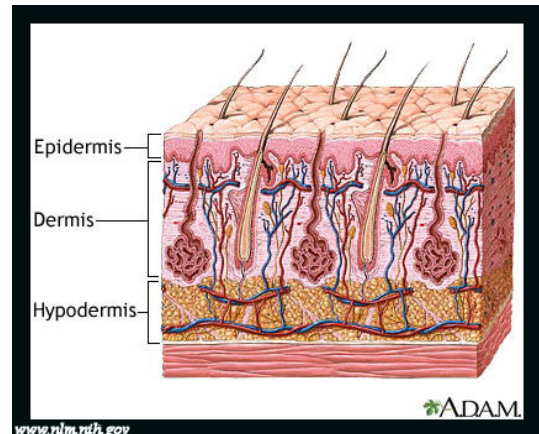


# Skin and Nail Composition

## Skin

### General Facts

The skin is the outer covering of the body. It is the largest organ of the integumentary system made up of multiple layers of epithelial tissues, and guards the underlying muscles, bones, ligaments and internal organs. The adjective cutaneous literally means "of the skin" (from Latin *cutis*, skin).



Because it interfaces with the environment, skin plays a very important role in protecting (the body) against pathogens. Its other functions are insulation, temperature regulation, sensation, synthesis of vitamin D, and the protection of vitamin B folates. Severely damaged skin will try to heal by forming scar tissue. This is often discolored and depigmented.

In humans, skin pigmentation varies among populations, and skin type can range from dry to oily.

### Skin Components

Skin has pigmentation, or melanin, provided by melanocytes, which absorb some of the potentially dangerous ultraviolet radiation (UV) in sunlight. It also contains DNA-repair enzymes that help reverse UV damage, and people who lack the genes for these enzymes suffer high rates of skin cancer. One form predominantly produced by UV light, malignant melanoma, is particularly invasive, causing it to spread quickly, and can often be deadly. Human skin

pigmentation varies among populations in a striking manner. This has led to the classification of people(s) on the basis of skin color.

Mammalian skin often contains hairs, which in sufficient density is called fur. The hair mainly serves to augment the insulation the skin provides, but can also serve as a secondary sexual characteristic or as camouflage. On some animals, the skin is very hard and thick, and can be processed to create leather. Reptiles and fish have hard protective scales on their skin for protection, and birds have hard feathers, all made of tough  $\beta$ -keratins. Amphibian skin is not a strong barrier to passage of chemicals and is often subject to osmosis. A frog sitting in an anesthetic solution could quickly go to sleep.

The skin is often known as the largest organ of the human body. This applies to exterior surface, as it covers the body, *appearing* to have the largest surface area of all the organs. For the average adult human, the skin has a surface area of between 1.5-2.0 square meters (16.1-21.5 sq ft.), most of it is between 2-3 mm (0.10 inch) thick. The average square inch (6.5 cm<sup>2</sup>) of skin holds 650 sweat glands, 20 blood vessels, 60,000 melanocytes, and more than a thousand nerve endings.

## **Skin Functions**

Skin performs the following functions:

1. Protection: an anatomical barrier from pathogens and damage between the internal and external environment in bodily defense;

Langerhans cells in the skin are part of the adaptive immune system.

2. Sensation: contains a variety of nerve endings that react to heat and cold, touch, pressure, vibration, and tissue injury.

3. Heat regulation: the skin contains a blood supply far greater than its requirements which



allows precise control of energy loss by radiation, convection and conduction. Dilated blood vessels increase perfusion and heat loss while constricted vessels greatly reduce cutaneous blood flow and conserve heat. Erector pili muscles are significant in animals.

4. Control of evaporation: the skin provides a relatively dry and impermeable barrier to fluid loss. Loss of this function contributes to the massive fluid loss in burns.

5. Aesthetics and communication: others see our skin and can assess our mood, physical state and attractiveness.

6. Storage and synthesis: acts as a storage center for lipids and water, as well as a means of synthesis of vitamin D by action of UV on certain parts of the skin.

7. Excretion: sweat contains urea, however its concentration is 1/130th that of urine, hence excretion by sweating is at most a secondary function to temperature regulation.

