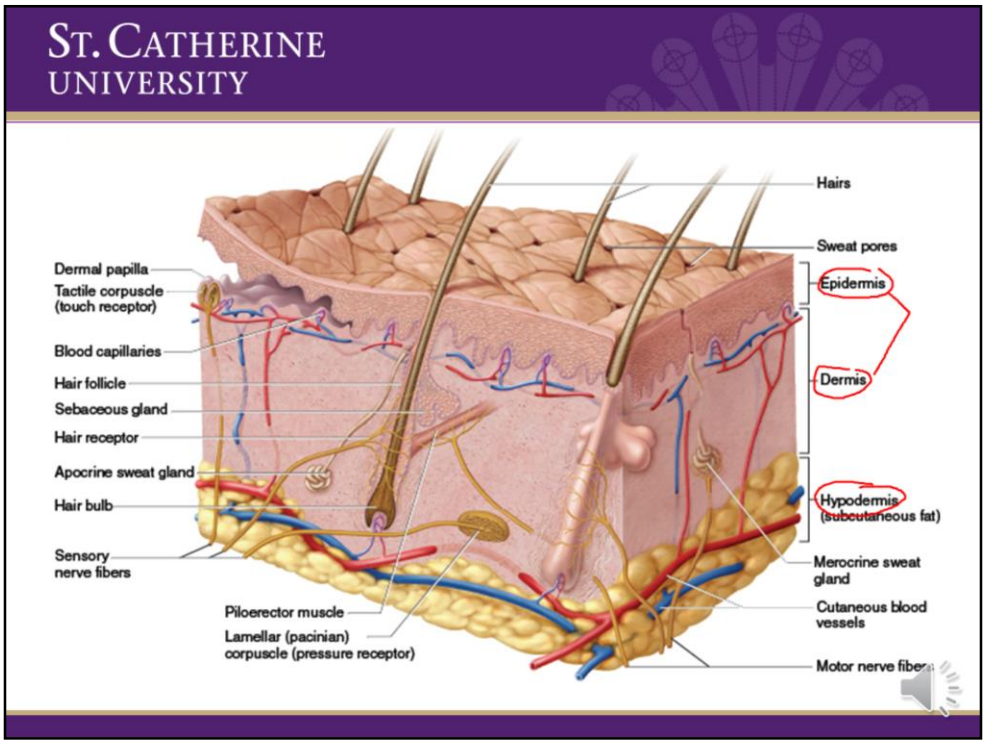
ST. CATHERINE UNIVERSITY

Integumentary System



An overview of the integumentary system:

The body's largest and heaviest organ making up 15% of body weight. Most skin is 1 to 2 mm thick

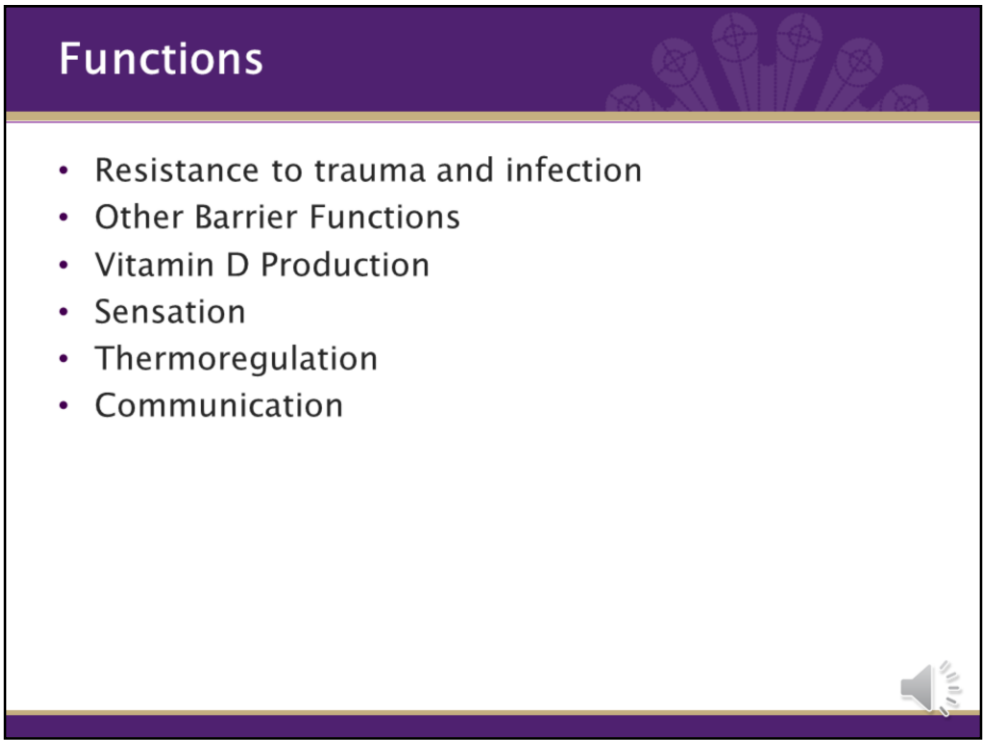
Two layers of the skin (cutaneous membrane)

