Okay, so now we're going to examine the integumentary system – more commonly known as the skin.

So the skin is the most accessible, but often one of the least appreciated organ systems of the body. The skin accounts for about 16 percent of your total body weight. Your skin surface is constantly being worn away, attacked by microorganisms. It is exposed to all of the environment – including the sunlight and any chemicals we come into contact. And the skin is composed of 2 major components – the cutaneous membrane and accessory structures, and we will examine each in more detail.

Now you should know the functions of the integumentary system – and the functions of the skin are to protect the underlying tissues and organs against impact abrasion, fluid loss, and chemical attack. We get rid of salts, water, and organic wastes via the various integumentary glands. The skin helps to maintain our normal body temperature – either through insulation in the hypodermis or evaporative cooling via sweating.

The skin is the site of production of both melanin and keratin. Melanin protects our tissues from ultraviolet radiation and keratin serves as a water repellent. The skin is also the site of synthesis of vitamin D, a steroid that's used – is converted to calcitriol – and that's a hormone you will learn about later on that is very important in calcium metabolism.

The skin is a storage of lipids and adipocytes in the dermis and adipose tissue in the hypodermis – and there's a number of receptors in the skin that allow us to detect touch, pressure, pain, temperature, stimuli – and that information can then be relayed to our nervous system for integration and processing.

Now the 2 components of the skin – there's 2 main layers of the skin – the epidermis and the dermis. The epidermis is the superficial region, the dermis is the middle region, and we will examine each.

Let's take a closer look at the epidermis. The epidermis is the superficial layer and the epidermis is composed of keratinized, stratified squamous epithelium. The epidermis has cells – keratinocytes and melanocytes – and it also has other types of cells, like epidermal dendritic cells.

The keratinocytes divide and produce a fibrous protein – keratin. The melanocytes are in the lower portion of the epidermis and produce a pigment – melanin, which helps protect our DNA. The dendritic cells are white blood cells from bone marrow to blood – and also macrophages that help activate our immune system.

Now thin skin has 4 strata layers, which we will examine – and thin skin covers most of the body surface. Thick skin is only found on the palms of the hands and the soles of the feet and it possesses five strata – including the stratum lucidum.

So let's look at the stratum – or layers – of the epidermis. So we have the stratum corneum – that is the most superficial layer; the stratum lucidum, which is only found in thick skin – it’s a clear
layer; the stratum granulosum is the granular layer; the stratum spinosum is the spiny layer; and the stratum basale. The stratum basale is the deepest epidermal layer, firmly attached to the dermis below; it consists of a single row of stem cells.

Now the journey from the basal layer to the surface takes anywhere from 25 to 45 days. The lowest layer here is very productive, so it's very active mitotically – and you have dividing keratinocytes, that will migrate upwards, fill with keratin, and die – and melanocytes are also numerous here, and melanin is present and darkens the layer. Remember melanin protects our cells from UV or ultraviolet radiation.

The next layer, the stratum spinosum – also called the spiny layer – contains cells that are attached by desmosomes and you see abundant melanin granules and dendritic cells – Langerhans cells – also here, which help protect and are part of our immune system. This layer is also active metabolically. It is several layers thick. Now we have some mitosis, but it's reduced from the basal layer below.

The next layer, the stratum granulosum – or the granular layer – is a thin layer, 3 to 5 cell layers, in which the cells start to flatten out. This is what we call a dying layer. These cells are flatter, the nuclei is disintegrating, and keratin production begins – and you can start to see the granules, hence its name the stratum granulosa.

The stratum lucidum is the clear layer and it's found only on the palms of the hands or the soles of the feet. It's a clear band, several layers thick, with keratin granules adhered to collagen fibers. There are no nuclei or organelles – so it's basically a few rows of flat, dead keratinocyte cells.

The stratum corneum – the horny layer or the outermost layer – is a layer of flat, dead cells, several rows thick. It is keratin-filled. You may also see some accumulation of the carotene pigment. It's thicker in parts of the body where friction occurs. The cells flake off through wear and tear and it functions to protect from abrasion and penetration, waterproofs, and is a barrier against biological; chemical; and physical hazards.

