# The Integumentary System – Study Guide

## Table of Contents

- **Introduction** ........................................................................................................ 2
- **The Layers of the Skin** ......................................................................................... 2
  - Epidermis .................................................................................................................. 3
  - Dermis ....................................................................................................................... 4
  - Subcutaneous Fascia ............................................................................................... 5
- **Accessory Structures** .......................................................................................... 6
  - Sudoriferous Glands ............................................................................................... 7
  - Hair ......................................................................................................................... 8
  - Nails ......................................................................................................................... 9
- **Functions of the Integumentary System** ............................................................. 10
  - Sensory Detection ................................................................................................. 10
  - Temperature Regulation ....................................................................................... 11
  - Manufacture and Storage ..................................................................................... 11
  - Accessory Structure Functions ............................................................................. 12
- **Diseases and Disorders** ..................................................................................... 12
  - Discoloration ........................................................................................................... 12
  - Burns ....................................................................................................................... 14
  - Skin Lesions ............................................................................................................ 15
  - Inflammations and Infections ............................................................................... 19
  - Common Diseases .................................................................................................. 20
  - Skin Cancer ............................................................................................................ 22
- **Patient Care** ........................................................................................................ 23
  - Asking Questions .................................................................................................... 23
  - Antibiotics .............................................................................................................. 24
  - Skin Care ............................................................................................................... 24
- **Table of Figures** .................................................................................................. 25
Introduction

When we think of our skin, we typically think of layers of skin tissue which cover and protect the rest of our body. However, protection is only one purpose that it serves. Skin is very complex, and though it is often referred to as either a membrane or an organ, when taken in its entirety it is a system which contains multiple components that work together to accomplish a variety of goals. This system is called the integumentary system.

The integumentary system is made up of multiple skin layers, as well as accessory structures (or appendages). These appendages include sebaceous (oil) glands, sudoriferous (sweat) glands, hair, and nails. This module will introduce you to these components of the integumentary system and the role they play in the human body as a whole. By the end of this course you will have a greater understanding of the importance of the skin and its appendages, and you will be able to identify several major health issues associated with the integumentary system.

The Layers of the Skin

There are three main layers of skin, and each layer serves the human body in a different way. These layers are the epidermis, the dermis, and the subcutaneous layer.
Epidermis

The epidermis is the outer layer of the skin, and its main purpose is to protect the layers of skin beneath it as well as the rest of the human body. Though the epidermis is composed of five sublayers (called strata), there are two main layers that we are concerned with:

The innermost layer of the epidermis is the stratum germinativum, or stratum basal as it is sometimes called. The epidermis does not contain blood vessels or any other appendages, so epithelial (skin) cells in the stratum germinativum are nourished by the dermis, the layer beneath the epidermis. These cells divide and also produce daughter cells. The resulting crowd forces many skin cells to rise away from nourishment toward the outer layers of the epidermis. The stratum germinativum also contains cells called melanocytes. These cells contain and produce melanin, a pigment which provides skin and hair color, and which also helps protect the skin from harmful ultraviolet rays.

The outermost layer is the stratum corneum. This layer is composed of skin cells that have risen up from the stratum germinativum called squamous (scaly) cells. As skin cells from the stratum germinativum get further away from the nourishment provided by blood vessels in the dermis, they die and their cytoplasm is replaced by keratin, a hard, fibrous protein that is also water resistant. These cells get flatter as they rise to the surface of the skin, and this combined with the keratin that they are composed of results in increased protection due to their scalelike quality. Areas of the body covered by thicker skin have stratum corneum in deeper layers than do other parts of the body.
**Dermis**

The dermis, as has already been mentioned, is the layer of skin below the epidermis. This layer is also called the corium, which means "true skin." This meaning fits, as the dermis contains not only skin cells but most of the accessory structures that make up a good deal of the integumentary system. Apart from these accessory structures, the dermis also contains blood vessels, lymph vessels, involuntary muscles and nerve fibers.

