

INTEGUMENTARY SYSTEM

INTEGUMENT :- Skin (Epidermis + dermis) & its derivatives makes integument.

BODY WALL :- It is more thicker than integument & consists of many layers :-

1. Integument
 2. Panculus adiposus : Layer of adipose connective tissue.
 3. Tela subcutanea : Layer of areolar connective tissue.
 4. Panculus carnosus : Layer of skeletal muscles
 5. Parietal peritoneum : Inner lining of body wall composed of Simple Squamous Epithelium
- All layers of body wall are mesodermal in origin except epidermis which is ectidermal in origin.
So complete body wall is **Ectomesodermal** in origin.
Study of skin is called **Dermatology**.

Largest organ of body is **skin**.

It is called **Jack of all trades** because it performs many functions.

Linings are clearly visible on sole & palm.

Dark linings of sole & palm called as **spy linings**.

Linings are also present on tip of fingers.

Impression of these linings are called **finger prints**.

Study of finger prints in called **Dactylography**.

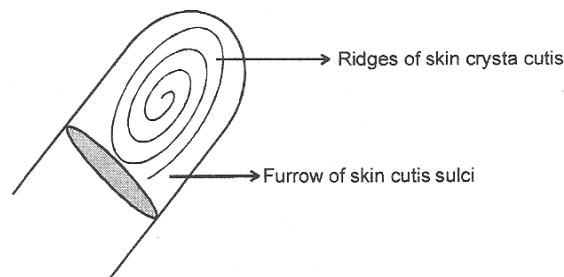
Father of Dactylography is **FRANCIS GALTON**.

Sixteen ridge pattern of finger prints of two individual are never same (**This is in accordance with Quetlets Rule**).

Finger prints consist of two structures :

Ridges of skin : Crysta cutis.

Furrows of skin : Cutis sulci.



Examination of finger prints by the help of simple hand lens is called Dactyloscopy.

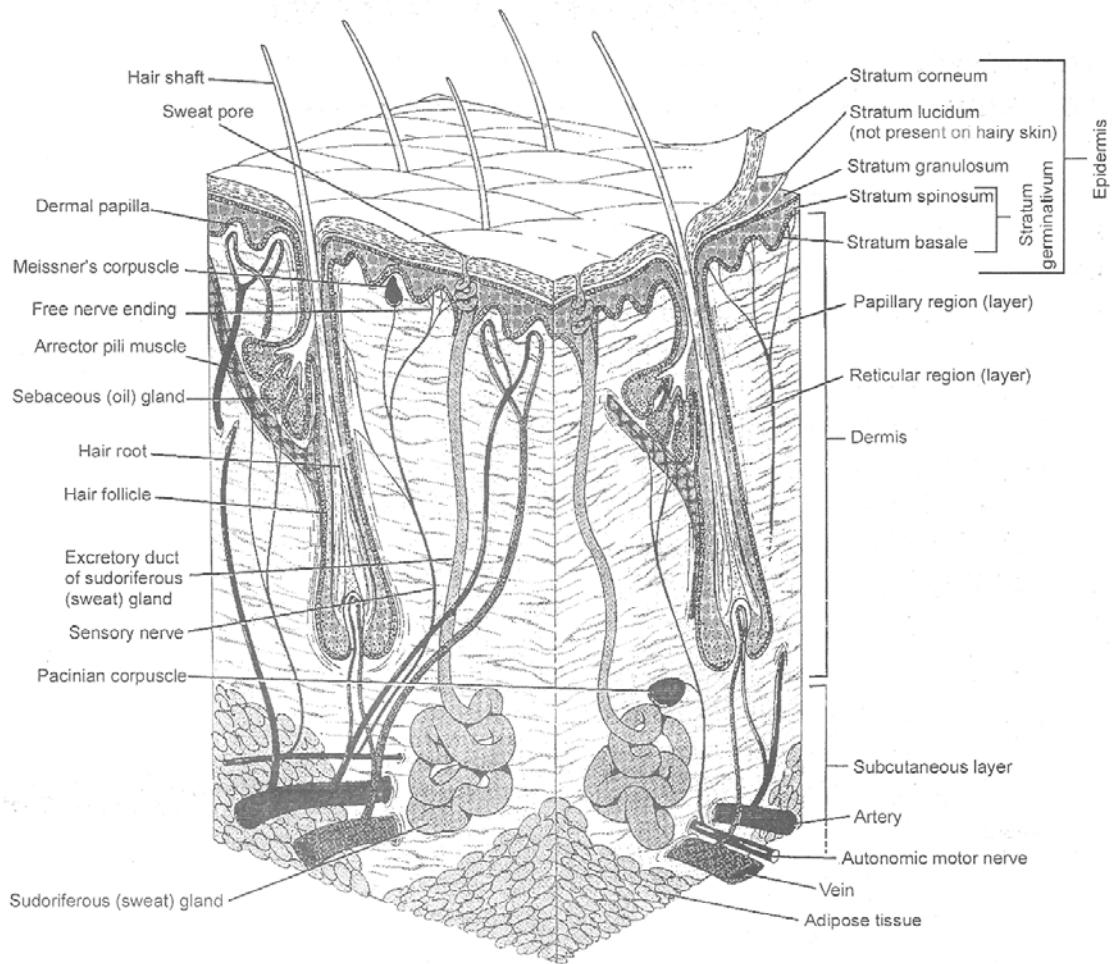
Permanent linings formed on abdominal skin in female after parturition are called as Linea Gravidarum.