Remember the epidermis is avascular, but it has an extensive nerve supply – and we will be examining some of the sensory receptors that are found throughout the skin.

Now the ridges of the skin – the deeper layers of the epidermis – form epidermal ridges, which extend into the dermis and are adjacent to the dermal projections called dermal papillae that project upward to the epidermis. These ridges and papillae are significant because they greatly increase the surface area for attachment, firmly binding the epidermis to the dermis.

The patterns of the dermal papillae in the thick skin – on the surface of the fingertips – produce fingerprints, which can be used to identify individuals and criminal investigations for quite some time now. And here you can see the dermal papillae, which produce the fingerprint patterns.

The dermis is a strong, flexible layer of connective tissue. It consists of 2 layers – the papillary and the reticular layer. It also has cells – such as fibroblasts, macrophages, some mast cells, and occasionally white blood cells.
The papillary layer is close to the stratum basale. It consists of loose connective tissue, elastic, and collagen fibers. The top surface forms the projecting cones, which form the dermal papillae, which we just examined, that push up into the epidermis, into ridges, making our fingerprints.

The reticular layer is dense, irregular connective tissue, and all three fiber types – elastic; collagen; and reticular can be found here.

Remember the dermis has an extensive blood and lymph supply. Blood supplies both the dermal and epidermal layers. The lymph supply returns excess fluid to our venous blood supply to prevent tissue edema. The nerve supply to the dermis is important in both motor commands and sensory input from the receptors found in the skin and there are many invaginations – like hair, sebaceous oil glands, sweat glands, and even our nails.

Cleavage lines within the dermis are collagen and elastic fibers that are arranged in parallel bundles, orientated to resist forces applied to the skin during normal movements. The resulting pattern of fiber bundles establishes the lines of cleavage. These lines are clinically significant. A cut parallel to a cleavage line will usually remain closed and heal with little scarring, whereas a cut at a right angle to a cleavage line will be pulled open as movement occurs and result in greater scarring.

The subcutaneous layer is the hypodermis. It connects our skin to underlying muscle. It is composed of adipose connective tissue and some loose, dense irregular connective tissue. Some sweat glands are present. We have vessels and nerves here and it functions as an energy storage, insulation, and cushioning protection.

Now our skin color results from different pigments. There are 3 pigments that contribute to skin color – melanin, carotene, and hemoglobin.

Melanin has variations in hue and intensity from reddish-brown to yellow-brown to brown-black to black, and is responsible for darker skin colors. Skin tone is determined by the amount of melanin produced – not the number of melanocytes. Variations in gene activity will produce this variation in color. Freckles and pigmented moles are also local accumulations of melanin.

Carotene is a yellow pigment related to vitamin A and accumulates in the hypodermis and stratum corneum.

Hemoglobin is related to our blood vessel distribution; when we dilate our vessels, we increase flow. Caucasian skin has very little melanin – so hemoglobin, which contributes to the pink-reddish hues of skin, is visible. Any clinical color change that occurs in skin could be indicative of a possible disorder. And you can see hemoglobin is the red pigment here, and less blood flow to an area would be pale color, or if you have a sustained reduction of blood flow would decrease the availability of oxygen – lower oxygen levels makes hemoglobin darker red. So from the surface view, our skin would have a bluish color, and could be indicative of cyanosis.
Okay, so let's look at some accessory organs of our skin. We have nerve fibers, and corpuscles, hair follicles, hair shaft, erector pili muscles, oil and sweat glands, arteries, veins, and lymph vessels – and nails that form from thickened epidermal cells into the dermis, forming a nail field.

Let's start with our hair. Hair functions to alert the body to the presence of insects on the skin. It guards our scalp against physical trauma, heat loss, and sunlight – and it’s distributed pretty much over the entire surface of the body, except the palms of the hand; soles of the feet; our lips; parts of external genitalia; and sides of our fingers and toes. It contains dead, keratinized cells; so it contains hard keratin. It's more durable than the soft keratin that's found in our skin and our hair pigments result from our melanin – grey-white hair is where we have decreased melanin production and also increased air bubbles in the shaft of hair.

