

Skin Anatomy, Physiology, and Assessment



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Purpose & Objectives

The focus of this skin anatomy, physiology, and assessment course is to teach healthcare professionals about the structures and functions of the skin and its associated assessment.

Understanding the fundamental structures and functions of the skin, as well as common assessment techniques, will allow the healthcare professional to provide care for all patients and effectively intervene when there is a problem.

After successful completion of this course, the participant will be able to:

1. Identify the functions of various anatomical structures within the skin.
2. Discuss the functions of the skin.
3. Outline a systematic approach to skin history and physical exam in patients.

Introduction

The skin is a complex organ system that has many important functions. The skin functions as a protective barrier against external organisms, maintains temperature control, senses our surroundings, eliminates wastes, and synthesizes Vitamin D.

This course outlines the anatomy and physiology and how to perform an effective assessment of the skin.

Function of Skin

Skin is much more than an outer covering. It functions to maintain the body in homeostasis despite daily external assaults (Stephen, Skillen, Day & Bickley, 2010). Skin also stores fat and water, and plays a role in immunity from disease.

Some of the skin's major protective functions are (Scanlon, 2011):

Thermoregulation

The skin acts to maintain temperature control by secreting sweat from our sudoriferous (sweat) glands. This sweat helps to lower body temperature.

Protection

The skin is the first layer of protection when it comes to invading organisms. It also helps protect against excessive water loss, chemicals and other harmful substances, and ultraviolet radiation.

Sensation

The skin has many nerve endings that send signals to the brain to convey sensations such as touch, pain, pressure, and temperature.

Excretion

The skin helps rid the body of wastes. It does this via perspiration. Perspiration secretes water, salt, and a small amount of organic chemicals.

Synthesis of Vitamin D

Vitamin D is required to allow the body to absorb calcium and phosphorus. When the skin is exposed to ultraviolet light or sunlight, it converts a vitamin D precursor to vitamin D via the liver and kidneys.

Structure of Skin

The skin is the heaviest single organ in the body (Stephen et al., 2010). Skin varies in thickness, color, and texture.

There are two major types:

- Thick and hairless, found on the palms and soles of feet in areas that are heavily used.
- Thin and hairy, found over most of the body.

Layers of Skin

The skin has three layers with different thickness, strength and function:

Epidermis: Thin outer layer

Dermis: Thick inner layer

Hypodermis or subcutis: A fatty layer of subcutaneous tissue (Jarvis, 2011)

Epidermis

The epidermis is the thin, tough outer covering of the skin that is devoid of blood vessels, and relies on the underlying dermis for nutrition and blood supply. It is composed of several layers:

Stratum germinativum: An inner cellular layer that forms new skin cells. This layer is mainly composed of keratin, which gives it strength and toughness. This basal layer also has melanocytes, which give skin its brown pigmentation to protect against ultraviolet radiation. After new cells are formed they migrate upwards to the stratum corneum and flatten at that level.

Stratum corneum is composed mainly of dead, keratinized cells.

The entire epidermal layer is replaced every four weeks. In fact, it is estimated that an individual will shed about one pound of skin every year (Jarvis, 2011).

The epidermis is innervated with sensory nerves. These nerves sense and transmit heat, pain, and other sensations.

Dermis

The dermis, or the inner supportive layer of the skin, is made mostly of collagen, and is well supplied with blood.

The body's nerves, sensory receptors, blood vessels, and lymphatics are located within the dermis. The dermis also houses some epidermal derivatives such as the skin, hair, and nails (Jarvis, 2011).

Hypodermis

The hypodermis, also known as the subcutaneous layer, is mainly fat tissue that cushions the skin from injury.

It aids with temperature control and provides fat for energy utilization when needed (Jarvis, 2011).

Test Yourself

The top or outer layer of the skin is called the:

- A. Hypodermis
- B. Epidermis - Correct
- C. Dermis

Epidermal Derivatives

Epidermal derivatives (appendages) are essential parts of the skin that have adapted to serve a variety of special functions (Scanlon, 2011).

Basket Cells - Surround the base of hair follicles and sense pressure. They are evaluated when assessing overall nerve health and condition.

Blood Vessels - Carry nutrients and oxygen-rich blood to the cells that make up the layers of skin and carry away waste products.