Structure of skin - Two parts :

Outer Part :- Epidermis : Ectodermal in origin.

Inner Part :- Dermis :- Mesodermal in origin.

So, complete skin is **ecto-mesodermal** in origin.

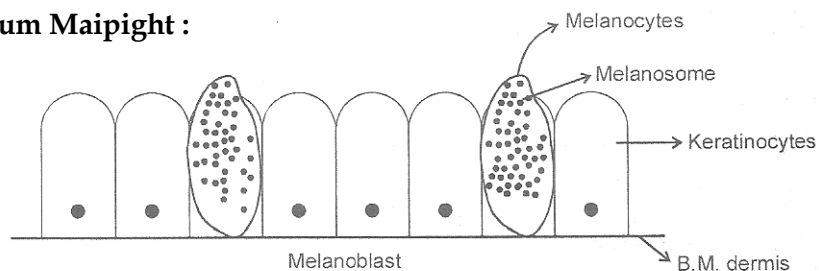


EPIDERMIS

Outer part of skin which is composed of Stratified squamous Epithelium keratinized. In the structure of epidermis on the basis of shape of cells & cytoplasm there are five stratum -

- (1) Stratum maipighi
- (2) Stratum Spinosum
- (3) Stratum Granulosum
- (4) Stratum lucidum
- (5) Stratum Corneum

1. Stratum Maipight :



Inner most stratum of epidermis consisting of one layer of cells. It is also called stratum basale. Cells are cuboidal or columnar in shape. In this stratum two types of cells are present.

- (i) **Melanocytes** :- Less than 10%. They are called **pigmented dendritic cell**. These cells are formed by modification of melanoblast cell which lies at the Junction of epidermis & dermis. In melanocytes melanosomes are present in which melanin pigment is synthesized and stored.

Functions :-

- (1) Provide colour to skin
- (2) Absorb harmful radiations & protect internal organs.

- (ii) **Keratinocytes** :-

More than 90%

In these cells high power of division is present (high mitotic index). They get their nutrition from underlying connective tissue of dermis & divide to form other stratum of epidermis.

So, innermost stratum of epidermis is called '**stratum germinativum**'. (Sometimes St. Spinosum & St. basale are together called as stratum germinativum)

At many places in skin this stratum invaginate in dermis to form cutaneous glands & hair follicle, so these structures are also ectodermal in origin.

2. **St. Spinosum** :

It consists of six to seven layers of polygonal shaped cells. These are nucleated & living cells. This stratum is also called as **Prickel cell layer**.

In this stratum few star shape cells are also present called as '**langerhans cell**'. They identify foreign antigen which enter into body through skin & stimulate immune system to produce antibody.

3. **St. Granulosum** :

It consist 6, 7 layers of cells.

Cells are nucleated & living.

In their cytoplasm keratohyaline granules are present. Which are composed of **Ca⁺⁺** , **acidic polysaccharides** & **RNA**.

They can be **stained by Hematoxylin**.

Glycogen granules are also present in their cytoplasm (in little amount).