![Image of Dermis layers and components](image_url)

*Figure 3 - Dermis layers and components illustrated*

The framework of the dermis is composed of elastic connective tissue that contains collagen, a flexible but tough protein material, which allows it to stretch with little damage. **Mast cells** are also found in this connective tissue. These cells have two functions: they respond to injury by releasing heparin, an anticoagulant that ensures blood flow so that the immune system can function properly; and they respond to allergens and infection by releasing histamine, also an integral part of the immune system.
The thickness of the dermis varies, with areas such as palms and soles having rather thick layers and eyelids and other delicate areas having very thin layers. In some places, the dermis has what are called dermal papillae, extensions of the dermis that let blood vessels and nerve endings get closer to the surface of the skin. This helps provide more warmth for the skin, especially the skin of the extremities. Dermal papillae fit into ridges in the stratum germinativum, which often results in visible striations on the skin. These striations can be seen best on fingers, toes, palms and soles. They are the lines that give each person a unique set of handprints and footprints, and they serve the practical functions of providing a better gripping surface for hands and feet.

The dermis contains sensitive nerve endings that transmit impulses to and from the spinal cord and the brain. The stimuli they react to include light touch, deep pressure, heat, cold, and pain. Each of these stimuli has different nerves in the dermis assigned to it.

**Subcutaneous Fascia**

The subcutaneous fascia, also called the subcutaneous layer, the superficial fascia, or the hypodermis, is the innermost layer of skin below the dermis. It is mainly composed of an outer layer of adipose (fat) tissue as well as an inner layer of elastic connective tissue. It is closely related to the dermis; elastic fibers within these two layers interconnect so that there is no distinct boundary between them. The inner layer of elastic tissue connects to muscles that lie below the subcutaneous layer, connecting the integumentary system to the muscular system.

![Figure 4 - Subcutaneous Fascia Illustrated](image-url)
Accessory Structures

The four types of accessory structures, or appendages, of the skin are sebaceous glands, sudoriferous glands, hair, and nails. Each of these types of accessory structures plays a vital role in maintaining the integrity of the integumentary system and the body as a whole.

Sebaceous glands are saclike oil glands that serve to lubricate skin and hair. The oil that they produce is called sebum, and this oil is transferred from the glands to the hair and skin through a duct which begins at the gland and opens directly into hair follicles. Sebum has a slightly acidic quality, which makes it effective against bacterial and fungal growth. Meibomian glands, which are specialized sebaceous glands, are found within eyelids. These secrete sebum to keep the eyes moist, and they also help seal the eyelids to the eyes.

Figure 5 - Integumentary Hair and Follicles Illustrated
Sudoriferous Glands

Sudoriferous glands, or sweat glands, are coiled tubes within the dermis that open up into pores on the skin. These glands are in charge of the process of hidrosis, or the manufacture and secretion of sweat. There are many different kinds of sudoriferous glands, though the following are some of the main ones that you should be aware of:

- **Eccrine glands** are the most common glands, and they can be found in many different parts of the body, especially the palms of the hands and the soles of the feet.

- **Apocrine glands** are typically developed during puberty, and are mainly present in the armpit and groin areas.

- **Ciliary glands**, or the glands of Moll, are modified sudoriferous glands that empty out into the eyelashes.

- **Ceruminous glands** are found in the ear canal.

- **Mammary glands** are found in the breasts of women, and will be covered in further detail in the Reproductive System Module.

Figure 6 - Accessory Structures Illustrated
Sweat, or perspiration, typically consists of 99% water, with a small amount of salts and bodily wastes. However, depending on the type of sudoriferous gland, perspiration can vary in its composition. Eccrine glands produce perspiration with the most common consistency that is mentioned above. Apocrine glands produce perspiration with a higher content of bodily wastes, which is mainly dead cellular material; it is the breakdown of bodily wastes by bacteria that causes body odor, not sweat itself, and thus areas with apocrine glands are generally associated with an increased odor. Ciliary glands produce a lipid that helps keep eyes moist, ceruminous glands produce earwax, and mammary glands produce breast milk.