Glands - Three types of glands exist within the skin: the sebaceous glands, or sweat glands, and ceruminous glands. The sebaceous glands secrete an oily substance that protects the skin and prevent excess water loss. The sudiferous or sweat glands secrete a dilute, saline solution that assists in thermal regulation. When the solution evaporates on the skin's surface, it cools the skin. The ceruminous glands secrete wax from the inner ear. This wax creates a sticky barrier to invading organisms.

Hair - Hair is an epidermal derivative that consists of keratinized cells tightly bound together. Hair is not permanent but is continuously being replaced. Hair assists in transmitting sensory information and is associated with gender identity. Culturally it can play an important role in self-esteem and status.

Hair Erector Muscles (Arrector Pili Muscle) - Are tiny muscles connected to each hair follicle and the skin. When they contract they cause the hair to stand erect.

Hair Follicle - Lies under the skin and nourishes the hair. It is a tube-shaped sheath that surrounds the part of the hair and is located in the epidermis and the dermis.

Hair Shaft - Is the part of the hair that is above the skin.

Langerhans Cells - Attach themselves to antigens that invade damaged skin. They alert the immune system to their presence.

Melanocyte - A melanocyte produces melanin, and is located in the basal layer of the epidermis.

Merkel Cells - Merkel cells are located in the basal layer of the epidermis. They are tactile cells of neuroectodermal origin.

Nails - Your nails are hard plates of keratin, once used in defense and to assist in opening potential food items.

Pacinian Corpuscle - A pacinian corpuscle is a nerve receptor that is located in the subcutaneous fatty tissue that responds to vibration and pressure.

Sebaceous Gland - Sebaceous glands are small, sack-shaped glands that release an oily substance onto the hair follicle that protects and coats the hair shaft from becoming brittle. They are located in the dermis.

Sensory Nerves - The epidermis is innervated with sensory nerves. These nerves sense and transmit heat, pain, and other sensations. When the nerves are not functioning properly, sensations such as pain, burning, numbness, tingling, and pins-and-needles may be felt.

Stratum Corneum - The stratum corneum is the outermost layer of the epidermis, and is comprised of dead skin cells. It protects the living cells below it by providing a tough barrier between the environment and the lower layers of the skin.

Sweat Gland (sudoriferous gland) - The sweat glands are located in the epidermis and produce sweat that is secreted through tiny ducts onto the surface of the skin (stratum corneum). When sweat evaporates, skin temperature is lowered.

Skin Assessment History

Communication during the history and physical must be respectful and performed in a culturally-sensitive manner. Privacy is vital, and the healthcare professional needs to be aware of posture, body language, and tone of voice while interviewing the patient (Jarvis, 2011; Caple, 2011). Take into consideration that a patient's ethnicity and culture may affect the history that the patient provides.

The first step in a focused skin assessment is taking a thorough history. Generally, eighty percent of a patient's assessment should focus on the medical history, focusing on what the patient and/or family member disclose about the patient's skin and risk factors for skin breakdown.

Some risk factors for skin breakdown include (Jarvis, 2011):

- Incontinence
- Excessive perspiration or diaphoresis
- Wound drainage
- Immobility
- Inactivity

- Paresthesia
- Paralysis
- Poor nutrition
- Confusion
- Agitation
- Decreased level of consciousness

Skin Assessment History

Focused history questions that will guide an age-specific skin assessment are summarized in the following table.

ADULTS	GERIATRIC	PEDIATRIC
* Past skin diseases	* Dryness and itching	* Use/type of diaper cream/bathing products
* Sun exposure	* Bruising tendency	* Rashes or lesions
* Recent change in wart or mole	* Longer healing time	* Bruising
* Sore that has not healed	* Nail texture changes	* Allergies
* Signs of abuse	* Signs of abuse	* Signs of abuse
		* Injury history
		* Sun exposure

Test Yourself

Taking a history is important to:

- Determine risk factors for skin breakdown - Correct
- Decide if the patient is using incorrect skin care products
- Let the patient know that you're in charge

Physical Examination

The skin is practically the only organ you can see. For that reason, you should closely examine the skin – ALL OF IT. A visual exam will enlighten you to many potential or evident skin problems that the patient may not be aware of.

The following signs may indicate impending pressure ulcer development:

- Persistent erythema
- Non-blanching erythema
- Blisters
- Discoloration

- Localized heat
- Localized edema
- Localized induration

In patients with darkly pigmented skin, observe for:

- Purplish/bluish coloration
- Localized areas of skin
- Localized edema
- Localized induration

Look for localized areas of heat or coolness. Heat may indicate underlying inflammation, but coolness may indicate underlying tissue damage. Any skin changes should be documented and reported immediately (Jarvis, 2011; Shaw, 2012).

