Histological Structure of Skin

Debajyoti Bhattacharya

The skin or *cutis* covers the entire outer surface of the body. Structurally, the skin consists of two layers which differ in function, histological appearance and their embryological origin. The outer layer or *epidermis* is formed by an epithelium and is of ectodermal origin. The underlying thicker layer, the *dermis*, consists of connective tissue and develops from the mesoderm. Beneath the two layers we find a subcutaneous layer of loose connective tissue, the *hypodermis* or *subcutis*, which binds the skin to underlying structures. Hair, nails and sweat and sebaceous glands are of epithelial origin and collectively called the *appendages of the skin*.

The skin and its appendages together are called the ***integumentary system***.

Epidermis

The epidermis is a *keratinised stratified squamous epithelium*. The main function of the epidermis is to protect the body from harmful influences from the environment and against fluid loss. Five structurally different layers can be identified:

1. **S*tratum basale***
   It is the deepest layer of the epidermis (closest to the dermis). It consists of a single layer of columnar or cuboidal cells which rest on the basement membrane. Basal cells are the stem cells of the epidermis. Their mitotic activity replenishes the cells in more superficial layers as these are eventually shed from the epidermis. The renewal of the human epidermis takes about 3 to 4 weeks.
2. **S*tratum spinosum***
   In this layer the cells become irregularly polygonal. The cells are often separated by narrow, translucent clefts. These clefts are spanned by spine-like cytoplasmatic extensions of the cells (hence the name of the layer and of its cells: *spinous cells*), which interconnect the cells of this layer. Spines of cells meet end-to-end or side-to-side and are attached to each other by desmosomes. In addition to the usual organelles of cells, EM shows membrane-bound *lamellar granules* in the cytoplasm of the spinous cells.
3. **S*tratum granulosum***
   This layer consists, in thick skin, of a few layers of flattened cells. Only one layer may be visible in thin skin. The cytoplasm of the cells contains numerous fine grains, *keratohyalin granules*. The keratohyalin is not located in membrane-bound organelles but forms "free" accumulations in the cytoplasm of the cells. The cells begin to release the contents of the lamellar granules. The lipids contained in the granules come to fill the entire interstitial space, which is important for the function of the epidermis as a barrier towards the external environment.
4. **S*tratum lucidum***
   This layer consists of several layers of flattened dead cells. Nuclei already begin to degenerate in the outer part of the stratum granulosum. In the stratum lucidum, faint nuclear outlines are visible in only a few of the cells. The stratum lucidum can usually

not be identified in thin skin.

3. ***Stratum corneum***
   In this layer cells are completely filled with keratin filaments (horny cells) which are embedded in a dense matrix of proteins. Individual cells are difficult to observe because (1) nuclei can no longer be identified, (2) the cells are very flat and (3) the space between the cells has been filled with lipids, which cement the cells together into a continuous membrane. In the EM, the cell membranes appear thickened and interdigitate with those of neighbouring cells. Closest to the surface of the epidermis, the stratum corneum has a somewhat looser appearance. Horny cells are constantly shed from this part of the stratum corneum.
   The protection of the body by the epidermis is essentially due to the functional features of the stratum corneum.

Other Cells of the Epidermis

The red and yellow hues of the skin are due to haemoglobin in the red blood cells, which pass through the capillaries beneath the epidermis, and carotene, which accumulates in fat cells found in the dermis and hypodermis.

Melanocytes

The brown colour component is due to *melanin*, which is produced in the skin itself in cells called melanocytes (typically 1000-2000 / sqr. mm). These cells are located in the epidermis and send fine processes between the other cells. In the melanocytes, the melanin is located in membrane-bound organelles called *melanosomes*. The cell bodies of melanocytes are difficult to distinguish in ordinary LM (light microscopy) preparations, because the melanosomes are located mainly in the processes of the cells. distinguish in ordinary LM preparations, because the melanosomes are located mainly in the processes of the cells.

Melanocytes can transfer melanin to keratinocytes - mainly to the basal cells. The fine processes of melanocytes may invade keratinocytes and bud-off part of the melanocyte cytoplasm, including the melanosomes, within the keratinocytes. Melanin protects the chromosomes of mitotically active basal cells against light-induced damage.

