

Mike was rewriting the Hinkel text, but now unable. This is an unfinished chapter that might be useful.

Chapter II

Structure and Function of Skin & Hair

The life and death of the human hair is a tale of little interest to most people. But to the electrologist, who often plays a principal role in this microscopic drama, knowledge of the hair's life cycle is essential. This chapter explains the structure and function of the skin and hair, with special attention to those topics that concern electrologists and other hair removal experts.

General Theory

Skin is elastic, flexible and covers some fourteen square feet on the average person. Skin is thinnest on the lips and eyelids, and thickest on the palms and soles of the feet. Constant friction/pressure (e.g., from ill-fitting shoes) tend to increase the thickness of skin and toughen it. Cold contracts the skin; warmth relaxes the skin.



Functions of the Skin: Skin is the body's largest organ, and the main part of the *integumentary system*. Your integumentary system is your body's protective outer covering that comprises your skin, hair, nails and glands of the skin. These glands and structures are your first line of defense against microorganisms, and help protect you from injury and too much sunlight. *The following are key functions of the skin:*

- 1) **Temperature Regulation:** The skin helps maintain body temperature. To maintain the normal body temperatures of 98.6 Fahrenheit, the skin sweats by producing moisture through secretions of the sudoriferous (sweat) glands. The evaporation of this moisture cools the body.
- 2) **Absorption:** The skin is capable of absorbing tiny amounts of substances such as nitrogen and oxygen. The skin produces oily materials such as sebum (skin oil), and can absorb certain oily substances. Thus, trans-dermal medications (creams/patches) are absorbed through the skin.
- 3) **Elimination:** The skin can expel waste material such as uric acid, ammonia, urea, and excess water. These unwanted byproducts are released from the skin by the sweat glands (sweating).
- 4) **Protection:** The skin protects us and acts as a barrier against the outside world. Our skin shields us from injury, dehydration, sun damage and microorganisms (e.g., bacteria).
- 5) **Sensation:** The skin allows us to feel pain, pleasure, touch, pressure, and temperature (heat and cold). The skin is covered in sensory receptors (nerves) which relay these sensations to the brain.

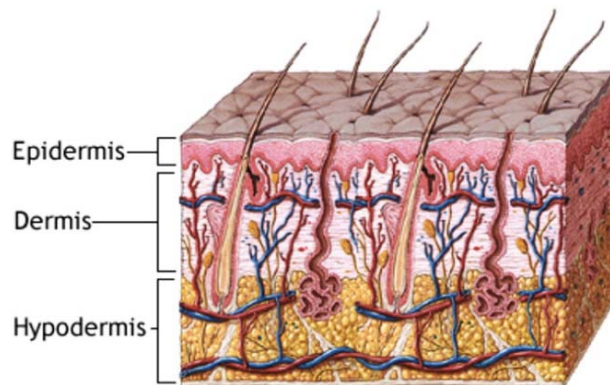
6) **Immunity:** The skin interacts with our immune system and helps destroy microorganisms and other foreign invaders. Specific immune cells in the skin, such as macrophages, help with infections. *Macrophages are cells that engulf and digest foreign material.*

7) **Endocrine:** The skin helps with vitamin D synthesis. When the skin is exposed to a proper amount of sunlight, special layers of the skin produce vitamin D3.

8) **Elasticity:** Skin has elastic and recoil properties in all of its layers. Thus, the skin can adapt to growth, movement and weight loss or gain.

9) **Sexual:** Although seldom mentioned, the skin has a sexual component. Beautiful, healthy and clear skin signifies health and vigor ... and heightens sexual attraction. Clients seek our help to maintain beautiful skin that enhances attractiveness.