Color

When assessing the color of a patient’s skin, careful inspection is necessary. Note any bruising, cyanosis, pallor, or edema. You may note areas that are not uniform in color. When assessing changes in skin color for dark-skinned persons, follow the following guidelines:

Assessment Finding	Technique
Cyanosis	Inspect the conjunctivae, palms, soles, oral mucosa, and tongue.
Pallor	Inspect the sclera, conjunctivae, oral mucosa, tongue, lips, nail beds, palms, and soles.
Petichiae	Inspect areas with lighter natural pigmentation, such as the abdomen.
Rashes	Palpate the area for skin texture changes.
Jaundice	Inspect the sclera and hard palate.
Erythema	Palpate the area for warmth.
Edema	Inspect the area for decreased color. Palpate for swelling or tightness.

Temperature and Moisture

Skin temperature can range from cool to warm. Warm is always normal. Note if the skin’s temperature is cool or warm, or the coolness or warmth is localized (Scanlon, 2012).

Normally, your patient’s skin should be dry with only a slight amount of moisture. Overly moist skin may be due to environmental conditions, anxiety, obesity, hyperthyroidism, fever, or diaphoresis (Shaw, 2012).

Texture, Thickness, Turgor and Mobility

Inspect the skin for a normally smooth, mobile texture. Rough, dry skin may indicate hypothyroidism, psoriasis, or age related changes (Shaw, 2012). You can check skin turgor by grasping the skin on the top of the hand and gently pulling up. After letting go of the skin, the skin should “snap” back into place within three seconds. Skin that remains elevated or “tented” may be due to age related changes, dehydration, or a combination of both.

Test Yourself

Skin that remains elevated or “tented” may be due to:

- A. Age related changes
- B. Dehydration
- C. A combination of both - Correct

Edema

When assessing edema it is useful to use an edema scale to guide your interpretation. This assessment is highly subjective and should be communicated at the patient’s bedside when possible so that each caregiver may interpret the degree of edema the same. In general, however, the following scale is useful in edema assessment.

Edema Scale

- 0 = no edema
- +1 = slight pitting, no visible distortion, disappears rapidly (about 2 mm depression)
- +2 = greater depth (~4 mm), no visible distortion of extremity, disappears in 10-15 seconds
- +3 = visible change in limb contour, definite pit (~6 mm) and persists greater than one minute
- +4 = grossly distorted limb, very deep pit (~8 mm) lasting 2-5 minutes

Moles (Nevi)

Nevi are growths on the skin that occur when melanocytes grow in a cluster with tissue surrounding them.

Moles are usually pink, tan, brown, or flesh-colored, and spread evenly throughout the skin. When skin is exposed to the sun, melanocytes produce additional pigment, causing the skin to tan, or darken.

Moles are very common, and most people have between 10 and 40 moles (National Institute of Health [NIH], 2011). Moles can be flat or raised, and are usually round or oval, and no larger than a pencil eraser.

Many moles begin as a small, flat spot and slowly become larger in diameter and raised.

Over many years, they may flatten again, become flesh-colored, and go away.

Dysplastic Nevi

It is important for the nurse to be able to recognize and distinguish abnormal nevi.

Dysplastic nevi usually have the following characteristics:

Color: Is usually a mixture of tan, brown, and red/pink.

Shape: Have irregular, sometimes notched edges. May fade into the skin around it. The flat portion of the mole may be level with the skin.

Surface: May have a smooth, slightly scaly, or rough, irregular, "pebbly" appearance.

Size: Often larger than 5 millimeters (about 1/4 inch) across and sometimes larger than 10 millimeters (about 1/2 inch).

Number: May be present in large numbers (more than 100 on the same person). However, some people have only a few dysplastic nevi.

Location: May occur anywhere on the body but most frequently on the back and areas exposed to the sun (NIH, 2011).

Lesions

When assessing a skin lesion, use the ABCDE mnemonic, which stands for:

A: Asymmetry: differences in appearance from one area of the lesion to another

B: Borders: irregular or poorly defined border

C: Color: changes or variation of color within the same lesion

D: Diameter: > 6mm or change in size

E: Evolving: mole looks different than surrounding ones, or the lesion is changing in size, color, or shape (Shenenberger, 2012)

Use the above mnemonic to describe the lesion's size, color, type, and location.

