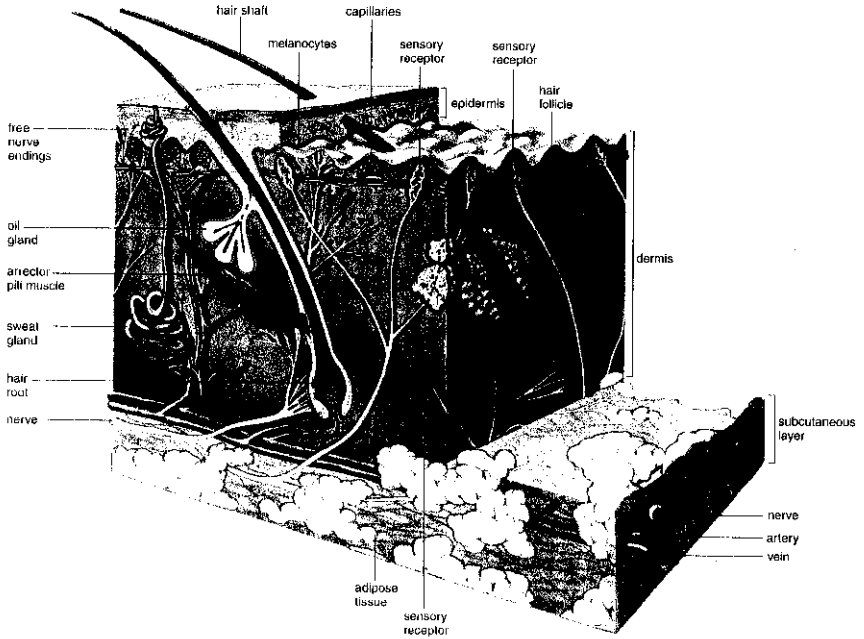
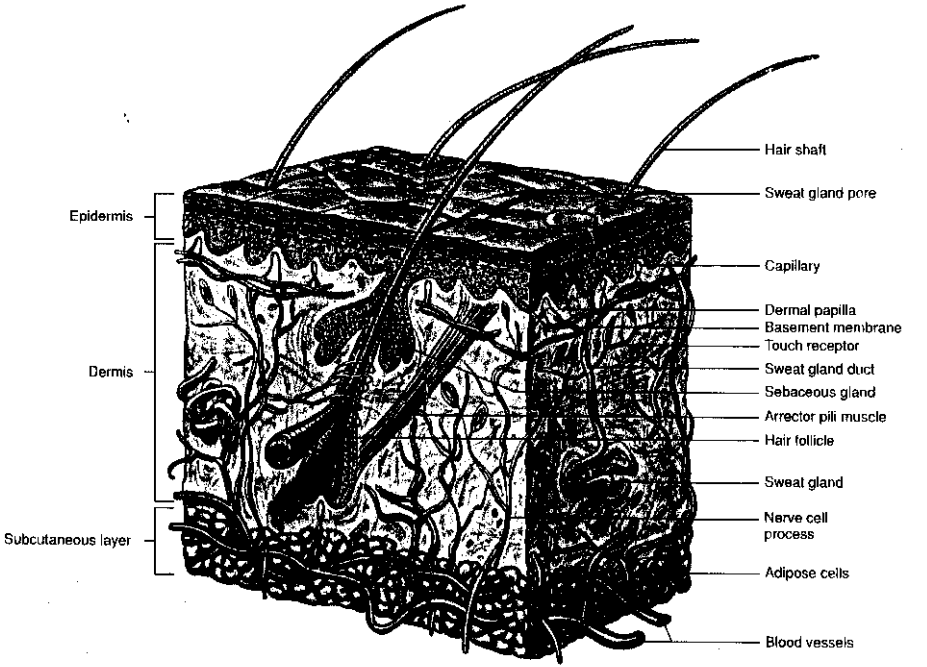


222 Human skin anatomy
Figure 11 9



183 **A section of skin**
Figure 6.2

EXERCISE 12

The Integumentary System

OBJECTIVES

On completion of this exercise, you should be able to:

- Identify the two main layers of the skin.
- Identify the layers of the epidermis.
- Distinguish between the papillary and reticular layers of the dermis.
- Identify a hair follicle, the parts of a hair, and an arrector pili muscle.
- Distinguish between sebaceous and sudoriferous glands.
- Describe three sensory organs of the integument.

