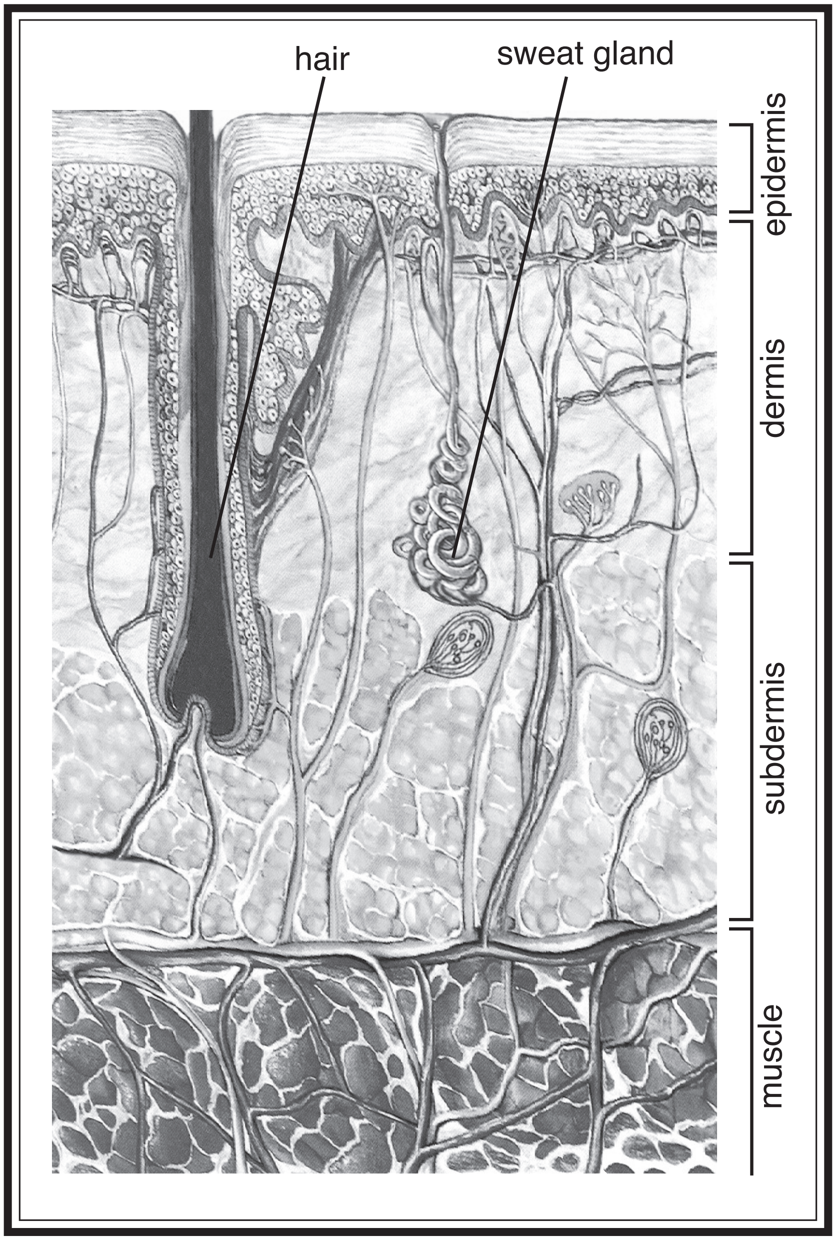
Secrets of Your Skin & Hair



by
Michael Bono

Preface ...

I've been in the business of hair removal (electrolysis) since 1975 and have seen countless fraudulent hair removal products come and go — many are still being used. Some of these are inexpensive little gadgets that don't work. Other methods involve elaborate devices that promise permanent hair removal; yet don't deliver either. Estimates say that people spend several billion dollars each year on hair removal — usually wasted on worthless procedures.

I have known too many ripped-off consumers that have spent hundreds, even thousands, of dollars on methods of hair removal that didn't work! I have met numerous consumers that tried legitimate permanent hair removal methods and, because of the operator's substandard technique, even that didn't work.

This booklet is intended to give you some idea of the "secrets of the skin" so that you can ask important questions when you decide on a hair removal technique. Use this booklet as a simple "guide" on the subject. Before you commit yourself to a technique or device, search the internet. Techniques and new devices are being introduced all the time.

The internet is your best source of information. Check the websites of national associations and the websites dedicated to providing consumer information and advice. A simple "google search" will bring up hundreds of sources. However, be diligent, not all of these websites are designed for information. Many are designed to lure you into buying worthless products or questionable therapies! ***Be an informed and inquisitive consumer!***

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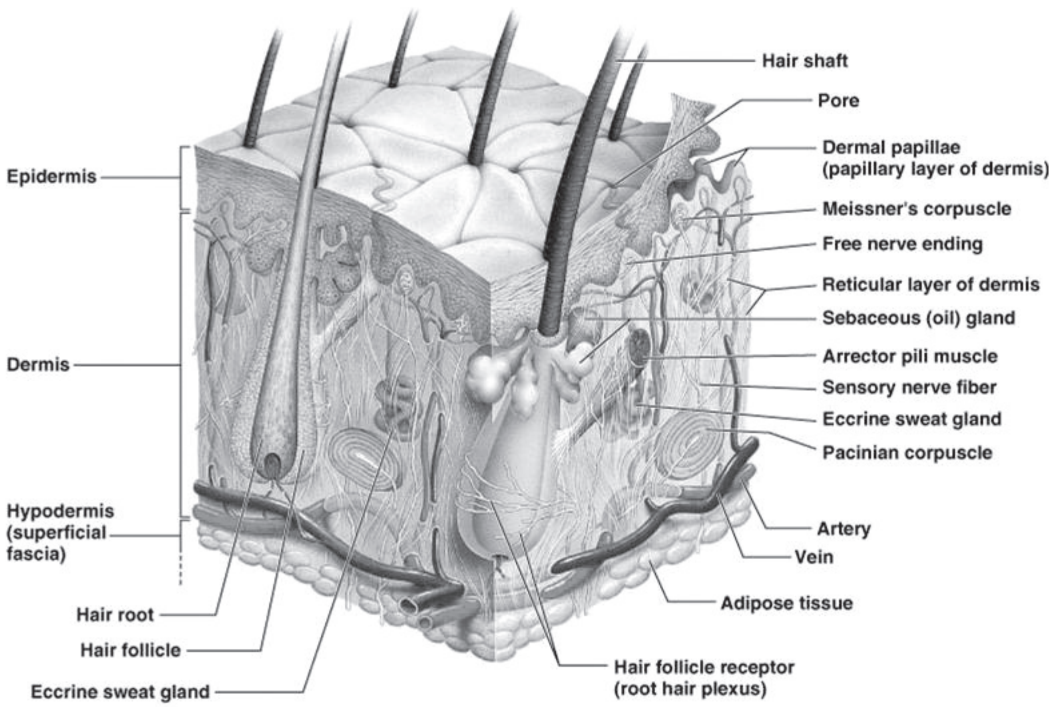
Hair shaft
Pore
Dermal papillae
(papillary layer of dermis)
Meissner's corpuscle
Free nerve ending
Reticular layer of dermis
Sebaceous (oil) gland
Arrector pili muscle
Sensory nerve fiber
Eccrine sweat gland
Pacinian corpuscle
Artery
Vein
Adipose tissue
Hair follicle receptor
(root hair plexus)
Epidermis
Dermis
Hypodermis
(superficial
fascia)
Hair root
Hair follicle
Eccrine sweat gland

Your Skin

The skin is one of the largest *organs* of the human body. The skin protects us from the outside environment and carries out biological functions essential for life. Although the skin has an amazing healing ability, it is vulnerable to outside agents such as heat, cold, light and chemicals. Before trying hair removal procedures that use such agents, you must consider that problems can result.

Don't blindly trust authorities. Certainly, science has provided us with many beneficial advancements. However, many procedures and medications once thought to be beneficial were later proven harmful. Remember the case of thalidomide (1957-1961), a "morning sickness" pill that caused more than 8,000 horribly deformed babies. Between 1940 and 1975, doctors prescribed the drug DES to millions of women to stop miscarriage. The drug was ineffective and, by 1972, shown to cause breast cancer. The drug later caused vaginal cancer in many of these women's female children. Consider the controversy and litigation regarding silicone breast implants — it may take decades to resolve this disturbing health issue.

Each year, hospitals infect more than 2,000,000 Americans with antibiotic-resistant bacteria. More Americans die from infections contracted while in the hospital than die from traffic accidents. As late as the 1940s, doctors recommended cigarettes to patients to "calm the nerves" and "stimulate digestion." Times have certainly changed that view! In the 1950s, doctors used X-ray to treat acne. For some patients, these treatments resulted in thyroid cancer. In 1997, the diet drug "fen-phen" was shown to damage the heart and was removed from the market. After years of trusted use, the laxative "Ex-Lax" was temporarily recalled (1997) because one of its ingredients was shown to cause colon cancer. And yes, until 1957, hair removal "experts" and doctors used X-ray for permanent hair removal. Years later, those women who had X-ray treatments developed assorted cancers. Sadly, it often takes years to show that a drug or procedure is unsafe. By then, numerous unsuspecting people have been injured.

The Human Cell

Our lives depend on countless individual cells performing complex operations at the molecular level. Altering the functions of even *one cell* can bring about disease. For example, those performing X-ray hair removal gave little thought about affecting the blood. Yet, X-ray caused genetic damage to white blood cells and caused leukemia in many patients.

An adult human is composed of about 60 trillion cells. Several thousand cells, such as those found in the skin, could easily fit inside this "o." More has been discovered about human cells since 1980 than in the preceding 350 years. Cells are far more complex and dynamic than earlier believed. For example, research shows that almost any human cell, if separated and put in a nutrient bath, takes on an independent life. The orphan cell moves around like a one-cell animal and displays a will of its own. If provided a healthy environment, some cells never die. Scientists say that cells have "eyes" (centrioles) and "brains" (centrosomes) that achieve a kind of consciousness. The cell moves, eats, breathes, "thinks," metabolizes and reproduces — the cell is life itself!

So many new structures have been discovered inside the human cell that the term "protoplasm" is now obsolete.[1] Biologists found that cells are packed with countless structures, each with a specific task. Cells are filled with endless "highways" that move molecules around by specialized "motor molecules." Cell membranes have complex receptor sites that allow only certain substances in and out. And of course, each cell in your body carries your complete genetic code in its DNA. In a sense, every individual cell in your body is a miniature model of you. Yet despite all these discoveries, or perhaps because of them, much of what happens at the cellular and molecular level of the body still remains a mystery.

Because the biology of cells is extremely complex, hair removal procedures must use proven technology and do minimal damage. The system should be like a "smart bomb" that targets the hair follicles only and has little effect on surrounding cells. Consumers must demand guaranteed safe hair removal methods that can never result in skin damage.

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1) Protoplasm: transparent "jellylike" substance that fills a cell. Earlier, researchers were unable to see all structures in the cell. The cell was said to be filled with "protoplasm."

The Human Skin

The skin is not just a pretty covering for the body, but is made up of billions of highly specialized cells that are critically important to our health. The following is a brief description of the cells, structures and functions that form our skin.

As an outer covering, the skin prevents the body from losing vital fluids. We would dry out and die in minutes without the skin. The skin barrier protects us from chemicals, microorganisms and impacts to the body — and it contains cells that make up our immune system.

Yet, the skin is not impenetrable. Certain natural and synthetic chemicals, such as solvents, are absorbed by the skin and enter the bloodstream. Some pharmaceuticals take advantage of this permeability to deliver drugs to the body through the skin. For example, stick-on patches can administer medications for seasickness and smoking control.

