

CHAPTER 3: THE INTEGUMENTARY SYSTEM

At the end of this chapter, student will be able to:

- a) Name the two major layers of the skin and the tissue of which each is made.
- b) State the locations and describe the functions of the stratum germinativum and stratum corneum.
- c) Describe the function of Langerhans cells.
- d) Describe the function of melanocytes and melanin.
- e) Describe the functions of hair and nails.
- f) Name the cutaneous senses and explain their importance.
- g) Describe the functions of the secretions of sebaceous glands, ceruminous glands, and eccrine sweat glands.
- h) Describe how the arterioles in the dermis respond to heat, cold, and stress.
- i) Name the tissues that make up the subcutaneous tissue, and describe their functions.

3.1. INTRODUCTION TO THE INTEGUMENTARY SYSTEM

The integumentary system consists of the skin, its accessory structures such as hair and sweat glands, and the subcutaneous tissue below the skin. The skin is made of several different tissue types and is considered an organ. Because the skin covers the surface of the body, one of its functions is readily apparent: It separates the internal environment of the body from the external environment and prevents the entry of many harmful substances. The subcutaneous tissue directly underneath the skin connects it to the muscles and has other functions as well.

3.2. THE SKIN

The two major layers of the skin are the outer **epidermis** and the inner **dermis**. Each of these layers is made of different tissues and has very different functions.

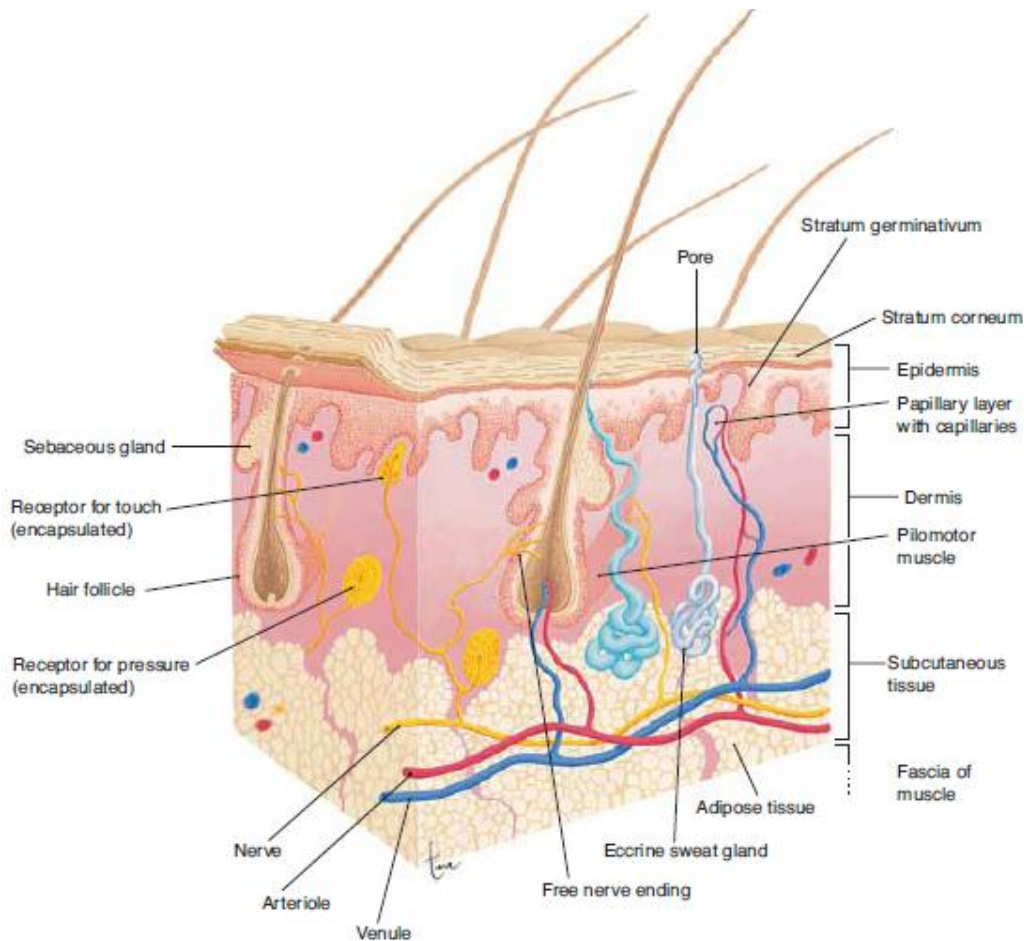


Figure: Skin. Structure of the skin and subcutaneous tissue.

