Integumentary System

Purpose of the Exercise
To observe the structures and tissues of the integumentary system and to review the functions of these parts.

Materials Needed
- Skin model
- Hand magnifier or dissecting microscope
- Forceps
- Microscope slide and coverslip
- Compound light microscope
- Prepared microscope slide of human scalp or axilla
- Prepared slide of dark (heavily pigmented) human skin
- Prepared slide of thick skin (plantar or palmar)

For Learning Extension Activity:
- Tattoo slide
- Stereomicroscope (dissecting microscope)

Learning Outcomes
After completing this exercise, you should be able to
1. Locate the structures of the integumentary system.
2. Describe the major functions of these structures.
3. Distinguish the locations and tissues among epidermis, dermis, and the hypodermis.
4. Sketch the layers of the skin and associated structures observed on the prepared slide.

Pre-Lab
Carefully read the introductory material and examine the entire lab. Be familiar with skin layers and accessory structures of the skin from lecture or the textbook. Answer the pre-lab questions.

Pre-Lab Questions: Select the correct answer for each of the following questions:
1. Which of the following is not a function of the integumentary system?
   a. protection
   b. excrete small amounts of waste
   c. movement
   d. aid in regulating body temperature

2. The two distinct skin layers are the
   a. epidermis and dermis.
   b. hypodermis and dermis.
   c. hypodermis and epidermis.
   d. dermis and hypodermis.

3. Apocrine sweat glands are located in __________ regions of the body.
   a. forehead
   b. axillary and genital
   c. palmar
   d. plantar

4. The hypodermis is composed of __________ tissues.
   a. adipose and stratified squamous epithelial
   b. areolar and dense irregular connective
   c. stratified squamous epithelial and adipose
   d. areolar and adipose connective

5. The ________________ layer of the epidermis is only present in thick skin.
   a. stratum corneum
   b. stratum lucidum
   c. stratum spinosum
   d. stratum granulosum

6. Frequent cell division occurs in the __________ of the epidermis.
   a. stratum corneum
   b. stratum spinosum
   c. stratum granulosum
   d. stratum basale

7. The greatest concentration of melanin is in the dermis.
   True ______ False ______

8. Thick skin of the palms and soles contains five strata of the epidermis.
   True ______ False ______
The integumentary system includes the skin, hair, nails, sebaceous (oil) glands, and sweat (sudoriferous) glands. These structures provide a protective covering for deeper tissues, aid in regulating body temperature, retard water loss, house sensory receptors, synthesize various chemicals, and excrete small quantities of wastes.

The skin consists of two distinct layers. The outer layer, the epidermis, consists of stratified squamous epithelium. The inner layer, the dermis, consists of a superficial papillary region of areolar connective tissue and a thicker and deeper reticular region of dense irregular connective tissue. Beneath the dermis is the hypodermis (subcutaneous layer; superficial fascia) composed of adipose and areolar connective tissues. The hypodermis is not considered a true layer of the skin.

Accessory structures of the skin include nails, hair follicles, and skin glands. The hair, which grows through a depression from the epidermis, possesses a hair papilla at the base of the hair which contains a network of capillaries that supply the nutrients for cell divisions for hair growth within the hair bulb. As the cells of the hair are forced toward the surface of the body, they become keratinized and pigmented and die. Attached to the follicle is the arrector pili muscle that can pull the hair to a more upright position, causing goose bumps when experiencing cold temperatures or fear. A sebaceous gland secretes an oily sebum into the hair follicles, which keeps the hair and epidermal surface pliable and somewhat waterproof.

Sweat glands (sudoriferous glands) are distributed over most regions of the body and consist of two types of glands. The widespread eccrine sweat glands are most numerous on the palms, soles of the feet, and the forehead. Their ducts open to the surface at a sweat pore. Their secretions increase during hot days, physical exercise, and stress; they serve an excretory function and can help prevent our body temperature from overheating. The apocrine sweat glands are most abundant in the axillary and genital regions. Apocrine sweat ducts open into the hair follicles and become active at puberty. Their secretions increase during stress and pain and have little influence on thermoregulation.

**Procedure—Integumentary System**

In this procedure you will use a skin model and make comparisons to the figures in the lab manual to locate the layers and accessory structures of the skin. Hair structures will be observed from your own body with different magnifications and then compared to additional detail using prepared slides. Several micrographs of different magnifications are provided of vertical sections of the skin layers and accessory structures. Use a combination of all of the micrographs as you observe the skin slides available in your laboratory.