The Skin: 3 Main Layers

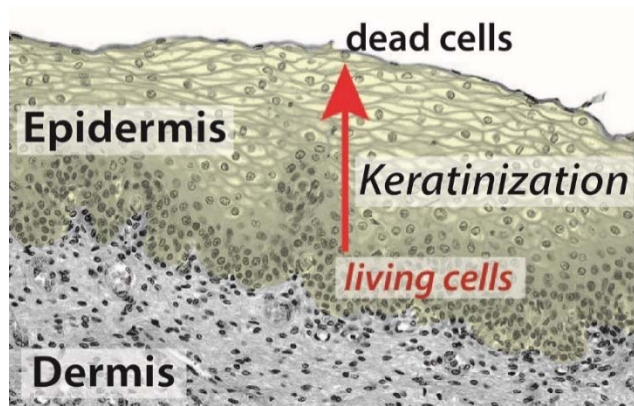


The skin is arranged in layers (stratification), and has three main layers (strata). The top layer of the skin is the **epidermis** (above the dermis), and is also called the cuticle or scarf skin.

The second layer is the **dermis**; also called the derma, cutis, corium or true skin. The deepest layer is the **hypodermis** (below the dermis). The hypodermis is also called the subcutis (under the cutis), the subdermis (under the dermis), and the subcutaneous layer. *All these terms are interchangeable!*

Note: As you can see, there are different terms that identify the same structure. This can be quite confusing, but try to remember all the terms because they are all in use. Presently, the terms most in use for the main layers of the skin are: **epidermis, dermis** and **hypodermis**.

Epidermis: 5 Layers



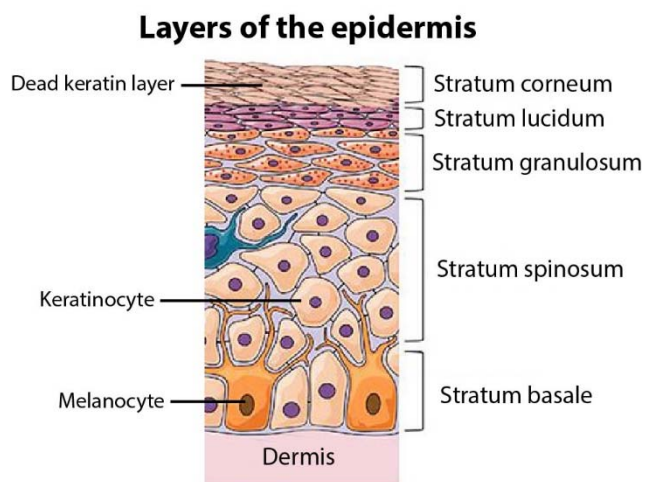
The epidermis is the skin's outermost layer that produces densely packed *dead cells* that protect the body. The epidermis lacks blood vessels and therefore depends on nutrients from the underlying blood vessels in the dermis. The epidermis has few nerve endings for touch and pain. Most sensations of the skin are from nerve endings in the dermis. Medical science classifies the epidermis as **keratinized stratified squamous epithelium**.

Keratinized (keratinization) is the biochemical process that produces keratin. Keratinocytes are special cells in the epidermis that produce keratin. Keratin is a structural fibrous protein. Keratin is the tough, dry and dense material making up scales, hair, nails, feathers, horns, claws, hooves, and the outer layer of human skin.

Stratified means the tissue is arranged in strata, or layers.

Squamous means the tissue is made up of flattened cells; like shingles on a roof. The term squamous is from Latin meaning “covered in scales.”

Epithelium is the membrane-type tissue composed of thin layers of cells. Epithelium is the covering of most internal and external surfaces of the body: the internal organs and our skin.



Stratum basale is a single layer of cube-shaped cells that form the bottom layer of the epidermis. The cells are attached to each other, like little bricks, and to the above stratum spinosum cells. The stratum basale is also called the basal layer, stratum germinativum, mucous layer, stratum mucosum, the stratum Malpighii and the Malpighian layer, named after the Italian biologist and physician **Marcello Malpighi** who discovered the basal layer (1628-1694).