A. EPIDERMIS

The **epidermis** is made of stratified squamous keratinizing epithelial tissue and is thickest on the palms and soles. The cells that are most abundant are called **keratinocytes**, and there are no capillaries present between them. Although the epidermis may be further subdivided into four or five sublayers, two of these are of greatest importance: the innermost layer, the stratum germinativum, and the outermost layer, the stratum corneum.

a) Stratum Germinativum

The **stratum germinativum** may also be called the stratum basale. Each name tells us something about this layer. To germinate means “to sprout” or “to grow.”

Basal means the “base” or “lowest part.” The stratum germinativum is the base of the epidermis, the innermost layer in which **mitosis** takes place. New cells are continually being produced, pushing the older cells toward the skin surface. These cells produce the protein **keratin**, and as they get farther away from the capillaries in the dermis, they die. As dead cells are worn off the skin’s surface, they are replaced by cells from the lower layers. Scattered among the keratinocytes of the stratum germinativum are very different cells called Merkel cells (or Merkel discs); these are receptors for the sense of touch.

The living keratinocytes are able to synthesize antimicrobial peptides called defensins; these and other chemicals are produced following any injury to the skin, as part of the process of inflammation. Defensins rupture the membranes of pathogens such as bacteria that may enter by way of breaks in the skin. The living portion of the epidermis also produces a vitamin; the cells have a form of cholesterol that, on exposure to ultraviolet light, is changed to vitamin D (then modified by the liver and kidneys to the most active form, called 1,25-D, or calcitriol, which is considered a hormone). This is why vitamin D is sometimes referred to as the “sunshine vitamin.” People who do not get much sunlight depend more on nutritional sources of vitamin D, such as fortified milk. But sunlight is probably the best way to get vitamin D, and 15 minutes a day a few times a week is often enough. Vitamin D is important for the absorption of calcium and phosphorus from food in the small intestine; this function has been known for years.

Recent research, however, suggests that vitamin D is also involved in maintaining muscle strength, especially in elderly people, in the functioning of insulin, and in some immune responses, where it may be protective for some types of cancer.

b) **Stratum Corneum**

The **stratum corneum**, the outermost epidermal layer, consists of many layers of dead cells; all that is left is their **keratin**. The protein keratin is relatively waterproof, and though the stratum corneum should not be thought of as a plastic bag encasing the body, it does prevent most evaporation of body water. Also of importance, keratin prevents the entry of water. Without a waterproof stratum corneum, it would be impossible to swim in a pool or even take a shower without damaging our cells. The stratum corneum is also a barrier to pathogens and chemicals.

Most bacteria and other microorganisms cannot penetrate unbroken skin. The flaking of dead cells from the skin surface helps remove microorganisms, and the fatty acids in sebum help inhibit their growth. Most chemicals, unless they are corrosive, will not get through unbroken skin to the living tissue within. One painful exception is the sap of poison ivy. This resin does penetrate the skin and initiates an allergic reaction in susceptible people. The inflammatory response that characterizes allergies causes blisters and severe itching. The importance of the stratum corneum becomes especially apparent when it is lost. Certain minor changes in the epidermis are undoubtedly familiar to you. When first wearing new shoes, for example, the skin of the foot may be subjected to friction. This will separate layers of the epidermis or separate the epidermis from the dermis, and tissue fluid may collect, causing a **blister**.