1. Use figures 5.1 and 5.2 and locate as many of these structures as possible on a skin model.
2. Use figure 5.3 as a guide to locate the specific epidermal layers (strata) on a skin model. Note the locations and descriptions from table 5.1.
3. Use the hand magnifier or dissecting microscope and proceed as follows:
   a. Observe the skin, hair, and nails on your hand.
   b. Compare the type and distribution of hairs on the front and back of your forearm.
4. Use low-power magnification of the compound light microscope and proceed as follows:
   a. Pull out a single hair with forceps and mount it on a microscope slide under a coverslip.
   b. Observe the root and shaft of the hair and note the scalelike parts that make up the shaft.
5. Complete Parts A and B of Laboratory Assessment 5.
6. As vertical sections of human skin are observed, remember that the lenses of the microscope invert and reverse images. It is important to orient the position of the epidermis, dermis, and hypodermis layers using scan magnification before continuing with additional observations. Compare all of your skin observations to the various micrographs in figure 5.4. Use low-power magnification of the compound light microscope and proceed as follows:
   a. Observe the prepared slide of human scalp or axilla.
   b. Locate the epidermis, dermis, and hypodermis; a hair follicle; an arrector pili muscle; a sebaceous gland; and a sweat gland.
   c. Focus on the epidermis with high power and locate the stratum corneum, stratum granulosum, stratum spinosum, and stratum basale. Note how the shapes of the cells in these layers differ as described in table 5.1.
**FIGURE 5.2** Vertical section of the skin and hypodermis (subcutaneous layer).

**FIGURE 5.3** Epidermal layers in this section of thick skin from the fingertip (400×).

**TABLE 5.1** Layers of the Epidermis

<table>
<thead>
<tr>
<th>Layer</th>
<th>Location</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratum corneum</td>
<td>Most superficial layer</td>
<td>Many layers of keratinized, dead epithelial cells; appear scaly and flattened; resists water loss, absorption, and abrasion</td>
</tr>
<tr>
<td>Stratum lucidum</td>
<td>Between stratum corneum and stratum granulosum on soles and palms of thick skin</td>
<td>Cells appear clear; nuclei, organelles, and plasma membranes no longer visible</td>
</tr>
<tr>
<td>Stratum granulosum</td>
<td>Beneath the stratum corneum (or stratum lucidum of thick skin)</td>
<td>Three to five layers of flattened granular cells; contain shrunken fibers of keratin and shriveled nuclei</td>
</tr>
<tr>
<td>Stratum spinosum</td>
<td>Beneath the stratum granulosum</td>
<td>Many layers of cells with centrally located, large, oval nuclei; develop fibers of keratin; cells becoming flattened in superficial portion</td>
</tr>
<tr>
<td>Stratum basale</td>
<td>Deepest layer</td>
<td>A single row of cuboidal or columnar cells; layer also includes melanocytes; frequent cell division; some cells become parts of more superficial layers</td>
</tr>
</tbody>
</table>
FIGURE 5.4 Features of human skin are indicated in these micrographs: (a) and (b) various structures of epidermis and dermis; (c) epidermis of dark skin; (d) base of hair structures.
Critical Thinking Activity

Explain the advantage for melanin granules being located in the deep layers of the epidermis, and not the dermis or deeper hypodermis.

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d. Observe the dense irregular connective tissue that makes up the bulk of the dermis (reticular region).

e. Observe the adipose tissue that composes most of the hypodermis (subcutaneous layer).

7. Observe the prepared slide of dark (heavily pigmented) human skin with low-power magnification. Note that the pigment is most abundant in the deepest layers of the epidermis. Focus on this region with the high-power objective. The pigment-producing cells, or melanocytes, are located among the stratum basale cells. Some melanin is retained within some cells of the stratum spinosum as cells are forced closer to the surface of the skin. Differences in skin color are primarily due to the quantity of the pigment melanin produced by these cells. Exposure to ultraviolet (UV) rays of sunlight can increase the amount of melanin produced, causing a suntan. Melanin absorbs the UV radiation, which helps to protect the nuclei of cells.

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Learning Extension Activity

Observe a vertical section of human skin through a tattoo, using low-power magnification. Note the location of the dispersed ink granules within the upper portion of the dermis. From a thin vertical section of a tattoo, it is not possible to determine the figure or word of the entire tattoo as seen on the surface of the skin. Compare this to the location of melanin granules found in dark (heavily pigmented) skin. Suggest reasons why a tattoo is permanent and a suntan is not.

