LESSON ASSIGNMENT

LESSON 3
Envelopes of the Body.

LESSON ASSIGNMENT
Paragraphs 3-1 through 3-42.

LESSON OBJECTIVES
After completing this lesson, you should be able to identify the functions of the envelopes of the body.

SUGGESTION
After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.
LESSON 3

ENVELOPES OF THE BODY

Section I. INTRODUCTION

Figure 3-1. The integument and related structures.

3-1. INTRODUCTION

The envelopes of the body serve to protect the living structures within the body in a number of ways. The envelopes are like an air conditioner; they help to remove heat. The envelopes are like a blanket; they help to retain heat when the surrounding air is cold. One of the envelopes, the skin, is like a chemical factory; it manufactures vitamin D in the presence of sunlight. The skin is like an umbrella; it helps to protect us from the sun and the rain. The skin also protects the body from dehydration and friction.

3-2. ENVELOPES OF THE BODY

a. The human body has three concentric coverings (Figure 3-1), one inside of the other. The outermost layer is the integument proper (skin). Immediately beneath the skin is the subcutaneous layer. Beneath this layer is the investing deep fascia, a membrane which completely covers the remaining structures of the body.
b. These three concentric layers form complete envelopes around the body, except for the various openings.

3-3. THE INTEGUMENTARY SYSTEM

An organ system is a group of organs performing a common overall function. The outermost covering of the body is the integument proper, the largest single organ of the body. A number of structures are formed or derived from the various layers of the integument proper. These structures are known as the integumentary derivatives, sometimes referred to as "appendages." Together, the integument proper and the integumentary derivatives make up the integumentary system.

Section II. INTEGUMENT PROPER

3-4. INTRODUCTION

The integument proper has two major parts--the dermis and the epidermis. The dermis (or corium) is made up of rather dense FCT, forming a continuous layer around the body. On top of the dermis is the epidermis. The epidermis and dermis are interlocked by extensions of the dermis up into the epidermis. These extensions are known as papillae.

3-5. LAYERS OF EPIDERMIS

The epidermis is a stratified squamous epithelial tissue. This means that it has several layers of epithelial cells and that its outermost layer is made up of squamous (flat) epithelial cells.

a. Mitotic Activity. The layer adjacent to the dermis is known as the basal layer. The basal layer is made up of columnar epithelial cells. Since all of the mitotic (cell-multiplying) activity of the epidermis occurs in the basal layer, the basal layer is often called the germinative layer. This mitotic activity involves about 4 percent of the cells in the basal layer at any given time. It occurs primarily between midnight and 0400 hours.

b. Migration of Cells to the Surface. Over a period of weeks, new cells gradually migrate from the basal layer to the surface. During this migration to the surface, the cells change in shape from the original columnar to cuboidal and then finally to squamous. As the cells become squamous in form, they also become hardened, or cornified, through the development of a special type of protein. As they approach the surface, they die. Thus, the outermost layers of the epidermis are dead, horny scales.
3-6. SPLIT LINES

There are specific lines of tension or stress that varies from one area of the body to the next. The dense FCT of the dermis tends to be oriented along these lines. If a blunt probe is inserted into the dermis, the FCT fibers will separate to form a split. The lines of splits, or split lines, follow the lines of tension in the local area.

3-7. DERMATOGLYPHICS

The surfaces of the palms, soles, and digital pads of the hands and feet are thrown up into ridges and grooves. The patterns formed by these ridges and grooves are called dermatoglyphics. These dermatoglyphics are used as a means of identification, both by law enforcement agencies and by hospitals for newborns. We often refer to such procedures as fingerprinting or foot-printing.

3-8. CREASES

The body is jointed to allow motion. To facilitate motion of the joints, the skin develops natural creases. These creases are in relationship to the joints, but not exactly opposite to the joints.

3-9. THICKNESS

As the continuous covering of the body, the integument proper, or skin, is everywhere. However, the actual thickness of the dermis and/or epidermis varies considerably from very thin to very thick. For example, the thickest skin is located across the back between the shoulders.