If the skin is subjected to pressure, the rate of mitosis in the stratum germinativum will increase and create a thicker epidermis; we call this a **callus**. Although calluses are more common on the palms and soles, they may occur on any part of the skin.

c) Langerhans Cells

Within the epidermis are **Langerhans cells**, which are also, called **dendritic cells** because of their branched appearance when they move. These cells originate in the red bone marrow, and are quite mobile. They are able to phagocytize foreign material, such as bacteria that enter the body through breaks in the skin. With such ingested pathogens, the Langerhans cells migrate to lymph nodes and present the pathogen to lymphocytes, a type of white blood cell. This triggers an immune response such as the production of antibodies (antibodies are proteins that label foreign material for destruction). Because of its position adjacent to the external environment, the skin is an important component of the body's protective responses, though many of the exact aspects of this have yet to be determined.

d) Melanocytes

Another type of cell found in the lower epidermis is the melanocyte. **Melanocytes** produce another protein, a pigment called **melanin**. People of the same size have approximately the same number of melanocytes, though these cells may differ in their level of activity.

In people with dark skin, the melanocytes continuously produce large amounts of melanin. The melanocytes of lightskinned people produce less melanin. The activity of melanocytes is genet-

ically regulated; skin color is one of our hereditary characteristics. In all people, melanin production is increased by exposure of the skin to ultraviolet rays, which are part of sunlight and are damaging to living cells. As more melanin is produced, it is taken in by the epidermal cells as they are pushed toward the surface. This gives the skin a darker color, which prevents further exposure of the living stratum germinativum to ultraviolet rays. People with dark skin already have good protection against the damaging effects of ultraviolet rays; people with light skin do not.

Melanin also gives color to hair, though its protective function is confined to the hair of the head. Two parts of the eye obtain their color from melanin: the iris and the interior choroid layer of the eyeball.

B. DERMIS

The **dermis** is made of an irregular type of fibrous connective tissue, irregular meaning that the fibers are not parallel, but run in all directions. Fibroblasts produce both **collagen** and **elastin** fibers. Recall that collagen fibers are strong, and elastin fibers are able to recoil after being stretched. Strength and elasticity are two characteristics of the dermis. With increasing age, however, the deterioration of the elastin fibers causes the skin to lose its elasticity. We can all look forward to at least a few wrinkles as we get older. The uneven junction of the dermis with the epidermis is called the **papillary layer**. Capillaries are abundant here to nourish not only the dermis but also the stratum germinativum.

The epidermis has no capillaries of its own, and the lower, living cells depend on the blood supply in the dermis for oxygen and nutrients. Within the dermis are the accessory skin structures: hair and nail follicles, sensory receptors, and several types of glands. Some of these projects through the epidermis to the skin surface, but their active portions are in the dermis.

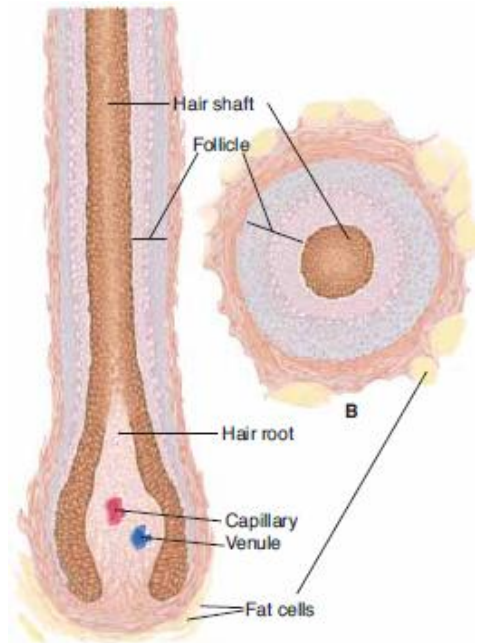
Hair Follicles

Hair follicles are made of epidermal tissue, and the growth process of hair is very similar to growth of the epidermis. At the base of a follicle is the **hair root**, which contains cells, called the **matrix**, where mitosis takes place.

The new cells produce keratin, get their color from melanin, then die and become incorporated into the **hair shaft**, which is pushed toward the surface of the skin. The hair that we comb and brush every day consists of dead, keratinized cells. The rate of hair growth averages 0.3 to 0.4 in./month (8 to 10 mm). Compared to some other mammals,

humans do not have very much hair. The actual functions of human hair are quite few. Eyelashes and eyebrows help to keep dust and perspiration out of the eyes, and the hairs just inside the nostrils help to keep dust out of the nasal cavities. Hair of the scalp does provide insulation from cold for the head. The hair on our bodies, however, no longer serves this function, but we have the evolutionary remnants of it. Attached to each hair follicle is a small, smooth muscle called the **pilomotor**.