WORD POWER

epidermis (epi—over, upon)
stratum (strat—layer)
melanin (melan—black)
spinosum (spin—thorn)
granulosum (gran—grain)
lucidum (luci—clear)
corneum (corn—horn)
dermis (derm—the skin)
papillary (papill—nipple)
sebaceous (seb—grease)
apocrine (apo—off, from)
eccrine (ec—out, away)
pili (pil—hair)

MATERIALS

skin models
skin charts
compound microscope
prepared microscope slides:
  scalp cross section
  palm or sole cross section

INTRODUCTION

The integumentary system is the most visible organ system of the human body. Most individuals spend more time grooming their skin and skin derivatives such as hair and nails than exercising their muscular system. Our impressions of others are sometimes influenced by their skin. If their skin is wrinkled, we may think of them as old. Tanned skin is associated with health even though the sun may damage the skin. Skin seals your body in a protective barrier that is flexible yet resistant to abrasion and evaporative water loss. We contact the external environment with the skin. Caressing a baby's head, feeling the texture of granite, and testing the temperature of your bath water all involve sensory organs in the skin. Sweat glands in the skin cool the body to regulate body temperature. Vitamin D, an essential compound in calcium and phosphorus balance, is synthesized by the skin on exposure to sunlight. In this exercise, you will study the structure of the skin.

The skin is organized into two tissue layers, a superficial layer of epithelium, called the **epidermis**, and a deeper layer of connective tissue, the **dermis**. Locate these layers in Figure 12.1. Isolating the dermis from underlying structures is a fatty layer of connective tissue, the **hypodermis** or **subcutaneous** layer.

A. Epidermis

The epidermis consists of stratified squamous epithelium organized into many distinct cell bands or strata as shown in Figure 12.2. Thick-skinned areas such as the palms of

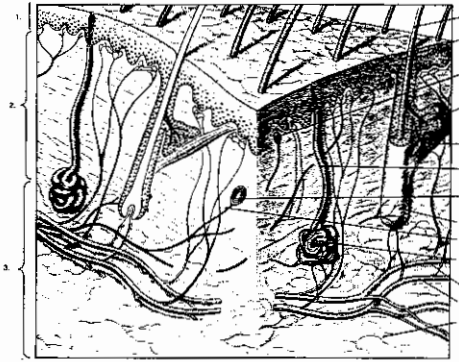


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Figure 12.1
Components of the Integumentary System.
Relationships among the major components of the integumentary system (with the exception of nails, shown in Figure 12.6).

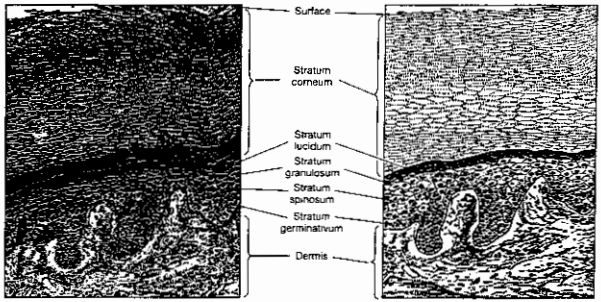

Figure 12.2
Layers of the Epidermis.
A light micrograph through a portion of the epidermis, showing the major stratified layers of epidermal cells. [LM ×90]

the hands and soles of the feet have five layers, and thin-skinned areas have four. Cells are produced in the basal region of the epidermis and pushed upward toward the surface of the skin. During this migration, they synthesize and accumulate the protein keratin which reduces water loss across their cell membrane. The uppermost layer of the epidermis consists of dead, dry, scalelike cells.