3-10. PIGMENTATION

The integument proper of humans has some type of coloration (pigmentation). This coloration is because the presence of special chemicals called pigments. Black, red, and yellow are the most common colors of these pigments.

a. Development. Special cells are located in the dermis, just below the basal layer of the epidermis. These special cells provide the precursors of the pigments to the basal cells. As these basal cells migrate to the surface, the precursor materials are gradually converted into the actual pigments or colors.

b. Genetic Control. Genes control the type of color for each individual. There are various genes (sometimes multiple genes) for each color.

(1) When these genes are absent, the individual is an albino. There is a pink glow to the skin and eyes that is produced by the red color of the blood shining through the clear layers of the skin. There is also a whiteness of the skin produced by the refraction of light rays.
Sometimes, the skin color varies for reasons other than genetic.

Not only is the color of the integument determined by genes, the pattern of distribution of the color is determined by other genes.

Section III. INTEGUMENTARY DERIVATIVES

3-11. INTRODUCTION

A number of structures are derived from the layers of the integument proper. These structures are referred to as the integumentary derivatives or "appendages."

3-12. HAIRS

More or less covering the body are derivatives called hairs. The hairs of the body vary in construction from area to area. An individual's genes determine the specific construction, growth, and pattern of hairs for that individual. Sex hormones more or less control the distribution of hairs (sexual dimorphism). Also, in different cultures of human beings, different patterns of hair growth have arisen because of cultural selection.

3-13. NAILS

Another integumentary derivative is the nails. A nail covers the dorsal aspect of the end of each digit (fingers and toes).

3-14. GLANDS

The various glands are another kind of integumentary derivative.

a. Sweat Glands. There are at least two types of sweat (sudoriferous) glands:

   (1) The general type throughout the body. This type produces a sensible and insensible perspiration. (See paragraph 2-7c(1).)

   (2) A second type found in special areas. This type is found especially in the palms of the hands. Such sweat glands respond to emotional stresses to produce the "clammy" hands of the frightened individual.

b. Sebaceous Glands. Oil-producing (sebaceous) glands are usually found in relationship to the hair follicles. The oily product of these glands keeps the following structures flexible:

   (1) The outer layers of the skin.
(2) The shafts of the hairs.

c. **True Scent Glands.** A third type of gland associated with the integument is the true scent gland. At least in older days, the product of these glands was supposed to be attractive to the opposite sex. (Here, we are not referring to the body odor known as BO. BO is a metabolic by-product produced by microorganisms located on the skin. These microorganisms act upon residue from perspiration, left after the water has evaporated.)

Section IV. **FUNCTIONS OF THE INTEGUMENTARY SYSTEM**

3-15. **INTRODUCTION**

The integumentary system forms the outermost covering of the human body. Thus, it is the boundary between the organism and the ambient (surrounding) environment. Because of this relationship, the integumentary system has a number of functions related to the environment and the individual’s reactions to the environment.

3-16. **REDUCTION OF FRICTION AND ITS EFFECTS**

Over time, the body is likely to rub against many varied objects. The resulting frictional forces would be expected to damage the body surface. For comparison, consider the outer surfaces of older automobiles and other man-made objects.

a. **Hairs.** Hairs minimize friction by allowing surfaces to slip or slide over each other.

b. **Outer Dead Cells.** Where there is no hair (glabrous condition), the outer dead squamous cells rub off to reduce frictional forces. Within a couple of weeks after they arrive at the surface, the outer dead cells are removed during the activities of daily life.

c. **Thickening of the Integument.** The dermis and epidermis tend to become thicker whenever they are subjected to forces of pressures greater than average. Callouses are an extreme example of this.

3-17. **WATERPROOFING**

The outer layers of dead horny cells are kept flexible by oil from the sebaceous glands. Thus, these layers form an essentially waterproof covering for the body. This is very important in preventing general dehydration of the body. Dehydration (water loss) is a very important problem in burn patients who have lost a full thickness of the integument.
3-18. PROTECTION FROM SOLAR RADIATION

The integument also protects the body from excessive penetration of solar radiation. Solar radiation is blocked by pigments (para 3-10) and by the layers of dead horny cells.