Now there are 2 types of hair – terminal hairs, which are large, coarse and darkly pigmented – found in our scalp and our armpit and vellus hairs – small, shorter, delicate – found on the general body surface.

Each hair is produced by a hair follicle. The hair follicle extends from the epidermal surface into the dermis. Hair contains a medulla cortex and cuticle; the shaft, which is three layers above the surface of the skin; the root, three layers below the surface of the skin; and the follicle is the invagination of the basal epidermal. The bulb is the deepest end of the follicle and that's where we see mitosis – cells are pushed up, keratinized, and that is our genetically-determined pigment hair color.

Now the erector pili muscle is a smooth muscle attached to the hair follicle. It's responsible for goosebumps, hair growth. It goes in phases, followed by a regressive and a resting phase. The growth varies; it can be, you know – shorter or longer, depending on the part of the body. Hair thinning and baldness – true baldness – is genetically determined and can be a sex influence condition. Alopecia is hair thinning that we can see in both sexes after the age of 40.

Now there's many sensory receptors in the skin – we have free nerve endings, Merkel cells, Meissner's corpuscles, and Pacinian corpuscles – and each of these receptors will respond to different types of touch. So the free nerve endings are sensitive to touch and pressure and they’re between epidermal cells. The Merkel cells detect texture and steady pressure and they might be found a little bit deeper in the epidermis. The Meissner’s corpuscles detect light pressure, so it would make sense that they're found in the upper region – the papillary layer. And the Pacinian corpuscles detect deep pressure and vibration, so they're found in the lower layers – the dermal and hypodermis of the skin.

Here are the functions of the integumentary system that were mentioned previously – make sure you know the functions of the integumentary system and we will examine those in a little bit more detail here.

Thermoregulation - So body temperature regulation – that is a critical, homeostatic function of the skin. We have insulation via adipose tissue in the hypodermis and cooling via a sweat evaporation and radiation, which is heat from our muscles that is carried in the blood, which
radiates throughout the blood vessels in the skin. So heat can be retained in the body or heat can be lost in the body through radiation and convection.

Other functions of the skin – Protection – remember there are different types of barriers in the skin – chemical, physical, biological. We synthesize vitamin D. We have various receptors in the skin, so the nerve cells that can respond to different types of pressure or touch – and the skin does have protection, and fluid and electrolyte balance, as well as metabolic functions.

Now skin cancer can be categorized according to the layers of the skin that are affected and whether the skin cancer has the ability to metastasize. Most skin tumors are benign; they don't metastasize. There is risk factors for skin cancer – like overexposure to UV radiation – and the three major types are basal cell carcinoma, which is the least malignant and most common; squamous cell carcinoma, which is the second most common; and melanoma, which is the most dangerous.

Basal cell carcinoma is usually readily observable. It's very slow to metastasize, therefore it's usually very easily treated, and most commonly occurs on sun-exposed areas of the face. You'll have a shiny, dome nodule, with an ulcer at the center – and these are the stratum basale cells that proliferate and slowly invade the dermis and hypodermis. Basal cell carcinoma is usually cured by surgical excision in about 99 percent of all cases.

Squamous cell carcinoma occurs in the stratum spinosum. The keratinocyte cells produce these scaly patches that can be found on the lower lip, ears, scalp, hands. It does have a faster metastasis, but it's still very easily treated when it's caught early. It involves the keratinocytes of the stratum spinosum. Most commonly – again, it's on the scalp, ears, lower lip, and hands – and it has a very good prognosis if treated by radiation therapy or removed surgically.

And remember, there is the ABCDE rule – A, asymmetry – the two sides of the pigment area do not match; the border exists indentations; the color is black, brown, tan, and sometimes red or blue; the diameter is larger than six millimeters, which is the size of a pencil eraser and it's evolving or changing.

Melanoma is the most deadly form – or serious form – of skin cancer, and it involves the melanocytes. It is very highly metastatic and resistant to chemotherapy. It has a high fatality rate due to its fast metastasis and resistance to chemotherapy. It can develop in pre-existing moles – and again, prevention is that early detection via the ABCDE rule. It can be treated by wide surgical excision, accompanied by immunotherapy.