8. Absorption: Oxygen, nitrogen and carbon dioxide can diffuse into the epidermis in small amounts, some animals using their skin for their sole respiration organ. In addition, medicine can be administered through the skin, by ointments or by means of adhesive

patch, such as the nicotine patch or iontophoresis. The skin is an important site of transport in many other organisms.

9. Water resistance: The skin acts as a water resistant barrier so essential nutrients aren't washed out of the body.

## **Hygiene and Skin Care**

The skin supports its own ecosystems of microorganisms, including yeasts and bacteria, which cannot be removed by any amount of cleaning. Estimates place the number of individual bacteria on the surface of one square inch (6.5 square cm) of human skin at 50 million though this figure varies greatly over the average 20 square feet (1.9 m<sup>2</sup>) of human skin. Oily surfaces, such as the face, may contain over 500 million bacteria per square inch (6.5 cm<sup>2</sup>). Despite these vast quantities, all of the bacteria found on the skin's surface would fit into a volume the size of a pea. In general, the microorganisms keep one another in check and are part of a healthy skin. When the balance is disturbed, there may be an overgrowth and infection, such as when antibiotics kill microbes, resulting in an overgrowth of yeast. The skin is continuous with the inner epithelial lining of the body at the orifices, each of which supports its own complement of microbes.

Proper skin hygiene is important because unclean skin favors the development of pathogenic organisms. The dead cells that continually slough off the epidermis mix with the secretions of the sweat and sebaceous glands and the dust found on the skin form a filthy layer on its surface. If not washed away, the slurry of sweat and sebaceous secretions mixed with dirt and dead skin is decomposed by bacterial flora, producing a foul smell. Functions of the skin are disturbed when it is excessively dirty; it becomes more easily damaged, the release of antibacterial compounds decreases, and dirty skin is more prone to develop infections.

Cosmetics should be used carefully on the skin because these may cause allergic reactions. Each season requires suitable clothing in order to facilitate the evaporation of the sweat. Sunlight, water and air play an important role in keeping the skin healthy.

Oily skin is caused by over-active sebaceous glands that produce a substance called sebum, a naturally healthy skin lubricant. When the skin produces excessive sebum, it becomes heavy and thick in texture. Oily skin is typified by shininess, blemishes and pimples. The oily-skin type is not necessarily bad, since such skin is less prone to wrinkling, or other signs of aging, because the oil helps to keep needed moisture locked into the epidermis (outermost layer of skin).

The negative aspect of the oily-skin type is that oily complexions are especially susceptible to clogged pores, blackheads, and buildup of dead skin cells on the surface of the skin. Oily skin can be sallow and rough in texture and tends to have large, clearly visible pores everywhere, except around the eyes and neck.

The goal of treating oily skin is to remove excess surface sebum without complete removal of skin lipids. Severe degreasing treatment can foster an actual worsening of sebum secretion, which defeats the aim of the cleansing. A method of cleansing oily skin is to cleanse with a natural face cleanser formulated especially for oily skin. The cleansers pH should be 4.5 - 5.5. Gel cleansers work best on oily skin. Oily skin products should contain very little natural oils. They should not contain waxes or other synthetic lipid agents that could aggravate the oily condition of the skin. A toning lotion should also be natural and have a pH of 4.5-5.5 and formulated especially to help balance and hydrate oily skin. Some cleansing products have lower concentrations of hydroxy acids, which remove dead cells from the upper levels of the stratum corneum. Those products should be used on a regular basis to work adequately. A light

moisturizer may be included in a hydroxy acid product to counteract any drying effects of the cleanser. People with oily skin should use a moisturizer with humectants and a clay masque containing bentonite clay twice a week.

## **Skin Aging**

As skin ages, it becomes thinner and more easily damaged. Intensifying this effect is the decreasing ability of skin to heal itself as a person ages. Skin aging is caused by the fall in elasticity. Aging skin also receives less blood flow and lower gland activity. Cortisol causes degradation of skin collagen, accelerating skin aging.