3-19. GENERAL SENSIBILITY

Not the least of the functions of the integument is its general sensibility. As the interface between the organism and the immediate environment, the integument is subjected to many stimuli. A number of general sensory receptor organs are located in the integument and the underlying subcutaneous layer. These receptor organs continuously inform the brain of the conditions immediately surrounding the body. These conditions include pain, temperature, light and heavy pressures, touch, and so forth.

Section V. SUBCUTANEOUS LAYER

3-20. INTRODUCTION

Between the integument proper and the investing deep fascia is the middle layer called the subcutaneous layer.

SUB = under

CUTANEOUS = skin

In general, the subcutaneous layer is made up primarily of loose areolar FCT and fat. The fat tends to be localized in special areas that are different in the two sexes. (In affluent societies, there may be general obesity rather than localized fat.)

3-21. CUTANEOUS NAVL

Also found in the subcutaneous layer are the cutaneous NAVL (nerves, arteries, veins, lymphatics). In addition, some of the sensory receptors of the nervous system actually extend from the subcutaneous layer up into the papillae of the dermis, immediately below the epidermis.

a. Cutaneous Capillaries. The cutaneous capillaries of the subcutaneous layer tend to be localized at two levels. First, there is a superficial layer near the underside of the dermis. Second, there is a deeper layer near the investing deep fascia. These two layers of capillaries are more or less separated by the fatty tissue in the subcutaneous layer.
b. **Sensory Innervations.** If one looks at a zebra or a tiger, one can immediately see that the fur of these animals has a belt-like color pattern. There is also a belt-like pattern in the integument of humans. It is not a pattern of colors, as with zebras and tigers. It is a pattern of sensory innervations. A "belt" is innervated by a specific spinal nerve, left and right. This belt-like area is called a dermatome. We refer to the nerves supplying these areas as **segmental nerves** because they "segment" the integument into dermatomes. Except for the three dermatomes of the face, there is an overlap of adjacent dermatomes.

### 3-22. INTEGUMENTARY MUSCLES

Also associated with the subcutaneous layer are a number of integumentary muscles.

a. **Facial Muscles.** As the term implies, facial muscles are associated with the face. Facial muscles are mainly involved with the various openings of the face. They are able to open and close these openings. Because they are also used in visual communication, they are sometimes called **mimetic muscles** ("muscles of expression").

b. **Arrector Pili Muscles.** Another group of integumentary muscles is known as the arrector pili muscles. Ordinarily, the hairs and the hair follicles are at an angle to the skin rather than perpendicular (straight up or down). At times of emotional stress, the arrector pili muscles contract. In hairy areas, the contraction of these muscles, attached to the follicles, causes the hairs to stand "straight up." In glabrous areas, their contraction produces "goose bumps."

### Section VI. INVESTING DEEP FASCIA

### 3-23. INTRODUCTION

The innermost of these three concentric layers is the investing deep fascia. The investing deep fascia is essentially a membrane of dense FCT completely surrounding the body. It overlies all of the remaining structures of the body.

### 3-24. VARIATIONS IN THICKNESS

a. The investing deep fascia varies in thickness in various parts of the body. This membrane is generally thicker the further inferior we go. In many areas, it is thick enough to be specifically named. For example, the investing deep fascia of the lower member is called the fascia lata.

b. The majority of the tissues of the body are made up primarily of water. Moreover, the interstitial spaces are filled with water. Therefore, the body within the investing deep fascia can be thought of as a hydrostatic column. As such, hydrostatic
pressures become greater as one goes inferiorly in the body. Accordingly, the fascia becomes thicker to withstand the increasing pressures.

