

ANATOMY & PHYSIOLOGY ONLINE COURSE - SESSION 4 – THE INTEGUMENTARY SYSTEM

Introduction

A fancy name for a very important body system...the integumentary system is composed of your skin, hair, and nails. What do these structures all have in common? The first thing that comes to mind is probably protection - your skin certainly protects your underlying tissues and organs, finger and toe nails protect the ends of our digits, but how is hair protective? Hair provides a bit of a "cushion" for some areas, as well as providing warmth. In this session we'll discover how important these functions really are. Let's start with the skin...

Skin Layers

The skin is composed of two layers of tissue. The top layer is called the epidermis (epi = upon, on top of, etc.; derm = skin), and the bottom layer is simply known as the dermis. A layer underneath the dermis, the hypodermis (hypo = below), is not technically part of the skin, but we'll discuss it here anyway!

Epidermis

The epidermis is composed of stratified squamous epithelium. Keratin is produced by the epidermal cells, and it helps provide protection from outside elements, as well as "toughening" the tissue layer. So really, we should say that the tissue found in the epidermis is keratinized stratified squamous epithelium.

What are some characteristics of epithelial tissues? Remember that epithelia is avascular. Cells in the epidermis rely on diffusion from underlying tissues to provide nutrition and eliminate wastes. The cells are tightly packed together in the epidermis, and are secured to each other by desmosomes. The epidermis is highly mitotic, as cells die in the top layers new ones are continually being pushed up from the bottom. In fact, your epidermal cells have a life span of only 35 - 45 days!

You'll find four types of cells in the epidermis:

1. **Keratinocytes** - most numerous by far of the 4 cell types, these are the cells which produce the waterproofing protein keratin
2. **Melanocytes** - produce the protein melanin, which gives skin its color, and protects the cells from UV radiation. Differences in skin color and tone are due not do varying numbers of melanocytes, but to differing activity levels of the melanocytes and the shade of melanin produced. Melanin granules are engulfed by keratinocytes, which then line up forming a cellular shield over the nucleus to protect the DNA inside.
3. **Langerhans cells** - macrophages (macro = large, phage = to eat) in the epidermis. Macrophages are involved in "garbage patrol" activities in tissues throughout the body
4. **Merkel cells** - sensory receptor cells for light touch. Each Merkel cell is associated with a nerve ending in the dermis.

Epidermal Layers

In some areas of the body you have what is called "thick skin", and everywhere else you have "thin skin" (bet you couldn't have guessed that). Thick skin has an extra layer (for a total of 5), and the layers are thicker. Where do you think you might have thick skin? Think about areas of your body that receive the most wear and tear - your hands and feet should come to mind. Thick skin is found on your palms, fingertips, and the soles of your feet. Here is the list of skin layers from superficial to deep.

Thick Skin

stratum corneum
stratum lucidum
stratum granulosum
stratum spinosum
stratum basale

Thin Skin

stratum corneum
stratum granulosum
stratum spinosum
stratum basale

Which layer is missing from thin skin? Only the stratum lucidum is not found in thin skin. Characteristics of the layers are the same, whether we are describing thick, or thin skin.

Layer Characteristics (deep to superficial)

- **Stratum basale** - this is a single layer of cells at the bottom of the epidermis. Underneath these cells is a basement membrane, then the dermis. Cells in this layer are highly mitotic, as new cells are made they are pushed up and form the upper layers. This cell layer is also known as the stratum germinativum (think of seeds germinating). You'll find keratinocytes in this layer, as well as the Merkel cells and

the melanocytes.

- **Stratum spinosum** - several cell layers thick, some mitosis occurs here, one of the components of keratin is being produced here (bundles of keratin filaments called tonofilaments). These cells look "spiny" in prepared microscope slides, hence the name.
- **Stratum granulosum** - a few layers of cells, granules of keratohyalin (the other component of keratin) are evident in these cells. At the top of the stratum granulosum the cells are beginning to die.
- **Stratum lucidum** - lucid means "clear", which is how this layer looks under the microscope. Composed of a few cell layers, keratohyalin and the tonofilaments produced in the lower layers combine to form keratin in this layer, or in the layer above...
- **Stratum corneum** - 20 to 30 cell layers thick, all cells in this layer are dead, and are awaiting their ultimate fate - being sloughed off and replaced by "fresher" cells below. Keratin is abundant in this thick, protective layer.

Dermis

The dermis is composed of several different varieties of connective tissue, and is quite different than the epidermis above. Living cells in a non-living matrix - the matrix of the dermis contains collagen fibers for strength, and elastic fibers for stretch.

Dermal Layers

- **Papillary layer** - loose connective tissue with lots of blood vessels. Fingerlike projections called the dermal papillae extend up into the epidermis. The dermal papillae bring blood vessels closer to the epidermis, and increase help hold the two layers together. Your fingerprints are a result of the arrangement of the papillae in the fingers and feet.
- **Reticular layer** - thicker than the papillary layer, and composed of dense irregular connective tissue (strength and flexibility in many different directions was the "job" of DIRT.)