Epidermis: stratified squamous epithelium

Dermis: connective tissue layer

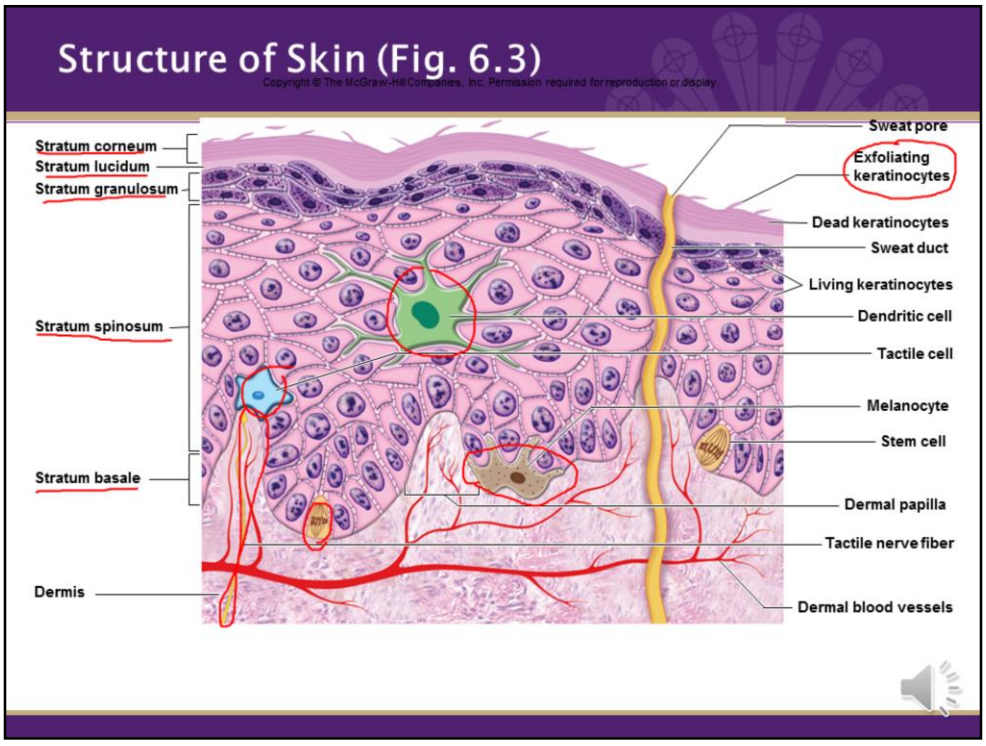
Hypodermis (subcutaneous membrane

Connective tissue layer below the dermis



Functions of skin includes:

1. Resistance to trauma and infection. Skin is composed of keratinized stratified squamous epithelium which is densely packed cells with a protein called keratin, this results in making skin resistant to trauma and provides a physical barrier against infection. Skin is also dry and acidic, this environment helps to prevents the growth of microbes
2. Skin has other barrier functions as well. Such as preventing water from entering or leaving the body. Skin is also a barrier to UV rays and many harmful chemicals
3. Vitamin D Synthesis. It initiate's this process by using UV radiation and warmth of the sunlight to convert steroids into what will eventually become Vitamin D (calcidiol). Vitamin D is needed for bone development and maintenance
4. Sensation. Skin contains many nerve endings for various sensations (heat, cold, touch, texture, pressure, vibration, and pain)
5. Thermoregulation. Skin contains mechanisms that allow the body to maintain homeostasis by warming or cooling the body. Mechanisms include vasodilation/vasoconstriction and sweating
6. Nonverbal communication such as facial expression (with skeletal muscles) and physical image (acne, birthmark, or scar)



Here is a diagram of our epidermis, its stratums and the various cells.

Epidermis is made up of keratinized stratified squamous epithelium. Some characteristics of the epidermis include:

- Contains dead cells at the surface packed with tough protein called keratin
- Lacks blood vessels
- Depends on the diffusion of nutrients from underlying connective tissue
- Sparse nerve endings for touch and pain

Going from deep to superficial, the epidermis is composed of the following stratums: **Stratum Basale** is the deepest and is made up of one layer of cells. This is the site for new skin cell production. The cells here appear cuboidal at first, but become stratified squamous as they move throughout the other stratums. This why the epidermis is classified as stratified squamous epithelium.