Now there are other forms of skin disorders that you should be familiar with – eczema, for example, is a type of skin disorder – which is an allergic reaction – that manifests as dry, itchy patches of the skin, that resemble rashes. It can be accompanied by swelling of the skin, flaking, and in severe cases – bleeding. Many people that suffer from eczema have antibodies against dust mites in their blood, but that link has not been proven yet. Symptoms are usually managed with moisturizers, corticosteroid creams, and immuno-suppressants.
Chapter 5
The Integumentary System

Acne is a skin disturbance that usually occurs on areas of the skin that are rich in sebaceous glands – both the face and the back. It is most common along with the onset of puberty, due to associated hormonal changes, but can also occur in infants and continue into adulthood.

Hormones – such as androgens – can stimulate the release of sebum. An overproduction and accumulation of sebum, along with keratin, can block hair follicles. This plug is initially white. The sebum, when oxidized by exposure to air, turns black. Acne can result from infection by acne-causing bacteria, which can lead to redness and potential scarring, due to the natural wound healing process.

Burns are damages that are inflicted by intense heat; electricity; radiation; or even certain chemicals. Burns are characterized by the degree of the skin that they impact – first degree, second degree, third degree, and fourth degree. Now burns – the immediate threat is usually dehydration and electrolyte imbalance that can lead to renal shutdown and circulatory shock – so it can cause death in burn victims, depending on how extensive the burn is.

A first-degree burn is a superficial burn that affects only the epidermis. A second-degree burn goes deeper and affects both the epidermis and a portion of the dermis. A third-degree burn fully extends into the epidermis and dermis, destroying the tissue and affecting the nerve endings and sensory function. A fourth degree is even more severe and can affect the underlying muscle and bone.

Now burns are evaluated based on the depth of the burn and the percentage of skin that has been burned – and there's a rule of 9s that is used to examine or estimate the volume of fluid loss from burns. Physicians can use this to get an idea of how much fluid loss has occurred and how much fluid replacement they need to give the patient.

Emergency treatment of burns – we need to replace loss fluids and electrolytes, provide nutrients, prevent infection and sometimes – depending on the level of damage – assist tissue repair with skin grafts. Burns are critical if greater than 25 percent of the body has second-degree burns, greater than 10 percent of the body has third-degree burns, or the face; hands; or feet bear third-degree burns.

Now there are also age-related changes that occur in the skin and a number of the age-related changes in the skin are shown here. Age-related changes happen over time, after the appearance – they've changed the appearance, or altered the appearance of the integument.

Melanocyte activity declines and in light-skinned individuals, the skin can become pale. This makes people more sensitive to sun exposure and more likely to experience sunburns.

Sebaceous gland secretions decrease with age, so the skin can become more dry and often scaly. The epidermis thins, as cell activity declines, and the connections between the epidermis and the dermis weaken – that makes us more prone to injury as we age and also more prone to skin tears and skin infections.
Metabolic activity in the skin decreases as well. Our synthesis of calcitriol – vitamin D3 – decreases, which can lead to muscle weakness and brittle bones. The number of dendritic cells decreases; this reduction in cells may decrease the sensitivity of the immune response and further encourage skin damage and infection. The dermis becomes thinner and has fewer elastic fibers, making the integument weaker and less resilient – that results in sagging and wrinkling, and that's usually most pronounced in parts of the body that have experienced the most sun exposure.

Our sweat glands become less active and impaired, and can impair the perspiration process. Therefore, as we age, older people cannot lose heat as fast as younger people – so they are at a greater risk of overheating in warm environments, heatstroke.

A reduction in dermal blood supply cools the skin, which can stimulate thermoreceptors and make a person feel cold – even in a warm room. Reduced circulation and sweat-gland function lessen a person's ability to lose heat, which can also cause their body temperature to get dangerously high.

With declining levels of sex hormones, differences in secondary sexual characteristics – with respect to hair distribution and body-fat distribution – begin to fade. As a consequence, people that are older – generally in their 90’s, of both sexes – can tend to look more alike. And hair follicles stop functioning or produce thinner finer hairs, with decreased melanocyte activity – that's where our hair appears grey or white.

This concludes our overview of the integumentary system.