Figure: A hair follicle (Longitudinal and Cross-section)



Nail Follicles

Found on the ends of fingers and toes, **nail follicles** produce nails just as hair follicles produce hair. Mitosis takes place in the **nail root** at the base of the nail, and the new cells produce keratin (a stronger form of this protein than is found in hair) and then die. Although the nail itself consists of keratinized dead cells, the flat nail bed is living epidermis and dermis. This is why cutting a nail too short can be quite painful. Nails protect the ends of the fingers and toes from mechanical injury and give the fingers greater ability to pick up small objects. Finger nails are also good for scratching. This is more important than it may seem at first. An itch might mean the presence of an arthropod parasite, mosquito, tick, flea, or louse. These parasites (all but the tick are insects) feed on

blood, and all are potential vectors of diseases caused by bacteria, viruses, or protozoa.

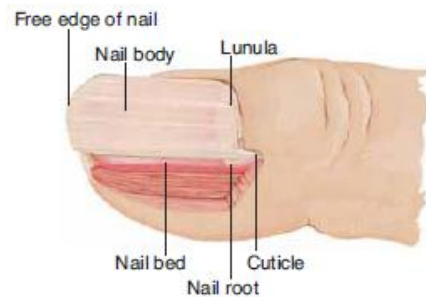


Figure: A fingernail shown in longitudinal section

A quick and vigorous scratch may kill or at least dislodge the arthropod and prevent the transmission of the disease. Fingernails grow at the rate of about 0.12 in./month (3 mm), and growth is a little faster during the summer months.

Receptors

Most sensory **receptors** for the cutaneous senses are found in the dermis (Merkel cells are in the stratum germinativum, as are some nerve endings). The cutaneous senses are touch, pressure, heat, cold, and pain. For each sensation there is a specific type of receptor, which is a structure that will detect a particular change. For pain, heat, and cold, the receptors are **free nerve endings**. For touch and pressure, the receptors are called **encapsulated nerve endings**, which mean there is a cellular structure around the sensory nerve ending. The purpose of these receptors and sensations is to provide the central nervous system with information about the external environment and its effect on the skin. This information may stimulate responses, such as washing a painful cut finger, scratching an insect bite, or responding to a feeling of cold by putting on a sweater. The sensitivity of an area of skin is determined by how many receptors are present. The skin of the fingertips, for example, is very sensitive to touch because there are many receptors per square inch. The skin of the upper arm, with few touch receptors per square inch, is less sensitive. When receptors detect changes, they generate nerve impulses that are carried to the brain, which interprets the impulses as a particular sensation. Sensation, therefore, is actually a function of the brain.

Glands

Glands are made of epithelial tissue. The exocrine glands of the skin have their secretory portions in the dermis.

- **Sebaceous Glands.** The ducts of **sebaceous glands** open into hair follicles or directly to the skin surface. Their secretion is **sebum**, a lipid substance that we commonly refer to as oil. As mentioned previously, sebum inhibits the growth of bacteria on the skin surface. Another function of sebum is to prevent drying of skin and hair. The importance of this may not be readily apparent, but skin that is dry tends to crack more easily. Even very small breaks in the skin are potential entryways for bacteria. Decreased sebum production is another consequence of getting older, and elderly people often have dry and more fragile skin. Adolescents may have the problem of overactive sebaceous glands. Too much sebum may trap bacteria within hair follicles and create small infections. Because sebaceous

glands are more numerous around the nose and mouth, these are common sites of pimples in young people.

- **Ceruminous Glands.** These glands are located in the dermis of the ear canals. Their secretion is called **cerumen** or ear wax (which includes the sebum secreted in the ear canals). Cerumen keeps the outer surface of the eardrum pliable and prevents drying. However, if excess cerumen accumulates in the ear canal, it may become impacted against the eardrum. This might diminish the acuity of hearing by preventing the eardrum from vibrating properly.

- **Sweat Glands.** There are two types of sweat glands, apocrine and eccrine.
 - ✓ **Apocrine glands** are most numerous in the axillae (underarm) and genital areas and are most active in stressful and emotional situations. Although their secretion does have an odor, it is barely perceptible to other people. Animals such as dogs, however, can easily distinguish among people because of their individual scents. If the apocrine secretions are allowed to accumulate on the skin, bacteria metabolize the chemicals in the sweat and produce waste products that have distinct odors that many people find unpleasant.

