BIOLOGY 211: HUMAN ANATOMY & PHYSIOLOGY

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**INTEGUMENTARY SYSTEM**

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Reference: Saladin, KS: Anatomy & Physiology, The Unity of Form and Function, 8th ed. (2018)

**Be sure you have read and understand Chapter 6 before beginning this lab.**

**INTRODUCTION:**

 The integumentary system includes the skin and those structures which develop from the skin, including hair, toenails, fingernails, and the glands which produce oil and sweat. It protects us from physical damage, keeps water and solutes in while keeping debris and damaging substances out, helps regulate body temperature, and serves as our interface with the world around us.

 The skin is the largest organ of the body, with a mass of more than ten kilograms (that’s about 22 pounds) and covering one and a half to two square meters of body surface. Most of the skin is one to two millimeters in thickness, although this ranges from less than one-half millimeter on the eyelids to more than five millimeters on the palms of the hand, soles of the feet, and skin of the back. Most areas of the body are covered by hair and have both sweat and oil glands in the skin, but these vary significantly in different regions and among different people.

 The skin consists of three layers. Most superficially, facing the external environment, is the ***epidermis*** consisting of a stratified squamous epithelium in which the outer layer of flattened cells have died to form a thick, waterproof layer. The middle layer of the skin, or ***dermis***, is the thickest. This consists of a dense irregular connective tissue with very thick collagen fibers and many elastic fibers. It has an extensive blood supply. Hairs, glands, and many different types of sensory receptors are located in this layer.

 The deepest layer of the skin is the ***hypodermis***, consisting of various amounts of areolar connective tissue and adipose tissue. By blending into the connective tissues covering underlying muscles, this layer binds the skin to these deeper structures and holds it in place. This is the layer in which subcutaneous (“below the skin”) fat accumulates. For most people in the United States it is not necessary to store fat for times when food is not available, but in our evolutionary history the ability to accumulate sufficient subcutaneous fat during the spring and summer was the difference between survival and death during the winter.

 We will use this lab period to study the structure of human skin. You should use chapter 6 of your Saladin textbook as a reference to help you understand structures on the models and microscopic slides of human skin. Pay particular attention to how various components of the skin are functionally related (for example, what structures are associated with a hair, and how does this affect their function?)

**TERMINOLOGY:**

 The root word for referring to the skin is ***derm-***. We see this in such words as *dermis, epidermis, dermatologist,* or *dermal papilla.* A number of other terms are also used in discussing the skin, however, and you should be familiar with these as well.

 a) As in many other tissues and organs, the prefix *epi*- means “on top of” or “above”.

 Thus the ***epi****dermis* lies on top of (superficial to) the *dermis.*

 b) As in many other tissues and organs, the prefix *hypo*- means “underneath” or “below”.

 Thus the***hypo****dermis* lies below (deep to) the *dermis.*

 c) The Latin word for “layer” is ***stratum*.** The plural is ***strata****.*

 d) The word ***germ-*** means growing, or at least capable of growing

**SURFACE APPEARANCE OF THE SKIN**

**1.**  **Use a magnifying glass to examine your own skin or the skin of your lab partner**.

 a) Examine the skin of the anterior surface of the arm. Note that the surface is not smooth,

 but the skin forms many ridges and grooves. Move to the tip of your finger, where these

 ridges and grooves are highly organized and clearly form the pattern of your fingerprint.

 b) Examine where a hair is emerging from the surface of the skin on the arm. You should be

 able to identify the pore, and you may see an accumulation of oil, or ***sebum****,* at this

 point. Examine where a hair is emerging from the scalp. Does it look the same?

 c) Try to identify the pores of sweat glands on the surface of the arm. If it is hot in the lab,

 and if you are patient, you may be able to watch sweat accumulating and spreading out

 over the surface.

**STRUCTURE OF THE SKIN:**

**2.**  **Examine Figures 6.1 and 6.11 in your Saladin text**. You should be able to identify the **epidermis, dermis**, and **hypodermis**. Observe the presence of blood vessels, nerves and specialized receptors, sweat and oil glands, and hairs. Note the small bands of smooth muscle, called the **piloerector or arrector pili** muscles, which pull the hairs into an erect position.

*In which of these parts of the skin are most of the nerve receptors located?*

*In which of these parts of the skin are the sweat glands and oil glands located?*

*In which of these parts of the skin are most of the piloerector muscles located?*

*In which of these parts of the skin do the hairs begin to grow?*



**3.** **Examine the models of the skin** (note that we have two different models of the skin which are not the same – be sure you examine both) and identify the ***epidermis, dermis****,* and ***hypodermis****.* Note the relative thickness of each of these layers.

**4.**  **Using the lowest (4x objective) power of your microscope, examine slide #18**, which is a section of human skin taken from the scalp. Identify the free surface (which would face the outside air). The other side of the tissue section was the deeper region where the skin was cut away from the underlying muscle or bone. Identify the (1**) *epidermis****,* (2)***dermis****,* and (3) ***hypodermis****.* Note the relative thickness of each of these layers.