Pigmentation is not just under the control of light. Hormones produced by the pituitary and the adrenal glands also affect pigmentation. *Diseases of these two endocrine organs often result in changes of pigmentation of the skin*.

Langerhans Cells

These are another cell type found within the epidermis. Morphologically they are not unlike melanocytes, but functionally they are more closely related to macrophages. They are important in immune reactions of the epidermis. Their fine processes form a network between the cells of the epidermis and phagocytose antigens which have entered the epidermis. Langerhans cells may only be temporary residents of the skin. If they have come into contact with an antigen, they can migrate to regional lymph nodes, where they initiate an immune response.

Dermis

The dermis is the thick layer of connective tissue to which the epidermis is attached. Its deepest part continues into the subcutaneous tissue without a sharply defined boundary. Its thickness is for this reason difficult to determine but 1-2 mm is a good guestimate for "average" skin. The dermis may be divided into two sublayers (again without a sharp boundary):

- The ***papillary layer*** consists of loose, comparatively cell-rich connective tissue, which fills the hollows at the deep surface (*dermal papillae*) of the epidermis. Capillaries are frequent. Collagen fibres appear finer than in the reticular layer.
- The ***reticular layer*** appears denser and contains fewer cells. Thick collagen fibres (5-10 µm) often aggregate into bundles (up to 100 µm thick). The fibres form an interlacing network, although their predominant direction is parallel to the surface of the skin. A preferred orientation of the collagen fibres is not visible in the sections, but the main orientation of the fibres differs in skin from different parts of the body. Usually, their main orientation will follow the "*lines of greatest tension*" in the skin (Kraissl lines). This is of some surgical importance since incisions parallel to these lines will heal faster and with less formation of scar tissue.

Appendages of the Skin

Hair

A characteristic feature of the human skin is the apparent lack of hair (*pili*) on most of the body surface. This is actually not quite true. Most of the skin is haired although the hair in most areas is short, fine and only lightly pigmented. This type of hair is called *vellus hair*.

Truly hairless are only the palms of hands and soles of feet, the distal phalanges and sides of fingers and toes and parts of the external genitalia.

In those parts of the skin which we perceive as "hairy" we find *terminal hairs*. The free part of each hair is called the *shaft*. The root of each hair is anchored in a tubular invagination of the epidermis, the *hair follicle*, which extends down into the dermis and, usually, a short distance into the hypodermis. The deepest end of the hair follicle forms an enlargement, the *bulb*. Cells in the bulb are mitotically active. Their progeny differentiates into the cell types which form the hair and the cells that surround its root, the *root sheath*. Hair cells keratinise within the lower one-third of the hair follicle. Above this level it is not possible to identify individual cells within the hair. Each hair follicle has an associated bundle of smooth muscle, the *arrector pili muscle*. This muscle inserts with one end to the papillary layer of the dermis and with the other end to the dermal sheath of the hair follicle.

Hair growth is discontinuous. Hairs are lost and replaced by new ones. The hair follicle goes through different stages that reflect the discontinuous hair growth. *Anagen* is the phase of growth. The resting stage is called *telogen*. The length of the anagen is variable in different regions of the body - lasting only a few months for hair of the eyebrows and eyelashes but 2 to 5 years for hair of the scalp. Hair

growth is controlled by a number of hormonal and hereditary factors and their interactions.

Sebaceous Glands

Sebaceous glands empty their secretory product into the upper parts of the hair follicles. They are therefore found in parts of the skin where hair is present. The hair follicle and its associated sebaceous gland form a ***Pilosebaceous unit***.

Sebaceous glands are also found in some of the areas where no hair is present, for example, lips, oral surfaces of the cheeks and external genitalia.

Sebaceous glands are as a rule simple and branched (Remember the nomenclature of glands!). *The secretory portion consists of alveoli*. Basal cells in the outermost layer of the alveolus are flattened. Basal cells are mitotically active. Some of the new cells will replenish the pool of basal cells, while the remaining cells are displaced towards the centre of the alveolus as more cells are generated by the basal cells. The secretory cells will gradullay accumulate lipids and grow in size. Finally their nuclei disintegrate, and the cells rupture. The resulting secretory product of lipids and the constituents of the disintegrating cell is a *holocrine secretion*.

The lipid secretion of the sebaceous glands has no softening effect on the skin, and it has only very limited antibacterial and antifungoid activity. Its importance in humans is unclear. Clinically the sebaceous glands are important in that they are liable to infections (e.g. with the development of acne).