4. **St. Lucidum** :

It consist of 2-4 layers of cells. But it is thickest in sole & palm where it is 3-5 layer thick. Cells are rectangular in shape.

In their cytoplasm water proof protein **eleidin** is present which makes the cells of this stratum water proof. So, stratum lucidum act as **barrier layer** & makes skin water proof.

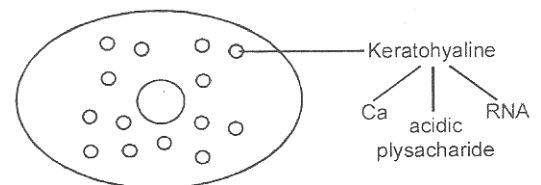
Note : In frog stratum lucidum is absent. Here stratum corneum makes skin water proof in which keratin protein is present which is also water proof protein.

In this stratum degeneration of nucleus & cell organelles starts, so cell starts dying.

5. **St. Corneum** :

Consist of 8-10 layers of cells. Cells are non nucleated & dead. Cells of outermost layer are flat or scale like in shape.

Most of the cells of outermost layer are dead in which keratin protein is present. Cells with keratin protein are called as horny cell which fall from epidermis time. This process is called **ecdysis/moulting**.



Periodic shedding of intact stratum corneum in snakes : Sloughing.

Keratin scales which falls from epidermis in frog are composed of simple Squamous epithelium in which cells are nucleated & living.

Formation of keratin protein in epidermis from keratohyaline is called as **cornification**.

In this stratum few living cells (less than 1%) are also present which are endocrine in nature they secrete unknown hormone which control & regulate division of stratum malpighi

Special points :-

Thickest St. Corneum is seen on **sole & palm**.

Thickest St. corneum on **lips**.

Thickest epidermis is seen on **conjunctiva of eye**.

Thickest epidermis is seen on **sole & palm**.

DERMIS/CORIUM :

Inner part of skin, mesodermal in origin. Dermis is derived embryologically from Dermatome.

Dermis is 2 or 3 times thicker than epidermis.

Tanning :

Process of leather formation is called tanning.

After separation of epidermis, tanning agent is applied on dermis (like **Cromium salts, Alum & Tannin** for colouring). By the application of these chemicals, collagen fibres become more tough & rigid.

Taxidermy :

Preservation of whole skin with its derivatives by the help of chemicals like **formalin** is called **taxidermy** In the structure of dermis there are two parts -

(1) Outer part : Part papillaris.

(2) Inner part : Pars reticularis

1. Pars Papillaris :-

Outer part of dermis in which bundle of collagen fibre are more in amount but they do not form reticulam. In this region papilla like grooves are present which enter into epidermis. In these grooves group of blood capillaries are present which provide nutrients to the cells of stratum germinativum.

These group of blood capillaries are present till dermal papilla.

Due to presence of papilla like grooves (Dermal papilla) epidermis also invaginate into dermis in the form of grooves which are called **Rete pegs**. Both these grooves makes dermal epidermal junction which provide rigidity to complete skin.

Due to presence of wavy dermis. ining apper on the skin which are called as **lines of Langerhans**.

2. Pars Reticularis :-

Inner part of dermis in which bundle of collagen fibres are less in amount but they form reticulum with otherfibres of connective tissue (like reticular & elastic fibres).

In cells fibroblast, mast cell & macrophage are more in numbers.

Matrix is composed of mucopolysaccharide. So skin is composed of modified areolar connective tissue.