 *Do you see sharp boundaries between the epidermis, dermis, or hypodermis or do they*

 *have irregular boundaries?*

 *What type of tissues do you expect will make up each layer of the skin?*

 *Epidermis \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

 *Dermis \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

 *Hypodermis \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**Based on the figures in your text and your examination of the slide, draw the appearance of the skin** (Draw it yourself! Refer to the book when necessary but do NOT trace or copy it from the book! The purpose of this is not to get a pretty picture – it is to determine whether or not your brain has learned it).

**The Epidermis:**

 This is the most superficial layer of the skin on the surface of the body. It consists of a ***stratified squamous* epithelium** which is ***keratinized*** or***cornified***because the outermost layers of cells produced large amounts of the protein ***keratin*** and then died, essentially leaving a thick layer of this protein on the surface of the skin. Like all epithelia, the epidermis is avascular and depends on blood vessels in the connective tissue deep to it for nutrition and removal of wastes.

 The epidermis is considered to consist of five layers of cells, but in reality these layers represent the same cells, called **keratinocytes**, at different stages of growth. New keratinocytes are constantly formed by mitosis (cell division) in the deepest layer of the epithelium. As this continues, older cells are pushed closer and closer to the surface. As this occurs, they synthesize large amounts of the protein **keratin** which fills the cytoplasm, the cells get flatter (more **squamous**), and eventually they die. Thus, the outermost layer consists of flattened, dead cells which are little more than bags of keratin.

**5. Examine figure 6.3 in your Saladin text** and identify the following strata (layers) of the epidermis before examining the prepared slide of the skin

 a) The ***stratum basale*** is the deepest layer. It consists of a single row of darkly stained,

 cuboidal cells lying on the dermis. In life, these cells are actively dividing, forcing older cells

 into more superficial layers. You should realize that a ***basement membrane*** separates the

 stratum basale from the dermis, even though this is too thin to see with the light microscope.

 b) The ***stratum spinosum*** is the next layer toward the surface, consisting of a few rows of

 cuboidal cells. When prepared for microscopy they appear to be attached to each other and

 to the underlying stratum basale by “spines”, although your microscope might not have good

 enough resolution to see this. Most of the cells in this layer are ***keratinocytes*** which will

 appear to have the same density, but you may be able to identify some cells with large

 amounts of a reddish-brown pigment in their cytoplasm. These are ***melanocytes (****Figure*

 *6.6),* and the reddish-brown material is ***melanin****.*

 c) The ***stratum granulosum*** is the next layer toward the surface, consisting of cells that are

 flattening out, and their nuclei appear smaller and darker as the cells have begun to die.

 You may be able to identify some melanocytes in this layer, and you should be able to notice

 that the more common keratinocytes contain noticeable amounts of melanin.

 d) Lying superficial to the stratum granulosum lies the ***stratum lucidum*** or “clear layer”,

 although this layer is generally only seen in thick skin from the palm of the hand or sole of

 the foot. The cells here have flattened out, and nuclei are rarely visible.

 e) The most superficial layer of the epidermis is the ***stratum corneum****.* This consists of many

 layers of dead, flattened cells. It is not held very tightly to underlying layers, so it often

 separates from the rest of the skin when prepared for microscopy. You should see no

 cellular detail in these cells, since they are dead and consist of little more than plasma

 membrane “bags” stuffed full of keratin.

 **-** *From memory, explain to your lab partners the changes which occur in the size, shape, and*

 *organelles of a keratinocyte as it moves from the stratum basale to the stratum corneum*

**6. Examine slide #18 again under low power and identify the epidermis**. Center this in your field of view and switch to higher power to examine this layer. Compare it to Figures 6.3, 6.5 (which used different stains), and 6.6 in your Saladin text. You’ll notice that the epidermis in our slides is much thinner (i.e., fewer layers of cells) than the picgures in the book. This is because those pictures were taken of skin from the arm or leg where the epidermis is thicker. The slides we have in lab are of skin from the scalp where the epidermis is much thinner**.** You should be able to identify the very outermost layer (stratum corneum) and the very deepest layer (stratum basale) for the lab exam, but you will probably not be able to easily identify the other three layers.

Examine the models of the skin again and note that the various strata of the epidermis can not be distinguished on all of them, but can be distinguished on some. Be sure you can do this.

**The Dermis:**

 This is the thickest layer of the skin, lying deep to the epidermis and superficial to the hypodermis. It is primarily composed of ***dense, irregular connective tissue***, and many structures of the skin such as hairs and glands are embedded within it.

**7.**  **On the models of the skin, identify the dermis again**. Note that it has many blood vessels, but none of these extend into the epidermis. Pay closer attention to its border with the epidermis, and notice that this is not even. Finger-like extensions of the dermis project upward, called ***dermal papillae****.* These often contain specialized nerve receptors, and many blood vessels extend into them.