Palpate the lesion:

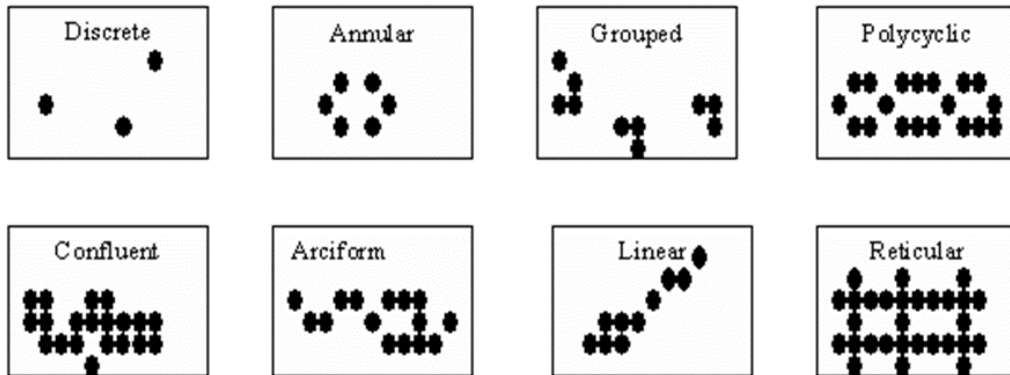
- Non-palpable lesions: Include macules and patches.
- Palpable lesions include: Papule, plaques, nodules, tumors, and wheals.
- Fluid-filled lesions consist of: Vesicles, bullae, pustules, and cysts.
- Skin lesions above the skin's surface include: Scales, crusts, lichenifications, and atrophy.

- Skin lesions below the skin's surface include: Erosions, fissures, ulcers, scars, keloids, and excoriations.

(Jarvis, 2011)

Lesion Configurations

If you do note a lesion, you must describe the configuration. You may use the following diagrams to guide you in identifying the lesion configuration you patient is manifesting.



Lesion Description

Accurate reporting and documentation of lesions is critical for appropriate management and treatment.

Use the following diagrams to guide you in identifying the symmetry, border, color variance and diameter of any lesions noted on the physical exam.

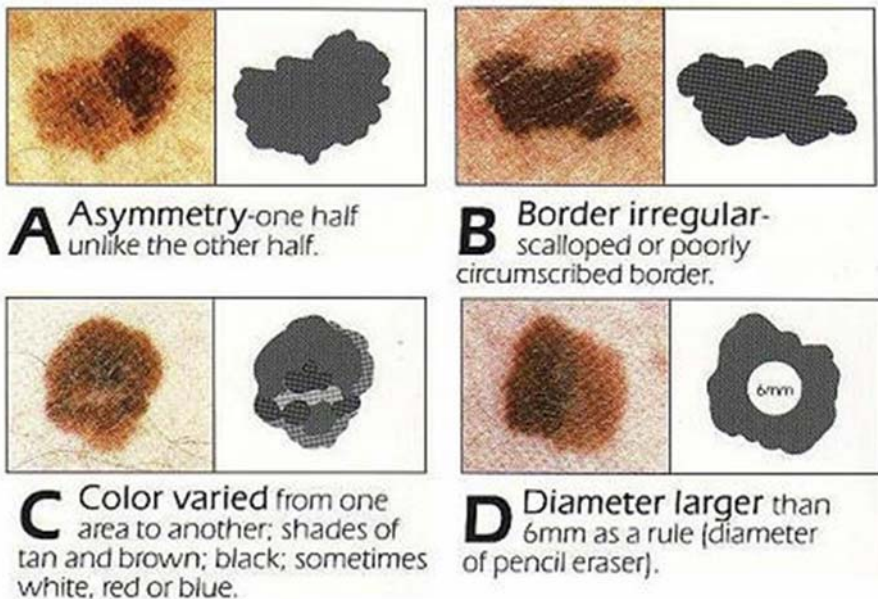


Image courtesy of NASA Wallops Flight Facility (www.wff.nasa.gov)

Test Yourself

The B in the ABCDE mnemonic stands for:

- A. Bluish
- B. Background
- C. Borders - Correct

Wounds

Assess any wounds or reddened areas of the skin. This assessment involves:

- Identification of the etiology of the wound
- Location, size, and depth of the wound
- Type of tissue present
- Quality and quantity of exudates
- Presence of infection
- Condition of the wound margins

In addition, it is important to obtain a thorough evaluation of any past and current treatments that may impact the presentation.