**Hair**

**Hair** covers almost all of the human body. Typically, it is soft and fine, so it is not often plainly visible, but it is present in nearly every area except for the palms and the soles of the feet. Hair is composed mainly of compacted protein cells filled with keratin, and is formed in bulbs that are the bases of hair follicles. It is produced from the rapid division of epithelial cells that surround these bulbs in what is called the hair matrix. Melanocytes also reside in the hair matrix, and the melanin they create dyes the hair as it is formed.
Though the bottoms of hair follicles are bulbs, the main portion of a follicle is a hollow tube through which hair is forced upward. The portion of hair in the follicle is called the root, and hair which grows above the surface of the skin is called the shaft. Many hair follicles have a muscle attached to them called the arrector pili (plural: arrectores pilorum). These muscles respond to impulses from nerves so that when a person feels cold or experiences fright, follicles contract and hair stands erect, an act that conserves heat.

**Nails**

Nails, or ungues, are made from hard keratin. They are formed to closely mold over nail beds, and their formation occurs at the base of the nail bed beneath the eponychium, or cuticle. This area is called the nail matrix; the visible part of this is called the lanula, which looks like a pale semi-circle that can typically be seen best at the base of the thumbnail.

The nail bed provides nourishment to the nails from the skin below. It is visible as a pink area, and the part of the nail that hangs out past the nail bed is called the free edge. The cuticle is a thin layer of epidermis that seals the nails and protects the growing cells as well as the nail beds. If lost, a nail will grow back over time provided that the nail bed is not overly damaged.
Functions of the Integumentary System

The functions of the integumentary system can be divided up into two different groups. The first group consists of the functions of the skin itself, while the second group consists of the functions of the accessory structures.

The first function of the skin is **physical protection**. Skin keeps unwanted materials out of the body, and prevents the evaporation of too much water from inside the body. The keratin-filled cells on the outside of the epidermis provide protection against foreign objects and present a physical barrier to water loss.

The second function is **prevention of infection**. The stratum corneum is made of tightly packed cells that prevent pathogens and some bacterial toxins from entering the body. Also, as the cells on the outer layer of skin fall or are sloughed off they take bacteria and other pathogens with them.

**Sensory Detection**

The skin **detects sensory information** through the various nerve endings that it contains. Free nerve endings detect pain, some nerves detect hot temperatures and some detect cold temperatures. Other nerves found in various places throughout the skin are called mechanoreceptors. These are divided into four kinds of **mechanoreceptors**:

- **Pacinian corpuscles** detect deep pressure.
- **Meissner's corpuscles**, which are sometimes called tactile corpuscles, detect light touch.
- **Merkel nerve endings** detect displacement of skin, increasing tactile sensory information from skin contact as well as detecting small, sharp points that penetrate the skin.
- **Ruffini corpuscles**, which have been found only in humans on hairless areas such as those on the palms of the hands, detect skin stretch so that positioning of the skin on a surface can be precise. This aids humans in maintaining grips on objects and footholds on rough terrain.
**Temperature Regulation**

The next function of the skin is the **regulation of temperature**. The supply of blood through the skin nourishes the integumentary system so that it can continue to grow and operate effectively, but it also serves the purpose of keeping the temperature of the body regulated. When the nerves in the skin detect cold, the blood vessels constrict in order to reduce heat loss by reducing blood flow. This results in cold skin looking pale. Meanwhile, certain exposed areas, such as the ears and nose, become red when they get cold because of specialized blood vessels that supply them with blood in order to prevent freezing. Color continues to matter with hot temperatures: the color of hot skin is red due to the fact that when skin becomes hot, blood vessels dilate so that blood can come close to the surface and cool the skin down.