## **Variability in Skin Tone**

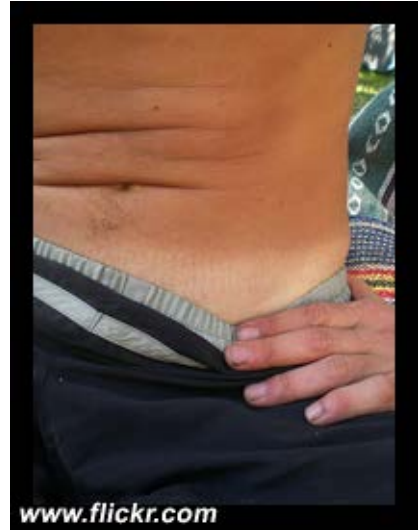
Individuals with ancestors from different parts of the world can have highly visible differences in skin pigmentation. Individuals with sub-Saharan African ancestry (black people) tend towards darker skin, while those of Northern European descent (white people) have paler skin. Between these extremes are individuals of Asian, South-East Asian, Native American, Middle Eastern, Polynesian and Melanesian descent.

The skin of black people has more variation in color from one part of the body to another than does the skin of other racial groups, particularly the palms of the hands and soles of the feet. Part of this is the result of the variations in the thickness of the skin or different parts of the body. The thicker the skin, the more layers of cells with melanin in them, and the darker the color. In addition, these parts of the body do not have melanin-producing cells.

Darker skin hinders UVA rays from penetrating. Because UVA degrades folate (a B vitamin) and is required for vitamin D synthesis, people with darker skin tones are more susceptible to deficiencies of these vitamins.

## Skin Types

Skin can be classified based on its reaction to ultraviolet radiation:



Type	Definition	Description
I	Always burns but never tans	Pale, Fair, Freckles
II	Usually burns, sometimes tans	Fair
III	May burn, usually tans	Light Brown
IV	Rarely burns, always tans	Olive brown
V	Moderate constitutional pigmentation	Brown
VI	Marked constitutional pigmentation	Black

## Skin Layers

Skin is composed of three primary layers:

- the *epidermis*, which provides waterproofing and serves as a barrier to infection;
- the *dermis*, which serves as a location for the appendages of skin; and
- the *hypodermis* (*subcutaneous adipose layer*).

## Epidermis

Epidermis, "epi" coming from the Greek meaning "over" or "upon", is the outermost layer of the skin. It forms the waterproof, protective wrap over the body's surface and is made up of stratified squamous epithelium with an underlying basal lamina.

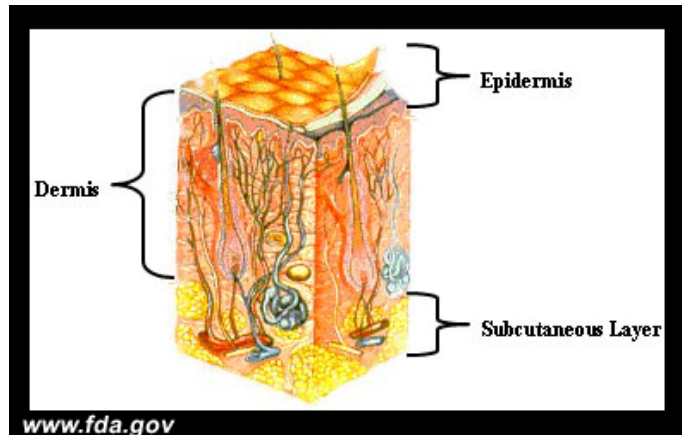
The epidermis contains no blood vessels, and cells in the deepest layers are nourished by diffusion from blood capillaries extending to the upper layers of the dermis. The main type of cells which make up the epidermis are Merkel cells, keratinocytes, with melanocytes and Langerhans cells. The epidermis can be further subdivided into the following *strata* (beginning with the outermost layer): corneum, lucidum (only in palms of hands and bottoms of feet), granulosum, spinosum, basale. Cells are formed through mitosis at the basale layer. The daughter cells move up the strata changing shape and composition as they die due to isolation from their blood source. The cytoplasm is released and the protein keratin is inserted. They eventually reach the corneum and slough off (desquamation). This process is called *keratinization* and takes place within about 27 days. This keratinized layer of skin is responsible for keeping water in the body and keeping other harmful chemicals and pathogens out, making skin a natural barrier to infection.

## **Components**

The epidermis contains no blood vessels, and is nourished by diffusion from the dermis. The main type of cells which make up the epidermis are keratinocytes, melanocytes, Langerhans cells and Merckels cells. The epidermis helps the skin to regulate body temperature.