There are a number of cell types found in this stratum. There are stem cells that divide to become keratinocytes. The keratinocytes are the basic skin cells. They are layered throughout the stratums to form the protective thickness of skin. They possess a protein called keratin which makes the cells waterproof and durable. There are also melanocytes, these cells produce melanin (a pigment protein) which absorbs

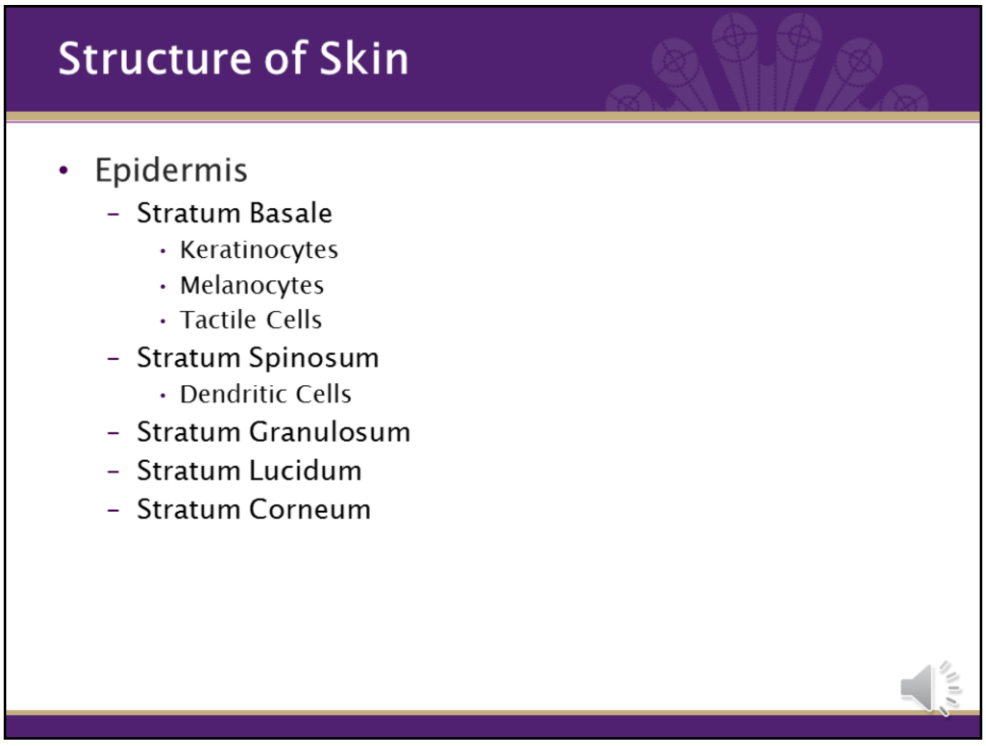
UV light and prevents it from going deeper. We all have the same number of melanocytes, what changes is the amount of melanin produced. Melanin is one of the pigments that give our skin color. Individual with darker skin produce more melanin, this is due to the fact that their ancestors lived in climates with intense UV radiation. To protect and limit the amount of radiation, more melanin is produced. Individuals with fairer skin have ancestors who lived in climates with less intense radiation and did not need as much UV protection. These cells are only found in this layer. Then, there are tactile cells, which are attached to neurons in the underlying dermis and allow for sensation.

Moving up one stratum is the **Stratum Spinosum**: often times the thickest layer (except for in thick skin) consist of keratinocytes and dendritic cells. The keratinocytes are the same as in the previous layer, but they are starting to flatten out. The dendritic cells are a type of White Blood Cell (also called macrophages) that patrols the skin looking for invading organisms and material. Their role is more of a "scout" than "destroyer. They are not necessarily limited to this layer, but commonly found here.

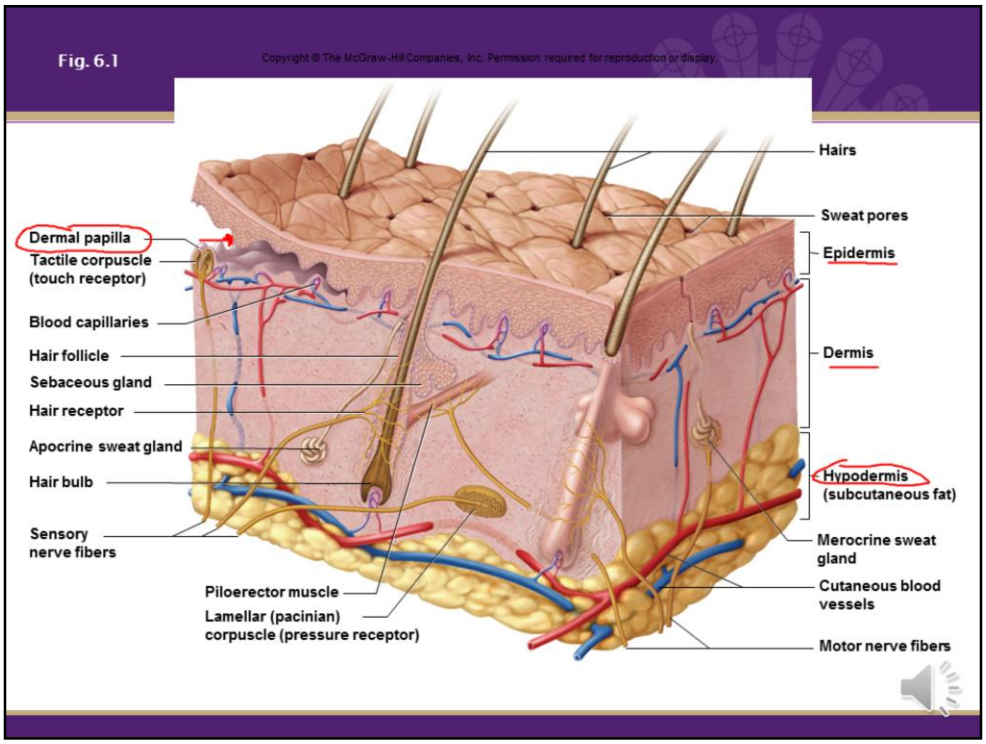
The next stratum up is the **Stratum Granulosum**: This layer consists of 3-5 layers of keratinocytes that at this point produce a protein called keratin, which creates a water proof barrier for skin. The water proof barrier keeps water in and prevents dehydration through evaporation. The keratinocytes begin to die because they have moved away from the stratum basale and lack oxygen needed for metabolism.