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8. Observe the prepared slide of thick skin from the palm of a hand or the sole of a foot. Locate the stratum lucidum, which is present only in thick skin. Locate the four other strata of thick skin and note the very thick stratum corneum (fig. 5.3).


10. Using low-power magnification, locate a hair follicle sectioned longitudinally through its bulblike base. Also locate a sebaceous gland close to the follicle and find a sweat gland (fig. 5.4). Observe the detailed structure of these parts with high-power magnification.

11. Complete Parts D and E of the laboratory assessment.
Integumentary System

Part A Assessments

1. Label the structures indicated in figure 5.5. ▶

**FIGURE 5.5** Label the features of the skin.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hair shaft</td>
<td>Sweat pore</td>
<td>Hair root</td>
<td>Sebaceous gland</td>
<td>Arrector pili muscle</td>
<td>Epidermis</td>
<td>Dermis</td>
<td>Hypodermis</td>
</tr>
</tbody>
</table>

2. Match the structures in column A with the description and functions in column B. Place the letter of your choice in the space provided. ▶

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Apocrine sweat gland</td>
<td>j. An oily secretion that helps to waterproof body surface</td>
</tr>
<tr>
<td>b. Arrector pili muscle</td>
<td>l. 2. Outermost layer of epidermis</td>
</tr>
<tr>
<td>c. Dermis</td>
<td>a. 3. Become active at puberty</td>
</tr>
<tr>
<td>d. Eccrine (merocrine) sweat gland</td>
<td>h. 4. Epidermal pigment</td>
</tr>
<tr>
<td>e. Epidermis</td>
<td>c. 5. Inner layer of skin</td>
</tr>
<tr>
<td>f. Hair follicle</td>
<td>d. 6. Responds to elevated body temperature</td>
</tr>
<tr>
<td>g. Keratin</td>
<td>e. 7. General name of entire superficial layer of the skin</td>
</tr>
<tr>
<td>h. Melanin</td>
<td>i. 8. Gland that secretes an oily substance</td>
</tr>
<tr>
<td>i. Sebaceous gland</td>
<td>g. 9. Hard protein of nails and hair</td>
</tr>
<tr>
<td>j. Sebum</td>
<td>k. 10. Cell division and deepest layer of epidermis</td>
</tr>
<tr>
<td>k. Stratum basale</td>
<td>f. 11. Tubelike part that contains the root of the hair</td>
</tr>
<tr>
<td>l. Stratum corneum</td>
<td>b. 12. Causes hair to stand on end and goose bumps to appear</td>
</tr>
</tbody>
</table>
Part B  Assessments

Complete the following:

1. How does the skin of your palm differ from that on the back (posterior) of your hand?  **Answers will vary.**

________________________________________________________________________________________________
________________________________________________________________________________________________

2. Describe the differences you observed in the type and distribution of hair on the front (anterior) and back (posterior) of your forearm.  **Answers will vary.**

________________________________________________________________________________________________
________________________________________________________________________________________________

3. Explain how a hair is formed.  **Cell divisions occur within the hair bulb. As the cells are forced toward the surface, they become keratinized and die.**

Part C  Assessments

Complete the following:

1. Distinguish the locations and tissues among epidermis, dermis, and hypodermis layers.  **The superficial epidermis is composed of stratified squamous epithelium. The dermis contains mostly irregular dense connective tissue. The hypodermis, beneath the dermis, is composed of areolar and adipose connective tissues.**

________________________________________________________________________________________________
________________________________________________________________________________________________

2. How do the cells of stratum corneum and stratum basale differ?  **Cells of the stratum basale are living and actively divide; cells of the stratum corneum are dead and keratinized and form the surface layer of the skin.**

________________________________________________________________________________________________

3. State the specific location of melanin observed in dark skin.  **Melanin is located primarily in the stratum basale of the epidermis.**

________________________________________________________________________________________________

4. What special qualities does the connective tissue of the dermis have?  **It contains abundant collagen fibers that give the dermis qualities of elasticity and strength.**

________________________________________________________________________________________________
**Part D  Assessments**

Complete the following:

1. What part of the hair extends from the hair papilla to the body surface?  
   - **hair root**

2. In which layer of skin are sebaceous glands found?  
   - **dermis**

3. How are sebaceous glands associated with hair follicles?  
   - Sebaceous glands are next to the hair follicles and secrete sebum into the follicles.

4. In which layer of skin are sweat glands usually located?  
   - **dermis**

**Part E  Assessments**

Sketch a vertical section of human skin, using the scanning objective. Label the skin layers and a hair follicle, a sebaceous gland, and a sweat gland.

(sketched diagram)