 - ✓ **Eccrine glands** are found all over the body but are especially numerous on the forehead, upper lip, palms, and soles. The secretory portion of these glands is simply a coiled tube in the dermis. The duct of this tube extends to the skin's surface, where it opens into a **pore**. The sweat produced by eccrine glands is important in the maintenance of normal body temperature. In a warm environment, or during exercise, more sweat is secreted onto the skin surface, where it is then evaporated by excess body heat. Recall that water has a high heat of vaporization, which means that a great deal of heat can be lost in the evaporation of a relatively small amount of water. Although this is a very effective mechanism of heat loss, it has a potentially serious disadvantage. Loss of too much body water in sweat may lead to **dehydration**, as in heat exhaustion or even after exercise on a hot and humid day. Increased sweating during exercise or on warm days should always be accompanied by increased fluid intake. Those who exercise regularly know that they must replace salt as well

as water. Sodium chloride is also lost in sweat, as are small amounts of **urea** (a nitrogenous waste product of amino acid metabolism). This excretory function of the skin is very minor, however; the kidneys are primarily responsible for removing waste products from the blood and for maintaining the body's proper salt-to-water proportion.

Blood Vessels

Besides the capillaries in the dermis, the other blood vessels of great importance are the arterioles.

Arterioles are small arteries, and the smooth muscle in their walls permits them to constrict (close) or dilate (open). This is important in the maintenance of body temperature, because blood carries heat, which is a form of energy. In a warm environment the arterioles dilate (**vasodilation**), which increases blood flow through the dermis and brings excess heat close to the body surface to be radiated to the environment. In a cold environment, however, body heat must be conserved if possible, so the arterioles constrict.

The **vasoconstriction** decreases the flow of blood through the dermis and keeps heat within the core of the body. This adjusting mechanism is essential for maintaining homeostasis. Regulation of the diameter of the arterioles in response to external temperature changes is controlled by the nervous system. These changes can often be seen in light-skinned people. Flushing, especially in the face, may be observed in hot weather. In cold, the skin of the extremities may become even paler as blood flow through the dermis decreases. In people with dark skin, such changes are not as readily apparent because they are masked by melanin in the epidermis. Vasoconstriction in the dermis may also occur during stressful situations. For our ancestors, stress usually demanded a physical response: Either stand and fight or run away to safety. This is called the “fight or flight response.”

Our nervous systems are still programmed to respond as if physical activity were necessary to cope with the stress situation. Vasoconstriction in the dermis will shunt, or redirect, blood to more vital organs such as the muscles, heart, and brain. In times of stress, the skin is a relatively unimportant organ and can function temporarily with a minimal blood flow. You have probably heard the expression “broke out in a cold sweat,” and may even have felt it in a stressful situation. Such sweating feels cold because vasoconstriction in the dermis makes the skin relatively

cool. Blood flow in the dermis may be interrupted by prolonged pressure on the skin. For example, a hospital patient who cannot turn over by herself may develop a **decubitus ulcer**, also called a pressure ulcer or pressure sore. The skin is compressed between the object outside, such as a bed, and a bony prominence within, such as the heel bone or the sacrum in the lower back. Without its blood supply the skin dies, and the dead tissue is a potential site for bacterial infection.

3.3. SUBCUTANEOUS TISSUE

The **subcutaneous tissue** may also be called the **superficial fascia**, one of the connective tissue membranes. Made of areolar connective tissue and adipose tissue, the superficial fascia connects the dermis to the underlying muscles. Its other functions are those of its tissues.

Areolar connective tissue, or loose connective tissue, contains collagen and elastin fibers and many white blood cells that have left capillaries to wander around in the tissue fluid between skin and muscles. These migrating white blood cells destroy pathogens that enter the body through breaks in the skin. Mast cells are specialized connective tissue cells found in areolar tissue; they produce histamine, leukotrienes, and other chemicals that help bring about inflammation the body's response to damage.