The **Stratum Lucidum** is found only in thick skin, such as areas the soles of your feet and palms of your hands. This layer contains keratinocytes that are densely packed with eleidin (clear protein)

The **Stratum Corneum** is the most superficial layer. It is composed of many (approximately 30) layers of dead keratinocytes and keratin. Keratinized skin are especially resistant to abrasion, penetration, and water loss. This layer is shed as new keratinocytes are made and pushed up from the stratum basale.



To summarize, the epidermis layer consist of:
1. Stratum Basale: this layer is the deepest and has one layer of cells. Keratinocytes, melanocytes, and tactile cells can be found in this layer
2. Stratum Spinosum: thickest layer (except in thick skin) of flattening Keratinocytes with Dendritic Cells
3. Stratum Granulosum: layer with Keratinocytes that contain granules
4. Stratum Lucidum: This layer is found only in thick skin.
5. Stratum Corneum: This is the most superficial layer. Contains dead keratinocytes and keratin



This is a diagram of all the layers.

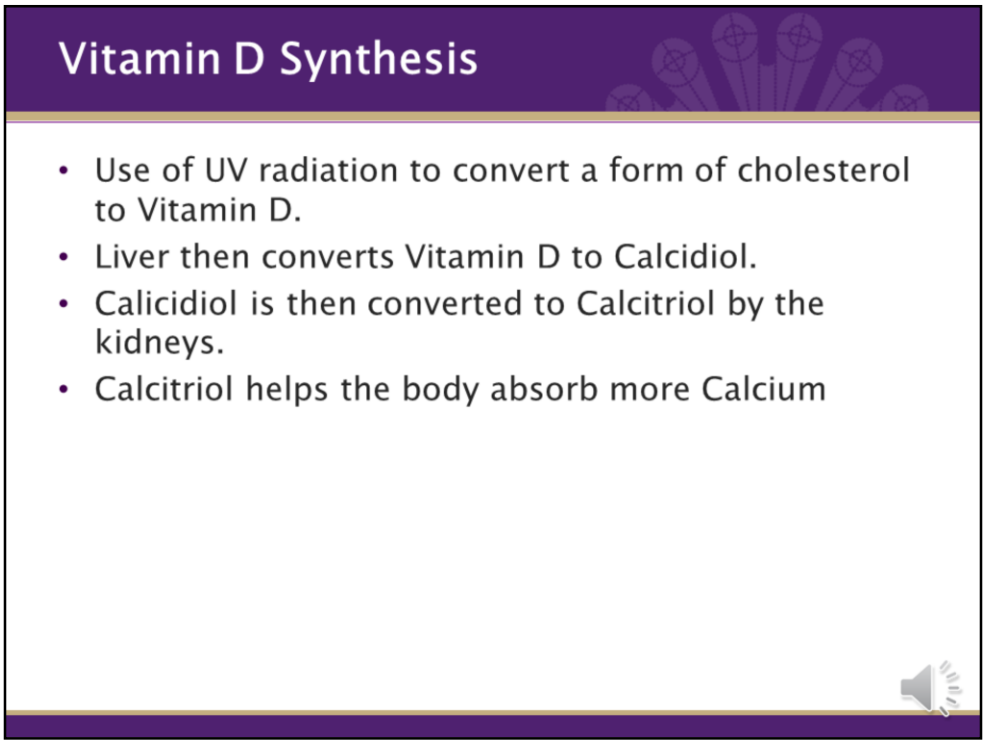
A few key points to know about the epidermis. It takes 30-40 days for a keratinocyte to make its way to the surface and be sloughed off. The epidermis is avascular, does not blood vessels. It does have a nerve supply through the tactile cells. It is highly mitotic, the fastest reproducing cells in the body.

The next layer is the dermis. It provides support for the epidermis and is extraordinarily thicker than the epidermis. There is a distinct line between the dermis and epidermis formed by the dermal papillae (of the dermis) and the epidermal ridges. These structures work like legos, with the finger like projections that lock together. They keep the epidermis in place and help it resist slipping and stress. The dermis is made of dense irregular and areolar connective tissue. The areolar tissue is the top, more superficial, layer under the epidermis. Lots of collagen and elastin fibers are found in the dermis which provides some stretchiness and elasticity to your skin. There is also a good nerve and blood supply. It also contains the associated structures such as glands, hair and follicles.