**Manufacture and Storage**

Another function of the skin is the absorption and use of the sun's ultraviolet rays in order to **manufacture pre-vitamin D3**. This occurs in the lowest levels of the epidermis when the compound found in human skin called 7-dehydrocholesterol is converted into pre-vitamin D3 after it absorbs ultraviolet radiation. This pre-vitamin then makes its way to the liver and kidney to be processed into a form of vitamin D3 that the body can employ. Vitamin D3 plays an essential role in various body processes and this role is crucial for maintaining the health of the human body as a whole.

![Image of UV light converting 7-dehydrocholesterol into cholecalciferol (pre-vitamin D3)](image.png)

**Figure 9 - Absorption of Vitamin D via Sunlight Illustrated**

Lastly, the skin is also used for **storage**. Not only does it store energy in adipose tissue, it stores water, salts, glucose, and vitamins.
Accessory Structure Functions

The functions of the accessory structures are very similar to the functions of the skin itself, save for the fact that their methods for achieving these functions are different.

The sebum produced by the sebaceous glands is antifungal and antibacterial, and this sebum also serves to waterproof the skin and prevent too much evaporation of water, which helps especially in keeping the eyes moist. Sebum also helps insulate the body against cold.

Sudoriferous glands excrete sweat, which helps the body get rid of excess water and even a small portion of body wastes. Also, the evaporation of sweat on skin draws heat away from the body; it is for this reason that hot and muggy conditions often feel uncomfortable, as sweat evaporates slowly in humid conditions.

The last functions to be discussed are provided by hair and nails. Hair serves to prevent heat loss from the body, as well as to prevent damage to the eyes in the cases of eyebrows and eyelashes. Nails serve to protect the distal phalanges - the end bones of the fingers and toes - as well as the skin around them.

Diseases and Disorders

The fact that the integumentary system is the first line of defense for the body means that it has a high risk for disease and disorder. The maladies that affect this system can best be divided by their physical characteristics, since as a medical professional part of your job will be identifying health issues through visible means. Keep in mind, however, that in some cases problems that can be identified by an examination of the skin are not necessarily issues that reflect on the health of the integumentary system but rather the dysfunction of other parts of the body.

Discoloration

The first noticeable sign of a health problem may be the discoloration of a patient's skin, and there are several common types of discoloration to look for. Once again, many discolorations of skin are a result of health issues that have little to do with the integumentary system.

Flushing, as most people know, can be a sign of fever, as the heat from a fever results in increased blood flow to skin so that the body can cool itself. This is characterized by increased redness about the face and neck.

Cyanosis occurs when blood is not oxygenated, or there is a defect in the hemoglobin of the blood. The deoxygenated or otherwise defective hemoglobin in blood vessels is a darker red
than normal; factors such as constriction and the fact that red light is less easily reflected than blue light causes this darker hemoglobin to appear as blue when seen from above the skin. This gives a blue pallor to fingers and toes as well as other parts of the body.

![Image of cyanosis](image10.jpg)

**Figure 10 - Cyanosis Illustrated**

**Jaundice** occurs when large amounts of bilirubin, or bile pigments, are present in the blood, causing the skin and the whites of the eyes to take on a yellow tint. This typically happens due to liver problems, and often occurs in the case of newly born babies whose livers are not yet developed enough to process bilirubin; these babies, and often others with jaundice, are treated with fluorescent lights that help their bodies process bilirubin without relying on the liver.

![Image of jaundice](image11.jpg)

**Figure 11 - Jaundice Illustrated**
Burns

Burns are identified in four stages or degrees of damage to the skin. Keep in mind that sunburns are accompanied by ultraviolet radiation, and may increase the risk of skin cancer.

First-degree burns, or superficial partial-thickness burns, affect the epidermis. While the skin may blister and appear red, these burns are not very serious.

Second-degree burns, which are either classified as superficial partial-thickness or deep partial-thickness burns, penetrate past the epidermis into the dermis. This penetration causes weeping skin, since fluids in the dermis are opened to the skin's surface. These burns are serious and may require treatment for infection, but affected skin is usually able to regenerate.