Nerves in the skin give us our only "touchable" contact with the outside world — every sensation from pleasure to pain. Human skin is more sensitive than the skin of any other animal (contains more nerve endings per square inch). Skin is also the main object of sexual attraction, which probably explains our obsession with keeping it beautiful and hairless. The skin's keen sensitivity plays a crucial role during sex.

Absorbing sunlight, the skin produces Vitamin D which is essential for human life. Likewise, only a few minutes of light per day initiate complex biochemical reactions in the skin that stimulate and regulate the endocrine (glandular) system. For example, sunlight helps regulate blood pressure and sex hormone production in both men and women. If a woman is deprived of sunlight for a long time, her hormone levels can become so low that she is less able to get pregnant.

The skin has three main subdivisions: the epidermis (upper skin), the dermis (the "true skin") and the subdermis (underlying skin). Although the skin functions as a unified whole, let's explore each layer separately.

Epidermis: Only about the thickness of a sheet of paper, the epidermis is the top layer of the skin.[2] Cells of the epidermis are packed tightly together and resemble kernels of corn on the cob. Glued together like a brick wall, epidermal cells prevent all but the smallest molecules from penetrating into the skin. The epidermis contains no blood or blood vessels,

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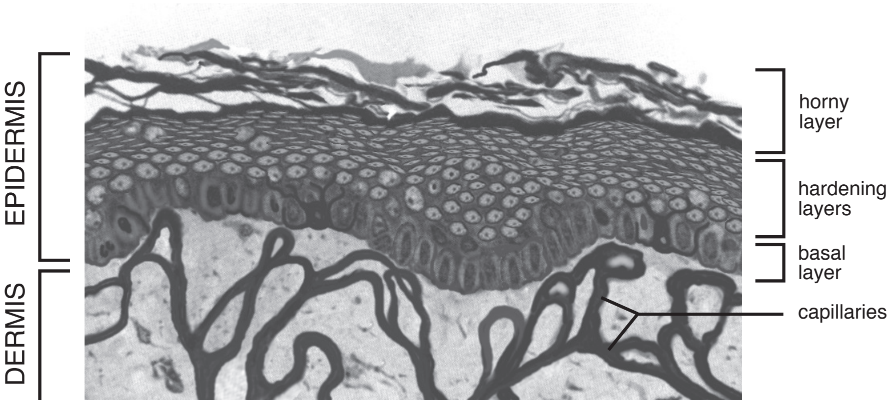
2) The epidermis is much thicker on the soles of the feet and palms of the hand. The epidermis and entire skin are thicker on the back of the body than on the front.

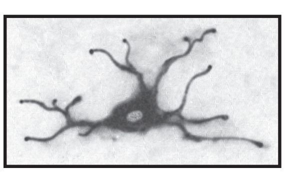
but is nourished by blood vessels (capillaries) of the underlying dermis. Countless nerve endings extend upward into the epidermis, helping to make our skin extremely sensitive.



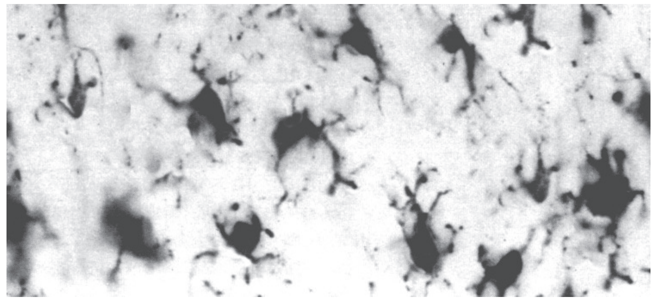
The epidermis is made up of several layers. The very bottom layer — called the basal layer — is only one cell thick and is the key growth layer. The basal layer is also called the germinative layer, because it "grows" the epidermis. The individual basal cells are sometimes called germ cells. The basal cells divide and move upward, forming various layers as they become increasingly harder and drier. Eventually, they form the stratum corneum layer or outer "horny layer." This outer layer of dead cells is only one-thousandth of a millimeter thick.

Along with the entire epidermis, the horny layer is our "thin line of life" against chemicals and microorganisms. Without this layer, we would be invaded by viruses and bacteria. Most burn patients that die actually succumb to bacterial infections due to the loss of this ultrathin skin barrier.

Every day, billions of dead cells are sloughed off (shed) from the horny layer, but are eventually replaced by the basal layer in a virtual frenzy of cellular growth. (We shed so many skin cells daily that as much as 50 percent of the dust in an average home is made up of dead skin.)

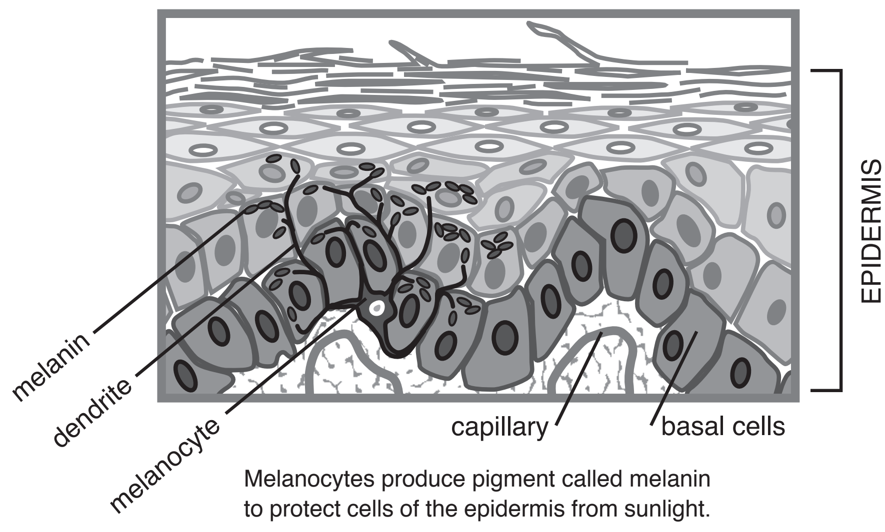

MELANOCYTE

Sandwiched between the epidermis and dermis are cells called melanocytes [Greek: *melas,* black + *kytos,* cell]. Melanocytes resemble black spiders. The cell bodies hang just below the epidermis. The dendrites (legs) extend upward and surround and encompass the cells of the epidermis. The ratio is about 1 melanocyte to 15 - 35 basal cells.



This photograph shows the spider-like melanocytes
as they appear from the underside of the epidermis.

When stimulated by sunlight, melanocytes produce pigment called melanin.[3] The pigment is pushed out the ends of the dendrites. The basal cells, and other epidermal cells, then "take up" the pigment into their own cell bodies. Once inside the epidermal cells, the melanin is positioned just above the nuclei — like tiny parasols. In this way, the pigment protects the cells' genetic material from excessive sunlight. This resulting darkening of the skin is, of course, a suntan.

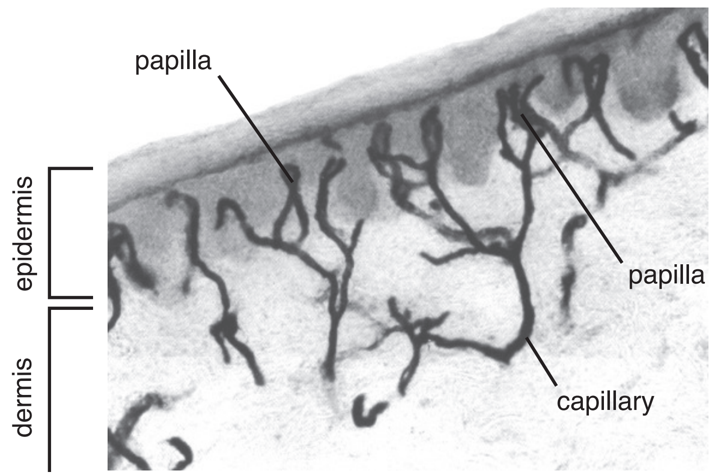


Melanocytes produce pigment called melanin
to protect cells of the epidermis from sunlight.

Dermis: Sometimes called the "true skin," the dermis underlies the epidermis and is much thicker: about three-eighths of an inch thick. Unlike the epidermis that consists entirely of cells, the dermis contains fewer cells and is mainly tough connective tissue. Indeed, leather is tanned animal dermis with the epidermis and subdermis (fat) layers removed.

3) Human skin color depends on the type and amount of melanin (pigment) produced. Dark-skinned people produce eumelanin (black-brown pigment); fair-skinned people make pheomelanin (yellow-red).

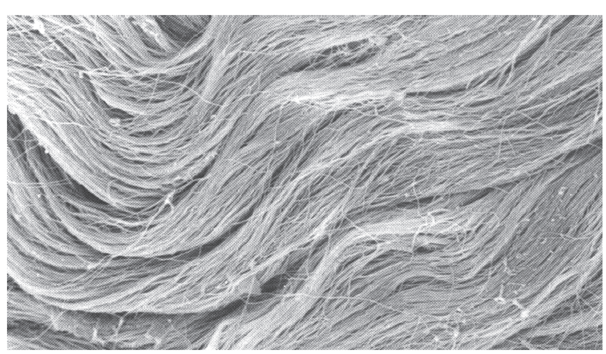
The dermis has a vast network of blood vessels. From these vessels, capillaries loop upward and nourish the epidermis. These tiny capillaries are housed in nipple-like structures called papillae (singular: papilla). Blood in the dermis also regulates body temperature. In a hot environment, blood rushes into the dermis; sweat forms and evaporates. This evaporation cools the skin and blood, and lowers body temperature. In a cold environment, the blood moves out of the dermis and into the internal organs to protect them from the cold.

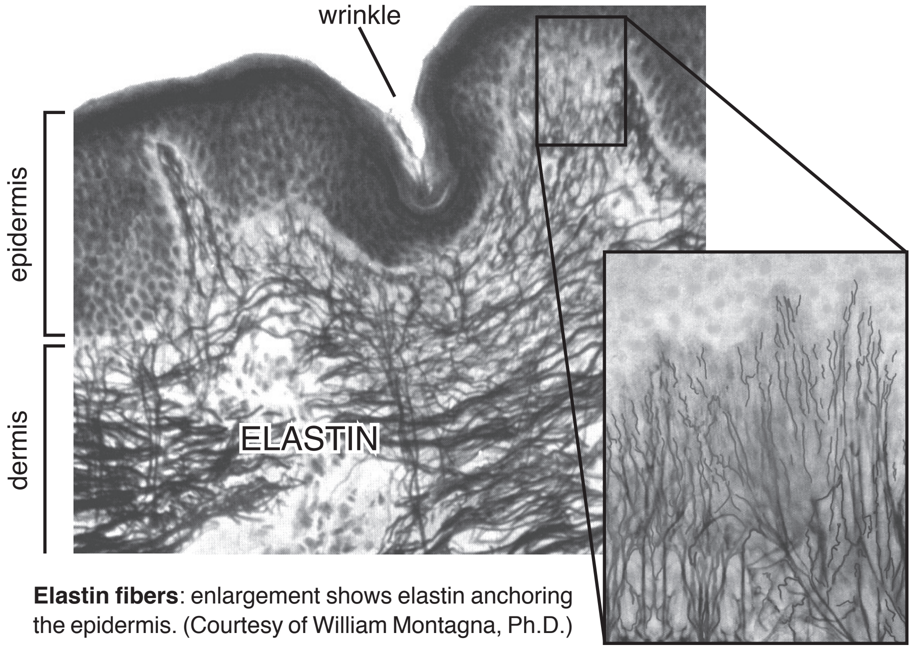


Dermis and epidermis: Notice the different layers of the epidermis. See the blood vessels of the dermis that nourish the epidermis. (Photo courtesy of William Montagna, Ph.D.)