Determining the etiology of the patient's wound is important so that systemic conditions can be enhanced to assist in healing (Shaw, 2012).

Wound Etiology

Acute wounds are usually obvious in their etiology (e.g. surgery, trauma), but the causative factors in chronic wounds can be less apparent. Often, location is an indication of its cause.

- Pressure-induced wounds: Usually located over bony prominences.
- Diabetic ulcers: Most commonly found on the feet.
- Arterial ulcers: Usually present over the lateral malleolus.
- Venous ulcers: Commonly present over the medial malleolus or dorsum of the foot.

Arterial Ulcers

Recognizing the differences between arterial and venous ulceration is important to facilitate accurate diagnosis and management.

Signs of arterial ulcers include:

- Location: Usually located on tips of toes, between the toes or on the outside of ankles.
- Absent or mild edema.
- Skin is often taut, hard, and shiny, and feels cool to the touch.
- There may be absence of hair on the skin and pain on movement (claudication).
- Faint to absent pedal pulse.

- Edges are usually well-rounded and smooth, with minimal drainage, and no odor.

Arterial ulcers are usually caused by poor circulation and lack of adequate arterial blood flow (Shaw, 2012).

To Test for Arterial Insufficiency

To assess for arterial insufficiency, have the patient lie supine for a few minutes, and then lift the affected limb above the heart. If arterial insufficiency is the cause of the ulcer, the limb will go white, as blood flow is impeded when flow is against gravity.

Important Note!

Never elevate a limb or use compression stockings when arterial insufficiency is suspected.

Venous Ulcers

Signs of venous insufficiency include:

- Edges of venous ulcers are irregular.
- Ulcers are moist most of the time, and dampness increases when limbs are maintained in a dependant position.
- Edema is usually marked, due to poor peripheral vascular drainage.
- Absence of pain on walking, but the patient reports pain on standing. Once movement begins, the pain subsides.

Venous Ulcers

Causes of venous ulcers

High blood pressure in the deep and superficial veins of the lower extremities cause increase vascular resistance, which the heart has to pump against. Prolonged stress of high pressure in the peripheral veins cause the veins to compress, resulting in insufficient blood flow to smaller capillaries, which results in necrosis (Shaw, 2012).

Did You Know?

Hyperpigmentation, edema and cyanosis occur with venous stasis ulcers, and are more prevalent when limbs are in a dependant position (Stephen et al., 2010).

Management includes the use of compression stockings and elevation of the limb to decrease edema and improve venous return.

Staging of Pressure Ulcers

Stages of pressure ulcers are summarized in the following table.

Stage Ulcer	Description
Stage 1	Skin is reddened, but intact
Stage 2	Epidermal and dermal layers are injured
Stage 3	Subcutaneous tissues are injured
Stage 4	Muscle and perhaps bone are injured

(National Pressure Ulcer Advisory Panel [NPUAP], European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance, 2014)

Examples of illustrations of pressure ulcers can be viewed at:

<http://www.npuap.org/resources/educational-and-clinical-resources/pressure-ulcer-categorystaging-illustrations/>

Location, Size and Depth Assessment

Assessing the size and depth of the wound will allow you to predict the course of the healing process.

Wounds that heal by secondary intention, such as chronic wounds, should be measured to provide some objectivity to the assessment. The perimeter can be measured with a ruler from head to toe (North to South) and side to side (East to West) measurements.

Using the face of a clock as a reference point will also allow communication of unusual wound shapes. For example the wound measures 3 inches North to South, 2 inches East to West and extended 5 inches from 11:00 to 5:00.

Depth can be measured by carefully probing the deepest part of the wound with a sterile swab or q-tip and then measuring the mark against a ruler (Jarvis, 2011).

Tissue Type and Thickness

The wound bed tissue reveals the phase and progress of wound healing.

There are four main tissue colors that can be seen in wounds: pink, red, black, and yellow / beige:

- Epithelial tissue is "pearly pink" in color.
- Granulation tissue is beefy red.
- Necrotic tissue is usually black and known as eschar.

- Yellow necrotic tissue is known as slough. A small amount of clear yellow or straw-colored drainage is normal exudate and facilitates healing.

Progress of healing can be identified by assessing the stage of wound healing:

- Partial-thickness wounds: Heal by epithelialization.
- Full-thickness wounds: Heal by contraction, filling with granulation tissue, and epithelial migration from the wound edges (Mercandetti, 2013).