Third-degree burns, or full-thickness burns, penetrate through the epidermis and dermis, and may even penetrate through the subcutaneous fascia into tissue beneath it. Affected skin in this case is dry and broken, and may be pale or charred. Full-thickness burns may require treatments such as skin grafting, and may even result in loss of life or limb.

Fourth-degree burns penetrate subcutaneous fascia, muscle, and bone.
Skin Lesions

Lesions of the skin are visible abnormalities that can have a variety of causes, ranging from physical damage to pathological issues. Some of them are depressed into the skin, some are raised, and some lie relatively flat on the skin.

Macules are blemishes that lie flat on the skin, such as freckles. Rashes caused by simple blemishes and even measles rashes are classified as macules.

Figure 15 - Macules illustrated

Papules, such as pimples without pus and some chickenpox bumps, are raised areas on the skin that are relatively firm and solid, and also less than 1 cm in diameter.

Figure 16 - Papules Illustrated
Vesicles are similar to papules, but they have thin walls, are saclike, and contain clear fluid; chickenpox causes these in most of its stages.

![Figure 17 - Vesicles Illustrated](image17)

Pustules are similar to vesicles, except that they usually contain pus rather than clear fluids.

![Figure 18 - Pustules Illustrated](image18)
Lacerations are jagged wounds that are caused by the tearing of skin.

Excoriations are shallow or deep injuries to skin such as scratches, abrasions, or burns.
**Fissures** refer to cracks in the skin that can be caused by diseases or injuries.

![Fissures Illustration](image1)

**Ulcers** are sores on the skin where skin cells have died and tissue has begun to disintegrate. Common ulcers that nurses should be especially aware of are called pressure ulcers, or bedsores. These can be caused when skin is pressured against bone for long periods of time, causing the skin to die.

![Ulcers Illustration](image2)
Inflammations and Infections

An inflammation of the skin is called dermatitis, which may be caused by allergens, infections, or disease. Inflammations are often the result of irritants such as the natural irritant in poison ivy or manufactured chemicals such as strong alkalies or acids, and can also be the result of skin conditions such as eczema.

Infections of the skin include bacterial, viral, and fungal infections. Bacterial infections are typically related to streptococcal or staphylococcal origins (these are commonly known as strep or staph). There are many different types of strep and staph infections, but most can be eliminated through the administration of antibiotics.

Fungal (mycotic) infections are caused by microorganisms that infect the skin. Ringworm, or tinea, and athlete's foot, which may be caused by different fungi, are types of fungal infections. Topical and oral antifungal agents are used in the treatment of mycotic infections.

Viral infections include the herpes simplex virus, herpes zoster or shingles, verruca or warts, and a wide variety of viral lesions that may at times be hard to identify. Some antiviral drugs may be effective against certain viral infections, but many viruses lead to outbreaks from time to time throughout a person's life and never fully go away. This lack of curability can be frustrating and angering for patients. For instance, most people associate throat infections with "strep throat," which is a bacterial infection. This can lead them to feel very strongly that they should be treated with antibiotics. However, most throat infections are actually viral in nature, and cannot be treated with antibiotics.
**Common Diseases**

**Athlete's Foot**, or tinea pedis, is a common fungal infection that is closely related to ringworm, so much so that it is often called ringworm of the foot. It is spread in public places such as locker rooms and hotel rooms, and can usually be treated with over-the-counter medications.

![Figure 24 - Athlete's Foot Illustrated](image1)

**Atopic dermatitis**, or eczema, is a recurring condition that causes inflammation and itching. Though it can recur often, it can also lie dormant for long periods of time. Eczema may result in increased outbreaks from irritants, and those with this condition often have other allergic disorders as well.

![Figure 25 - Atopic dermatitis illustrated](image2)
Gangrene is the result of reduced or interrupted circulation to parts of the body, usually the extremities. This lack of blood causes the death and decay of skin tissue, muscle tissue, and even organs. Gangrene can involve bacterial infections as well; in these cases, the patient can be treated with antibiotics. However, the most common treatment is surgery to remove dead tissue. Failure to remove dead tissue can lead to the buildup of toxins in the body of a patient, which can result in death.