Collagen is the main connective tissue of the dermis. Made of elongated protein molecules, collagen fibers twist and form long, rope-like structures. In this way, collagen makes the skin tough yet pliable. So-called elastin fibers are intertwined with the collagen. More like rubber bands, elastin gives the skin even greater flexibility. Elastin fibers also anchor and hold in place skin structures such as glands, hair follicles and even the epidermis. The spaces between the collagen and elastin are filled with a gel-like material called ground substance.

Collagen makes the skin tough. It is made up of large, stiff, elongated, rod-shaped protein molecules that overlap each other and form long, spiraling, fibrous strands.





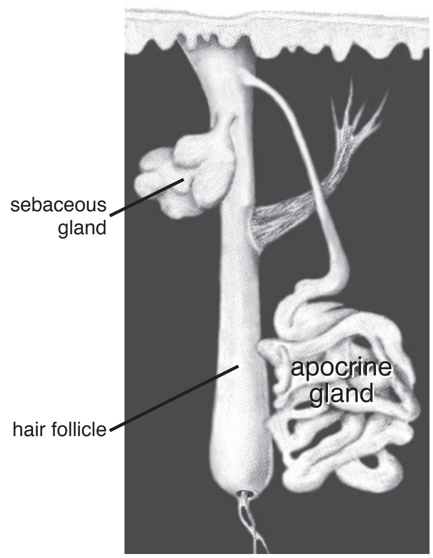
Elastin fibers: enlargement shows elastin anchoring the epidermis. (Courtesy of William Montagna, Ph.D.)

There are about 3 million eccrine (sweat) glands in the dermis. Each gland is a simple coiled tube that forms a corkscrew duct and a "pore" opening through the epidermis to the skin's surface. Each eccrine gland weighs only about 0.000013 grams, but it secretes more than 1,000 times its own weight in sweat daily. No other gland in the body comes close to such a heroic accomplishment. We sweat constantly — at least one liter of water per day without visibly sweating.

ECCRINE GLAND

Sweating (perspiring) regulates body temperature by dissipating 580 calories of body heat for every gram of sweat evaporated. Sweating also eliminates toxins (poisons) from the body. Sweating is often the final step in the body's elimination process of harmful substances. Such toxins include: medications, illegal drugs, environmental pollutants, pesticide residues on foods, unhealthy chemicals naturally found in foods and the body's own harmful by-products of metabolism. If you lose the ability to sweat, you will die because your body must maintain the correct temperature and eliminate toxins.

“Human odor”-producing apocrine glands are found concentrated in the underarm and groin areas, and elsewhere in limited numbers (ear canals and scalp). These glands are attached to large hair follicles and release a milky fluid that mixes with sweat in the hair canals and on the skin’s surface. Normal bacteria on the skin break down this mixture and create our own personal and distinctive “fragrance.” These odor-producing glands probably served a purpose millions of years ago when we identified each other by scent. Today, they largely aid the deodorant manufacturers who produce endless cosmetic products to cover up our “rightful heritage.”



APOCRINE GLAND

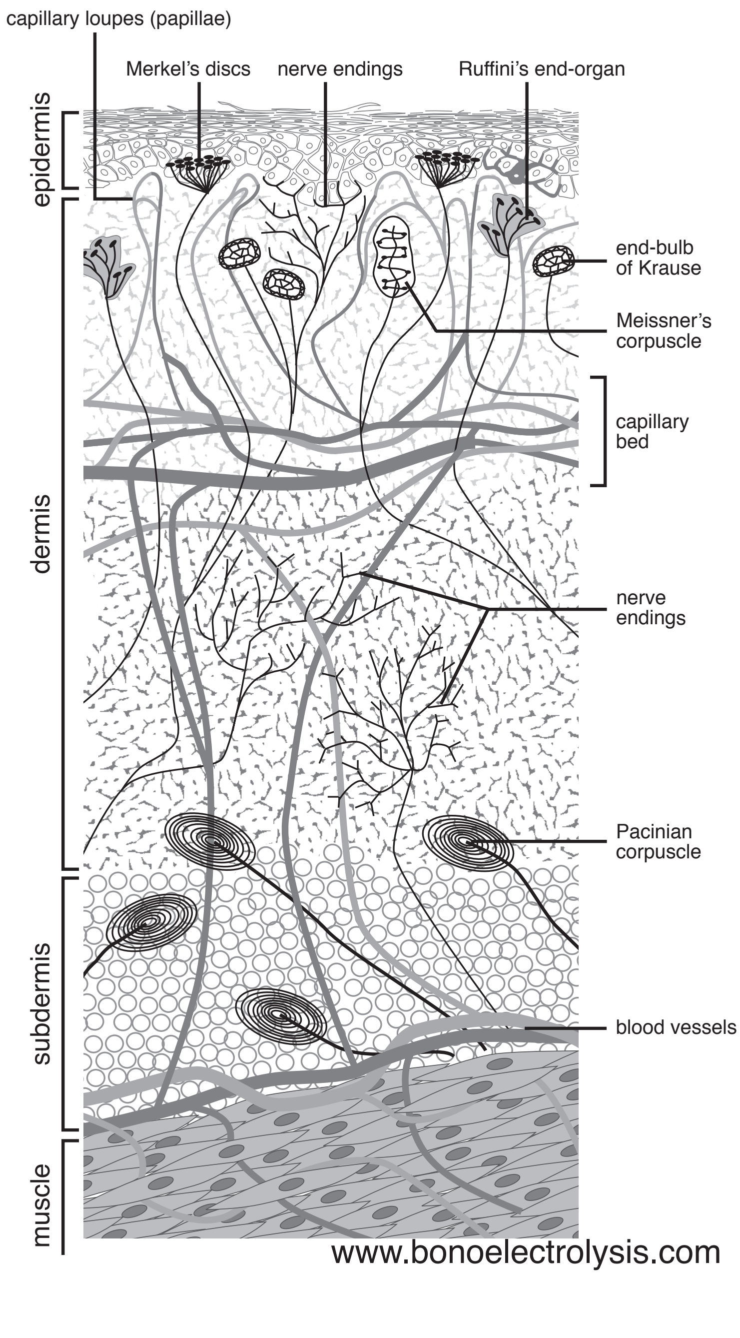
The dermis has more than 5 million oil glands called sebaceous [Latin: oily] glands. Sebaceous glands excrete sebum, a light oily substance. Most sebaceous glands are attached to the upper part of hair follicles (both large and microscopic hairs). Except for the palms and bottoms of the feet, these oil glands cover the entire body. Such areas as the scalp, neck, forehead, shoulders and anogenital areas have many sebaceous glands.

SEBACEOUS GLAND

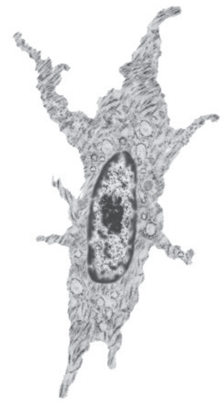
Scientists do not fully understand the biological purpose of sebum. However, sebum lubricates the skin and probably helps deter skin dehydration. This light oil also acts as a chemical agent against microorganisms (fungi, viruses and bacteria). Sebum, along with tears, lubricates the eyes and gives luster to the hair on our heads. Sebum (and apocrine discharge) is also thought to act as a pheromone: a distinct human scent that communicates sexual maturity. Overactive sebaceous glands produce blackheads and, in severe cases, acne.

The dermis contains billions of specialized nerve structures that detect heat, cold, touch and pressure. These diverse nerve impulses interact and give us elaborate sensations. The skin detects everything from pleasure to pain and gives us our only "touchable" contact with the outside world. Any loss of skin sensitivity can be disastrous to your health. For example, working with lepers in Africa, Dr. Albert Schweitzer discovered that patients did not lose fingers and toes because of the disease itself. Instead, leprosy destroys the skin's ability to feel. Not feeling pain, these patients severely injured their fingers and toes. Acute infection occurred and finally the appendages just fell off.

NERVES OF THE SKIN



Fibroblasts are the most numerous cells in the dermis. These spindle-shaped cells make and maintain collagen, elastin and ground substance. Fibroblasts are highly active in wound healing: they "knit" wounds together with collagen fibers. Scars are dense collagen masses that appear whiter because they have fewer blood vessels than the surrounding skin. Cousins of the fibroblasts, the myofibroblasts attach themselves in the wound and pull the skin together to close the wound gap.

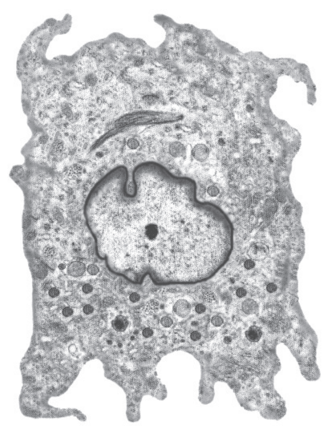


FIBROBLAST

Assembled alongside blood vessels in the dermis, so-called mast cells are virtual chemical storehouses. These large, egg-shaped cells contain various chemicals housed in round structures within the cells. Such chemicals include heparin (an anticoagulant), and histamine and prostaglandin (substances that act on blood vessels). When the skin is injured, mast cells break apart and release their chemicals into the skin. This action causes inflammation and starts the entire wound-healing process. Inflammation activates the immune system so that any invading microorganisms are destroyed. These chemicals also stimulate the fibroblasts to "mend" the damaged skin, and signal the epidermis to rapidly grow over the wound site (a process called epithelization).

MAST CELL

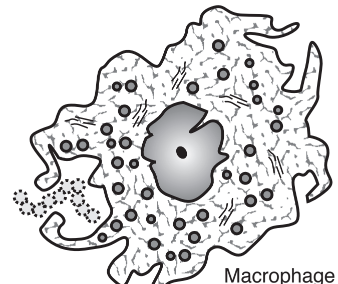
Macrophages are found throughout the body, and are plentiful in the dermis. If you've seen the movie *The Blob,* you have a good idea of how macrophages operate. Macrophages [Greek: *macro,* large + *phagein,* to eat] are truly large eating cells. Similar to amoebas, macrophages roam around the dermis by stretching their bodies and pulling themselves along. They change shape and slither into tiny spaces to seek out their prey: unwelcome material such as bacteria and defunct cells. Once detected, the macrophage surrounds its victim and digests it with proteolytic



MACROPHAGE

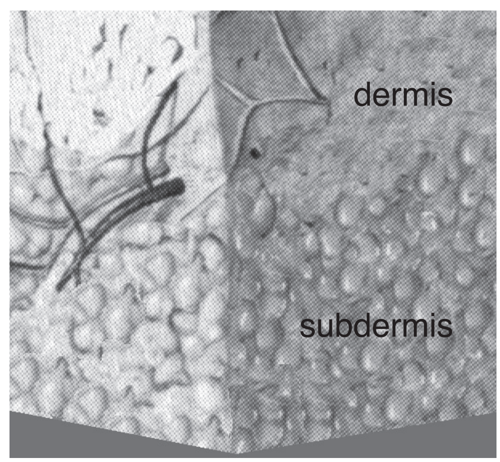
(protein dissolving) enzymes located within its cell body.

Macrophages continuously devour worn-out collagen and elastin and feed the discharged remains to the fibroblasts that reconstruct new collagen and elastin. Macrophages consume 100 billion defunct red blood cells every day. They seek out and destroy dysfunctional cells such as cancer cells, and are our first line of defense against all types of infections. In wound healing, they "eat" dead tissue, foreign particles and harmful microorganisms. Indeed, macrophages are formidable predators — and our greatest defenders!



