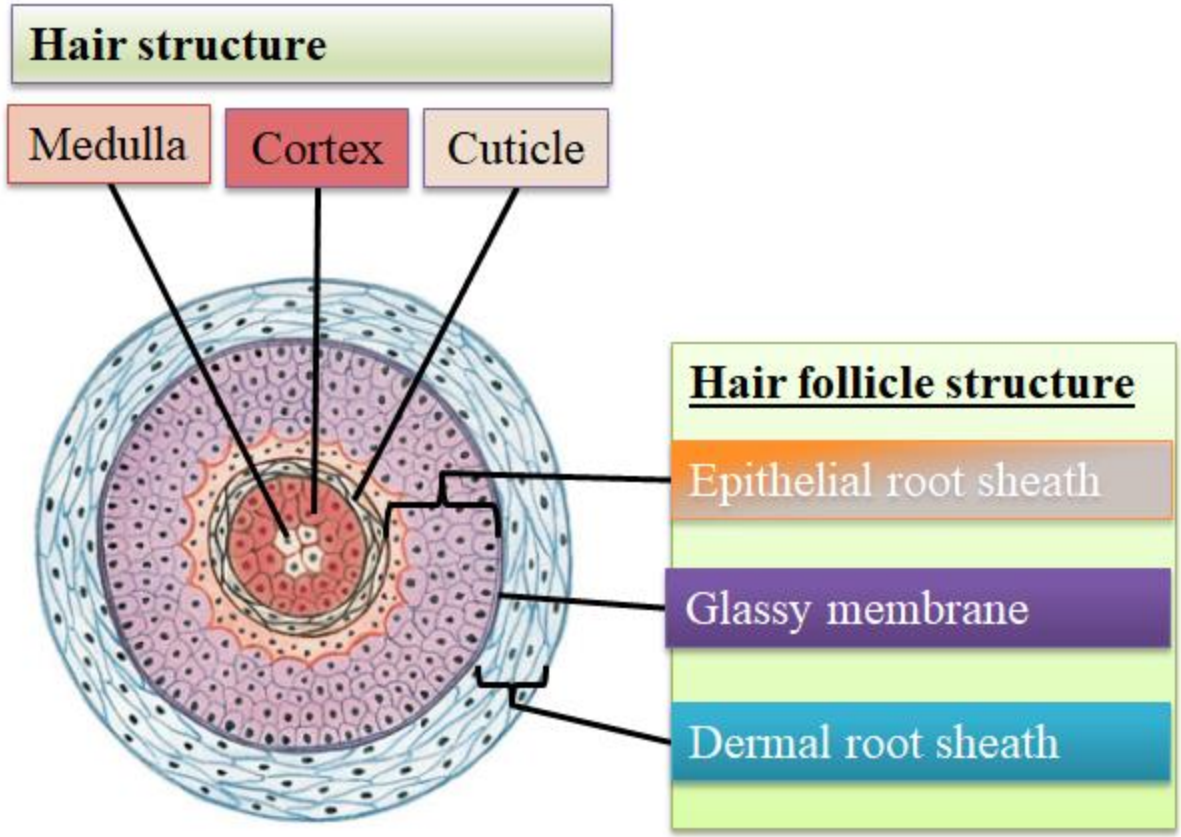
- Formed of (from the inside out):
  1. ***Epithelial root sheath*** derived from the epidermis and formed of two layer: **(a)***internal root sheath* that disappears above the level of the attached sebaceous gland and **(b)***external root sheath* that extends to the epidermis to become continuous with the stratum basale and spinosum.
  2. ***Glassy membrane:*** the thickened basement membrane that separates the epithelial and dermal root sheaths.
  3. ***Dermal root sheath*** derived from the connective tissue of the dermis.

- The lower part of the hair follicle is expanded to form the ***hair bulb***. This hair bulb:

  - Is invaginated by the ***hair dermal papilla*** **which contains loose areolar connective tissue and blood vessels (capillary loop) that nourish the hair.**
  - Contains the *hair matrix* formed of keratinocytes continuous with the stratum basale of the epidermis. The matrix is responsible for the formation of the hair. **Within the hair matrix, we have melanocytes that give hair its color.**

As we know the stratum basale is the layer that forms the other layers so the hair matrix is continues with stratum basale ((that means that the hair matrix is the source that forms the hair))

  - Is surrounded by the hair root plexus **(which detects the movement of the hair).**