3-25. INTERMUSCULAR SEPTA

a. In the limbs of the upper and lower members, dense FCT membranes extend from the underside of the investing deep fascia to the bones. The membranes are known as the intermuscular septa. They divide the space within the investing deep fascia into discrete muscular compartments.

b. Each muscular compartment is a hydrostatic chamber. In a normal healthy human being, each compartment is full. Therefore, as arterial blood flows into a compartment, hydrostatic pressures are created which assist the flow of blood in the venous vessels back to the heart.

Section VII. BODY TEMPERATURE CONTROL

3-26. INTRODUCTION

In order to function properly, the human body must be maintained within a relatively narrow range of temperature.

3-27. SOURCES OF BODY HEAT

Body heat is derived from several sources.

a. Muscle Contractions. Muscle contractions produce a significant amount of heat. If muscles were very efficient, they would produce energy in the form of contractions and very little heat. Since muscles are inefficient, they produce much heat as they contract. For example, during strenuous physical exercise, the body temperature tends to rise by several degrees.

b. Metabolic Activity. Another source of heat in the body is certain organs such as the brain, liver, and so forth. These organs produce heat during their metabolic activity.

c. Solar Radiation. Another source of body heat is solar radiation. When received in excess, solar radiation can cause sunstroke.

3-28. TYPES OF BODY TEMPERATURE

a. Core Temperature. The core temperature is the temperature within the body proper. Normally, the core temperature is maintained within narrow limits. The core
temperature of the blood is continuously monitored by special temperature detectors. These detectors are located in the hypothalamus of the brain.

b. **Peripheral Body Temperature.** The temperature of the body surface and the upper and lower members is called the peripheral body temperature. Peripheral body temperature can vary widely. Temperature receptors in the body periphery monitor the peripheral body temperature.

### 3-29. COUNTERCURRENT MECHANISM

In the limbs of the upper and lower members, the venous blood often has a low temperature. The return of this non-warmed blood to the core of the body might be dangerous. However, within the upper and lower members, the deep veins are generally located adjacent to the major arteries. As the venous blood flows toward the center of the body, it is gradually warmed by the arterial blood coming from the body. This condition is called the **countercurrent mechanism**.

### 3-30. REMOVAL OF HEAT

By selecting shady or cool surroundings, an individual can avoid becoming overheated. In other cases, however, the body heat may become excessive. In such cases, if the body is to remain healthy, the surplus body heat must be removed.

a. **Sweating.** Sweat (perspiration) is made up primarily of water, with various substances dissolved in it. As one of its physical characteristics, water has a relatively high heat-carrying capacity. In addition, it evaporates from the surface of the body. Another physical characteristic of water is that it removes large numbers of calories during evaporation.

b. **Radiation.** In addition, heat can be radiated directly from the surfaces of the body. This is particularly true of the surfaces of the axillae (armpit areas), the inside of the elbow areas, and the groin. These are areas where the skin tends to be thinner than average.

### 3-31. CONSERVATION OF HEAT

When the ambient (surrounding) temperature is cool or cold, the body must conserve heat rather than remove it.

a. **Less Sweating.** An immediate means of conserving heat is to stop sweating. This prevents heat loss by evaporation.

b. **Less Radiation.**

(1) In cool surroundings, the superficial capillaries are shut down. Thus, circulation is limited to the deep cutaneous capillaries. Because of the insulating fatty
tissues of the subcutaneous layer, these deep cutaneous capillaries radiate much less heat to the surface.

(2) If the exposed surface area is reduced, there will be less loss of body heat. This can even serve as a lifesaving measure. For example, if an individual has been in cold water (as in a shipwreck or other accident), his body can be folded to reduce exposure.

c. **Shivering.** During shivering, muscles contract without synchronization. Although this produces minimal motion, it produces considerable heat.

d. **Proper Clothing.** Obviously, proper clothing is a measure for conserving body heat.

e. **External Heat Sources.** External heat sources are commonly used by humans to conserve body heat.

**Section VIII. VITAMIN D PRODUCTION**

3-32. **INTRODUCTION**

Vitamin D is a fat-soluble vitamin. It is required by the body in relation to calcium metabolism.