Subdermis: The subdermis is a layer of fat that underlies the dermis. The subdermis is also called the subcutaneous layer and the hypodermis. The subdermis has far fewer blood vessels than the dermis. Consisting of globular cells that store fat, the subdermis is pale yellow in color and has the consistency of butter.

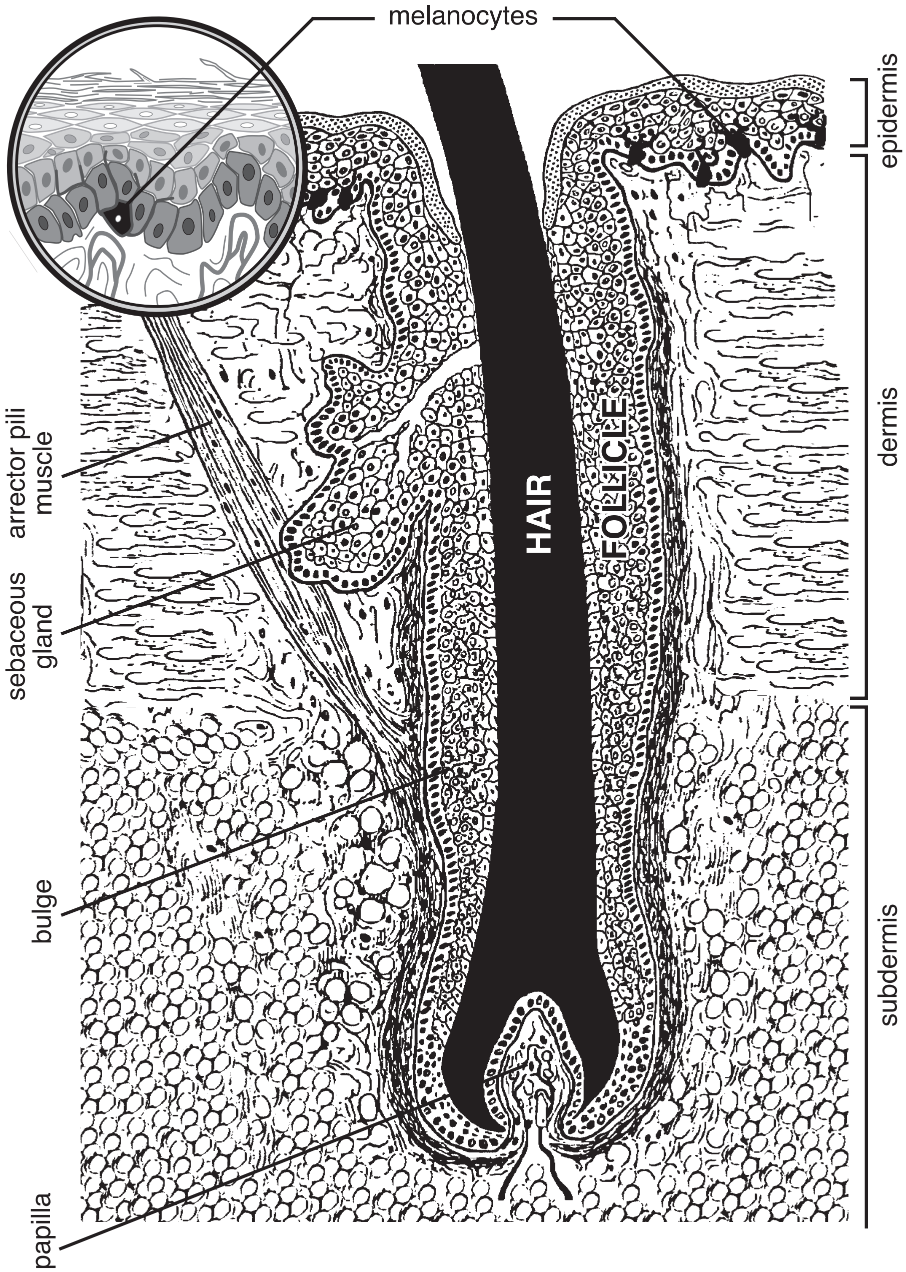
The subdermis gives shape and padding to the body and protects the underlying muscle from impacts. It is also a storehouse of triglycerides (fatty acids) that the body uses for emergency fuel. You are born with a set amount of fat cells that get larger or smaller depending on how many calories you consume and burn. A lumpy subdermis is sometimes called *cellulite* [French], an erroneous term for "trapped deposits of fat and toxins."



THE SUBDERMIS

Conclusion: The purpose of this chapter was to point out some of the important structures and functions of your skin. You must not allow any hair removal method, temporary or permanent, to interfere with or damage these functions.

The Human Hair



Your Hair

Hair. We love it in the "right" places; we hate it in the "wrong" places. We spend "zillions" of dollars annually to correct our hair problems. We shave, tweeze, dye, curl, straighten, style, and otherwise torture our hair. Indeed, every culture has its own myths about "good" and "bad" hair — and has special ways to make it conform to the accepted standard.

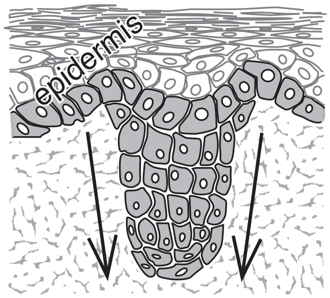
Our obsession with hair is not a modern phenomenon. Archeologists have found flint razors, shell tweezers and fish bone combs in prehistoric villages, including those of Neanderthals. Native Americans and ancient Hawaiians idolized hair and thought it possessed a person's spirit. They braided it into elaborate adornments worn by kings and queens.

Even today, hair on every part of the body — from head to toe — communicates social messages about age, strength, virility, fertility and sexuality. At an almost unconscious level, we understand these signals but seldom analyze our feelings about hair. Our feelings can be intense, irrational and cause great psychological distress. A balding person, a woman with a mustache or a man with a hairy back often experiences deep psychological trauma. Yet, for all our emotions about hair, for all the wealth we spend on hair, most of us know very little about these curious appendages of the skin.

Hairs develop — about 5 million of them — during the third to fourth month of pregnancy and cover the fetus evenly. Because the fetus's head is huge and the body tiny, we end up with more hair concentrated on our head (as the body grows, hairs get separated). These fluffy hairs are called lanugo [Latin: downy] hairs and are shed at the time of birth; then quickly replaced. Excessive lanugo hair, seen after delivery, is not a concern; it falls out within a few days. *Surprisingly, all of us are born with a predetermined amount of hair that we will have for life. We cannot develop new hair follicles!*

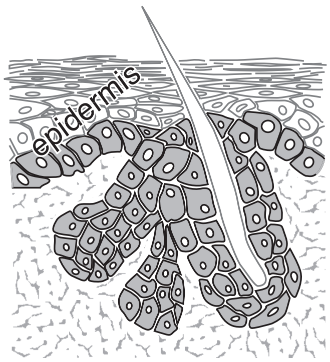
HUMAN FETUS

A hair itself is made of hard protein called keratin — the same substance that makes up fingernails. The structure that grows a hair is called a follicle. In the fetus, follicles develop from the epidermis. A tiny knot of basal cells forms and pushes down into the dermis to form pilosebaceous units [from Latin: *pilus,* hair + *sebaceous,* oily].



HAIR DEVELOPS

All hairs on the body grow out of pilosebaceous units. Each so-called "PSU" consists of a hair, follicle and sebaceous gland. Although PSUs extend into the dermis, and even into the subdermis, they remain part of the epidermis.

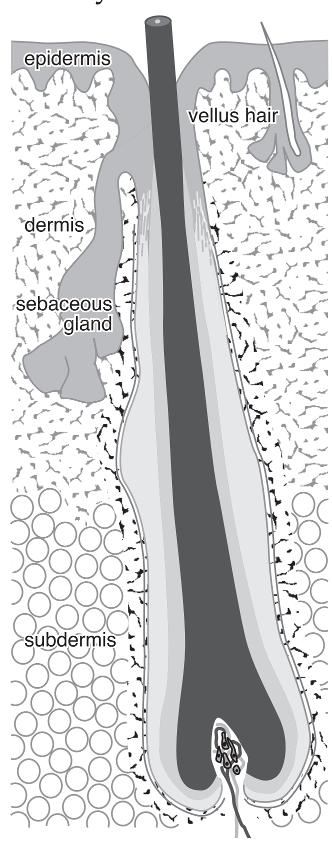


VELLUS HAIR

After lanugo hairs fall out, they are quickly replaced by two types of hairs: vellus [Latin: fleece] and terminal [Latin: the end]. Vellus hairs are colorless, nearly microscopic and cover most of the body, e.g., the "peach fuzz" seen on the face. Vellus pilosebaceous units extend into the dermis only. Terminal hairs are longer and pigmented; their follicles often extend well into the subdermis. Terminal hairs grow in such areas as the legs, beard and underarms.

Except for terminal hairs on the scalp and eyebrows, children have mostly vellus hairs — but not for long. Indeed, hairs go through an incredible lifetime journey of continual metamorphosis. *Every hair on the body* changes with each phase of life — and it's all about hormones!

Hormones [Greek: *hormon,* to set in motion] are natural chemicals made by certain tissues and endocrine glands such as the pituitary, thyroid and adrenal glands. Endocrine glands are internal-secreting: they release hormones directly into the bloodstream. Specific "target organs" take up these



TERMINAL HAIR

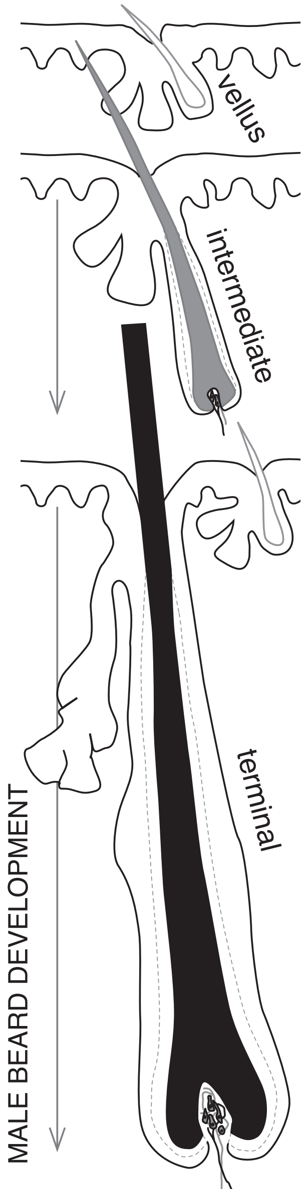
chemicals from the blood and react. Generally, the reaction is delayed and causes long-lasting changes. The reaction can also be immediate. For example, adrenaline, made by the adrenal glands, causes a "fight or flight" reaction — our heart rate increases, muscles tense, we sweat and become anxious.

The body produces at least 29 different hormones. These chemicals regulate body functions such as growth, blood pressure, blood sugar levels and even emotions. So-called sex hormones regulate our reproductive systems and give us male or female attributes. Male sex hormones are called androgens; female sex hormones are called estrogens. The testicles, ovaries and adrenal glands produce these hormones. *The skin is the largest sex hormone target organ in the body.* The reaction of sex hormones in the skin causes astonishing changes in hairs.

Hair is classified into three hormonal types: 1) Asexual hair is present at birth and is influenced by changes in growth hormone (HGH) production. Such hairs include scalp hair, eyebrows and eyelashes. 2) Ambisexual hair develops in both males and females at puberty and is caused by increased adrenal and androgen hormone production. These hairs populate the pubic area, underarms, arms, legs and abdomen. 3) Sexual hair includes facial hair (beards on men) and most body hair (chest and back). Although biologists have established these three categories, hormonal influence is complicated and not always predictable. Hairs are probably influenced by many hormones. Furthermore, this hormone sensitivity often changes with each phase of life.