The highly active cells of the basal layer produce all the other cells of the epidermis through the process of *mitosis* (cell division). The first cells produced by this layer are called **prickle cells**, and form at the juncture of the stratum spinosum. These cells become flattened and lose their moisture as they advance to the surface, thus becoming a part of each layer, until they finally slough off as the so-called “horny cells” of the stratum corneum. *Prickle cell is a cell with spiny processes that connect with similar processes of adjoining cells.*

Some cells of the stratum basale act like stem cells and have the ability to divide and produce not only skin cells, but also entirely new cells. These cells are sometimes called **basal keratinocyte stem cells**. Other types of cells found within the stratum basale are **melanocytes** (pigment-producing cells) and **Merkel cells** (touch receptors).

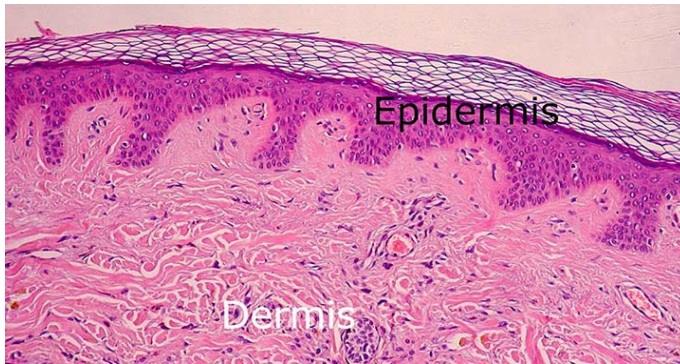
Stratum spinosum: The stratum spinosum, situated just above the stratum basale, is also called the prickly layer, the spinous layer and the prickle cell layer. It gets the name from the spiny microfilament projections that are found in this layer. The cells in this layer develop strong fibrous connections that serve as the underlying structural reinforcement that provides strength, elasticity and flexibility to the epidermis.

The stratum spinosum is thicker in those areas of the skin, such as the soles of the feet and palms of the hands, that experience more irritation from external surfaces. The thickening of this layer enhances its ability to provide strength and flexibility. The stratum spinosum is

composed of *keratinocytes* and other cells. Keratinization (the formation of keratin) begins in the stratum spinosum, although the actual keratinocytes are formed in the stratum basale.

Stratum granulosum: The stratum granulosum (granular layer) is similar in thickness to that of the stratum corneum, ranging in thickness from one to ten cells. *Keratinocytes* in the stratum granulosum are flatter and more irregular in shape than those in the stratum spinosum. The keratinocytes mature to the point where they are producing abundant keratin that will eventually fill the entire keratinocyte. As keratinocytes mature, they migrate upward to the top layer of the skin: the stratum corneum. The keratinocytes, in this granular layer, also release elements which play a role in creating a water barrier and help cell adhesion in the stratum corneum.

Stratum lucidum: The stratum lucidum is a thin, clear layer of cells named for its translucent appearance. (*Lucidum is Latin for clarity*). Located between the stratum granulosum and stratum corneum layers, it is composed of three to five layers of dead, flattened keratinocytes. The keratinocyte cells of the stratum lucidum do not have distinct borders and are filled with an intermediate form of keratin. The cells are surrounded by an oily substance that results from various cells discharging their products into the layer. Melanocytes (pigment cells) in the stratum basale determine the darkness and colorization of the stratum lucidum.