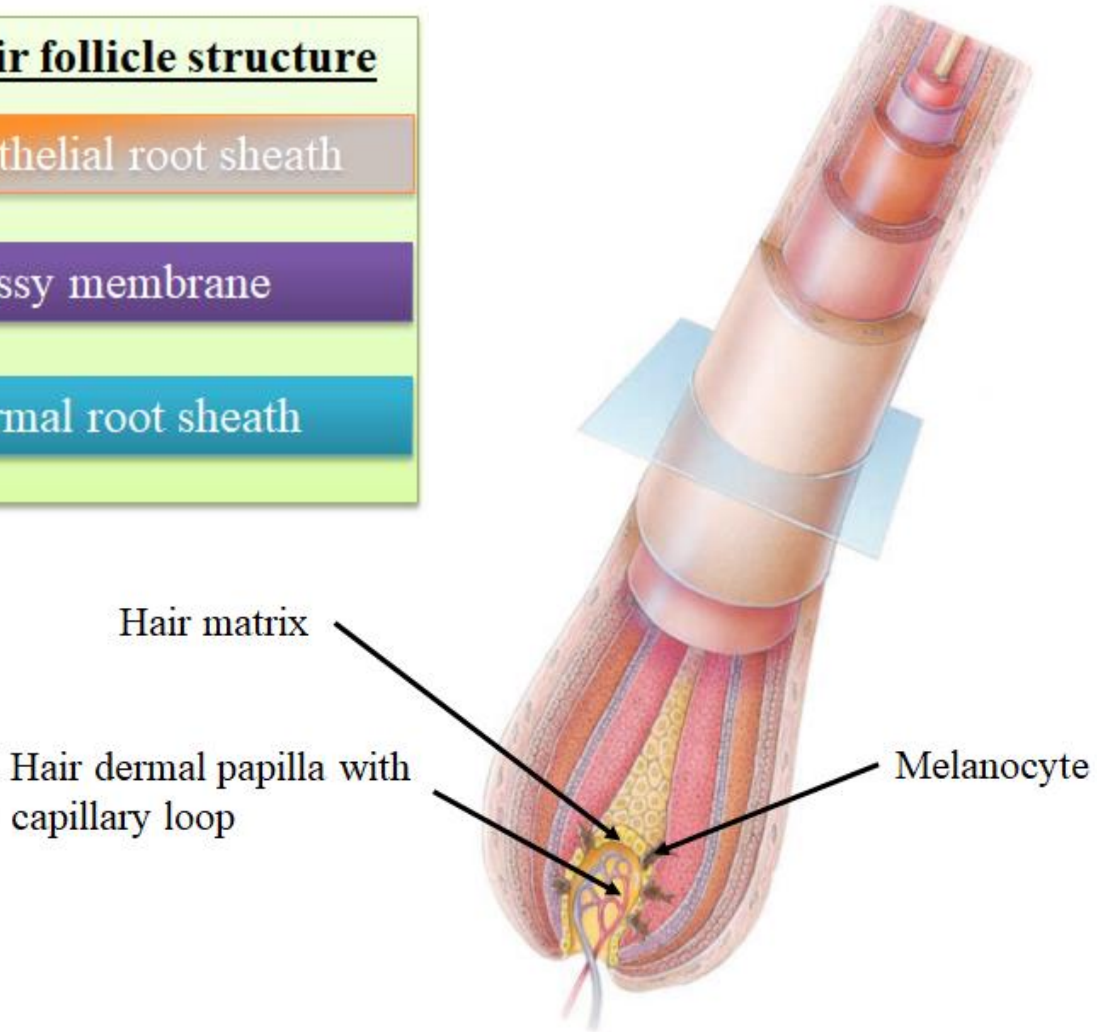


Fig.18: The hair follicle. To the right, the expanded part is the hair bulb. Above, a cross section through the hair follicle.

The root of the hair is surrounds by hair follicle if we take a cross section
So the layers of hair follicle are as shown in the figure

The hair is formed in the middle from medulla surrounded by cortex, surrounded by cuticle

-the epithelial root sheath is formed from 2 layers (external and internal((which is attached to sebaceous gland ,usually attaches itself to the hair and the internal disappears under the gland))

-there is a dilated part at the end this is called the hair bulb

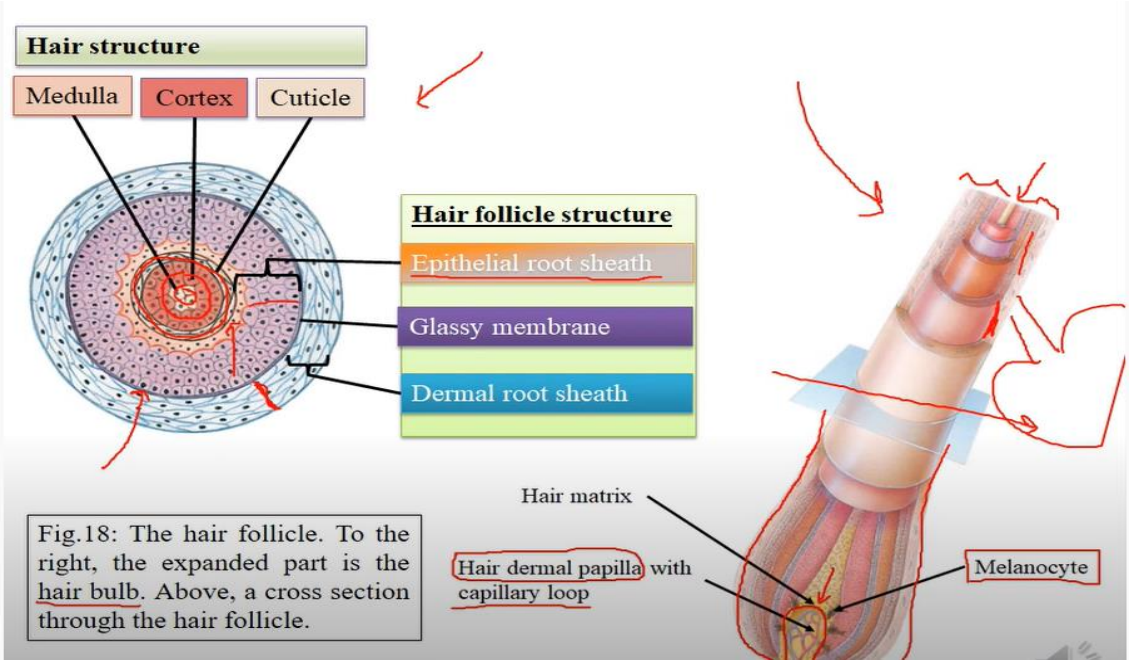
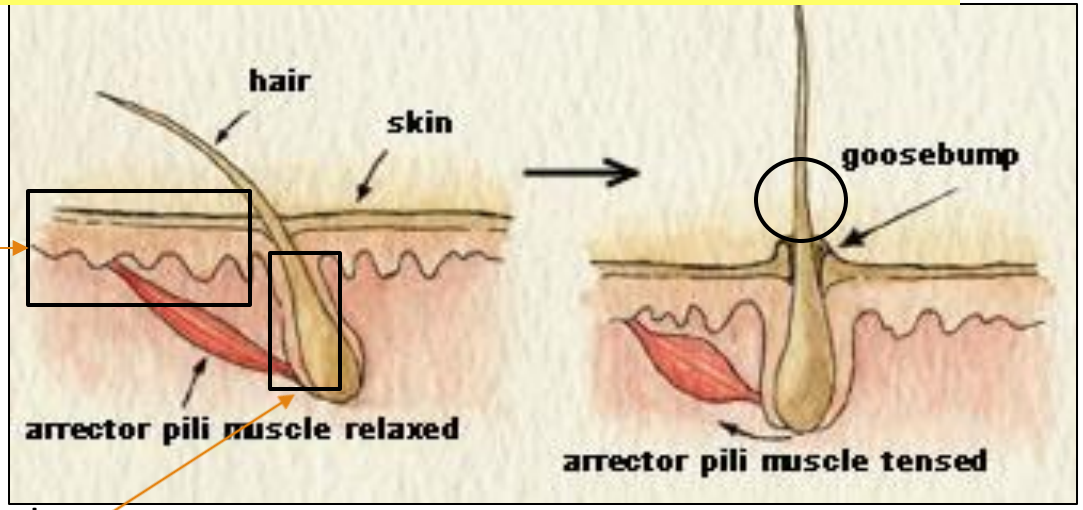