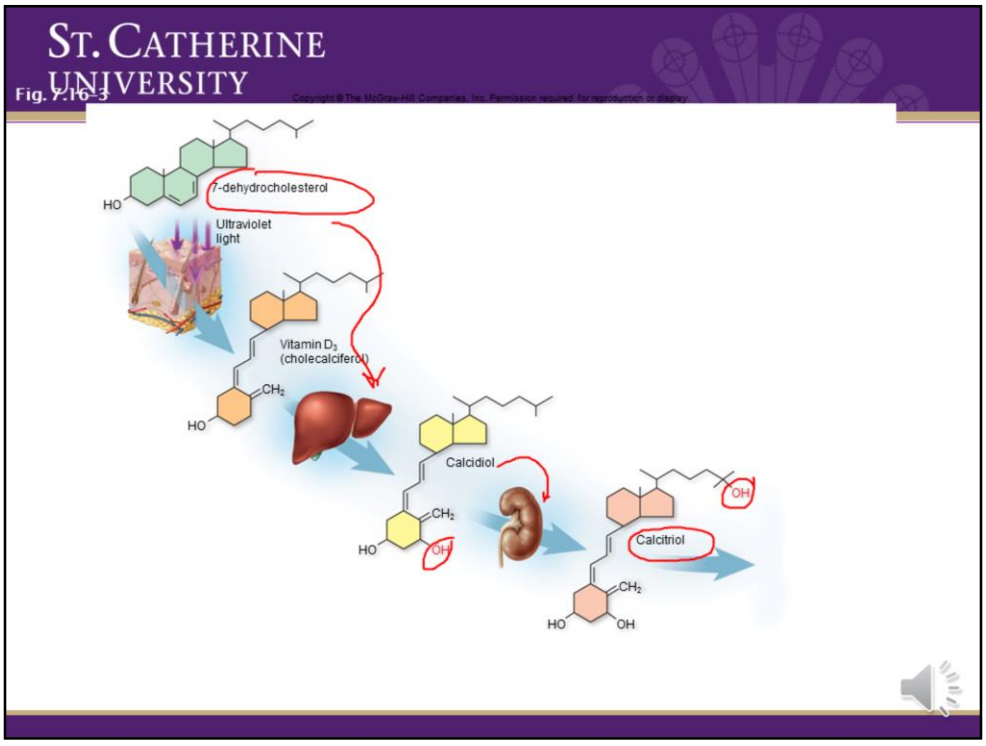
Under the dermis is the SUBCUTANEOUS MEMBRANE or HYPODERMIS. This layer is beneath the skin and binds skin to underlying tissue and structures.
It is sometimes considered the 3rd layer of skin, depending on who you talk to, but it is technically different and our author separates it from skin. The boundary between

the dermis and hypodermis is not as well defined as it is between the dermis and epidermis. Generally the hypodermis has more areolar and adipose tissue than the dermis. The adipose acts as an as insulator for thermoregulation and energy reservoir. The hypodermis or subcutaneous membrane, also has a large blood supply with lots of blood vessels. It also has carotene, a yellow pigment, that comes from vitamin A and our diet. Carotene is found in subcutaneous fat most commonly in thick skin, like callouses and adds color to skin. Sometimes carotene can also be found in the stratum corneum.

Recall that skin is a membrane. Before moving on, take a moment to consider how it compares to the other membranes we discussed at the end of our histology presentation. How similar or different is skin to other membranes?



One of the most important functions of skin is VITAMIN D SYNTHESIS, or the production of vitamin D.
The Keratinocytes use UV radiation to convert 7-dehydrocholesterol (a steroid) to previtamin D.
Over 3 days, previtamin D is fully converted to vitamin D which then travels in the blood to the liver.
The liver converts vitamin D to calcidiol by adding a hydroxyl group (OH).
Calcidiol travels to the kidney, where another OH is added, converting the molecule to calcitriol.
Calcitriol is the most functional form of vitamin D. It helps the small intestines and bones absorb more Calcium and reduces the amount of Calcium excreted by kidney.



To go through the steps again with a diagram.