Psoriasis is a chronic disease in which skin cells form irritated red patches and silvery scales on the surface of the skin. These problems result from the fact that psoriasis causes a dramatic increase in the life cycle of skin cells; without the disease, such cells typically take weeks to form in the stratum germinativum and then travel to the stratum corneum, but psoriasis causes this process to take days. The cause of psoriasis is not known, but heredity and a possible immune disorder may be involved. There is no cure for the disease, but treating skin with ultraviolet light exposure and over-the-counter cortisone cream is typically advised.
**Shingles**, or herpes zoster, is a viral infection caused by the varicella-zoster virus, which also causes chickenpox. It is a rash of painful blisters that usually only cover an area on one side of the body, typically wrapping from around the middle of the back to the middle of the chest. The varicella-zoster virus can lie dormant for years after a chickenpox infection and then reappear as shingles, which is more painful than chickenpox but not life-threatening. If caught early, the length of infection can be shortened, minimizing negative effects.

![Shingles](image)

**Figure 28 - Shingles illustrated**

**Skin Cancer**

The most common cancer in humans is skin cancer, which is usually the result of overexposure to ultraviolet radiation from the sun or from tanning booths. Severe sunburn is especially harmful, as it has been shown to increase the likelihood of getting a form of skin cancer. These cancers can harm skin and tissue beneath it, but they become especially dangerous when cancerous cells reach lymph vessels and blood vessels and travel to other areas of the body; this is why it is imperative that they be diagnosed as early as possible. The three most common types of skin cancer are basal cell carcinoma, squamous cell carcinoma, and melanoma.

**Basal cell carcinoma** can take years to develop, and it develops in the stratum germinativum (also called the stratum basal). It can usually be surgically removed if it is diagnosed in time, and it is the least dangerous of the three main types of skin cancer because is not as likely to spread.
**Squamous cell carcinoma** is more deadly than basal cell carcinoma in that it is more likely to spread, but it can still be treated effectively through surgical removal if it is caught in time. Squamous cell carcinomas are found in the middle of the epidermis, affecting an area where cells should be dead. However, living cells in this case have been forced up to this level after having been reproduced wildly, resulting in growths just below the surface of the skin.

**Melanoma** is by far the most deadly of the three common types of skin cancer because it spreads rapidly, reaching deep into the skin in a short period of time. Melanomas are made of cancerous melanocytes, the cells that produce melanin. Since many moles and some birthmarks consist largely or entirely of melanocytes, these are usually the areas where melanomas form. Melanoma can often be detected by watching for changes in moles and birthmark areas, and it should be diagnosed as soon as possible since melanoma tumors grow so quickly. If not diagnosed in a short period of time, it can spread throughout the body.

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**Patient Care**

As a medical professional, caring for your patients' skin is a top priority. Serious complications can arise when patients are improperly cared for.

The first key to proper care is ensuring that your own skin is clean. Though the washing of hands has been brought up in other modules, it cannot be stressed enough that keeping your hands clean according to CDC Hand Hygiene Guidelines is vitally important.

**Asking Questions**

The second key to proper care is asking questions as much as possible. As a nurse, you will often be the person who deals with patients first; one of the best ways that you can help your employers and your clients avoid problems is by asking pointed questions and determining the best course of action for dealing with patients. Doing so can also help you address patient concerns while determining the level of importance of their health issues.

Poor nutrition is one factor in skin care. Some of the questions you will ask your patients deal with addressing their diets and the amount and type of liquids that they drink. Other questions should be asked according to the types of skin maladies that your patients have. For instance, a communicable illness would prompt questions as to who your patient has been in contact with or where your patient has been that they might have caught or spread the illness. Questions about a patient's medical history can also help you and your employer identify how to go about treating a patient.
It can be difficult to know which questions you should ask for each situation; however, advanced medical training will give you a broad knowledge base from which you can decide on the proper avenue of questioning. Also, your employers will typically provide question lists or guidelines for asking questions.