Fig.18: The hair follicle. To the right, the expanded part is the hair bulb. Above, a cross section through the hair follicle.

- The ***arrector pili*** muscle is a bundle of smooth muscle cells that extend **from the superficial part of the dermis to the dermal sheath of the hair follicle**. Under stressful conditions (cold), **the muscle contracts pulling the hair so that the shaft becomes perpendicular to the surface and bulging the skin around the hair producing 'goosebumps'**.

This is beneficial for the animals a lot of hair to trap warm air between the erected hairs (keeping the body warm)
Humans have less hair but this mechanism is not effective in warming the body (so why does this reaction happens to human is not exactly known)



Superficial part of the dermis

Dermal sheath

Fig.19: Action of the arrector pili muscle.

Hair growth

- Hair growth is cyclical. However, it's asynchronous **(doesn't happen at the same time)** and occur at different rates in different regions of the body (even in the same region).

- Phases of hair growth:
  - ***i.*** ***Anagen:*** a generally long period of mitotic activity and growth.
  - ***ii.*** ***Catagen:*** a brief period of arrested growth and regression of the hair bulb.
  - ***iii.*** ***Telogen:*** a long period of inactivity in which the hair may be shed.

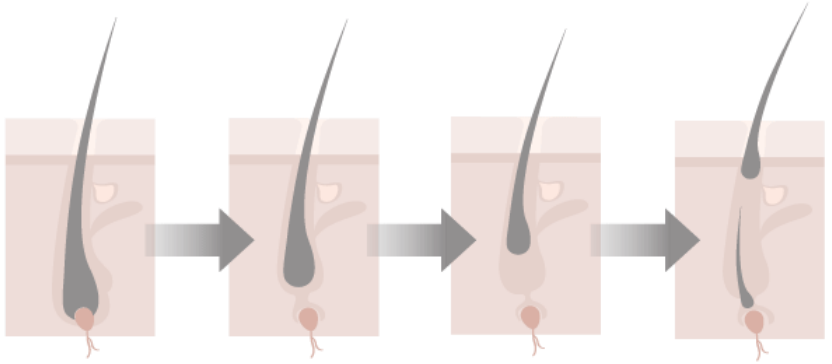


Fig.20: Phases of hair growth animation.

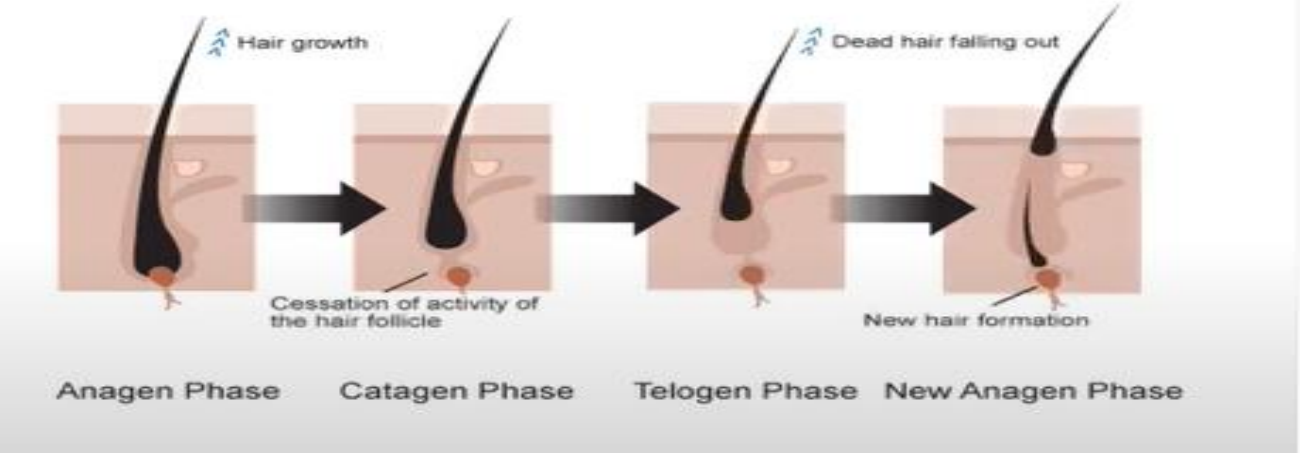
3 phases for hair growth :