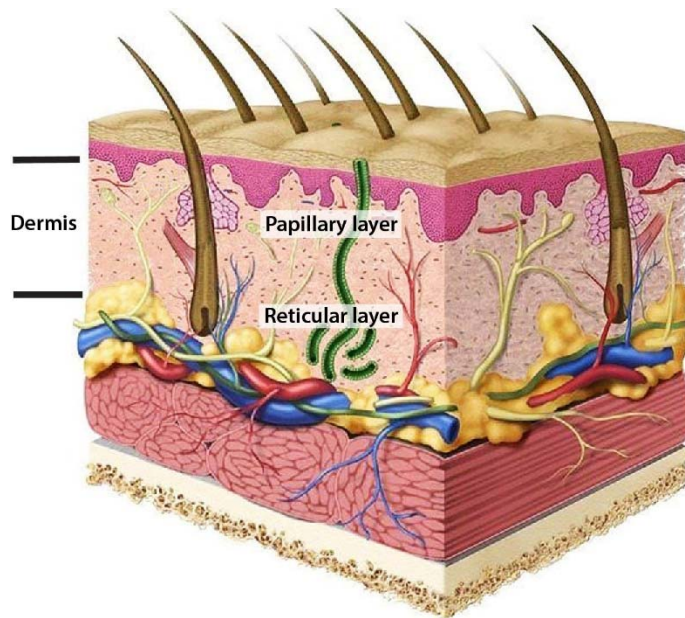
Stratum corneum: The stratum corneum is sometimes called the *horny layer* because the cells are tough like an animal's horns. Most areas of the stratum corneum are about 20 layers of cells thick. Your eyelids are thinner, while other layers such as your hands and heels are much thicker. The stratum corneum is mostly composed of keratin and *lipids*. *Lipids are a group of naturally-occurring*

molecules which includes fats, waxes, and fat-soluble vitamins.

The cells of the stratum corneum start life in the stratum basale. As the cells progress upward, layer-by-layer, they are gradually transformed into the stratum corneum. When keratinocytes enter the stratum corneum, they are changed into *corneocytes*. Corneocytes are basically dead keratinocytes that are like a brick wall mortared together by lipids ... that make the skin waterproof. *The term stratum corneum is named for the corneocytes.*

A healthy stratum corneum sheds approximately one layer of corneocytes each day. The corneocytes are then replaced by new keratinocytes from the underlying stratum granulosum. If everything is working properly in the stratum corneum, it defends you against dehydration, toxins and microorganisms (bacteria).

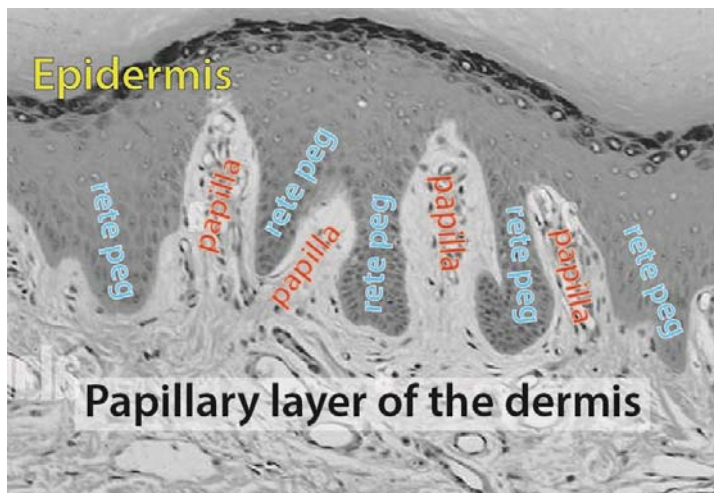
Dermis: 2 layers



The dermis is the skin's middle and thickest layer, and is often called the "true skin" because this layer contains all the essential elements for a healthy skin. The dermis is also called the derma, cutis and the corium. *Corium* is the Latin word for leather and skin. In fact, it's the corium (dermis) of animal skin that is processed into leather.

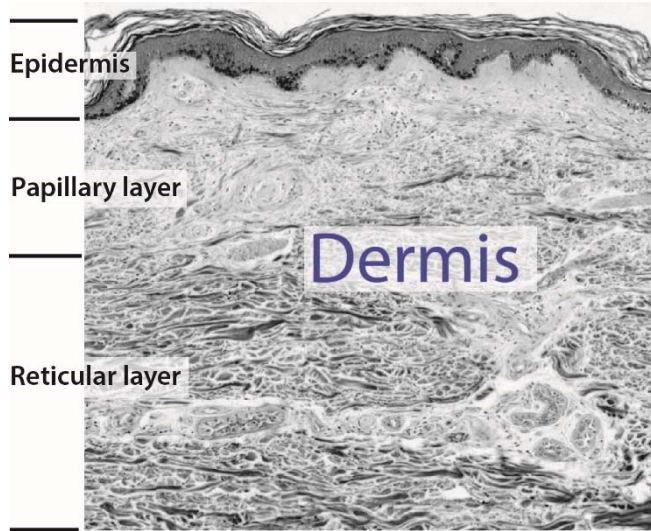
The dermis contains **collagen** and **elastin fibers**, which support the skin's overall structure. All of the skin's connective tissues, nerve endings, sweat glands, oil glands and hair follicles are located in the dermis. Together with the other layers of skin, the dermis protects