Childbirth reveals the hormone-dependency of hairs. While in the womb, the baby receives hormones from its mother. These "in utero" hormones stimulate the pilosebaceous units and cause luxurious lanugo hair growth and plentiful excretion of sebum (a thick coating of sebum covers the newborn). Childbirth shuts off mother's hormones. Because of this deprivation, the pilosebaceous units go into "shock" and the lanugo hairs fall out. As we develop, however, our own endocrine system provides hormones to both sustain and transform hair growth.

Androgen hormones are primarily responsible for the great physical changes we see in hairs. Androgens are "male hormones," but women produce them too — although in lesser amounts. Certain hairs respond dramatically to androgen activity in the skin and go from tiny vellus hairs to gigantic terminal hairs. For example, consider the spectacular genesis of

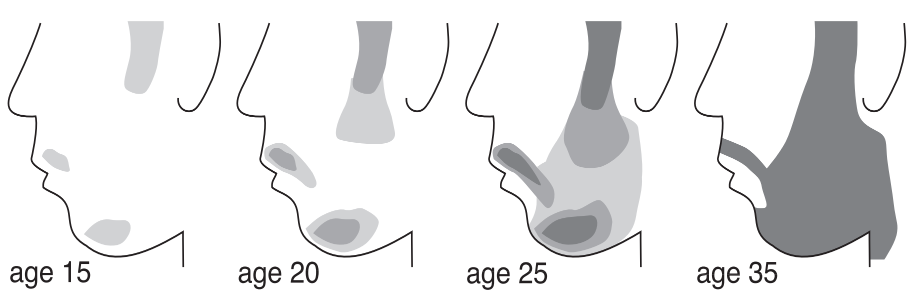


the male beard. Even though both men and women have the same amount of facial vellus hair, men develop beards because of their abundant androgens (such as testosterone). At ages 12 - 14, puberty begins and sex hormones dramatically change the body. Vellus hairs on the chin, sideburns and upper lip darken and grow longer: they become "intermediate hairs." Relentless androgen activity causes facial hair to progressively advance in size, density and range of pattern. In time, intermediate hairs develop into terminal hairs (they achieve their final growth potential). At last, by ages 30 - 35, the full beard has developed (see drawing below).

Notice that the beard takes years to develop and, once established, is confined to a very distinct boundary. You don't, for example, see the beard encroaching onto the nose or ears. This specificity is not limited to beard hairs. *Every follicle on the body is like a tiny computer that has been individually programmed to react uniquely and independently to hormones in the skin.* Identically programmed "hair computers" (follicles) populate each region of the body, and so we have distinct beards, head hair, eyebrows, eyelashes, leg hair, underarm hair, pubic hair, chest and back hair — and so on.

Most hairs on the body start out as vellus hairs but then go through a lifetime of predetermined change. Consider the changes that the hair on our heads undergoes. At birth it is short, sparse, light colored and fine in texture. Preadolescent

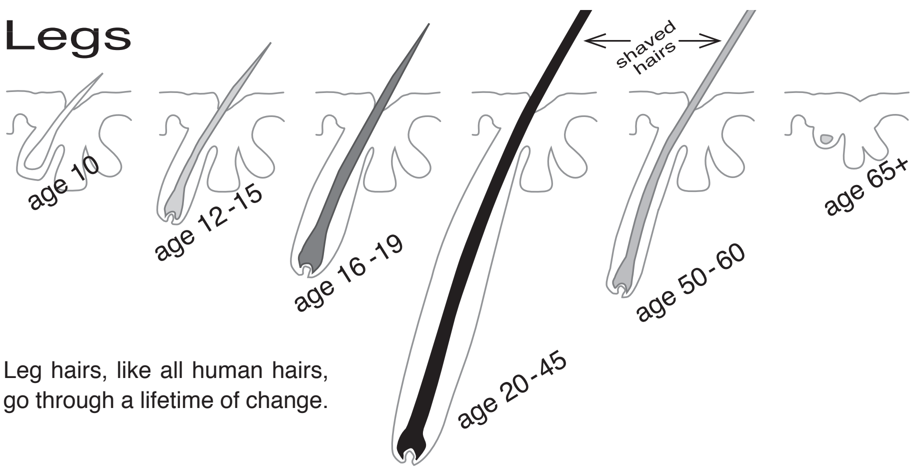
MALE BEARD DEVELOPMENT



scalp hair is soft, dense and muted in color. When we go through puberty the scalp becomes oily, the hairs coarsen and become vibrant in color. By middle-age our hair becomes less dense, more brittle and surrenders its youthful color and luster. With advancing years our hair thins, loses pigment and turns white, and, with men, balding occurs.

Notice that the eyebrows of a young person are short and vivid. By contrast, old men have long, wiry eyebrows and, commonly, old women have lost most of their eyebrows. Leg hairs also change with each phase of life. Starting out as fine vellus hairs, leg hair quickly becomes luxuriant after puberty when hormones are plentiful. With age, both men and women gradually lose leg hair. Notice that old men who had thick leg hair in youth now have smooth, hairless legs.

Legs



Leg hairs, like all human hairs, go through a lifetime of change.

Clearly then, the primary factors that determine your lifetime of hair growth are: 1) Heredity — how your skin and follicles are genetically programmed to react to sex hormones, and 2) The amount of sex hormones available in the blood. Let's take a closer look at these two interactive forces.

Heredity: We inherit nearly all our physical characteristics from our parents; hair growth is no exception. If you're a woman and the women in your family tend to have upper lip hair, you will probably develop "the family mustache." If you're a man and most men in your family are bald, you are likely to inherit "the ancestral pate."

Not just family traits, but your ethnic heritage also influences "follicle programming" and the resulting amount and coarseness of hair growth. Europeans are thought to be the hairiest, followed by Africans and Asians (the least hairy). A Japanese woman may have excess androgens in her blood that cause her to have irregular periods. However, because she is Asian, her follicles are relatively insensitive to androgens; so she develops no facial hair. By contrast, a Turkish woman may have normal androgen levels; however, she grows facial hair because her "European - Mediterranean follicles" are programmed to react to even low levels of androgens.

All hair follicles are genetically programmed with a unique sensitivity to androgens. Some follicles do not react to androgens and produce vellus hairs for your entire life. Other follicles react quickly and produce terminal hairs. For example, hair follicles in the underarm and pubic areas are extremely sensitive to hormone stimulation. At puberty, we get our first "shot" of sex hormones, and these areas rapidly develop big terminal hairs. Once established, underarm and pubic hairs change little, even after years of androgen availability.

Other follicles are "programmed" to react slowly to androgens and need years of constant hormone stimulation to change. For example, facial hairs are sensitive to hormones but take a long time to react. Thus, it takes years for a man's beard to develop. Likewise, postmenopausal women who have hormone-sensitive follicles and elevated androgen levels will develop facial hairs gradually over a period of many years.

Androgens also cause male pattern baldness, if the follicles are programmed for such an unfortunate event. The scalp follicles react slowly and produce progressively smaller hairs. The hair loss process takes years, but eventually hairs become so tiny that the area appears bald. Interestingly, only certain hairs on the head "miniaturize." Hair follicles at the back of the head do not respond to androgens. For this reason, surgeons are able to transplant follicles (the entire PSU) from the back of the head to the bald areas. Being "androgen resistant," the transplanted follicles and hairs remain for life.

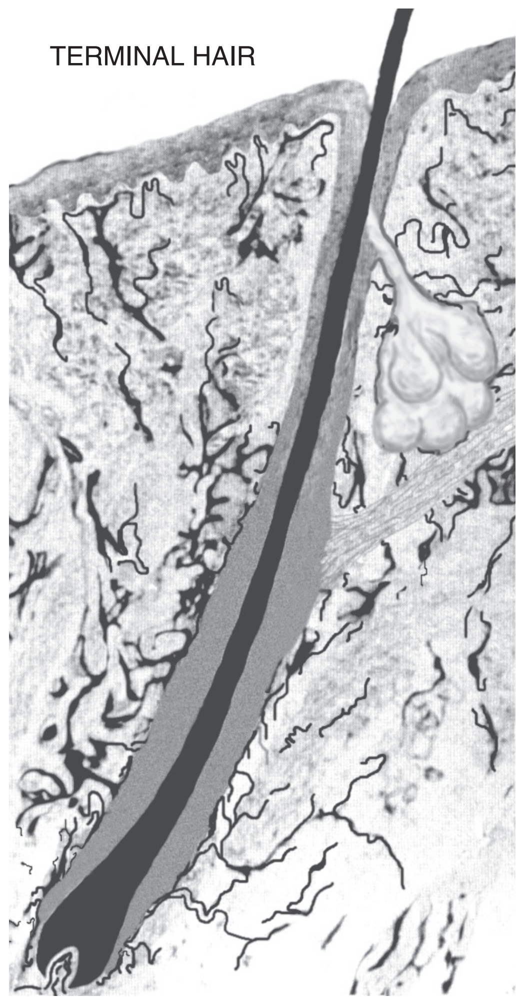
Amount: The interaction between hormones and hair growth is complicated and well beyond the scope of this book. For example, both men and women produce hair-stimulating androgens *and* antagonist estrogens.[1] The skin itself produces estrogen and androgen from inactive hormones, makes hormones that block androgens and can produce hormones restricted to a small area. The follicles themselves are able to modify the available hormones. Furthermore, medical science does not completely understand this follicle/hormone relation-

1) In women, the ovaries produce the female hormones estrogen, progesterone, and male androgens in small amounts. In men the testicles produce androgens, primarily testosterone, and other hormones that act like weak estrogens. The adrenal glands produce androgens in both men and women.

ship. Regardless of these complexities, the overall amount of androgen hormones you produce most certainly determines hair growth. Many factors govern androgen levels.

Overwhelmingly, the ovary, testicle and adrenal gland output determines blood hormone levels. At certain ages, these glands produce more hormone. There is a great increase at puberty and a reduction with age and menopause (women). Pregnancy also elevates hormone levels and causes temporary hair growth on some women. Excess hair produced by elevated androgens is called "hirsutism" [Latin: shaggy].

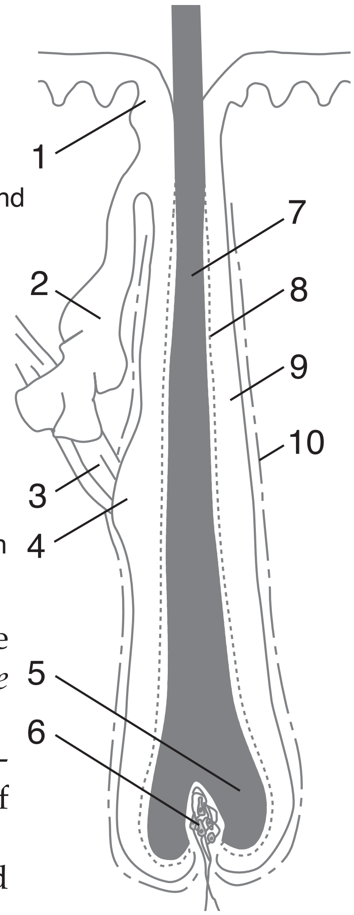
Fat cells can also produce androgen hormones. Overweight people sometimes have excess androgen and hair growth due to their large and active fat cells. Both physical and psychological stress stimulate the adrenal glands to produce adrenaline. The overactive adrenal glands also release androgens into the blood. Thus, stress can cause unwanted hair growth. Many medications cause hair growth by elevating hormone levels or interfering with the normal utilization process. Additionally, several diseases can elevate hormone levels or distort hormone balances and activate hair growth.