1-angen: the hair bulb is large and the hair is growing

2-catagen : here the growth will be slowed down and arrested (the hair follicle will become smaller)

3-tolegen :the hair follicle here stop working at all and because of that there will be no further nourishment for the hair ,so it will fall off

After that a new anagen phase will start

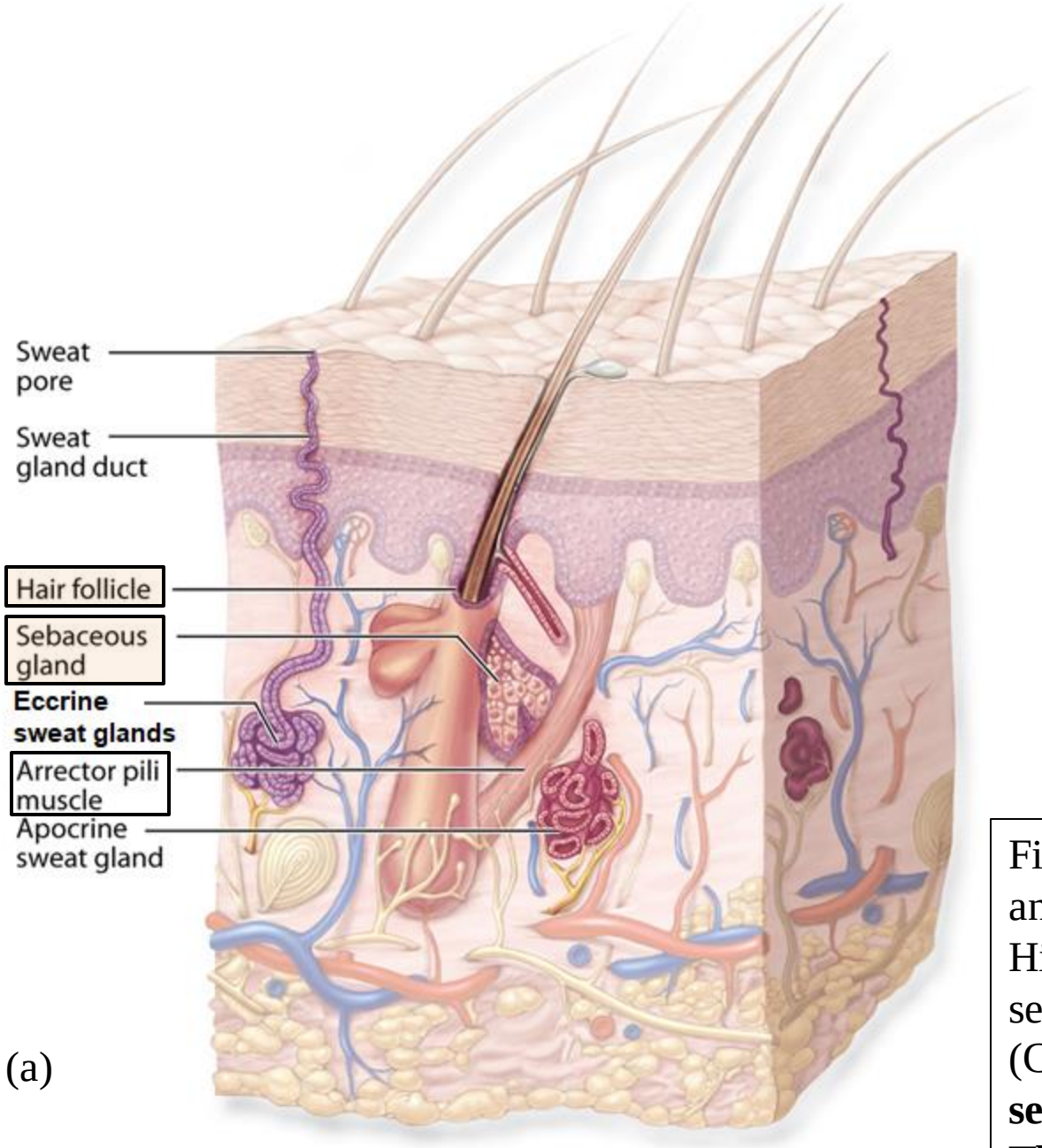


Sebaceous Glands

- Simple **branched acinar holocrine glands.**
- Found in the angle between the arrector pili muscle and the hair follicle. **With the hair follicle, it forms the *pilosebaceous unit* derived from the same stem cells.(sebaceous gland+hair follicle)**

- Found in most regions of the body with highest density in the face and scalp. They are absent in the palms and soles.
- **Duct opens into hair follicle. In hairless regions (eyelids, nipples, penis, and clitoris), the duct opens directly onto the epidermal surface.**

- Secretion of these glands is called ***sebum*** and it's mainly formed of lipids. The cells that produce it are called ***sebocytes***.
- **Sebum helps maintain the stratum corneum and the hair shaft and has some antibacterial effect**.