The **stratum germinativum**, or **stratum basale**, is a single cell layer between the base of the epidermis and the upper dermis. Locate this layer in Figure 12.2. The cells of this stratum are in a constant state of mitosis, replacing cells that have rubbed off the epidermal surface. As new cells are produced, they push previously formed cells toward the surface. It takes from 15 to 30 days for a cell to migrate from the stratum basale to the top of the stratum corneum.

Many different cell types populate the stratum basale. **Melanocytes** produce a pigment called **melanin** which protects deeper cells from the harmful effects of ultraviolet (UV) radiation from the sun. Prolonged exposure to UV light causes an increase in melanin synthesis, resulting in a darkening or tanning of the skin. Other epidermal cells produce a yellow-orange pigment called **carotene**. This pigment is common in light-skinned individuals.

Superficial to the stratum basale is the **stratum spinosum**, which consists of five to seven rows of cells interconnected by thickened cell membranes called **desmosomes**. During the slide preparation process, cells in this layer often shrink, whereas the desmosome bridges between cells remain intact. This results in cells with a spiny outline, hence, the name "spinosum."

Superior to the stratum spinosum is a layer of darker cells that make up the **stratum granulosum**. As cells from the stratum basale are pushed upward, they synthesize the protein **keratohyalin** which increases durability and reduces water loss from the skin. Keratohyalin granules stain dark and give this layer its color.

The uppermost layer of the epidermis is the **stratum corneum**, which has many layers of flattened, dead cells. As cells from the stratum granulosum move upward, keratohyalin granules are converted to the fibrous protein **keratin** which kills the cells and waterproofs them with a hard covering. If the skin is located in an area of high abrasion, like the palms or soles, a thin transparent layer of cells called the **stratum lucidum** lies between the stratum granulosum and the stratum corneum. In the stratum lucidum, keratohyalin is converted to a intermediate protein called **eleidin** which eventually becomes keratin. Cells of the stratum corneum are constantly being shed or worn off and replaced by new cells produced in and pushed up from deeper layers.

B. Dermis

Below the stratum germinativum is the **dermis**, a band of connective tissues that anchors the epidermis in place (see Figure 12.1). The dermis is divided into two regions, the **papillary** and **reticular** layers. Although no distinct boundary occurs between these layers, the upper fifth of the dermis is designated the papillary region. This layer consists of loose connective tissue with numerous collagen and elastic fibers. The tissue projects folds, called dermal ridges, into the epidermis, which result in the swirls of fingerprints. These patterns on the skin are genetically based and do not change during an individual's life. Within the projections of dermal tissue are small sensory receptors for light touch, **Meissner's corpuscles**.

Deep to the papillary layer is the reticular region, distinguished by widely scattered cells and dense, irregular connective tissue with interlaced collagen fibers. By comparison, collagen fibers in the papillary layer are less distinct. Large blood vessels, sweat glands, and adipose tissue are less visible in the reticular region. Sensory receptors in this layer, called **Pacinian corpuscles**, detect deep pressure. Attaching the dermis to

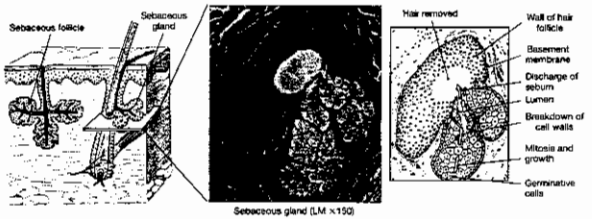

Figure 12.3
Sebaceous Glands and Follicles.
The structure of sebaceous glands and sebaceous follicles in the skin.

underlying structures is the **subcutaneous layer** or **hypodermis**, which is profuse with adipose tissue and loose connective tissue.

C. Accessory Structures of the Skin

During embryonic development, the epidermis produces accessory structures called *epidermal derivatives*, which include oil and sweat glands, hair, and nails. These structures are exposed on the surface of the skin and project deep into the dermis.