The cells (adipocytes) of adipose tissue are specialized to store fat, and our subcutaneous layer of fat stores excess nutrients as a potential energy source. This layer also cushions bony prominences, such as when sitting, and provides some insulation from cold. For people, this last function is relatively minor, because we do not have a thick layer of fat, as do animals such as whales and seals. Adipose tissue is involved in the onset or cessation of eating and in the use of insulin by body cells, and it contributes to inflammation by producing cytokines, chemicals that activate white blood cells. Just as the epidermis forms a continuous sheet that covers the body, the subcutaneous tissue is a continuous layer, though it is internal. If we consider the epidermis as the first line of defense against pathogens, we can consider the subcutaneous tissue a secondary line of defense. There is, however, a significant anatomic difference.

The cells of the epidermis are very closely and tightly packed, but the cells and protein fibers of subcutaneous tissue are farther apart, and there is much more tissue fluid. If we imagine the epidermis as a four-lane highway during rush hour with bumper-to-bumper traffic, the superficial fascia would be that same highway at three o'clock in the morning, when it is not crowded and cars can move much faster. This is an obvious benefit for the migrating white blood cells, but may become a disadvantage because some bacterial pathogens, once established, can spread even more rapidly throughout subcutaneous tissue.

Group A streptococcus, for example, is a cause of **necrotizing fasciitis**. *Necrotizing* means “to cause death,” and *fasciitis* is the inflammation of a fascia, in this case the superficial fascia and the deep fasciae around muscles. Necrotizing fasciitis is an extremely serious infection and requires surgical removal of the infected tissue, or even amputation of an infected limb, to try to stop the spread of the bacteria. The body’s defenses have been overwhelmed because what is usually an anatomic benefit, the “looseness” of areolar connective tissue, has been turned against us and become a detriment.

AGING AND THE INTEGUMENTARY SYSTEM

The effects of age on the integumentary system are often quite visible. Both layers of skin become thinner and more fragile as mitosis in the epidermis slows and fibroblasts in the dermis die and are not replaced; repair of even small breaks or cuts is slower. The skin becomes wrinkled as collagen and elastin fibers in the dermis deteriorate.

Sebaceous glands and sweat glands become less active; the skin becomes dry, and temperature regulation in hot weather becomes more difficult. Hair follicles become inactive and hair on the scalp and body thins. Melanocytes die and are not replaced; the hair that remains becomes white. There is often less fat in the subcutaneous tissue, which may make an elderly person more sensitive to cold.

It is important for elderly people (and those who care for them) to realize that extremes of temperature may be harmful and to take special precautions in very hot or very cold weather.

- **Applications to the nursing care**

1. BURNS

Burns of the skin may be caused by flames, hot water or steam, sunlight, electricity, or corrosive chemicals. The severity of burns ranges from minor to fatal, and the classification of burns is based on the extent of damage.

First-Degree Burn: only the superficial epidermis is burned, and is painful but not blistered. Lightcolored skin will appear red due to localized **vasodilation** in the damaged area. Vasodilation is part of the inflammatory response that brings more blood to the injured site.

Second-Degree Burn: deeper layers of the epidermis are affected. Another aspect of **inflammation** is that damaged cells release **histamine**, which makes capillaries more permeable. More plasma leaves these capillaries and becomes tissue fluid, which collects at the burn site, creating blisters. The burned skin is often very painful.

Third-Degree Burn: the entire epidermis is charred or burned away, and the burn may extend into the dermis or subcutaneous tissue. Often such a burn is not painful at first, if the receptors in the dermis have been destroyed. Extensive third-degree burns are potentially lifethreatening because of the loss of the stratum corneum. Without this natural barrier, living tissue is exposed to the environment and is susceptible to infection and dehydration. Bacterial infection is a serious problem for burn patients; the pathogens may get into the blood (**septicemia**) and quickly spread throughout the body. Dehydration may also be fatal if medical intervention does not interrupt and correct the following sequence: Tissue fluid evaporates from the burned surface, and more plasma is pulled out of capillaries into the tissue spaces.

As more plasma is lost, blood volume and blood pressure decrease. This is called **circulatory shock**; eventually the heart simply does not have enough blood to pump, and heart failure is the cause of death. To prevent these serious consequences, third-degree burns are covered with donor skin or artificial skin until skin grafts of the patient's own skin can be put in place.