(a)

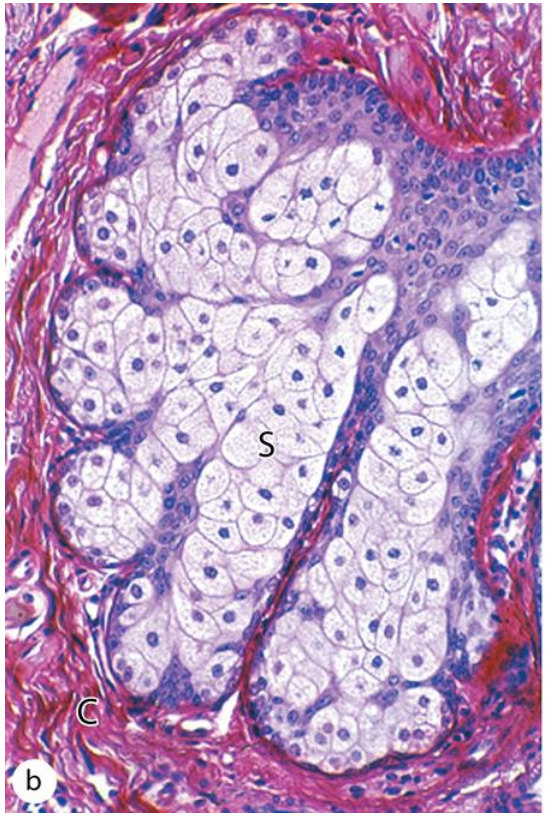
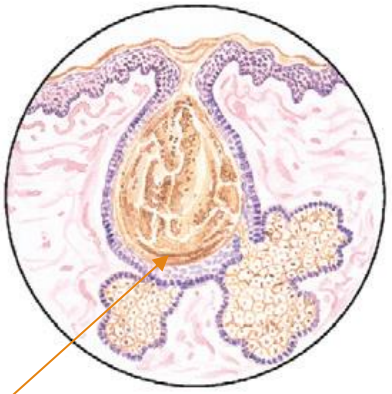


Fig.21: (a) The pilosebaceous unit and the arrector pili muscle. (b) Histological appearance of the sebaceous gland. Note the capsule (C) **and white appearance of the sebocytes (S).**
The cells appear empty because the sebum has many lipids

Acne vulgaris(disorder of hair follicle+ sebaceous gland) is an inflammatory disorder of the pilosebaceous unit in which there is excessive keratinization and sebum production that leads to blockage of the duct of the gland. This will lead to accumulation of sebum that may be infected. It most commonly occurs during **adolescence.(حب الشباب)**



Accumulated sebum may be infected

Demodex folliculorum is a small mite that normally lives in the hair follicle and feeds on dead cells and sebum. It's thought to be implicated in some skin disorders, but nothing is conclusive yet.

((there are some skin diseases that scientists think that this might be the cause but nothing has been proven about that))

Sweat Glands

- Long epidermal invagination (derived from epidermis). They are **simple coiled merocrine glands** of two types:

i. Eccrine sweat glands

- Found all over the body with highest density in palms and soles.
- Play an important role in thermoregulation with some excretory function.(help in preserve the heat or cool the body/also the body can excrete certain substances through sweating)
- Controlled by the sympathetic nervous system and function from birth.
- The secretory portion has a small lumen with stratified arrangement of cells. The coiled duct is lined by two layers of more eosinophilic epithelial cells filled with mitochondria(because they are filled with mitochondria ,they are eosinophilic) so the cells that line the duct are eosinophilic . These duct cells absorb Na^+ ions to prevent excessive loss of this electrolyte. They open on the surface of the skin at ***sweat pores***.

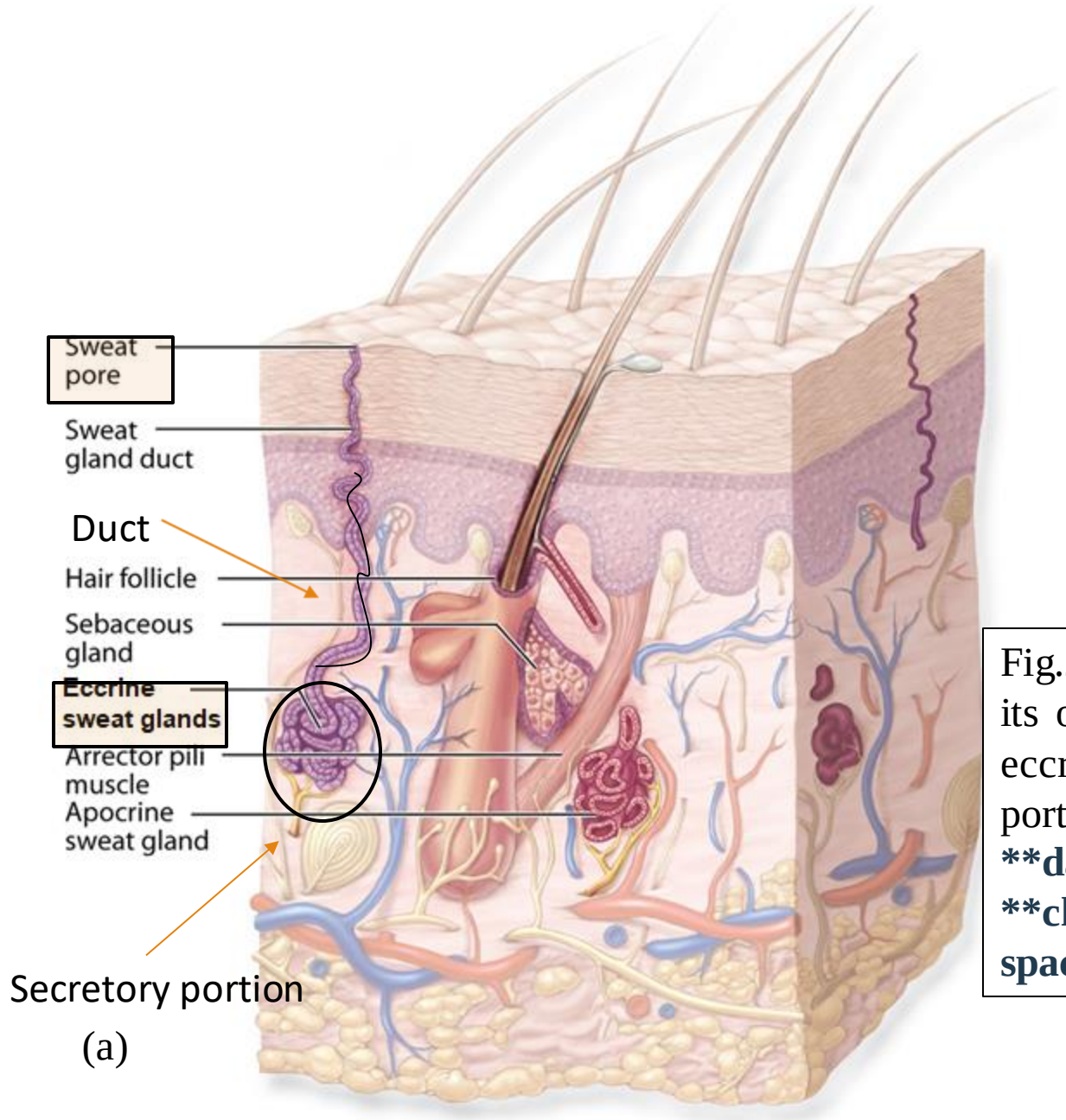
**We need mitochondria in the cells because the cells absorb sodium ion from the sweat to require that they need pumps and pumps energy (mitochondria)