Sweat Glands

Two types of sweat glands are present in humans. They are distinguished by their secretory mechanism into *merocrine (~eccrine) sweat glands* and *apocrine sweat glands*. In addition, they differ in their detailed histological appearance and in the composition of the sweat they secrete.

Merocrine sweat glands are the only glands of the skin with a clearly defined biological function. They are of critical importance for the regulation of body temperature. The skin contains ~3,000,000 sweat gland which are found all over the body - with the exception of, once again, parts of the external genitalia.

- Sweat glands are *simple tubular glands*. The secretory tubulus and the initial part of the excretory duct are coiled into a roughly spherical ball at the border between the dermis and hypodermis.
- The secretory epithelium is cuboidal or low columnar. Two types of cells may be distinguished: a light type, which secretes the watery eccrine sweat, and a dark type, which may produce a mucin-like secretion. The cells have slightly different shapes and, as a result of the different shapes, the epithelium may appear pseudostratified.
- A layer of *myoepithelial cells* is found between the secretory cells of the epithelium and the basement membrane.
- The excretory duct has a stratified cuboidal epithelium (two layers of cells).

The excretory ducts of merocrine sweat glands empty directly onto the surface of the skin.

Apocrine sweat glands occur in, for example, the axilla. They are stimulated by sexual hormones and are not fully developed or functional before puberty. Apocrine sweat is a milky, proteinaceous and odourless secretion. The odour is a result of bacterial decomposition and is, at least in mammals other than humans, of importance for sexual attraction.

The histological structure of apocrine sweat glands is similar to that of merocrine sweat glands, but the lumen of the secretory tubulus is much larger and the secretory epithelium consists of only one major cell type, which looks cuboidal or low columnar. Apocrine sweat glands as such are also much larger than merocrine sweat glands.

The excretory duct of apocrine sweat glands does **not** open directly onto the surface of the skin. Instead, *the excretory duct empties the sweat into the upper part of the hair follicle*. Apocrine sweat glands are therefore part of the pilosebaceous unit.

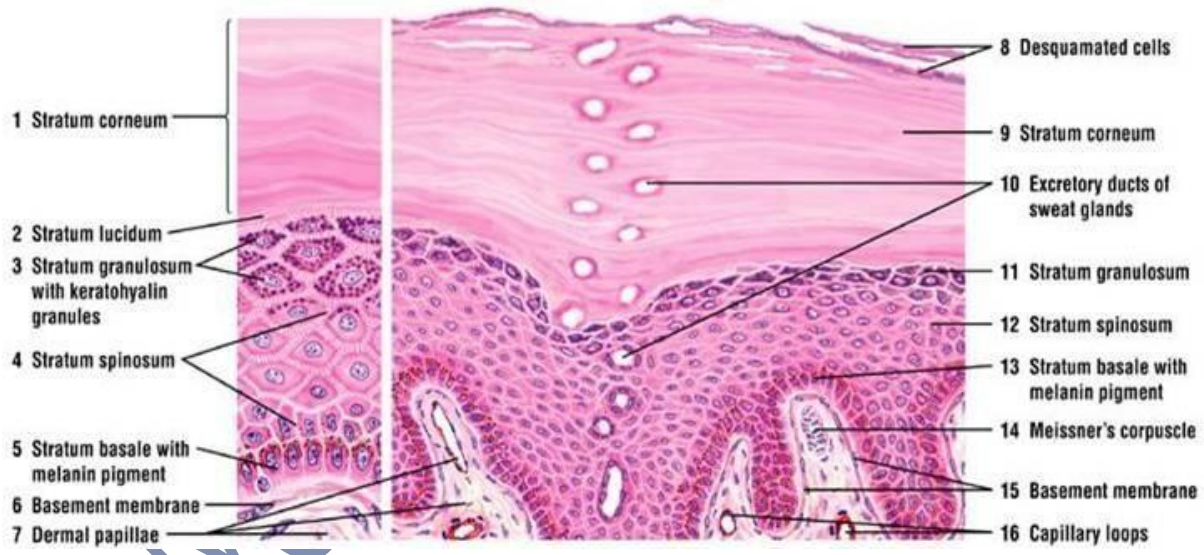

Diagram showing the different histological layers of skin