## **Layers**

Epidermis is divided into several layers where cells are formed through mitosis at the innermost layers. They move up the strata changing shape and composition as they differentiate and become filled with keratin. They eventually reach the top layer called *stratum corneum* and are sloughed off, or desquamated. This process is called *keratinization* and takes place within weeks. The outermost layer of the epidermis consists of 25 to 30 layers of dead cells.



### Sublayers

Epidermis is divided into the following 5 sublayers or strata:

- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum germinativum (also called "stratum basale")

Mnemonics that are good for remembering the layers of the skin (using "stratum basale" instead of "stratum germinativum"):

- "Cher Likes Getting Skin Botoxed" (from superficial to deep)
- "Before Signing, Get Legal Counsel" (from deep to superficial)

Blood capillaries are found beneath the epidermis, and are linked to an arteriole and a venule. Arterial shunt vessels may bypass the network in ears, the nose and fingertips.

## **Dermis**

The dermis is the layer of skin beneath the epidermis that consists of connective tissue and cushions the body from stress and strain. The dermis is tightly connected to the epidermis by a basement membrane. It also harbors many Mechanoreceptor/nerve endings that provide the sense of touch and heat. It contains the hair follicles, sweat glands, sebaceous glands, apocrine glands, lymphatic vessels and blood vessels. The blood vessels in the dermis provide nourishment and waste removal to its own cells as well as the Stratum basale of the epidermis.

The dermis is structurally divided into two areas: a superficial area adjacent to the epidermis, called the *papillary region*, and a deep thicker area known as the *reticular region*.

### **Papillary region**

The papillary region is composed of loose areolar connective tissue. It is named for its fingerlike projections called *papillae* that extend toward the epidermis. The papillae provide the dermis with a "bumpy" surface that interdigitates with the epidermis, strengthening the connection between the two layers of skin.

In the palms, fingers, soles, and toes, the influence of the papillae projecting into the epidermis forms contours in the skin's surface. These are called *friction ridges*, because they help the hand or foot to grasp by increasing friction. Friction ridges occur in patterns that are genetically and

epigenetically determined and are therefore unique to the individual, making it possible to use fingerprints or footprints as a means of identification.

### **Reticular region**

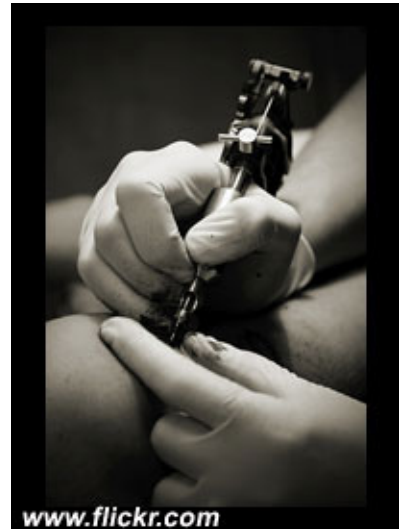
The reticular region lies deep in the papillary region and is usually much thicker. It is composed of dense irregular connective tissue, and receives its name from the dense concentration of collagenous, elastic, and reticular fibers that weave throughout it. These protein fibers give the dermis its properties of strength, extensibility, and elasticity.

Also located within the reticular region are the roots of the hair, sebaceous glands, sweat glands, receptors, nails, and blood vessels.

Tattoo ink is held in the dermis. Stretch marks from pregnancy are also located in the dermis.

### **Hypodermis**

The hypodermis is not part of the skin, and lies below the dermis. Its purpose is to attach the skin to underlying bone and muscle as well as supplying it with blood vessels and nerves. It consists of loose connective tissue and elastin. The main cell types are fibroblasts, macrophages and adipocytes (the hypodermis contains 50% of body fat). Fat serves as padding and insulation for the body.



Microorganisms like *Staphylococcus epidermidis* colonize the skin surface. The density of skin flora depends on region of the skin. The disinfected skin surface gets recolonized from bacteria residing in the deeper areas of the hair follicle, gut and urogenital openings.

## **Nail Anatomy**

A nail is a horn-like structure at the end of an animal's finger or toe.