3-33. **MECHANISM OF PRODUCTION**

The human body produces vitamin D in the integument. An organic compound known as ergosterol is converted into vitamin D by ultraviolet solar radiation.

3-34. **CONTROL OF PRODUCTION**

Excessive production of vitamin D can become lethal to a human being. The main purpose of skin pigmentation seems to be the limitation of vitamin D production. In their "original" distribution, the peoples of the equatorial (sunny) areas tended to be dark skinned. The peoples of subarctic (unsunny) areas tended to be light skinned.
Section IX. SUPERFICIAL WOUND HEALING

3-35. INTRODUCTION

A wound of the integument creates an opening. This opening is an avenue for infection and water loss.

3-36. RELATIONSHIP WITH SPLIT LINES

A wound crossing the split lines of the dermis tends to gape open. A wound parallel to the split lines closes easily. For this reason, when a surgeon can choose an incision, he tends to follow the split lines.

3-37. HEALING

A wound is healed by the reuniting of the margins. This is accomplished by the growth and multiplication of the cells at the margins of the wound.

3-38. SCARRING

Scars result from the healing process. In some human groups (for example, Orientals), scars can become quite large and are called keloids. For all groups, the scar (cicatrix) is much less prominent for wounds that parallel the split lines.

Section X. GENERAL ADAPTATIONS FOR GRASPING/HOLDING

3-39. INTRODUCTION

The hands grasp or hold onto things. The soles of the feet provide a nonslipping contact with the ground. For these reasons, frictional forces are maximized in the palms of the hands and the soles of the feet. This is accomplished by several adaptations of the coverings of the body in these areas.

3-40. ADAPTATIONS

These adaptations are described below:

a. The epidermis and dermis are quite thickened in these areas.

b. These two areas are hairless (glabrous).

c. The dermal papillae holding the dermis and epidermis together are increased in number and size.
d. The surface of the skin has many ridges and grooves. These, in effect, form miniature suction cups.

e. Deep in the palm and sole, there is a very dense FCT, referred to as the palmar aponeurosis and plantar aponeurosis. A thickened subcutaneous layer firmly attaches the modified integument to the underlying aponeurosis.

Section XI. VARIATIONS IN PENETRATION

3-41. VARIATIONS IN INFANTS AND THE ELDERLY

In infants and the elderly, substances more readily penetrate the skin than with other age groups. One such substance is hexachlorophene. Hexachlorophene is an ingredient in some soaps and detergents used to maintain a germ-free environment in the hospital. If the skin of the infant or elderly person is not thoroughly rinsed after the use of such soaps or detergents, the skin of these individuals will readily absorb the residual hexachlorophene. This may produce neurological damage.

3-42. VARIATIONS ACCORDING TO BODY AREA

This condition may also exist in other age groups in those areas where the skin is thinnest. These areas include the inner surfaces of the flexing joints, axillae, and groin and particularly the areas between the fingers and toes.

Continue with Exercises
EXERCISES, LESSON 3

REQUIREMENT. The following exercises are to be answered by completing the incomplete statements.

After you have completed all the exercises, turn to "Solutions to Exercises," at the end of the lesson and check your answers.

1. The envelopes of the body are like an air conditioner; they help to remove _____. The envelopes are like a blanket; they help to retain ____ when the surrounding air is ____ d. The skin is like a chemical factory; it manufactures v ____ in the presence of sunlight. The skin is like an umbrella; it helps to protect us from the s__ and the r____.

2. The mitotic activity of the epidermis occurs in the ____ l layer. At any given time, about ____ percent of the cells in this layer are involved in m____ s. As cells migrate to the surface, they change shape from ____ r to ____ l and finally to ____ s. As the cells become squamous, they also become h____ d, or c____ d.

3. The color of the skin is due to special chemicals called ____ s. Special cells located in the dermis provide the p____ s of pigments to the basal cells. As basal cells migrate to the surface, the precursors are gradually converted to the actual p____ s. The type of color for each individual is controlled by____ s.