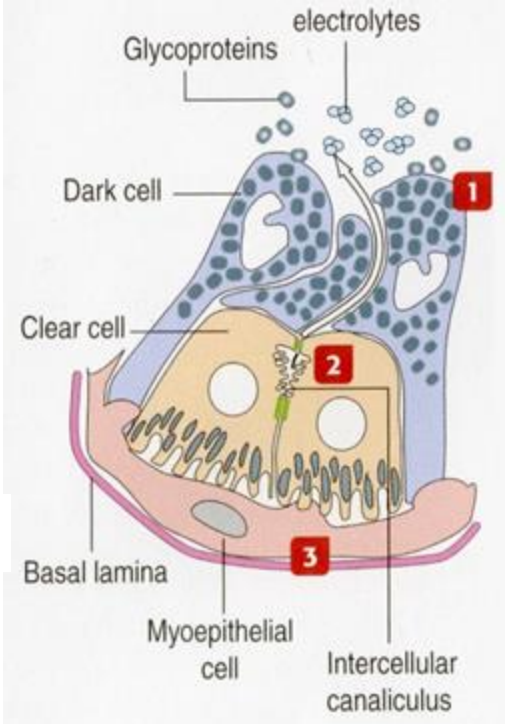
- Cells of the secretory portion of **eccrine sweat glands** are:

1. ***Clear cells:*** Pale staining with numerous mitochondria. Microvilli **and basal infoldings increase the surface area**. They do not reach the lumen**(the cells are not in contact with the lumen).** **Interstitial fluid from nearby dermis is taken up by these cells and released into intercellular canaliculi**(that's how the secretions of these cells reach the lumen). They secrete the water and electrolytes components of sweat.**(intercellular canaliculi:small spaces between the cells lead to lumen)**

2. ***Dark cells:*** Inverted-cone-shaped cells. **They reach the lumen but do not rest on the basal lamina.** The cytoplasm contains mitochondria, Golgi apparatus, and rough endoplasmic reticulum.**(indicates that they produce protiens)** The wide apical part is filled with strongly eosinophilic granules**(because these cells release glycoproteins).** They release glycoproteins by exocytosis into the lumen.

3. ***Myoepithelial cells:*** Rest on the basal lamina. They contract to help push sweat into the ducts.





(b)

Fig.22: (a) Eccrine sweat gland. Note its opening. (b) The types of cells in eccrine sweat glands secretory portion.