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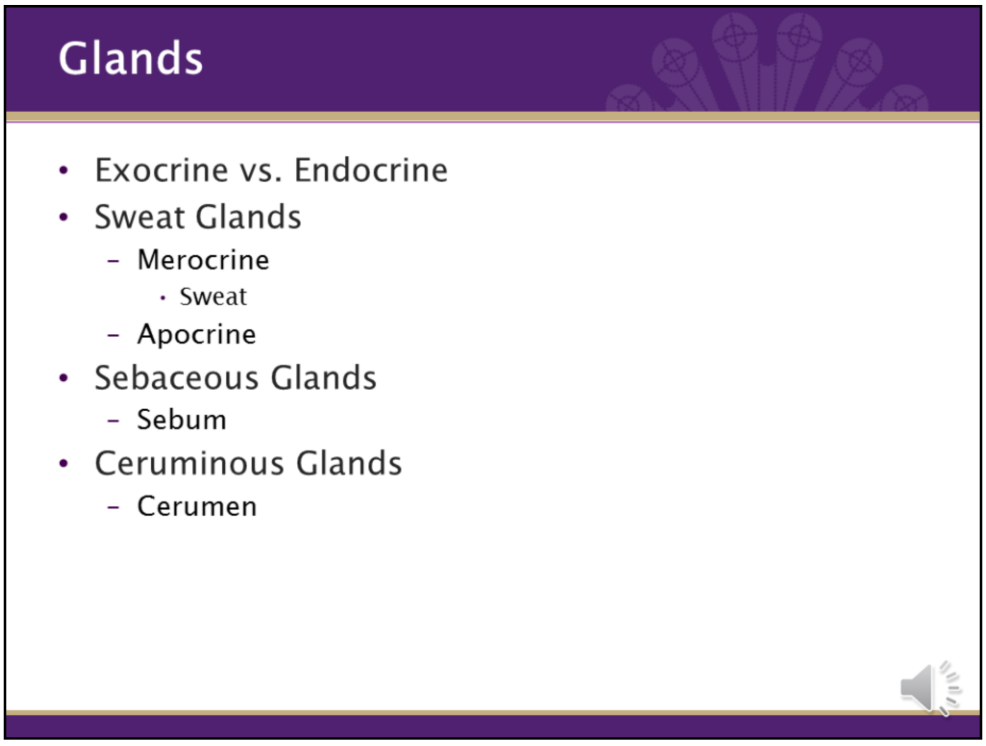


Glands are the first associated structures that we will discuss.
There are two types: Exocrine and Endocrine. Exocrine use ducts to transport their products and Endocrine uses the blood supply. We will talk a great deal about endocrine at the end of the semester.

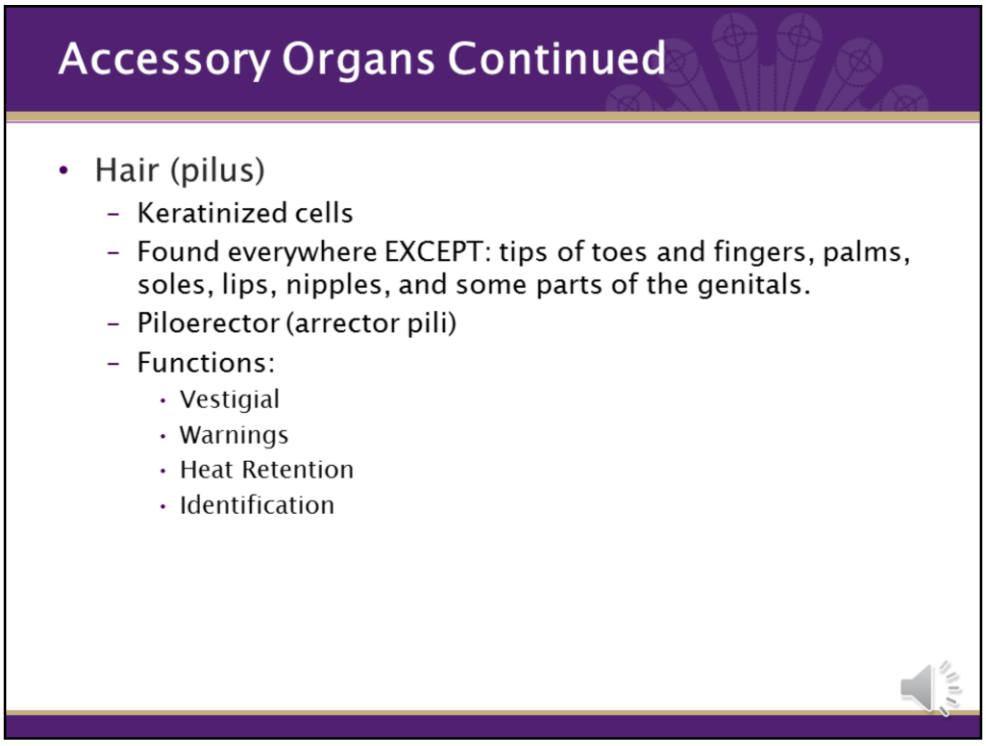
There are a number of exocrine glands in the integumentary system.
1. Sweat Glands are found in the dermis and there are two types.
a. Merocrine sweat glands are the most numerous glands in skin. They produce watery perspiration for temperature regulation and waste removal. Perspiration, or sweat, is primarily composed of water, sodium chloride, potassium, urea, lactic acid, and ammonia. Some drugs and toxins can also be removed through sweat. There is insensible perspiration (500ml/day) that is secreted but does not produce visible wetness to skin. There is also diaphoresis sweating that occurs during exercise and this does produce a visible wetness to the skin. 3-4 million merocrine glands can be found in the adult body. They are a simple tubular gland that leads to sweat pore on the surface.
b. Aprocrine sweat glands occur in the groin, axilla, and areola and develop at puberty. The ducts lead to nearby hair follicles rather than an independent sweat pore. These sweat glands act as scent glands that release pheromones in response to stress and sexual stimulation.