### **Parts of a Nail**

Anatomically fingernails and toenails are made of a tough protein called keratin and have many different parts:

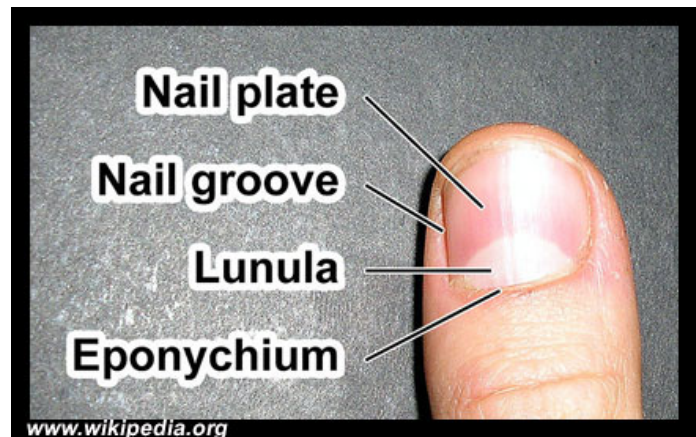
- eponychium or cuticle, the fold of skin at the proximal end of the nail
- paronychium, the fold of skin on the sides of the nail
- hyponychium, the attachment between the skin of the finger or toe and the distal end of the nail
- nail plate, the hard and translucent portion, composed of keratin
- nail bed, the adherent connective tissue that underlies the nail, often referred to as the *quick*
- lunula, the crescent-shaped whitish area of the nail bed (when visible)
- nail fold, a fold of hard skin overlapping the base and sides of a fingernail or toenail
- the free edge, the part of the nail that extends past the finger, beyond the nail plate.

Nails act as a counterforce when the end of the finger touches an object, thereby enhancing the sensitivity of the fingertip, even though there are no nerve endings in the nail itself. The growing

part of the nail is the part still under the skin at the nail's proximal end. The average thickness of this portion of the nail is .017 inches, or 0.43 millimeters. In common usage, the word *nail* often refers to the nail plate only.

Nails grow at an average rate of 3 millimeters a month. Fingernails require 3 to 6 months to regrow completely, and toenails require 12 to 18 months. Actual growth rate is dependent upon age, gender, season, exercise level, diet, and hereditary factors. Contrary to popular belief, nails do not continue to grow after death; the skin dehydrates and tightens, making the nails (and hair) appear to grow.

This growth record can show the history of recent health and physiological imbalances, and has been used as a diagnostic tool since ancient times. Major illness will cause a deep transverse groove to form across the nails. Discoloration, thinning, thickening, brittleness, splitting, grooves, Mees' lines, small white spots, receded lunula, clubbing (convex), flatness, spooning (concave) can indicate illness in other areas of the body, nutrient deficiencies, drug reaction or poisoning, or merely local injury. Nails can also become thickened (onychogryphosis),



loosened (onycholysis), infected with fungus (onychomycosis) or degenerate (onychodystrophy).

## Health and Care

Nails can dry out, just like skin. They can also peel, break and be infected. Toe infections, for instance, can be caused or exacerbated by dirty socks, specific types of aggressive exercise, tight footwear, and walking unprotected in an unclean environment.

Manicures and pedicures are health and cosmetic procedures to groom, trim, and paint the nails and manage calluses. They require various tools such as cuticle scissors, nail scissors, nail clippers, and nail files. Artificial nails can also be appended onto real nails for cosmetic purposes.

Nail tools used by different people may transmit infections. Regarding nail tools such as files, "If they're used on different people, these tools may spread nail fungi, staph bacteria or viruses," warns Rick Lopes, a spokesperson for the California Board of Barbering and Cosmetology. In fact, over 100 bacterial skin infections in 2000 were traced to footbaths in nail salons. To avoid this, new improved contactless tools can be used, for example, gel and cream cuticle removers instead of cuticle scissors.

Inherited accessory nail of the fifth toe occurs where the toenail of the smallest toe is separated, forming a smaller, "sixth toenail" in the outer corner of the nail. Like any other nail, it can be cut using a nail clipper.

## Nail Biting

Onychophagia or nail biting is a common oral compulsive habit in children and adults, affecting around 30% of children between 7 to 10 years and 45% of teenagers.