****dark cell: has narrow basal part**

****clear cells: has intercelllular space which is basal foldings**

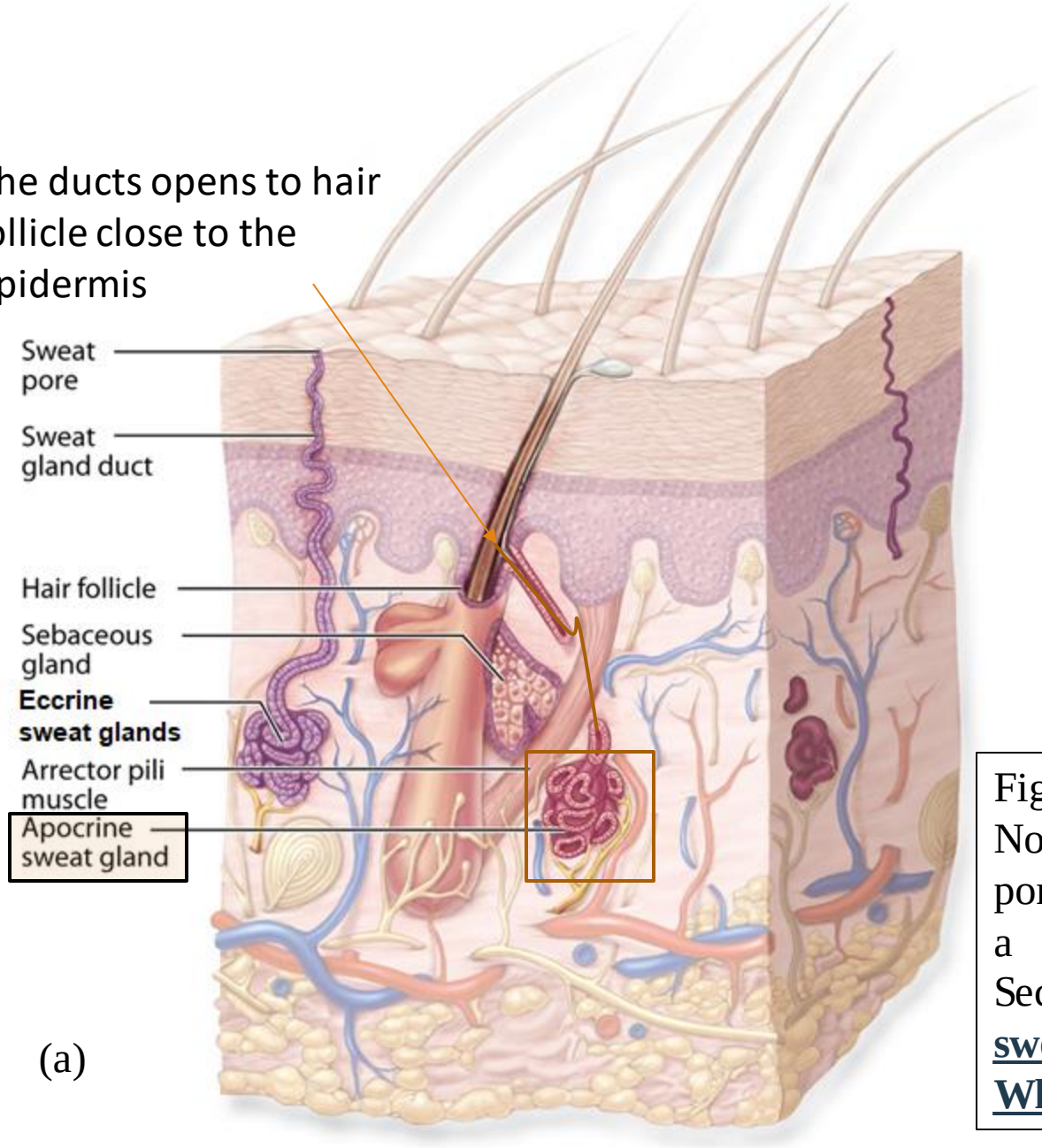
Both the secretory portion and the duct are coiled and open on the surface of the skin at pores

i. Apocrine sweat glands

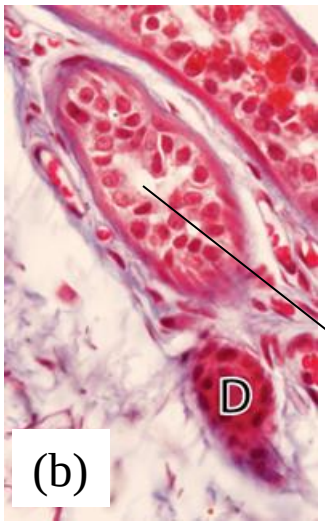
- Found in the axillary and perianal regions.
- Controlled by the sympathetic nervous system and sex hormones. They become fully functional after puberty.
- The secretory portion has a large lumen with simple cuboidal eosinophilic cells **(here the cells are arrangend only in one layer).** The duct opens into the hair follicle near the epidermis.
- They produce a **viscous protein-rich secretion**. In humans, they may also produce pheromones but in a reduced manner.**(but in animals they produce pheromones)**
- The secretion of these glands is odorless. Bacteria act on this secretion giving it a distinctive odor; this is what is called '***body odor***'. **((Every person has a distinctive odor so this odor results from the bacteria that acts on the secretion of such gland))**

Note: When first discovered, these glands were thought to be apocrine and were named so. Research, however, have shown that they actually release their **secretions by exocytosis and, thus, were merocrine glands**.

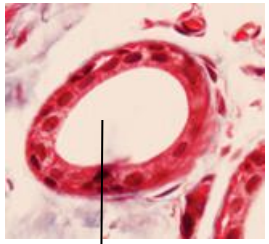
The ducts opens to hair follicle close to the epidermis



(a)



(b)



(c)

Lumen

Fig.23: (a) Apocrine sweat gland. Note its opening. (b) Secretory portion of eccrine sweat gland with a small lumen. D = duct. (c) Secretory portion of **apocrine sweat gland with a larger lumen. While in eccrine has small lumen**

Feature	Eccrine	Apocrine
Location	All over the body, especially palms and soles	Axillary and perianal regions
Type	Simple coiled	Simple coiled
Secretion	Watery	More viscous
Method of secretion	Merocrine	Merocrine
Secretory portion	Small lumen. Stratified epithelium	Large lumen. Simple epithelium
Open	Usually on the surface of the skin	Into the hair follicle
Control	Nervous (cholinergic)	Nervous (adrenergic) + Hormonal
Onset of action	From birth	At puberty
Functions	Thermoregulation Excretion	Stimulated during emotional stress

Nails

- **Hard plates of keratinized cells found on the dorsal surface** of the distal phalanges.