**Antibiotics**

One troublesome issue that the health community faces today is the prescription of antibiotics. Many patients will ask for antibiotics, thinking that these drugs will cure their illnesses. However, only bacterial infections can be treated with antibiotics, and even some bacteria cannot be suppressed with them. It is very important to keep in mind that the overprescription of antibiotics due to patient requests can lead to strains of bacteria that are resistant to antibiotics. Also, patients can be severely allergic to certain antibiotics such as penicillin, so any medicinal allergies that they are aware of should be known before the prescription of an antibiotic is considered. Informing patients about the issues surrounding antibiotics can be crucial to keeping patients satisfied without risking harm to their health or the health of their community.

**Skin Care**

The physical maintenance of patients' skin is a duty of many medical professionals. Cleaning will remove foreign objects, pathogens, and dead skin, improving the health of your patients' skin and preventing further damage or infection.

You may also be tasked with preventing bedsores and other skin damage by adjusting the bodies of less mobile patients and providing several steps of skin therapy for them. First of all, the patient must be properly hydrated, sheets on the bed should be changed often, and the head of the patient's bed should be as flat as possible to avoid a concentration of pressure in certain areas. The patient's body should be adjusted periodically, usually once every two hours, and pillows should be placed between the knees of patients when gravity forces them together. The body should be inspected for redness around bony areas where bedsores are most apt to occur, and skin should be free of dirt and excess moisture at all times. Also, skin can be massaged with lotion to increase circulation.
# Table of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Skin Layers Illustrated</td>
<td>2</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Epidermis layers and cell types illustrated</td>
<td>3</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Dermis layers and components illustrated</td>
<td>4</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Subcutaneous Fascia illustrated</td>
<td>5</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Integumentary Hair and Follicles Illustrated</td>
<td>6</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Accessory Structures Illustrated</td>
<td>7</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Hair follicle cross section</td>
<td>8</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Human Nail illustration</td>
<td>9</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Absorption of Vitamin D via Sunlight Illustrated</td>
<td>11</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Cyanosis Illustrated</td>
<td>13</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Jaundice illustrated</td>
<td>13</td>
</tr>
<tr>
<td>Figure 12</td>
<td>First Degree Burn Depiction, Epidermis affected</td>
<td>14</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Second Degree Burn Depiction, Epidermis and Dermis affected</td>
<td>14</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Third Degree Burn Depiction, Epidermis, Dermis and Subcutaneous affected</td>
<td>14</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Macules illustrated</td>
<td>15</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Papules Illustrated</td>
<td>15</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Vesicles Illustrated</td>
<td>16</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Pustules Illustrated</td>
<td>16</td>
</tr>
<tr>
<td>Figure 19</td>
<td>Laceration Illustration</td>
<td>17</td>
</tr>
<tr>
<td>Figure 20</td>
<td>Excoriation Illustration</td>
<td>17</td>
</tr>
<tr>
<td>Figure 21</td>
<td>Fissures Illustration</td>
<td>18</td>
</tr>
<tr>
<td>Figure 22</td>
<td>Ulcers Illustration</td>
<td>18</td>
</tr>
<tr>
<td>Figure 23</td>
<td>Illustration of a fungal infection</td>
<td>19</td>
</tr>
<tr>
<td>Figure 24</td>
<td>Athlete's Foot Illustrated</td>
<td>20</td>
</tr>
<tr>
<td>Figure 25</td>
<td>Atopic dermatitis illustrated</td>
<td>20</td>
</tr>
<tr>
<td>Figure 26</td>
<td>Gangrene illustrated</td>
<td>21</td>
</tr>
<tr>
<td>Figure 27</td>
<td>Psoriasis illustration</td>
<td>21</td>
</tr>
<tr>
<td>Figure 28</td>
<td>Shingles illustrated</td>
<td>22</td>
</tr>
</tbody>
</table>