**8.** **Examine slide #18 again at low power to find the dermis**, then switch to higher power.

 a) Identify the many dark, wavy ***collagen fibers.***  These are what give the dermis, and in fact

 the whole skin, its strength. Small, elongated dark structures between the collagen fibers

 are the nuclei of the ***fibroblasts***or***fibrocytes***, which are the primary cell type in this tissue.

 Even though your microscope can’t resolve them, you should realize that the skin also

 contains many elastic fibers.

 b) Identify the **dermal papillae**.

 *Are the fibers as dense here as they are in deeper regions of the dermis?*

 c) Looking carefully, try to identify **blood vessels** running throughout the dermis.

 These are difficult to identify because they collapse during preparation of the tissue for

 microscopy.

 d) You will notice many other structures in the dermis such as hairs, sweat glands, etc. We will

 examine these in more detail in a few minutes.

**The Hypodermis:**

 This is the deepest layer of the skin, and part of it was probably cut away when the tissue was prepared. Larger blood vessels run through here to get to the more superficial dermis. Most of it consists of adipose tissue, or fat.

**9. On the models of the skin, identify the hypodermis again**. Its thickness varies widely among different regions of the body. Note that it has many blood vessels, and much of it consists of fat. This is where you store the *subcutaneous fat* which most of us try to keep to a minimum.

**10.**  **Identify the hypodermis under low power on slide #18,** then switch to higher power.

 a) Identify the large accumulations of fat cells, or **adipose tissue** (shown in Figure 5.18 of your

 Saladin text). Identify the **collagen fibers** which lie between these.

 b) Try to identify the many **blood vessels** which lie in this layer. Again, these may be

 difficult to identify if they have collapsed during preparation of the tissue.

**STRUCTURES IN THE DERMIS:**

 Many structures which originate in the epidermis of the embryo grow deep until they came to lie in the dermis. However, many of these have cells that continue to resemble the epidermis from which they arose rather than the dermis around them.

**11.**  **On the models of the skin, identify the following structures** as shown n Figure 6.1:

 a) **Hair follicles and hair**. Identify the ***bulb, root****,* and ***shaft*** of the hair. Note that the tissue

 forming the hair follicle deep in the dermis has the same layers as the epidermis from which

 it formed. Identify the blood vessels supplying the bulb of the hair.

 b) **Sebaceous, or oil, glands** which open into the hair follicles.

 c) **Piloerector** or **arrector pili muscles**, bands of smooth muscle which make hairs stand

 more upright.

 d) **Merocrine (eccrine) sweat glands**, which are deeply coiled deep in the dermis but then

 send a duct more-or-less straight up to the surface. These are found in almost all regions

 of the skin.

 e) **Apocrine sweat glands**, which are larger than the eccrine gland but otherwise similar in

 structure. These are found only in the axilla and around the anus and genitals.

 **-** *Explain to your lab partners the functions of the sebaceous glands, arrector pili muscles,*

 *merocrine sweat glands, and apocrine sweat glands.*

 **-** *Explain to your lab partners what the symptoms would be if each of these structures failed*

 *to function normally.*

**12**. **Examine the dermis on slide #18**. You should be able to identify all of the structures listed above **except for the apocrine sweat glands**, and you may have difficulty locating the piloerector muscles. Note that the hairs and hair follicles, the sebaceous glands, and the sweat glands are epithelial (many cells with little extracellular matrix), not composed of connective tissue even though they are physically found in the dermis. Figures 6.7 and 6.11 in your Saladin text will be helpful.

**BLOOD VESSELS AND NERVES IN THE SKIN:**

 The skin has a very extensive supply of both blood vessels and nerves located in both the hypodermis and the dermis. Because it is our “interface” with the outside world, the presence of these structures in our skin has significant physiological importance.

 Dilation (widening) of the blood vessels increases blood flow into the skin from where significant amounts of heat can be lost to the surrounding environment. Constriction (narrowing) of these vessels, on the other hand, restricts blood flow into the skin and conserves body heat. You have undoubtedly noticed this on yourself. On a hot day or in hot water, the skin becomes very warm and red as more blood is directed to the skin. On a cold day or in cold water, the skin becomes pale and cool as blood is directed away from the skin to other organs

 Nerve endings and specialized sensory receptors in the skin are constantly providing us with information about temperature, touch, pressure, pain, movement of hairs, and many other things. Some of these are simple nerve endings, while others form complex receptors involving layers of different types of cells.

**13. Examine the models of the skin** and identify the many blood vessels, nerves, and sensory receptors of the skin. Vessels are particularly abundant in the superficial part of the dermis (papillary layer) and in the hypodermis, while nerves and sensory receptors are distributed throughout it. Although you will not be responsible for identifying specific types of nerves and receptors, you should note the different types which are present.

**REVIEW:**

As with other tissues and organs we have examined in lab, the skin appears different on different slides. Be sure you examine a number of different slides of the skin and can identify all of the layers and structures noted above on all of them.

Be sure you examine the structures indicated on different models of skin in the lab since they are not all the same.