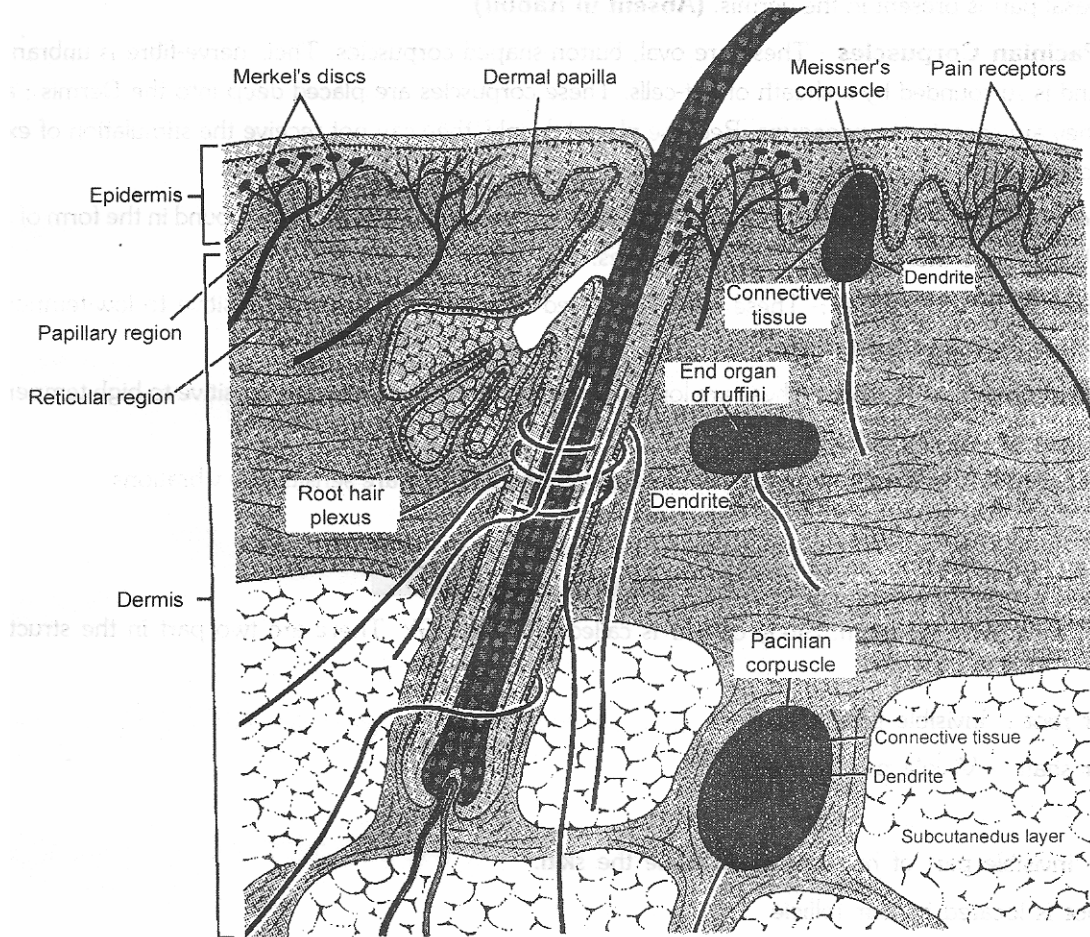
Special point :-

In the dermis of frog, two regions are present.

(i) **Outer part : Spongiosum layer.**

(ii) **Inner part : Compactum layer.**

CUTANEOUS RECEPTORS



Structure and location of cutaneous receptors

Primary function of Cutaneous-receptors is to receive sensations for protection. On the basis of structure, these are classified into 2 categories:-

- (i) **Naked Nerve-fibres** (non cap) - These are present in the form of a network which accepts the external-stimulations. These nerve-fibres do not have any sort of covering on them.
- (ii) **Corpuscles** (capsulated) - These are also made up of nerve-fibres but are not naked. They are surrounded by a covering of connective tissue.

* **On the basis of functions, cutaneous receptors are of the following types.**

1. **Algesireceptors** :- These are sensitive towards pain; and are found only in the form of naked nerve-fibres (Max. 40 lakh in man).
The type of receptors are maximum in number.
2. **Tangoreceptors** - These are sensitive towards touch. These are found in the form of both naked nerve-fibres and corpuscles. Many type of corpuscles sensitive to touch are found in the skin