Test Yourself

Eschar is also known as:

- A. Granulation tissue
- B. Necrotic tissue - Correct
- C. Epithelialization

Quality and Quantity of Exudate

Exudate should be described and documented according to the color and consistency of the fluid. Some common findings include:

Serous (clear) or straw-colored exudate: Is normal but may possibly indicate infection if not clear and watery.

Fibrinous exudate: Cloudy and thin, and contains fibrin protein strands. Is normal.

Serosanguinous exudate: Clear, pink, and watery. Is normal.

Sanguinous exudate: Red, thin and watery. Indicates trauma to blood vessels.

Seropurulent exudate: Murky or yellow and thick and creamy in texture. Indicates active infection.

Purulent exudate: Yellow / Grey / Green and thick in consistency. Indicates infection.

Hemopurulent exudate: Dark, blood-stained, viscous, and sticky. The exudates contains neutrophils, dead/dying bacteria, and inflammatory cells. This means an established infection is present. Consequent damage to dermal capillaries leads to blood leakage.

Hemorrhagic exudate: Red, thick, and usually infected. Caused by trauma. Capillaries are so friable they break down easily and spontaneous bleeding occurs. Hemorrhagic exudates is not to be confused with bloody exudate produced by over-enthusiastic debridement.

(Jarvis, 2011)

Wound Margins

Pay close attention to wound margins, looking specifically for undermining or dead spaces. These are areas where the wound edges have come away from the wound base.

These areas may show signs of poor circulation such as grey or purple coloration.

Dead spaces should carefully be investigated to determine the extent of the undermining.

When treating, dead spaces should be packed lightly with a non-adherent dressing or hydrogel, so the wound may begin to granulate and fill in (Shaw, 2012).

Classification of Burns

Burns are classified according to degree. The following interaction summarizes the types of burns you may see in your patients, depending on your specialty (Jarvis, 2011).

First Degree Burn (Superficial)

Affects epidermis only. Epidermis is injured or destroyed. Skin will be red, swollen, painful and sensitive to touch. Usually heals in 1-2 days. Mild sunburn is a common 1st degree burn.

Second Degree Burn (Partial Thickness)

Involves the dermis and part of the dermal layer of skin. Skin will be painful, swollen, red, and blistered or oozing fluid.

Third Degree Burn (Full Thickness)

Destroys the epidermis and dermis, and may also damage the underlying bones, muscles, and tendons. The skin will be black, white, and charred. There is less pain because the nerves have been destroyed.

Hair

When inspecting the hair, you should note the hair over the entire body, not just the head:

- Sparse hair may indicate hypothyroidism.
- Thin, silky hair often indicates hyperthyroidism.

Note any patchy hair loss and any accompanying redness or scaling (potential ring worm infestation).

Sometimes patients may exhibit increased hair growth, such as in Cushing's syndrome (Shaw, 2012).

Nails

The appearance of the patient's nails may provide information about systemic illnesses and yield information about their self care abilities or behaviors:

- Clubbed nails may indicate chronic hypoxia. Bases are flat or rounded, not concave.
- Cyanosis: May be present in the nail bed, indicating poor perfusion and possible underlying vascular insufficiency. Nicotine staining can be seen in the nails.

Observe for infections of the nails or nail bed (Shaw, 2012).

Aging and the Skin

Skin changes are among one of the most visible signs of aging. With aging, the epidermis becomes thinner, and melanocytes decrease in number. The subcutaneous fat layer also thins, which increases the risk of skin injury and reduces the skin's ability to maintain body temperature. These are reasons why older persons' skin is more translucent.

Large pigmented spots may also appear, such as age spots or liver spots. The dermal layer changes as well, and loses its strength and elasticity. Blood vessels become more fragile and bruising and bleeding under the skin is more common.

Sebaceous glands produce less oil, leading to dry, flaky skin. Skin growths such as skin tags and warts may also become more common (Jarvis, 2011).

Test Yourself

With the aging process, the epidermis and subcutaneous fat layer thins.

- A. True - Correct
- B. False

Applications to Health

When there is a disruption in the skin's normal anatomy or physiologic processes, disease states result. Some of these disease states include: acne, psoriasis, systemic lupus erythematosus, skin cancer, burns, sun burns, and decubitus ulcers.

Conclusion

A thorough knowledge of skin anatomy and physiology is essential in effectively caring for your patients, especially those with skin-related disorders.

If you have a good understanding of how these processes work you can successfully care for your patients from the most minor skin problems to those experiencing true emergencies.

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