Bitten fingertips can become very sensitive to pain, usually at the place the skin meets the edge of the nail. Hangnails are broken skin on the cuticle. When they are improperly removed, they are susceptible to microbial and viral infections producing whitlows. When the nails are infected with saliva the scratching of them makes the skin get red and infect the skin. Finally it may also result in the transportation of bacteria that are buried under the surface of the nail, or pinworms from anus region to mouth. Nail biting is also related to dental problems, such as gingival injury.

Regarding social effects the aesthetic aspect of the nail may affect employability, self-esteem, and interaction with other people.

Behavioral treatments are based in discouraging the habit and replace it with a more constructive habit. The most common treatment, as it is cheap and widely available, is a special clear nail polish that has to be applied to the nails. It releases a bitter flavor on contact with the mouth which discourages the habit and has demonstrated its effectiveness. There are also mouthpieces that prevent biting.

Behavioral therapy is beneficial when simpler measures are not effective. Habit Reversal Training (HRT), seeks to "unlearn" the habit of nail biting and possibly replace it with a more

constructive habit and has shown its effectiveness versus placebo both in children and adults. In addition to HRT, stimulus control therapy is used to both identify and then eliminate the stimulus that frequently triggers biting urges.

Finally nail cosmetics can help to ameliorate nail biting social effects.

## **Nail Changes and Conditions Associated with Them**

Nail inspection can give a great deal of information about the internal working of the body:

### **Pliability**

- Brittleness is associated with iron deficiency, thyroid problems, impaired kidney function, circulation problems, and biotin deficiency.
- Splitting and fraying are associated with psoriasis and deficiencies of folic acid, protein and Vitamin C.
- Unusual thickness is associated with circulation problems.
- Thinning nails and itchy skin are associated with lichen planus.

### **Shape and Texture**

- Clubbing, or nails that curve down around the fingertips with nail beds that bulge is associated with oxygen deprivation and lung, heart, or liver disease.
- Spooning, or nails that grow upwards is associated with iron or B12 deficiency.
- Flatness can indicate a B12 vitamin deficiency or Raynaud's disease.
- Pitting of the nails is associated with Psoriasis.
- Ridges across the nail indicate stress.

- Beau's lines across the nail are associated with many serious conditions.
- Ridges along the nail are associated with arthritis.
- Grooves along the nail are associated with kidney disorders, aging, and iron deficiency.
- Beading is associated with rheumatoid arthritis.
- Nails that resemble hammered brass are associated with (or portend) hair loss.
- Short small beds are associated with heart disease.

### Coloration of the Nail Bed

- Mee's lines are associated with arsenic or thallium poisoning, and renal failure.
- White lines across the nail are associated with heart disease, liver disease, or a history of a recent high fever
- Opaque white nails with a dark band at the fingertip are associated with cancer, cirrhosis, congestive heart failure, diabetes and aging
- Paleness or whitening is associated with liver or kidney disease or anemia.
- Yellowing of the nail bed is associated with chronic bronchitis, lymphatic problems, diabetes, and liver disorders.
- Brown or copper nail beds are associated with arsenic or copper poisoning, and local fungal infection.
- Grey nail beds are associated with arthritis, edema, malnutrition, post-operative effects, glaucoma and cardio-pulmonary disease.



- Redness is associated with heart conditions.
- Dark nails are associated with B12 deficiency.
- Stains of the nail plate (not the nail bed) are associated with nail polish, smoking, and henna use.

## **Markings**

- Pink and white nails are associated with kidney disease.
- Muehrcke's lines are white lines across the nail associated with hypoalbuminemia.
- Red skin at the base of the nail is associated with connective tissue disorders.
- Blue lunulae are associated with silver poisoning or lung disorder.
- Blue nail beds are (much like blue skin) associated with poor oxygenation of the blood (asthma, emphysema, etc).
- Small white patches are associated with zinc deficiency or malabsorption, parasites, or local injury.
- Receded lunulae (fewer than 8) are associated with poor circulation, shallow breathing habits or thyroid dysfunction.
- Large lunulae (more than 25% of the thumb nail) are associated with high blood pressure.

## **Nail Diseases**

- *Onychia* is an inflammation of the matrix (surrounding tissue) of the nail with formation of pus and shedding of the nail. Onychia results from the introduction of microscopic pathogens through small wounds.