Whatever the underlying cause, the hormone-stimulated terminal hair is the target for permanent hair removal. Indeed, such hairs diminish in time. You will eventually lose the hair on your legs and underarms. However, most of us don't want to wait until we're 80 to have hairless skin. So, let's take a closer look at our quarry: the magnificent terminal hair.

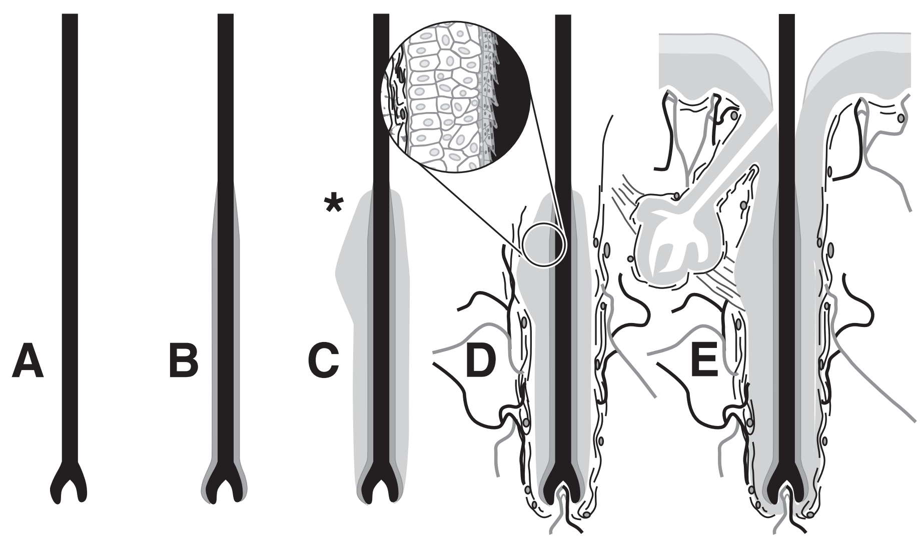
The terminal hair is the "big daddy" pilosebaceous unit — fully developed and functioning as an independent organ. Biologists describe 10 distinct parts of the terminal PSU:

Terminal Hair:
1 follicle
2 sebaceous gland
3 arrector pili
4 bulge
5 bulb
6 papilla
7 hair shaft
8 inner sheath
9 outer sheath
10 dermal sheath



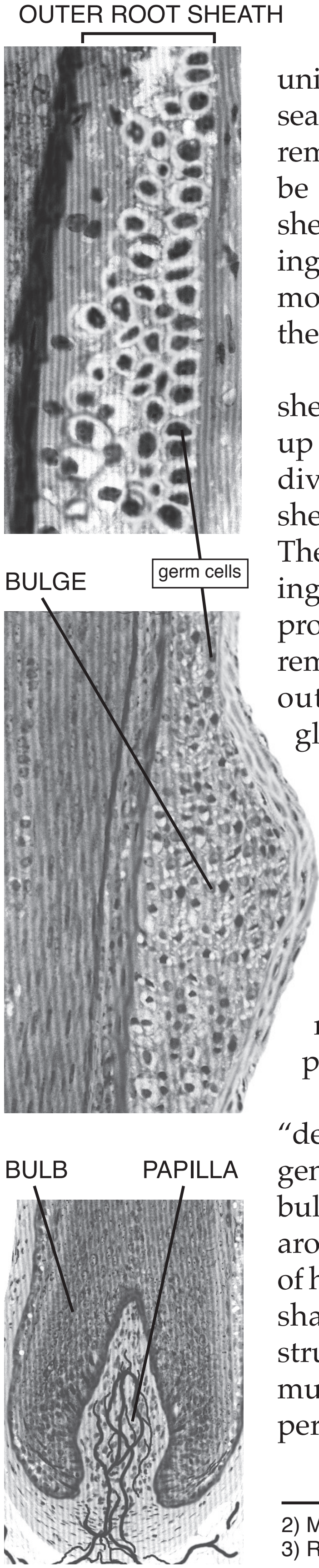
1) The ***follicle*** is an "indentation" of the epidermis. Except for minor cell differences, the epidermis and follicle are identical — *anatomically, the entire follicle is epidermis!*
2) The ***sebaceous gland*** produces sebum and expels this light oil out of the follicle opening.
3) The ***arrector pili*** muscle is attached to the follicle and dermis. Under certain conditions, such as cold, fear or excitement, arrector pili muscles contract and give you "goose bumps," and make your hairs stand up. (The next time you hear Pavarotti or Streisand sing, you can thank your arrector pili muscles.)
4) The ***bulge*** is a protruding section of the follicle, located where the arrector pili muscle attaches to the follicle. The bulge contains stem cells that can grow a new PSU.
5) The ***bulb*** is part of the hair. It contains cells that produce and push up protein fibers that form the hair shaft. The bulb also generates the inner root sheath. The bulb contains melanocytes that "inject" color into the hair shaft.
6) The ***papilla*** [Latin: nipple] is a cone-like structure that contains nerves, blood vessels and connective tissues (collagen and elastin). The papilla is part of the dermis and dermal sheath. The papilla supplies nutrients to cells in the hair bulb.
7) The ***hair shaft*** is a column of tough protein fiber called "keratin" that has upward-pointing scales that securely interlock with the follicle. The hair shaft is just dead fibrous material.

8) The ***inner root sheath*** is classified as part of the follicle and is only two cells thick. The tough fiber-like cells resemble scales that point downward and firmly interlock with the hair shaft. The inner root sheath grows with the hair. It acts like a sausage casing and molds the upward growing hair shaft.
9) The ***outer root sheath*** is part of the epidermis and makes up most of the follicle. Like the epidermis, the outer root sheath contains no nerves or blood vessels. When you tweeze a hair, the clear tubelike structure you see is the outer root sheath.
10) The ***dermal sheath*** surrounds the entire follicle. The dermal sheath is part of the dermis and contains nerves, blood vessels and connective tissues (collagen and elastin). The papilla is part of the dermal sheath. Just as blood vessels of the dermis "feed" the epidermis, blood vessels of the dermal sheath "feed" the follicle. The dermal sheath's connective tissues fasten the follicle to the skin; the abundant nerves make the hair an exquisite sensory organ, like a cat's whisker.



COMPONENTS OF THE TERMINAL PSU

A) Hair shaft and bulb form a joined unit.
B) Inner root sheath surrounds the hair shaft.
C) Outer root sheath (and bulge) make up most of the follicle.
* When you tweeze a hair, you pull out the shaft, bulb, inner root sheath and a large part of the outer root sheath. The papilla stays in the skin, it cannot be tweezed out.
D) Dermal sheath and papilla are a connected unit that envelopes the entire follicle.
E) Epidermis, sebaceous gland and arrector pili complete the PSU. Notice that the outer root sheath and epidermis are the same.



As you can see, the pilosebaceous unit contains many different parts. Yet, research shows that to cause permanent hair removal, only three key structures must be destroyed: the bulge, the outer root sheath and the section of the PSU containing the bulb and papilla. Some hair removal experts refer to this requirement as the "3 strikes and you're out" principle.[2]

Outer root sheath: The outer root sheath is part of the epidermis and makes up most of the follicle. Highly mitotic (cell dividing) basal cells line the outer root sheath and can regenerate a new follicle. These "germ cells" play a critical role during the hair's shedding and regrowing process. The target for any permanent hair removal method must include the entire outer root sheath from the sebaceous gland duct to the level of the papilla.

Bulge: The bulge is part of the outer root sheath and contains stem cells that spring into action to grow a new follicle and hair. Not much was known about the bulge until 1990, but researchers now believe this area is an essential hair growing mechanism.[3] The bulge is included as an important target.

Papilla & Bulb: The papilla, or "dermal papilla," supplies life-giving oxygen and nutrients to cells in the bulb. The bulb resembles an onion and fits perfectly around the papilla. The bulb is composed of highly mitotic cells that "grow" the hair shaft and inner root sheath. These two structures are central to hair growth and must, therefore, be destroyed to achieve permanent hair removal.

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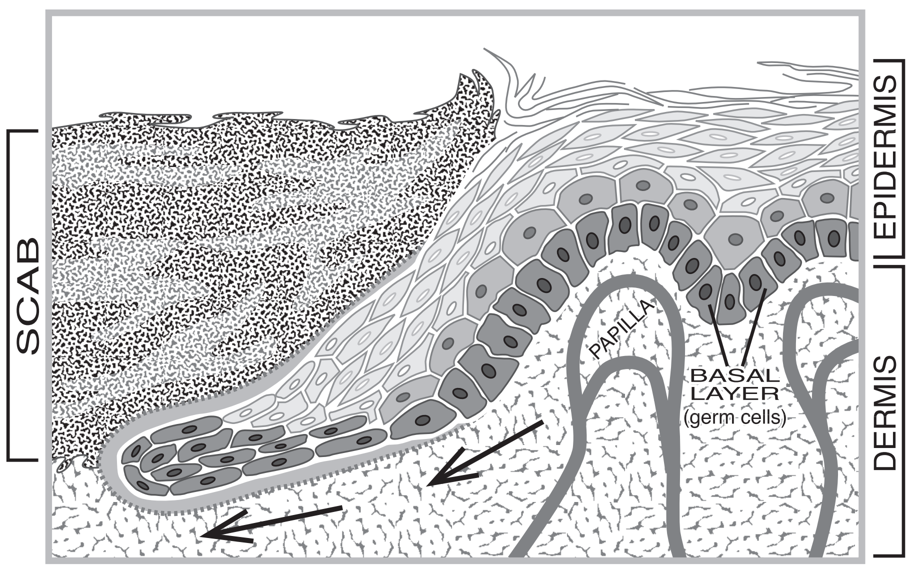
2) Michael Bono, *The Blend Method*, p. 17-31 (1994).
3) Robert M. Lavker, "Cell," June 29, 1990, p. 1329-1337.

Regeneration and "Shedding Cycle"

Lizards regrow detached tails and salamanders replace lost legs. Imagine if we could regrow a severed finger. Well, that is exactly what PSUs do. Indeed, observation shows that hairs cannot easily be destroyed by plucking them out. Instead, the PSU regenerates from only a few germ cells remaining in the torn-out follicle. Except for the liver that regrows torn-out or diseased sections, only so-called "epithelium" can completely regenerate [Greek: *epi*, upon + *thele*, nipple].[4]

Epithelium is thin, bloodless cellular tissue that forms the outer protective covering of all our organs and body parts. A transparent epithelial film even covers our eyes. The skin's epidermis is our largest epithelial structure — it covers the entire body. The regenerative power of the epidermis is awesome. When our skin is injured, the epidermis rapidly grows over the break in the skin and becomes identical to uninjured epidermis. The pilosebaceous unit is a structure of the epidermis and is epithelial tissue. *Therefore, the PSU — the entire follicle and hair — can totally regenerate!* In theory, an entire PSU could regenerate from only one viable epithelial (germ) cell.



In wound healing, the epidermis rapidly grows over the wound. The cell growth is so explosive that the epidermis actually burrows under the scab. The epidermis completely regenerates — like a lizard's tail.

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4) **Epithelium**: (Originally defined as the thin skin covering the nipples.) The purely cellular, avascular layer covering all the free surfaces of the body — cutaneous, mucous, and serous — including the glands and other structures derived therefrom.
Epithelial: Relating to or consisting of epithelium.