Skin Color

What accounts for the tremendous variation in skin color among humans? There are 3 main pigments that give color to our skin. We've already mentioned melanin - it can be found in shades of yellow, brown, and black. The melanocytes make the melanin, which is picked up by the keratinocytes (via phagocytosis). The melanin is important because it protects the DNA in the nucleus from UV radiation. The amount and color of melanin you make is pre-programmed into your DNA, or your genes. So, if you have very fair skin, not much melanin is produced, and it is a very light shade. If you have very dark skin, on the other hand, you make lots of melanin, and it is of a darker shade. All humans have roughly the same number of melanocytes, but some people's melanocytes are "busier" than others!

Another pigment that adds to our skin tone is carotene - a yellow-orange pigment. Carotene tends to accumulate in the stratum corneum and in the adipose tissue found in the hypodermis.

Do you know what hemoglobin is? Hemoglobin is the oxygen-carrying protein found in our red blood cells. If you have very fair skin you might see oxygenated hemoglobin, which is red in color, in underlying blood vessels, giving the skin a pink cast. If the blood is not adequately oxygenated, the hemoglobin will be blue in color, and so the skin might also have a blue cast. This would not be a normal situation, and might indicate anemia, or other impairment in oxygen delivery (heart attack, respiratory failure, etc.)

Other Terms Which Relate to Skin Color

- **Erythema (eryth = red)** - a reddish cast - from blushing, exercise, fever, etc.
- **Jaundice** - A liver disease, which causes a yellow skin tone - caused by the deposition of bile pigments normally used in the liver to make bile
- **Hematoma** - the "fancy" word for bruising, caused by blood, which has escaped from the blood vessels after injury

Skin Appendages

Those other "players" in the integumentary system - hair, nails, and oil and sweat glands. These structures are all derived from the epidermis.

Hair

Each hair is nested in a hair follicle which extends into the dermis and possibly the hypodermis. Around each hair follicle you'll find a sensory nerve ending - the root hair plexus. The hair itself is composed of three cell layers, the inner medulla, the middle cortex, and the outer cuticle. The hair cells are keratinized, and the cells in the cuticle overlap themselves like shingles on a roof. Hair growth occurs when cells in the basal layer

reproduce and push themselves upward, as in the epidermis.

Melanin is produced by the melanocytes in the hair, and is deposited in the cells to give the hair color. As we age our melanin production decreases, and melanin is replaced by air bubbles in the shaft of the hair. These 2 things give us the dreaded gray hair - which of course like most other things is pre-programmed genetically, and there is little you can do to stop it! (Of course, modern societies have invented hair coloring to help out here!)

Each hair follicle has a small bundle of smooth muscle fibers arranged so that when the muscle contracts the hair is pulled perpendicular to the skin surface. These muscles are known as the arrector pili muscles. These are the same muscles that a cat uses to make the hair on its body stand on end, giving it a more fierce presence. The arrector pili muscles are stimulated to contract involuntarily by the nervous system in times of stress or cold. The hair standing on end will trap more air, and thus keep you warmer.

There are 2 types of hair found on humans:

1. **Vellus hair** - the fine body hair of children and adult women
2. **Terminal hair** - the coarser hair of the scalp, eyebrows, etc. At puberty terminal hair begins to grow in the axillary (under the arm) and pubic regions of both boys and girls. Men also have terminal hair growth on the face, chest, and limbs. Again, distribution and amount of terminal hair is genetically pre-programmed

Hair follicles go through cycles of growth and inactivity, followed by shedding. Hairs of the eyebrows and eyelashes have short growth cycles, so they never reach the length of scalp hair.

Nails

Human nails are analogous to other animals' hooves or claws. We use fingernails to help us pick things up, and both finger and toe nails help protect the tissues underneath. Nails are composed of keratin. Nail growth occurs at the matrix, which forms new cells in a similar fashion to the epidermis and hair follicle. The half-moon shaped white portion of the proximal portion of the nail is called the lunula (little moon). This area is white in color because the matrix is thickened here.

Sudoriferous (Sweat) Glands

Most of your body's sweat glands are coiled tubes found in the dermis with a duct leading to the skin's surface. Sweat is more than just water, you'll also find dissolved salts, antibodies, and waste products. Sweating helps regulate our body temperature.

Ceruminous Glands

Ceruminous glands are found in the lining of the external ear, and produce earwax, or cerumen.

Sebaceous Glands

A sebaceous gland can be found with each hair follicle, and it produces sebum, helps lubricate the hair and skin. Blocked ducts can cause whiteheads, blackheads, and if infection occurs acne, which is a bacterial infection of the sebaceous glands.

ANATOMY AND PHYSIOLOGY ONLINE COURSE - SESSION 4 - QUESTION & ANSWERS

NAME: _____

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Please be sure to fill out the information above, complete the test and e-mail or fax it back to us at iridology@netzero.net or 530-878-1119. We will grade your question & answer session and will let you know if we have questions or comments.

1. The skin is composed of _____ layers of tissue.
2. Epidermal cells have a life span of only _____ - _____ days.
3. What are the 3 main pigments that give color to our skin:
4. What is Jaundice?