- I **Meissener's Corpuscles** - These are found in the Dermal-papilla i.e, located in the outer part of Dermis. Their nerve-fibre is branched and is surrounded by a covering of connective tissue. These are more in number in the skin of lips, finger-tips, nipples.
 - II **genital-corpuscles** : Meissener's corpuscles which are present in the skin of external genital organs like clitoris and glans penis are termed as genital-corpuscles.
 - II. **Merkel's disc** - These are small cup like receptors. Their upper part extends in the epidermis and their basal part is present in the dermis. **(Absent in Rabbit)**
 - III. **Pacinian Corpuscles** - These are oval, button-shaped corpuscles. Their nerve-fibre is unbranched : and is surrounded by a sheath of flat-cells. These corpuscles are placed deep into the Dermis : and so they are sensitive to **pressure**. Because placed deeply, they can not receive the stimulation of external touch.
3. **Thermo receptors** :- These are found only in the form of corpuscles ; and are never found in the form of Naked nerve-fibres. These thermoreceptors are of 2 types.
 - I. **End Bulb of Krause** :- These are bulb-shaped corpuscles. These are sensitive to low-temperature. These are frigidoreceptors.
 - II. **End Organ of Ruffini** - These are long and spiral corpuscles. These are sensitive to high temperature. These are caloreceptors.
 4. **Vibroreceptors** :- In Rabbit, these are vibrissae or Whishers. These are sensitive to vibrations.

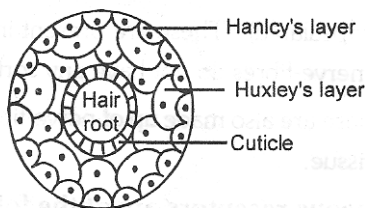
DERIVATIVES OF SKIN

Hair :- Ectodermal in origin. Study of hair is called TRICOLOGY. There are two part in the structure of hair :-

- (1) **Hair root** :- Invisible part of hair
- (2) **Hair shaft** :- Visible part of hairs

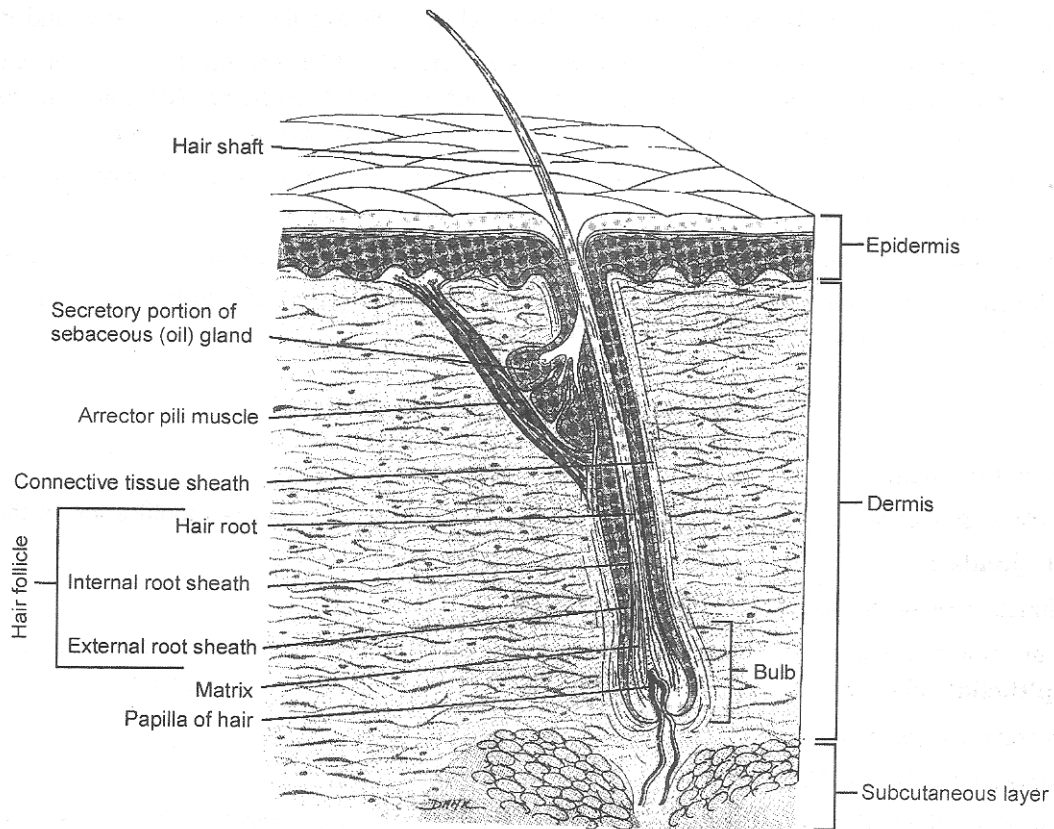
Hair Root :- Invisible part of hair embedded inside the skin.
Hair root is located in hair follicle

- (1) **Hair follicle** :- By the invagination of epidermis in dermis a tube like structure is formed called hair follicle in which hair root is present. In transverse section of hair follicle hair root is present in centre & outside of hair root, two types of coverings are present called as Root sheath. Outside this sheath, fibres of dermis densely arranged to form fibrous sheath which is called as **dermal hair sheath**.