4. The integumentary system is the boundary between the organism and the surrounding e____ t. For this reason, the integumentary system has a number of functions related to the ____ t.

Friction against the integument is reduced by ____ s and outer dead ____ s. When subjected to friction, the integument tends to become _____ er.

The outer layers of cells are kept flexible by ____ l from the sebaceous glands. This forms an essentially w____ f covering for the body. This is important in preventing general d____ n of the body.

Because of pigments and outer layers of dead cells, the integument helps to protect the body from excessive ____ r radiation.

Receptor organs in the integument and the subcutaneous layer continuously inform the ____ n of conditions immediately surrounding the body.
5. Sources of body heat include m_______ contractions, m_______ c activity, and _______ r radiation.

   The core temperature is the temperature within the b____ p____ r. The core temperature is continuously monitored by detectors in the h_______ s of the brain. The temperature of the body surface and the upper and lower members is called the p_______ l body temperature.

   Blood within the deep veins of the upper and lower members is warmed by the adjacent major ______ s. This situation is called the c____________ t mechanism.

   Heat is removed from the body by s_______ g and ra_______ n.

   Means of conserving heat are decreased s_______ g, shutting down of the superficial ________ s, reduction of the exposed s_______ a____, and external h____ t s_______ s.

6. The main purpose of skin pigmentation seems to be the limitation of the production of ________ ___.

7. The opening of a wound is an avenue for i_______ n and w____ loss. In healing, the cells at the margins of the wound ____ w and ________ y to reunite the margins.

   Check Your Answers on Next Page
SOLUTIONS TO EXERCISES, LESSON 3

1. The envelopes of the body are like an air conditioner; they help to remove heat. The envelopes are like a blanket; they help to retain heat when the surrounding air is cold. The skin is like a chemical factory; it manufactures vitamin D in the presence of sunlight. The skin is like an umbrella; it helps to protect us from the sun and the rain. (para 3-1)

2. The mitotic activity of the epidermis occurs in the basal layer. At any given time, about 4 percent of the cells in this layer are involved in mitosis. As cells migrate to the surface, they change shape from columnar to cuboidal and finally to squamous. As the cells become squamous, they also become hardened, or cornified. (para 3-5)

3. The color of the skin is because of special chemicals called pigments. Special cells located in the dermis provide the precursors of pigments to the basal cells. As basal cells migrate to the surface, the precursors are gradually converted to the actual pigments. The type of color for each individual is controlled by genes. (para 3-10)

4. The integumentary system is the boundary between the organism and the surrounding environment. For this reason, the integumentary system has a number of functions related to the environment.

   Friction against the integument is reduced by hairs and outer dead cells. When subjected to friction, the integument tends to become thicker.

   The outer layers of cells are kept flexible by oil from the sebaceous glands. This forms an essentially waterproof covering for the body. This is important in preventing general dehydration of the body.

   Because of pigments and outer layers of dead cells, the integument helps to protect the body from excessive solar radiation.

   Receptor organs in the integument and the subcutaneous layer continuously inform the brain of conditions immediately surrounding the body. (paras 3-15 thru 3-19)

5. Sources of body heat include muscular contractions, metabolic activity, and solar radiation.

   The core temperature is the temperature within the body proper. The core temperature is continuously monitored by detectors in the hypothalamus of the brain. The temperature of the body surface and the upper and lower members is called the peripheral body temperature.

   Blood within the deep veins of the upper and lower members is warmed by the adjacent major arteries. This situation is called the countercurrent mechanism.
Heat is removed from the body by sweating and radiation.

Means of conserving heat are decreased sweating, shutting down of the superficial capillaries, reduction of the exposed surface area, and external heat sources. (paras 3-27 thru 3-31)

6. The main purpose of skin pigmentation seems to be the limitation of the production of vitamin D. (para 3-34)

7. The opening of a wound is an avenue for infection and water loss. In healing, the cells at the margins of the wound grow and multiply to reunite the margins. (paras 3-35, 3-37)

End of Lesson 3