2. ADMINISTERING MEDICATIONS

You have probably seen the skin patches that supply nicotine, and you know that their purpose is to help smokers give up cigarettes. This method of supplying a medication is called *transdermal administration*. The name is a little misleading because the most difficult part of cutaneous absorption of a drug is absorption through the stratum corneum of the epidermis. Because such absorption is slow, skin patches are useful for medications needed in small but continuous amounts, and over a prolonged period of time. You would expect that such patches should be worn where the epidermis is thin. These sites include the upper arm and the chest. The recommended site for a patch to prevent motion sickness is the skin behind the ear. Also available in patch form are medications for birth control, overactive bladder, high blood pressure, and both systemic and localized pain relief. Medications may also be injected through the skin. Some injections are given subcutaneously, that is, into subcutaneous tissue. Subcutaneous adipose tissue has a moderate blood supply, so the rate of absorption of the drug will be moderate, but predictable. Insulin is given subcutaneously. Other injections are intramuscular, and absorption into the blood is rapid because muscle tissue has a very good blood supply. Most injectable vaccines are given intramuscularly, to promote rapid absorption to stimulate antibody production.

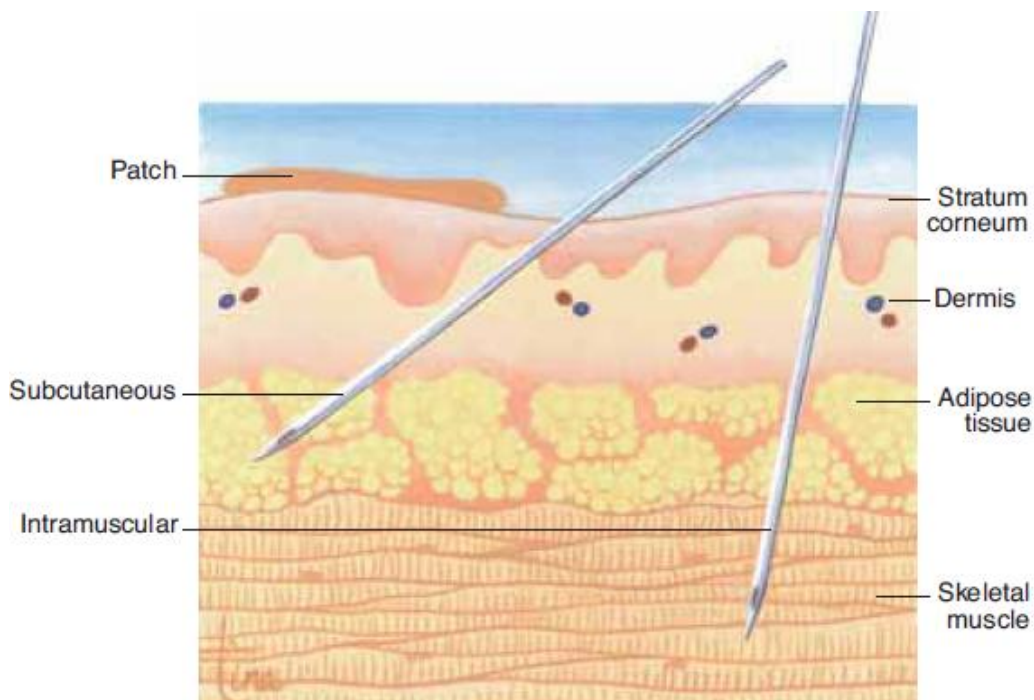


Figure: The skin, subcutaneous tissue, and muscle sites for the delivery of medications.

3. *PREVENTING SKIN CANCER: COMMON SENSE AND SUNSCREENS*

Anyone can get skin cancer, and the most important factor is exposure to sunlight. Light-skinned people are, of course, more susceptible to the effects of ultraviolet (UV) rays, which may trigger **mutations** in living epidermal cells. Squamous cell **carcinoma** and basal cell carcinoma are the most common forms of skin cancer. The lesions are visible as changes in the normal appearance of the skin, and a **biopsy** (microscopic examination of a tissue specimen) is used to confirm the diagnosis. These lesions usually do not **metastasize** rapidly, and can be completely removed using simple procedures.