NOTE: Sweat doesn't actually smell, odor is the result of bacteria breaking down stale

sweat, which releases a fatty acid with a strong odor.

2. Sebaceous Glands (See By Shus) produce an oily substance called sebum. Sebum keeps skin from becoming dry and brittle and makes hair shiny. It is basically our natural lotion. Ducts usually open into a hair follicle, but some can open to the surface. Acne occurs when our glands produce a large amount of sebum that sticks to skin cells and plugs up the hair follicle. This situation causes bacteria that get trapped under the plug to thrive. This results in the redness, swelling, and lesions we commonly refer to as acne.

3.Ceruminous Glands (She-Roo-Mih-Nus) are found only in the external ear canal. They secrete sebum and dead epidermal cells to form ear wax (cerumen). Their ducts lead directly to surface skin. Cerumen waterproofs the ear canal and keeps the eardrum pliable.



Another accessory organ is hair, also known as pilus. It is a slender filament of keratinized cells. It is found everywhere BUT the tips of the toes and fingers, palms and soles, lips, nipples and some parts of the genitals. It is divided into zones: bulb, root, and shaft. The bulb is where hair originates in the dermis or hypodermis and contains living hair cells. The root is the remainder of the hair in the follicle. The shaft is the portion of hair that is above the skin surface.

Hair is contained in a follicle, or an oblique tube in skin that allows hair to grow. Under the bulb, at the base of the follicle the dermal papilla provides blood capillaries. The piloerector (arrector pilli) is a muscle that causes hair to stand up in response to fear, cold and other stimuli.

Hair has numerous functions:

1. Some vestigial, or functionless. Evolution has not gotten rid of it, but is probably retained for warmth
2. Stimulation of hair alerts us to parasites, fleas, bugs, etc. on our skin.
3. It helps the scalp retain heat and protects from sunburn.
4. It aids in identification of sex and individuals.