- Externally, the nail is formed of a nail plate (body) surrounded by three folds **(two lateral and one proximal)** with a distal free edge**(the part that we cut).**

- The proximal part of the nail is the ***nail root*** which is covered by the proximal nail fold. At this fold, the stratum corneum doesn't pass with the other layers of the epidermis but continues distally as the ***eponychium*** (cuticle)**((white thin line which is proximally and is actually the stratum corneum))**

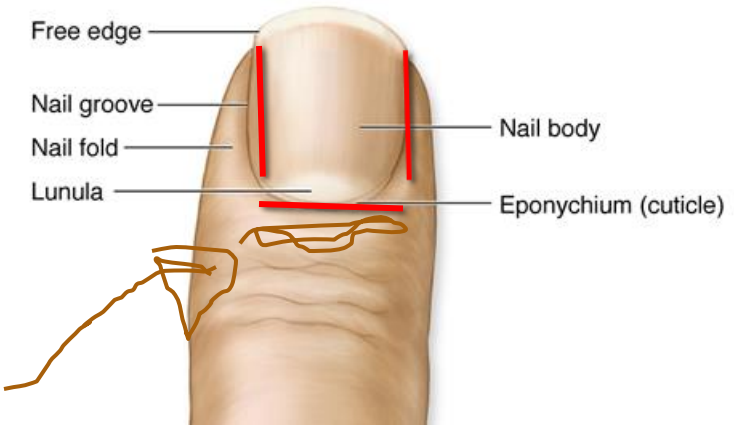


Fig.24: External appearance of nails.

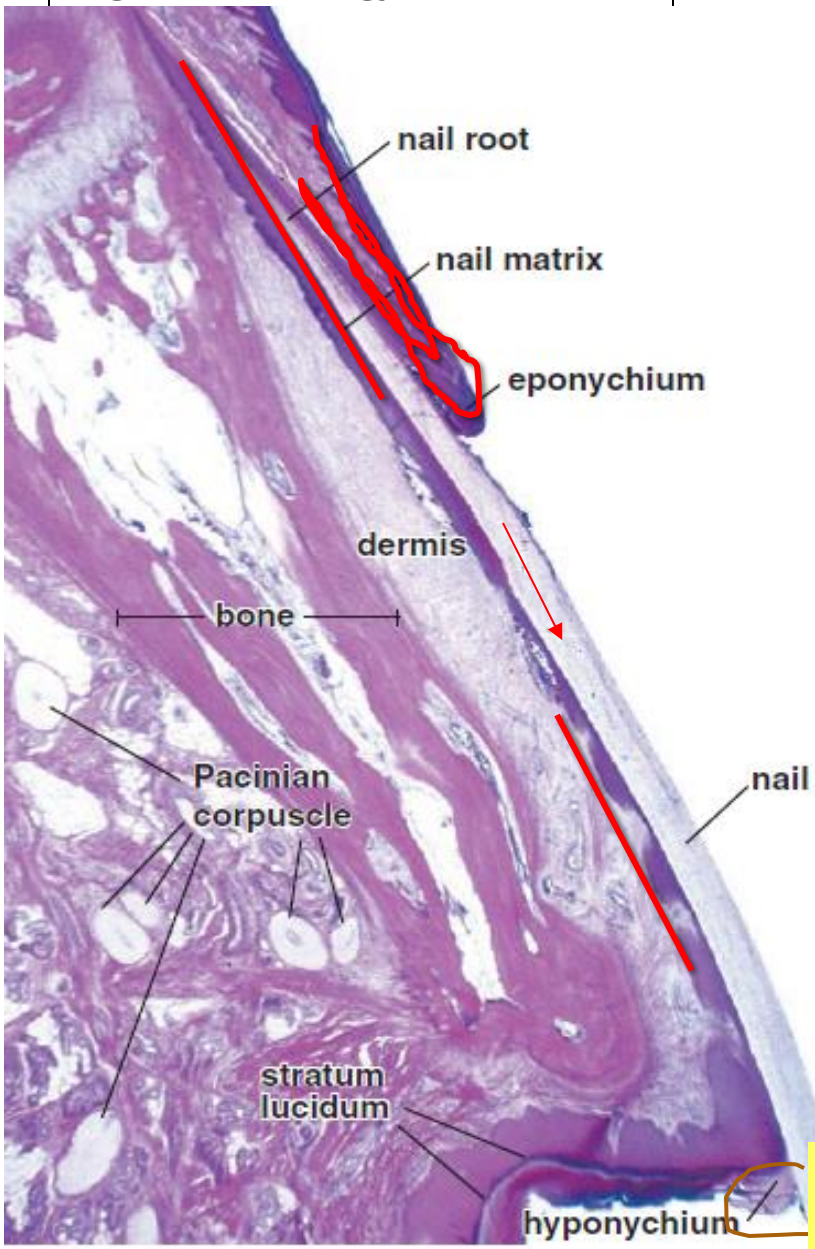
- The nail root is formed from the ***nail matrix*** derived from the epidermis. As more cells are added, the root grows and the plate extends distally over the ***nail bed***.**(the part which the nail grows is called nail bed)**

Proximally in the nail plate, we have a whitish area called the ***lunula***. The white color comes **from the opaque nail matrix under the lunula** **(the nail matrix that form the nail root is thick and therefore the nail plate above it is white in color) …**The nail bed is thin formed of stratum basale and spinosum only. **Because of this and because the mature nail plate is semitransparent**, the color of blood in the dermal vessels is seen through the nail **(and that's why the nail plate appear pinkish in color).**

So in the state of deoxygenation we can see that on the nail plate ((bluish color on the nail))

- Distally, the free edge of the nail is adhered to the fingertip by a fold of epidermis called the ***hyponychium***.

Fig.25: Histology of the nail.



Fingernails grow at a faster rate than toenails. This is why we clip fingernails more often.

Here we have the nail plate and proximal fold ,formed of all the layers of the epidermis

So the layers in the epidermis will fold however the stratum corneum will not fold it will continue distally to form eponychuim

The other layers of epidermis will continue to form the nail matrix ((the part that forms the nail))

The first part that is formed by the nail matrix is the nail root

More cells are added distally to this direction((red arrow))

The area which is the nail grow is called nail bed (red line)((thin and blood vessels that they are in the dermis can be seen easily through the nail))

Here the finger has ended and there is a free edge part but it is attached to the finger tip by hyponychuim

The END

Good luck ☺