SEBACEOUS GLANDS

Sebaceous glands secret **sebum**, an oily substance, which coats hair shafts and the epidermal surface. Observe in Figure 12.3 the infolding of epithelium to form the hair follicle and sebaceous gland. Notice how the glandular cells empty onto the follicle. The gland is a **holocrine** exocrine gland. The cells fill with secretory materials and burst to deliver the product into a duct. In sebaceous glands, oil-filled sebaceous cells are pushed toward the lumen of the duct. Once on the free surface of the lumen, their cell membranes rupture and sebum is discharged into the duct. Sebum coats the hair shaft to reduce brittleness and prevents excessive drying of the scalp.

Sebaceous **follicles** secrete sebum onto the surface of the skin. These glands lack hair and are distributed on the face, most of the trunk, and the male reproductive organs. Secretions from these glands lubricate the skin and provide antibacterial action.

Most teenagers have dealt with skin blemishes called acne. When sebaceous ducts become blocked, sebum becomes trapped in the ducts. As the sebum accumulates, it causes the skin to raise, resulting in a pimple. The white head of the pimple shows the duct is infected with bacteria that are feeding on the sebum.

SUDORIFEROUS (SWEAT) GLANDS

Sudoriferous glands are scattered throughout the dermis of most of the skin. Sweat glands are exocrine glands that secrete their fluid into sweat ducts leading directly to the surface of the skin or into ducts that empty into hair follicles, as shown in Figure 12.4.

Two types of sweat glands occur in the dermis, apocrine and eccrine glands. **Apocrine glands** are found in the groin, nipples, and axillae. Apocrine sweat glands secrete a thick **sweat** into ducts associated with hair follicles. Bacteria on the hair metabolize the sweat and produce the characteristic body odor of, for example, axillary sweat. When body temperature increases, **eccrine glands** secrete sweat containing electrolytes,

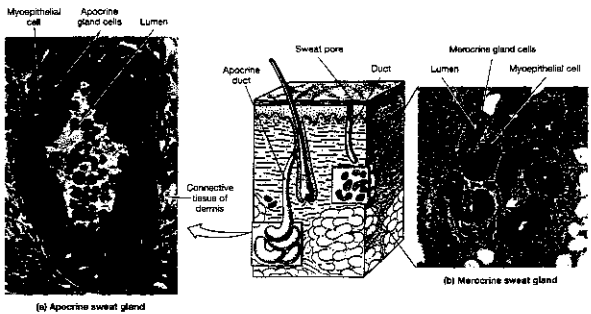

Figure 12.4
Sweat Glands.

(a) Apocrine sweat glands are found in the axillae, groin, and nipples. They produce a thick, odorous fluid by apocrine secretion. (LM ×390) **(b)** Merocrine sweat glands produce a watery fluid by merocrine secretion. (LM ×199)

proteins, urea, and other compounds onto the body surface. The sweat absorbs body heat and evaporates from the skin, cooling the body. It also contributes to body odor because of the presence of waste products, such as urea, in the sweat. Eccrine glands are not associated with hair follicles and are distributed throughout most of the skin.

Most of the skin is covered with hair. Only the lips, the nipples, portions of the external genitalia, and the palmar and plantar surfaces of the fingers and toes are without hair. Hair generally serves a protective function. It cushions the scalp and prevents foreign objects from entering the eyes, ears, and nose. Hair also serves as a sensory receptor. Wrapped around the base of each hair is a **root hair plexus**, a sensory neuron sensitive to movement of the hair.

Examine Figure 12.5 and note that each hair is embedded in a **hair follicle**, a pocket of epidermis extending deep into the dermis. At the base of the hair follicle is the **hair root**. At the root is a **papilla** containing nerves and blood vessels and the living, proliferative part of the hair, the **matrix**. Cells in the matrix undergo mitotic divisions that cause elongation and growth of the hair. Above the matrix, keratinization of the hair cells causes them to harden and then die. The resulting **hair shaft** contains an outer **cortex** and an inner **medulla**. Figure 12.5 also depicts an **arrector pili muscle** attached to each hair follicle. When furry animals such as dogs and cats are cold, these muscles contract to raise the hair and trap a layer of warm air next to the skin. In humans, the muscle has no known thermoregulatory use; humans do not have enough hair to gain an insulation benefit. These muscles contract when we are cold and produce "gooseflesh." The arrector pili muscles also respond to emotional stimuli such as beautiful music and chalk scratching on a chalk board. The arrector pili muscles in animals also have an emotional response. Animals raise their fur to look bigger when they feel threatened.