the skeletal system, organs, muscles and tissues from external harm ... both physical and chemical. The dermis consists of two layers, the **papillary layer** and the **reticular layer**.



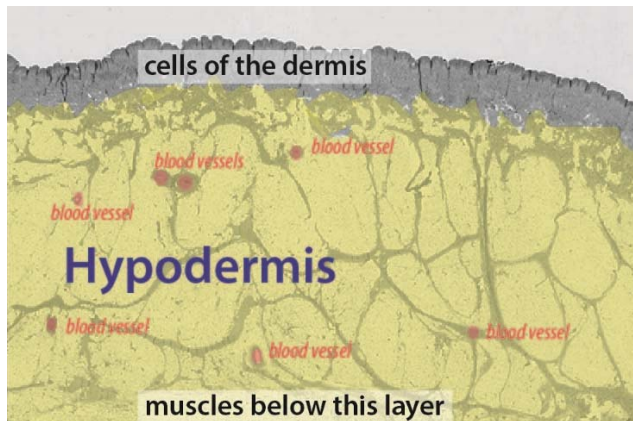
Papillary layer: The papillary layer, also called the **papillary dermis**, is the top layer of the dermis. It's much thinner than the lower reticular dermis. The term papillary is from the Latin word *papilla* meaning nipple. The entire dermis, and the papillary layer, contain fibroblast cells, connective-tissue fibers, and cells that fight bacteria. Notably the papillary layer contains nerve fibers, touch receptors ... and abundant blood vessels.

The papillary layer is named for the millions of blood-carrying papillae (nipples) that underly the epidermis. These nipple-like structures of the dermis extend up into the epidermis and contain capillary loops. Capillary loops are tiny bundles (loops) of capillaries. The capillary loops, located within the papilla, supply the bloodless epidermis with blood and all the necessary nutrients. The rete pegs (or ridges) of the epidermis likewise extend down into the dermis; thus, anchoring these layers together like interlocking fingers. The papilla and rete pegs create a much greater surface area. The increased surface area allows for better absorption of nutrients and the of expelling waste material.



Reticular layer: The reticular layer, also called the *reticular dermis*, is the bottom layer of the dermis. The term reticular is from the Latin word *reticulum* meaning a net. Indeed, the reticular dermis contains a dense net-like structure of elastin and collagen fibers. These fibers support your skin's overall structure, and allow the skin to move and stretch. The reticular layer contains blood vessels, sebaceous glands (oil glands) and sudoriferous glands (sweat glands). The reticular layer also houses large hair follicles, lymphatics, nerves and fat cells.

Hypodermis: 1 Layer



The hypodermis is the skin's bottom layer ... between the dermis and the muscle ... and comprises only one layer. This layer is known by many names, including: the subcutis (under the cutis), the subdermis (under the dermis), the subcutaneous fat layer and subQ (shorthand for subcutaneous). The hypodermis consists of connective tissues that attach the dermis to the muscles, and adipose (fat) tissue called SAT. **SAT** stands for "Subcutaneous Adipose Tissue."