T.S. of hair follicle

- (i) **Outer root sheath** :- It is composed of st. Spinosum like cell in which cells are inter connected by Desmosomes.
- (ii) **Inner root sheath** :- **Consist of three layers** :-
Hanley's layer :-composed of one layer of cells in which cells are cuboidal in shape nucleated & living cell.



Huxley's layers :- Consist one or two layers of flat cell which are nucleated & living

Cuticle :- Inner most layer just outside root. It is also present in hair shaft. It is composed of one layer of flat non nucleated & dead cell.

At the lateral surface of hair follicle two structures are attached

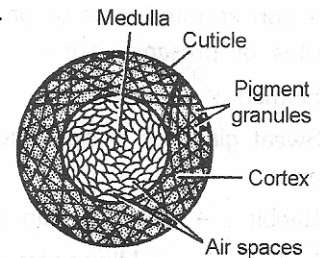
- (a) **Sebaceous gland** :- Simple branched alveolar gland, their secretion is called as SEBUM which is oily secretion which makes hairs & skin around hairs oily.
- (b) **Arrector pili muscles** :- These are involuntary muscles. When they contract hair comes in erect position. Erect position of hairs is called CUTIS ANSERINA. In this condition a shallow pit is formed in the skin around hair called as GOOSE FLESH.

- (2) **Hair papilla** :- At the base of hair root hair follicle evaginate to form cup like structure in which group of blood capillaries is present.

It is called as hair papilla which provide nutrients to the cells of germinal matrix.

Just upon hair papilla a group of germinative cells is present called as germinal matrix. These cells get their nutrients from hair papilla & divide to form cells in upward direction. When these cells shift outwards, by the process of cornification keratin protein is formed so, hair is dead keratinized and cylindrical structure which originates from hair bulb.

Hair Shaft :- Visible part of hair which is present outside of skin. In the structure of hair shaft 3 regions are present.



T.S. of Hair shaft

1. **Cuticle :-** Outermost, consist of one layer of cells in which cells are flat, non nucleated and dead.
2. **Cortex :-** Middle region, in this region elongated cells are present which are attached on their ends & form reticulum in cortex region. In these cells melanin pigment is present which provide colour to hair. In the absence of melanin, air is present which reflects complete light, so hair appear white in colour.
- (3) **Medulla :-** Central region in which keratinized cells are present. In these cells & in between cells of medulla. air filled spaces are present.
 - ☛ In human these spaces are large in size & less in number. This type of hairs are called hollow hairs.
 - ☛ In late foetal age of human, thick growth of hair is present on complete body. In these hair medulla region is completely absent, these are called **LANUGO HAIR**.

CUTANEOUS GLANDS

Ectodermal in origin.

Sweat gland & sebaceous glands are main cutaneous glands & rest glands are modification of these gland.

1. **Sweat glands :-**

Main function of sweat glands is **thermoregulation**.

These are coiled tubular in structure. Coiled part of this gland is called secretory unit, around secretory unit **myoepithelial** cells are present. When they contract sweat comes out from this gland.

This secretion is called as **sweat**.

In composition it is like dilute urine.

In sweat more than 99% is water & in rest part urea, acid, ammonium chloride & sodium chloride salts are present.

In sweat lysozyme is also present which destroy bacteria.

Smell in sweat due to presence of fatty substances.

Sweat glands are of two types :-

(a) **Ecrrine or merocrine :**

They secrete sweat by simple diffusion so their secretion is like watery liquid.

e.g. Maximum Sweat gland of human body

Maximum Sweat gland are found on Sole & palm

Sweat gland are Absent on lips, nipples, Glans penis and clitoris.

In Rabbit Sweat gland of this type are found on paws

mammals in which Sweat gland are absent

Dog

Shrew

Whale

} mammals in which Sweat gland are absent

(b) **Apocrine :**

In their secretion little part of cytoplasm of gland or part of gland itself is present so their secretion is concentrated. Due to presence of pigment, sweat of these gland is pale yellow in colour. Its common sites of presence are :-

Human : - armpits

Sweat gland of pubis region, skin around lips, nipples (areolar region : Areola mammae) skin around anus.