Malignant **melanoma** is a more serious form of skin cancer, which begins in melanocytes. Any change in a pigmented spot or mole (**nevus**) should prompt a person to see a doctor. Melanoma is serious not because of its growth in the skin, but because it may **metastasize** very rapidly to the lungs, liver, or other vital organ.

Researchers are testing individualized vaccines for people who have had melanoma. The purpose of the vaccine is to stimulate the immune system strongly enough to prevent a second case, for such recurrences are often fatal.

Although the most common forms of skin cancer are readily curable, prevention is a better strategy. We cannot, and we would not want to, stay out of the sun altogether (because sunlight may be the best way to get sufficient vitamin D), but we may be able to do so when sunlight is most damaging.

During the summer months, UV rays are especially intense between 10 A.M. and 2 P.M. If we are or must be outdoors during this time, dermatologists recommend use of a sunscreen.

Sunscreens contain chemicals such as PABA (para-amino benzoic acid) that block UV rays and prevent them from damaging the epidermis. An SPF (sun protection factor) of 15 or higher is considered good protection. Use of a sunscreen on exposed skin not only helps prevent skin cancer but also prevents sunburn and its painful effects. It is especially important to prevent children from getting severely sunburned, because such burns have been linked to the development of skin cancer years later.

4. COMMON SKIN DISORDERS

Impetigo: a bacterial infection often caused by streptococci or staphylococci. The characteristic pustules (pus-containing lesions) crust as they heal; the infection is contagious to others.

Eczema: a symptom of what is more properly called atopic dermatitis. This may be an allergic reaction, and is more common in children than adults; the rash is itchy (**pruritus**) and may blister or ooze. Eczema may be related to foods such as fish, eggs, or milk products, or to inhaled allergens such as dust, pollens, or animal dander. Prevention depends upon determining what the child is allergic to and eliminating or at least limiting exposure.

Warts: caused by a virus that makes epidermal cells divide abnormally, producing a growth on the skin that is often raised and has a rough or pitted surface. Warts are probably most common on the hands, but they may be anywhere on the skin. Plantar warts on the sole of the foot may become quite painful because of the constant pressure of standing and walking.

Fever blisters (cold sores): caused by the herpes simplex virus, to which most people are exposed as children. An active lesion, usually at the edge of the lip (but may be anywhere on the skin), is painful and oozes. If not destroyed by the immune system, the virus “hides out” and becomes dormant in nerves of the face. Another lesion, weeks or months later, may be triggered by stress or another illness.

5. TATTOOING AND BODY PIERCING

Tattooing is a permanent coloration of the skin in which a foreign pigment is deposited with a needle into the dermis. It is believed that the practice originated in ancient Egypt between 4000 and 2000 B.C. Tattoos are created by injecting ink with a needle that punctures the epidermis and moves between 50 and 3000 times per minute and deposits the ink in the dermis. Since the dermis is stable (unlike the epidermis, which is shed about every four weeks), tattoos are permanent. However, they can fade over time due to exposure to sunlight, improper healing, picking scabs, and flushing away of ink particles by the lymphatic system.

Tattoos can be removed by lasers, which use concentrated beams of light. In the procedure, which requires a series of treatments, the tattoo inks and pigments selectively absorb the high-intensity laser light without destroying normal surrounding skin tissue. The laser causes the tattoo to dissolve into small ink particles that are eventually removed by the immune system.

Laser removal of tattoos involves a considerable investment in time and money and can be quite painful.

Body piercing, the insertion of jewelry through an artificial opening, is also an ancient practice employed by Egyptian pharaohs and Roman soldiers, and a current tradition among many Americans. For most piercing locations, the piercer cleans the skin with an antiseptic, retracts the skin with forceps, and pushes a needle through the skin.

Then the jewelry is connected to the needle and pushed through the skin. Total healing can take up to a year. Among the sites that are pierced are the ears, nose, eyebrows, lips, tongue, nipples, navel, and genitals.

Potential complications of body piercing are infections, allergic reactions, and anatomical damage (such as nerve damage or cartilage deformation). In addition, body piercing jewelry may interfere with certain medical procedures such as masks used for resuscitation, airway management procedures, urinary catheterization, radiographs, and delivery of a baby.