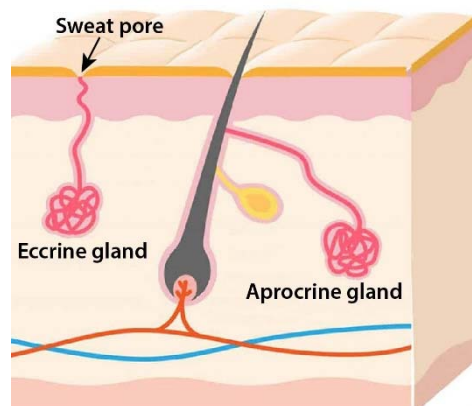
Depending on how much carotene (pigment)

is in your hypodermis, the SAT can be light to dark yellow. *The word adipose is from the Latin "adiposus" meaning fat. The word carotene is based on the Latin word for carrot*

Adipose tissue (body fat) is found throughout the body. Adipose tissue is found in the hypodermis, between the internal organs, and even in the inner cavities of bones. In the past, not much attention was given to the hypodermis. This layer was said to insulate the body, cushion the skin, contain blood vessels and lymphatics, and loose meshes of connective tissues.

Indeed, the hypodermis' subcutaneous adipose tissue (SAT) is primarily known for storing and releasing energy and providing insulation. However, scientists now recognize that SAT is also an active organ in your endocrine system. SAT contains nerve cells and blood vessels. SAT body fat communicates through hormone signals with other organs throughout the body. Hypodermis body fat performs several important functions in regulating metabolism and whole-body health. *Deep hair follicles sometimes extend into the hypodermis.*

Glands of the Skin



Once again, scientific literature uses different terms for the same structure ... and can make your reading confusing. The term *sudoriferous gland* is used as a general term for all sweat glands of the skin. The *eccrine glands* are sudoriferous glands that empty their sweat directly onto the skin. The eccrine glands are often called sudoriferous glands with no other reference. Eccrine glands are sometimes called merocrine glands. The *apocrine glands* are also sudoriferous glands. However, these glands empty sweat into large hair follicles located primarily in the underarms and groin areas. The apocrine glands are much larger than the eccrine glands. Both eccrine glands and apocrine glands are an important part of the integumentary system. *I'll explain these separately.*

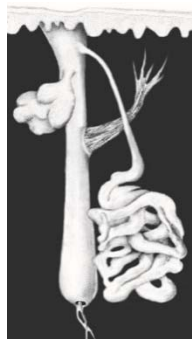


Eccrine glands: The eccrine glands are the most numerous sudoriferous (sweat) glands of the skin. Humans have some three million eccrine glands, and up to 3,000 per square inch in certain areas of the skin. These coiled tube-like glands are distributed throughout the skin in all parts of the body except the lips, nail beds, glans penis, glans clitoris, labia minora, and inner ear canal. Eccrine glands are most numerous on the palms of the hands and bottoms of the feet.

The bottom part of the gland secretes perspiration (sweat). The bottom part is coiled and lies deep in the dermis or hypodermis. From this coiled section a slender straight tube ascends through the dermis and epidermis to empty the perspiration directly onto the surface of the skin.

Perspiration is a transparent colorless acidic fluid with a distinct odor.

Perspiration consists mostly of water, but also contains minerals, lactate, and urea. Eccrine glands perform two functions: 1) They eliminate waste materials through perspiration, 2) They control body temperature by the evaporation of perspiration. We sweat about 0.8 to 1.4 liters every day, but this increases with high temperature and humidity, exercise, drugs, excitement, nausea, nervousness, pain or disease.



Apocrine glands: Apocrine glands are also sudoriferous glands and are concentrated in the underarms and groin areas and in other limited areas. These glands are attached to large hair follicles. They release a milky fluid that mixes with sweat and sebum (skin oil) in the hair pore and on the skin's surface.

Normal bacteria on the skin breaks down this mixture and produces our distinctive human odor. Removal of underarm hair by electrolysis or laser greatly diminishes, or eliminates, underarm odor. Hairs and follicle openings contain bacteria. Bacteria is necessary to act on the secretions of the apocrine glands to produce our human odor. Removing the hair removes most of the bacteria and therefore most of the underarm odor. *Your clients will love this!*