Rabbit : - On lips, skin around lips

- In Kangaroos, Hippopotamus and Monkey - Colour of sweat is red due to the presence of carotein pigments and strontium salts.

2. Sebaceous/Oil glands

- Simple branched alveolar in structure.
- Holocrine in nature (complete cytoplasm is destroyed).
- They are found in attached position with the lateral surface of hair follicle.
- In few body parts they are present in the absence of hair follicle, like lips, nipples, glans penis & clitoris.

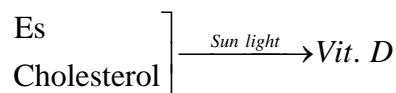
These glands are completely absent in sole & palm.

They are maximum on forehead & face.

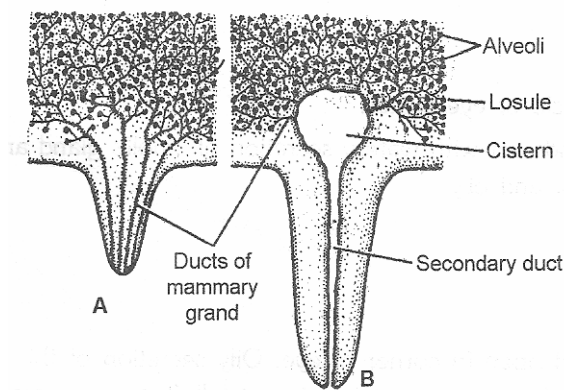
In whale and seal (aquatic mammals) sebaceous glands are completely absent.

Their secretion is called **Sebum**.

In composition of sebum, all fatty substances are present like **Ester, Cholesterol, Phospholipids and Triglycerides**.



- * Ester and cholesterol are converted into Vit. D in presence of sunlight.
 - * Vit. D also increase calcium absorption in intestine.
- ## 3. Mammary gland
- * In eutherians/mammary glands are modification of apocrine sweat glands so their secretion is concentrated.
 - * In Eutherians active mammary glands are found in females while in males they are present in inactive form.
 - * In prototherians mammary glands are modification of sebaceous glands, so their secretion is thick and sticky (semi-solid).
 - * In prototherians both male and female have active mammary glands. This condition is called **Gynaecomastism**.
 - * In Prototherians nipples are absent and sticky milk is collected in two shallow pits which are present on abdominal skin.
 - * Active mammary glands are **compound tubulo alveolar** in structure.
- Inactive mammary glands are **compound tubular** in structure.
- In prototherians active mammary glands are **compound tubular** in structure.
- Secretion → **Milk**



Composition of milk :-

Lactoalbumin

Lacto globulin

Lactose sugar

* Casein (phosphor protein)

Fats

Calcium

In milk IgA secretory antibody is present, Iron & Vit-C are absent in milk.

* Control of mammary glands :-

Alveolar growth → Progesterone

Tubular growth → Oestrogen

Ejection of milk → Oxytocin (milk let down hormone)

Synthesis of milk → Prolactin

4. Ceruminous glands

→ Modified sweat glands

→ Found in external auditory canal (meatus)

→ Secretory duct of this gland opens in hair follicle of auditory canal.

→ Watery secretion of ceruminous glands makes serumen or **ear wax** with the secretion of sebaceous glands attached with the hair follicle.

Function of Cerumen →

Prevent growth of bacteria

Prevent the entry of insects and dust particle auditory canal and protect ear drum.

5. Perineal glands

→ Modified apocrine sweat glands or sebaceous glands (for rabbit → sebaceous)

→ **They are found in rabbit & absent in human.**

→ They are found in the skin of external reproductive organs and skin around anus.

→ Their secretion is milky white in which specific smell is present. Due to smell in their secretion these glands are called as **Scent-glands**.

Function : Help in sexual attraction.

6. Moll's glands

They are modification of sweat glands so their secretion is watery liquid. These glands are found in eye lids of eye. Secretory duct of this gland opens in the hair follicle of eye lashes. Moll's gland act with zeis gland which is attached with the hair follicle of eye lashes. Secretion of both these glands makes eye lashes and skin around eye lashes moist & oily.