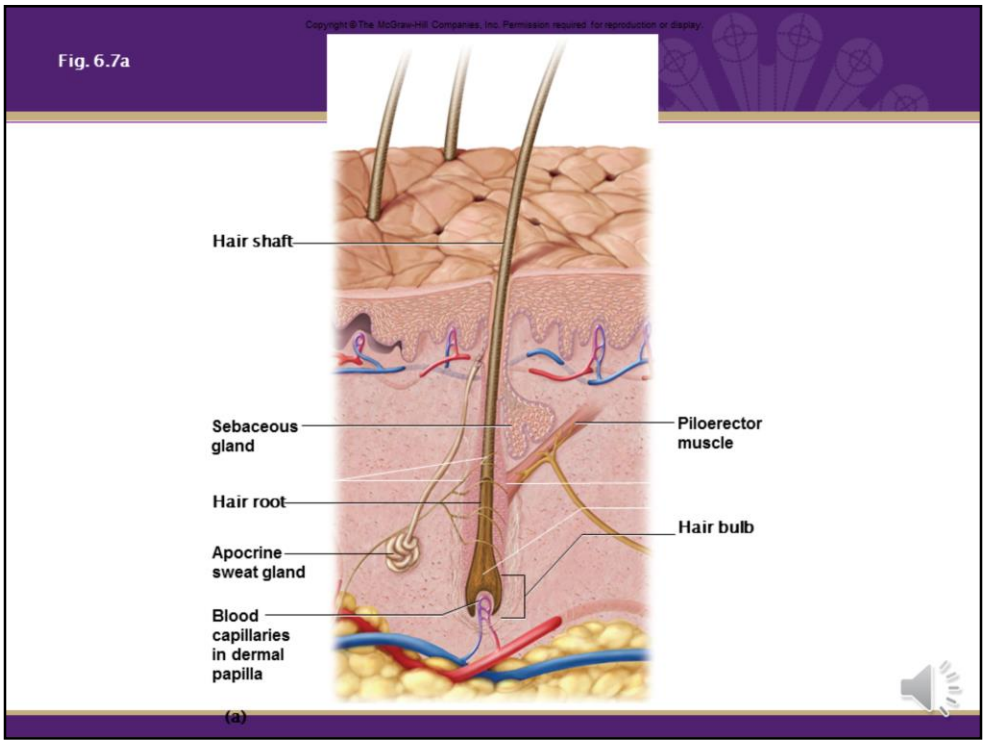
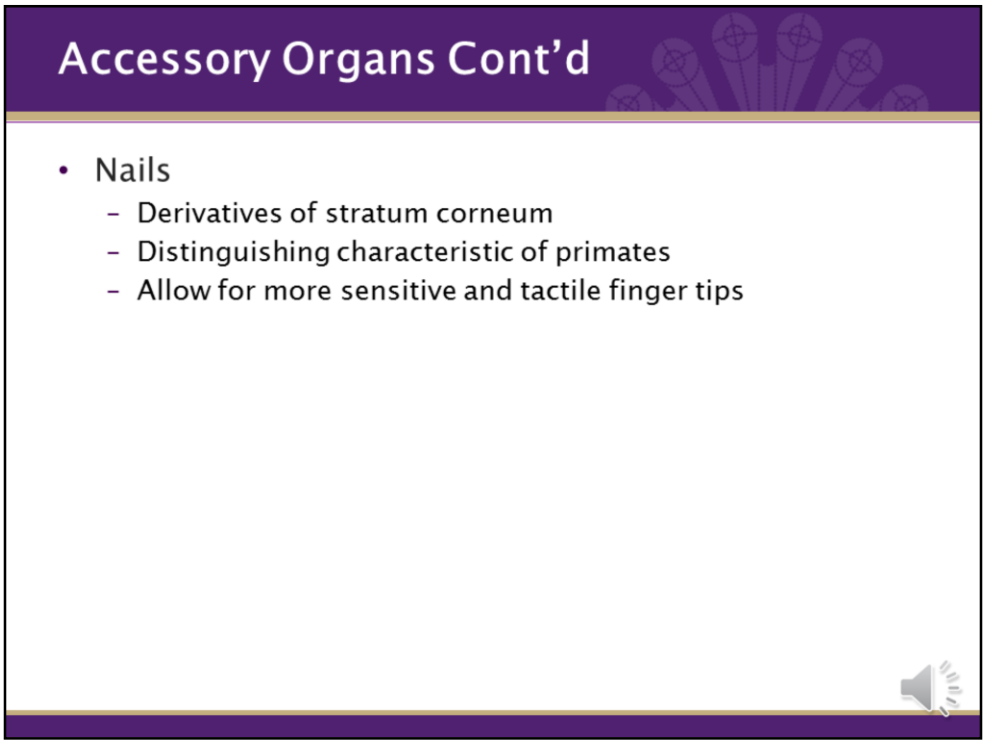
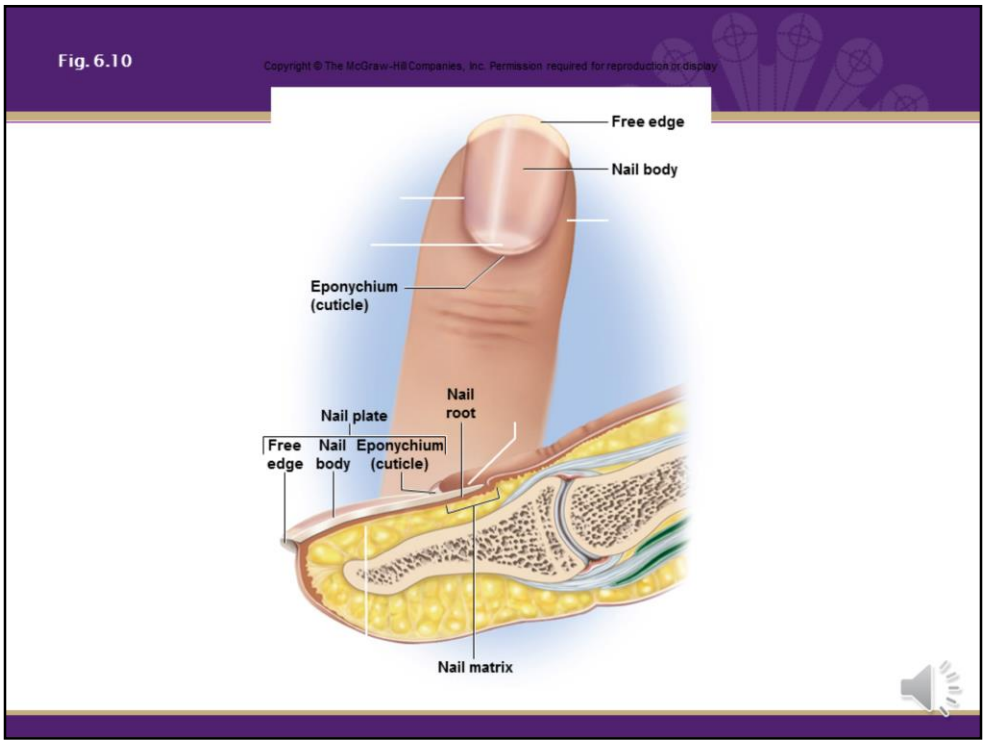


Diagram of hair within a follicle in the dermis.

1. Hair shaft
2. Hair root
3. Hair bulb
4. Piloerector muscle
5. Sebaceous gland
6. Apocrine gland
7. Blood capillaries



Nails are also an accessory organ. They are a clear, hard derivative of the stratum corneum. Flat nails are one of the distinguishing characteristics of primates (humans, monkeys, great apes). They allow for more sensitive and tactile finger tips. There are two primary portions, the nail matrix and the nail plate. The nail matrix is the growth zone beneath skin. The nail plate is the hard part of the nail. The nail plate includes: free edge (portion that overhangs the fingertip), nail body (visible attached part of nail), and nail root (extends proximally under overlying skin).



This is a diagram of our nail with the nail matrix under the skin and the nail plate the visible portion.