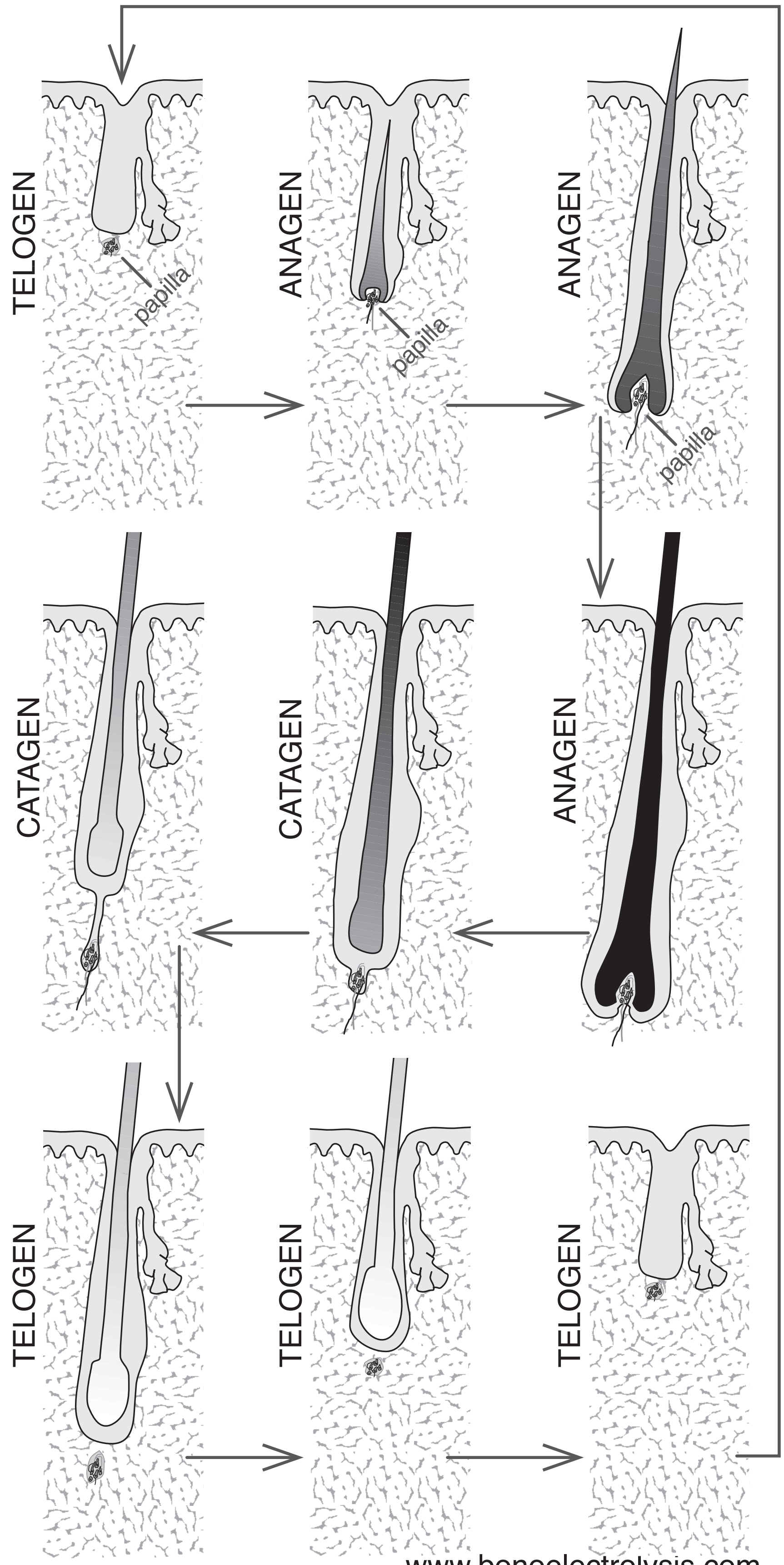
Follicle regeneration is astounding. However, there is one more surprise — the "shedding cycle." A hair grows for a period of time. Then, it stops growing and falls out. Most of the follicle withers and becomes dormant. After a brief rest, the remnants of the follicle resurrect and generate *an entirely new hair and follicle.* The shedding cycle is a spectacle that no other body part performs: the PSU dies and is then reborn.

The shedding cycle explains an age-old enigma: except for hair on the scalp, our hairs appear to stay the same length. Notice that the hairs on your arms and legs never need clipping; they just stay the same length — yet they are growing. Hairs seem static because they are "programmed" to grow for a set time, and then shed. Shedding does not happen all at once. Instead, we shed and regrow hairs every day; so each area of the body appears to have a fixed amount of hair that stays a certain length. Both vellus and terminal hairs shed.

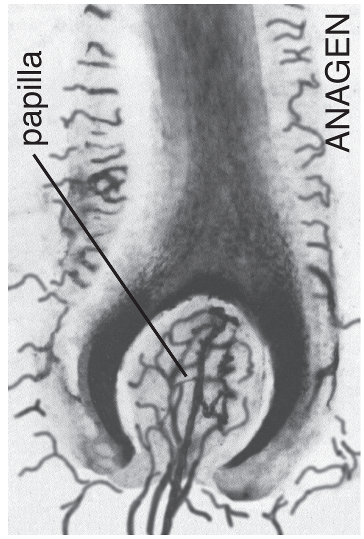
Biologists do not yet completely understand the PSU's so-called "Lazarus effect" — growth, death and rebirth. However, researchers believe the shedding cycle may hold one of the secrets to curing cancer! When a hair and follicle regrow, cell division is identical to the explosive growth of cancer cells. Unlike tumors, however, cell growth in the follicle suddenly ceases. Researchers seek to find the chemical mechanism that stops the cancer-like growth in follicles. If this chemical were found, it could be synthesized and injected to kill malignant tumors. As we shall see, "photodynamic therapy" is already treating certain cancers based on targeting "rapidly dividing cells" such as those found in the regenerating PSU.

The shedding cycle is divided into 3 growth phases. The active growth phase is called anagen [Greek: *ana,* start + *gen,* growth]. In anagen, the papilla and follicle are fully formed and functioning. Active melanocytes populate the bulb and give the hair intense color. Suddenly, cell division slows and the follicle begins to shrink upward as the PSU enters catagen phase [Greek: *cata,* down + *gen,* growth]. In telogen phase [Greek: *telos,* end + *gen,* growth], the follicle shrinks to one-third its original depth. Melanocytes disappear from the bulb and the hair gets lighter in color. The papilla detaches from the follicle and "drifts" upward with the shrinking follicle. Hair production stops and the hair eventually falls out. After a brief rest, the PSU reenters anagen phase and generates a new hair and follicle. This process continues over and over for your entire lifetime — each hair "doing its thing" independently.

THE "SHEDDING CYCLE"

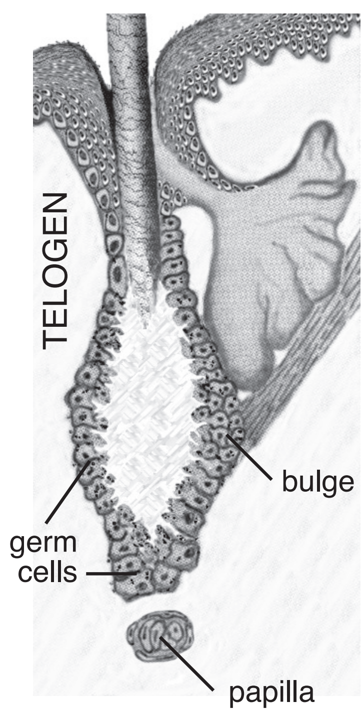


The shedding cycle reveals the important role of the bulge, the outer root sheath and the section of the PSU containing the bulb and papilla. These parts work together to regenerate the lifeless telogen hair and follicle. Obviously, all of these structures must be destroyed to guarantee permanent hair removal.

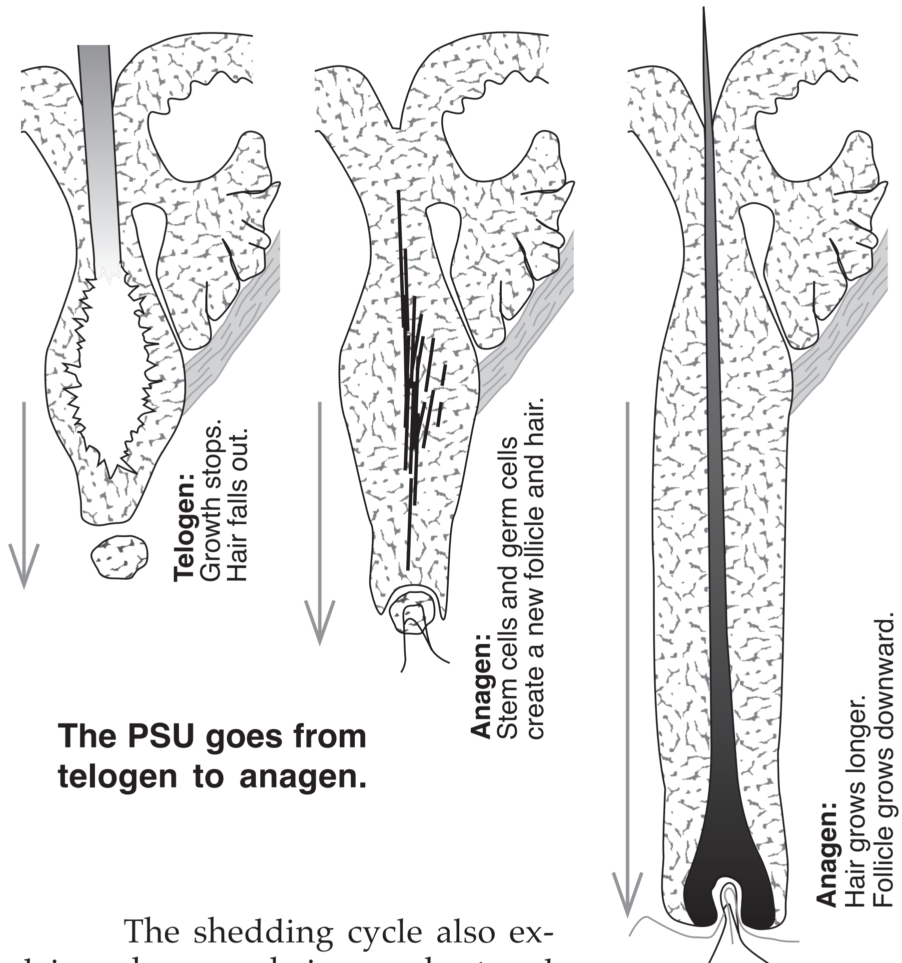


In anagen, the papilla nourishes the bulb. Experts conclude that destruction of the bulb and papilla would most likely destroy a hair in anagen. However, the telogen hair's sudden return to anagen shows that hair regeneration is not necessarily dependent on the papilla only. In telogen phase, the papilla is detached from the follicle and has become an amorphous jumble of connective tissue — it contains no blood vessels. Likewise, the bulb disappears in telogen phase. When the lifeless telogen PSU ignites with vitality, hair and follicle regeneration starts in the remnant follicle itself.

The PSU returns to anagen when the papilla releases chemicals that stimulate cells in the bulge. These "stem cells" generate a new follicle that migrates toward the papilla. A new hair shaft forms that grows both upward and downward. At the same time, other basal cells of the outer root sheath — now called "germ cells" — help to reconstruct the new follicle. These dynamic agents team up and attach themselves to the papilla. The PSU, now in anagen phase, pushes downward and carries the papilla with it. New blood vessels form in the rejuvenated papilla. A new hair bursts upward and emerges from the follicle opening. Renowned biologist William Montagna, Ph.D., states the following: "[In the regenerating follicle] these primordial cells build a new follicle and hair in exactly the same way as the follicle was built for the first time in the fetus."[5]



5) W. Montagna: *Skin, Your Owner's Manual*, p. 124.