7. Zeis glands :-

Modified sebaceous glands.

Attached with the hair follicle of eye lashes.

Oily secretion of these glands act with watery secretion of moll's gland makes the skin around eye-lashes and aya-lashes moist and oily.

8. Meibomian glands :-

Modified sebaceous glands.

Found in eye lids of eye.

Secretory duct of this gland open in corner of eye. Oily secretion of this gland makes oily layer on the layer of tears on the conjunctiva of eye, so tears do not fall. Tears are essential for the protection of living cells of conjunctiva.

Fuction of Skin

1. **Protection :-**

Main function of skin.

Skin makes covering around entire body & prevent entry of foreign particles in body.

Skin makes 1st line of defence because -

- (a) Most of the cells of outermost layer of skin are dead.
- (b) Lysozyme is present in sweat which destroy bacteria.
- (c) pH of skin is highly acidic (3 - 5) so bacteria are unable to grow on skin.

2. **Respiration - Frog.**

Frog cannot live without cutaneous respiration. During hibernation frog respire only through skin. In skin of frog, mucous glands are present which makes skin moist. These glands are multicellular glands.

Mammalian skin does not help in respiration due to absence of mucous glands.

3. **Excretion :-** Urea, Uric acid, NH_4Cl .

4. **Absorption :-** Creams, oil

5. **Secretion :-** Cerumen

6. **Synthesis :-** Vit. D

7. **Storage of food :-** Fat

8. **Shape for body**

9. **Good receptor.**

10. **Locomotion :-** Eg. Earth worm

11. **Membranous bone formation.**

12. **Temperature regulation (Thermoregulation).**

Mammals in which well developed hypothalamus is present they can regulate their body temperature easily by the help of skin. In hypothalamus two centres are present :-

- (i) **Anti-rise centre**
- (ii) **Anti-drop centre.**

When body temperature increases, anti-rise centre of hypothalamus stimulates and dilate blood vessels in skin so cutaneous blood circulation increases. Due to more sweating and more vapourization of sweat heat loss occurs and body temperature becomes normal.

When body temperature decreases anti drop centre of hypothalamus stimulates and cause involuntary contractions in skeletal muscles called as shivering. Also skin perfusion falls due to vasoconstriction of cutaneous vessels.

In muscular contraction energy is released which is modified in heat energy and body temperature becomes normal.

Mammals in which hypothalamus is less developed their body temperature also decreased when atmospheric temperature decreases and they show hibernation (winter sleep).

During hibernation nutrition is provided from collected brown fat.

Eg. **Rat & Shrew**

In **Dog** due to absence of sweat glands, this animal regulates its body temperature by **panting mechanism** with the help of tongue.

COMPARATIVE STUDY OF INTEGUMENT OF RABBIT AND MAN

RABBIT	MAN
<p>1. Different parts of the body have different kinds of skin like, hard, moist, dry, smooth, wasty Etc.</p>	<p>Whole body is covered by, similar type of skin Except palm & sole where it is quite thick.</p>
<p>2. Whole skin is covered by fur</p>	<p>Absence of fur, skin is covered by different Morphological types of hairs.</p>
<p>3. Skin is having different kinds of colour like back, Black brown, white, brown etc.</p>	<p>Whole skin is having similar colours.</p>
<p>4. Skin is divided into two layers - (i) Epidermis (ii) Dermis. Epidermis is further Divided into five sub layers (a) Stratum malpighi (Germinativum) (b) St. Spinosum (c) St. Granulosum (d) St. Lucidium (e) St. Corneum</p>	<p>Skin is divided into two layers - (i) Epidermis & (ii) Dermis. Epidermis is further Divided into five sub layers as it is found in rabbit. (a) Stratum malpighi (Germinativum) (b) St. Spinosum (c) St. Granulosum (d) St. Lucidium (e) St. Corneum</p>
<p>5. Dermis is divided into two sub layers (i) Pars papillaris (ii) Pars reticularis</p>	<p>Dermis is divided into two sub layers (i) Pars papillaris (ii) Pars reticularis</p>
<p>6. Generally sweat glands are found on the complete Body but on the lips it is found maximum in Numbers.</p>	<p>Generally sweat glands are found on the complete Body are maximum in palm soles and arm pits.</p>