- *Onychocryptosis*, commonly known as "ingrown nails" (*unguis incarnatus*), can affect either the fingers or the toes. In this condition, the nail cuts into one or both sides of the nail bed, resulting in inflammation and possibly infection. The relative rarity of this condition in the fingers suggests that pressure from the ground or shoe against the toe is a prime factor. The movements involved in walking or other physical disturbances can contribute to the problem. Mild onychocryptosis, particularly in the absence of infection, can be treated by trimming and rounding the nail. More advanced cases, which usually include infection, are treated by surgically excising the ingrowing portion of the nail down to its bony origin and thermally or chemically cauterizing the matrix, or 'root', to prevent recurrence. This surgery is called matrixectomy. The best results are achieved by cauterizing the matrix with phenol. Another, much less effective, treatment is excision of the matrix, sometimes called a 'cold steel procedure'.

- *Onychodystrophy* is a deformation of the nails that can result from cancer chemotherapy which includes bleomycin, hydroxyurea, or 5-fluorouracil. It can include discoloration of the nail, or dyschromia.

- *Onychogryposis*, also called "ram's-horn nail", is a thickening and increase in curvature of the nail. It is usually the result of injury to the matrix. It may be



partially hereditary and can also occur as a result of long-term neglect. It is most commonly seen in the great toe but may be seen in other toes as well as the fingernails. An affected nail has many grooves and ridges, is brownish in color, and grows more

quickly on one side than on the other. The thick curved nail is difficult to cut, and often remains untrimmed, exacerbating the problem.

- *Onycholysis* is a loosening of the exposed portion of the nail from the nail bed, usually beginning at the free edge and continuing to the lunula. It is frequently associated with an internal disorder, trauma, infection, nail fungi, allergy to nail enhancement products, or side effects of drugs.
- *Onychomadesis* is the separation and falling off of a nail from the nail bed. Common causes include localized infection, minor injury to the matrix bed, or severe systemic illness. It is sometimes a side effect of chemotherapy or x-ray treatments for cancer. A new nail plate will form once the cause of the disease is removed.
- *Onychomycosis*, also known as *tinea unguium*, is a contagious infection of the nail caused by the same fungal organisms which cause ringworm of the skin (*Trichophyton rubrum* or *T. mentagrophytes*, rarely other trichophyton species or *Epidermophyton floccosum*). It can result in discoloration, thickening, chalkiness, or crumbling of the nails and is often treated by powerful oral medications which, rarely, can cause severe side effects including liver failure. Mild onychomycosis sometimes responds to a combination of topical antifungal medication, sometimes applied as special medicinal nail lacquer, and periodic filing of the nail surface. For advanced onychomycosis, especially if more than one nail is infected, systemic medication (pills) is preferred. Home remedies are often used, although their effectiveness is disputed. In a study at the University of Rochester tea tree oil applied twice daily in conjunction with debridement was found to be an appropriate initial treatment strategy, equally effective to topical use of clotrimazole. Another procedure is to apply two drops of distilled white vinegar to the nail base, or,

additionally, nail plate and under the nail, two or three times daily for approximately six months or until the fungus is gone. This treatment is very effective, due to the vinegar's acidity, if followed consistently.

- *Onychophosis* is a growth of horny epithelium in the nail.
- *Onychoptosis* is the periodic shedding of one or more nails, in whole or part. This condition may follow certain diseases such as syphilis, or can result from fever, trauma, systemic upsets or adverse reaction to drugs.

- *Paronychia* is a bacterial or fungal infection where the nail and skin meet.



- *Koilonychia* is when the nail curves upwards (becomes spoon-shaped) due to an iron deficiency. The normal process of change is: brittle nails, straight nails, spoon-shaped nails.
- *Subungual hematoma* occurs when trauma to the nail results in a collection of blood, or hematoma, under the nail. It may result from an acute injury or from repeated minor trauma such as running in undersized shoes. Acute subungual hematomas are quite painful, and are usually treated by releasing the blood by creating a small hole in the nail. Drilling and thermal cautery (melting) are common methods for creating the hole. Thermal cautery is not used on acrylic nails because they are flammable.