Figure 12.3 Accessory Structures of the Skin.
(a) A three-dimensional view of the skin. **(b)** A light micrograph showing the sectional appearance of the skin of the scalp. (LM ×73)

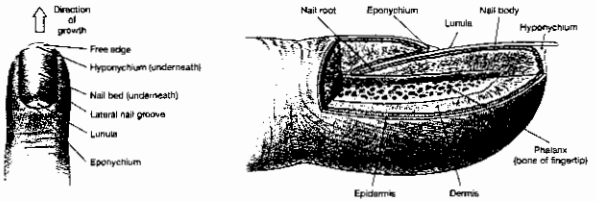

Figure 12.6
Structure of a Nail.
These drawings illustrate the prominent features of a typical fingernail as viewed from the surface and in section.

To protect the tips of the fingers and toes, hard **nails** cover their dorsal surface. Nails consist of tightly packed keratinized cells. Figure 12.6 illustrates the parts of a typical nail. The visible elongated body of the nail, called the **nail body**, protects the underlying nail bed of the skin. Blood vessels underneath the nail body give the nail its pinkish coloration. The **free edge** of the nail body extends past the end of the digit. The **nail root** is at the base of the nail where new growth occurs. The **lunula** is a whitish portion of the proximal nail body where blood vessels do not shown through. The cuticle around the nail is called the **eponychium.** It is composed of a band of epidermis which seals the **nail groove** to the epidermis. Under the free edge of the nail is the **hyponychium**, a thicker region of the epidermis.

LABORATORY ACTIVITY Microscopic Observation of the Skin

MATERIALS

compound microscope
prepared slide of the scalp (cross section)

PROCEDURE

1. Label Figures 12.1, 12.3, and 12.4.
2. Scan the scalp slide at low magnification and identify the epidermis, dermis, and hypodermis.
3. Increase the magnification and examine the epidermis. Locate the epidermal layers beginning with the deepest layer, the stratum germinativum.
4. Study the dermis and identify the papillary and reticular regions. In the papillary region, look for Meissner's corpuscles positioned where the dermis folds upward along the epidermis.
5. Locate a hair follicle. Identify the hair shaft, cortex, and medulla. Identify a sebaceous gland associated with the hair follicle.
6. Scan the dermis of the slide for a sudoriferous gland. Trace the duct from the gland to the surface of the skin.
7. Study the models, charts, and other material available in the lab.

Name _____ Date _____

Section _____ Number _____

THE INTEGUMENTARY SYSTEM

Laboratory Report Exercise 12

A. Matching

Match each skin structure listed on the left with the correct description on the right.

1. _____ sebaceous gland	A. layer in thickened areas of epidermis
2. _____ apocrine sweat gland	B. deep to the dermis, contains adipose
3. _____ keratin	C. sweat gland associated with hair follicle
4. _____ arrector pili	D. produces new epidermal cells
5. _____ stratum corneum	E. deep layer of the dermis
6. _____ papillary layer	F. protein that reduces water loss
7. _____ stratum germinativum	G. functions in thermoregulation
8. _____ reticular layer	H. surface layer of epidermis
9. _____ subcutaneous layer	I. muscle attached to hair follicle
10. _____ stratum lucidum	J. folded layer of dermis next to epidermis
11. _____ eccrine sweat gland	K. produces sebum

B. Short-Answer Questions

1. Describe the layers of epidermis in an area where the skin is thick.

2. Why is the epidermis keratinized?

3. How does the skin tan when exposed to sunlight?

4. List the types of sweat glands associated with the skin.