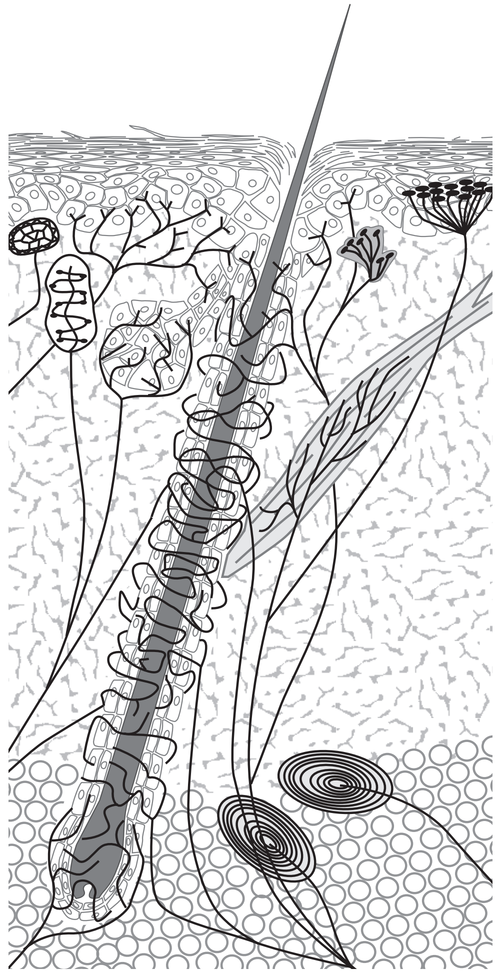
The PSU goes from telogen to anagen.

The shedding cycle also explains why some hairs are short and others long. All hairs on the body grow about the same amount: between 0.15 mm - 0.35 mm per day. The difference is the time they spend in anagen — the active growth phase. For example, scalp hairs actively grow for 2 - 6 years before they go into telogen and shed. By contrast, eyelash hairs only grow for 4 - 8 weeks. Therefore scalp hair grows long and requires cutting, but eyelashes stay short and never need trimming.

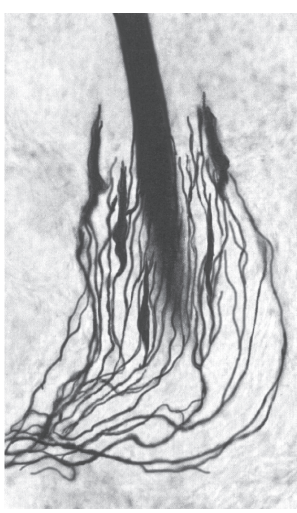
There are marked differences in each person's shedding cycle. One woman grows her scalp hair down to her waist, but another woman complains that her hair "just won't grow." The difference is that the "lucky" woman with long hair may have a 4 - 6 year anagen period. The woman with "problem hair" may only have a 2 - 3 year anagen period. No cosmetic product will make hair grow longer. "Short hair" is genetic: that's how the shedding cycle was programmed. Unfortunately, we spend millions of dollars on cosmetics to make our hair grow longer. Such expenditures are a complete waste of money.

Still, the original questions remain: Why do we have hair? What is the purpose of hair? Why do we "hate" certain hairs and "love" others?

Our hair's absolute link to sex hormones reveals its real purpose. *Hair is sexual.* Hair, everywhere on the body, communicates sexual maturity and vitality. The male beard, thick vibrant scalp hair, luxurious underarm and pubic hair and an unblemished, *hairless* face and body (women) are the hallmarks of youth and sexual vigor. Humans are highly sexual. We consciously (and unconsciously) seek to maintain and display our sexual presence to others of our species, and so we have an almost fanatical concern about hair.



Nerves surround all terminal hairs.



Nerves surround all vellus hairs.

Anatomically, the purpose of hair is unmistakable — hairs are sensory organs. Every PSU is enveloped by nerve endings. A terminal hair has an extensive network of nerves surrounding the entire follicle. There are separate nerves for the sebaceous gland and arrector pili muscle. Even tiny vellus hairs have abundant nerve endings.

If you gently stroke the hairs on your arm, you will notice the remarkable sensitivity of hairs. The skin is said to be our "largest sex organ," because it responds to sex hormones and is highly erotic. Hairs add to this exquisite sensitivity. Most likely, our embarrassment about unwanted hair has something to do with our cultural uneasiness (and fixation) about sexual matters. Few people discuss unwanted hair with their friends.

Summary: This booklet gave you a brief survey of skin and hair. Indeed, the biology of skin and hair is complicated and constitutes an entire field of study. The following are the major points:

1) Human life depends on healthy skin. Skin biology is complex; many factors are still unknown. Hair communicates sexuality.

2) The skin's functions must not be altered. Such functions include: touch, temperature regulation, toxin elimination, vitamin and hormone production and protection of underlying tissues.

3) The epidermis is our "thin line of defense" against microorganisms.
The epidermis must not be altered in an attempt to destroy hairs.

4) Blood flow to the skin is extensive. The entire blood supply passes through the skin. Blood contains crucial cells, including cells of the immune system.

5) The dermis contains important immune system cells.
These cells must not be altered in any way.

6) The follicle (outer root sheath) and epidermis are the same tissues.
Hair "germ cells" and epidermis "germ cells" are the same cells.

7) The follicle is not an open tube.
The hair shaft and all components of the follicle are bonded together.

8) Melanocytes (pigment cells) of the hair and epidermis are the same cells.
Melanin (pigment) of the hair and epidermis are the same end product.

9) The hair is a sensory organ. All follicles are surrounded by nerves of the dermal sheath. These are the same nerve structures that underlie the epidermis.

10) Papillae of the epidermis are the same as a papilla of a hair.
Papillae contain nerves, blood vessels, and connective tissues.

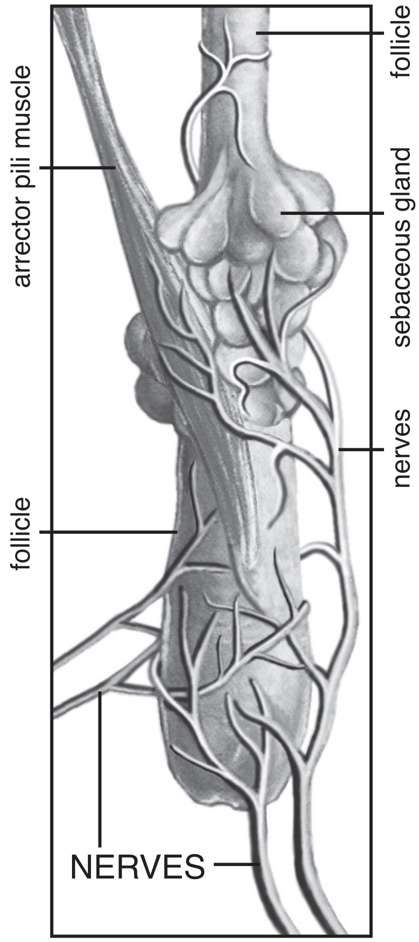
11) In telogen, the hair and bulb contain no pigment or pigment cells.

12) In telogen, the follicle has retreated to one-third its original depth;
the papilla has "drifted" upward and is not attached to the follicle.

12) Hairs have a shedding cycle and can regenerate from most injuries.
Only a few cells in a damaged follicle can regrow an entire PSU.

13) You must have "3 strikes" to kill a hair. Any permanent hair removal system must destroy the bulge, the outer root sheath and the bulb and papilla.

Notes ...



The Human Hair

The hair shaft is a column of tough protein fiber that has scales pointing upward that fasten to the follicle. There is no "space" between the hair and the follicle — they are tightly joined. The bulb, at the base of the hair, has active cells that produce the hair and inner root sheath. The inner root sheath is only two cells thick and acts like the skin of a sausage to mold the upward growing cells of the hair.

The outer root sheath surrounds the inner root sheath and is the same tissue as the epidermis. When you tweeze a hair, you pull out the hair shaft, bulb and a large part of the follicle: inner and outer root sheath. The follicle appears like a clear sleeve around the hair.

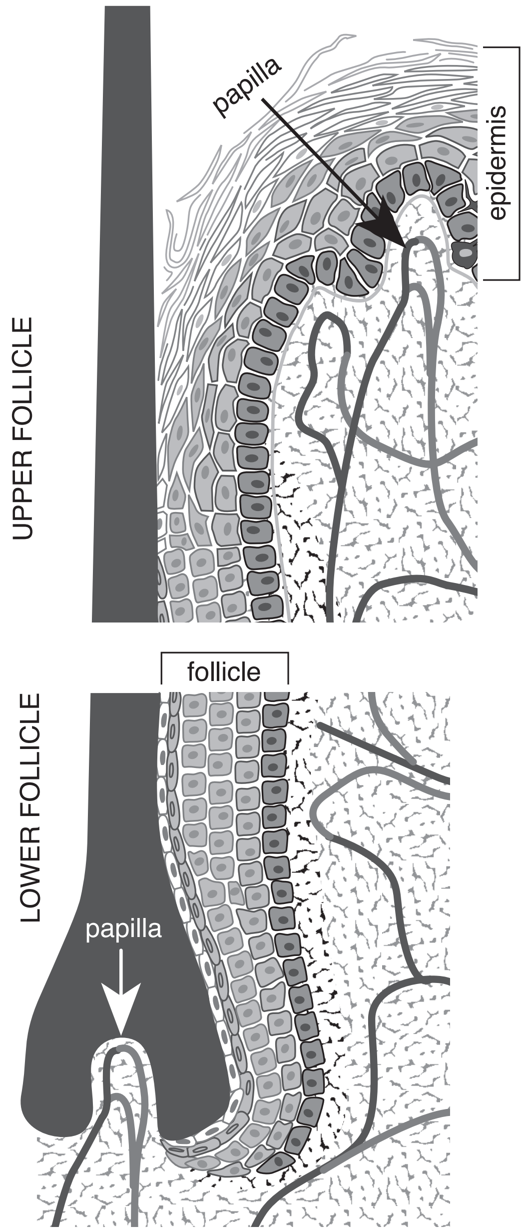
The dermal sheath encases the hair and sheaths. This fibrous structure is much tougher than the outer root sheath and contains abundant nerves and blood vessels—including the hair's dermal papilla. The dermal sheath and papilla cannot be pulled out.

Finally, the dermis envelops the follicle. The epidermis (upper skin layer) is continuous with the outer root sheath. Except for minor cell differences, the epidermis and outer sheath are identical. For this reason, the follicle is sometimes called an indentation of the epidermis.

The keratogenous zone is located about one-third up from the bulb. Here the hair undergoes a complex biochemical process known as keratinization. The product of this process is a hard yet pliable fibrous material called keratin (such as fingernails). Beneath the keratogenous zone, the hair remains soft and mushy. Above this zone, the hair becomes substantially harder and firmer.

Melanocytes are pigment bearing cells found in the bulb that transfer melanin (color) to cells that make up the hair shaft. In catagen and telogen the bulb becomes a jumbled cluster of cells and melanin production ceases. Thus, in catagen and telogen, the hair shaft becomes lighter in color. (When the base of a similar-size hair appears lighter than neighboring hairs, you may assume it is in catagen or telogen.)

Notes ...



The follicle and epidermis are identical — The follicle is the epidermis! Essentially, the epidermis grows the outer horny layer and the follicle grows a hair. The follicle comprises two so-called root sheaths. The inner sheath shapes the hair shaft; the outer sheath contains active "growth cells." Outer sheath cells are called germ cells, because they can "germinate" a new hair — even if you rip the hair out. When you tweeze a hair, the clear tubelike structure you see is part of the follicle. However, enough of the germ cells remain in the skin so that a new hair regrows. As you have probably discovered, you can't kill a hair by tweezing.